Technology and Industrial Arts

Construction Technology

Junior High

Grade 10

Teacher Guide

Standards-Based

Department of Education

'FREE ISSUE
NOT FOR SALE'

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Construction Technology

Junior High

Grade 10

Teacher Guide

Standards-Based

Papua New Guinea
Department of Education

Issued free to schools by the Department of Education

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Acronyms

AAL	Assessment as Learning
ARS	Audience Response System.
AFL	Assessment for Learning
AOL	Assessment of Learning
BoS	Board of Studies
CDD	Curriculum Development Division
CP	Curriculum Panel
DA	Diagnostic Assessment
IHD	Integral Human Development
GoPNG	Government of Papua New Guinea
KSVA	Knowledge Skills Values and Attitudes
MTDG	Medium Term Development Goals
NDoE	National Department of Education
OBC	Outcomes-Based Curriculum
OBE	Outcomes-Based Education
PNG	Papua New Guinea
SAC	Subject Advisory Committee
SBC	Standards-Based Assessment
SBC	Standards-Based Curriculum
SBE	Standards-Based Education
SCG	Subject Curriculum Group
STEAM	Science, Technology, Engineering, Arts and Mathematics
SRS	Student Response System
UOW	Unit of Work
TIA	Technology and Industrial Arts

Secretary's Message

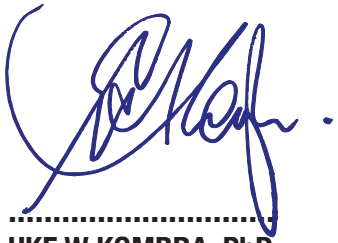
The ultimate aim of Standards-Based Education in Papua New Guinea (PNG) is to prepare students for careers, higher education, and citizenship. This means that education should focus on developing and equipping students with essential knowledge, skills, values, and attitudes that they can use in all aspects of their lives. Education must also aim to motivate and prepare students to pursue Science, Technology, Engineering, Arts, and Mathematics (STEAM) courses in higher education institutions and pursue careers in STEAM related fields.

The Technology and Industrial Arts subject has 5 strands with their own teacher guides developed and this Construction Technology teacher guide is one of them. Construction Technology is a significant curriculum to develop in students' proficiency and competency in the engineering applications, methodology and processes of structures that encompass building, electrical, plumbing and welding. Thus enabling students' knowledge and skills in building through opportunities to design and build various construction projects. However, it is equally important for students to understand technology, its impacts and implications and make decisive and collaborative decisions that will enable themselves to utilise technology more to their advantage.

Technology and Industrial Arts as a subject of which Construction Technology is a strand, is envisioned to benefit students in enabling them to utilise technology knowledge, skills, values and attitudes, and systems and processes to solve problems using the design process in a methodical and precise manner to innovate and invent design solutions. The integration of STEAM in the teaching and learning of Construction Technology will instill in students the abilities and capabilities to be highly proficient and competent end users and possibly creators of technology as STEAM is an integral component of the core curriculum.

Teachers are encouraged to read this teacher guide carefully to become familiar with the content so that they can be confident to use the new concepts and strategies as well as teach the content well. They can also adjust to suit the needs of the students.

I commend and approve this Grade 10 Technology and Industrial Arts: Construction Technology Teacher Guide to be used in all high schools throughout Papua New Guinea.



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UKE W KOMBRA, PhD
Secretary for Education

Introduction

The strand Construction Technology in the Technology and Industrial Arts (TIA) subject aims to help students become competent and confident in construction technology, who can make efficient, effective and creative use of building, electrical, plumbing, welding skills in their everyday activities. It further encourages them to individually and collaboratively apply processes, systems, techniques and materials to create, monitor, analyse, predict and shape the interactions within and between construction structures and the impact of on individuals, societies, economies and environments. It embraces the development in technology and emerging technologies using software and applications, safely, ethically and with greater responsibility.

The study of Construction Technology will enhance the students' knowledge to create and read technical drawings; become familiar with construction materials, components, processes and perform a variety of building operations using engineering skills and procedures of design. Thus understanding the importance of occupational health and safety, building codes and standards and regulations and further identify the impacts of construction technology in society. It also aims to provide lifelong skills and opportunities for students to live a productive life as well as a career or pursuing further learning. In the 21st Century, it is important to recognise that technology has become part of the educational process for all age levels and should be viewed and taught as a tool for problem solving and decision- making. Students should be encouraged to analyse, synthesise and evaluate situations at home, and school, thereby, apply technology to complete tasks efficiently and effectively and be prepared for the future in the face of a changing construction landscape.

Students' employability will be enhanced through the study and application of STEAM principles. STEAM is an integral component of the core curriculum. It is envisioned that the study of STEAM will motivate students to take up academic programs and careers in STEAM related fields. STEAM has been embedded in the Technology and Industrial Arts: Construction Technology curriculum.

Teachers of Construction Technology strands will plan and program the strand for 13 weeks on a rotational basis with the other 4 strands as they are taught concurrently, hence the total coverage of learning Technology and Industrial Arts as a subject. The learning integration is more relevant including the STEAM approach to teach the essential knowledge, skills, values and attitudes, and processes.

Technology and Industrial Arts: Construction Technology is to be timetabled for 200 minutes (5 periods) per week in junior high school.

Structure of the Teacher Guide

The Construction Technology Strand Teacher Guide comprises four main sections that provide essential information that all teachers should know and do to effectively implement the Construction Technology curriculum.

1. General Information of the Subject/Strand

The general information section of the Teacher Guide informs teachers on the Construction Technology Strand under the following headings below;

- Introduction of the Strand Teacher Guide
- Structure of the Strand Teacher Guide
- Purpose of the Strand Teacher Guide
- How to use the Strand Teacher Guide

2. Teaching and Learning Section

The teaching and learning section of the Teacher Guide informs and guides teachers to apply the teaching and learning theories, principles, pedagogies and practices in planning, programing, teaching and assessing students. They are outlined in the headings bulleted below;

- Syllabus and Teacher Guide Alignment
- Learning and Performance Standards
- Core Curriculum
- Science Technology Engineering Arts Mathematics (STEAM)
- Curriculum Integration
- Essential Knowledge, Skills, Values and Attitudes
- Teaching and Learning Strategies
- Strands, Units and Topics
- Sample SBC Lesson Plans

3. Assessment Section

The assessment section of the Teacher Guide informs and guides teachers to plan and program assessment activities, formulate assessment rubrics and apply assessment strategies to assess studies. This section also guides teachers to monitor and report students' progress of learning and performances of the attainment of standards.

4. Glossary, References and Appendices Sections

These sections guide teachers to refer to terms and definitions of the strand/subject content, references outlined to guide the development of this teacher guide and essential and supplementary information provided to guide teachers on the content and the delivery of this strand/subject.

Purpose of the Teacher Guide

This teacher guide describes what teachers should know and do to effectively plan, program, teach and Grade 9 Business Studies content to enable all students to attain the required learning and proficiency standards.

Ample information with thorough guidelines is provided for the teacher to use to achieve the essential Knowledge, Skills, Attitudes and Values (KSAV) embedded in the set national content standards and grade level benchmarks.

The overarching purpose of this teacher guide is to assist teachers to;

- understand the significance of aligning all the elements of standards-based curriculum (SBC) as the basis of achieving the expected level of education quality,
- effectively align all the components of SBC when planning, programming, teaching, and assessing students learning and levels of proficiency,
- effectively translate and align the Technology and Industrial Arts Syllabi and Construction Technology Strand teacher guides to plan, program, teach and assess different Construction Technology Strand Teacher Guide units and topics, and the essential knowledge, skills, attitudes and values (KSAVs) described in the grade – level benchmarks,
- understand the Construction Technology Strand national content standards, grade-level benchmarks, and evidence outcomes,
- effectively make sense of the content (KSAVs) described in the Communication Technology Strand national content standards and the essential components of the content described in the grade – level benchmarks,
- effectively guide students to progressively learn and demonstrate proficiency on a range of Construction Technology Strand skills, processes, concepts, ideas, principles, practices, values and attitudes,
- confidently interpret, translate and use Construction Technology Strand content standards and benchmarks to determine the learning objectives and performance standards, plan and program appropriately to enable all students to achieve these standards,
- embed the core curriculum in the Construction Technology Strand lesson planning, programming, instruction, and assessment to permit all students to learn and master the core knowledge, skills, values and attitudes required of all students,
- provide opportunities for all students understand how STEAM has and continues to shape the social, political, economic, cultural, and environment contexts and the consequences, and use STEAM principles, skills, processes, ideas and concepts to inquire into and solve problems

relating to both the natural and physical worlds (human –made) as well as problems created by STEAM,

- integrate cognitive skills (critical, creative, reasoning, decision-making, and problem solving skills), high level thinking skills (analysis, synthesis and evaluation skills), values (personal, social, work, health, peace, relationship, sustain values), and attitudes in lesson planning, programming, instruction and assessment,

- meaningfully connect what students learn in Construction Technology Strand with what is learnt in other subjects to add values and enhance students learning so they can integrate what they learn and develop in-depth vertical and horizontal understanding of subject content,

- formulate effective SBC lesson plans using learning objectives identified for each of the topics,

- employ SBC assessment approaches to develop performance assessments to assess students' proficiency on a content standard or a component of the content standard described in the grade –level benchmark,

- effectively score and evaluate students' performance in relation to a core set of learning standards or criteria, and make sense of the data to ascertain status of progress towards meeting grade-level and nationally expected proficiency standards,

- use evidence from the assessment of students' performance to develop effective evidence – based intervention strategies to help students making inadequate or slow progress towards meeting the grade-level and national expectations to improve their learning performances.

- provide opportunities for all students understand how STEAM has and continues to shape the social, political, economic, cultural, and environment contexts and the consequences, and use STEAM principles, skills, processes, ideas and concepts to inquire into and solve problems relating to both the natural and physical worlds (human –made) as well as problems created by STEAM,

- integrate cognitive skills (critical, creative, reasoning, decision-making, and problem solving skills), high level thinking skills (analysis, synthesis and evaluation skills), values (personal, social, work, health, peace, relationship, sustain values), and attitudes in lesson planning, programming, instruction and assessment,

- meaningfully connect what students learn in Food Technology Strand with what is learnt in other subjects to add values and enhance students learning so they can integrate what they learn and develop in-depth vertical and horizontal understanding of subject content,

- formulate effective SBC lesson plans using learning objectives identified for each of the topics,

- employ SBC assessment approaches to develop performance assessments

to assess students' proficiency on a content standard or a component of the content standard described in the grade –level benchmark,

- effectively score and evaluate students' performance in relation to a core set of learning standards or criteria, and make sense of the data to ascertain status of progress towards meeting grade-level and nationally expected proficiency standards, and

- use evidence from the assessment of students' performance to develop effective evidence – based intervention strategies to help students making inadequate or slow progress towards meeting the grade-level and national expectations to improve their learning performances.

How to use the Teacher Guide

The Grade 10 Construction Technology Strand Teacher Guide is an expansion of the content in the Technology and Industrial Art Syllabus. The Syllabus contains the content standards, benchmarks and evidence outcomes which are expanded into teaching and learning Activities in the Teacher Guide. The Teacher Guide provides essential information about what the teacher needs to know and do to effectively plan, teach and assess students' learning and proficiency on learning and performance standards. It should be read in conjunction with the syllabus in order to understand what is expected of teachers and students to achieve the envisaged quality of education outcomes.

The first thing teachers should do is to read and understand each of the sections of the Teacher Guide to help them understand the key SBC concepts and ideas. A thorough understanding of these components will help teachers meet the teacher expectations for implementing the SBC curriculum, and therefore the effective implementation of Grade 10 Construction Technology Strand in TIA Curriculum. Based on this understanding, teachers should be able to effectively use the teacher guide to do the following:

The scope of learning is translated and programmed according to the four terms. The suggested teaching and learning strategies and the key important instructions provided for teachers can be used to design and manage teaching and learning activities for the students in the classroom.

The assessment methods, assessment samples, reporting and recording strategies contained in this guide will assist teachers to plan assessment in Strands for the school year.

The strand teacher guide can be used for developing both classroom learning and professional development activities. The document is a useful resource for developing school and community based in-service programs.

Teachers must thoroughly read the contents of the documents in order to develop an understanding and do the following;

Determine Learning Objectives and Lesson Topics

- The teaching and learning Standards are derived from the Content Standards and Benchmarks in the Syllabus. The Learning Objectives are extracted from the grade-level benchmarks and are used for teaching topics. And lesson objectives are derived from learning objectives and are used for teaching Lessons.

Identify and Teach Grade Appropriate Content

- Grade appropriate content has been identified and scoped and sequenced using appropriate content organisation principles. The content is sequenced using the spiralling sequence principles. The strand, topics and lesson concepts in the Teacher Guide can be spiralled and taught by Strand, by Topics or by lessons using the Benchmarks.

Using the Benchmarks, Content Mapping in Programing will enable teacher to see the content from what the students have already learned in line with current to be taught and link to the next learning content.

Integrate the Core Curriculum in Lesson Planning, Instruction and Assessment

- This sequencing of content will enable students to progressively learn the essential knowledge, skills, values and attitudes as they progress further into their schooling.

Integrate cognitive, high level and 21st century skills in lesson planning, instruction and assessment

- Lesson titles in the teacher guide were drawn out from the benchmarks. From the lesson titles outlined in the planning and programming section, the values, the attitude, the skills and the knowledge are identified.

Integrate Technology and Industrial Arts: Construction Technology Values, and Attitudes in lesson planning, instruction and assessment

- When planning a lesson, it is important that, the values, attitudes, skills and knowledge of the lesson come out clearly in the teaching and learning activities as displayed in the sample guided lessons.

Integrate Science, Technology, Engineering, Arts and Mathematics (STEAM) principles and skills in lesson planning, instruction and assessment

- STEAM principles and skills must be effectively taught and learned by students. Teachers should use the teacher guide to help them make informed decisions when selecting the types of teaching and learning methodologies to use in their teaching of the subject content, including STEAM principles and skills.

Identify and Use Grade and Content Appropriate, Innovative, Differentiated and Creative Teaching and Learning Methodologies

Lesson titles in the teacher guide were drawn out from the benchmarks. From the lesson titles outlined in the planning and programming section, the values, the attitude, the skills and the knowledge are identified.

Plan and address the principles of Inclusive Teaching and Learning'

Teachers are obliged to create an inclusive learning environment to include students with special needs to promote learning for all. These special needs may include students who are gifted or disadvantaged physically, socially, emotionally and intellectually. Students may display combinations of any of these needs and therefore, the teaching and learning activities must have students with special needs in to participate to their fullest abilities. The different types of needs in students include;

- Physical disabilities
- Intellectual disabilities
- Hearing impairment
- Sight-vision impairment
- Speech impairment
- Behavioural and emotional disorders

It is important that the learning activities for TIA: Construction Technology are inclusive and foster the learning needs of all students.

Syllabus and Teacher Guide Alignment

The Grade 10 Construction Technology Strand Teacher Guide is closely aligned and complementary to the Technology and Industrial Art Syllabus.

They are the essential focus points for teaching and learning the essential knowledge, skills, values and attitudes.

Syllabus and Teacher Guide Alignment	
Syllabus Outlines the ultimate aim and goals, and what to teach and why teach it	**Teacher Guide** Describes how to plan, teach, and assess students' performance
• Overarching and SBC principles • Content overview • Core curriculum • Essential knowledge, skills, values and attitudes • Strands and units • Evidence outcomes • Content standards and grade-level benchmarks • Overview of assessment, evaluation, and reporting	• Determine topics for lesson planning, instruction and assessment • Formulate learning objectives • Plan SBC lesson plans • Select teaching and learning strategies • Implement SBC assessment and evaluation • Implement SBC reporting and monitoring

The syllabus outlines the ultimate aim and goals of SBE and SBC, what is to be taught and why it should be learned by students, the underlying principles and articulates the learning and proficiency standards that all students are expected to attain. On the other hand, the teacher guide expands on what is outlined in the syllabus by describing the approaches or the how of planning, teaching, learning, and assessing the content so that the intended learning outcomes are achieved.

This teacher guide should be used in conjunction with the syllabus. Teachers should use these documents when planning, teaching and assessing Grade 9 Construction Technology Strand content.

Teachers will extract information from the syllabus (e.g., content standards and grade-level benchmarks) for lesson planning, instruction and for measuring students' attainment of a content standard as well as progress to the next grade of schooling.

Learning and Performance Standards Alignment

Content Standards, Benchmarks and Evidence Outcomes are linked to Learning Objectives, Lesson Objectives and Performance Standards in the Teacher Guide. (see table). There is a close linear relationship between these standards. Students' performance on a significant aspect of a benchmark (KSVA) is measured against a set of performance standards or criteria to determine their level of proficiency using performance assessment. Using the evidence from the performance assessment, individual student's proficiency

on the aspect of the benchmark assessed and progression towards meeting the benchmark and hence the content standard are then determined.

Standards Alignment	
Standards in Syllabus	**Standards in Teacher Guide**
• SBC Aims and Goals • Content Standard • Benchmarks • Evidence Outcomes	• Learning Objectives • Lesson Objectives • Essential Knowledge, Skills, Values and Attitude • Performance Standard

Standard Alignment

Standard Alignment shows the link between different standards in the Syllabus and Teacher Guide. It begins with SBC Aims and Goals which are National Standards in which the Syllabus Standard are derived from. The Content Standards or Subject Standards are expanded into Benchmarks which are Achievable Benchmarks for particular Grade Levels and are translated into the Teacher Guide as Teaching and Learning Standards and Assessment Standards. And they become the components of Unit of Work.

The Unit of Work (UOW) consists of the Achievable Standards for a particular Grade Level and is translated into Teaching and Learning Activities and Assessment Tasks.

It is essential that teachers know and can do standards alignment when planning, teaching, and assessing students' performance so that they can effectively guide their students towards meeting the grade-level benchmarks (grade expectations) and subsequently the content standards (national expectations).

Below is a diagram to show the relationship between Standards in the Syllabus and the Teacher Guide.

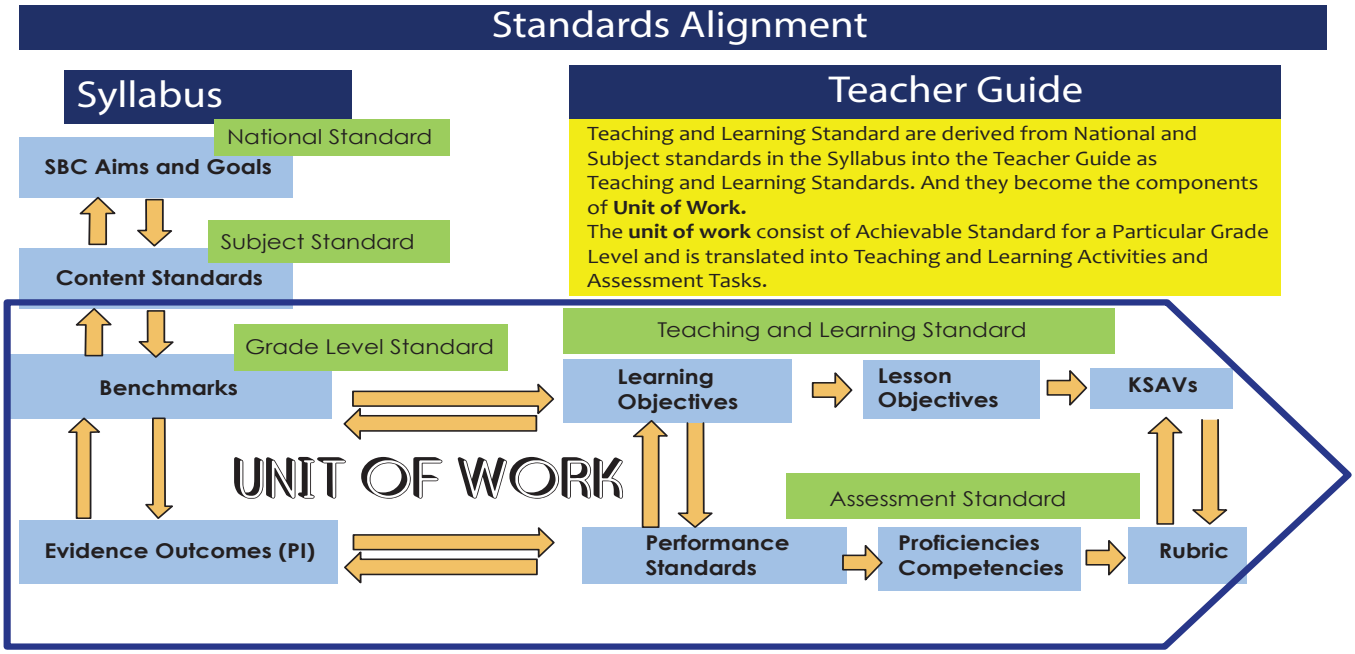


Figure 1 Standards Alignment that shows the alignment of standards in the syllabus and teacher guide

Learning and Performance Standards

Standards define the expected level of education quality that all students should achieve at a particular point in their schooling.

Content standards, benchmarks, and learning objectives are called learning standards while performance and proficiency standards (evidence outcomes) can be categorised as performance standards. These standards are used to measure students' performance, proficiency, progression and achievement of the desired level of education quality. Teachers are expected to understand and use these standards for programming, lesson planning, instruction and assessment.

Student's progression and achievement of education standard(s) are measured using performance standards or criteria to determine their demonstration or performance on significant aspects of the standards and therefore their levels of proficiency and competency. When they are judged to have attained a proficiency on a content standard or benchmark or components of these standards, they are then deemed to have met the standard(s) that is, achieve the intended level of education quality.

Content Standards

Content standards are evidence-based, rigorous and comparable regionally and globally. They have been formulated to target critical social, economic, political, cultural, environment, and employable skills gaps identified from a situational analysis. They were developed using examples and experiences from other countries and best practice, and contextualised to PNG contexts.

Content standards describe what **(content - knowledge, skills, values, and attitudes)** all students are expected to know and do **(how well students must learn and apply what is set out in the content standards)** at each grade-level before proceeding to the next grade. These standards are set at the national level and thus cannot be edited or changed.

Content Standards:

- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the national level;
- state or describe the expected levels of quality or achievement;
- are clear, measurable and attainable;
- are linked to and aligned with the ultimate aim and goals of SBE and SBC and overarching and SBC principles;
- delineate what matters, provide clear expectations of what students should progressively learn and achieve in school, and guide lesson planning, instruction, assessment;
- comprise knowledge, skills, values, and attitudes that are the basis for quality education;
- provide teachers a clear basis for planning, teaching, and assessing lessons;

- provide provinces, districts, and schools with a clear focus on how to develop and organise their instruction and assessment programs as well as the content that they will include in their curriculum.

Benchmarks

Benchmarks are derived from the content standards and benchmarked at the grade-level. Benchmarks are specific statements of what students should know (*i.e.*, essential knowledge, skills, values or attitudes) at a specific grade-level or school level. They provide the basis for measuring students' attainment of a content standard as well as progress to the next grade of schooling.

Grade-level benchmarks:

- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the grade level;
- are linked to the national content standards;
- are clear, measurable, observable and attainable;
- articulate grade level expectations of what students are able to demonstrate to indicate that they are making progress towards attaining the national content standards;
- provide teachers a clear basis for planning, teaching, and assessing lessons;
- state clearly what students should do with what they have learned at the end of each school-level;
- enable students' progress towards the attainment of national content standards to be measured, and
- enable PNG students' performance to be compared with the performance of students in other countries.

Learning Objectives

Learning or instructional Objectives are precise statements of educational intent. They are formulated using a significant aspect or a topic derived from the benchmark, and is aligned with the educational goals, content standards, benchmarks, and performance standards. Learning objectives are stated in outcomes language that describe- the products or behaviours that will be provided by students. They are stated in terms of measurable and observable student behaviour. *For example,* students will be able to identify all the main towns of PNG using a map.

Performance Standards

Performance Standards are concrete statements of how well students must learn what is set out in the content standards, often called the **"be able to do"** of "what students should know and be able to do." Performance standards are the indicators of quality that specify how competent a student's demonstration or performance must be. They are explicit definitions of what students **must do to demonstrate proficiency or competency at a specific level on the**

content standards. Performance standards:

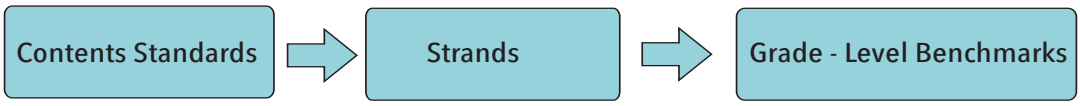
- measure students' performance and proficiency **(using performance indicators)** in the use of a specific knowledge, skill, value, or attitude in real life or related situations.
- provide the basis **(performance indicators)** for evaluating, reporting and monitoring students' level of proficiency in use of a specific knowledge, skills, value, or attitude.
- are used to plan for individual instruction to help students not yet meeting expectations **(desired level of mastery and proficiency)** to make adequate progress towards the full attainment of benchmarks and content standards.
- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards.

Proficiency Standards

Proficiency standards describe what all students in a particular grade or school level **can do** at the end of a strand, or unit. These standards are sometimes called evidence outcomes because they indicate if students can actually apply or use what they have learnt in real life or similar situations. They are also categorised as benchmarks because that is what all students are expected to do before exiting a grade or are deemed ready for the next grade.

As per presented above, should teachers wish to develop additional benchmarks to cater for their students learning needs. You are encouraged to follow the process below to develop them.

Approach for Setting National Content Standards and Grade - Level Benchmarks



Development of Additional Benchmarks

Teachers should develop additional benchmarks to meet the learning needs of their students. They should engage their students to learn about local, provincial, national and global issues that have not been catered for in the grade-level benchmarks but are important and can enhance students' understanding and application of the content. However, it is important to note that these benchmarks will not be nationally examined as they are not comparable. Only the benchmarks developed at the national level will be tested. This does not mean that teachers should not develop additional benchmarks. An innovative, reflective, creative and reflexive teacher will continuously reflect on his/her classroom practice and use evidence to provide challenging, relevant, and enjoyable learning opportunities for his/her students to build on the national expectations for students. Teachers should follow the following process when developing additional grade-level benchmarks.

Core Curriculum

Core curriculum refers to a core set of common learnings (knowledge, skills, values, and attitudes) that are integrated into the content standards and grade-level benchmarks for all subjects. The core curriculum includes:

- Cognitive skills (critical and creative thinking);
- Reasoning, problem-solving and decision-making skills;
- High level thinking skills (analysis, evaluation and synthesis);
- 21st Century skills;
- STEAM principles and skills;
- Seven Principles for Teaching Procedural and Technical Skills (Plan ahead, Demonstration, Observation of learner in action, Provide specific feedback, Encourage self-evaluation, Allow learner practice, Prepare to modify approach)
- Working Diagrams (sketching and technical drawing)
- Reading, writing and communication skills, and
- Essential values and attitudes.

Technology and Industrial Arts: Construction Technology teachers are expected to include the core learning's in their lesson planning, teaching and assessment of students in all their lessons. In addition to these are the essential core curriculums; OHS, designing, technical drawing, CAD Software and computer applications, engineering skills, methodology and construction materials, codes, standards and regulations, design process, design solutions and building structures in Construction Technology. Teachers may include other core curriculum concepts in relation to the subject to cater for students learning needs.

A practical example of integrating core curriculum in Teaching and Learning

Teachers can identify a set of core curriculum to teach in one lesson for example; in Technology and Industrial Arts: Construction Technology, students may be posed with an opportunity to find solutions on how technology can be used to utilise one of the core concepts of technology and industry in their area. The core concepts include; design process, design folio, design solutions, materials, processes, techniques, systems and safety.

Students will be required to use what they learnt in Construction Technology about designing, communication, the design process and how technology is engaging in people's livelihood in terms of designing and making products and marketing as a quicker and cheaper way of advertising and selling their products. They can use STEAM principles and skills in finding cause and solutions, use high level thinking skills to analyse and evaluate the effects and how to improve design products, use decision making and critical thinking skills to find the solutions for making and marketing a product.

They can be able to confidently and boldly communicate their findings and present intelligent and convincing arguments, which we can conclude that learning of the core curriculum is evident.

If students can be able to demonstrate mastery, proficiency and competency of core curriculum in such a manner, then the learning of core curriculum has been achieved.

Science, Technology, Engineering, Arts and Mathematics

STEAM education is an integrated, multidisciplinary approach to learning that uses Science, Technology. Engineering, Arts and Mathematics as the basis for inquiring about how STEAM has and continues to change and impact the social, political, economic, cultural and environments contexts and identifying and solving authentic (real life) natural and physical environment problems by nitrating STEAM- based principles, processes, skills, values and attitudes to prepare them for careers, higher education and citizenship.

TIA: Construction Technology utilises both the goals of STEAM rather than just the goal of problem- solving. This is to ensure that all students are provided opportunities to learn, integrate and demonstrate proficiency on all essential STEAM principles, processes, skills, values and attitudes to prepare them for careers, higher education and citizenship.

Objectives:

Students will be able to:

i. Examine and use evidence to draw conclusions about how STEAM has and continues to change the social, political, economic, cultural and environmental contexts.
ii. Investigate and draw conclusions on the impact of STEAM solutions to problems on the social, political, economic, cultural and environments contexts
iii. Identify and solve problems using STEAM principles, skills, concepts, ideas and process
iv. Identify, analyse and select the best solution to address a problem
v. Build prototypes or model of solutions to problems.
vi. Replicate a problem solution by building models and explaining how the problem was or could be solved.
vii. Test and reflect on the best solution chosen to solve a problem
viii. Collaborate with others on a problem and provide a report on the process of problem solving used to solve the problem.
ix. Use skills and processes learnt from lessons to work on and complete STEAM related projects.
x. Demonstrate STEAM principles, skills, processes, concepts and ideas through simulation and modeling.
xi. Explain the significance of values and attitudes in problem solving.

STEAM Problem -Solving Methods and Approaches

Problem –solving involves the use of problem- solving methods and processes to identify and define a problem, gather information to understand its causes, draw conclusions, and use the evidence to design and implement solutions to address it. Even though, there are many different problem -solving methods

and approaches; they share some of the steps of problem-solving, for example:

- Identifying the problem;
- Understanding the problem by collecting data;
- Analyse and interpret the data;
- Draw conclusions;
- Use data to consider possible solutions;
- Select the best solution;
- Test the effectiveness of the solution by trialing and evaluating it, and
- Review and improve the solution.

STEAM problem-solving processes go from simple and technical to advanced and knowledge- based processes. However, regardless of the type of process used students should be provided opportunities to learn the essential principles and processes of problem solving and more significantly, to design and create a product that addressed a real problem and meets a human need.

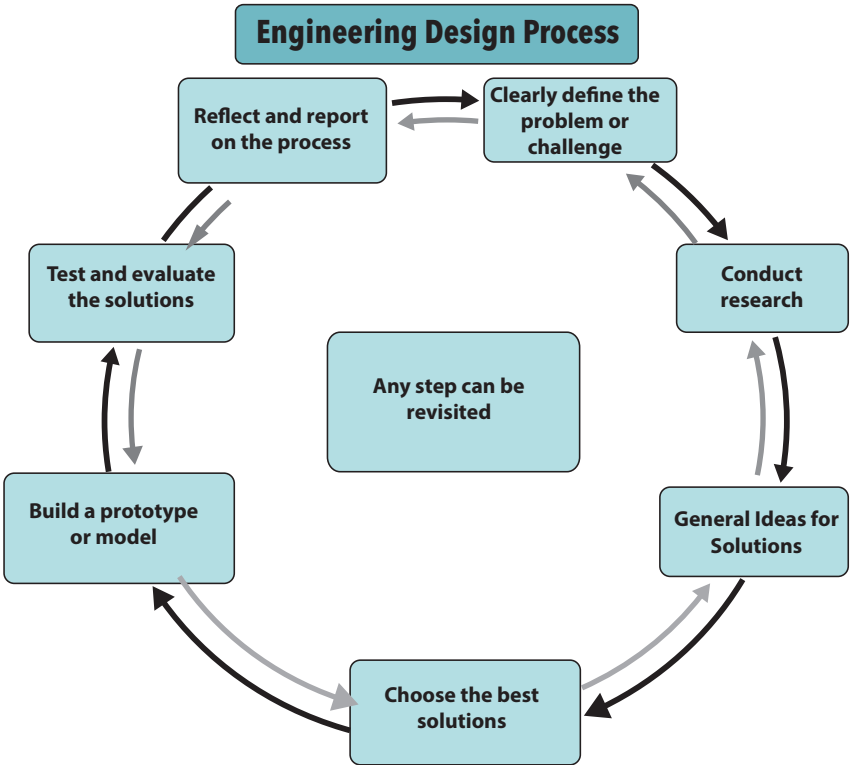
Engineering Design Process

Technological fields used the engineering design process to choose the best solution to solve the problem.

It is an open-ended problem solving process that involves the full planning and development of products or services to meet identified needs. It involves the following sequence of steps:

- Analyse the context and background, and clearly define the problem.
- Conduct research to determine design criteria, financial or other constraints, and availability of materials,
- Generate ideas for potential solutions, using processes such as brainstorming and sketching.
- Choose the best solution.
- Build a prototype or model.
- Test and evaluate the solution.
- Repeat steps as necessary to modify the design or correct faults.
- Reflect and report on the process.

The sequential engineering design process steps described above are illustrated in the diagram below.



Students should be guided through every step of the process so that they can explain it and its importance, and use the steps and the whole process proficiently to identify, investigate and solve problems. They should be provided with opportunities to practice and reflect on each step until they demonstrate the expected level of proficiency before moving on to the next one.
It involves the following sequence of steps;

Step 1: IDEA GENERATION
Step 2: RESEARCH
Step 3: PLANNING (DESIGN BRIEF)
Step 4: PROTOTYPING
Step 5: PRODUCTION
Step 6: COSTING
Step 7: MARKETING

Step 1: Idea Generation

- Ideation, iteration, and brain storming new product ideas

Students should be guided and provided opportunities to identify human made, natural and physical environment problems using their senses and describe what the problem is and its likely causes.

Example: *Residential backyard design that is not pleasing.*

Step 2: Research

- Questionnaires Feedback from a substantial and unbiased audience for product validation

After the problem is identified and described, several questions will be derived from a main issue question. The questionnaire will be formulated and then will be answered in the survey. This questionnaire will guide the researcher in conducting research and investigation for the appropriate solution to the problem.

Example: Main Question 'How can the residential backyard are designed including the elements of design that is aesthetically functional?'

Step 3: Planning (Design Brief)

- Bring the product to life through sketching, illustrations and working diagrams

Creating working sketches, illustrations and working diagrams helps the researcher to better understand his or her research problem, refine the research question and decide on investigation approach before the investigation is conducted.

Example: *Description of an Authentic Situation of an aesthetic and functional residential backyard design.*

The researcher may look into the various designs of backyards in the schools and surrounding residences outside of the school premises take pictures and produce sketches or other subject areas for tips or conduct online search on how to improve the design of residents' backyards from relevant websites. The researchers may even analyse information and past practices or similar but better regarding aesthetic and functional backyard designs.

Step 4: Prototyping

- Construct a scale model of a residential backyard design.

The researcher will make or develop a prototype of the solution and test how it would be used to solve the problem.

Example: Prototype

The illustration of sketches in the planning stage can be created in sketches and technical drafts or use CAD as the basic solution for residential back-yard design. He /she will complete a scale drawing, with annotation and development.

Step 5: Production

- Gather materials and production begins.

This step is the gathering of materials and producing of the product from the best prototype. This involves the identification of lists of materials, procedural steps with their respective tools or equipment to be used to produce the intended product.

It is obviously known during the production that certain procedural steps are needed to be done in certain order before the others because later steps depend on them being prioritized. In addition, concepts of other subjects needed for producing the product maybe gathered, integrated and utilised in the production of the product.

Example: *Producing the product*

Step 6: COSTING

- Total cost of product sold to determine retail price and gross margin

This stage is known as product pricing which involves the calculation of the costs of materials used, labour cost, markup and selling price.

The selling price may be influenced by responses to the questions in the survey due to the interest of the buyers which will determine the cost of the product.

The cost for producing the item are:

1) Material unit cost: K____
2) Labor costs (No of Hours Spent X Your Rate): 10 hrs x K ___ = K____
3) Selling/Marketing cost: K____

A simple formula to calculate a good markup percentage for the project:
Example: Pricing the product

Step 7: MARKETING

- **Launch product into market**

This stage involves the marketing of the finished product. The potential buyers of the product are the targeted audience that were used in the research.

The finished product can be promoted using flyers, put out on public places and market page can be created on social media networks.

STEAM- Based Lesson Planning

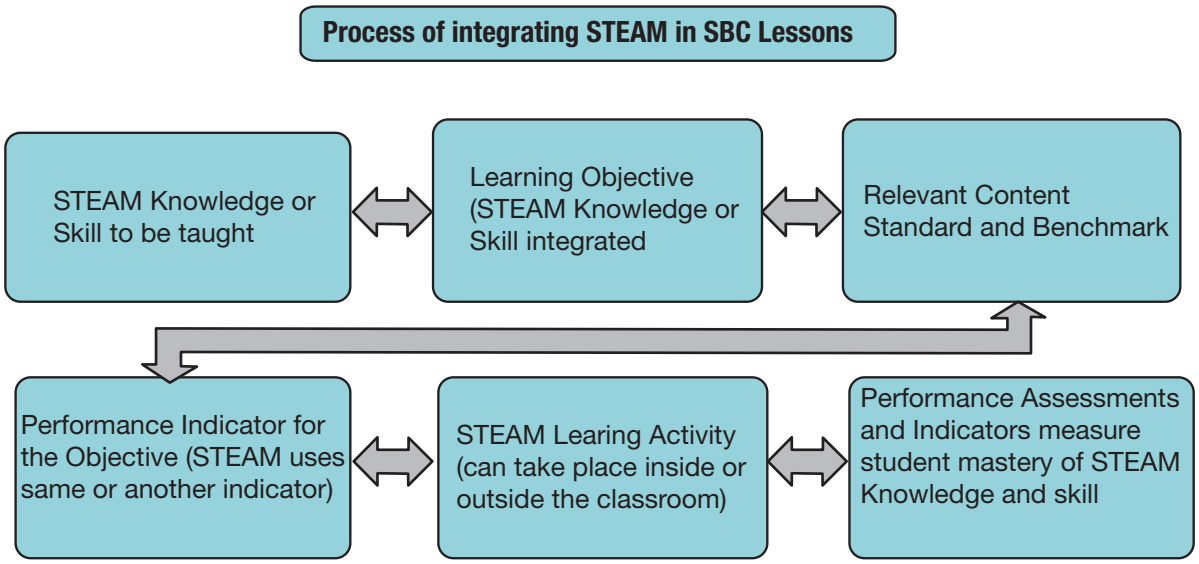
Effective STEAM lesson planning is the key to the achievement of the expected outcomes. STEAM Skills can be planned and taught using separate STEAM-based lesson plans or integrated into the standards- based lesson plans. To effectively do this, teachers should know how to write effective standards and STEAM-based lesson plans.

Developing STEAM-based Lesson Plans

An example of a standards- based lesson is provided below. Teachers should use this to guide them to integrate STEAM content and teaching, learning and assessment strategies into their standards- based lesson plans.

Integration of STEAM problem-solving skills into standards-based lesson plans

Process for Integrating STEAM Principles and Problem-Solving Skills into Standards-Based Lessons



Teachers should follow the steps given below when integrating STEAM problem-solving principles and skills into their standards-based lesson plans. (Refer to Appendices)

Step 1: Identify the STEAM knowledge or skill to be taught (From the table of KSAVs for each content standard and bench mark). **This could be already being captured in the learning objective stated in the standards-based lesson plan.**

Step 2: Develop and include a performance standard or indicator for measuring student mastery of the STEAM knowledge or skill (e.g. level of acceptable competency or proficiency) **if this is different from the one already stated in the lesson plan**

Step 3: Develop student learning activity (An activity that will provide students the opportunity to apply STEAM knowledge or skill specified by the learning objective and appropriate statement of standards). Activity can take place insideor outside the classroom and during or after school hours.

Step 4: Develop and use performance descriptors (standards or indicators) to analyze student STEAM related behaviors or products (results or outcomes), which provide evidence that the student has acquired and mastered the knowledge or skill of the learning objective specified by the indicator(s) of the standard(s).

STEAM- Based Assessment

STEAM-based assessment is closely linked to standards-based assessment where assessment is used to assess student's level of proficiency or competency of a specific knowledge, skill, value or attitude taught using a set of performance standards (indicators or descriptors). The link also includes the main components such as the purpose, the assessment principles and assessment strategies and tools.

In STEAM-based assessment, assessment is designed for what the students should know and be able to do. In STEAM learning students are assessed in a variety of ways including portfolios, project/problem-based assessment, backward designs, authenticity assessment, or other students centered approaches. When planning and designing the assessment, teachers should consider the authenticity of the assessment by designing an assessment that relates to a real world task or discipline specific attributes (such as simulation, role play, placement assessment, live projects, debates) should make the activity meaningful to the student, and therefore be motivating as well as developing employability skills and discipline specific attributes.

Effective STEAM-Based Assessment strategies

The following six sections describe six assessment tools and strategies shown to impact teaching and learning as well as help teachers foster a 21st century learning environment in their classrooms.

1. **Rubrics**
2. **Performance-based assessment (PBAs)**
3. **Portfolios**
4. **Student self-assessment**
5. **Peer-assessment**
6. **Students response system (SRS)**

Although the list does not include all innovative assessment strategies, it includes what we think are the most common strategies, and ones that may be particularly relevant to the educational context of developing countries in this 21st Century. Many of the assessment strategies currently use fit under one or more of the categories discussed. Furthermore, it is important to note that strategies also connect in a variety of ways.

1. Rubrics

Rubrics are both a tool to measure students' knowledge and ability as well as an assessment strategy. A rubric allows teachers to measure certain skills and abilities not measurable by standardized testing systems that assess direct knowledge at a fixed moment in time. Rubrics are also frequently used as part of other assessment strategies (portfolios, performances, projects, peer-review and self-assessment), they will be discussing in those sections as well.

2. Performance- Based Assessments

Performance- Based Assessments (PBA), also known as authentic assessment are generally used as a summative evaluation strategy to capture not only what students know about a topic, but if they have the skills to apply that knowledge in a; 'real-world' situation by asking them to create an end product. PBA pushes students to synthesize their knowledge and apply their skills to a potentially unfamiliar set of circumstances that is likely to occur beyond the confines of a controlled classroom setting. The implementation of performance-based assessment strategies can also impact other instructional strategies in the classroom.

3. Portfolio Assessment

Portfolios are a collection of student work gathered over time that is primary used as a summary evaluation method. The most salient characteristic of the portfolio assessment is that rather than being a snap shot of a student's knowledge at one point in time (like a single standardised test) it highlights student effort, development, and achievement over a period of time; portfolios measure as student's ability to apply knowledge rather than simply regurgitate. They are considered both student-centered and authentic assessment of learning.

4. Self-Assessment

Its main purpose is for students to identify their own strengths and weakness and to work to make improvements to meet specific criteria. Self-assessment occurs when students judge their own work to improve performance as they identify discrepancies between current and desired performance. In this way, self-assessment aligns well with standards-based education because it provides clear targets and specific criteria against which students or teachers can measure learning.

Self-assessment is used to promote self-regulation to help students reflect on their progress and to inform revisions and improvements on a project or paper. In order for self-assessment to be truly effective, four conditions must be in place, the self-assessment criteria, criteria is negotiated between the teachers and students, students are taught how to apply the criteria, students receive feedback on their self-assessments. Teachers then help students use assessment data to develop an action plan.

5. Peer Assessment

Peer assessment, much like self-assessment, is a formative assessment strategy that gives students a key role in evaluating learning. Peer assessment approaches can vary greatly but, essentially it is a process for learners to consider and give feedback to other learners about the quality or value of their work. Peer assessments can be used for a variety of products like papers, presentations, projects and or other skills behaviors. Peers assessment is understood as more than only a grading procedure and is also envisioned as teaching strategy since engaging in the process develops both the assessor and the assessees skills and knowledge. The primary goal for using peer assessment is to provide feedback to the learners. This strategy may be particularly relevant in the classrooms with many students per teacher since student time will be more plentiful than teacher time, although any single student's feedback may not be rich or in-depth as teachers feedback, the research suggests that peer assessment can improve learning.

6. Students Response system

Students response system (SRS), also known as classroom response (CRS), audience response system (ARS) is a general term that refers to a variety of technology-based formative assessment tools that can be used to gather student- level data instantly in the classroom through the combination of hardware, (voice recorders, PC, internet connection, projector and screen) and software.

Teachers can ask students a wide range of questions (both closed and open ended), where students can respond quickly and anonymously, and the teacher can display the data immediately and graphically. The use of technology also includes a use of video which examines how a range of strategies can be used to assess students understanding. The value of SRS comes from the teachers analysing information quickly and then devising real-time instructional solutions to maximise students learning. This includes a suggested approach to help teachers and trainers assess learning.

Essential Knowledge, Skills, Values, and Attitudes

Students' level of proficiency and progression towards the attainment of content standards for Technology and Industrial Arts subject will depend on their mastery and application of essential knowledge, skills, values, and attitudes in real life or related learning experiences and situations across the secondary curriculum.

Examples of the different types of knowledge, skills, values and attitudes, including processes, that all students are expected to learn and master as they progress through the grades are provided in;

- Technology and Industrial Arts syllabuses for grades 9&10 page 24-27

These knowledge, skills, values and attitudes have been integrated into the content standards, benchmarks and performance standards developed for Technology and Industrial Arts subject

Teachers are expected to plan and teach these in their lessons, and assess students' performance and proficiency, and progression towards the attainment of content standards.

Construction and Industrial Arts

Technology and Industrial Arts provides and instills in students the confidence to use a range of specific knowledge, skills, values and attitudes in various technologies. These are scoped and embedded within the strands curriculum content in the subject, with the intension to create related career pathways. The content in each strand encourage students to be proactive, competent, creative, responsible and reflective learners, enabling them to pursue career opportunities in respective fields of technology studied in this subject.

Provided herein are recognised knowledge for the subject which are applicable across the strands.

Types of common knowledge for Technology and Industrial Arts

These are specific content knowledge for the subject. They include;	
• Creativity • Branding • Communication skills • Technical expertise • Industry expertise • Critical thinking- • Information Technology skills • Innovation	• Building and Engineering Knowledge. • Physical Strength and Stamina. • Mathematical formulas in technology • **Technology and Industrial** Language Coordination. • Technology Skills. • Problem Solving Skills. • Prototype

skills oriented subject, therefore embraces all the commonly recognised skills which can be used across the strands scoped in the content. Listed here for teacher's convenience are commonly recognised skills across the strands.

Types of Skills for Technology and Industrial Arts

These are specific content Skills for the strand. They include;	
• Creativity • Critical thinking • Technical knowledge • Commercial awareness of food industries/catering services • Research and data handling capacity • Critical analysis and interpretation of materials • Management skills • Organisational Skills. • Problem solving skills • Mathematical skills • Language Literacy skills • Leadership • Innovative skills • trans formational skills	• Food Server Skills • Focus Communication skills (approachability, circumstantial awareness, diligence, efficiency, thoroughness • Multitasking skills • Attention to detail skills (multitasking , approachability, • Technical Skills • Decision making skills • Coding • information technology soft skills • logical thinking • collaboration • teamwork • software engineering • software quality assurance • customer Service • Modeling

Types of Values

Personal engagement and civic engagement strategies help young people to acquire and apply skills and dispositions that will prepare them to become competent and responsible citizens.

1. Personal Values (importance, worth, usefulness, etc

Core values	Sustaining values
• Sanctity of life • Truth • Aesthetics • Honesty • Human • Dignity • Rationality • Creativity • Courage • Liberty • Affectivity • Individuality	• Self-esteem • Self-reflection • Self-discipline • Self-cultivation • Principal morality • Self-determination • Openness • Independence • Simplicity • Integrity • Enterprise • Sensitivity • Modesty • Perseverance

2. Social Values

Core Values	Sustaining Values
• Equality • Kindness • Benevolence • Love • Freedom • Common good • Mutuality • Justice • Trust • Interdependence • Sustainability • Betterment of human kind • Empowerment	• Plurality • Due process of law • Democracy • Freedom and liberty • Common will • Patriotism • Tolerance • Gender equity and social inclusion • Equal opportunities • Culture and civilization • Heritage • Human rights and responsibilities • Rationality • Sense of belonging • Solidarity • Peace and harmony • Safe and peaceful communities

Types of Attitudes

Attitudes - Ways of thinking and behaving, points of view	
• Optimistic • Participatory • Critical • Creative • Appreciative • Empathetic • Caring and concern • Positive • Confident • Cooperative	• Responsible • Adaptable to change • Open-minded • Diligent • With a desire to learn • With respect for self, life, equality and excellence, evidence, fair play, rule of law, different ways of life, beliefs and opinions, and the environment.

Construction Technology strand

The **Construction technology** strand encourages students to “think out of the box”. This simply means to think openly and freely beyond the learning situation to bring about fresh creative ideas into the classroom lessons. This gives opportunity to the students to apply creativity and critical thinking to participate .Teachers must ensure that even students with rudimentary

creativity skills end up improvising their designs, models of prototypes and products.

Types of knowledge for Construction Technology

These are specific content knowledge for the Strand. They include;	
• Technical drawing • Print and layout reading • Design • Construction Materials specifications • Constructions Systems • Constructions Processes • Construction techniques • Prototype • Constructions materials estimates and costs‘	• Designs of structures • Construction tools • Construction equipment • Construction tools, equipment and correct functions • OHS • Maintenance skills, • Storage skills • Construction supervisory skills • Project management Skills

Processes in Technology & Industrial Arts

Technology and Industrial Arts expounds on the classroom practices using processes for effective and evidence based lesson deliveries. The commended/ suggested processes are for teachers to use as the starting points planning skills or practice based lessons in any of the strands as presented in the subject syllabus.

Types of Processes- Inquiry processes for Technology & Industrial Arts subject

Technology & Industrial Arts Inquiry processes include:

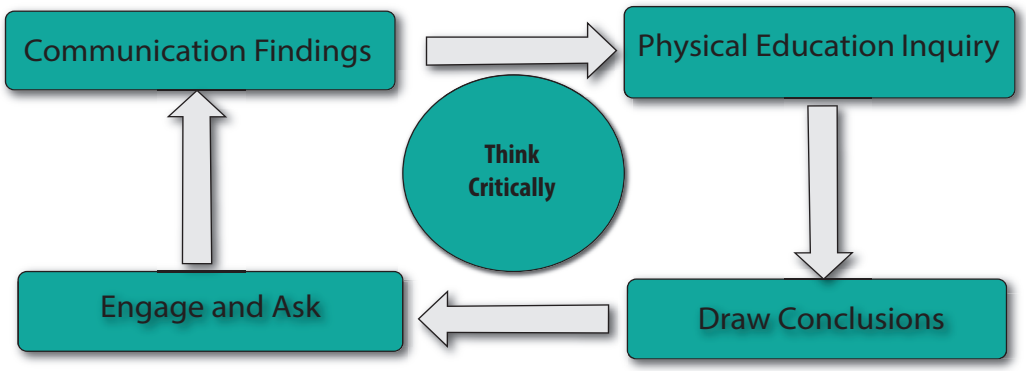
- Gathering information
- Analysing information
- Evaluating information
- Making judgements
- Taking actions
- Instructional technology
- Integration process
- Project planning process
- Organization of learning experiences

Technology & Industrial Arts Inquiry Processes

Engage and Ask	How will I engage my students in the topic and prompt them to ask questions? • Determine the enduring understandings about the topic being studied. • Engage your students with the topic by grabbing their interest with a hook connected to the enduring understandings. • Allow students to generate questions based upon the topic and hook. • Determine what questions will be essential to achieving the enduring understandings. (Student generated or teacher determined • With students, determine what other information is needed in order to fully answer the questions.
Think Critically	How will students access and analyse information about this topic? • Have students think about where they can find answers to the questions posed about the topic. • Gather and organize multiple primary and secondary sources. • Ensure that sources used expose students to different perspectives and viewpoints about the topic. • Students should use sources to collect, analyse, and interpret data. • Ensure students are analysing sources for credibility, bias, and perspective in order to identify gaps in the research.
Draw Conclusion	How will students synthesize ideas to answer the questions posed based on sources used? • Students should engage in civic discussion to answer the questions posed while respecting diverse opinions. • Engage students in evaluating possible courses of action and their consequences. • Students should make and justify an informed decision or choice and/or design an action plan supported by evidence from sources. • Have students evaluate the consequences of a decision or choice. • Allow students to make revisions based on feedback and further study.

Communi-cate Findings	How will students demonstrate what they have learned and take action on that learning? • Determine how students will apply what they have learned and share their findings with others. • Explore appropriate audiences for students to present conclusions. • Determine if there is an opportunity for students to take action and influence others to make more informed decisions. • Have students develop strategies to persuade others, including policy makers when applicable. • Prepare students to defend their analysis against alternative.

Below is how the Technology & Industrial Arts Inquiry Process will be taught in the classroom. Be specific as you make notes of the activities or prompts you will use to ensure students will have the opportunity to practice these skills as a requirement in the Grade 10 content standards.



Technology & Industrial Arts Enquiry

1. **Developing Questions and Planning Inquiries**
   a. *Constructing Essential Questions*
   - Address essential questions that reflect an enduring issue in the field
   b. *Constructing Supporting Questions*
   - Explain how supporting questions contribute to an enquiry.
   c. *Determining Helpful Sources*
   - Develop new supporting and essential questions through investigations, collaboration and using diverse sources.

2. **Evaluating Sources and Using Evidence**

a. *Gathering and Evaluating Sources*

- Gather and evaluate information from multiple sources while considering the origin, credibility, point of view, authority, structure, context and corroborative value of the sources.

b. *Developing Claims and Using Evidence*

Identify evidence that draws information from multiple sources to revise or strengthen claims.

- Communicating Conclusions and Taking Informed Action

c. *Communicating Conclusions*

- Construct and evaluate explanations and arguments using multiple sources and relevant, verified information.

d. *Critiquing Conclusions*

- Articulate explanations and arguments to a targeted audience in diverse setting.

e. *Taking Informed Action*

- Use interdisciplinary lenses to analyse the causes and effects of and identify solutions to local, regional or global concerns.
- Use deliberative processes and apply democratic strategies and procedures to address local, regional or concerns and take action in or out of school.

5. Literacy Skills

A strong emphasis must be placed on various types of literacy, from financial to technological, from media to mathematical, from content to cultural. Literacy may be defined as the ability of an individual to use information to function in society, to achieve goals and to develop her or his knowledge and potential. Teachers emphasise certain aspects of literacy over others, depending on the nature of the content and skills they want students to learn.

The following literacy skills are intended to be exemplary rather than definitive;

Types of Literacy Skills – Skills in basic literacy, digital literacy and financial literacy

- Define and apply discipline-based conceptual vocabulary
- Describe people, places, and events, and the connections between and among them
- Arrange events in chronological sequence
- Differentiate fact from opinion
- Determine an author's purpose
- Determine and analyse similarities and differences
- Analyse cause and effect relationships
- Explore complex patterns, interactions and relationships
- Differentiate between and among various options
- he ability to locate, evaluate and use digital information.
- The ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills
- The ability to effectively and critically navigate, evaluate and create information using a range of digital technologies.
- Making choices about personal finances and having the skills to make decisions that will have positive outcomes.
- Effectively use financial skills
- Improve personal financial management skills
- Improve budgeting and investing skills
- Create a savvy relationship with money application skills
- Create a lifelong journey of learning for education is the key to success when it comes to money
- Effective use financial skills
- Improve personal financial management skills
- Improve budgeting and investing skills
- Create a savvy relationship with money application skills
- Create a lifelong journey of learning for education is the key to success when it comes to money

6. Numeracy Skills

Numeracy skills refer to the ability to use, interpret and communicate mathematical information to solve real-world problems. These include the ability to understand basic math like addition, subtraction, division and multiplication. More advanced numeracy skills incorporate the use of graphical, spatial, statistical and algebraic concepts and the ability to interpret that data and apply it to real-world situations.

Types of Numeracy Skills – skills that are driven by the basic mathematical aspects
• Basic knowledge of numbers • Calculation skills • Budgeting • Interpreting mathematical information • Understanding the relationships between numbers • Understanding trends • Measurement and data analysis

7. High Level Thinking Skills

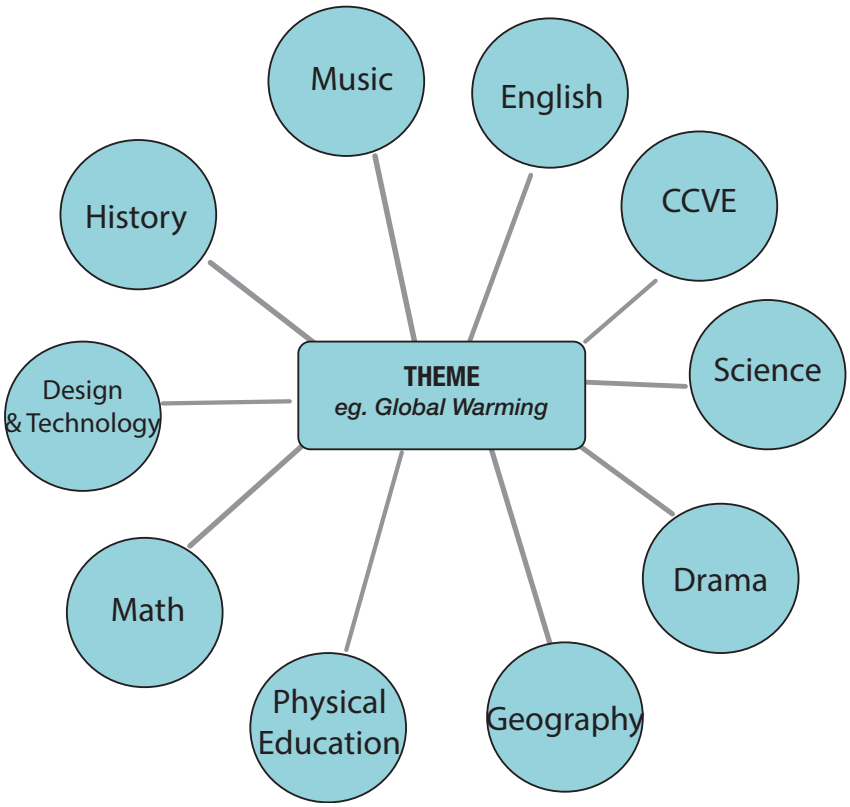
These skills include analysis, synthesis, and evaluation skills.

i. Analysis Skills – Analysis skills involve examining in detail and breaking information into parts by identifying motives or causes, underlying assumptions, hidden messages; making inferences and finding evidence to support generalisations, claims, and conclusions.

ii. Synthesis Skills – Synthesis skills involve changing or creating something new, compiling information together in a different way by combining elements in a new pattern proposing alternative solutions.

iii. Evaluation Skills – Evaluation skills involve justifying and presenting and defending opinions by making judgments about information, validity of ideas or quality of work based on set criteria.

Key Words				
Analyse	Differences	Find	Reproduce	Similar to
Appraise	Discover	Focus	Motivate	Simplify
Arrange	Discriminate	Function	Omit	Take part in
Assumption	Discussion	Group	Order	Test for
Breakdown	Distinction	Highlight	Organise	Themewebbing
Categorise	Distinguish	In-depth	Point out	Create
Cause & effect	Dissect	Inference	Research	Innovate
Choose	Divide	Inspect	See	Design
Classify	Establish	Isolate	Select	collaborate
Comparing	Examine	Investigate	Separate	recreate
				networking


Music
English
History
CCVE
Science
Design & Technology
THEME
eg. Global Warming
Drama
Math
Physical Education
Geography

Sample Curriculum Integration Outline of Linkages

THEME: "ADVOCACY FOR ACTIVE CITIZENSHIP AND PARTICIPATION"		
SUBJECT: CHRISTIAN AND CITIZENSHIP VALUES EDUCATION		**GRADE: 12**
STRAND 3: CHRISTIAN CITIZENSHIP AND SOCIETY		
UNIT 1: Christian Civics Systems		
TOPIC: Christian civic organizations use technology to advocate for good health, better education and for protection of the natural environment and its sustainability.		
Subject	**Benchmark**	**Concept of focus to learn and assessed for the Theme**
CCVE	**12.3.1.4** Inquire and discuss how Christian civic Organizations use technology to advocate for good health, better education and for protection of the natural environment and its sustainability.	How Civic Organizations use technology to advocate for protection of the natural environment and its sustainability
Agriculture	**12.3.1.4.3** Suggest ways for improving problems that a□ect conservation in Papua New Guinea	Improving Conservation problems in PNG as Citizens
Arts	**12.3.3.2** Conduct research and create artworks to advocate for social change. **12.1.2.2** Use a range of techniques and technological tools in a variety of applications relating to music to communicate a theme.	Use data from research to create artwork to advocate for active Citizenship Use Music Technological Tools to communicate active Citizenship
Business Studies	**12.4.2.9**. Establish the e-business by creating a website or using a mobile application (apps) using the Apple operating system (App Store) or Google Android operating system (Google Play).	Create a website or a mobile application to as a platform to advocate for active Citizenship[p
Character and Social Development		
English	**12.2.6.2:** Take advantage of technology's capacity to link to other information and to display information flexibly and dynamically. **12.5.4.2:** Give a clearly articulated, well-structured presentation on a complex topic.	How to display Citizenship information flexibly and dynamically with use of technology. Do a clearly articulated, well-structured presentation on active Citizenship

Mathematics	**12.4.4.3** Use appropriate technology to aid concept development as a tool for problem solving. (General Maths) **12.1.1.5** Apply quadratic equations to solve real-world situations and complex number problems. (Advance Math)	Application of quadratic equations to solve real-world situations as part of active citizenship Use appropriate technology as a tool for problem solving when they engage as active citizens in real life situations
Physical Education	**12.2.2.2** Distinguish and illustrate sporting greats of PNG in respect to their contribution in the country	How they can actively participate as sporting greats to model active citizenship participation
Science	**12.2.1.6** Investigate human population growth by comparing recent and future population growth in developed and developing countries (Biology)	Use of data from investigations to compare human population growth and use the information to participate in informed decision making
Social Science	**12.1.4.6**. Critique various national and global strategies, agenda, and actions for addressing climate change. (Geography) **12.2.4.2.** Examine the different ways the United Nations promote change and maintain stability in different regions of the world. (Political Science) **12.3.3.1** Identify and appraise the different ways people from different cultures, religions, and ethnic and ideological backgrounds relate to each other (History)	Use of strategies to actively participate in addressing climate change Understanding of how UN maintains stability to be able to actively advocate for understanding of world peace Learn how common grounds of understanding and relationships minimizes differences in cultures, religions, and ethnic and ideological backgrounds and advocate for tolerance
TIA	**12.5.2.4;** Describe the characteristics of client site scripting and creating interactive menus (Computer Tech)	The use of site scripting to create interactive menus for advocacy on issues of national and global interest as part of active citizenship participation

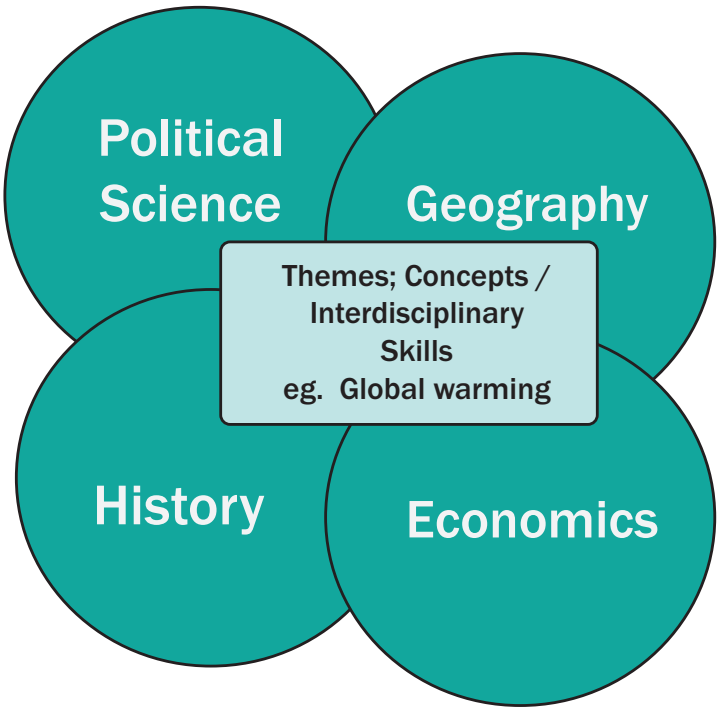
Planning for assessment will be a collaborative effort of all the subject teachers who wish their students to be part of the project with the CCVE subject Teacher as the overall coordinator of the Project and leading the Team.

See the process of this assessment in the Assessment Section.

(ii) Interdisciplinary Approach

This approach addresses learning similarly to the multidisciplinary approach of integrated learning whereby learning takes place within the subject area. It is termed interdisciplinary as the core curriculum of learning is interwoven into each subject under study by the students. For instance; in CCVE, under the strand "Governance and Leadership" students will learn the different types of leadership and common governance principles cut across the different leadership styles they will learn. Apart from learning these, students learning in CCVE are expected to use the application of writing, speaking and communication presentation skills in writing text types in their essay, such as argumentative essay, informative, explanatory, descriptive, expository and narrative essay, oral presentations and speech delivery in debates, advocacies and awareness campaigns. They must be able to capture the mechanics of English skills such as grammar, punctuation etc... Though these skills are studied under English, they are considered as core skills that cut across all subjects under study.

Therefore, essential knowledge, skills, values and attitudes comprising the core curriculum are interwoven and provide an essential and holistic framework for preparing all students for careers, higher education and citizenship in this learning.



(iii) Intra-disciplinary approach

This approach involves teachers integrating sub-disciplines within a subject area. For instance, within the subject CCVE, the four different strands will all be captured studying a particular content for CCVE. For example, under the Civic Systems and Principles, students will learn about civic different identities of different contexts and their participation likewise in the other 3 strands. Thus, children are well aware of their responsibility in active civic participation.

(iv) Trans-disciplinary Approach

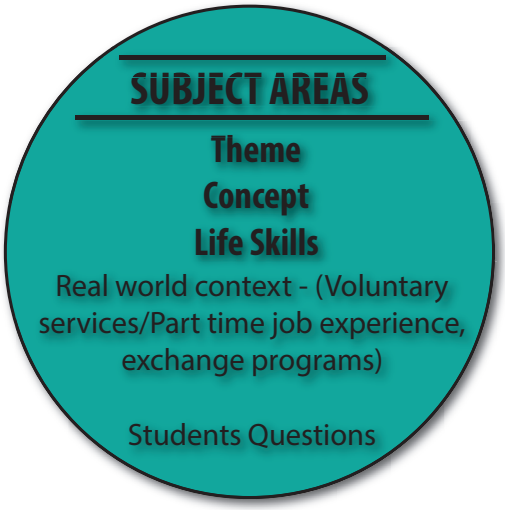
In this approach learning goes beyond the subject area of study. Learning is organised around students' questions and concerns. That is, where there is a need for change to improve lives, students develop their own curriculum to effect these needs. The Trans-disciplinary approach addresses real-life situations thus gives the opportunity to students to attain real life skills. This learning approach is more to do with Project–Based Learning also referred to as problem-based learning or place- based learning.

The three steps to planning project-based curriculum (Chard 1998).

1. Teachers and students select a topic of study based on student interests, curriculum standards, and local resources.
2. The teacher finds out what the students already know and helps them generate questions to explore. The teachers will also provide resources for students and opportunities to work in the field.
3. Students share their work with others in a culminating activity. Students display the results of their exploration and review and evaluate the project.

For instance; students may come up with slogans for school programs such as 'Our culture – clean city for a healthier PNG'. The main aim could be to curb betel nut chewing in public areas especially around bus stops and local markets. Here, students draw up their own instructions and criteria for assessment which is they have to clean the nearest bus stop or local market once a week throughout the year. They also design and create posters to educate the general public as their program continues. They can also involve the town council and media to assist them especially to carry out awareness. Studies (Susan M. Drake and Rebecca C. Burns) have proven that Project based-programs achievements have led to the following:

- Students go far beyond the minimum effort.
- Make connections among different subject areas to answer open-ended questions.
- Retain what they have learnt.
- Apply learning to real-life problems.
- Have fewer discipline problems.
- Lower absenteeism (Curtis, 2002).



These integrated learning approaches will demand for teachers to be more proactive in order to improve students learning and achievements. In order for SBC to serve its purpose fully; these three approaches must be engaged for better learning for the children of Papua New Guinea now and in the future.

Teaching and Learning Strategies

Technology & Industrial Arts emphasises and embraces the use of cognitive, reasoning, decision-making, problem solving and higher level thinking skills to teach to enhance students' understanding of inter-disciplinary concepts and issues in relation to environment, geography, history, politics and economic within PNG and globally.

It aims to provide a meaningful pedagogical framework for teaching and learning essential and in demand knowledge, skills, values, and attitudes that are required for the preparation of students for careers, higher education and citizenship in the 21st Century.

Students must be prepared to gather and understand information, analyse issues critically, learn independently or collaboratively, organise and communicate information, draw and justify conclusions, create new knowledge, and act ethically.

Teaching and learning is a two-way interactive interaction between teacher and a student , a student to a student/students and occurs in any learning environment in or outdoors depending on the nature of teaching strategies learning activities and performance assessments teachers plan to use in the delivering of the lesson.

Technology and Industrial Arts teaching and learning takes on a **blended perception and practices** of its content delivering with envisioning intentions to reinforce evidence based learning. It embraces these in the classrooms whereby each technology strand content in the form of content standards, benchmarks and performance standards direct or determine the planning of the types of learning situations and activities, assessments throughout the school year.

These standards, including the specific knowledge skills and attitudes ,how they are planned for students learning and performance attainment purposes in the respective grade levels are through highly commended teaching, learning and assessing strategies. For example; using blended learning strategies. This is where/when the traditionally recognised strategies(teacher centred) is blended with using e-teaching/learning strategies(online using smart phones) to learn about properties of fabrics, in a Textile Technology strand lesson.

Teaching strategies

Find listed for your convenience are identified teaching strategies commended for TIA subject lesson deliveries lessons However teachers can blend these in with the existing or current teaching practices using technology.

- Use of multimedia for content research.
- Utilisation of social media for fact finding on particular technology .
- Using variety of resources for meaningful teaching .
- Making most of games in electronic devices for learning.
- Use technology to empower students and reach out.

Learning Strategies

These are suggested learning strategies that can be used across the learning of all the five content strands in TIA subject.

- Using multiple types of instructional materials for learning
- Incorporate technology for reinforcement and motivation for learning
- Try new learning techniques for
- Keep your traditional teaching methods
- Vary your assessments
- Mix up group work styles
- Try a digital curriculum

Classroom assessment strategies

- Find for your convenience suggested assessment strategies to assess technology curriculum content.
- Clarifying learning intentions and criteria for success.
- Engineer effective classroom-based questioning and discussions on performance tasks that provoke or draw out evidence of learning.
- Constantly provide feedback that move learners forward.
- Present or address students as instructional resources for each other,
- Computer assisted video-based test

All Teachers teaching TIA from grades 9-10 and Construction Technology in Grade 11 and 12 are encouraged to also add to this list for the good of their student's learning.

TIA Classroom

This classroom will be a learning environment prepared especially for the teaching and learning of TIA subject. As we are moving through the 21st century technology era, TIA classrooms must reflect shadow image to encourage the teaching and learning of all the strands in the subject content.

It is suggested that teachers and students could work together to ensure that this technology classroom tips could be accommodated. These are:

- Regularly keep updates on new advancements in technology.
- Ongoing Effective Evaluation on an Ongoing Basis.
- Make Technology a Treat & Not an Expectation.
- Monitor closely usage of electronic devices .
- Set ground rules for all.
- Share knowledge on how to get technical support.
- Communicate with parents.
- Familiarise yourself with the Technology First aid.
- Use of Technology by students.

These teaching and learning strategies will help teachers to;

- familiarise themselves with different methods of teaching in the classroom,
- develop an understanding of the role of a teacher for application of various methods in the classroom.

Successful teachers always keep in view that teaching must "be dynamic, challenging and in accordance with the learner's comprehension. He/she does not depend on any single method for making his/her teaching interesting, inspirational and effective".

Please find a list of the different teaching and learning strategies in the Appendix.

These strategies;

- make learning more engaging,
- make learning more effective,
- make learning fun,
- encourage higher motivational level,
- improve attention spans,
- develop higher order thinking and reflective skills,
- improve communication skills,
- develop the spirit of teamwork /collaboration,
- develop leadership skills and qualities, and
- encourage discovery learning.

Therefore, teachers are encouraged to utilise the suggested strategies as well as others.

Strands, Units and Topics

This section of the teacher guide contains the Technology and Industrial Arts: Construction Technology content to be taught in grade 9. It consists of;

- a brief explanation of how the topics, learning objectives and lesson topics are derived.
- an overview of the content distributed according to the four terms in an academic year;
- the unit of work per strand

Technology and Industrial Arts is organized around five main strands – Textiles, Food, Construction, Communication, and Computer of which Construction Technology is one strand. These strands embed the content that students are expected to learn and master at each grade and school level. National content standards are benchmarked at each grade level, which allows for essential KSAVs to be reinforced and expanded throughout the grades.

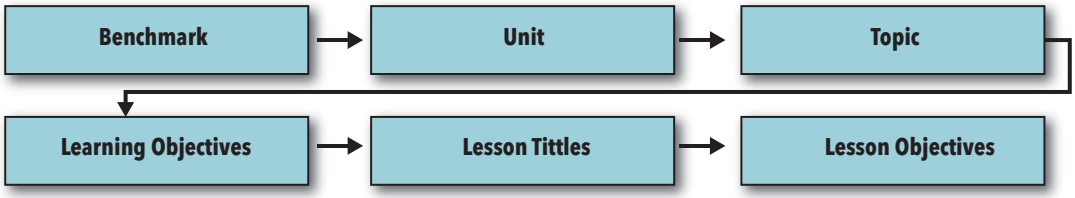
Benchmarks show grade level expectations of what students are able do to demonstrate that they are making progress towards attaining the content standard.

These grade-level benchmarks were then unpacked to identify the topics, learning objectives and the lesson topics. Below is a description of how topics were derived from the grade-level benchmarks.

Identifying topics from benchmarks

In order to identify the topic from the benchmark, we need to unpack the benchmark. When we unpack a benchmark, we are identifying what students will know and be able to do when they have mastered the benchmark.

1. Write out the benchmark that you want to unpack.
2. Write the verbs (skills/actions) – Higher order thinking skills
3. Underline or highlight the big idea (content) in the benchmark. The big idea (content) is the topic derived from the benchmark.
4. Write essential questions that would be engaging for students
5. Develop sub-topics from the big idea (topic)
6. Write learning objectives according to the sub-topics
7. Write lesson Topics from the learning objectives



Content Overview

The teaching and learning of Construction Technology in Grades 10 will follow the outline of content for the four terms in a year as a strand within the Technology and Industrial Arts.

This is only a sample to guide teachers as to how they are going to plan and teach the five strands in Technology and Industrial Arts in a school year.

TERM	STRAND	UNIT	CONTENT STANDARD
1	**Textiles Technology**	Fibres and Fabrics	**CS1.1** Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.
		Textiles and Clothing	**CS1.2** Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions.
	Food Technology	Food and Nutrition	**CS2.1** Examine and analyse the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on their production and compliance with ethical principles and standards.
		Food Science	**CS2.2** Investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (eg, health, occasions, lifestyle, business).
2	**Construction Technology**	Building Technology	**CS3.1** Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.
		Electrical Technology	**CS3.2** Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

		Plumbing Technology	**CS3.3** Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.
		Welding Technology	**CS3.4** Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.
		Engineering Technology	**CS3.5** Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.
3	**Communication Technology**	Data Communication and Network	**CS4.1** Investigate and analyse communication technology utilising multi-media and the practices and systems in designing, installing, configuring and managing networks.
		Computer Security and Safety	**CS4.2** Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both hardware, software and information security in society.
4	**Computer Technology**	Computer Architecture	**CS5.1** Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.
		Computer Software	**CS5.2** Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.

Strand 3: Construction Technology

UNITS	TOPICS	Lesson Titles
Unit 1. Building Technology	Topic 1: The components of Building and Woodwork	1.Building Components 2.Woodwork 3. Types of Furniture 4. Types of Joinery 5. Methods of cutting joints and fittings.
	Topic 2: Building Tools and Materials	1. Manual Tools 2. Hand Tools 3. Power Tools 4. Types of Building Materials
	Topic 3: Methods of Trade Drawing.	1. Isometric Drawing 2. Pictorial Drawing 3. Orthographic Drawing
	Topic 4: Safety on Construction Tools and Equipment	1. Personal Safety 2. Safety in Handling Tools and Equipment
	Topic 5: Building Codes and Regulation	1. Building Codes 2. National Building Board
	Topic 6: Elements of Estimating Building Materials	1. Use of Price Catalogues 2. Materials List and Quotations 3. Estimating Costs
Unit 2: Electrical Technology	Topic 1: Electrical Technological Environment	1. Electrical Safety 2. Electrical Workspace 3. Electrical Issues/Problems 4. Electrical Problem Management
	Topic 2: Social Applications of electricity	1. Electricity in the Changing World 2. Wise Usage of Electricity 3. Cost of Power and Installations
	Topic 3: Technologies in Electrical	1. Computer Applications 2. Emails and FAX 3. Telephones
Unit 3: Plumbing Technology	Topic 1: The Main Components of Plumbing System.	1. Introduction to Plumbing System. 2. Components of Plumbing Systems. 3. Water Distribution System. 4. Drain, Waste, Vent System.
	Topic 2: OHS on Plumbing tools and Equipment, Materials	1. Personal Safety 2. Safe Handling of Tools and Equipment
	Topic 3: Plumbing Tools and Materials.	1.Types of Manual Plumbing Tools. 2. Types of Power Plumbing Tools. 3. Categories of Plumbing Materials.
	Topic 4: Application of Trade Drawings in Plumbing	1. Construction of Blueprints. 2. Plumbing Sketches.

Unit 4: Welding Technology	Topic 1: Safety in Handling Tools and Equipment	1.Safe Handling for Tools 2. Safe Maintenance and Storage Procedures 3. Mechanical Fasteners used in Welding
	Topic 2: Measurements	1. Basic Measurement 2. Application of Measurement in Print Reading 3. Application of Measurement in Layout or Fit-up Techniques
	Topic 3: Metals	1. Types of Metals 2. Preparations and use of Metals According to Job Specification
	Topic 4: Fabrication Fundamentals	1. Fundamentals of Fabrication 2. Application of Welding Processes and Techniques 3. Application of Cutting Processes and Techniques
Unit 5: Engineering Technology	Topic 1 Scope of Engineering	1. General Functions of Engineering Innovations 2. Types of Innovations 3. Product Designs 4. Manufacturing Processes
	Topic 2: Engineering Materials	1. Properties of Materials 2. Engineering Materials 3. Engineering Tools and Equipment.
	Topic 3: Problem Solving Engineering	1. Architectural Basics 2. 3D Sketching 3. Comparison of the Engineering Design and Scientific Method 4. Graphical Methods
	Topic 4: Graphic Techniques	1. Graphics Communication 2. Elements of Graphics Communication 3. Drawing Formats and Elements 4. Graphics Applications
	Topic 5: Planning and Management Skills	1. Analytical Thinking 2. Teamwork and Clear Communication 3. Leadership Skills 4. Organisational Skill
	Topic 4: Engineering Applications	1. Engineering Applications 2. Engineering Innovations 3. Impacts of Engineering Innovations on Society

Unit 1: Building Technology

Unit	Benchmark	Topics	Lesson Titles
1.Building Technology	10.3.1.1 Describe and analyse components of building and woodwork materials and processes in those material are used.	Topic 1: The Components of Building and Woodwork.	1.Building Components 2.Woodwork 3. Types of Furniture 4. Types of Joinery 5. Methods of cutting joints and fittings.
	10.3.1.2 Practice correct terminology to describe building components and construction tools, materials and their specifications.	Topic 2: Building Tools and Materials Specification.	1. Manual tools 2. Hand tools 3. Power tools 4. Types of Building Materials
	10.3.1.3 Practice correct in isometric drawing pictorial drawing orthographic drawing in trade drawing.	Topic 3: Methods of Trade Drawing.	1. Isometric Drawing 2. Pictorial Drawing 3. Orthographic Drawing
	10.3.1.4 Demonstrate and understanding of the safe and correct use construction tools and equipment.	Topic 4: Safety on Construction Tools, Equipment and Shop Environment.	1. Personal Safety 2. Safety in Handling Tools , Equipment 3. Shop Environment
	10.3.1.5 Investigate building codes and regulations in society and the building trade.	Topic 5: Building codes and Regulation.	1. Building Codes 2. National Building Board
	10.3.1.6 Identify and describe elements of estimating building material cost.	Topic 6: Elements of Estimating Building Materials.	1. Use of Price Catalogues 2. Materials List and Quotations 3. Estimating Costs

Grade 10

Construction Technology

Teaching Content

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 10.3.1.1 Describe and analyse components of building and woodwork materials and processes in those material are used.

Topic 1: The Components of Building and Wood work

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and discuss building and woodwork components, materials and processes.

Essential Questions:

1. What are the components of wood work?
2. What are the types of furniture?
3. What are the types of joints and fasteners used in cabinets and joinery?
4. What are the common methods of cutting joints and fitting fasteners?
5. What are the components of building?
6. What are the processes involved in woodworking materials?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skill	Value	Attitudes
The components of building and wood work	Describe and analyse The components of building and wood work	Appreciate and Respect the importance, worth and usefulness of the components of building and wood work	Appreciate building component with a desire to learn by showing positive attitude and confidence when Identifying and

Technology and Industrial Arts Application: Construction Technology: Building Technology

Content Background

Components of Building

Buildings serve needs of society like a shelter from the climate, security, residing space, to store belongings and to comfortably reside and work. A building as a shelter represents a physical division of human habitation.

The basic components of a building structure are foundations, floors, walls, beams, columns, roofs, stairs, etc… These components serve the purpose of supporting, enclosing and protecting the building structure

Foundation The Foundation is a structural unit that uniformly distributes the load from the superstructure to the underlying soil. This is the first structural unit to be constructed for any building construction. A good foundation prevents settlement of the building.	**Floors** The floor is the surface laid on the plinth level. Flooring can be done by a variety of materials like tiles, granites, marbles, concrete, etc. Before flooring, the ground has to be properly compacted and leveled.	**Walls** Walls are vertical elements which support the roof. It can be made from stones, bricks, concrete blocks, etc. Walls provide an enclosure and protect against wind, sunshine, rain etc. Openings are provided in the walls for ventilation and access to the building.
Beams and slabs Beams and slabs form the horizontal members in a building. For a single storey building, the top slab forms the roof. In case of a multi-storey building, the beam transfers the load coming from the floor above the slab which is in turn transferred to the columns. Beams and slabs are constructed by reinforced cement concrete (R.C.C).	**Columns** Columns are vertical members constructed above the ground level. Columns can be of two types: Architectural columns and structural columns. Architectural columns are constructed to improve the building's aesthetics while a structural column takes the load coming from the slab above and transfers safely to the foundation.	**Roof** The roof forms the topmost component of a building structure. It covers the top face of the building. Roofs can be either flat or sloped based on the location and weather conditions of the area.

Components of woodwork

Woodworking is the skill of making items from wood, and includes cabinet making (cabinetry and furniture), wood carving, joinery, carpentry, and woodturning.(*Wikipedia)*
Woodworking can also be simply referred to as a productive craft that involves **cutting, shaping** and **joining** wood to create decorative and or useful things

It is important that a beginner should become impressed with the importance of keeping his tools in the best condition. Good results can be obtained only when tools are kept sharp and clean, and used only for the purposes for which they are made. Tools properly sharpened and properly used permit one to work easily as well as accurately.

Types of Joints and Fasteners

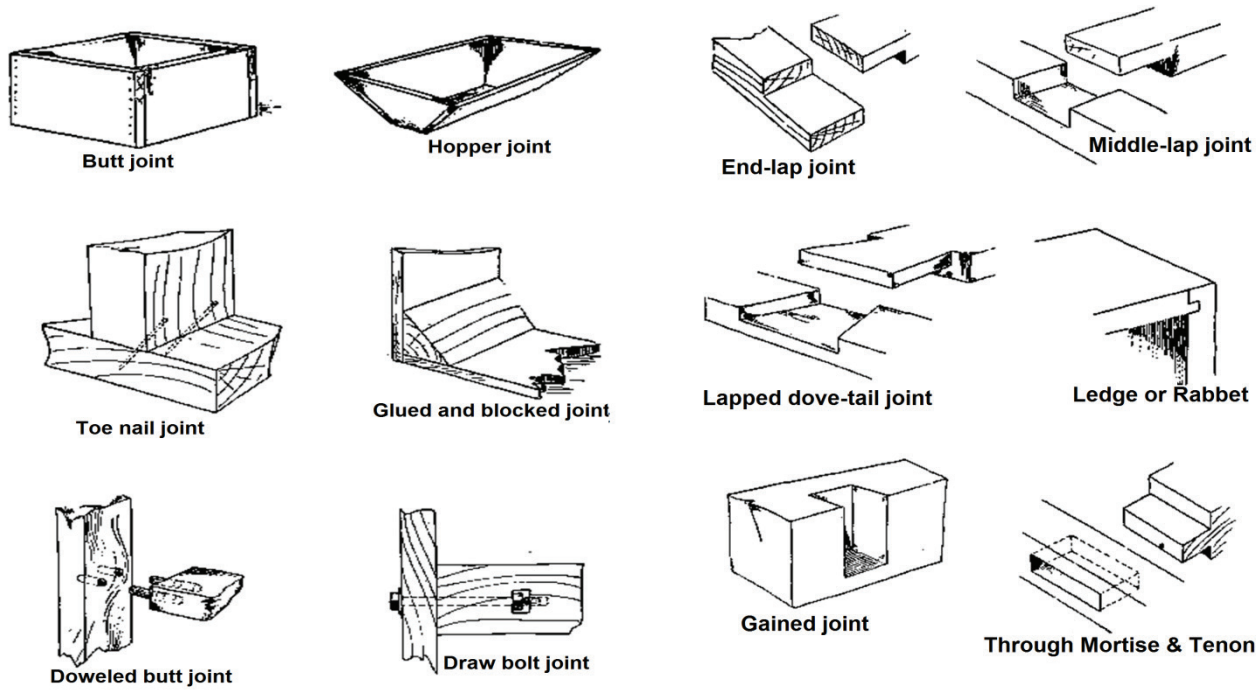


Figure 1.1a Types of joints and fasteners
Source: https://theconstructor.org/building/types-wood-joints/568735/

To be successful in woodwork construction the possession of two secrets is essential—to know the right joint to use, and to know how to make that joint in the right way. The woodwork structure or the piece of cabinet-work that endures is the one on which skillful hands have combined to carry out what the constructive mind planned.

What is a Fastener?

A fastener is a broad range of mechanical tools/elements used to hold two or more objects together as a rigid attachment. Fasteners allow for the separation or dismantling of the pieces without suffering any damage. However, they can be used as permanent joints as well. Screws, nuts, bolts, nails, washers, etc are different types of fasteners.

Types of Fasteners

There are different types of fasteners that are used in industrial applications. The most common types of mechanical fasteners are:

- Nuts and Bolts
- Washers
- Screws
- Nails
- Anchors
- Rivets
- Pins
- Retaining Rings
- Inserts

Types of Furniture

What are the three main types of "wood" used in furniture?

There are, essentially, three types of "wood" used in furniture: Solid wood, particleboard or MDF, and plywood.

Within these categories, there are high quality and lower quality versions which ultimately will affect the long-term durability of the furniture and the price.

Solid wood is a natural resource that we come by organically rather than through a manufacturing process. Solid wood can be either hardwood or softwood. No surprise, hardwoods are stronger with a higher density and lot of more expensive than softwoods.

Typical hardwoods found in high-quality wood furniture are:

- Oak
- Cherry
- Maple
- Walnut
- Birch
- Ash

Figure 1.1b Hardwoods
Source: https://wsri.org/main-types-of-wood-furniture/

Typical softwoods are:

- ✓ - Pine
- ✓ - Poplar
- ✓ - Acacia
- ✓ - Rubberwood

Figure 1.1c Softwoods
Source: https://wsri.org/main-types-of-wood-furniture/

Hardwoods grow at a slower rate and are more fire resistant than softwoods, making them more scarce to harvest and more desirable for high-quality goods.

Another factor in the price of hardwood comes from the fact we are only using the best parts of the tree - the heartwood - the central core of the tree where the rich color tones and core strength come from. Within these hardwoods, there are tiers of price as well. Walnut is more expensive as it is a bit rarer due to natural limitations such as size.

Oak, Ash, Maple, and Cherry are more abundant as they grow larger but have highly sought after aesthetics in the grain which make them less expensive than Walnut but more expensive than some other hardwoods. Birch is slightly cheaper than all of these because the natural tones in the wood grain are not as even. Birch is excellent to use for stained or colorfully painted furniture.

Particleboard and Medium Density Fiberboard

Particleboard and Medium Density Fiberboard (MDF) are both engineered wood composites made up of leftover hardwood or softwood. MDF can be quite dense and sturdy, so reliable that it is near impossible to cut with a table saw.

Particleboard, or chipboard, however, is much less sturdy as it is made up of large chips of wood that are bound together with glue and resin (think wood salami).

Figure 1.1d Fiberboard
Source: https://wsri.org/main-types-of-wood-furniture/

Common methods of cutting joints and fitting fasteners

Joinery

•The process of connecting or joining two pieces of wood together through the use of various forms of wood joints.
•In basic materials processing, common forms of joinery include dovetail joints, mortise-and-tenon joints, biscuit joints, lap joints, and spline joints.

Wood Fasteners

•What fastener is best to use?
•There are a few questions you need ask to determine which type of fastener you need to use.
–What materials need to be joined? Wood, metal and masonry all require different fasteners.
–What is the thickness of the material to be joined? For a secure connection, the fastener must be the correct length.
–What weight or strength requirements are there? From framing a house to hanging a picture, there's a fastener for the job.
–How permanent will the connection be? If the work will be disassembled at some point, use a screw.
–Will the work be indoors or outdoors? There are specific fasteners for both types of applications.

Processes involved in Woodworking materials

Live edge or **natural edge** is a style of furniture where the carpenter incorporates the natural edge of the wood into the design of the piece. Live edge furniture often incorporates gnarly wood that is not used in conventional woodworking. There are special challenges involved in working with this type of wood, hence, several methods for live edge woodworking are developed. The expert craftsman leaves the natural holes and cracks in the wood which exposes the natural color and hue of the wood which makes the furniture a piece of art.

Material Selection

First step in converting a piece of wood into a live edge furniture piece is the selection of the right raw material. Old trees which are dead or near dead are ideal for live edge furniture. Near dead trees are often the most beautiful with exciting shapes and highly figured grains. Each slab(s) is selected carefully for each project based on wood type, size, shape, color, and grain pattern. Shape of the tree often determines its usage. We will never use a tree which is right for a dining table, for making a chair. Our expert craftsman visualizes the furniture in a piece of lumber.

After we finalise the log it comes to a saw mill. It is sawn under personal supervision and the logs are kept in storage for a minimum of 6 months and then sent for seasoning in a kiln - drying chamber. It takes around a month for seasoning where the wood moisture is brought down to roughly 10-12%.

After seasoning, the wood is ready to take the shape of furniture. The real making process begins.

Measure twice, Cut once is the holy grail of furniture making. We do not hurry the crafting process. For a piece to come out perfect, patience is more important than turnaround time. The furniture we make presents the edge in the natural shape and form, it does take a lot of work to present it in it's best light. After the slab is selected, we mill it and remove the bark to expose the live edges. The bark if left intact, will invite insects like the powderpost beetle. Beyond that, over time, the bark would weaken and begin to disintegrate, leaving dirt and dust on your floor. Expert craftsman equipped with specialized tools are required to remove the rough bark and smoothen the edges to convert the rough lumber into a piece of furniture.

Strengthening & Repairing Natural Flaws

The live edge slabs are kept in their most natural state so we need to repair and/or strengthen any natural voids, splits, cracks, or knots. We ensure that they don't weaken or spread over time. These imperfections add to the style and detail to the piece.

Naturally, each slab is unique and is treated differently. The knots and voids are treated with two-part clear epoxy mixed with the saw dust and bark bits of the slab itself.

Splits and cracks are natural in wood. We ensure that splits are prevented from growing over time. Our craftsmen utilise these imperfections to give the furniture a unique look to the piece of furniture.

Joints and Finish

Joints are carefully chosen to compensate for natural wooden expansion and shrinkage which happens as seasons change. Live edge tables may highlight natural imperfections in wood, but their surfaces are buffed to spectacular smoothness. The butterfly joinery pieces, which preserve slab pieces by stabilizing natural splits, become part art, part architecture in talented hands.

Finally, the furniture is all glued up and ready for the surface finishing process. Multiple coats of tung oil/ linseed oil are applied to bring out the figured grain patterns and to impart resistance to water. Post curing of the tung oil/linseed oil, another top coat of polyurethane varnish is done to make the furniture functional and durable. This process makes the grain really come to life.

The ready piece of furniture is passed through final inspection and once it passes the stringent quality check, it is dispatched to its new home.

The Woodworking Process

Components of Woodwork

The Wood work and building components are basically the common elements that are involved in constructing cabinets particularly cupboards, tables, chairs, wardrobes etc. Similarly the components of building that includes the sub- floor members, super -structure members of a building. And the processes on how to construct a building structures from a Foundation, footings, dry wall, wall framing, Roof framing.

Wood work	Description	Building components	Description
woodwork component	Work made of wood especially interior fittings (such as mouldings or stairways) of wood.	Sub-structure members	*-are components of building including foundation and plinth.*
Types of furniture	Are tables, cupboard, chairs etc.	Superstructure members	*Are components of building include wall, columns, doors, windows etc.*
Types joint and fastener	Butt joints, Halving joints, Tenon joints, dowel joints		

Building specification: also called 'specs' are used by sub-contractors and teams as a guide to choosing the right materials for the specialised project. It is a detailed description of the dimensions, construction, workmanship, materials , of work done or to be done, prepared by an architect or engineer.

The basic components of a building structure are the **foundation, floors, walls, beams, columns, roof, stair,** etc. These elements serve the purpose of supporting, enclosing and protecting the building structure.

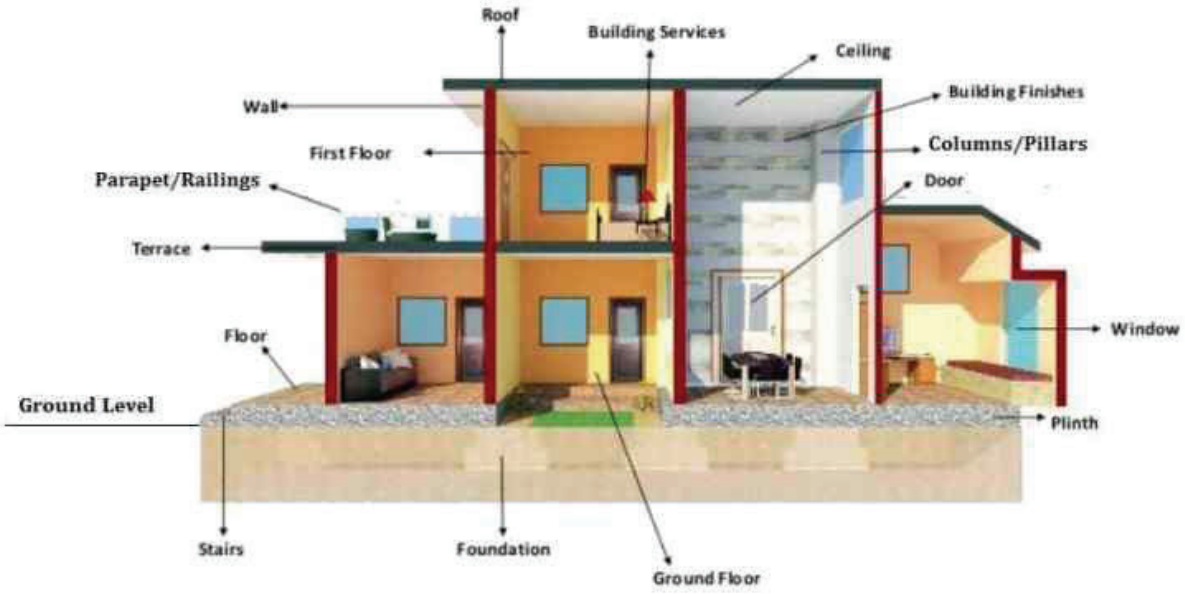


Fig.1.1e Basic Components of a Building
Source: https://theconstructor.org/building/12-basic-components-building-structure/34024/

Mentioned below are the 12 basic components a building structure.

1. Roof
2. Parapet
3. Lintels
4. Beams
5. Columns
6. Damp proof course (DPC)
7. Walls
8. Floor
9. Stairs
10. Plinth Beam
11. Foundation
12. Plinth

1. Roof

The roof forms the topmost component of a building structure. It covers the top face of the building. Roofs can be either flat or sloped based on the location and weather conditions of the area and the financial support.

2. Parapet

Parapets are short walls extended above the roof slab. Parapets are installed for flat roofs. It acts as a safety wall for people using the roof.

3. Lintels

Lintels are constructed above the wall openings like doors, windows, etc. These structures support the weight of the wall coming over the opening. Normally, lintels are constructed by

reinforced cement concrete. In residential buildings, lintels can be either constructed from concrete or from bricks

4. Beams and slabs

Beams and slabs form the horizontal members in a building. For a single storey building, the top slab forms the roof. In case of a multi-storey building, the beam transfers the load coming from the floor above the slab which is in turn transferred to the columns. Beams and slabs are constructed by reinforced cement concrete (R.C.C).

5. Columns

Columns are vertical members constructed above the ground level. Columns can be of two types: Architectural columns and structural columns. Architectural columns are constructed to improve the building's aesthetics while a structural column takes the load coming from the slab above and transfers safely to the foundation.

6. Damp Proof Course(DPC)

DPC is a layer of waterproofing material applied on the basement level to prevent the rise of surface water into the walls. The walls are constructed over the DPC.

7. Walls

Walls are vertical elements which support the roof. It can be made from stones, bricks, concrete blocks, etc. Walls provide an enclosure and protect against wind, sunshine, rain etc. Openings are provided in the walls for ventilation and access to the building.

8. Floors

The floor is the surface laid on the plinth level. Flooring can be done by a variety of materials like tiles, granites, marbles, concrete, etc. Before flooring, the ground has to be properly compacted and leveled.

9. Stairs

A stair is a sequence of steps that connects different floors in a building structure. The space occupied by a stair is called as the stairway. There are different types of stairs like a wooden stair, R.C.C stair etc.

10. Plinth Beam

Plinth beam is a beam structure constructed either at or above the ground level to take up the load of the wall coming over it.

11. Plinth

The plinth is constructed above the ground level. It is a cement-mortar layer lying between the substructure and the superstructure.

12. Specification

A well, structured, detailed description of the quality, standards, workmanship, materials, and completion of work, which evolves across a project. These are usually prepared by architects, engineers, designers and specifiers. This may be published as part of the contractual documentation for building contractors, to be read in parallel with schedules, drawings and sometimes models, and later forming the part of the handover information.

12. Foundation

The Foundation is a structural unit that uniformly distributes the load from the superstructure to the underlying soil. This is the first structural unit to be constructed for any building construction. A good foundation prevents settlement of the building

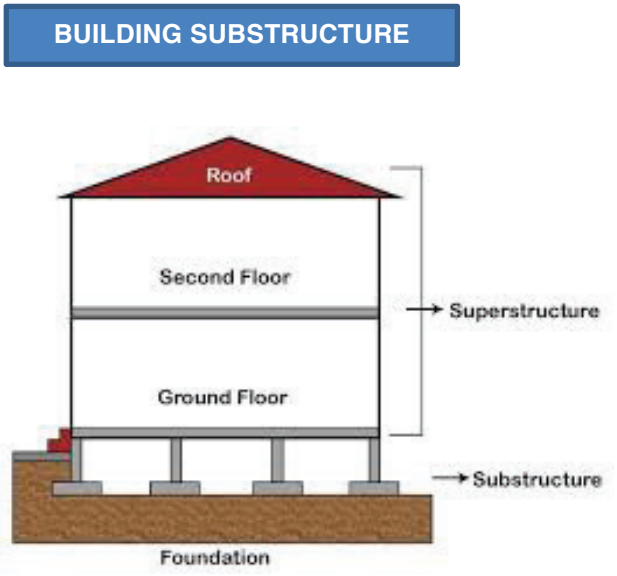


Fig. 1:1e Superstructure and Substructure in a Building
Source: https://theconstructor.org/building/superstructure-substructure-building-construction/1651/

Generally, there are two major components of a building project which are substructure and superstructure. The substructure is the part of the building that is built below the ground level whereas superstructure is the part of the structure that is constructed above the ground level.

Superstructure

The superstructure is the portion of a building which is constructed above the ground level and it serves the purpose of structure's intended use. It includes columns, beams, slab upwards including all finishes, door and window schedules, flooring, roofing, lintels, and parapets.

Substructure

The substructure is the lower part of a building which is constructed below the ground level. The function of substructure is the transfer of loads from the superstructure to the underlying soil.

So, the substructure is in direct contact with supporting soil. Substructure involves footing and plinth of a building.

An experienced structural engineer should generate plans and works for the substructure of a building project. Added to that, structural engineers are responsible for computing stresses and loads which are required to be supported by the building under consideration. Lastly, structural engineers need to comprehend how to incorporate support beams, columns and foundations into the substructure plans.

Table-1 Differences between superstructure and substructure of a building

Superstructure	**Substructure**
The portion of a building built above ground level	The part of a building built below ground level
May include walls, floors, beams, windows, doors, and columns	It consists of the foundation, abutment, and pier
Transfers loads from the upper part of the building to the substructure	Transfers loads from the superstructure to the soil underneath the building
It covers the portion of the building that is below the plinth	It covers the part of the building from the top of the plinth to the top of the building
Provides living space and protects the building from the elements	It **supports the structure** and prevents it from collapsing

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Building Components

Teacher Teaching Strategies	Students Learning Strategies
Introduction	
Introduces the topic	Students engage in brainstorming exercise to define woodwork component They then are allowed to design guiding questions that will enable them to conduct research on definition of woodwork component Discussions in groups on the research findings of Definition of woodwork component
Body	
Modelling	
Activity 1 Brainstorming activity on how to design guiding questions for their research on definition of woodwork component.	Do brainstorming activity
Guided Practice	
Activity 2 Conduct research on woodwork component and process of cabinet making.	Conduct research
Independent Practice	
Activity 3 Discussions and presentation of research findings of woodwork components and process of cabinet making	Group presentation of the findings
Conclusion	
Conclude lesson with main concepts being explained on the board	Take lesson notes
Assessment	
Assess the research and the presentation activities	Complete assessment task.

Resources
Teacher Notes

Lesson 2: Woodwork

Teaching Strategies
Students engage in brainstorming exercise to define woodwork component
They then are allowed to design guiding questions that will enable them to conduct research on definition of woodwork component
Discussions in groups on the research findings of Definition of woodwork component

Learning Strategies

Activity 1: Brainstorming activity on how to design guiding questions for their research on definition of woodwork component.

Activity 2: Conduct research on woodwork component and process of cabinet making.

Activity 3: Discussions and presentation of research findings of woodwork components and process of cabinet making.

Resources

Lesson 2: Types of Furniture

Teaching Strategies
Students engage in brainstorming exercise on the types of furniture.
They then are allowed to design guiding questions that will enable them to conduct research on types of furniture.
Discussions in groups on the research findings of Types of furniture.

Learning Strategies

Activity 1: Brainstorming activity on how to design guiding questions for their research on types of furniture.

Activity 2: Conduct research on the types of furniture and process of cabinet making

Activity 3: Discussions and presentation of research findings types of furniture and process of cabinet making.

Resources
Teacher Notes

Lesson 3: Joinery

Teaching Strategies
Students engage in brainstorming exercise on the types of joints and fasteners.
They then are allowed to design guiding questions that will enable them to conduct research on types of joints and fasteners.
Discuss in groups on the research findings of the types of joints and fasteners.

Learning Strategies
Activity 1: Brainstorming activity on how to design guiding questions for their research on types of joints and fasteners.

Activity 2: Conduct research on the types of joints and fasteners and the processes of construction cabinets.

Activity 3: Discussions and presentation of research findings the types of joints and fasteners and the processes of construction cabinets.

Resources
Teacher Notes

Lesson 4: Methods of Cutting Joints and Fittings

Teaching Strategies
Students engage in brainstorming exercise on the Methods of cutting joints and fittings
They then are allowed to design guiding questions that will enable them to conduct research on Methods of cutting joints and fittings
Discussions in groups on the research findings of the Methods of cutting joints and fittings

Learning Strategies

Activity 1: Brainstorming activity on how to design guiding questions for their research on Methods of cutting joints and fittings.

Activity 2: Conduct research on the different methods of cutting joints and fittings and the process of connecting timbers together to make a cabinet/furniture.

Activity 3: Discussions and presentation of research findings different methods of cutting joints and fittings and the process of connecting timbers together to make a cabinet/furniture.

Resources
Teacher Notes

STEAM Activity Students work in groups to sketch a Plan and follow process to construct a model of a gable/skillion roof building. Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis the components of wood work and building. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Define woodwork
2. Types of furniture
3. Joinery
4. Methods of cutting joints and fittings
5. Analyse and define the components of building

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Define woodwork	Defines and clearly explains woodwork with specific examples and illustrations	Defines and clearly explains woodwork with specific examples and illustrations	Defines and explains woodwork.	Does not define explain woodwork.
2.Types of furniture	Correctly names the types of furniture with clear illustrations	Names the types of furniture with clear illustrations	Names the types of furniture.	Does not name the types of furniture.
3.Define Joinery	Clearly defines joinery with specific examples and illustrations	Clearly defines joinery with specific examples and illustrations	Defines joinery with few examples.	Does not define joinery with no examples.
4.Methods of cutting joints and fittings	Clearly and correctly describes with specific clarity and illustrations	Clearly describes with specific clarity and illustrations	Describes cutting joints and fittings.	Does not describe cutting joints and fittings.
5.Analyse and define the components of building	Correctly and clearly analyses and defines the components of building with very clear pictures/illustrations	Clearly analyses and defines the components of building with very clear pictures/illustrations	Analyses and defines the components of buildings .	Does not analyse and define the components of building.

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 10.3.1.2 Practice correct terminology to describe building components and construction tools, materials and their specifications.

Topic 2: Building Tools and Materials

Learning Objectives:

By the end of this topic, the students will be able to;

1. Use correct terminologies for tools, equipment, processes and specifications of materials.

Essential Questions:

1. What are the types of building tools?
2. What are the building manual tools?
3. What are the building power tools?
4. What are the building materials and their specification?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Building tools and materials and their correct uses	Describe and analyse Building tools and materials by practising correct uses of tool	Value the importance of tools and materials the worth and usefulness of the Building tools and materials and their correct uses	Care and safety conscious by showing positive attitude and confidence when Identifying and explaining Building tools and materials and their correct uses

Technology and Industrial Arts Application: Constructions Technology: Building Technology

Content Background

Carpentry hand tools have been used for hundreds of years and, in many cases, their basic design has changed very little. They can be divided into three categories:
- hand (manual)
- power (electrical and battery)
- pneumatic (compressed air).

These days, carpenters tend to use power and pneumatic tools, because they're faster and require less physical effort. However, having a selection of hand tools available and knowing how to use them is important as there may be occasions when a power source (electricity or compressed air) is not available, or a job has a particular detail that requires the use of a hand tool.

Types of hand tools Hand tools can be divided into categories, each with a specific function or purpose. In this section, you'll look at tools in the following categories:
• measuring and marking out
• saws
• impelling
• planes
• chisels
• shaping
• boring
• holding and supporting
• setting out
• levelling.

Measuring tools
The first step in almost every carpentry project is being able to correctly transfer measurements from working drawings or plans onto the materials being used. There are many measuring devices available and the appropriate tool will depend on the type of work being carried out. Measuring and marking out are generally carried out at the same time; however, we'll look at them separately for now as the tools used for each are quite specific. Retractable tape measure Retractable tape measures have a built-in coil spring which automatically retracts the blade into the casing when it's released. They're used mostly by site carpenters but can also be useful on larger joinery projects. There are a variety of sizes available but the most common are 5–7.5 m.

Building tools and Materials Specification- Building tools and materials are the tools and materials that are used to building a structure. The common tools that are used to construct building are categorized in two main groups; Hand tools, power tools. The hand tools are that commonly tools that are by hand example hand saw, hammer, spirit level, try square etc. The common power tools are; circular saw, electric drill, ripping saw, drop saw, etc. The power tools would be classified in two main categories; Portable power tools and Static machine.
Power tools are tools that are easy to carry around to work site, workshops. For example; Portable circular saw, planner, drill, grinder, etc. Static machines are machine that are fixed in the workshops and they are very heavy to carry them around. For example; ripping saw, thickness, drop saw, mitre saw, drill etc.
Foundation and Substructure materials- are building materials that are used on foundation/substructure plinth. For example Reinforcement bars and mesh wire, round bars, cement bags.

Manual Tools.

Manual tools are the hand tools that are used by hand/manual to perform specific tasks. The common hand tools are hand saw, hammer, tape measure, pencil, spirit level.

Manual Tools	Description
Hand saw	It's a manual tool that used to cut across the grain of the timber. It comes in various sizes; 14",22"24" etc.
Hammer	Is used to drive the nails on the timber to connect joints together. The claw is used to remove nail from the timber. It comes in various sizes and shapes.
Tape measure	Is used to measure certain lengths of timber before cutting. It has measurement on the tape in millimetre, metres. And Inches or feet on the other side.
Pencil	Is used to mark on the certain measurement of the timber /material before cutting.
Spirit level	Is used to level the drywall, stumps, frames before nailing. It is used to plumb or level certain material before nailing.
Builders Line	It is used on setting out foundation to check the squareness of building. And also it helps to determine the level of certain height of material before marking and cutting the timbers.

Figure:1.2a Manual Tools
Source: https://www.bing.com/search?q=manual+building+tools&qs=n&form=QBRE&sp=-1&ghc=1&lq=0&pq=manual+building+tools&sc=521&sk=&cvid=40D1086963B9480BB51A803FCAB4065D&ghsh=0&ghacc=0&ghpl=

2.) Power tools;

Power tools are the tools that are used by power/ electricity to make them work to perform certain task/function. Below are the common tools used in construction Industry.

Power tool	Description
Electric circular saw	Is a portable power tool used to cut across/along the grains of a timber. It comes in various sizes ranging from 100 mm-200mm diameter of the disk size.

Electric drill 	Is portable power tools used to drill/bore holes on the timber/metal/concrete. The type and shape of the bit would determine what type of material to drill on. Example the HSS bit is used for metal boring, Auger bit is used to drill wood and the concrete bit is used to bore masonry materials.
Jigsaw 	It is used to cut curve cut/designs on the timber faster and easier compared to copying saw. It comes in different sizes and shapes**.**
Planner 	It used to remove unwanted rough surfaces of timber to require thickness before sanding them .It also comes in various sizes and design.
Belt sander 	It is used to sand the surface of a wood/timber before applying vanish. They come in various sizes and designs.
Grinder	Is a portable power tool used to grind mental/removing rust, unevenly surface.The type of the disk will determine the type of material you are cutting. It is easy to identify them by their labels on the disk whether it's used for metal, masonry etc. before purchasing them to do a particular job.

Figure 1.2b Power Tools
Source: https://constrofacilitator.com/different-types-of-power-tools-used-in-construction/

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Manual Tools

Teaching Strategies

Students engage in brainstorming exercise to discover definition of manual tools.

They then are allowed to design guiding questions that will enable them to conduct research on definition of manual tools.

Discussions in groups on the research findings of definitions of manual tools.

Learning Strategies

Activity 1 Brainstorming activity definitions of manual tools.

Activity 2 Conduct research on definition of manual tools and their functions.

Activity 3 Discussions and presentation of research findings definition of manual tools and **their** functions.

Resources

Carpentry for vocational schools

Building Design and construction Hand book

Lesson 2: Hand Tools

Teaching Strategies

Engage students in presentation of hand tools.

Engage students in the discussion of hand tools and their uses.

Learning Strategies

Activity 1 Brainstorming activity on the hand tools.

Activity 2 Conduct research on hand tools.

Activity 3 Discussions and presentation of research findings on hand tools and their uses.

Resources

Tools Chart
Teacher Notes

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Lesson 3: Power Tools

Teaching Strategies

Engage students in presentation of types of power tools.

Engage students in the discussion types of power tools and their uses.

Learning Strategies

Activity 1 Brainstorming activity on the types of power tools.

Activity 2 Conduct research on types of power tools and their uses.

Activity 3 Discussions and presentation of research findings types of power tools and their uses.

Resources
Tools Chart
Teachers Notes

Lesson 4: Types of Building Materials

Teaching Strategies

Engage students in presentation of types of building materials.

Engage students in the discussion types of building materials and their uses.

Learning Strategies

Activity 1 Brainstorming activity on the types of building materials.

Activity 2 Conduct research on types of building materials and their uses.

Activity 3 Discussions and presentation of research findings types of building materials and their uses.

Resources
Teachers Notes

STEAM Activity Students work in groups to create a simple manual and power tool to construct a building/furniture . (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to building tools and materials specification. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define manual tools
2. Identify and describe the types of hand tools
3. Define and describe the power tools

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Define manual tools	Clearly and correctly define manual tools with illustrations and examples and neat presentation	Clearly and correctly define manual tools with illustrations and examples	Define manual tools with no illustrations and examples	Does not define manual tools with illustrations and examples
2.Identify and describe the Types of Hand tools	Correctly and clearly identify hand tools with examples and neat presentation	Correctly and clearly identify hand tools with examples	Identify hand tools with no examples	Does not identify hand tools with examples
3.Define and describe the power tools	Correctly and clearly describe power tools with illustrated examples in neat presentation	Correctly and clearly describe power tools with illustrated examples	Describe power tools with no illustrated examples	Does not describe power tools with illustrated examples

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 10.3.1.3 Practice correct isometric drawing, pictorial drawing, orthographic drawing in trade drawing.

Topic 3: Methods of Trade Drawing

Learning Objectives

By the end of this topic, the students will be able to;

1. Employ isometric, pictorial and orthographic projections in terms of building plans and layout.

Essential Questions:

1. What are the methods of trade drawing?
2. What are the types of trade drawing?
3. What are common practices of drawing plan using isometric, pictorial, orthographic drawing in building trade?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Method of practice on building trade drawing	Practice the different types of trade drawing.	Value the importance of building trade drawing	Resilience to master trade drawing.

Technology and Industrial Arts Application:

Content Background

Methods of trade drawings are the methods or techniques of drawing building plan, geometrical shapes/figure using the types of drawing used in building trade drawing. There are three main types of drawings that would be used to draw/sketch a building plan, Isometric drawing, pictorial drawing, and orthographic drawings.

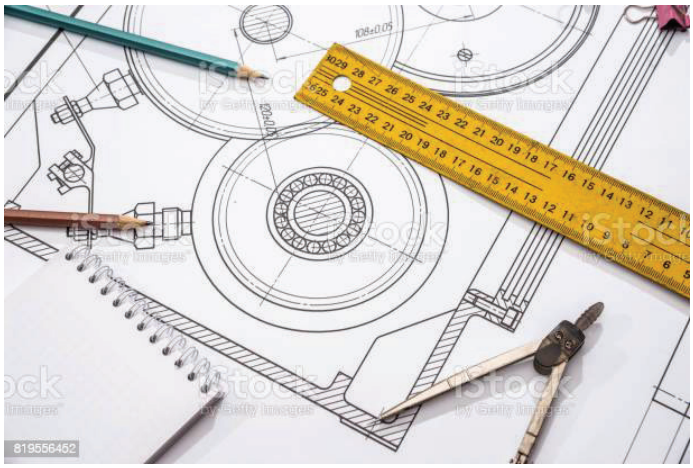


Figure 1a: Blueprint
Source: https://byjus.com/maths/isometric-sketch/

1. Methods of drawing geometrical shape using isometric drawings

Isometric Sketch

Isometric sketch or isometric drawing is a pictorial representation of an object in which all three dimensions are drawn at full scale. It looks like an isometric projection. In this case, all the lines parallel to its major axes are measurable.

What is Isometric Sketch?

Three-dimensional objects can be represented on a two-dimensional plane easily if appropriately drawn.

Oblique sketching is a method of representing 3-D objects on a 2-D plane. Although oblique sketches are capable enough to project the correct image of the object, the actual measurement of the object may vary as compared to the image projected on a two-dimensional plane. To overcome this limitation, the isometric sketch is used, which portrays the exact measurement of the object along with the projection of its image on two dimensions. Important points of an isometric drawing are:

1. The meaning of isometric is having equal measurements or dimensions.
2. In an isometric sketch, the image of the object is drawn in such a manner that the original dimension of the object is intact irrespective of its position.

Isometric sketching allows us to draw an object in the three-dimensions. This kind of sketching is often used by illustrators, engineers who specialise in technical drawings. An isometric sketch is one of the types of axonometric drawings. The other two types are dimetric and oblique sketches.

Rules for Isometric Sketching

Some of the rules for isometric sketching are as follows:

- We know that an isometric object can be drawn using vertical lines and horizontal lines. In the isometric drawing, the vertical lines will stay vertically, whereas the horizontal lines are drawn at an angle of 30-degree to the horizontal plane.
- The angle between all the three axes of the coordinate plane must be equal to 120 degrees. If you follow rule 1, then rule 2 can be automatically achieved.
- The isometric projection displays the three faces of an object, and they all are uniformly foreshortened.

Uses of Isometric Sketch

- Any objects that can be drawn using the isometric projection give a clear perception of the object.
- From the isometric sketching, one can take actual measurements of the object.
- Isometric projections should be extensively used in the situation when if you have a product idea in mind, and you want to show it to your Boss or an Investor. It would help if you showed your plan by drawing it using isometric sketching.
- It is broadly used by various professionals such as Game Designers, Architects, Interior designers, Infographics and so on.

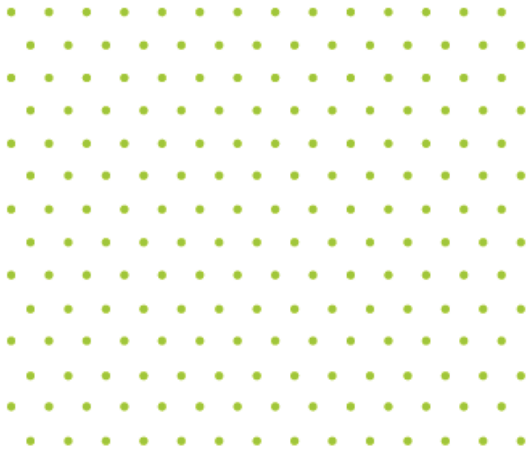
Isometric Sketch of Cube

An isometric sketch of a cube represents three faces that resemble three equilateral parallelograms. The parallel edges of the cube appear as parallel lines. The horizontal edges of the cube are drawn at an angle from the horizontal axes and vertical edges are parallel to the principal axes. All the vertical lines are drawn in proportion.

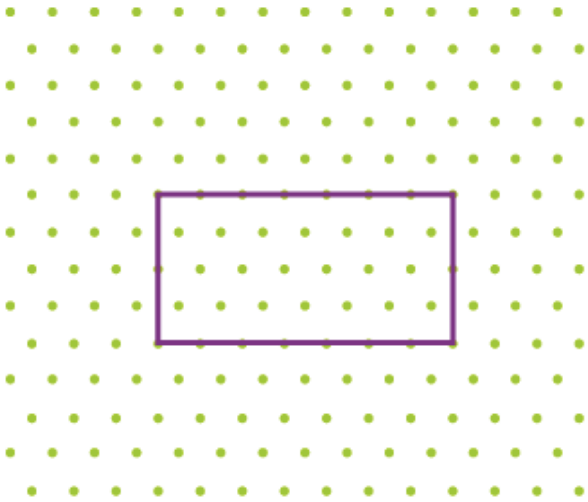
Isometric Sketch Example

An example to draw the isometric sketching is given below. Follow the steps given to draw an isometric sketch of an 8 × 3 × 3 cuboid. The same steps can be used to draw an isometric sketch of a cube also.

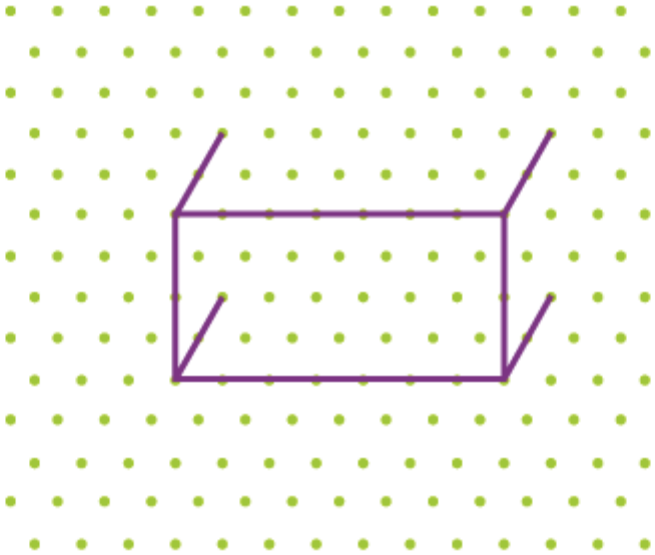
Step 1. To draw an isometric sketch of a cuboid with dimension 8 × 3 × 3, take an isometric dot paper as shown below:



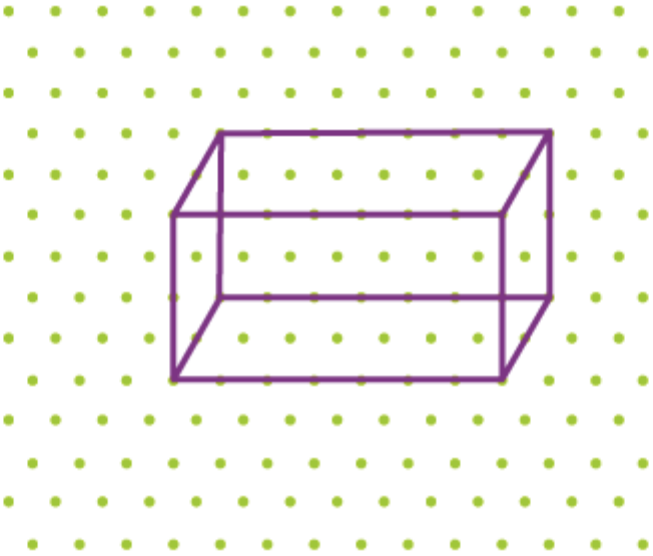
Step 2. To draw the front face, join 8 dots to form the length of the cuboid and 3 adjacent dots to form its breadth as shown:



Step 3. From the corners of the rectangle drawn above, draw 4 parallel line segments as shown below:



Step 4. Join the corners of the image together as shown below:



5. According to the convention redraw the hidden edges as dotted lines as shown:

This isometric sketch is representing a cuboid of dimension 8 × 3 ×3. Thus, using an isometric dot sheet, we can draw three-dimensional shapes of exact measurements or dimensions without any ambiguity. Thus, isometric sketches of different shapes can be drawn easily.

2. The Methods of drawing building plans using pictorial drawing Sketches and working drawings

Architectural drawing is an international graphic language used to communicate precise ideas and information from one person to another. Using standard conventions reduces the amount of space needed to communicate important features and information. Drawings are found wherever there is a need to learn, record, teach, explain and make complex information more understandable. In everyday life the use of drawings is increasing and to read them a person needs to develop special knowledge and skills. The objective of working drawings is to present clear, concise and easily read information on a proposed building project. Various types of drawing methods are used to communicate this information. Usually, freehand sketches are prepared first, and then final working drawings and specifications are completed once the design details have been decided on. Each drawing should be neat, to scale and clearly labelled.

3. The Methods of drawing geometrical shapes using orthographic drawing Drawing to scale

When preparing a set of working drawings it is usually impossible to draw objects full size, so the building project or its location must be reduced proportionally to allow it to fit on conveniently sized drawing paper. This reduction process is called scaling and should be clearly recorded on the drawing. A scale of 1:100 means 1mm will represent 100mm on the drawing. COMMON SCALES USED FOR CONSTRUCTION DRAWINGS: Site plans 1:200, 1:500 Floor/foundation plans 1:100, 1:50 Elevations 1:100, 1:50 Cross sections 1:100, 1:50 Where an object needs to be shown larger than full size, scales of 2:1, 5:1 or 10:1 can be used. It's important to select the correct scale on the scale rule to correspond to the one noted on the drawing. It's also a good idea to check that the measurements written on the drawings are correct. (For example, a drawing may have been enlarged or reduced using a photocopier and the scale may not be accurate.)

4. Describe and practice the types of lines use

Certain features on a Engineering Drawing requires specific ways of indication. For example, holes require center lines to identify the center and show that it is round. Hidden detail are shown with a certain line type to avoid confusion with visible edges.

Most CAD Software packages will have these different line types predefined as layers. Depending on the layer chosen, the line will display it in a certain way. Often, most drafting companies will have their own custom layers with different colours, however the final product on paper will (or should) be as discussed below.

Line	Description
	Continuous Thick Line
	Continuous Thin Line
	Continuous Thin Freehand Line
	Continuous Thin Zigzag Line
	Thick or Thin Dashed Line
	Thin Chain Line
	Thin Chain Line with Thick ends

	Thick Chain Line
	Thin Chain Double Dashed Line

Continuous Thick Line
The continuous thick line is used to show visible outlines or edges of a component or assembly. This line may be made thin if the drawing is congested and a lot of lines are so close to each other that the clarity of the drawing is negatively influenced.

Continuous Thin Line
The continuous thin line is the most frequently used line type on Engineering Drawings.

These lines are solid and have no break in them. Here is the list of cases where the continuous thin line will be used:
Imaginary lines of intersection
Dimension line
Projection lines
Leader lines
Hatching
Outlines of revolved sections
Short center lines (as opposed to the chain line)
Bending lines

Continuous Thin Freehand Line
Freehand lines show breaks or cuts in parts or assemblies. The edge of the partial or interrupted view is indicated with a freehand line.

Continuous Thin Zigzag Line
The Continuous Thin Zigzag Line shows a break line. If a part needs to be shortened with a break for ease of visibility, a break can be made using this line. *Remember, any dimensions spanning over the break needs to have a dimension break indicated on the dimension line also.

Thick or Thin Dashed Line
The Dashed Line is used to indicate hidden details like hidden outlines and hidden edges. The dashed line may be either thick or thin, but only one type (thick or thin) should be used on a single drawing or set of drawings.

Thin Chain Line
The Thin Chain Line is used to indicate center lines, the lines of symmetry and also trajectories. Often this line is used as a point of reference on engineering drawings.
Thin Chain Line with Thick ends

Sectional cutting planes are indicated with a Thin Chain Line with Thick ends. This helps to identify the plane in which the part or assembly is cut. If the cut line is on more than one plane, the change in direction should also be indicated with thicker ends.

Thick Chain Line
A Thick Chain Line is used to indicate special requirements on a surface. This line does not form part of the geometry of the part, but is rather used to identify the surface

Thin Chain Double Dashed Line
The Thin Chain Double Dashed Line is used to show adjacent components. This is especially useful when the component has a reference to the existing components.
It is also used to show alternative or extreme positions. On drawings where bends are indicated, these lines are used to show the initial outlines before forming or bending.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Isometric Drawings
Teaching Strategies
Students engage in brainstorming exercise to discover methods of drawing geometrical shapes using isometric drawings.
They then are allowed to design guiding questions that will enable them to conduct research on methods of drawing geometrical shapes using isometric drawings.
Discuss in groups on the research findings on methods of drawing geometrical shapes using isometric drawings.

Learning Strategies
Activity 1 Brainstorming activity methods of drawing geometrical shapes using isometric drawings.
Activity 2 Conduct research on methods of drawing geometrical shapes using isometric drawings.
Activity 3 Discuss and present research findings on methods of drawing geometrical shapes using isometric drawings.

Resources
Graphics paper
Pencils

Teachers Notes

Lesson 2: Pictorial Drawings

Teaching Strategies
Students engage in brainstorming exercise to discover methods of drawing geometrical shapes using Pictorial drawings.
They then are allowed to design guiding questions that will enable them to conduct research on methods of drawing geometrical shapes using pictorial drawings.
Discuss in groups on the research findings on methods of drawing geometrical shapes using pictorial drawings.

Learning Strategies
Activity 1 Brainstorming activity methods of drawing geometrical shapes using pictorial Drawings.
Activity 2 Conduct research on methods of drawing geometrical shapes using pictorial Drawings.
Activity 3 Discussions and presentation of research findings methods of drawing geometrical shapes using pictorial drawings.

Resources
Graphics paper
Pencils
Teachers Notes

Lesson 3: Orthographic Drawing

Teaching Strategies
Students engage in brainstorming exercise to discover methods of drawing geometrical shapes using orthographic drawings
They then are allowed to design guiding questions that will enable them to conduct research on methods of drawing geometrical shapes using orthographic drawings
Discuss in groups on the research findings on methods of drawing geometrical shapes using orthographic drawings.

Learning Strategies
Activity 1 Brainstorming activity Methods of drawing geometrical shapes using orthographic drawings.
Activity 2 Conduct research on methods of drawing geometrical shapes using orthographic drawings.
Activity 3 Discussions and presentation of research findings methods of drawing geometrical shapes using orthographic drawings.

Resource
Graphics paper
Pencils

STEAM Activity Students work in groups to create an activity incorporating methods of trade drawing. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to Methods of trade drawing. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

Methods of drawing geometrical shape using isometric drawings.
The methods of drawing building plans using pictorial drawings.
The methods of drawing geometrical shapes using orthographic drawings.
Describe and practice the types of lines use.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Methods of drawing geometrical shape using isometric drawings	Correctly and accurately uses methods of drawing geometrical shape using isometric drawings	Correctly uses methods of drawing geometrical shape using isometric drawings	Partially uses methods of drawing geometrical shape using isometric drawings	Does not use methods of drawing geometrical shape using isometric drawings
2.The Methods of drawing building plans using pictorial drawings	Correctly and accurately uses the methods of drawing building plans using pictorial drawings	Correctly uses the methods of drawing building plans using pictorial drawings	Partially uses the methods of drawing building plans using pictorial drawings	Does not use the methods of drawing building plans using pictorial drawings
3.The Methods of drawing geometrical shapes using orthographic drawings	Correctly and accurately uses the methods of drawing geometrical shapes using orthographic drawings	Correctly uses the methods of drawing geometrical shapes using orthographic drawings	Partially uses the methods of drawing geometrical shapes using orthographic drawings	Does not use the methods of drawing geometrical shapes using orthographic drawings

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 10.3.1.4 Demonstrate and understanding of the safe and correct use of construction tools and equipment.

Topic 4: Safety on Construction Tools and Equipment

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and observe personal safety and safety in handling tools and equipment

Essential Questions:

1. What are the safety construction tools?
2. What are the safeties on construction equipment?
3. What are the OHS on construction tools and equipment?
4. What are the safety measures in the workshop environment?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
OHS on construction tools and equipment	Practice safety in handling construction tools and equipment.	value the importance OHS on tools and equipment	Considerate of the safety of tools, self and others

Technology and Industrial Arts Application: Construction Technology: Building Technology

Content Background

Safety on construction tools and equipment:

The safety on construction tools and equipment are basically the safe practice on how to work and use of construction tools and equipment during construction process. This is particularly applied on manual tools, power tools, building equipment and static machines.

1. the safety use on manual tool.

2. the Safety use on power tools.
3. the Safety use on building equipment.
4. the Safety use on the static machines.

5. Below are the safety of tools and equipment during construction.

Figure 1.4a Safety Gear

Source:https://www.acuteinstitute.com/knowledge-center/safety-equipment-personal-protective-equipment/

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Personal Safety

Teaching Strategies

Students engage in brainstorming exercise to discover personal safety use on manual too.

They then are allowed to design guiding questions that will enable them to conduct research on safety use on manual tool.

Discuss in groups on the research findings on safety use on manual tool.

Learning Strategies

Activity 1 Brainstorming activity safety use on manual tool.

Activity 2 Conduct research on safety use on manual tool.

Activity 3 Discussions and presentation of research findings safety use on manual tool then design safety rules on the use of manual tools.

Resources

Lesson 2: Safety in Handling Tools and Equipment

Teaching Strategies

Students engage in brainstorming exercise to discover safety use on power tools.

They then are allowed to design guiding questions that will enable them to conduct research on safety use on power tool.

Discuss in groups on the research findings on safety use on power tools.

Learning Strategies

Activity 1 Brainstorming activity safety use on power tools.

Activity 2 Conduct research on safety use on power tools.

Activity 3 Discussions and presentation of research findings safety use on power tools then design safety rules on the use of power tools.

Resources

Lesson 3: Shop Environment

Teaching Strategies

Students engage in brainstorming exercise to discover safety use for the workshop environment.

They then are allowed to design guiding questions that will enable them to discover safety for workshop environment.

Discuss in groups on the research findings on safety for workshop environment.

Learning Strategies

Activity 1 Brainstorming activity safety use on power tools.

Activity 2 Conduct research on safety use on power tools.

Activity 3 Discussions and presentation of research findings safety use on power tools then design safety rules on the use of power tools.

Resources

STEAM Activity Students work in groups to create an activity incorporating safety on construction tools and equipment. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to safety on construction tools and equipment .Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Describe and analyse the safety use on manual tool.
2. Analyse and describe the Safety use on power tools.
3. Identify safety measures for the workshop environment.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Describe and analyse the safety use on manual tool	Accurately describe and analyse the safety use on manual tool	Correctly describe and analyse the safety use on manual tool	Partly describe and analyse the safety use on manual tool	Poorly describe and analyse the safety use on manual tool
2. Analyse and describe the Safety use on power tools	Accurately analyse and describe the Safety use on power tools	Correctly analyse and describe the Safety use on power tools	Partly analyse and describe the Safety use on power tools	Poorly analyse and describe the Safety use on power tools
3. Identify safety measures for the workshop environment	Accurately identify safety measures for the workshop environment	Correctly identify safety measures for the workshop environment	Partially identify safety measures for the workshop environment	Cannot identify safety measures for the workshop environment

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 10.3.1.5 Investigate building codes and regulations in society and the building trade.

Topic 5: Building Codes and Regulations

Learning Objectives
By the end of this topic, the students will be able to;

1. Discuss correct applications of building codes and regulations
2. Investigate and describe the function of National Building Board and what they represent in the building industry.

Essential Questions:
1. What are building codes and regulations?
2. Why are there building codes and regulations in place?
3. How do building codes and regulations have an impact on the building industry?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Building codes and regulations	Investigate and describe building codes and regulations.	Appreciation and reasoning	Express understanding, honesty

Technology and Industrial Arts Application: Building Technology

Content Background

Building codes and regulations

Building codes is a set of rules that specify the standards for constructed objects such as buildings and non- building structures. Building must conform to the code to obtain planning permission, usually from the local authority. The main purpose of building codes is to protect public health, safety and the general welfare as they relate to the construction and occupancy of building structures. The building codes become law of a particular jurisdiction when formally enacted by the appropriate government or private authority. Violating these regulations can result in fines and/or penalties. Building codes are generally intended to be applied by architects, engineers, interior designs, constructors and regulators but also used for various functions purposed by safety inspectors.

Building codes apply to all sorts of real estate, both commercial and residential. Older buildings must be “brought up to code”, that is, updated to current standards. If they fail to be updated, a building inspector could deem them unfit to live or work in.

New buildings must be constructed using the most recent codes. In addition to fines, failure to meet code standards during construction could possibly delay a project while problems are addressed. Serious violations could even end a project before it is complete.

Building codes tackle a variety of health and safety concerns, from materials that are banned in construction to the number of fire escapes needed in a single structure. In addition, cities and counties that are prone to a certain type of natural disaster may establish codes directly to counter that type of event.

In the construction industry, the term 'standards' typically refers to published documents that are intended to define the common specifications, methods and procedures that are to be used. By establishing common standards, greater reliability and consistency is ensured in terms of the quality, compatibility and compliance of the particular product, service, material, and so on.

The Building Regulations establish minimum standards to be achieved in the construction of buildings. They are supported by a series of approved documents that provide guidance about how the building regulations can be satisfied in common building situations, and these in turn are supported by a wide range of reference documents. Specifications also typically refer to a range of standards for materials to be used, quality of workmanship, tests to be performed and so on. There are several organisations that provide standards for the built environment. (Wikipedia, 2022)

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building codes and standards. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Building Codes

Teaching Strategies

Students research and study building codes and standards and do case studies on buildings adherence to the building codes and standards.

Discussions in groups on the research findings.

Learning Strategies

Activity 1 Conduct research on building codes and standards.

Activity 2 Do case studies on selected buildings if they adhered to the building codes and standards.

Activity 3 Discussions and presentation of research findings

Resources

Lesson 2: National Building Boards Requirements

Teaching Strategies

Engage students in presentation of types of codes in the building industry.

Engage students in the discussion on building codes in the industry.

Learning Strategies

Discover computer presentation tools on the building codes in the building industry.

Activity 1 Research on the building codes in the building industry in PNG and a selected developed nation and do a comparison.

Activity 2 Do a computer presentation on the building codes in the building industry in PNG and the selected developed country and show the similarities and differences and how they impact the building industry.

Resources

STEAM Activity Students work in groups to create an activity incorporating building codes and regulations. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to Building codes and regulations . Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. State and describe the types of building codes.
2. Analyse and define the forms of codes.
3. State and describe the classification of codes.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.State and describe the types of building codes	Accurately and correctly state and describe the types of building codes	Correctly state and describe the types of building codes	Poorly state and describe the types of building codes	Cannot state and describe the types of building codes
2.Analyse and define the forms of codes	Accurately and correctly analyse and define the forms of codes	Correctly analyse and define the forms of codes	Poorly analyse and define the forms of codes	Cannot analyse and define the forms of codes
3.State and describe the classification of codes	Accurately and correctly state and describe the classification of codes	Correctly state and describe the classification of codes	Poorly state and describe the classification of codes	Cannot state and describe the classification of codes

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 10.3.1.6 Identify and describe elements of estimating building material cost

Topic 6: Elements of Estimating Building Material

Learning Objectives

By the end of this topic, the students will be able to;

1. Use price catalogues to do materials list and estimates cost.
2. Obtain quotations and compare between quality, quantity and cost.

Essential Questions:

1. What are the elements of estimating building material?
2. What are the formulae used to calculate foundation, wall framing, roof framing?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Estimating building materials	Calculate and estimate	Appreciate the formulae given	Value costing, be economical

Technology and Industrial Arts Application: Building Technology

Content Background

Elements of estimating building material

Estimating of building materials is basically to calculate the total cost of material using correct formulae to estimate the project cost of building construction. They are three estimation cost; composition of project cost, estimating direct cost, estimating contingency cost.

An estimate for any construction work may be defined as the process of calculating the quantities and costs of the various items required in connection with the work.

Before the start of any work for its execution, the owner of the builder should have a thorough knowledge of the volume of work. The minutest details can help him understand if the work can be completed within the stipulated time frame and budget. It also enables him to understand the probable cost that may be incurred to complete the proposed work. Therefore, it is necessary to

list the probable costs or develop an estimate for the proposed work from its plans and specifications.

An estimate is prepared by calculating the quantities from the drawings for various items and multiplying them with the unit cost of the item concerned. To prepare an estimate one requires -

- Drawing - The drawing is the basis from which quantities of various items for a work are calculated. The drawings consist of the plan, the elevations, and the sections through important points.
- Specifications -
    - General Specification - The general specification forms the general idea for the project. In this, the nature and class of work and the names of materials that should be used are described.
    - Detailed Specification - Detailed specification describes every item of work in the estimate. This specification of work serves as a guide to execute the work to the owner's satisfaction.
- Rates - Rates for different items of works are vital factors to determine the estimated cost.
- Standing circulars for taxes and insurance etc. are required to fix up rates of those items which are not in the schedule of rates.

1) Purpose of Estimation

Estimate for a work or project is necessary mainly for the following purposes:

1. To ascertain the necessary amount of money required by the owner to complete the proposed project. For public construction works, estimates are required in order to obtain administrative approval, allotment of funds, and technical sanctions.
2. Ascertain quantities of materials required to program their timely procurement.
3. Calculate the number of workers that are to be employed to complete the work within the scheduled time of completion.
4. Assess the requirements of tools and equipment required to complete the work according to the program.
5. Fix up the completion period from the volume of works involved in the estimate.
6. Draw up a construction schedule and program.
7. Justify the investment from the benefit-cost ratio.
8. Invite tenders and prepare bills for payment.

9. An estimation for an existing property is required for valuation.

2) Different Types of Estimates

2.1 Detailed Estimate

This includes the detailed particulars for the quantities, rates, and costs of all the items involved for the satisfactory completion of a project. This is the best and the most accurate estimate that can be prepared.

A detailed estimate is accompanied by -

- Report,
- Specifications,
- Detailed drawings showing plans,
- Design data and calculations and,
- Basis of rates adopted in the estimate.

Such a detailed estimate is prepared for technical sanction, administrative approval, and also for the execution of a contract with the contractor.

2.2 Preliminary or Approximate or Rough Estimate

This is an approximate estimate to determine an approximate cost in a short time and thus enables the authority concerned to consider the financial aspect of the scheme, for according sanction to the same. Such an estimate is framed after knowing the rate of similar works and from practical knowledge in various ways for various types of works.

2.3 Quantity Estimate or Quantity Survey

This is a complete estimate or list of quantities for all work items required to complete the concerned project. The quantity of each item of work is worked out from the respective dimensions on the drawing of the structure.

The purpose of the Bill of quantities is to provide a complete list of quantities necessary for the completion of any engineering project, and when priced, it gives the estimated cost of the project.

2.4 Revised Estimate

A revised estimate is a detailed estimate of the revised quantities and rates of items of works originally provided in the estimate without material deviations of a structural nature from the design originally approved for a project. It is accompanied by a comparative statement abstract form showing the probable variations for quantity, rate, and amount for each item of work of the project compared with the original estimate side-by-side stating the reasons for variations. For fresh technical sanction, a revised estimate is prepared and submitted.

2.5 Supplementary Estimate

During the progress of the work, some modifications or additions due to material deviation of a structural nature from the design originally approved may be thought necessary for the development of a project. A supplementary estimate includes all such works. The method of preparation is the same as that of a detailed estimate, and it should be accompanied by a full report of the circumstances which render its necessity.

2.6 Complete Estimate

The complete estimate is related to the work in addition to the main contract or to the 'detailed estimate.'

2.7 Annual Maintenance or Repair Estimate

After completion of a work, it is necessary to keep the maintenance aspect in view for its proper functioning. An estimate is prepared for the items which require renewal, replacement, repairs, etc. for maintenance purpose. The total estimated cost of maintenance of a structure is generally kept within the prescribed limits on the percentage basis of the cost of construction of the structure and its importance. This cost can vary according to the age and importance of the structure. (*Pai,K, 2023)*

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Use of Price Catalogue

Teaching Strategies

Students engage in brainstorming exercise to discover Composition of project cost.

They then are allowed to design guiding questions that will enable them to conduct research on Composition of project cost.

Discussions in groups on the research findings on composition of project cost.

Learning Strategies

Activity 1 Brainstorming activity composition of project cost.

Activity 2 Conduct research on composition of project cost.

Activity 3 Discussions and presentation of research findings on composition of project cost.

Resources

Lesson 2: Materials List and Quotations

Teaching Strategies

Students engage in brainstorming exercise to discover estimating direct cost.

They then are allowed to design guiding questions that will enable them to conduct research on Estimating direct cost.

Discussions in groups on the research on findings estimating direct cost.

Learning Strategies

Activity 1 Brainstorming activity estimating direct cost.

Activity 2 Conduct research on estimating direct cost.

Activity 3 Discussions and presentation of research findings on estimating direct cost.

Resources

Estimating and costing text book

Lesson 3: Estimating Costs

Teaching Strategies

Students engage in brainstorming exercise to discover estimating contingency cost.

They then are allowed to design guiding questions that will enable them to conduct research on estimating contingency cost.

Discuss in groups on the research findings on estimating contingency cost.

Learning Strategies

Activity 1 Brainstorming activity estimating contingency cost.

Activity 2 Conduct research on estimating contingency cost.

Activity 3 Discuss and present research findings on estimating contingency cost.

Resources

Estimating and costing text book

STEAM Activity Students work in groups to create an activity incorporating estimating costs of building materials in the construction industry. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Elements of estimating building material. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.
Performance Assessment

1. Analyse and estimate the composition of project cost.
2. State and describe the estimating direct cost.
3. State and describe the estimating contingency cost.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Analyse and estimate the Composition of project cost	Correctly and accurately analyse and estimate the composition of	Correctly analyse and estimate the composition of project cost	Partly analyse and estimate the composition of project cost	Cannot analyse and estimate the composition of project

	project cost			cost
2. State and describe the Estimating direct cost	Correctly and accurately state and describe the estimating direct cost	Correctly state and describe the estimating direct cost	Partly state and describe the estimating direct cost	Cannot state and describe the estimating direct cost
3. State and describe the Estimating contingency cost	Correctly and accurately state and describe the estimating contingency cost	Correctly state and describe the estimating contingency cost	Partly state and describe the estimating contingency cost	Cannot state and describe the estimating contingency cost

Unit 2 Electrical Technology

Unit	Benchmark	Topic	Lesson Titles
2.Electrical Technology	**10.3.2.1.** Identify and solve problems in the electrical technological environment using critical and creative thinking, in order to develop creativity and cultivate innovation in learners.	Topic 1: Electrical technological Environment	1. Electrical Safety 2. Electrical workspace 3. Electrical issues /problems 4. Electrical Problem management
	10.3.2.2. Investigate the social applications of electricity for improvement of the quality of life and solutions to problems in the made environment.	Topic 2: Social Applications of electricity	1. Electricity in the changing world 2. Wise Usage of electricity 3. Cost of Power and installations
	10.3.2.3. Use technology to organise and manage electrical activities responsibly and effectively considering the interrelatedness of systems as a context for problem solving.	Topic 3: Technologies in Electrical	1. Computer applications 2. Telecommunications

UNIT 2. Electrical Technology

Content Standard 3.2 Investigate, analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving quality of life responsive to individual, community and industrial needs.

Benchmark 10.3.2.1 Identify and solve problems in the electrical technological environment using critical and creative thinking, in order to develop creativity and cultivate innovation in learners.

Topic 1: Electrical Technological Environment

Learning Objectives

By the end of this topic, the students will be able to;

1. Identify common electrical technological problems and issues.
2. Manage and identify solutions for common electrical technological problems issues with innovation and creativity

Essential Questions:

1. What is Electrical Technological environment or electrical workspace?
2. What is electrical safety?
3. What are some common issues or problems in the electrical technological environment?
4. How do we manage common electrical technological environment issues and problems?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Problems in electrical technological environment,	Identify, solve, develop and cultivate knowledge on technological environments.	creativity, innovative, critical and responsible	Responsibility and deliberate considerations

Technology and Industrial Arts Application: Construction Technology, Electrical Technology

Content Background

Electrical safety

Electrical safety is a system of organizational measures and technical means to prevent harmful and dangerous effects on workers from electric current, electric arc, electromagnetic field and static electricity.

Electrical safety is an integral part of every workplace and needs to be diligently followed because of electricity's amazing, yet deadly, qualities. As a firm part of our everyday life, electricity needs to be handled with care to avoid incidents that can result in serious injury or even death, so it's important to know how you can help in a life-threatening situation.

(https://www.safetyandhealthmagazine.com/articles/18835-electrical-safety)

What are some general safety tips for working with or near electricity?

- Inspect portable cord-and-plug connected equipment, extension cords, power bars, and electrical fittings for damage or wear before each use. Repair or replace damaged equipment immediately.
- Always tape extension cords to walls or floors when necessary. Do not use nails and staples because they can damage extension cords and cause fire and shocks.
- Use extension cords or equipment that is rated for the level of amperage or wattage that you are using.
- Always use the correct size fuse. Replacing a fuse with one of a larger size can cause excessive currents in the wiring and possibly start a fire.
- Be aware that unusually warm or hot outlets or cords may be a sign that unsafe wiring conditions exists. Unplug any cords or extension cords from these outlets and do not use until a qualified electrician has checked the wiring.
- Always use ladders made with non-conductive side rails (e.g., fibreglass) when working with or near electricity or power lines.
- Place halogen lights away from combustible materials such as cloths or curtains. Halogen lamps can become very hot and may be a fire hazard.
- Risk of electric shock is greater in areas that are wet or damp. Install Ground Fault Circuit Interrupters (GFCIs) as they will interrupt the electrical circuit before a current sufficient to cause death or serious injury occurs.
- Use a portable in-line Ground Fault Circuit Interrupter (GFCI) if you are not certain that the receptacle you are plugging your extension cord into is GFCI protected.
- Make sure that exposed receptacle boxes are made of non-conductive materials.
- Know where the panel and circuit breakers are located in case of an emergency.
- Label all circuit breakers and fuse boxes clearly. Each switch should be positively identified as to which outlet or appliance it is for.
- Do not use outlets or cords that have exposed wiring.
- Do not use portable cord-and-plug connected power tools if the guards are removed.
- Do not block access to panels and circuit breakers or fuse boxes.
- Do not touch a person or electrical apparatus in the event of an electrical incident. Always disconnect the power source first.

Electrical Work Space

The safety of maintenance electricians depends on the consideration of adequate workspace around electrical equipment. For safe equipment operation and maintenance, you must design and install all electrical equipment with “sufficient” access and workspace.

The following must be taken into consideration for electrical workspace

1. Depth of workspace. You must ensure the depth of the workspace measured from exposed, live parts or from the front of an enclosure is in accordance with the Electrical set standards measurements.
2. Width of workspace. The width of the workspace must be wide, but no less than the width of the equipment. Measure the width of the workspace from left to right, right to left, or from the centreline of the piece of equipment. In all cases you must make sure the workspace is of sufficient width, depth, and height to permit at least a 90° opening of all equipment doors.
3. Height of workspace. The height of the workspace in front of equipment must be measured from the grade, floor, or platform. This pertains to service equipment,

switchboards, and motor control equipment. You can locate equipment such as raceways, cables, wire ways, cabinets, and panels above or below electrical equipment.

Common Electrical Issues/ problems Management

Electrical problems can be scary. They don't just damage the appliances but also pose a risk to life and property. Issues like high electricity bills, flickering lights, etc., indicate an electrical problem. Let's look at 5 common electrical problems and solutions.

1. Poor Circuit Protection
   - *No RCCB* – Residual Current Circuit Breaker (RCCB) is a device that detects and prevents low voltage circuit if there is a current leak. It disconnects the load from the main supply when the circuit has residual current. Get an RCCB installed as it gives protection against direct and indirect currents, shock and electrical fire.

   - *Constant Tripping of Circuit Breaker* – If the circuit breaker constantly trips, it means there are some issues in the circuit and flow of current. When the circuit breaker trips, just flip the switch on. If the problem persists, you need to call an electrician.

   - *Uncovered Junction Box* – Junction boxes separate one section of wires from another and protect them from external factors. If the box is uncovered, it will be hard to locate which set of wires have problems. Get the junction box covered by a professional.

2. Grounding Issues
   - *No GFCI Installed* – GFCI breaks the circuit if there is an imbalance between incoming and outgoing current. Without GFCI, there is a risk of overheating of electrical wires, shocks, burns, or an electrical fire. Get GFCI installed if you don't have one already.

   - *Ungrounded Connections* – These are connections that do not have a grounding system as an added failsafe. Grounding provides a pathway for the excessive current to flow in case of a short circuit. Make sure all the connections are grounded.

3. Lighting Problems
   - *Light Bulbs Burn Out Too Frequently* – If your light bulbs go out too often, it could indicate electrical problems. Bulbs can burn out if: Wattage is too high, High voltage, Improper air circulation, and the bulb is fixed too tightly, Bad wiring on mains or circuit. If you face this problem often, check if the holder is loose. Bring in a professional to determine the root cause of the problem.

   - *Flickering Lights and Too Bright or Dim Lighting* – If you notice the lights flickering or if one is brighter or dimmer than the others, there could be two reasons for that. They either consume different wattage of power or the main power panel has technical problems.
   - If the bulbs are of different wattage, there would be no issue, but if there is a problem in the power panel you need to call a professional.

4. Electrical Shocks
   - You may experience electrical shocks when you turn an appliance on or off. Even if the shocks are mild, it is an indication that the appliance has an electrical problem or

there are issues with the wiring. You can plug in another device and see if you face the same problem. If the results are reproducible, call in an electrician to fix the problem before anyone gets hurt.

5. High Electricity Bills
   - Some reasons why you may get a high electricity bill are: Damaged wiring and circuit, Leakage in electrical systems, Electrical devices are outdated and consume more power. You can reduce the cost of electricity bills by switching to more cost-effective devices and unplugging appliances when they are not in use. Repair damaged wires and identify electrical devices that may be causing power surges.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to identify electrical technological issues and problems then manage and solve them. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Electrical Safety

Lesson Objective: Students will be able to:

1. Define electrical safety
2. Describe the importance of understanding and applying electrical safety

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Electrical safety Tips for electrical safety	Define and describe with examples through research on tips on electrical safety, workplace and common electrical issues/problems and how to manage them	Appreciate responsible, safety and betterment of outlook on human lives.	Express understanding of Careful application and responsibility by showing positive attitude and confidence when Identifying and explaining electrical safety and its tips through collaborative presentations

Teaching Strategies

- Students engage in brainstorming exercise to discover define electrical safety and why do we observe electrical safety.
- design guiding questions that will enable them to conduct research on tips and importance of electrical safety
- Discussions in groups on the research findings and facilitate students' research findings as a class discussion.

Learning Strategies

Activity 1 Brainstorming activity on electrical safety
Activity 2 Conduct research on tips and importance of electrical safety.
Activity 3 Discussions and presentation of research findings on electrical safety.

Teacher	Students
Introduction	
1.Present pictures on electrical incidents. 2.What is electrical safety and what is its importance?	1.Look through the pictures to understand the importance of observe electrical safety 2.Think about the key questions to lead into the lesson.
Body	
Teachers share an personal or third-party experience on electrical incident. **Activity 1:** Brainstorming Activity. **Activity 2:** conduct a video analysis. **Activity 3:** Group Presentation.	Listen attentively and work out the area of electrical safety that could have been followed to avoid the incident mentioned. Do brainstorming activity. Carry out a video review in pairs. Do Group presentation on the video review.
Conclusion	
Conclude lesson with main concepts being explained.	Take lesson notes.
Assessment	
Assess the research and presentation activity.	Complete assessment task.

Resources

Video or electrical incident or a case study

Lesson 2: Electrical workspace

Teaching Strategies

Teacher takes students to visit an electrical workspace. Students are guided to discuss and present views on reasons for such workstations organisation.

Learning Strategies

Students are grouped to do observations of an electrical workspace and present views.
Activity 1: Group observation and discussion
Activity 2: Presentation of observations

Resources

Electrical workspace and notes

Lesson 3: Common Electrical Issues/ Problems Management

Teaching Strategies

Teachers guide students to discover common issues or problems electrical technology personnel face on daily basis in term of electrical work and issues in the workplace among co-workers and employer. Identify industry personnel to share experience to the students.

Learning Strategies
Students listen attentively to the industry personnel's experience and do extra research and present in small groups then in class after identifying issues and problems encountered in the electrical technological environment.
Activity 1: Students conduct individual research and present in small group discussions.
Activity 2: Then they identify the most common from all presentation in small groups then present in class.

Resources
Lesson Notes

STEAM Activity Students work in groups to create an activity incorporating the electrical technological environment. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to electrical technological problems. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Identify common electrical technological problems and issues.
2. identify solutions and manage for common electrical technological problems issues with innovation and creativity

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Identify common electrical technological problems and issues.	Confidently identifies any issues and problems in the electrical technological Environment	Identifies common issues only in the electrical technology environment	Lacks confidence in identifying the issues in the electrical technological environment	Cannot identify any problems or issues in Electrical Technology environment
2. Identify solutions and manage common electrical technological problems issues with innovation and creativity	Confidently work out solutions and manage electrical technology issues with creativity and innovation	Work solutions out for electrical technology problems and issues but not innovatively or creatively.	No innovation in providing solutions and managing of issues	Cannot work out solutions and is not creative or innovative.

UNIT 2. Electrical Technology

Content Standard 3.2 Investigate, analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving quality of life responsive to individual, community and industrial needs.

Benchmark 10.3.2.2 Investigate the social applications of electricity for improvement of the quality of life and solutions to problems in the made environment.

Topic 2: Social Applications of Electricity

Learning Objectives

By the end of this topic, the students will be able to;

1. Explore the social application of electricity to improve quality of human life
2. Identify solutions to electrical problems to improve social application of electricity

Essential Questions:

1. What are the effects of electrical as a social application in improving quality of life?
2. How do we conserve electrical energy?
3. What is the level and impact of the cost of power and its installation?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Social application of electricity, solutions to electrical issues	Investigate and explore social application of electricity, solutions to electrical issues	Appreciate, responsible and betterment of outlook on human lives.	Express understanding of Safety conscious and responsibility by showing positive attitude and confidence when Investigating and exploring social application of electricity and solutions to electrical issues through collaborative presentations

Technology and Industrial Arts Application: Construction Technology, Electrical Technology

Content Background

Social Applications of Electricity

Electrical energy is used throughout the world to power devices, appliances and methods of transportation utilized in daily life. To make things operate, electrical energy must be emitted from energy sources such as power plants, to enable an object to consume the power it needs to function. As a result, the electrical energy permits people to watch television in their home, or purchase soda from a vending machine because the electrical energy is available.

Electricity in the changing world

The changing world of energy is making it increasingly challenging to optimize power reliability, energy costs, and operational efficiency in critical power environments such as hospitals, data centers, airports, and manufacturing facilities. Utility power grids are getting more dynamic, facility power distribution systems are becoming more complex, and cyberattacks threaten network stability. More competitive pressures and environmental regulations are pushing expectations for energy efficiency and business sustainability higher than ever. Addressing these challenges requires new digital tools designed specifically to enable faster response to opportunities and risks related to power system reliability and operations.

In recent years, teams managing medium and large sized facilities have recognised that energy represents a significant line item in their operational costs. Many have also experienced how the quality and reliability of their electrical power impacts operational uptime and, in turn, has negative impacts to their bottom line. Therefore, many organisations have established power and energy management programs. A variety of information and analysis tools are now available that help facility teams use a balanced approach in mitigating risks to every aspect of their power supply, from energy efficiency to power quality (PQ) and reliability. However, for facilities with critical power needs – such hospitals, data centers, airports, and industrial plants – ensuring high power efficiency and availability remains a very challenging prospect.

Wise usage of electricity

We enjoy a very comfortable life by using electric energy, but we must also be aware that energy is a limited resource. Further, global environmental problem literally became a global concern for us all and each of us is expected to consume energy wisely in our daily lives. This is not really difficult. Just being a little cautious, you can conserve energy without much trouble. Using energy wisely can even reduce your electricity bill. Using energy wisely and conserving energy efficiently are two major global issues. It is always a good idea to minimise household electricity costs. Not only does this mean that you minimize expenses, but it also helps the environment (i.e. minimising use of fossil fuels). It is quite possible to significantly reduce electricity costs, even with relatively easy-to-implement measures.

Cost of power and installations

Electrical power is the rate of electrical energy supply. It is the amount of energy supplied per unit of time. In simpler terms, it is how fast the electrical energy is supplied. Power is measured in watts (W).

We can calculate the power using the formula:
Power = energy/time (Energy is measured in joules and so this means that power is the amount of joules supplied in a certain period of time. When doing calculations of power, you need to have the energy measured in joules and time measured in seconds.)

1 watt is the same as 1 joule of energy transferred in a second. (1 watt = 1 joule per second)
There are 1000 watts in 1 kilowatt (kW).

Different appliances use different amounts of power, depending on their function. All electrical appliances have a stamp or a sticker which indicates the power rating. If you look at your hairdryer or kettle you should find it easily.

PNG Power charges us for the electrical energy we use in our homes. PNG Power charges us based on our energy consumption. The more electrical energy we use to run our household electrical appliances, the more PNG Power charges us.

How do we work out how much energy we use? Think for example of using a 1000 W microwave to warm your food for 1 minute. How much energy is transferred? We can rearrange the following equation:

Power = energy/time So that we have:
Energy = power × time (In this formula, energy is measured in joules, time is measured in seconds and power in watts.)
Therefore to calculate the energy consumption of using a 1000 W microwave, we can calculate it as follows:
Energy = Power × Time
= 1000 W × 60 s
= 60 000 J

PNG Power now wants to work out our energy consumption for the whole month for all the appliances in your home. If 60 000 J of energy were used to warm food for 1 minute, then you can see that we would calculate an extremely large number for our energy consumption for the whole month in joules. This is not practical for electricity bills. We therefore have an alternative unit for energy consumption.

The quantity used for energy consumption is the **kilowatt-hour** (kWh). 1 kWh is the energy used if a 1000 W appliance is used for 1 hour.

Example.
Have you ever notice your fridge start humming after a period of silence? Fridges are extremely energy-expensive electrical appliances. To keep the temperature at a constant cool temperature, fridges contain a thermostat that measure how cool the air is inside your fridge. When the temperature inside the fridge warms beyond a certain point the thermostat will switch on the energy-expensive compressor and condenser. Fridges are specially insulated so try keep cool air inside, and the energy demands of a fridge varies greatly depending on how often the doors are opened, and what is kept inside.

Imagine now, that you left the fridge door open by accident as you rushed to school and didn't notice until the next day! We now want to work out how much it costs to run a fridge with a power rating of 2200 W for a day.

COST = POWER RATING × TIME × PRICE
power rating = 2200 W= 2,2 kW
time = 24 hours
price = K0.35 kWh
cost = 2.2 kW × 24 hours × K0.35 kWh
= K18.48
The cost is K18.48 to run a fridge for 1 day.

Download tariff3May 2013 – PNG Power for more Electricity Tariffs

Teaching and Learning Strategies
Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to how social application of electricity impacts lives. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Electricity in the changing World

Teaching Strategies
Students engage their experience and world around them in brainstorming exercise to discover how electricity is changing the world evolutions.
Discussions in groups on the research findings.

Learning Strategies
Students share their views and experience of the world around them and how electricity affect them both positively and negatively.
Activity 1 Brainstorming activity on the negative and positive effects of electricity on people and the way they do things.
Activity 2 Discussions and presentation on the positive and negative impacts of electricity of electricity on people and the way they do things.

Resources

Lesson 2: Wise usage of Electricity

Teaching Strategies
Teachers encourage students to carry out survey on Wise usage of Electricity on Teachers and students in the school to work out how each conserves energy. They construct survey questions and tasked them to write a report when they finish collect survey data. Eventually facilitate students' report presentation.

Learning Strategies.
Students design questions and do up a survey questionnaire to run and collect information on how people use electricity wisely. They then design put together data collected and present findings.

Activity 1: Design and prepare survey questionnaire.
Activity 2: Put together data on the chart or graph from the survey.
Activity 3: Present findings and conclusions on how we can conserve energy in our own little ways.

Resources
Charts, markers, A4 papers, computers (for PowerPoint presentation)

Lesson 3: Cost of power and installations

Teaching Strategies
Teachers present students with case study of information on cost of power and installations and present questions for students to read and comprehend answers from the cost of installation notes. Then facilitate students as they share by answering questions.

Learning Strategies
Students in small groups or in pairs do the case study and present views on the impacts of the cost of Power installations.

Activity 1: Read through case study and analyse findings.
Activity 2: Present and discuss analysis with classmates.

Resources
Worksheet on cost of power and electrical installations

STEAM Activity Students work in groups to create an activity incorporating the social applications of electricity. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to understand and analyse how social application of electricity impacts lives. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.
Performance Assessment

1. Explore the social application of electricity to improve quality of human life
2. Identify solutions to electrical problems to improve social application of electricity

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Explore the social application of electricity to improve quality of human life	Explores social application of electricity and states clearly an example of how electricity contribute meaningfully to quality of human life	Generally states how electricity improve quality of human life	Not confident in explaining the social application of electricity	Not able to explore and cannot explain
2. Identify solutions to electrical problems to improve social application of electricity	Confidently identifies solutions to electrical problems to improve social application of electricity	Identifies few solutions to improve social application of electricity	Lacks confidence in identifying solutions to improve social application of electricity	Cannot identify at all

UNIT 2. Electrical Technology

Content Standard 3.2 Investigate, analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving quality of life responsive to individual, community and industrial needs.

Benchmark 10.3.2.3 Use technology to organise and manage electrical activities responsibly and effectively considering the interrelatedness of systems as a context for problem solving.

Topic 3: Technologies in Electrical

Learning Objectives

By the end of this topic, the students will be able to;

1. Apply technology such as computer applications, to organise electrical activities in inter-related systems.
2. Use technology such as emails, fax and telecommunication to manage Electrical activities in inter-related systems.

Essential Questions:

1. What are the computer applications used in electrical technology to organise electrical activities?
2. How do emails, fax and telecommunication manage electrical activities?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Technology, Electrical activities and systems	Use, organise and manage Technology, Electrical activities and systems through computer applications & telecommunications	Appreciate, value, considerate and responsible	Awareness and considerate to anticipate problems is shown through positive attitude and confidence when Investigating and exploring Technology, Electrical activities and systems through collaborative presentations

Technology and Industrial Arts Application: Construction technology, Electrical Technology

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Content Background

Computer applications

Computer applications help electrical work efficient and accurate and more organised and is manageable.

Types of computer applications that are useful in Electrical technology

1. Microsoft Office

Microsoft Office is a collection of office-related applications. Each application serves a unique purpose and offers a specific service to its users. Here's a short description of the apps and their purpose:

- Word – to create documents, flyers, publications
- PowerPoint – to create presentations
- Excel – to store, organise, and manipulate data
- OneDrive – to store data online
- OneNote – to organise data you collect including handwritten notes, drawings, screen captures, audio clips, and more
- Publisher – to create extensive publications, posters, flyers, menus
- Outlook - to manage email and calendars, to do lists, and contacts
- Access – to capture and analyse data from computers or networks

Microsoft has designed the applications in the suites to work together seamlessly. If you take a look at the list above you can imagine how many combinations of apps can be used together. For instance, you can write a document in Word and save it to the cloud using OneDrive. You can write an email in Outlook and attach a presentation you've created with PowerPoint. You can import contacts from Outlook to Excel to create a spreadsheet of the people you know, their names, addresses, and so on.

2. Pspice (Electrical Schematic Software)
   Or CAD EE PSpice is a SPICE circuit simulator application for simulation and verification of analog and mixed-signal circuits. PSpice is an acronym for Personal Simulation Program with Integrated Circuit Emphasis.

   Or CAD EE typically runs simulations for circuits defined in Or CAD Capture, and can optionally integrate with MATLAB/Simulink, using the Simulink to PSpice Interface (SLPS). Or CAD Capture and PSpice Designer together provide a complete circuit simulation and verification solution with schematic entry, native analog, mixed-signal, and analysis engines.
   https://www.eepowerschool.com/softwares/10-must-learn-electrical-engineering-software/

3. Multisim (Circuit Simulation & PCB Design Software)
   Multisim integrates industry-standard SPICE simulation with an interactive schematic environment to instantly visualize and analyse electronic circuit behavior. Its intuitive interface helps educators reinforce circuit theory and improve retention of theory throughout engineering curriculum. By adding powerful circuit simulation and analyses to the design flow, Multisim helps researchers and designers reduce printed circuit board (PCB) prototype iterations and save development costs.
   https://www.eepowerschool.com/softwares/10-must-learn-electrical-engineering-software/

4. Auto Cad and 3D CAD
   AutoCAD is a computer-aided tool that allows many different types of designers to create diverse kinds of drawings and designs. This program helps designers create their designs much more quickly than by hand and offers many quick, easy, and useful features, such as copy and paste.

   AutoCAD can create any 2D drawing and 3D model or construction that can be drawn by hand. The program also allows the user to group or layer objects, keep objects in

a database for future use, and manipulate properties of objects, such as size, shape, and location.

Telecommunication

1. Email and Fax

- A company needs to implement etiquette rules for various important reasons:
  Professionalism: by using proper email language your company will convey a professional image.
  Efficiency: emails that get to the point are much more effective than poorly worded emails

General Email Etiquette

- Include a clear, direct subject line.
- Use a professional email address.
- Think twice before hitting 'reply all.'
- Include a signature block.
- Use professional salutations.
- Use exclamation points sparingly.
- Be cautious with humour.
- Know that people from different cultures speak and write differently.
- Reply to your emails--even if the email wasn't intended for you.
- Proofread every message.
- Add the email address last.
- Double-check that you've selected the correct recipient.
- Keep your fonts classic.
- Keep tabs on your tone.
- Nothing is confidential--so write accordingly.

"A basic guideline is to assume that others will see what you write," she says, "so don't write anything you wouldn't want everyone to see." A more liberal interpretation: Don't write anything that would be ruinous to you or hurtful to others. After all, email is dangerously easy to forward, and it's better to be safe than sorry.

2. FAX

A fax machine uses a telephone line to send and receive data to create and print documents. They will not work through an internet-based phone line. Be sure to have an active phone line and a phone number for the fax machine so your machine can transmit and receive signals to create the documents

FAX procedures

1. Create a fax cover page for your transmission. Most companies have a standard cover page with the company logo and space for the number of pages to be transmitted, including the cover page. Include sender contact information in case there is a transmission problem, and recipient information so the document can be delivered to the right person.
2. Place the pages on the tray so that the cover page will transmit first. Most fax machines have an input tray or slot to receive the document to be transmitted. Be sure you orient

the document according to the instructions that are usually found on the machine or tray itself. If you place it the wrong-side down, you will transmit a blank sheet of paper.
3. Enter the phone number of the destination fax machine on the fax machine's keypad. Your business's phone system may require you to enter a number to acquire an outside line, so be sure to follow your internal procedures for phone calls.
4. Press the "Start" or "Send" button to begin the transmission. The fax machine scans the document, dials the destination number and transmits the document. When finished, it prints a transmission status page with either an "OK" or a "Transmission Failed" message. If the latter is the case, repeat the process.

Computer and Scanner application in FAX

1. Scan the document you want to transmit into a word processing document or an imaging document. Settings depend on your particular scanner, but should be at least 300 dots per inch, or dpi. Document types available may be "Image," "Text," "Color" or "Black and White."
2. Click "File," then "Print." If you have fax software installed, you should see "Fax Printer" as one of the options. If you do not see this option, install the fax machine's software on your computer. Select the "Fax Printer" and click "OK" to start the fax information dialog process.
3. Enter information into the dialog boxes. This includes sender and recipient information, as well as the phone number of the recipient's fax machine. You may have the option of sending a cover sheet that will incorporate all of this information. Click "OK" or "Finished" on the final dialog to start the fax process and open the fax monitor window. If your computer's volume is on, you hear the dial process begin, and when the fax is sent, you get a confirmation in the fax monitor window.
https://smallbusiness.chron.com/fax-step-step-48323.html

3. Telephones

Telephone Communication is the transmission of speech over a distance either by electric signals propagated along conductors or by radio signals; a type of telecommunication. Telephone communication permits conversations to be carried on between people (subscribers) separated by almost any distance.

There are three basic types of business telephone systems: KSU, PBX, and VoIP. For each of these systems, there is a hosted (cloud) and a non-hosted version. Let's take a closer look at how they differ.

i. Key system units

The most basic phone system is the key business telephone system that uses the Key System Unit (known as the KSU). This type of system is only suitable for small businesses with no more than 40 employees working as phone operators, due to the limitations of the number of phone lines incorporated into it. It's an easy-to-use system, relatively comparable to a home telephone system. It has all the basic features a business will need; however, it lacks portability and flexibility. It uses a central switching device – the key system unit – to manually determine the phoneline selection.

ii. Private branch exchange

Another type of system is the private branch exchange system (known as PBX). This is a more advanced system than the KSU and KSU-Less systems, and as such, it has more features. It uses *p*rogrammable switching devices, allowing for the

automatic routing of incoming calls. This type of business phone system is suitable for a company with 40-plus employees, as it's a much more automated system. Another major advantage of the PBX system is that it features an uninterruptible power supply (UPS), allowing a business to remain functional for some time, even without electricity.

iii. Voice over Internet Protocol

The latest telephone innovation offered for businesses is Voice over Internet Protocol (known as VoIP*)*. This is the most advanced system by far, allowing a potential client and phone operator to communicate with each other even if the two are in completely different countries. It works with the use of both the internet and a computer. However, this also makes it the most costly system, with the cost determined by the number of employees needing to use the system. The main benefit of this system is that all functionalities can be accessed via a computer.

TELEPHONE ETIQUETTES

1. Answer a call within three rings.
    a. If your position entails always being available to callers, you should actually be available. That means staying focused and answering calls immediately. The last thing you want to do is keep a customer waiting after a string of endless ringing or send them to voicemail when you should've been able and ready to reply.
    b. As long as you're alert and at your phone at all times — excluding breaks — this rule should be fairly simple to follow. However, we recommend responding within three rings in order give yourself enough time to get in the zone and prepare for the call. Picking up the phone right away might leave you flustered.
2. Immediately introduce yourself.
    a. Upon picking up the phone, you should confirm with the person whom they have called. In personal calls, it's sufficient to begin with a "Hello?" and let the caller introduce themselves first. However, you want to allow the caller to know if they've hit a wrong number, as well as whom they are speaking with.
    b. Practice answer the phone with, "Hi, this is [Your first name] from [Your company]. How can I help you?" Your customer will be met with warmth, which will encourage a positive start to your call. And, if it ends up being an exasperated college student trying to order pizza, they'll at least appreciate your friendliness.
3. Speak clearly.
    a. Phone calls, while a great option for those who detest in-person interaction, do require very strong communication skills. For one, the person on the other end of the line can only judge you based on your voice, since they don't get to identify your body language and — hopefully — kind smile.
    b. You always want to speak as clearly as possible. Project your voice without shouting. You want to be heard and avoid having to repeat yourself. A strong, confident voice can make a customer trust you and your support more. In case of bad cell service or any inability to hear or be heard, immediately ask to hang up and call back.
4. Only use speakerphone when necessary.
    a. We all know the trials of speakerphone. It's easier for you because you can use your hands to multitask. However, for the other caller, it's like trying to hear one voice through a honking crowd of taxis in Manhattan — impossible and frustrating.

   b. Give your customers your full attention, and avoid speakerphone. This will make it easier for both parties to be heard, and it will ensure that you're actually paying attention to them. You may need to use speakerphone at rare occasions, such as when it's a conference call or when you're trying to troubleshoot on the phone. While speakerphone may be appropriate at these times, it's always better to use a headset to remain hands-free.
5. Actively listen, and take notes.
   a. Speaking of paying attention to your customers, it's essential that you're actively listening to them throughout the conversation. Actively listening means hearing everything they have to say and basing your response off of their comments, rather than using a prescribed script. This proves to your customers that you're present and are empathetic to their inconveniences.
   b. It's helpful to take notes during support calls. You'll want to file a record post-conversation, and notes will be immensely helpful. It also ensures that, during long-winded explanations from customers, you can jot down the main points and jump into problem-solving without requiring them to repeat.

6. Use proper language.
   a. A key difference between professional and personal phone calls is obvious — the language. It might be acceptable to use slangs when talking on the phone with your friends, but this kind of language can cause you to lose a customer for life.
   b. Always be mindful and respectful when on the phone. You never know what customers might be offended by something you say, so it's best to use formal language. It's okay to throw in humour if appropriate, but never crack a joke that could upset a customer.
7. Remain cheerful.
   a. You never know when a customer is having a bad day. When someone is rude to you on the phone, your immediate reaction may be to put them in your place. First, though, take a moment to step into their shoes and recognize why they're so upset.
   b. The point is to always remain positive and friendly, especially in the face of negativity. Your optimistic outlook may be enough to turn a failing phone call right around. Remind yourself that the last thing your customer probably wanted was to spend their afternoon on the phone with customer support. So, make that call the best it can be, and it may create a loyal, lifetime customer.
8. Ask before putting someone on hold or transferring a call.
   a. There's often nothing more infuriating than being put on hold. After waiting on hold for ten or fifteen minutes to speak with a real-life human being, you finally get to explain your problem. Then, you're immediately put back on hold and then transferred to someone else to whom you must re-explain the whole problem. Talk about exhausting.
   b. However, if you must put a customer on hold or transfer their call, always ask for their permission first. Explain why it's necessary to do so, and reassure them that you — or another employee — are going to get their problem solved swiftly. By keeping your customer in the loop, they'll be less inclined to complain about a long wait time.
9. Be honest if you don't know the answer.
   a. You might need to put a customer on hold or transfer their call if the dreaded occurs — you don't know the solution. Perhaps you've tried everything you can or simply have no idea what they're talking about. Don't panic; customer support

representatives are humans, too, and it's okay not to be the omniscient voice of reason.

b. It's best to admit when you don't know something, rather than making excuses or giving false solutions. However, tell them that you're going to do everything you can to find an answer and get back to them momentarily, or find a co-worker who does know the answer. Customers don't typically expect you to have all the solutions at hand, but they will expect you to be transparent.

10. Be mindful of your volume.
    a. You may be so focused on your phone call with a customer that you're barely paying attention to your present setting. When working in a call center, things can get pretty loud. You always want to be mindful of your volume and ensure that you're not disrupting the ability of your co-workers to speak to customers and get their work done.
    b. If you are on a call that requires you to speak louder due to a bad connection or a hard-of-hearing customer, simply step out of the room and speak with them separately. Your customers are always your main concern, but you don't want to inhibit the work ethic of others in your workplace.
11. Check for and respond to voicemails.
    a. It's quite possible that a customer might reach out to you when you're on a break or after you've left work for the day. If it's possible for you to receive voicemails, make sure you're always checking for them. It's easy for a voicemail to slip under the radar, but the customer won't easily forget.
    b. Start and end each day by checking your voicemail. It takes just a few minutes and can avoid a lost customer support request. Your customers will appreciate your prompt response, and you can get on to doing what you do best — providing knowledgeable and friendly support.

These tips should provide you and your team with basic guidelines for phone etiquette and, if executed properly, your company should see significant improvement in customer experience. However, there will be some interactions where these actions may not be enough to defuse the situation. Some customer interactions will require your team to take special measures to ensure you're meeting the customer's immediate and long-term needs. In the next section, we'll break down a few of these scenarios and what you can do to resolve them.

Resources

Fax machine, or computer with scanner attached

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of communication and network. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Computers applications

Teaching Strategies
Students engage in brainstorming computer applications used in electrical activity.
They then are assigned to one application discover and they do research on how it is applicable in electrical technology. Teacher facilitates discussions in groups on the research findings.
Learning Strategies
Activity 1 Brainstorming activity on computer applications
Activity 2 Conduct research on an application discovered
Activity 3 Discussions and presentation of research findings
Resources
Internet, notes of common computer applications used in electrical technology

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Lesson 2: Telecommunications

Teaching Strategies
Teacher presents an outline of what email and fax machines are and email etiquette. Distribute each etiquette to a pair for them to discuss and expound with an example.
Engage students in sharing their views and examples on each etiquette. They further bring phones along to new email addresses. They are then shown how to operate a fax machine.

Learning Strategies
Students take note of teachers modelling and work on an email etiquette to explain further with examples.
Activity 1: Listen and take note of lesson presentation from the teacher.
Activity 2: Discuss in pairs to explain an email etiquette in identify an example of the email etiquette given and present
Activity 3: Use mobile phones to create personal email addresses and have hands on to operate a Fax machine.

Resources
Internet, desktop computers, mobile phones, fax machines, telephones and notes on email and telephone etiquettes

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STEAM Activity Students work in groups to create an activity on technologies in electrical. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to aid learning in applying technology such as computer applications and telecommunication to organise and manage electrical activities. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Apply technology such as computer applications, to organise electrical activities in inter-related systems
2. Use telecommunication instruments such as emails, fax and telecommunication to manage electrical activities in inter-related systems

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Apply technology such as computer applications, to organise electrical activities in inter-related systems	Confidently use all Computer applications studied to organise Electrical activities in the interrelated systems without doubt.	Use a few computer applications studied to organise the electrical activities in the inter-related systems	Use just one computer application to organise electrical activities	Not able to use any computer application to sort electrical activities
2. Use technology such as emails, fax and telecommunicati on to manage Electrical activities in inter-related systems	Confidently use fax, emails and telephones to manage electrical activities in the interrelated systems	Use fax, emails and telephones to manage electrical activities	Need assistance when handling fax, emails and telephones	Cannot operate fax, emails or telephones.

Unit 3: Plumbing Technology

Unit	Benchmark	Topic	Lesson Titles
3.Plumbing Technology	**10.3.3.1** Describe and apply the main components of plumbing that link to Building system	Topic 1: The main components of plumbing system.	1. Introduction to Plumbing system. 2. Components of plumbing systems. 3. Water distribution system. 4. Drain, waste, vent system.
	10.3.3.2 Identify and apply OHS on plumbing tools and materials in the workplace according to OHS standards	Topic 2: OHS on plumbing tools and equipment, materials	1. Personal Safety 2. Safe Handling of Plumbing Tools and Equipment
	10.3.3.3 Investigate and apply plumbing tools and materials into their categories such, plastic pipes and fitting Cast Iron pipes &fittings	Topic 3: Plumbing tools and materials.	1.Types of manual plumbing tools. 2. Types of power plumbing tools. 3. Categories of plumbing materials.
	10.3.3.4 Analyse and interpret isometric drawing, pictorial drawing Orthographic drawing	Topic 4: Applications of trade drawings in Plumbing	1. Construction Blueprints 2. Plumbing Sketches

UNIT 3. Plumbing Technology

Content Standard 3.3 Investigate and analyse the concepts and underlying theories in plumbing materials, tools and equipment.
Benchmark 10.3.3.1 Describe and apply the main components of plumbing that link to Building system.

Topic 1: The Main Components of Plumbing System

Learning Objectives
By the end of this topic, the students will be able to;
1. Discuss functions of the main components of the plumbing system.

Essential Questions:
1. What makes up the main components of a plumbing system?
2. What are the key functions of each of the components in a plumbing system?
3. What major role do plumbing and pipe fittings play in the construction of buildings?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Main concepts of plumbing that links to Building System.	Describing and applying through research components of plumbing system, water distribution system inclusive of Drain, Waste, Vent (DWV) system	Appreciation of the components of plumbing system, water distribution system inclusive of Drain, Waste, Vent (DWV) system Diligence, patience and betterment of outlook on human lives.	Confidence is shown through positive attitude when Describing and applying through research components of plumbing system, water distribution system inclusive of Drain, Waste, Vent (DWV) system through collaborative presentations

Technology and Industrial Arts Application: Construction Technology; Plumbing Technology

Content Background

Introduction
The plumbing and sanitary system is an essential part of every house or building. Proper planning and designing of plumbing system is crucial as it takes care of the hygiene requirements of the occupants. It has been reported that about 8 per cent of the construction cost of a building is marked for plumbing and sanitary work.

A plumber's role consists of installation, repair, maintenance and servicing of plumbing fittings and fixtures. Besides having a thorough understanding of the mechanisms required for performing various tasks, a plumber should be laborious, have effective communication skills and be a result-oriented worker with a positive attitude.

Role of Plumbing

Water is supplied to a house or a building from storage tanks through pipes. Similarly, the waste water from kitchen and washrooms is drained out with the help of pipes. Any building, be it a residential, commercial or industrial, cannot function properly without having plumbing and sanitary arrangements in place. It is, therefore, important to have regular and adequate water supply and a proper system for the disposal of waste water.

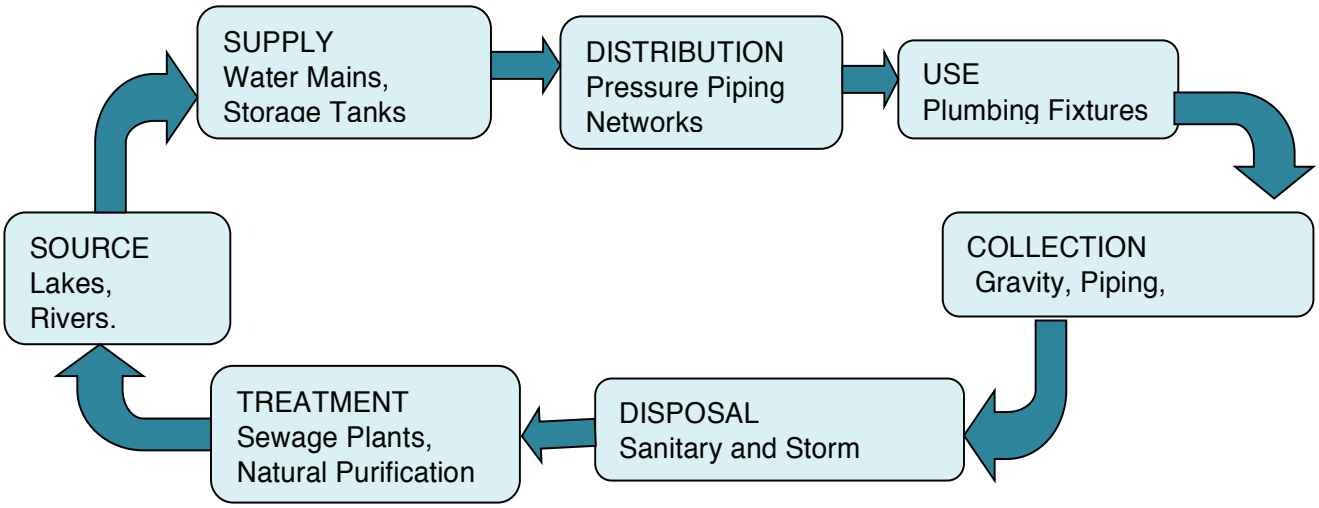


Figure 3.1a.Plumbing Cycle
Source: https://ncert.nic.in/textbook/pdf/iepg101.pdf

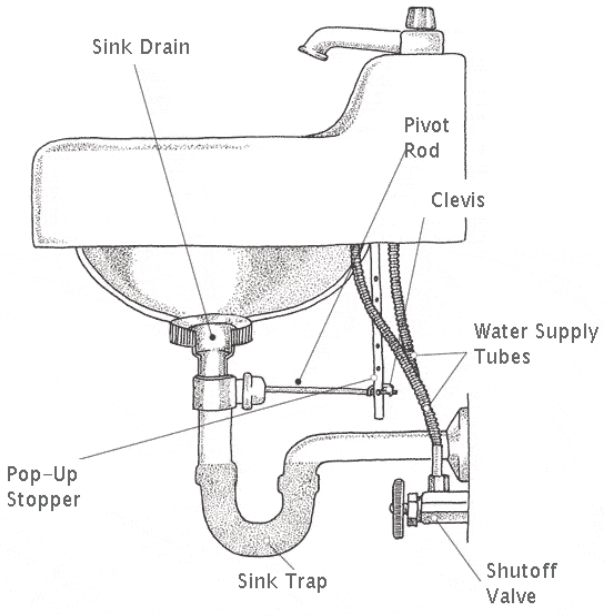


Fig. 1.3:b Washbasin and its components
Source: https://ncert.nic.in/textbook/pdf/iepg101.pdf

Plumbing cycle refers to a mechanism through which water is taken from a source, then supplied to the users, and finally waste water is collected and recycled to the source after proper treatment. Plumbing and pipe-fittings play a major role in the construction of all types of buildings. An efficient plumbing work keeps the atmosphere free from bad smell and ensures better sanitation. The skill and art that is needed to transport water from the source to the users, then to the treatment plants, and finally supplying the treated water to the users through a distribution system is known as plumbing. It is a system of pipes and fittings that carry water.

Sanitary Work

Sanitary work refers to carrying the waste water to the waste disposal system (sewerage system) through plumbing fixtures.

The plumbing installation is governed by the regulations and rules. Plumbing and sanitation work thus plays an important role in the construction of a building.

A plumbing system consists of pipe fittings and appliances used for water supply and drainage, as you see the fitting for the washbasin in Fig. 1.1. In this system, different pipes are used for different purposes. The plumbing system includes:

- water supply, galvanized iron (or plastic) pipes and fixtures;
- soil pipes and fixtures;
- sanitary drainage system; and
- rainwater drainage system.

For an efficient plumbing system, it is important that standard plumbing and sanitary material are used. It is also important that quality workmanship, practical checks and supervision are ensured during plumbing and sanitary work. It helps in getting the best out of the skilled and unskilled labour.

Before starting the work, the plumber must keep the following points into consideration;

1. Water supply system: sources of clean and potable water
2. Plumbing fixtures and pipes: knowledge about different requirements and specifications
3. Sanitary and drainage system: knowledge about sewerage system
4. Rainwater drainage system
5. Plumbing drawing and their uses: role of plumbing drawing

Components of a plumbing system.

Each plumbing system has three major components: pipes and fittings, drainage, and fixtures. Knowing how the plumbing system works in home helps find the best and safest plumbing pipe and helps minimise plumbing emergencies. With proper maintenance and proper installation, one can enjoy years of a stress-free plumbing system. Having better insight into the plumbing system will bring understanding on how the system works and to better diagnose problems when they occur.

1. Pipes and Fittings

The plumbing system runs throughout a home. One might have plumbing in his kitchen, basement, bathroom, and even garage. The pipes and fittings include every pipe that runs throughout a home from the main water supply lines. This includes the safest plumbing pipe for one's water supply. Most systems have cold water and hot water pipes. Each pipe can withstand a certain temperature. These pipes and fittings can be made of a variety of materials including:

- Copper
- Brass
- Lead
- PVC
- CPVC

These pipes and fittings connect throughout a home from kitchen to bathroom.

2. Plumbing Fixtures

The plumbing fixtures connect to the pipes and give you access to your water supply. These are devices that are supplied with water and discharges wastes into the drainage system directly or indirectly. Plumbing fixtures include:

- Sinks
- Bathtubs
- Hot Water Heater
- Washing Machines
- Dish Washers
- Toilets

Each fixture needs to be properly installed and maintained to save on water usage and minimize leaks.

Being knowledgeable about how to maintain bathroom fixtures will maximize their life span and decease unwanted plumbing emergencies.

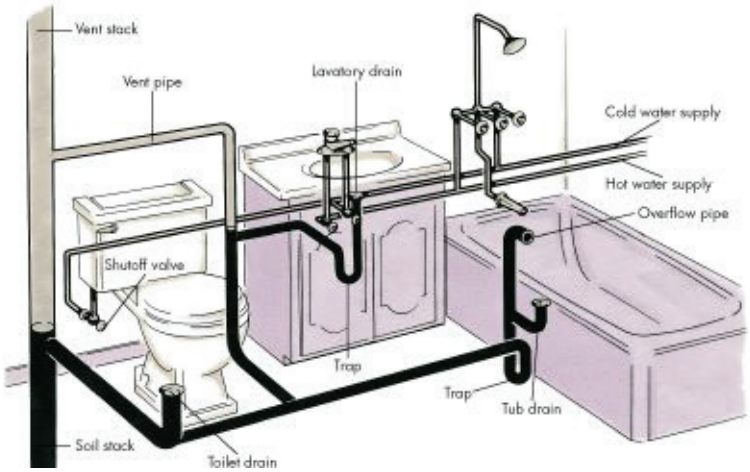


Fig. 1.3: c Washbasin and its components
Source: https://ncert.nic.in/vocational/pdf/kepg204.pdf

3. The Drainage System

Outside of a clogged toilet, the drainage system is a key part of your plumbing system that might cause a costly emergency. The drains connect the plumbing fixtures to the waste removal lines and the sewage system. Be sure to avoid clogging the drains. This allows sewage and waste to pass through freely without clogging.

When clogs occur, household chemical drain cleaners and plungers can address minor drainage problems.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the main components of a plumbing system. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Introduction to plumbing system

Teaching Strategies
Students engage in brainstorming exercise to discover the plumbing system
They then are allowed to design guiding questions that will enable them to conduct research on the plumbing system
Discuss in groups on the research findings with presentations of research on plumbing system.

Learning Strategies
Activity 1 Brainstorming activity on the plumbing system
Activity 2 Conduct research on plumbing system
Activity 3 Discussions and presentation of research findings plumbing system

Resources
Teacher notes and the actual piping system in residences and the school.

Lesson 2: Components of Plumbing system

Teaching Strategies
Engage students in presentation of Plumbing system and its components and what their functions are
Engage students in the discussion of the plumbing system in the school
Learning Strategies
Discover the components of the plumbing system in relation to the plumbing system in the school.

Activity 1 Class presentations and discussions on the components of the plumbing system in the school,
Activity 2 Discussion of components of the plumbing system and its function
Activity 3 Discussion components of plumbing system in the school

Resources
Teacher notes and the actual piping system in residences and the school.

Lesson 3: Water Distribution System

Guided discovery of the water distribution system and that of the school

Teaching Strategies
Guided Discovery of water distribution system and study how the water distribution system works in the school.

Learning Strategies
Activity 1 General discussion of guided discovery activity on the water distribution system in the School.
Activity 2 Use sketching skills to sketch the water distribution system of a building in the School.
Activity 3 Presentation of research and the sketch of water distribution system of a building in the school.

Resources
Teacher notes and the actual piping system in residences and the school.

Lesson 4: Drain, waste, vent system

Introduce students to Drain, Waste, Vent System or DWV system.

Teaching Strategies
Introduce the DWV system, what it is and how it works, and its importance.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the terms are and what it is and how it functions and its importance.
Activity 1 Develop guiding questions for research on DWV system.
Activity 2 Conduct the research in groups.
Activity 3. Presentation of findings of research followed by discussions on the presentations**.**

Resources
Teacher notes and the actual piping system and components in residences and the school.

STEAM Activity Students work in groups to create an activity incorporating the main components of plumbing system. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to describe and apply the main components of plumbing that link to building system. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define main components of plumbing system.
2. Describe main components of plumbing system.
3. Identify types of plumbing system.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define main components of plumbing system.	Define main components of plumbing system using correct language with example.	Define main components of plumbing system using correct language	Define main components of plumbing system incorrect language with no examples.	Very poorly defines main components of plumbing system.
2. Describe main	Describe main	Describe main	Describe main	Very poorly

components of plumbing system.	components of plumbing system using correct language with examples.	components of plumbing system using correct language.	components of plumbing system using incorrect language with no examples.	describes main components of plumbing system.
3. Identify types of plumbing system.	Identifies all the types of plumbing systems in the building with correct English and proper terminologies.	Identifies most types of plumbing systems in the building with correct English	Identifies some types of plumbing systems in the building with incorrect English.	Identifies none of the types of plumbing systems in the building .

UNIT 3. Plumbing Technology

Content Standard 3.3 Investigate and analyse the concepts and underlying theories in plumbing materials tools and equipment.

Benchmark 10.3.3.2 Identify and apply OHS on plumbing tools and materials in workplace according to OHS standards

Topic 2: Occupational Health and safety on plumbing tools and equipment, and materials

Learning Objectives

By the end of this topic, the students will be able to;

1. Apply safe practices in handling tools, equipment and materials in plumbing.

Essential Questions:

1. What are the OHS standards in relation to plumbing, plumbing tools and materials?
2. What the effects of non-adherence to OHS standards?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
OHS on plumbing materials, tools, in the workplace according to OHS Standards.	Identifying and applying through research Occupational Health & Safety (OHS) on plumbing materials, tools, in the workplace according to OHS Standards.	The plumbing materials, tools, in the workplace conforming to health and safety standards for the betterment of outlook on human lives.	Awareness and appreciation of OHS on plumbing materials and tools in the workplace according to OHS Standards through collaborative presentations

Technology and Industrial Arts Application: Construction Technology; Plumbing Technology

Content Background

What does a plumber do?

A plumber is a person who installs repairs and maintains plumbing fixtures or systems in businesses, industries or residences.

The main duties of a plumber are to:

- Haul supplies, measure, cut, and shape, assemble and join various materials (e.g. pipes, fittings, fixtures) with various tools, servicing the water supply system, waste disposal, and heating systems.
- Use, clean and maintain various equipment.
- Read, prepare or interpret blueprints and drawings.
- Conform to building codes and other regulations.

- Prepare cost estimates and documentation for clients.
- Supervise apprentices or other workers.

What are some health and safety issues for plumbers?

Plumbers work in a variety of settings, some of which may contain hazards. The main occupational hazards for plumbers to be aware of include:

- Exposure to hazardous substances such as: lead, sulphur dioxide, asbestos, silica, mould, adhesives, solvents, solder, dusts, and other hazardous products.
- Proximity to flammable products.
- Exposure to biohazards including raw sewage when working on sewage pipes or septic tank outlets, when laying new pipe in soil or flood clean-up.
- Potential infection from bird or rodent droppings:
    - histoplasmosis
    - psittacosis
    - hantavirus
- Working in awkward positions, or performing awkward manual tasks which increases the risk of musculoskeletal injuries.
- Lifting heavy or awkward objects.
- Exposure to electricity, extreme temperatures, or noise.
- Working in confined spaces.
- Working at highland fatigues (e.g., on platforms/scaffolding or ladders).
- Risk of eye injury from flying particles.
- Slips, trips and falls, especially when working in wet environments.
- Burns from hot equipment parts, steam lines, and the release of hot water or steam.
- Working with various tools (both hand tools and powered tools).
- Stress.
- Shift work or extended work days.
- Working alone.

What are some good work practices for plumbers?

Safety Procedures

- Follow company safety rules.
- Get training on the potential hazards at the job sites where you are assigned.
- Learn about chemical hazards.
- Use safety data sheets (SDSs) to learn about the chemical properties, health hazards, and required personal protective equipment (PPE) that you will need.
- Know how to report a hazard.
- If you will be working with specific substances – such as lead, asbestos or mould – follow the required work practices for the province in which you are working.
- Follow a recommended shift work pattern, and know the associated hazards.
- Practice safety procedures for:
    - Confined space entry
    - Working at heights
    - Working with hand tools, and power tools
    - De-energising and locking out machinery and equipment before performing maintenance
    - Selection, use and maintenance of personal protective equipment

- Lifting
- Shift work
- Avoiding slips, trips and falls
- Heat exposure

Working Safely with Sewage

Health effects of exposure to sewage and contaminated soil include:

- Tetanus – caused by a toxin produced by bacteria common in soil and sewage.
- Leptospirosis – caused by a parasitic worm.
- Hepatitis A, B or C.
- Bacteria such as *E. coli*, and parasites such as *giardia* and *cryptosporidium*.

Human pathogens from soil and raw sewage can enter the body through the nose or mouth, particularly if a person drinks contaminated water or by touching contamination and then touching your mouth or nose. Exposure can also occur through open wounds or by inhaling (human pathogens in dust, for example).

- Avoid exposure to sewage by wearing gloves, coveralls, rubber boots, eye protection, washing your hands, and decontaminating your equipment after use.
- Do not eat or drink while working in a potentially contaminated area. Wash your hands before meals.
- After working with raw sewage or soil, wash immediately with soap and water. Do not use solvents to wash your hands as the solvents can cause irritation that may lead to skin infections.
- Change out of work clothes before leaving the work site. If any sewage has gotten onto your clothes, change them right away. Soiled work clothes should be sealed in a plastic bag and laundered separately from other clothing. Wash your hands thoroughly after handling the clothing.

Personal Protection

- Use fall protection and other precautions when working at heights.
- Use eye protection when cutting or grinding to avoid eye injuries from flying particles.
- Use appropriate personal protective equipment for the task (e.g. hard hats, eye protection, face protection).
- Wear appropriate footwear (sturdy shoe with a protective toe box and a non-slip sole)
- If working on hot pipes, use heat-insulating gloves and eye/face shields and make sure to drain pipes before you open them.
- To avoid electric shock, only use power tools that are safe for a wet environment and that have a ground fault circuit interrupter. Be cautious when working on metal pipes – if you feel tingling when touching a metal pipe, stop work immediately.
- Install and maintain good ventilation.

Material Handling

- Avoid awkward body positions and repetitive manual tasks, or take frequent breaks. Try to rotate your tasks and take a quick break every 30 minutes.
- Learn safe lifting techniques.

Maintenance

- Keep tools and equipment, and their safety features, in good working order.
- Keep cutting equipment sharp so they will work properly. Cut away from your face and body to avoid cuts and punctures.
- Keep work areas clear of clutter and equipment. Place, stack, or store materials and equipment so they will not cause injury to yourself or other workers.
- Follow good housekeeping procedures – clean up spills quickly; empty waste containers often; discard oily rags and other flammable waste materials safely.

Safety during work

The following precautionary measures may be taken for the safe use of the plumbing tools.

1. Use the correct methods given in the 'Instruction Manual of tools' while using them.
2. Use the appropriate tools required for the specific work or job. For example, do not use pliers instead of a hammer; use only a hacksaw to cut.
3. Keep the tools in working condition and ensure the required maintenance.
4. Ensure that the necessary protective equipment is available.
5. Follow safety methods while using electrical wires.
6. Use kerosene oil for removing dust from rusty nuts.
7. Do not use tools without a handle as they may not give proper grip.
8. Remove burrs or stuck material from the head of the chisel and the edges of tools.
9. Wear safety glasses while using power tools like a drill machine.
10. Keep metal parts lightly lubricated.
11. Do not apply excessive pressure or force.
12. Inspect the tools regularly.
13. Use or wear safety gear (helmet, gloves, goggles, safety shoes, ear plugs, etc.).

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of safety in plumbing. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Personal Safety

Teaching Strategies

Students engage in brainstorming exercise to discover the type of work plumbers do that puts them at health risk.

They then are allowed to design guiding questions that will enable them to conduct research.

Discuss in groups on the research findings.

Learning Strategies
Activity 1 Brainstorming activity on the type of work plumbers do that puts them at health risk.
Activity 2 Conduct research on health risks involved in plumbing work.
Activity 3 Discuss and present research findings.

Resources
Text on introduction to plumbing
Text on OHS in Plumbing work.

Lesson 2: Safe Handling Practices for Tools and Equipment

Teaching Strategies
Engage students in discussion of good practices that plumbers can be engage themselves in to avoid dangers when handling tools and equipment.
Engage students in the presentations of discussions.

Learning Strategies
Activity 1 Research the good practice of a plumber or plumbing work when handling tools and Equipment.
Activity 2 Discuss in groups or individual brainstorm.
Activity 3 Present their findings.

Resources
Text on OHS in plumbing

STEAM Activity Students work in groups to create an activity on Occupational Health and safety on plumbing tools and equipment, and materials in plumbing. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to identify and apply OHS on plumbing tools and materials in workplace according to OHS standards**.** Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Identify and describe health issues relating to plumbers.
2. Identify and describe areas in plumbing trade that is hazardous.
3. Identify and describe OHS in relation to plumbing trade.
4. Describe how plumbers can protect themselves, tools and those around them.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Identify and describe health issues relating to plumbers.	Correctly identify and clearly describe more than five health issues that plumbers are exposed to in their trade,	Correctly identify and clearly describe five health issues that plumbers are exposed to in their trade,	Partially identify and describe three health issues that plumbers are exposed to in their trade,	Does not identify and describe health issues that plumbers are exposed to in their trade,
2. Identify and describe areas in plumbing trade that is hazardous.	Correctly identify and clearly describe all the areas in plumbing that are hazardous	Correctly identify and clearly describe all the areas in plumbing that are hazardous	Correctly identify and clearly describe all the areas in plumbing that are hazardous	Does not identify and describe all the areas in plumbing that are hazardous
3. Identify and describe OHS in relation to plumbing trade.	Correctly identify the OHS in plumbing with detailed applications in various situations.	Correctly identify the OHS in plumbing	Poorly identify the OHS in plumbing	Does not identify the OHS in plumbing
4. Describe how plumbers can protect themselves, tools and those around them.	Correctly and clearly describe how plumbers can protect themselves, the tools and those around them in the specific categories	Correctly and clearly describe how plumbers can protect themselves, the tools and those around them in categories	Partially describe how plumbers can protect themselves, the tools and those around them in a few words	Does not describe how plumbers can protect themselves, the tools and those around them

UNIT 3. Plumbing Technology

Content Standard 3.3 Investigate and analyse the concepts and underlying theories in plumbing materials tools and equipment.

Benchmark 10.3.3.3 Investigate and apply plumbing tools and materials into their categories such, plastic pipes and fitting Cast Iron pipes &fittings

Topic 3: Plumbing Tools and Materials

Learning Objectives
By the end of this topic, the students will be able to;
1. Discuss and categorise plumbing tools and materials

Essential Questions:
What are plumbing tools and materials?
What are the different types of plumbing tools and materials?
What are their functions?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Plumbing tools and materials.	Investigating and applying through collaborative presentations findings on manual plumbing tools and categorizing of plumbing tools	The plumbing materials, tools, in the workplace conforming to health and safety standards for the betterment of outlook on human lives.	Care and concern is shown through collaborative presentations findings on manual plumbing tools and categorizing of plumbing tools

Technology and Industrial Arts Application: Construction Technology: Plumbing Technology

Content Background
A plumber requires several tools for the fitting work for plumbing, fixing a tap or to carryout repairs. These tools help the plumber in performing his/her work properly, and therefore it is important that the tools are used systematically and handled carefully to avoid any damage. They should be kept at a designated place after use. The tools can be categorised as per the nature of work like holding tools, fitting tools, cutting tools, pipe threading and bending tools, etc.

. **Types of Plumbing Tools**

There are several essential tools that every plumber should have, which are listed below:

Plumbing tools for pipe work
1. Hacksaw
2. Hole saw kit
3. Mole grip

4. Tubing cutter
5. Plumber's torch
6. Thread sealing tape
7. Pliers
8. Press fitting system
9. Bucket
10. Ratcheting pipe threader set

Plumber's wrenches

1. Adjustable wrench
2. Pipe wrench
3. Basin wrench
4. Faucet key
5. Internal pipe wrench
6. Torque wrench

Drain cleaning tools for plumbers

1. Plungers
2. Hand auger
3. Snake machine
4. Hydro jetting machine
5. Drain inspection camera

Safety tools for plumbers

1. Drain cleaning gloves
2. Goggles
3. Flashlights
4. Heat shields or pads

Plumbing Tools for Pipe Work

	1 Hacksaw Plumbers commonly use hacksaws to cut perfectly in the pipe, and sometimes electricians to cut conduit. There are many different types of hardware that plumbers need to cut through, including pipes, nuts, bolts, and screws. The name hacksaw comes from the fact that historically these saws did not cut easily. However, developments in tooling have improved the cutting accuracy of the hacksaw. It's challenging work and requires plumbers to secure their blades tightly.

	2 Hole Saw A hole saw is also a useful addition to the toolkit that is needed in some cases. With the help of a hole saw, it is possible to cut perfectly round holes in a variety of different materials. If a hole is needed for a drainage or waste pipe, a hole saw can be used to cut the hole to the exact size with a minimum of effort.
	3 Mole Grip Mole grips are types of metal pliers characterized by the ability to be locked in place. It is usually made of hardened steel. The upper jaw and handle are fixed, while the lower handle and jaw are adjustable. It is primarily used to hold metal parts in place during welding, similar to when a plumber is using a plumber's torch to solder and seal the copper pipe.
	4 Tubing Cutter Any professional plumber who deals with copper or plastic piping regularly knows that, eventually, it needs to be removed, replaced, and resized. A tubing cutter is useful for cutting tubes to a specified length. Tube cutter and pipe cutter are often used interchangeably on tube and pipe. Plumbers use tubing cutters to cut through plastic tubing, with each of them having a different cutting range, which is why they are so useful.
	5 Plumber's Torch Plumber torches are the most common type used by professionals and DIY homeowners. The plumber's torch is a small, hand-held tool that allows plumbers to apply intense heat in the most precise areas to solder and seal new piping for the purpose of installing and replacing it. Propane torches are inexpensive and easy to use. Most professional plumbers often upgrade the torch assembly to a higher quality torch head with interchangeable tips and a regulator to control gas pressure

6 Thread Sealing Tape

Thread seal tape is a versatile film tape used by most plumbers, usually a joint sealer to seal pipe threads. Sometimes it is used as a leak preventer. This type of device is also known as Teflon tape, plumber's tape, or polytetrafluoroethylene film, abbreviated as PTFE tape. In addition to the general-purpose, hand-held flashlight, several forms have been adapted for specialized uses. High-quality thread sealing tape is resistant to high and low temperatures. It also stretches for enhanced, form-fitting coverage and never dries out

7 Pliers

Plumbers also use pliers every day. It is best for plumbers to use these smaller tools for loosening and tightening nuts and bolts that are too small to grasp with a wrench. The pliers fit easily in a plumber's hand to squeeze into tight spaces where a wrench won't work.

8 Press Fitting System

In plumbing, securely connecting pipes is critical to the success of any plumbing project. Press fitting is a connection between pipes with fittings done by means of electro-mechanical pressing machines.
Pressing permanently deforms the fitting onto the pipe, making a perfect mechanical joint, while the O-ring provides for a hydraulically tightened connection. The main reason for use is that it saves plumbers time and money because plumbers can make connections to pipes in less time than it would take to weld or solder them.

9 Bucket

When plumbing, you should know that even when you have turned off the water in your house, there is still going to be some water leakage, so it makes sense always to have a bucket nearby to collect any leakage.

10 Ratcheting Pipe Threader Set

The ratcheting pipe threader tool allows you to cut threads into the pipe so that it will accept the fitting when the pipes are joined together.
These plumbing tools work with a pump-action handle that turns a thread-forming die and cuts threads on the pipe. They accept a range of compatible dies to thread various pipe sizes. These are also known as manual ratchet threaders.

Plumber's Wrenches The wrench is the most closely associated with plumbing, and no list of plumbing tools would be complete without it. There isn't a wrench that works as all-purpose. That's why having some type of wrench in your toolbox is essential.	
	11 Adjustable Wrench Also known as an adjustable pipe or Stillson, the wrench is used to grip or bend pipe or circular bars. The work of tightening and loosening hexagonal nuts and fittings on pipes can be easily done using this wrench. They are available in a variety of sizes, but plumbers often have the 6- and 10-inch versions as they consider them perfect
	12 Pipe Wrench The pipe wrench operates as the plumber's most enormous wrench. These wrenches are good for tightening and loosening nuts and fittings on pipes. Typically, they use two wrenches of this type; one to hold the pipe in place while the other is used to rotate the fitting or nut in the appropriate direction. These wrenches also come in various lengths, and skilled plumbers usually work with a full set of these tools.
	13 Basin Wrench This plumbing tool is used for turning fasteners in tight spaces that would be hard or impossible to reach with a plumber's wrench. These types of wrenches are also known as sink wrenches. This wrench resembles a T-shaped tool used by plumbers to work exclusively on faucets. A clamp-like mechanism on one end of these wrenches allows plumbers to reach into tiny spaces.
	14 Faucet Key Not exactly a traditional wrench, but an essential item on any list of plumbing tools. Small, X-shaped tools called faucet keys are used for opening and closing spigots and sillcocks. For dealing with various stem fittings, such as 14″, 9/32″, 5/16″, and others, there are adaptable models on the market.

	15 Internal Pipe Wrench The plumber uses an internal pipe wrench to remove pipe plugs, fittings, small nipples, and broken threaded ends. In addition, it can also be useful for removing old rusted fittings on galvanized pipes. These tools hold a pipe or fitting's interior. Each wrench has markings for different pipe sizes and can be used with a hex body.
	16 Torque Wrench Essentially, a torque wrench is a tool that is used to tighten nuts and bolts according to a predetermined torque value. This makes it possible to tighten the fasteners to the correct tension, preventing damage from over-tightening or stripping the joints. The no-hub torque wrench is perfect for pipe fitters and plumbers to use when installing pipes, couplings, and other no-hub cast-iron work, like installing soil pipes.
Drain Cleaning Tools for Plumbers Plumbers routinely clean drains because sometimes the issue isn't with the pipe, but with what's located inside. Good plumbers are familiar with how to get rid of a tough clog and which tools they'll need to keep. Some are explained below.	
	17 Plungers The most common plumbing tool in a plumber's toolbox is the plunger. Sink and toilet plungers are commonly owned by homeowners, but plumbers should also carry them. It is mainly used to clear blockages in drains or pipes commonly used in household toilets. Choosing a good and high-quality plunger, though, is crucial. The plungers are simple to use and very affordable tools. The professionals in the trade should have heavy-duty flange plungers and cup plungers of different sizes on hand, as these plungers produce considerably more suction than the average plunger on the market.
	18 Hand Auger It is used to clear clogs from the drain lines and is also referred to as a plumber's snake, drain snake, or toilet jack. The hand auger consists of a long, flexible metal wire with a corkscrew auger attached to the end. The hand-auger market now offers a variety of models and features that plumbing professionals can take into consideration when making their list of plumbing tools. A drain snake or drain auger should be adequate for smaller drains (such as

	those in kitchen sinks or hand basins).
	19 Snake Machine A snake machine is simply a bigger and updated version of a hand auger. Snake machines typically have the strength to clear clogs that are particularly deep or challenging to move. Also known as a plumber's snake or drain snake, it is often reserved for tough blockages that cannot be loosened with a plunger.
	20 Hydro Jetting Machine It is a very efficient way to clean out sewer and drain lines. The first method for unclogging blocked lines is usually hydro jetting, which uses high-speed or high-pressure water to clear obstructions in pipe systems. These tools come with hose attachments that will blast water into drain lines and sewer lines.
	21 Drain Inspection Camera Most plumbers today carry inspection cameras, also called borescopes, which used to be considered top technology in the plumbing trade. These tiny cameras attached to a long, flexible cable are inserted deep into drains and sewer lines. This gives a better look at the condition of the piping and whatever else may be obstructing it. High-end models that connect directly to a smartphone for quick, simple applications are now available for use by smaller plumbing businesses.
Safety Tools for Plumbers Plumbers always get injured due to some incidents while on the job. Obviously, there are a variety of tools that assist in protecting plumbers and significantly reduce the likelihood of an accident.	
	22 Drain Cleaning Gloves Drain-cleaning gloves are one of the most common and essential plumbing tools, usually made from leather, PVC (rubber), or synthetic materials. This is significant because plumbers frequently handle materials that others would prefer to avoid touching with their bare hands. In addition, there are several types of heavy-duty gloves on the market that can protect plumbers' hands, make it easier for them to grip smooth objects, and provide many other benefits.

	23 Goggles They mainly protect the eyes from liquid or chemical splash, irritating mist, vapor, and smoke. When working on a plumbing project, goggles shield your eyes from any potentially harmful materials you come into contact with. Plumbers must carefully inspect leaks, soldering, and other things that may be hazardous to their eyes. Therefore, it is pretty useful to have goggles in the toolbox.
	24 Flashlights The majority of plumbers will find themselves having to go into dark spaces regularly, such as basements, so it is always a good idea to have a flashlight handy.
	25 Heat Shields or Pads Using the right safety equipment is essential if soldering is a regular part of your day-to-day activities. This will protect both you and the homeowner. It's good to round out your plumbing tool list with reliable heat shields and pads. When soldering is required, they assist in preventing

Figure 3.3a Plumbing Tools and equipment
Source: https://www.tradecounterdirect.com/plumbing-tools

Types of plumbing materials and specifications

A home **plumbing** system will have different types of **piping materials** for different uses, including fresh water supply, waste drainage, irrigation, gas **pipes** for appliances, and so on. The type which is used in each application will largely depend on the age of the home **plumbing** system.

Here are types of plumbing materials used in piping for waste lines, water supply pipes, and natural gas supply:

- Cast iron for plumbing waste lines
- PVC (PolyVinyl Chloride) for plumbing waste lines
- Chromed brass for plumbing waste lines
- Chromed copper for water supply lines
- Galvanized iron for water supply lines

- Poly pipes

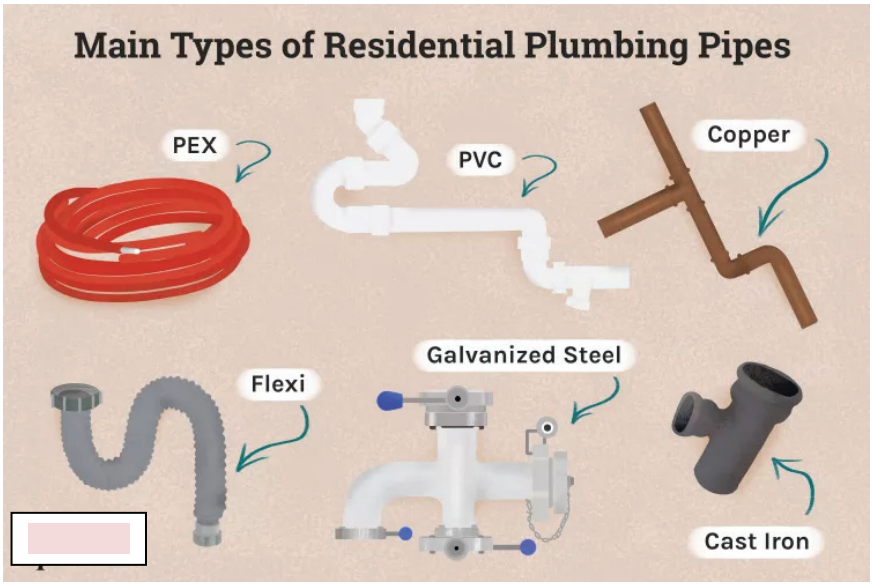


Figure: 3.3b Plumbing pipes
Source: https://www.thespruce.com/basic-types-of-plumbing-pipes-1822487

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of plumbing tools and materials. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Types of Manual Plumbing Tools

Teaching Strategies

Students engage in brainstorming exercise to discover the types of manual plumbing tools.
They then are allowed to discover manual tools used by a plumber.
Discussions in groups o a chosen tool, and how it can be used by a plumber.

Learning Strategies

Activity 1 Brainstorming activity to discover the types of manual plumbing tools.
Activity 2 Discover the types of manual plumbing tools.
Activity 3 Discussions and presentation of findings on manual plumbing tools and how they are used by plumbers.

Resources

Teacher Notes

Lesson 2: Types of Power Plumbing Tools

Teaching Strategies
Engage students in inquiry of various plumbing technology tools that a plumber uses.
Engage students in the discussion of their inquiries into the types of power plumbing tools and their effective functions.

Learning Strategies
Discover the various power plumbing technology tools a plumber uses**.**

Activity 1 Use inquiry into the types of power plumbing tools and their functions.
Activity 2 Present findings in discussions on the power plumbing tools.
Activity 3 Describe how a power tool can be used by a plumber.

Resources
Teacher Notes

Lesson 3: Categories of plumbing materials

Teaching Strategies
Guide the students to identify and categorise all the tool into their different groups.
Differentiate the manual tool from the electrical tools.
Categories of tools will indicate, type, function and effectiveness

Learning Strategies
Activity 1 List all plumbing tools, manual or electrical
Activity 2 Discuss and group them into their categories of specificity, type, function and effectiveness

Resources
Text on plumbing tools.

STEAM Activity Students work in groups to create an activity incorporating plumbing materials and equipment. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to investigate and apply plumbing tools and materials into their different categories such, plastic pipes and fitting Cast Iron pipes &fittings . Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Identify the plumbing tools.
2. Categorise the plumbing tools into different groups

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Identify the plumbing tools	Clearly and accurately Identify the plumbing tools	Correctly Identify the plumbing tools	Partly Identify the plumbing tools	Cannot Identify the plumbing tools
2. Categorise the plumbing tools into different groups	Clearly and accurately Categorise the plumbing tools into different groups	Correctly Categorise the plumbing tools into different groups	Partly Categorise the plumbing tools into different groups	Cannot Categorise the plumbing tools into different groups

UNIT 3. Plumbing Technology

Content Standard 3.3 Investigate and analyse the concepts and underlying theories in plumbing materials tools and equipment.

Benchmark 10.3.3.4 Analyse and interpret isometric drawing, pictorial drawing and Orthographic drawing.

Topic 4: Applications of Technical Drawing in Plumbing

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and interpret plumbing drawings and applications for the plumbing trade.

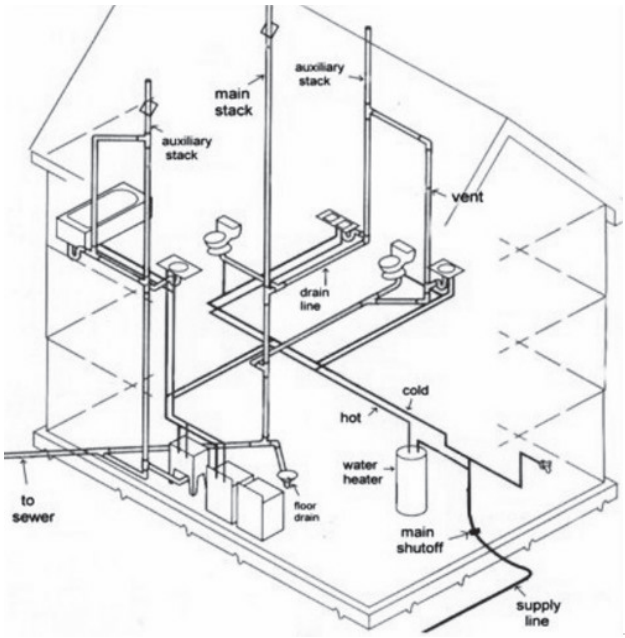
Essential Questions:

1. What are plumbing trade drawings and applications?
2. What are the key features of plumbing trade drawings
3. What are the key features of plumbing applications?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Isometric, pictorial and orthographic drawings used in plumbing	Analyse and interpret the key features of plumbing trade drawings and applications esp. plumbing blueprints and sketches	Patience and diligence is valued in Isometric, pictorial and orthographic drawings used in plumbing for the betterment of outlook on human lives.	Self-control, patience, precision and articulation is evident when Analysing and interpreting the key features of plumbing trade drawings and applications esp. plumbing blueprints and sketches

Technology and Industrial Arts Application: Construction Technology: Plumbing Technology



Content Background

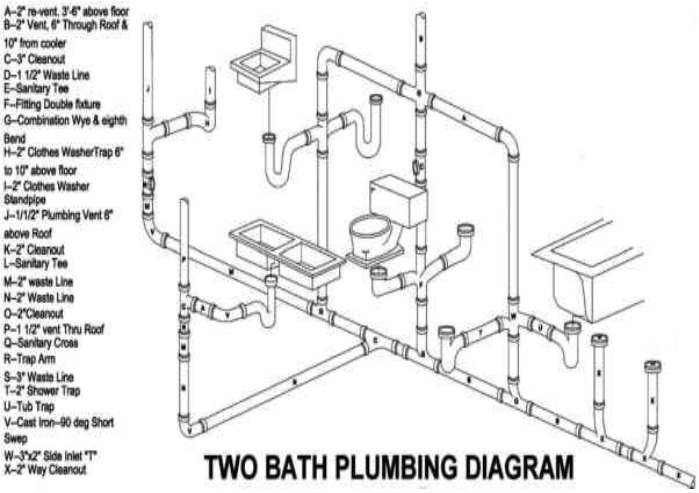


Figure 3.4 a and b Plumbing blueprints

Source: https://www.northernarchitecture.us/building-codes/plumbing-drawings.html

Interpreting Bluprints

Construction blueprints
are technical drawings created by architects, engineers, and designers to put all the construction specifics of a house in one package to which the builder can refer as they construct the house. Although a package of blueprints can be daunting, as many as 50 pages long, the concept of the blueprint is simple: It is a series of two-dimensional representations of a three-dimensional building.

“A blueprint is the fundamental plan for the construction of any structure. The print is what shows the builders, the electricians, the framers – all of the trades people exactly what needs to be done on any construction project.”
The main sections of a blueprint are:

- Title Sheets and Site Plans
- Floor Plans
- Elevations and Sections
- Details and Schedules
- Structural Drawings
- Mechanical, Electrical, and Plumbing (MEP) Drawings

Each of these sections uses symbols, scale, and abbreviation to simplify reading the many elements that each plan contains. When you are able to read a blueprint all the way through, you will get a comprehensive understanding of its dimensions, building materials, installation methods, and the mechanical inner workings of the house, such as electrical and plumbing. Blueprints also contain details such as quality specifications, building codes, the information necessary for obtaining building permits, and even the schedule for accomplishing all aspects of the building.

The ability to read and understand blueprints is an essential skill for those working in the building trades.

An Isometric Drawing is drawing details representing pipes, fittings, and fixtures at a 45° angle. In plain terms it’s the plumbing drawing scheme. The goal is to represent three-dimensional designs on two-dimensional drawings.
Having a well-done set of isometric drawings is like having a well-done set of instructions to build a swing set. When a good draftsmen, estimator or project manager is skilled enough to be able to provide the foreman or project superintendent with plumbing isometric drawings, the men in the field can do what they get paid to do. That’s to put in pipe and fittings.

Plumbing Sketches

1.) Back to Back Bathtubs, Water Closets, and Lavatories
This is a plumbing isometric of the water piping for an apartment building. There are two bathrooms in the same unit or in separate units piped back to back. The water supply risers are coming in on one end of the bathrooms as you can see in the plumbing riser diagram.

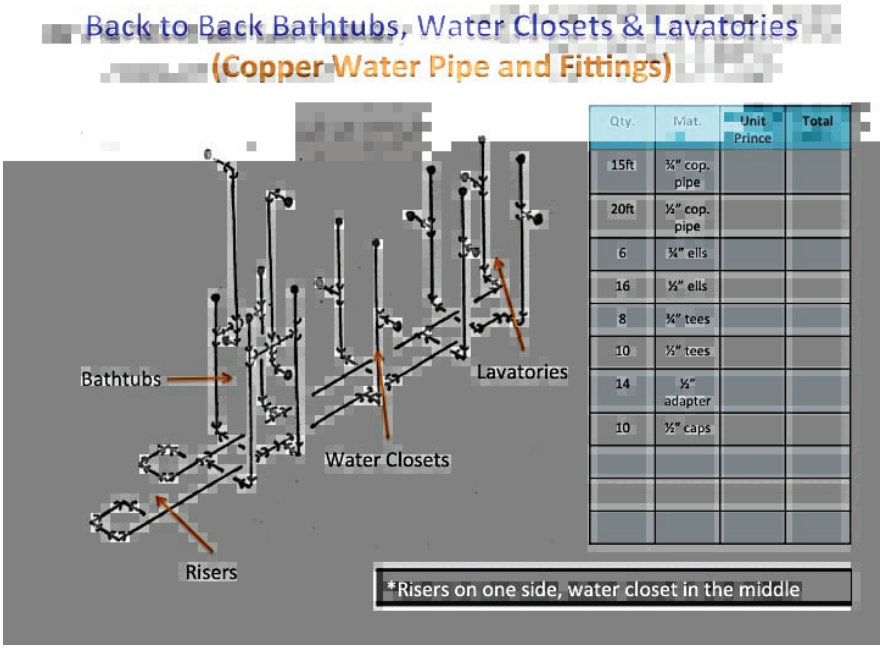


Figure 3.4 c Plumbing blueprints
Source: https://www.pinterest.com/pin/635711303627525973/?mt=login`

2.) Single Bathtub, Water Closet, and Lavatory
This plumbing isometric represents a battery of plumbing fixtures with just one bathtub, water closet, and lavatory. This would be used most commonly in a small apartment building where there is only one bathroom per apartment. It is possible there are two sets of water risers serving bathrooms. However, it can get expensive. Therefore, the architect/engineer usually likes to reconfigure a building to make use of as few risers as possible.

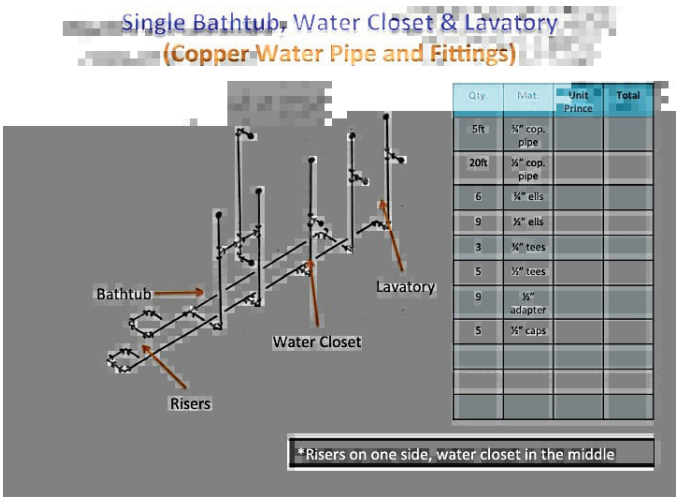


Figure 3.4 d Plumbing blueprints
Source: https://www.pinterest.com/pin/635711303627525973/?mt=login

3.) Single Bathtub, Water Closet, and Lavatory with Utility Sink
This isometric represents a battery of plumbing fixtures with a little twist. In order to save pipe chase space, an architect may put the kitchen or utility room behind the bathroom. This way, you can use the water piping to pipe in a kitchen or utility sink.

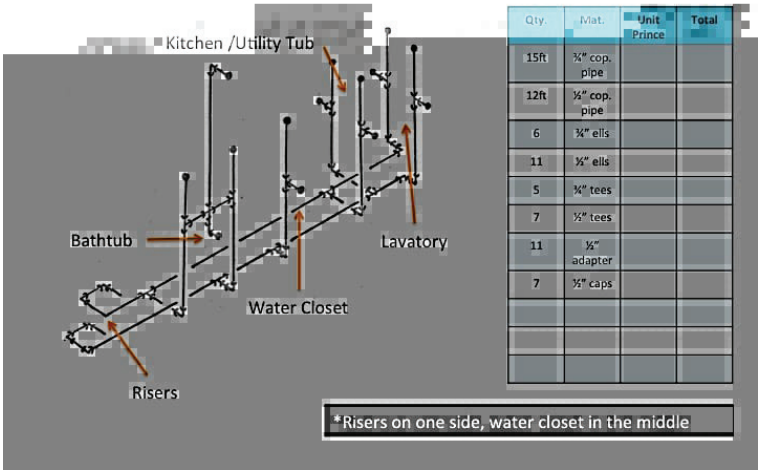


Figure 3.4 e Plumbing blueprints
Source: https://www.pinterest.com/pin/635711303627525973/?mt=login

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of plumbing trade drawings and applications. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Construction Blueprints

Teaching Strategies

Students engage in brainstorming exercise to discover construction blueprints and how they are used, and where they are significant.
They then are allowed to design guiding questions that will enable them to conduct research on construction blueprints.
Discussions in groups on the research findings on construction blueprints in designing..

Learning Strategies

Activity 1 Brainstorming activity on construction blueprints, their meaning, their significance
Activity 2 Conduct research on construction blueprints, their meaning, their significance
Activity 3 Discussions and presentation of research findings construction blueprints, their meaning, their significance

Resources

Notes on construction blueprints

Lesson 2: Plumbing Sketches

Teaching Strategies

Students engage in brainstorming exercise to discover plumbing sketches they learnt in grade 9. They then are allowed to design guiding questions that will enable them to conduct research on plumbing sketches
.Discussions in groups on the research findings.

Learning Strategies
Activity 1 Brainstorming activity the type and use of an plumbing sketches.
Activity 2 Conduct research on how technical drawing is used in plumbing.
Activity 3 Presenting a design of a plumbing part in isometric diagram.

Resources
Text on technical drawing.

STEAM Activity Students work in groups to create an activity incorporating applications of technical drawing in plumbing. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to analyse and interpret isometric drawing, pictorial drawing. Orthographic drawing Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Use isometric drawings to draw plumbing drawings.
2. Analyse and interpret plumbing trade drawings and applications for the plumbing practice.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Identify the different types of drawings involved in plumbing.	Correctly identify the different types of drawings involved in plumbing.	Clearly Identify the different types of drawings involved in plumbing.	Partly identify the different types of drawings involved in plumbing.	Cannot Identify the different types of drawings involved in plumbing.
2. Use the drawings to draw some type of plumbing drawings	Correctly use the drawings to draw some type of plumbing drawings	Clearly Use the drawings to draw some type of plumbing drawings	Partly use the drawings to draw some type of plumbing drawings	Cannot Use the drawings to draw some type of plumbing drawings

Unit 4: Welding Technology

Unit	Benchmark	Topic	Lesson Titles
4. Welding Technology	**10.3.4.1.** Apply safety procedures when handling tools and equipment.	Topic 1: Safety in Handling Tools & Equipment	1.Safe Handling Techniques for Tools 2. Safe Maintenance and Safe Procedures 3. Mechanical Fasteners used in Welding
	10.3.4.2. Apply Print Reading, Measurement and Layout or fit-up techniques.	Topic 2: Measurement	1. Measurement accuracy 2. Application of measurement in Print reading 3. Application of measurement in layout or fit-up techniques
	10.3.4.3. Prepare and identify types of metals according to job specifications.	Topic 3: Metals	1. Types of Metals 2. Preparations and use of metals According to Job specifications
	10.3.4.4. Describe properties of fabrication materials and apply welding techniques and cutting processes in fabrication fundamentals.	Topic 4: Fabrication Fundamentals	1. Fundamentals of Fabrication 2. Application of Welding processes and techniques 3. Application of cutting processes and techniques

UNIT 3. 4 Welding Technology

Content Standard 3.4 Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 10.3.4.1 Apply safety procedures when handling tools and equipment.

Topic 1: Safety in Handling Tools and Equipment

Learning Objectives

By the end of this topic, the students will be able to;
1. Apply safety handling and storing procedures for tools and equipment.
2. Identify welding tools, equipment and mechanical fasteners.

Essential Questions:

1. What are the safety procedures in handling welding tools and equipment?
2. What are the common welding tools and equipment?
3. What are mechanical fasteners?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Safety procedures, Tools and equipment	Apply the safety procedures for handling welding equipment and tools inclusive of mechanical fasteners	Value being Vigilant, taking precautions while learning about Safety procedures, Tools and equipment	Awareness and safety of tools, self and others is evident when Applying the safety procedures for handling welding equipment and tools inclusive of mechanical fasteners

Technology and Industrial Arts Application: Construction Technology: Welding Technology

Content Background

Hand and power tools Welding Tools

Measuring

The success of a project greatly depends on making proper prior measurements, so invest in measuring and marking devices. You will need a tape measure, calipers, metal T-squares and some sort of marking tool.

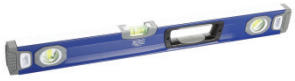


Figure 4.1 a Welding measuring Tools
Source:https://www.google.com/search?rlz=1C1GCEU_enPG1032PG1032&q=plumbing%20measurement%20sheet&ved=2ahUKEwjjkOe15_H_AhWYm1YBHS1WCFcQmoICKAR6BAgEEA8&biw=544&bih=913&dpr=1

Welding Clamps

This is an absolute must have welding tool. Welding clamps allow you to firmly set up your work piece, so the welding will produce a tight joint. Clamps come in many different sizes. It's best to have at least 10 clamps, so you'll always have one ready for the project at hand. Without metal clamps, the metal warpage produced by welding will throw your project out of square and create welding defects.

Figure 4.1b Butt Welding Clamp

Source: https://www.amazon.com/ABN-Butt-Welding-Clamps-Piece/dp/B084666CCL/ref=sr_1_3?keywords=welding%2Bclamps&qid=1688361987&sr=8-3&th=1

Welding Magnets

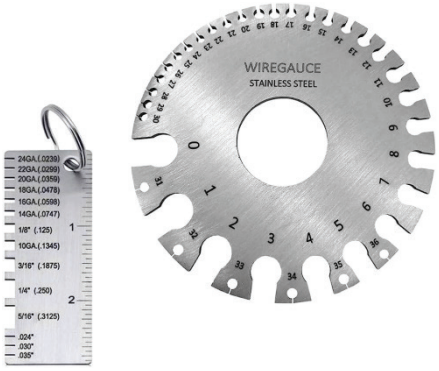
Another essential for welding projects is the magnet. Using them, you can set up your metal pieces to hold at a variety of angles, such as 45^0, 90^0 and other. They also come in different sizes, so you can get a few of them to always be available for different project needs.

Figure 4.1c 90⁰ Welding magnets
Source: https://www.grainger.com/category/welding/weld-fixturing-marking-preparation/welding-magnets

Sheet Metal Gauge

This tool is very useful for those times when you're not sure of your metal thickness. You can't eyeball the thickness, so that's where this gauge comes in. It's not an absolute necessary welding tool, but it will definitely come in handy around the workshop.

Figure 4.1d Sheet metal gauge
Source:



https://www.google.com/search?q=sheet+metal+gauge+tool&rlz=1C1GCEU_enPG1032PG1032&oq=sheet+metal+&aqs=chrome.1.69i57j69i59j0i512l8.10147279j0j15&sourceid=chrome&ie=UTF-8#imgrc=-3UymErlvKM-hM

Electrode

An electrode is a tip that is installed on the end of the tool and through which the electric current is passed from the welder to the material. For different applications, you'll need a certain type of electrode. Also, electrodes used for MIG and stick welding differ from those used for TIG welding. The electrodes for TIG welding are made from non-consumable tungsten. This means that unlike with MIG and stick welding, TIG electrodes don't need regular replacement.

Figure 4.1e Welding electrodes
Source: https://www.badilihardware.com/product-category/welding-electrodes

Wire And Electrode Feed

The wire electrode used in gas metal arc welding comes in large coils (spools) or drums. These wire coils or drums contain hundreds or even thousands of feet (meters) of wire. Small coils of wire are mounted on free-turning axles near the wire feed mechanism. If the larger drums of wire are used, the drum is placed near the wire feeder. The wire is smoothly drawn from either the coil or drum. Depending on the type of welding you'll be doing, you'll be using either a wire or electrode feed. TIG welding uses the wire feed since the electrode is non-

consumable. MIG welding, even though it uses a consumable electrode, also uses the wire feed. Stick welding, however, uses the electrode.

Figure 4.1f Wire And Electrode Feed
Source: http://www.halversoncts.com/710-wire-feeders-used-with-gmawfcaw.html

Angle Grinder

An angle grinder is a useful tool to have for prepping and finishing welds. Before you start welding, you can use the angle grinder to remove rust, paint or dirt from the work piece. You can also use the welding tool after you finish welding to remove the slag that has built up. You can even cut metal with an angle grinder as it can easily chop through thin metal.

Figure 4.1g Angle Grinder
Source: https://www.amazon.com/Avid-Power-Grinder-Grinding-Auxiliary/dp/B07P5D6M4V

Metal Brush

A wire brush is used for cleaning the welding surface, removal of slag, rust etc. The brush has stainless steel bristles. When working on stainless steel, a brush with stainless steel bristles and chipping hammer made of stainless steel must always be used. If your welding process creates a lot of slag, you'll also need a metal brush. For example, if you're stick or flux-cored welding, there'll be a lot of slag left behind after the weld is completed. To reveal the final weld, you'll need to use the metal brush to scrape off that slag coating.

Figure 4.1h Metal Brush
Source: file:///I:/CDD%20EDIT_23/388sss.webp

Types of Portable Power Tools and Their Safe Use

Figure 4.1i Portable Circular Saws
Source: https://eastmanshop.com/blog/wp-content/uploads/2018/07/Circular-Saw.jpg

Portable power tools are a general category of tools used in manufacturing and construction industries, designed to be moved from place to place. They are different from standard tools which are permanently mounted in a workspace.

Portable power tools refer to small hand tools, which can be carried inside a tool belt or easily shipped in a toolbox. They will be either electric tools powered by a cord or cordless versions powered by powerful lithium-ion batteries.

Progress in the technology of Lithium-ion batteries has made the modern versions of such tools more powerful, lighter and easier to transport compared to their predecessors. Several tools which once needed a power cord to maintain peak performance can now run effectively on lithium-ion batteries.
One of the most common portable power tools is the *drill.* By switching on its bit, the drill can serve many functions. It can be used as an auger, power screwdriver and most of all, as a drill. Based on the bit switch, a drill can be used to create a hole in metal, drywall, plastic, and wood. An auger bit may be used to drill big holes. There are also circular bits for cutting holes of many inches in diameter.

Certain other power tools are less versatile and more specialised. Examples are power hammers and power wrenches. While having the capacity to serve a few uses, these tools are less heavy and smaller compared to traditional power tools and mostly fit into a tool belt carrier. These tools are less impactful than conventional drills or hammers but they are very useful for building maintenance workers and electricians.

Circular saws are used mainly for cutting planks of wood. While cutting big sheets of plywood, mostly Jig saws are used. Both kinds of **saws** are available as portable power tools and make the job of a carpenter easy. The reciprocating saw is one of the most versatile tools which can cut through many different materials like metal, drywall, plastic, and wood.
Another set of portable power tools is the sander. Its portability and small size permit woodworkers to handle many types of projects. As an alternative to lifting the wood to the sander, like in case of a table sander, the sander is brought to the wood. Modern versions of sanders feature bags to capture sander dust.

Portable power tools are frequently made of interchangeable batteries. This implies that the same batteries which power the sander can also power the drill. This helps protect the environment by rendering fewer batteries to fill up landfills.
Portable power tools save time and effort on jobs. The enhanced use of power tools increases the need for being aware of the hazards in case they are not operated properly.

The following are some general safety rules, common to all power tools:

- Avoid operating power tools unless authorised.
- Inspect tools every day to make sure they are working properly.
- Avoid using defective or damaged tools
- Use tools for their intended purpose and the intended manner.
- All the power tools must be rightly grounded.
- Keep protective devices and guards in place, always. Avoid using tools whose guards have been removed.
- Avoid using electrical equipment and power tools, while in contact with water.

- Electric tools must be repaired only by qualified persons.

Mechanical Fasteners
Types of Nuts and Bolts
Fasteners come in many different forms. To make it easy for you, we've compiled the data below as a guide for figuring out what each fastener is called. Scroll down to learn about many different types of nuts, bolts and screws!*
*Note: Bolts are fasteners that require a nut or pre-tapped hole to be installed. Screws use their threads to provide their own holding power. The terms in the industry are commonly mixed so sometimes you will see something that is called a screw or a bolt that is actually the opposite.

Example: Lag Bolts and Lag Screws are the same thing.

Safety procedures in handling hand and power tools
When used correctly and with the proper safety measures, you can significantly reduce the chance of an accident.

General safety tips for hand and power tools:
- Buy quality tools. Many tools, including cutters and hammers, should be made of steel and should be heat-treated.
- Regularly inspect tools to make sure they are in good shape and fit for use.
- Be sure to maintain your tools by performing regular maintenance, like grinding or sharpening. Always follow the manufacturer's instructions.
- Dress for the job by avoiding loose clothing or articles that can get caught in a tool's moving parts, like jewellery.
- Wear appropriate personal protective equipment, like leather gloves.
- Use the right tool for the job. In other words, don't try to use a wrench as a hammer.
- Make sure that your feet are planted on a stable surface.
- Be aware of the people around you and make sure they stay clear of the tools you are using.
- Never carry tools up a ladder by hand. Instead, use a bucket or bag to hoist tools from the ground to the worker.
- When working at heights, never leave tools lying out in the areas where they could present a hazard to workers below.
- When appropriate, secure work with a clamp or vise to keep it from slipping.
- Never carry pointed tools in your pocket. Carry them in a toolbox or cart instead.
- Inspect your tools on a regular basis, checking for damage. Report damaged tools to your supervisor.
- Make sure to keep extra tools handy in case the tool you had planned to use is damaged.
- Make sure tools are stored in a safe place.

Safety tips for electric power tools:
- Keep floors dry and clean to avoid slipping while working with or around dangerous tools.
- Keep cords from presenting a tripping hazard.
- Never carry a power tool by its cord.
- Use tools that are double-insulated or have a three-pronged cord and are plugged into a grounded receptacle.
- Do not use electric tools in wet conditions unless they are approved for that use.

- Use a ground fault circuit interrupter (GFCI) or an assured grounding program.
- Use appropriate PPE.

Safety tips for pneumatic tools:

- Verify that all parts of the tool are fastened securely before use.
- Never point a compressed air gun at yourself or another person.
- When you are finished using the tool, make sure that the pressure is released before you break the hose connections.
- Use a safety clip or retainer to prevent attachments from being ejected during operation, and use a chip guard when using high-pressure compressed air for cleaning. Be sure to limit the nozzle pressure to 30 pounds per square inch.
- Always wear eye protection.
- Use screens to protect nearby workers from flying fragments.
- Never leave your tool unattended.
- Never store a loaded air gun.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of welding tools and equipment. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Safe Maintenance and Storage Procedures for Tools and Equipment

Teaching Strategies

Engage students in the brainstorming and discussion of safe maintenance and the storage procedures for welding tools and equipment.
Engage students in presentation of the types of safe maintenance and the storage procedures for welding tools and equipment.

Learning Strategies

Activity 1 Discuss the types of mechanical fasteners used in welding.
Activity 2 Write their discussions on charts or presentation papers.
Activity 3 present in pairs or groups.

Resources

Chart papers and texts on safety and maintenance of welding tools and equipment

Lesson 2: Mechanical Fasteners used in Welding

Teaching Strategies

Engage students in the brainstorming and discussion of the types of mechanical fasteners used in welding technology.
Engage students in presentation of the types of mechanical fasteners used in welding technology.

Learning Strategies

Activity 1 Discuss the types of mechanical fasteners used in welding.
Activity 2 Write their discussions on charts or presentation papers.
Activity 3 present in pairs or groups.

Resources
Teacher Notes

Lesson 3: Safety Procedure for Handling Equipment & Tools
Teaching Strategies

Teachers introduce students to the safety in the use of hand and power tools.
Engage students in the brainstorming and discussion of the safety in the use of hand and power tools used in welding technology.
Engage students in presentation of the safety in the use of hand and power tools used in welding technology.

Learning Strategies

Conduct a research with guiding questions that will lead to discovering what the terms are in.
Activity 1 the safety use of hand tools.
Activity 2 the safety use of power tools
Activity 3 safety in overall work done using materials and tools of welding

Resources

Information or text on safety in hand tools and power tools
Record of anecdotal notes taken on notes of the topic.

STEAM Activity Students work in groups to create an activity incorporating safety in handling tools and equipment. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to apply safety procedures when handling tools and equipment. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Apply safety handling and storing procedures for tools and equipment.
2. Identify welding tools, equipment and mechanical fasteners.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Identify and clearly present handling and storing procedures for tools and equipment	Identify and clearly present 6 or more handling and storing procedures for tools or equipment	Identify and clearly present 3-5 handling and storing procedures for tools or equipment	Identify and present 2 handling and storing procedures for tools or equipment	Identify and present 1 handling and storing procedure for a tool or equipment
Identify and clearly present the use of mechanical fasteners.	Identify and clearly present the use of more than 6 tools.	Identify and clearly present the use of more than 3-5 fasteners.	Identify and present the use of 2 fasteners.	Identify the use of 1 fastener.

UNIT 3.4. Welding Technology

Content Standard 3.4 Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 10.3.4.2 Apply Print Reading, Measurement and Layout or fit-up techniques.

Topic 2: Measurements

Learning Objectives

By the end of this topic, the students will be able to;

1. Apply correct measurement in print reading and layout or fit-up technique in welding and fabrication

Essential Questions:

1. What is measurement?
2. What is print drawing?
3. How do we apply print reading in welding?
4. What is fit-up or layout technique in welding?
5. How do we apply fit-up or layout techniques in welding?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Measurement, print reading and fit-up or layout technique.	Apply print reading and fit-up or layout techniques in terms of general application of measurement in welding.	Value self-control and patience regarding Measurement, print reading and fit-up or layout technique.	Awareness, self-control and patience is shown regarding Measurement, print reading and fit-up or layout technique.

Technology and Industrial Arts Application: Construction Technology: Welding technology

Content Background

Basic Measurement

If you need to convert from Imperial or US Standard units to Metric, or the other way around, one of the tables below should help.

Example 1: Convert 500 millimeters to inches:
500 mm x 0.03937 = 19.7 inches

Example 2: Convert 500 millimeters to feet:
500 mm x 0.03937 = **19.7 inches**, and there are 12 inches in a foot, so
19.7/12 = **1.64 feet** (or 1 foot and 7.7 inches)
Note: values are accurate to 4 significant digits only.

Length

Metric			US or Imperial
1 millimeter [mm]		→	0.03937 in
1 centimeter [cm]	10 mm	→	0.3937 in
1 meter [m]	100 cm	→	1.0936 yd
1 kilometer [km]	1000 m	→	0.6214 mile

US or Imperial			Metric
1 inch [in]		→	2.54 cm
1 foot [ft]	12 in	→	0.3048 m
1 yard [yd]	3 ft	→	0.9144 m
1 mile	1760 yd	→	1.6093 km
1 int nautical mile	2025.4 yd	→	1.853 km

Area

Metric			US or Imperial
1 sq cm [cm^2]	100 mm^2	→	0.1550 in^2
1 sq m [m^2]	10,000 cm^2	→	1.1960 yd^2
1 hectare [ha]	10,000 m^2	→	2.4711 acres
1 sq km [km^2]	100 ha	→	0.3861 $mile^2$

US or Imperial			Metric
1 sq inch [in^2]		→	6.4516 cm^2
1 sq foot [ft^2]	144 in^2	→	0.0929 m^2
1 sq yd [yd^2]	9 ft^2	→	0.8361 m^2
1 acre	4840 yd^2	→	4046.9 m^2
1 sq mile [$mile^2$]	640 acres	→	2.59 km^2

Volume/Capacity

Metric		US	Imperia

			Measure	
1 cu cm [cm^3]		→	0.0610 in^3	
1 cu decimeter [dm^3]	1,000 cm^3	→	0.0353 ft^3	
1 cu meter [m^3]	1,000 dm^3	→	1.3080 yd^3	
1 liter [l]	1 dm^3	→	2.113 fluid pt	1.7598 pt

US Measure	Imperial		Metric
1 cu inch [in^3]		→	16.387 cm^3
1 cu foot [ft^3]		→	0.02832 m^3
1 fluid ounce	1.0408 UK fl oz	→	29.574 ml
1 pint (16 fl oz)	0.8327 UK pt	→	0.4732 liters
1 gallon (231 in^3)	0.8327 UK gal	→	3.7854 liters

Mass

Metric			US or Imperial
1 milligram [mg]		→	0.0154 grain
1 gram [g]	1,000 mg	→	0.0353 oz
1 kilogram [kg]	1,000 g	→	2.2046 lb
1 tonne [t]	1,000 kg	→	1.1023 short ton
1 tonne [t]	1,000 kg	→	0.9842 long ton

US or Imperial			Metric
1 ounce [oz]	437.5 grain	→	28.35 g
1 pound [lb]	16 oz	→	0.4536 kg
1 stone	14 lb	→	6.3503 kg
1 hundredweight [cwt]	112 lb	→	50.802 kg
1 short ton (US)		→	0.9072 t
1 long ton (UK)		→	1.0160 t

Temperature

To convert from Celsius to Fahrenheit, first multiply by 9/5, then add 32.
To convert from Fahrenheit to Celsius, first subtract 32, then multiply by 5/9

Application of print reading

Blue Print
is a technical drawing of an architectural or engineering design. In welding, they include standard welding symbols that indicate the required design, size, location, and number of welds as well as other joining and inspection information.

It is very important for welders to be able to interpret welding symbols accurately. It allows them to produce better quality work in shorter periods. Reading blueprints correctly also saves costs by getting projects done the right way in the first attempt.

Unfortunately, a large number of welders have a hard time reading blueprints correctly. Many welders in the market do not take vocational training. The ones that do take classes either do not get trained on blueprints or decide not to pay attention to the written material. The result is that only a few welders know how to read blueprints accurately or use them in their work.

Fundamentals of Welding Blueprints

If you look at your average welding blueprints, you will see three basic types of view. These are the front, top, and right-side views. You will also notice a variety of welding symbols at specific areas on the sketch. These symbols identify the type of work that must be carried out to complete the welding project.

Print Reading

Welding symbols are drawn with a specific structure that describes the direction and type of weld to make. Every welding symbol that you see will have an arrowhead which points to the location where you need to make the weld.

The arrow is connected to what we call a leader line. This line intersects with additional reference lines that run horizontally. The arrow can point upwards or downwards, signifying where to make the weld.

Finally, there is a tail at the opposite end of the reference line. The tail may have several forks that point off in different directions. This tail suggests specialized instructions for the weld.

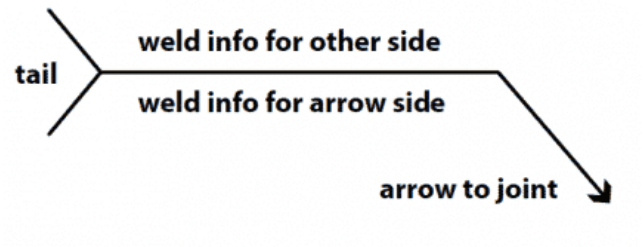


Figure 4.2a. The Welding Symbol contains a reference line, arrow and tail.
Source: https://www.millerwelds.com/resources/article-library/deciphering-weld-symbols

If you look at the center of the reference line, you will see either parallel lines or a geometric shape. These lines indicate the kind of weld you need to make on the metal frames.

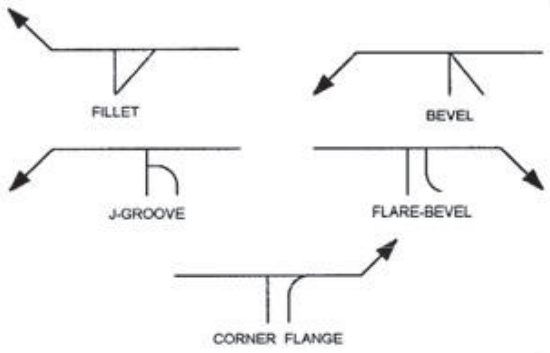


Figure 4.2b. The Welding Symbol contains a reference line, arrow and tail.
Source: https://www.millerwelds.com/resources/article-library/deciphering-weld-symbols

There are more than a dozen types of welds that you can make. To do an accurate job, it is important not to confuse the weld symbols. The symbols on the reference lines indicate the type of weld that should be done while the overall welding symbol gives you complete instructions for the welding project.

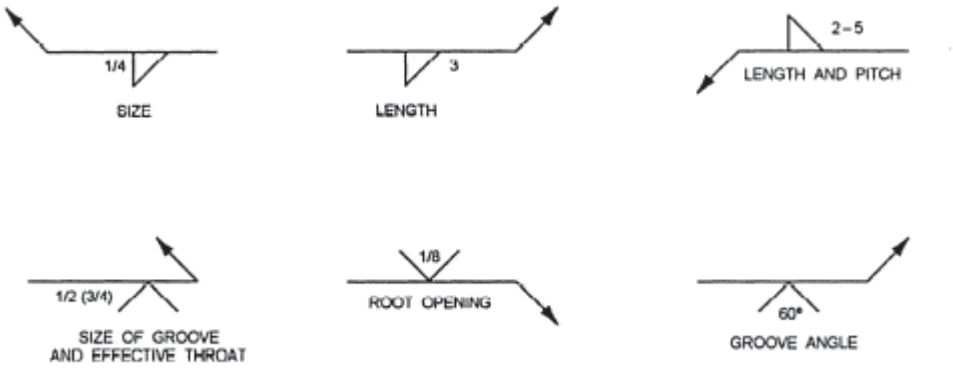


Figure 4.2c. The Welding Symbol contains a reference line, arrow and tail.
Source: https://www.millerwelds.com/resources/article-library/deciphering-weld-symbols

When you are reading a welding diagram, pay close attention to the placement of the symbol on the reference line. If the weld symbol is present below the reference line, the weld should be carried out on the arrow side of the joint. On the other hand, if the weld symbol is present on top of the reference line on the diagram, the weld should be made on the opposite side of the joint from where the arrow is pointing.
If the weld symbol is noted on both sides of the reference line, then multiple welds must be made on both sides of the joints.
Various welding symbols have been developed to differentiate between the types of welds you can use on your project. For example, a “II” shaped symbol indicates a square weld while a “V” indicates a V weld should be used.

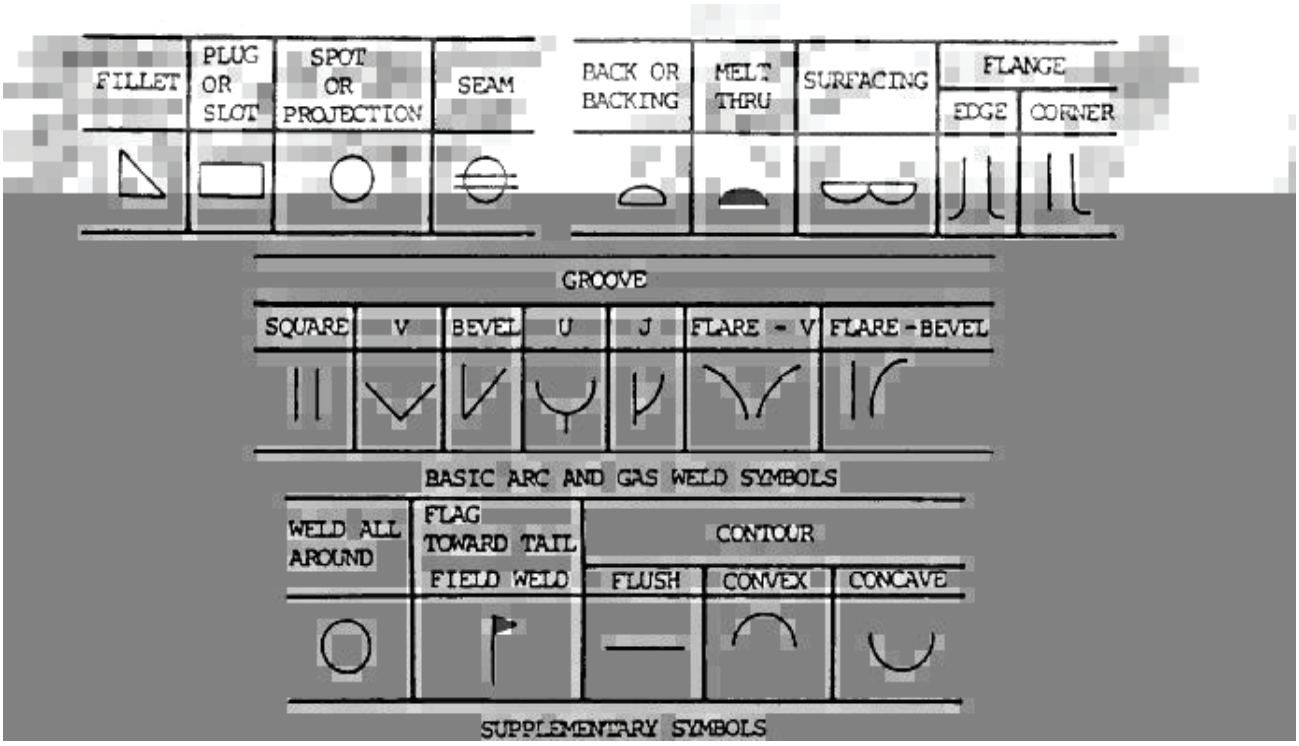


Figure 4.2 d Welding Symbol Chart
Source: https://welder101.com/how-do-you-read-welding-symbols/

Since there are so many symbols, it takes some time for welders to memorise the differences. You can get a print out of the most basic symbols and put it on the welder to make it easier for you to recognise them. Once you have memorised the most common symbols you can move on to additional symbols that aren't very common.

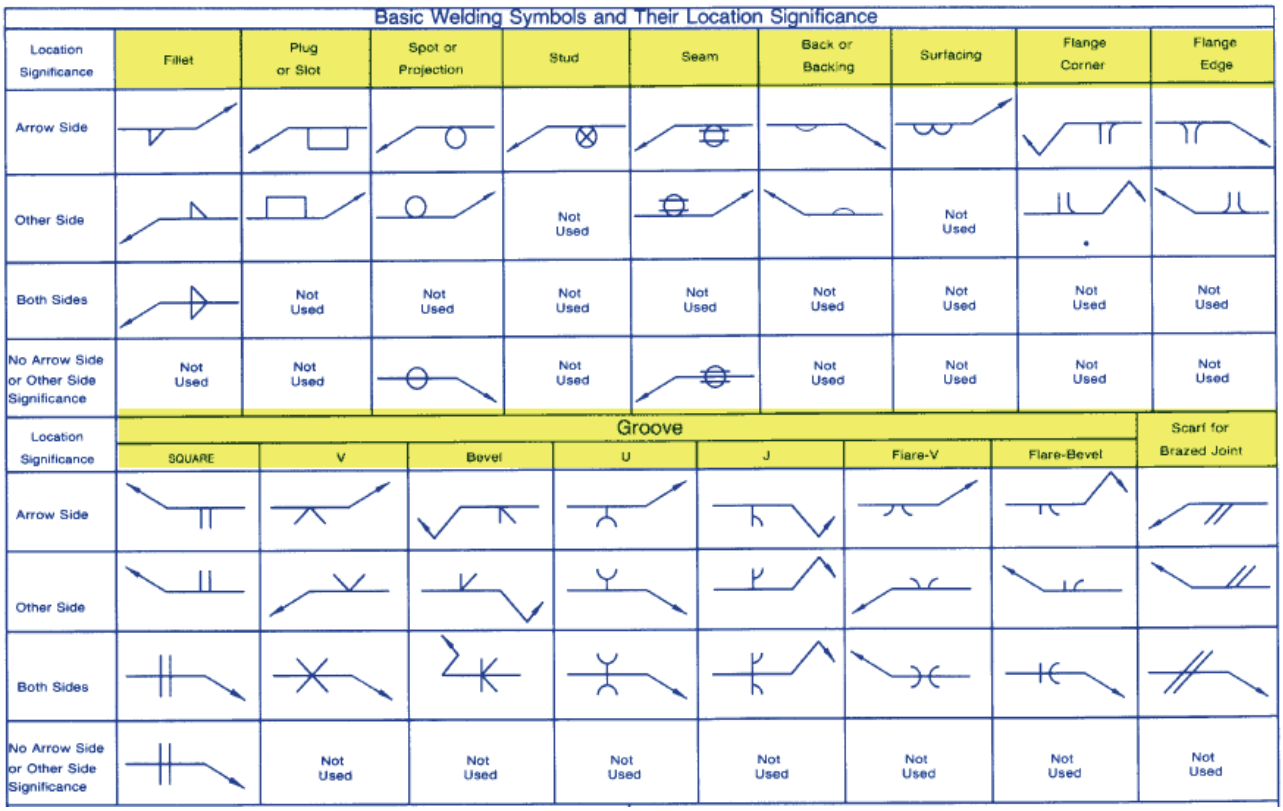


Figure 4.2 e Welding Symbols
Source: https://welder101.com/how-do-you-read-welding-symbols/

Letters on the Welding Symbols

When you start reading welding blueprints, you will also find some letters on the charts. These letters show you important information to consider when making the welds, such as length and root openings. Here is a reference to use for the letters.

- **A:** Angle of Countersink
- **C:** Chipping Finish
- **F:** Finish Symbol
- **G:** Grinding Finish
- **L:** Length of the Weld
- **M:** Machining Finish
- **N:** Number of spot welds or projection welds
- **P:** Pitch of Welds (Center-to-Center Spacing)
- **R:** Root Opening; Depth of Filling
- **S:** Depth of Preparation; Size of Strength
- **T:** Specification Process

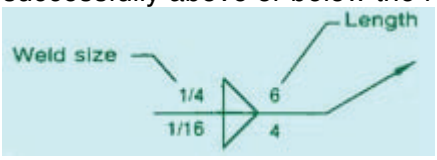
You will see these letters along with the symbols of welding if there is a specific weld that must be done to complete the project. The letter may also be found on some welding blueprints on its own.

Dimensions and Angles

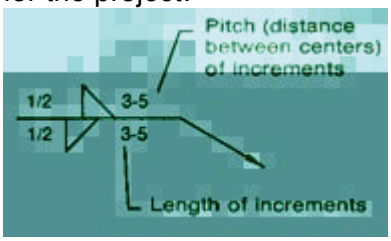
The welding symbol's angles and dimensions are very important to note as they make it easier to understand the welding blueprint. The blueprints are packed with information and provide a lot of information with just a few lines to an experienced user. They can be used to communicate length, width, depth and the opening of the weld.

The diameter or width of the weld is generally noted on the left of the weld symbol and will be written down as a fraction in inches. The length, also expressed in inches, is written on the right of weld symbol.
Welding symbols also indicate whether the welds should be offset on both sides or mirror each other. Welds are mirrored when they are made on the exact location of a sheet on opposite sides. They are considered to offset one another when they are not made on the exact opposite location of the frame.

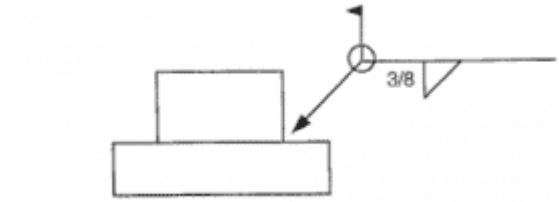
The welding symbol also includes the angle of the weld, its root opening or root face dimensions. Numbers are a big part of identifying the weld depth and angle specifications. They help clarify the beveling required on the base metal before welding can be performed successfully above or below the reference line.



Dimensions written under the reference line are used for the joint on the arrow side while dimensions noted over the line apply to the joint on the opposite side. If we look at the image above, welds are identified for both sides of the joint.
In some cases, a series of separate welds may be specified for a project that should be used instead of a single long weld. When working with heat-sensitive or thin metals that can get damaged with a long and consistent weld, this is a common practice. If you read the welding diagram shown below, you'll see that a string of 3-inch intermittent fillet welds is recommended for the project:



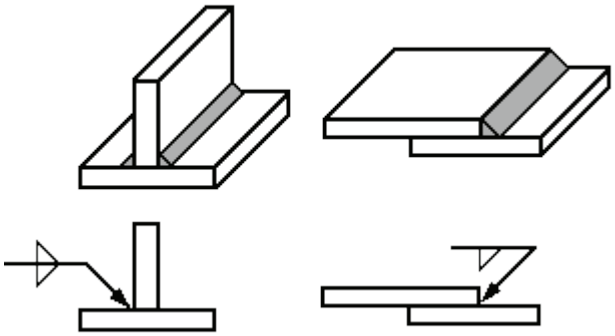
If you ever see a flag at an intersection of the reference line do not perform the weld inside a workshop. The flag is used to indicate that the weld must be carried out in the field.



Common Symbols and Their Meanings
There are dozens of cryptic symbols used in welding blueprints for identifying the weld. These symbols help the welder understand the size and other finishing and processing information for the project.
In this section, we will go over some of the common symbols and their meaning. You can find the complete set of symbols through the American National Standards Institute (ANSI) for welding.

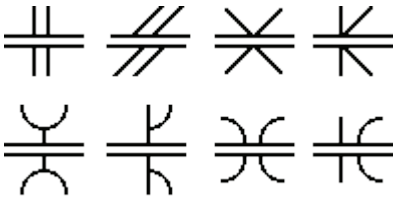
Fillet Welds

The fillet weld (pronounced “fill-it”) is generally used to make 90-degree lap joints, T-joints, and corner joints. As the symbol shows, the weld is almost triangular at its cross-section. The shape is not always a 90-degree right-angled triangle however and there can be some variation to the weld.
A small quantity of welding metal is deposited in the corner of the joint formed by the two members. It penetrates and fuses with the material of the frames to form the joint.



The triangle’s perpendicular leg is always drawn to be on the left side of the symbol, irrespective of the orientation of the weld. The size of the leg is written on the left side of the weld symbol. If the two legs of the weld are supposed to be the same size, the symbol will show only one dimension. If the weld is supposed to have legs that are different sizes then both dimensions will be given. The drawing will also illustrate which leg is supposed to be longer.

Groove Welds

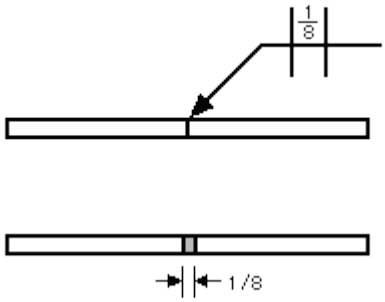


The groove weld is generally used to create joints that are connected between the edge of two different metal frames or sheets. As can be seen by the image above, the groove weld can be made in a variety of ways. This type of weld is also used in T joints, corner joints or joints between curved and flat pieces of metal.

The difference in welding mainly depends on the geometrical shapes of the parts that are to be joined together and how they are prepared at their edges. During the welding process, the joining metal is deposited within the groove as it penetrates and fuses with the base metal on different sheets to form the joint.

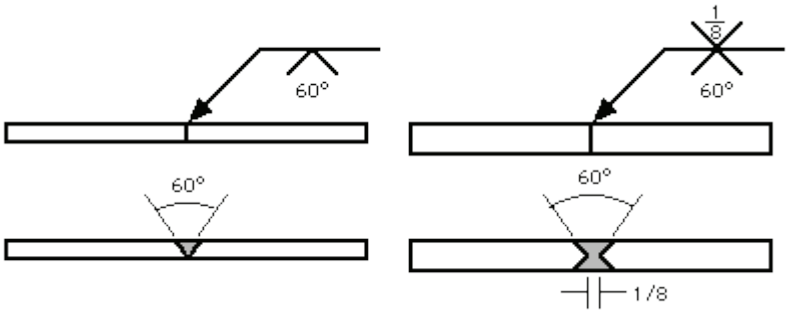
The groove weld can be further classified into the following categories.

Square Groove Welds
This type of groove is formed by either creating a slight parting of the metal edges or a tight fit between two metal frames. The diameter of the space created with this method, if any, is shown on the weld symbol.

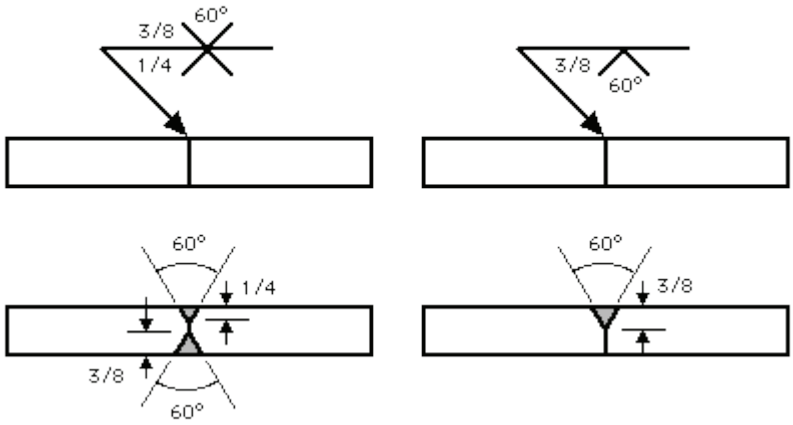


V-Groove Welds

It is similar to the square weld with the difference being that the edges of both metal pieces are chamfered, on one side or both, to create the groove. The degree of the V angle is present on the weld symbol, as well as the separation at the root, where required.

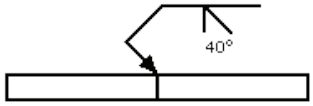


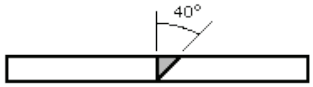
In case the groove is created by separating the metal, the thickness of the groove may not run fully deep into the metal sheet.



Bevel Groove Welds

In this type of weld, the edge on one side of the joint is chamfered and the other edge is left square to create a bevel groove. The bevel symbol's perpendicular line is always drawn on the left side irrespective of which direction the weld is oriented towards. The arrow points toward the metal joint that must be chamfered. The significance of the direction is emphasized by breaking the arrow line.

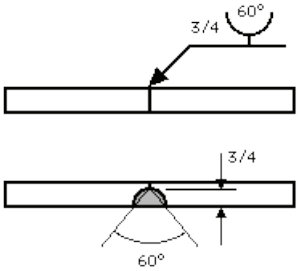




U-Groove Welds

This weld is formed by giving a concave treatment to the edges of both metal pieces. When joined together, they form a U-shaped groove.

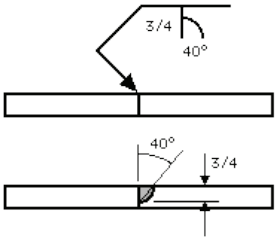
Depth of this edge treatment, separation at the root and effective throat are shown by using the same method as the V-groove.



J-Groove Welds

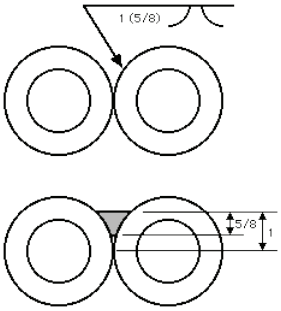
The J-groove is formed by giving a concave treatment to one piece of metal and leaving the other one as a square. This is done in a process that is similar to the bevel groove joint formation.

The perpendicular line is drawn on the left and the arrow points to the metal that receives the concave edge treatment. Depth of edge treatment, root separation, and effective throat are described in the manner shown below.



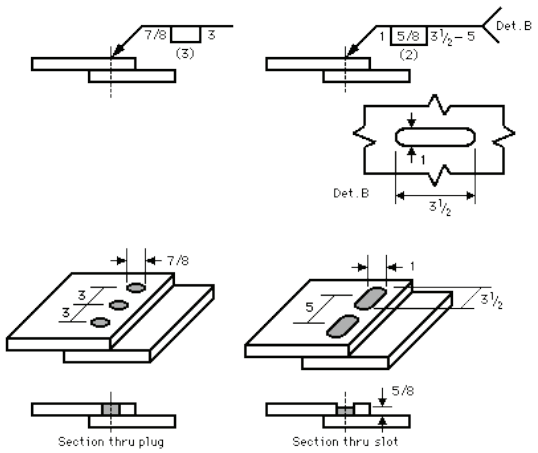
Flare Groove Welds

This type of weld is used to join two or more rounded parts together. The ideal depth of the weld is shown on the left side of the symbol while the weld depth appears in parentheses.



Plug and Slot Welds

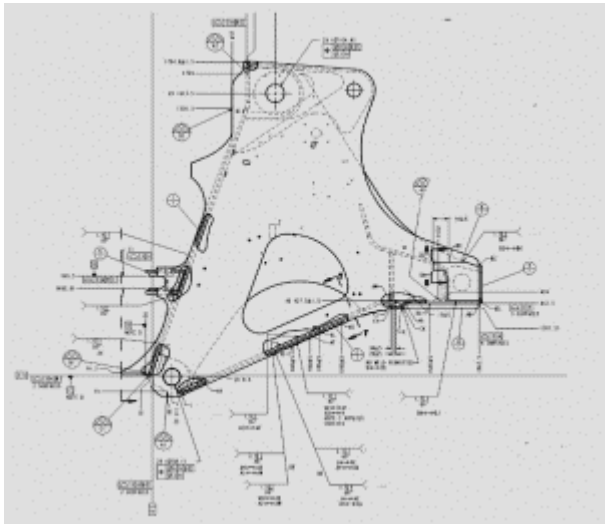
Plug welds and slot welds are used to join frames and metal sheets that overlap one another. Usually, both the pieces have holes in them for connecting them. Metal sheets with plugs have round holes while elongated holes are built into slot sheets.
Weld metal is deposited inside the holes as it penetrates and fuses with the base metal of the two sheets to form the joint.



For plug welds, the diameter of each plug is given to the left of the symbol. The pitch of the plugs is labeled on the right. In slot welds, width is used for each slot which is given on the left side of the symbol while the length and pitch are illustrated to the right of the symbol. The detailed drawing is referenced near the tail.

The total number of plugs or slots to weld is given below the weld symbol in parenthesis. The arrow side and other side designate which piece contains the hole(s).
In a case where the hole does not need to be filled completely with welding metal, the depth for filling it up is noted within the weld symbol.

Putting It All Together
Some of the welding diagrams shown above have the metals represented as two blocks coming together. This is done to make it easier to understand how the weld should be performed. This is usually not the case for an actual welding blueprint. A real welding diagram looks more like this.



In some welding blueprints, you will also see the reference lines with a break. This indicates that preparation should be done for the joint, before welding the pieces together. The design of the break also represents the kind of preparation that should be done for the weld.
If you are just starting out with welding blueprints, you may find it difficult to read and understand how the blueprints work. Sometimes, the drawings are too complicated and confusing, even for experts. It takes time and patience to learn how to read them.
Once you master the art of reading blueprints, it will become easier and you will be able to create beautiful and advanced projects without trouble.

Application of layout or fit-up techniques

Understanding Metal Fabrication Fit-Up
Fit-up is the step between producing the parts needed for a fabrication and welding them. If there are just a couple of pieces they might be clamped together. For more complex assemblies it's usual to make some kind of fixture that holds all the pieces in position. This is the fit-up.

It's essential to get the fit-up right because that determines how well the finished fabrication conforms to the drawing. Usually the parts are fixed with small gaps between them, (not more than 3/16" and preferably less,) and the welder bridges these with filler. If the gaps are too small or nonexistent you're likely to get distortion in the fabrication as the pieces expand and contract. If they're too big though it's more work for the welder to bridge them.

The Consequences of Poor Fit-Up
Larger gaps between pieces being welded have several consequences, all of which end up costing money. Bigger welds:

- Need more filler wire
- Take longer to make
- May need more clean up
- Can look unsightly
- Can create weak spots in the fabrication

The Quantity Aspect
Poor fit-up, meaning excessively large gaps or worse, inconsistent gaps, is a problem when the fabrication is a one-off, for all the reasons listed above. It's an even bigger problem when multiples are being fabricated. The excess time and cost all scale of course, but in addition there are a couple of other issues.
First, when each fabrication needs a slightly different approach the welder doesn't get a chance to optimise technique. Usually repetition increases speed, but inconsistent fit-up turns every supposedly identical fabrication into a one-off.

Second, the variation means there's no chance of going to robotic welding. Getting a quality job from robotic welding cells is totally dependent on the consistency of the incoming pieces and their fit-up. Robots might look smart but poor fit-up will defeat them every time!

Avoiding Fit-Up Problems
There are two aspects to address.
First, the pieces must be held in the same position every time. That requires sturdy and repeatable fixturing.

Second, the pieces must be both accurate and consistent. Accurate, meaning they should be as close to the specified lengths and angles as possible and consistent in that there should be a minimum of variation between pieces.

How do you achieve this accuracy and consistency? This can be achieved through mastery of the cutting and forming processes. Machinery should be in top condition, the measuring equipment properly calibrated, and the people doing the work must be skilled and experienced.

Attention to Cutting and Forming Prevents Welding Mistakes
In the fabrication world welding skills are essential, but on their own they're not enough to produce quality work. It's just as important to be good at the business of cutting and forming the pieces going in to each fabrication.

Teaching and Learning Strategies
Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of measurement, print reading, fit-up and lay-out technique.. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Basic Measurements

Teaching Strategies
Students engage in brainstorming exercise to discover how measurements are applied in welding.
They then are allowed to design guiding questions that will enable them to conduct research on the applications of measurements in welding.
Discuss in groups on the research findings.

Learning Strategies
Activity 1 Brainstorming activity on the applications of measurements in welding
Activity 2 Conduct research on the applications of measurements in welding
Activity 3 Discuss and present research findings.

Resources
Teacher Notes

Lesson 2: Print Reading

Teaching Strategies
Engage students in the discussions of the Applications in Print Reading.
Engage students in presentation of group activities of the different applications of Print Reading.

Learning Strategies
Discover Terminologies and technical applications in Print Reading.
Activity 1 Gather in groups and read texts on applications of Print Readings.
Activity 2 Discuss using discussion points and questions as guidelines.
Activity 3 Present in groups the points discussed.
Resources

Supplementary texts on applications of Print Reading.

Lesson 3: Layout of Fit up Technique

Teaching Strategies
Guided Discovery of the applications of layout or fit-up techniques.

Learning Strategies
Activity 1 Students are given reading materials on application of layout or fit-up techniques.
Activity 2 Guide questions or points are given.
Activity 3 Students individually discover the application techniques using guided questions and points.

Resources
Reading texts on layout or fit-up techniques, Charts on the techniques.

STEAM Activity Students work in groups to create an activity in Measurements in welding. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to apply Print Reading, Measurement and Layout or fit-up techniques. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.
Performance Assessment
1. Explain print reading and fit-up or layout technique in welding.
2. Apply correct measurement in print reading and layout or fit-up technique in welding

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
2. Can explain clearly how print reading application and fit-up or lay out techniques are used in welding.	In clear fluent English using technical terms explain how print reading application and the lay out or fit-up techniques work in welding.	In clear fluent English explain how print reading application and the lay out or fit-up techniques work in welding.	In plain English just explain print reading and the lay out or fit-up technique.	Explain print reading or fit- up or lay out technique.
3. Can describe how measurement is used in the applications of print reading and fit-up or lay out techniques.	Can apply with perfect distinction, measurements to print reading and fit-up or lay out technique.	Can apply measurements to print reading and fit-up or lay out technique.	Can apply measurements to either one of print reading or fit-up or lay out technique.	Can vaguely apply measurements to either one of print reading or fit-up or layout technique.

UNIT 3.4 Welding Technology

Content Standard 3.4 Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 10.3.4.3 Prepare and identify types of metals according to job specifications.

Topic 3: Metals

Learning Objectives

By the end of this topic, the students will be able to;

1. Discuss types, uses and correct preparation of metals according to job specifications.

Essential Questions:

1. How do we prepare and identify metals in welding?
2. What are metals?
3. What are metal properties?
4. How do we write out job specification for a welding project?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Types of metals used in welding	Prepare and identify several considerations when selecting a metal for according to job specifications in welding.	Responsibility and diligence is valued towards the Preparation and identification of several considerations when selecting a metal for according to job specifications in welding through collaborative presentations	Responsibility and diligence towards the Preparation and identification of several considerations when selecting a metal for according to job specifications in welding through collaborative presentations

Technology and Industrial Arts Application: Construction Technology: Welding Technology

Content Background

Each metal responds to heat in its own way. Depending on the fact how they expand and soften on heating, they can be used for different applications. Even the welding processes such as SMAW, MIG, TIG, and FCAW determine the choice of welding materials. Since the types of materials for welding used can make or mar the entire process, it is necessary to have complete knowledge about them.

There are several types of metals, but 4 of them are most commonly used in welding. These are explained below.

1. Steel

Have you ever thought about why steel welding electrode price is lower than other metals? It is because steel is a cheaper metal. Moreover, it has a high tensile strength and hence, it is highly resistant to stress. Steel is available in different variants such as stainless steel, carbon steel, and low carbon steel.

2. Cast Iron
It is a type of welding iron. Since cast iron has a high percentage of carbon content, it is also less malleable and ductile. This means that it is vulnerable to cracking. However, an expert welder can work with cast iron efficiently using preheating and heating methods.

3. Aluminium
Aluminum is another type of popular welding rod material. Lighter than steel, it is less corrosive as compared to other metals. Hence, it is considered a durable metal. It also has good electrical conductivity. However, certain grades of aluminum may require filler metals to help materials fuse together.

4. Titanium
Like aluminum, titanium is also light-weight than steel but as strong with high corrosion resistance. It gives durable and long-lasting results. Titanium metal sheet welding requires a strong shielding gas.

There are four more metals that are used in welding:

5. Copper
Among the types of welding electrodes metals, copper is another strong contender. Its characteristics comprise good electrical conductivity and heat conductivity, wear and tear resistance, and corrosion resistance.

6. Nickel
Nickel is highly suitable as an arc welding electrode material. It has high corrosion resistance properties and hence, works best in an extreme environment.

7. Magnesium
The properties of magnesium are similar to aluminum. It can absorb vibrations and is easy to weld. If magnesium is used in joining metals, the welders must be extra careful or else welding can go wrong. Welding dissimilar metals is a complex process and magnesium can be joined by laser, resistance spot, or friction stir welding.

8. Tungsten
Tungsten electrodes are used in the **arc welding process** with the **TIG** Welding or plasma welding process. In both of the welding processes, the arc, weld, and weld pools are protected from atmospheric contamination by inert gases. Some welding processes like spot welding and ERW process require a flux coated electrode. These processes do not consume the electrodes. The welding electrode dissolves itself and bonds with the welding component and electrode. On the contrary, non-consumable electrodes remain integral and do not dissolve during the welding process.

Types of Welding: Conventional vs Reclamation Welding

Flux, filler metals and welding rods are known as conventional welding consumables. TIG Welding and MIG Welding are the most common forms of welding where these welding consumables are used. These fluxes and filler metals are melted and joined together to create a strong weld.

Reclamation welding is basically repairing badly worn components and equipment to their original state. Welding rod and FCW wires are mainly used for reclamation welding activities.

As you can understand, each type of metal has its own properties, merits and demerits. You have to select a metal based on the welding technique and type of product that needs to be welded.

Preparations and identification of metals
Understanding welding metals is one of the pillars of knowledge needed to be a successful welder. Each metal and metal alloy responds differently to heat and in the way they can be manipulated. Metals expand and soften when heated, resulting in different uses and applications.

They also respond in different ways to the various types of welding methods used.
Review the characteristics of each of metal below.

Considerations
There are several considerations when selecting a metal for welding. This includes:

- Melting point
- Ductility: metal reactions to bending, stretching.
- Electrical Conductivity: affects what the metal can be used for.
- Strength: the breaking point of a metal.

Types of Welding Metals
Steel

- Everyone is familiar with the strength of steel.
- It is an alloy that contains iron and 2% of other elements.
- Carbon/steel alloy is common and can be found in high, low and medium varieties.
- Higher carbon content means stronger steel.
- Steel is versatile and can be used with any welding process. Welding areas need to be cleaned.
- On the downside, it can rust and flake from oxidation.

Stainless Steel

- Unlike plain steel, stainless is made to resist corrosion and is hygienic.
- This is achieved by adding 10% to 30% chromium to other elements such as iron. There is also a nickel alloy available.
- Stainless is welded using arc welding (tig, mig, stick).
- The downside is the higher cost.

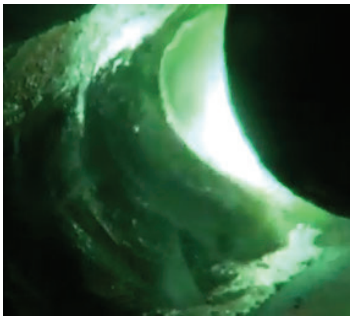


Figure 4.3a: Magnified view of aluminum welding in progress
Source: https://weldguru.com/welding-metals/

Magnified view of aluminum welding in progress

Aluminum

Similar to stainless steel, aluminum also isn't as corrosive as other metals.
It is lighter than stainless steel. In welding, pure aluminum and alloys are used.
Alloys include:

- copper/aluminum alloy
- manganese alloy
- zinc alloy

Tig welding (GTAW) is the process of choice for welding aluminum. Other welding methods that are used include GMAW (gas metal arc welding or Mig). Stick aluminum welding is only used for smaller projects. The process starts by selecting a joint design for the base metals (tee, lap, edge, corner or butt).

Thickness	Tungsten Size	Filler Rod Size	Amps	Volts	Gas Cup	Gas Flow (cfh)
1/16"	1/16" – 3/32"	1/16" – 3/32"	70 - 100	15	3/8"	20
3/32"	3/32" – 1/8"	1/8"	90 - 120	15	3/8"	20
1/8"	1/8" – 5/32"	1/8" – 5/32"	125 – 175	15	7/16"	20
3/16"	5/32" – 3/16"	5/32" – 3/16"	170 – 225	15	7/16" – 1/2"	25
1/4"	3/16" – 1/4"	3/16"	220 – 275	15	1/2"	30
3/8"	1/4"	3/16" – 1/4"	330 – 380	15	5/8"	35

TIG Welding Guidelines for Aluminum

Copper

Among the welding metals, copper is popular due to its electrical conductivity, heat conductivity, corrosion resistance, appearance and wear resistance. To be called copper it needs to be 99.3% minimum copper content. Processes used in welding include welding, brazing and soldering. There are multiple types of copper alloys:

- copper-nickel-zinc (called nickel silver)
- copper-nickel
- copper-silicon (called silicon bronze)
- copper-aluminum alloy (aluminum bronze)
- copper-tin
- copper-zinc (also known as brass)
- high copper alloys (up to 5% alloy)

Copper is welded using Gas Tungsten Arc Welding (Tig) and Gas Metal Arc Welding.
Some welders will use manual metal arc welding, but it can result in poor quality.
When welding copper the joint designs are wider than those recommended for steel. The shielding gas for copper is welding grade argon.

Weld areas are cleaned with a wire bronze brush and then degreased. Oxides that form should be removed after welding. Copper is preheated, however, copper alloys do not need to be preheated due to high levels of thermal conductivity.

Figure 4.3b Weld using copper alloy
https://weldguru.com/welding-metals/

Cast Iron

In terms of welding metals, low carbon steel is easier to weld than cast iron.
Cast iron has higher carbon and silicon content, and is not as ductile. When welding with cast iron the surface will need to be cleaned to remove any ingrained grease and oil. All cracks need to be grinded or filed. Cast iron is welded with oxyacetylene welding.

Nickel Alloys

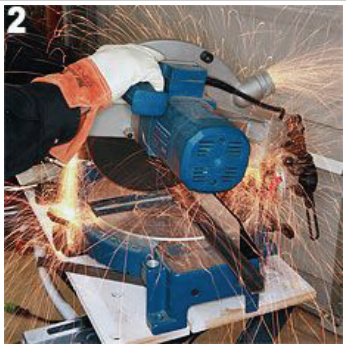
Nickel welding metals come in the form of several alloys. These include:

- Nickel Alloy 141: Used for welding case and wrought pure nickel (nickel 200 and 201). It is also used to join nickel to steel.
- Nickel Alloy 61: Same as above.
- Nickel-Copper Alloy 190: For welding to itself or to stell.
- Nickel-Copper Alloy 60: Used for welding to itself.

Magnesium

Magnesium alloys are lightweight (2/3 of aluminum), it absorbs vibration and is easy to cast. It has a melting temperature similar to aluminum and is welded in a similar way.
When you grind magnesium note that the shavings are flammable (do not use water to put out any flames). The metal is welded with a Tig welder.

Job Specifications Steps

	
1. Lay it all out. In this case, on a flat,	**2. Cut here.** You could hacksaw these pieces of

noncombustible surface--the shop floor. Now square up the pieces of the frame and lightly tack-weld them together. Some clamps or weights will hold everything in place.	¾-in. angle iron easily enough, but you can save some time by using an abrasive metal-cutting blade as the wheel in a chop saw. A slow, steady feed cuts fast without making excess heat.

3. Proper tacking is important. Weld just enough to pin the parts together. As you add more parts, adjust to keep everything square. Never finish-weld any joints until you have a fairly complete subassembly that's well tacked; measure diagonally to square things up.	**4. Cope it out.** We used a plasma cutter to trim part of the angle iron at the joints. This is known as coping, and it allows the pieces to fit more closely. You can achieve the same thing with a grinder or even a hacksaw.
5. Keep adding parts. After you assemble the front and rear frames, add the horizontal frame elements. Another pair of hands can help here. Tack everything together, and check that it's all square, aligned and intact before attempting full welds.	**6. Good posture helps.** If you're not comfortable, the weld bead is going to wander. Use both hands to hold the welding gun, and brace at least one elbow against your torso. Rehearse the movement in longer beads with the welder shut off.

7. Measure, and measure again. As you build up, constantly check the assembly for squareness by measuring across diagonals. Use a few light hammer taps to correct to within 1/8 in. before you finish the weld.	**8. End result:** We added a handle, a rack for clamps and ground cables at the rear and, of course, wheels and casters. Shelves are made of expanded metal, so they won't collect dust or slag. Then we sandblasted the slag off the welds and finished with Hammertone silver paint. The cart is topped with a plasma cutter--one that cuts 1/4 in.-thick steel plate like warm tofu.

Figure 4.3c. Job Specifications Steps
Source: http://www.timewelder.com/uppic/woed/Welding%20Procedure%20Preparation.pdf

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of types of metals in welding. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Types of Metals

Teaching Strategies

Students engage in brainstorming exercise to discover the different types of metals and to prepare them for welding purposes.
They are then allowed to design guiding questions that will enable them to conduct research on the different types of metals and alloys and how they can be welded.
Discussions in groups on the research findings.

Learning Strategies

Activity 1 Brainstorming activity the different types of metals.
Activity 2 Conduct research on how they are used in welding.
Activity 3 Discussions and presentation of research findings.

Resources

Texts on metals in welding

Lesson 2: Preparation and use of metals according to job specification

Teaching Strategies

Engage students in the discussion of steps in job specification in the preparation and use of metals..
Engage students in presentation of their discussions in groups.

Learning Strategies

Discover what job specification is in welding and describe the steps involved.
Activity 1 Discuss job specification is in welding.
Activity 2 Describe the logical steps involved.

Activity 3 Present as group presentation.

Resources
Text on job specifications in welding

STEAM Activity Students work in groups to create an activity incorporating metals, and their properties. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

The main purpose of assessment is to find out if students can use the skill of synthesis to prepare and identify types of metals according to job specifications. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define metals and explain metal properties.
2. Identify and prepare metals according to job specifications.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define metals and explain metal properties	Advance definition and clear explanation of 5 or more metals and their properties.	Advance definition and clear explanation of 3-4 metals and their properties.	Definition and clear explanation of 2 metals and their properties.	Definition or explanation of a metal and its properties.
2. Prepare metals according to job specifications.	Organisation of all job specification in clear distinguished order.	Organisation of more than half of all steps in job specifications in order.	Organisation of less than half of all steps in job specifications in order.	Organisation of 1 or 2 steps in job specifications in order.

UNIT 3.4 Welding Technology

Content Standard 3.4 Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 10.3.4.4 Describe properties of fabrication materials and apply welding techniques and cutting processes in fabrication fundamentals.

Topic 4: Fundamentals of Fabrication

Learning Objectives

By the end of this topic, the students will be able to;

1. Describe properties of fabrication materials
2. Apply welding and cutting processes and techniques in fabrication.

Essential Questions:

1. What is Fabrication?
2. What are some of the common fabrication materials?
3. What are the properties of fabrication materials?
4. What are welding and cutting processes and techniques of fabrication materials?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Fabrication materials, welding processes, cutting processes	Describe and Apply the fundamentals of fabrication, welding processes & techniques and cutting processes & techniques	Appreciation for the betterment of outlook on human lives is valued towards fabrication materials, welding processes and cutting processes	awareness and appreciation is shown towards fabrication materials, welding processes and cutting processes through collaborative group presentations,

Technology and Industrial Arts Application: Construction Technology: Welding Technology

Content Background

Fabrication Materials

Methods for metal fabrication range in complexity with respect to the desired qualities of the end product and the composition of the materials in use. Strength, conductivity, hardness and resistance to corrosion are all commonly desired properties. Through varying techniques in cutting, bending and welding, these metals can be used in a variety of products ranging from appliances and toys, to larger structures like furnaces, duct-work and heavy machinery.

- **Iron** is a chemical element, and the most common on earth in terms of mass. It is abundant and essential for the production of steel.

- **Steel** is an alloy of iron and carbon, which typically includes a mix of iron ore, coal, limestone and other elements. It is the most common steel utilized in metal fabrication, and has an almost endless list of uses from construction materials to machinery and weaponry.
- **Carbon Steel** can be fabricated to a variety of hardness levels depending greatly on the amount of carbon used. As the quantity of carbon rises the strength of the steel increases but the ductility, malleability and melting point of the material decreases.
- **Stainless Steel** is composed of carbon steel, aluminum, chromium and other elements that combine to form a highly corrosion-resistant metal. Stainless steel is known for its distinctive polished silver mirror coating. It is lustrous, brittle and does not tarnish in air. The myriad applications of stainless steel include surgical instruments, cookware, appliances, metal ceramics, cabinet fittings and collectibles.
- **Copper** is an impeccable conductor of electricity. It is tough, ductile, malleable and resistant to corrosion in many atmospheres, which makes it useful in marine and industrial environments.
- **Bronze** is a copper alloy that has have been in use since around 3500 BC. It is stronger than copper, heavier than steel and features a low melting point. Bronze has been used in the manufacture of coins, weapons, armour, cookware and turbines.
- **Brass** is composed of copper and zinc. It is often used for nuts, bolts, pipe fitting, door knobs, furniture trim, clock components and much more. Its acoustic properties make it an ideal alloy for casting musical instruments.
- **Aluminium** is lightweight, durable and versatile with good thermal and electrical conductivity. Aluminium does not perform well at temperatures higher than 400 degrees Fahrenheit, but excels at sub zero temperatures, making it ideal for low-temperature applications like refrigeration and aeronautics.
- **Magnesium** is the lightest structural metal. Its low density makes it ideal when strength is not overly important but stiffness is required. Magnesium is used for aircraft housings, automobile parts, and elements of rapidly rotating machines.

Basic Raw Materials Involved With Metal Fabrication

Metal fabricators have numerous standard raw materials at their disposal that can reduce cycle times and workflow. This guide discusses the various types of raw materials that are typically used in metal fabrication.

Metal fabrication is the creation of metal parts, machinery, or components through forming, cutting, and other like processes. Common fabrication techniques include welding, lathing, broaching, grinding, milling and honing, though many metal fabrication shops offer a variety of specialties that may be well-suited to your specific needs. A vital process for virtually all manufacturers, metal fabrication ranges from industries such as automotive and electrical to food and beverage. Over the years, the use of popular raw materials has resulted in the standardization of many fabrication parts and components. Before beginning a metal fabrication process, it is helpful to understand which materials are available and appropriate for your unique application. The following types of raw materials should be readily available from a wide variety of metal suppliers:

- Plate Metal
- Fittings
- Castings
- Formed and expanded metal
- Hardware
- Sectional metal
- Welding wire

Casting Raw Materials

Casting, a fabrication process that has been in use for over 6,000 years, involves forcing liquid metal into a mold and allowing it to cool and harden in the desired shape. A high degree of custom flexibility makes casting an ideal choice for applications that require complex geometries. Raw materials used in the process typically include molten metal, but epoxies, concrete, and clay are also used. Common metals used in the casting process include:

- Aluminum
- Iron
- Steel
- Stainless steel
- Gold
- Silver
- Copper
- Magnesium

Formed and Expanded Metal Raw Materials

Expanded metal derives its name from the process through which it is created: stock metal sheeting is sheared in a press to create diamond-shaped holes surrounded by interlinked strands of metal—the shearing stretches (or expands) the metal to its final size. The resulting grate-like aesthetic makes expanded metal ideal for outdoor furniture, fencing, screen doors, and various architectural details. It is also used as guarding on machinery to avoid contact with hot surfaces. Expanded metal raw materials come in a variety of standard thicknesses and grating sizes.

Types of Hardware Raw Materials

In terms of metal fabrication, hardware is defined as various standardized parts or fittings that are used to make a product stronger, more functional, or easier to fabricate. Categories of metal fabrication hardware are numerous, and include such basic raw materials as:

- Corners
- Handles
- Locks
- Keys
- Latches
- Chains
- Wires

Types Of Sectional Metals

Sectional metals are composed of steel and are available in a variety of standardized shapes—they are most commonly used in the engineering and construction industries. The American Society for Testing and Materials (ASTM) rigidly defines both the physical and chemical properties of each type of sectional metal. Popular types include:

- I-beam: A long steel cross-section beam that resembles the shape of the letter "I." In America, wide flange (WF) and H-beams are considered subsections of this category.

- Z-shape: This resembles the shape of the letter "Z," with half a flange protruding in opposite directions.
- Hollow structural section (HSS): HSS consists of hollow piping and is available in a variety of standard shapes: square, circular, rectangular, and elliptical. HSS-shapes can also be angled, channeled, T-shaped or asymmetrical.
- Bar: This type of sectional shape consists of a flat, long, piece of rectangular cross-sectioned metal.
- Rod: A rod is a long piece of metal that is circular or square; rebar is one example of rod sectional metal.

Flat Metal Raw Materials

Flat metal is metal that has been pressed or rolled into very thin, flat pieces. The thickness of a particular piece of sheet metal can vary greatly, from less than a millimeter to several centimeters, and is measured in gauges. Flat metal raw materials can be broken into three general categories:

- Foil or leaf metal: This is the thinnest type of flat metal
- Sheet metal: Sheet metal is the most common type of flat metal, with typical thicknesses less than 6mm in size
- Plate metal: Flat metal that is thicker than 6.55 mm falls into this category.

Welding Wire Raw Materials

Welding wire consists of easily soldered metals that have been formed into thin, circular rods. These raw materials are used to aid the welding process and are melted to help bond two or more pieces of metal together. Welding wire is available in a variety of thicknesses and metal types, allowing for customization in the welding process.

Benefits of Using Basic Raw Materials for Metal Fabrication

The usefulness of standardized raw materials for the numerous metal fabrication processes is immediately apparent. Having uniform shapes and sizes of raw materials reduces the amount of metal fabrication necessary to create a product and dramatically decreases production times. The result is a lower cost per piece fabricated.

The fact that different suppliers are required by the ASTM to use raw materials that are standardized across a narrow spectrum also serves to create compatibility and uniformity throughout an industry. Furthermore, it serves to ensure quality and structural integrity in metal fabrication processes.

Application of Welding processes and techniques

The Four Main Welding Processes

- Oxy Acetylene (Gas Welding)
- Arc Welding (Stick welding)
- MIG Welding
- TIG Welding

Welding process #1: Oxy Acetylene Welding

This welding process uses two cylinders of gas mixed together at the torch, and then ignited into an extremely hot flame. Most times its acetylene mixed with oxygen, but sometimes its propane mixed with oxygen. Either way, a fuel gas is always mixed with oxygen to attain the high temperature needed to melt steel. The temperature of an oxy acetylene flame burns at about 3667□C.

Figure 4.4a Welding Processes
Source:
https://staff.emu.edu.tr/mohammedasmael/Documents/courses/

The flame is used to heat the metal until a molten weld puddle is formed. At this point you move the puddle by manipulating the travel direction of the torch while simultaneously dipping a filler rod. A filler rod is simply a rod of metal that is dipped into the weld puddle that becomes the weld bead. An oxy-fuel setup like this is very versatile. You can weld steel, aluminium, copper, stainless steel, and

e five goggles when using
're cutting or welding, you will
s of metal flying around. You
don't want one of these hitting you in the eyes. But, as versatile as an oxy fuel setup can be, it's a very slow and clumsy process to actually be efficient at welding.

Welding Process #2: Arc Welding

Arc welding is also known as stick welding. It was the first electric welding process to be invented, and it's still very commonly used today. The image of a stick welder is probably what you think of today when you imagine someone welding.

Figure 4.4a Welding Processes
Source:
https://staff.emu.edu.tr/mohammedasmael/Documents/courses/MENG364%20%20%20%20%20Manufacturing%20Technology/WELD

There's the long electrode (stick) attached to a stinger that runs an electric current through the electrode, causing a short circuit at the work piece. You can weld almost any metal, and even cut using an arc welder.

Stick welding is known for its ability to get deep penetration in metal. So, it's often used when welding in shipyards, boilers, and other fields where the deepest weld penetration is needed. The stick electrodes used in arc welding actually burn down in length as you weld.

This is why they're called consumables. And when you look at a finished weld, the weld bead you see is that electrode actually burned down to present a weld bead.

However, this does mean that you have to stop pretty often to discard your old electrode, and add a new one.

Trying to learn stick welding for a beginner can be pretty frustrating. Another reason it's called stick welding is because your electrode often sticks to the metal when starting your arc. It can be frustrating to say the least. Stick electrodes come with a flux coating on the outside of the rod. This coating is an absolute essential, and without it your welds would be very weak. That's because in order for a weld to be solid all the way through, you have to keep the atmospheric gases away from the puddle.

Welding Process #3: MIG Welding

If you're a beginner to welding, MIG welding is without a doubt the process that will get you up and running quickly and smoothly.
With MIG (GMAW Welding) the electrode comes on a roll of continuously fed wire, rather than a "stick".

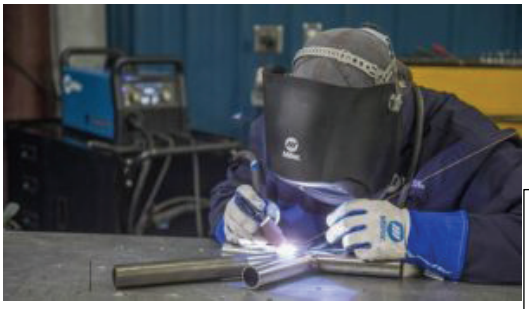
And with MIG you have a handheld gun. You just pull the trigger and the machine starts to feed out the wire. It's essentially an endless supply of welding wire since you don't have to change out the roll of wire very often.

You can choose to weld with either flux core wire, or with solid wire. If you're using flux core wire, the flux (protective agent) is on the inside of the wire. Opposite to that of stick welding.
But if you're using solid wire then you need to use a shielding gas. Typically you'd use C25 gas which is a combination of 25% carbon dioxide and 75% Argon. This shielding gas does the same thing as flux. It purges the weld area of any oxygen or nitrogen that could contaminate the weld.

To successfully learn to weld with a MIG welder you need to master not only a flat position weld, but also, horizontal welds, vertical welds, and overhead welds. On top of that, you need to master the welding joints.

Welding Process #4: TIG Welding

TIG welding is an advanced welding process. It's used mainly in industrial applications where the welds need to be very accurate.



The difference is that with TIG you're heating the metal with an electric arc while dipping the filler rod. And the way the TIG is so clean and so accurate is that it doesn't use a short circuit welding process. In other words, there are not sparks flying everywhere. Just you, the heat of the torch, and the filler rod. There are foot control ll be tricky, and not

Figure 4.4c Welding Processes
Source:
https://staff.emu.edu.tr/mohammedasmael/Documents/courses/MENG364%20%20%20%20%20Manufacturing%20Technology/WELD

Application of cutting processes and techniques

Cutting

If iron or steel is heated to its kindling temperature (not less than 1600ºF (871ºC)), and is then brought into contact with oxygen, it burns or oxidizes very rapidly. The reaction of oxygen with the iron or steel forms iron oxide (Fe_3O_4) and gives off considerable heat. This heat is sufficient to melt the oxide and some of the base metal; consequently, more of the metal is exposed to the oxygen stream. This reaction of oxygen and iron is used in the oxyacetylene cutting process. A stream of oxygen is firmly fixed onto the metal surface after it has been heated to the kindling temperature. The hot metal reacts with oxygen, generating more heat and melting. The molten

metal and oxide are swept away by the rapidly moving stream of oxygen. The oxidation reaction continues and furnishes heat for melting another layer of metal. The cut progresses in this manner.

Theoretically, the heat created by the burning iron would be sufficient to heat adjacent iron red hot, so that once started the cut could be continued indefinitely with oxygen only, as is done with the oxygen lance. In practice, however, excessive heat absorption at the surface caused by dirt, scale, or other substances, make it necessary to keep the preheating flames of the torch burning throughout the operation.

Cutting Steel and Cast Iron

Plain carbon steels with a carbon content not exceeding 0.25 percent can be cut without special precautions other than those required to obtain cuts of good quality. Certain steel alloys develop high resistance to the action of the cutting oxygen, making it difficult and sometimes impossible to propagate the cut without the use of special techniques.

High carbon steels.

The action of the cutting torch on these metals is similar to a flame hardening procedure, in that the metal adjacent to the cutting area is hardened by being heated above its critical temperature by the torch and quenched by the adjacent mass of cold metal. This condition can be minimised or overcome by preheating the part from 500 to 600ºF (260 to 316ºC) before the cut is made.

Waster Plate on Alloy Steel

The cutting action on an alloy steel that is difficult to cut can be improved by clamping a mild steel “waster plate” tightly to the upper surface and cutting through both thicknesses. This waster plate method will cause a noticeable improvement in the cutting action, because the molten steel dilutes or reduces the alloying content of the base metal.

Chromium and Stainless steels

These and other alloy steels that previously could only be cut by a melting action can now be cut by rapid oxidation through the introduction of iron powder or a special non-metallic powdered flux into the cutting oxygen stream. This iron powder oxidizes quickly and liberates a large quantity of heat. This high heat melts the refractory oxides which normally protect the alloy steel from the action of oxygen. These molten oxides are flushed from the cutting face by the oxygen blast. Cutting oxygen is enabled to continue its reaction with the iron powder and cut its way through the steel plates. The non-metallic flux, introduced into the cutting oxygen stream, combines chemically with the refractory oxides and produces a slag of a lower melting point, which is washed or eroded out of the cut, exposing the steel to the action of the cutting oxygen.

Cast Iron

Cast iron melts at a temperature lower than its oxides. Therefore, in the cutting operation, the iron tends to melt rather than oxidize. For this reason, the oxygen jet is used to wash out and erode the molten metal when cast iron is being cut. To make this action effective, the cast iron must be preheated to a high temperature. Much heat must be liberated deep in the cut. This is done by adjusting the preheating flames so that there is an excess of acetylene. Note the use of a mild iron flux to maintain a high temperature in the deeper recesses of the cut, is also effective.

Cutting with Mapp Gas

Quality cuts with MAPP gas require a proper balance between preheat flame adjustment, oxygen pressure, coupling distance, torch angle, travel speed, plate quality, and tip size. MAPP gas is similar to acetylene and other fuel gases in that it can be made to produce carburizing, neutral or oxidizing flames. The neutral flame is the adjust most likely to be used for flame cutting.

After lighting the torch, slowly increase the preheat oxygen until the initial yellow flame becomes blue, with some yellow feathers remaining on the end of the preheat cones.
This is a slightly carburizing flame. A slight twist of the oxygen valve will cause the feathers to disappear. The preheat cones will be dark blue in colour and will be sharply defined. This is a neutral flame adjustment and will remain so, even with a small additional amount of preheat oxygen.
Another slight twist of the oxygen valve will cause the flame to suddenly change colour from a dark blue to a lighter blue color. An increase in sound also will be noted, and the preheat cones will become longer. This is an oxidizing flame. Oxidizing flames are easier to look at because of their lower radiance.

MAPP gas preheat flame cones are at least one and one-half times longer than acetylene preheat cones when produced by the same basic style of tip. The situation is reversed for natural gas burners, or for torches with a two-piece tip. MAPP gas flame cones are much shorter than the preheat flame on a natural gas two-piece tip. Neutral flame adjustments are used most cutting. Carburizing and oxidizing flames also are used in special applications. For example, carburizing flame adjustments are used in stack cutting, or where a very square top edge is desired. The “slightly carburizing” flare is used to stack cut light material because slag formation is minimized. If a strongly oxidizing flame is used, enough slag may be produced in the kerf to weld the plates together. Slag-welded plates often cannot be separated after the cut is completed.

A “moderately oxidizing” flame is used for fast starts when cutting or piercing. It produces a slightly hotter flame temperature, and higher burning velocity than a neutral flame. An oxidizing flame commonly is used with a “high-low” device. The large “high” oxidizing flame is used to obtain a fast start. As soon as the cut has started, the operator drops to the “low” position and continues the cut with a neutral flame.

“Very oxidizing” flames should not be used for fast starting. An overly oxidizing flame will actually increase starting time. The extra oxygen flow does not contribute to combustion, but only cools the flame and oxidizes the steel surface.

The oxygen pressure at the torch, not at some remotely located regulator, should be used. Put a low volume, soft flame on the tip. Then turn on the cutting oxygen and vary the pressure to find the best looking stinger (visible oxygen cutting stream).

Low Pressures

Low pressures give very short stingers, 20 to 30 in. (50.8 to 76.2 cm) long. Low-pressure stingers will break up at the end. As pressure is increased, the stinger will suddenly become coherent and long. This is the correct cutting oxygen pressure for the given tip. The long stinger will remain over a fairly wide pressure range. But as oxygen pressures are increased, the stinger returns to the short, broken form it had under low pressure.

High Oxygen Pressure
If the oxygen pressure is too high, concavity often will show on the cut surface. Too high an oxygen pressure also can cause notching of the cut surface. The high velocity oxygen stream blows the metal and slag out of the kerf so fast that the cut is continuously being started. If too low a pressure is used, the operation cannot run at an adequate speed. Excessive drag and slag formation results, and a wide kerf often is produced at the bottom of the cut.

Cutting Oxygen and Travel Speed
Cutting oxygen, as well as travel speed, also affects the tendency of slag to stick to the bottom of a cut. This tendency increases as the amount of metallic iron in the slag increases. Two factors cause high iron content in slag: too high a cutting oxygen pressure results in an oxygen velocity through the kerf high enough to blow out molten iron before the metal gets oxidized; and too high a cutting speed results in insufficient time to thoroughly oxidize the molten iron, with the same result as high oxygen pressure.

Coupling Distance
The coupling distance is the distance between the end of the flame cones and the work piece. Flame lengths vary with different fuels, and different flame adjusts. Therefore, the distance between the end of the preheat cones and the work piece is the preferred measure. When cutting ordinary plate thicknesses up to 2 to 3 in. (5.08 to 7.62 cm) with MAPP gas, keep the end of the preheat cones abut 1/16 to 1/8 in. (0.16 to 0.32 cm) off the surface of the work. When piercing, or for very fast starts, let the preheat cones impinge on the surface. This will give faster preheating. As plate thicknesses increase above 6 in. (15.24 cm), increase the coupling distance to get more heating from the secondary flame cone. The secondary MAPP gas flame will preheat the thick plate far ahead of the cut. When material 12 in. (30.48 cm) thick or more is cut, use a coupling distance of 3/4 to 11/4 in. (1.91 to 3.18 cm) long.

Torch Angle
Torch, or lead angle, is the acute angle between the axis of the OFW torch and the work piece surface when the torch is pointed in the direction of the cut. When cutting light-gauge steel (up to 1/4 in. (0.64 cm) thick) a 40 to 50 degree torch angle allows much faster cutting speeds than if the torch was mounted perpendicular to the plate. On plate up to 1/2 in. (1.27 cm) thick, travel speed can be increased with a torch lead angle, but the angle is larger, about 60 to 70 degrees. Little benefit is obtained from cutting plate over 1/2 in. (1.27 cm) thick with an acute lead-angle. Plate over this thickness should be cut with the torch perpendicular to the work piece surface.

Angled Torch
An angled torch cuts faster on thinner-gauge material. The intersection of the kerf and the surface presents a knife edge which is easily ignited. Once the plate is burning, the cut is readily carried through to the other side of the work. When cutting heavy plate, the torch should be perpendicular to the work piece surface and parallel to the starting edge of the work. This avoids problems of non-drop cuts, incomplete cutting on the opposite side of the thicker plate, gouging cuts in the centre of the kerf and similar problems.

Cutting Speed
There is a best cutting speed for each job. On plate up to about 2 in. (5.08 cm) thick, a high quality cut will be obtained when there is a steady “purring” sound from the torch and the spark stream under the plate has a 15 degree lead angle. This is the angle made by the sparks coming out of the bottom of the cut in the same direction as the torch is traveling. If the sparks go straight down, or even backwards, it means travel speed is too high.

Cut Quality
Variations in cut quality can result from different work piece surface conditions or plate compositions. For example, rusty or oily plates require more preheat, or slower travel speeds than clean plates. Most variations from the ideal condition of a clean, flat, low-carbon steel plate tend to slow down the cutting action.

One method to use for very rusty plate is to set as big a preheat flame as possible on the torch, then run the flame back and forth over the line to be cut. The extra preheat passes do several things. They spall off much of the scale that would otherwise interfere with the cutting action; and the passes put extra preheat into the plate which usually is beneficial in obtaining improved cut quality and speed.

When working with high strength low alloy plates such as ASTM A-242 steel, or full alloy plates such as ASTM A-514, cut a little bit slower. Also use a low oxygen pressure because these steels are more sensitive to notching than ordinary carbon steels. Clad carbon-alloy, carbon-stainless, or low-carbon-high-carbon plates require a lower oxygen pressure, and perhaps a lower travel speed than straight low-carbon steel. Ensure the low carbon-steel side is on the same side as the torch. The alloyed or higher carbon cladding will not burn as readily as the carbon steel. By putting the cladding on the bottom, and the carbon steel on the top, a cutting action similar to powder cutting results. The low-carbon steel on top burns readily and forms slag. As the iron-bearing slag passes through the high-carbon or high-alloy cladding, it dilutes the cladding material. The torch, in essence, still burns a lower carbon steel. If the clad or high-carbon steel is on the top surface, the torch is required to cut a material that is not readily oxidizable, and forms refractory slags that can stop the cutting action.

Tip Size and Style
Any steel section has a corresponding tip size that gives the most economical operation for a particular fuel. Any OFW fuel will burn in any tip, of course. But the fuel will not burn efficiently, and may even overheat and melt the tip, or cause problems in the cut. For example, MAPP gas will not operate at peak efficiency in most acetylene tips because the preheat orifices are not large enough for MAPP. If MAPP gas is used with a natural-gas tip, there will be a tendency to overheat the tip. The tips also will be susceptible to flash back. A natural-gas tip can be used with MAPP gas, in an emergency, by removing the skirt.

Similarly, an acetylene tip can be used if inefficient burning can be tolerated for a short run. The reasons for engineering different tips for different fuel gases are complex. But the object is to engineer the tip to match the burning velocity, port velocity, and other relationships for each type of gas and orifice size, and to obtain the optimum flame shape and heat transfer properties for each type of fuel.

Correct cutting tips cost so little that the cost of conversion is minute compared with the cost savings resulting from efficient fuel use, improved cut quality, and increased travel speed.

Teaching and Learning Strategies
Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of fabrication fundamentals. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a

way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Fundaments of fabrication

Teaching Strategies
Students engage in brainstorming exercise to discover the materials included in fabrication or the fundamentals of fabrication
They are then allowed to design guiding questions that will enable them to conduct research on the fundamentals of fabrication and all it entails
Discussions in groups on the research findings.

Learning Strategies
Activity 1 Brainstorming activity on fabrication materials
Activity 2 Conduct research on how different metals are fabricated.
Activity 3 Discussions and presentation of research findings.

Resources
Texts on materials used in metal fabrication

Lesson 2: Application of welding processes and techniques

Teaching Strategies
Engage students in the discussion of application of Welding processes and techniques.
Engage students in presentation of the application of Welding processes and techniques.

Learning Strategies
Discover the applications of welding processes and techniques
Activity 1 Provide reading materials on welding processes and techniques.
Activity 2 Use guideline points and questions to investigate welding processes and techniques.
Activity 3 Individual presentation of processes and techniques.

Resources
Reading texts and charts on welding processes and techniques.

Lesson 3: Applications of cutting process and techniques

Teaching Strategies
Guided Discovery of application of cutting processes and techniques

Learning Strategies
Activity 1 Provide reading materials on cutting processes and techniques.
Activity 2 Use guideline points and questions to investigate cutting processes and techniques.
Activity 3 Individual presentation of processes and techniques.

Resources
Reading texts and charts on cutting processes and techniques

STEAM Activity Students work in groups to create an activity incorporating the fundamentals of fabrication. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to describe properties of fabrication materials and apply welding techniques and cutting processes in fabrication fundamentals. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Describe properties of fabrication materials
2. List types of fabrication materials
3. Apply welding and cutting processes and techniques in fabrication.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Describe properties of fabrication materials	Can safely apply with perfect distinction, measurements to print reading and fit-up or lay out technique.	Can apply measurements to print reading and fit-up or lay out technique.	Can apply measurements to either one of print reading or fit-up or lay out technique.	Can vaguely apply measurements to either one of print reading or fit-up or layout technique.
2. Apply the welding processes and techniques	Can safely apply the welding processes and techniques with precision	Can apply the welding processes and techniques with precision	Can apply the welding processes and techniques	Can vaguely apply the welding processes and techniques
3. Apply welding and cutting processes and	Can apply with perfect distinction, welding and cutting processes and techniques in fabrication.	Can apply welding and cutting processes and techniques in fabrication.	Can apply either welding or cutting processes or techniques to one of the metal fabrication.	Can vaguely apply welding and cutting processes and techniques to one of metal fabrications.

Unit 5: Engineering Technology

Unit	Benchmarks	Topic	Lesson Titles
5. Engineering Technology	**10.3.5.1.** Describe the scope of engineering and critically analyse current innovation.	Topic 1:Scope of Engineering	1. General functions of Engineering innovations 2. Product designs 3. Manufacturing processes
	10.3.5.2. Differentiate between properties of materials and justify the selection of materials, components and processes in engineering.	Topic 2:Engineering materials	1. Properties of Materials 2. Engineering materials
	10.3.5.3. Use mathematical, scientific and graphical methods to solve problems of engineering practice.	Topic 3: Problem Solving in Engineering	1. Architectural 3D Sketching 2. Comparison of the engineering design and scientific method 3. 3D Free-Hand Sketching
	10.5.3.4. Develop and use specialised techniques in the application of graphics as a communication tool.	Topic 4:Graphic techniques	1. Graphics Communication 2. Elements of Graphics Communication 3. Drawing Formats and Elements 4. Graphics applications
	10.5.3.5. Select and use appropriate management and planning skills related to engineering.	Topic 5:Planning and management Skills	1. Analytical thinking 2. Teamwork and Clear Communication 3. Leadership skills 4. Organisational skill
	10.5.3.6. Analyse and synthesise engineering applications in specific fields and report on the importance of these to society.	Topic 6:Engineering applications	1. Engineering Applications 2. Engineering Innovations 3. Impacts of Engineering Innovations on Society

UNIT 5. Engineering Technology

Content Standard 3.5 Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 10.3.5.1 Describe the scope of engineering and critically analyse current innovation.

Topic 1: Scope of Engineering

Learning Objectives

By the end of this topic, the students will be able to;

1. Describe scope of engineering innovations with products designs and manufacturing processes.

Essential Questions:

1. What are the general functions of engineering innovations?
2. What are engineering product designs?
3. What are the manufacturing processes?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Scope of Engineering	Conduct research and collaboratively present findings on AI and its application in engineering, nanotechnology and its application in engineering, types of manufacturing processes and product designs	functionality and betterment of outlook on human lives is appreciated throughout conducting of research and collaborative presentations of findings on Artificial Intelligence (AI) and its application in engineering, nanotechnology and its application in engineering, types of manufacturing processes and product designs	open-mindedness is evident throughout conducting of research and collaborative presentations of findings on Artificial Intelligence (AI) and its application in engineering, nanotechnology and its application in engineering, types of manufacturing processes and product designs

Technology and Industrial Arts Application: Construction Technology: Engineering Technology

Content Background

Engineering is one of a kind ; a field which never ceases to grow. This field has a lot to offer to everyone who is willing to learn, innovate, go above and beyond their comfort zone and build a strong foundation for successful career. Innovation engineering is a framework for engineering solutions with innovation and emerging technologies.

Today engineering is considered;

- the general functions of engineering innovation
- the product designs
- the manufacturing process

Engineering has always been a leader in innovation and progress. From building towering skyscrapers to developing cutting-edge technologies, engineers have pushed boundaries and paved the way for a better future. Emerging technologies in engineering are transforming the way they design and build products. It is intensive, experiential and project based.

Emerging Technologies In Engineering

The rapid advancements in emerging technologies in engineering are changing the landscape of various industries. Introducing new and disruptive technologies such as IoT, AI, blockchain, AR/VR, and 3D printing presents new opportunities for businesses to improve their productivity.

However, one of the engineers' most significant challenges is keeping up with these latest innovations to stay competitive. By visiting abreast of emerging technologies in engineering, engineers can gain a competitive edge, improve product design and development processes, and ultimately contribute to industry growth.

Artificial Intelligence and Its Applications in Engineering

Artificial Intelligence (AI) is like having a super-smart robot friend who can help you solve problems and make decisions. It is a computer program that can learn from data like humans. AI can recognise patterns in data, make predictions, and even understand human language.

From chatbots that help us order food to self-driving cars that take us where we need to go, AI is changing how we live our lives. And with new technological advances happening every day, the possibilities for what AI can do are endless!

Applications of AI in Engineering

The major application of AI in engineering are:

1. Predictive Maintenance

AI algorithms can analyse sensor data to predict when machines need maintenance, reducing downtime and increasing efficiency.

2. Design Optimisation

AI can help engineers optimise designs by analysing data and generating new designs based on specific parameters.

3. Quality Control
AI-powered systems can detect product defects and anomalies during manufacturing, ensuring consistent quality.

4. Autonomous Vehicles
AI is being used to develop self-driving and other autonomous vehicles, potentially revolutionising transportation.

Robotics and its Applications in Engineering
Robotics is a fascinating field that has revolutionised engineering in countless ways. From manufacturing to healthcare, robotics has transformed how we work and live. Here are some applications of robotics in engineering:

1. Manufacturing

In manufacturing plants, robots are commonly utilised to carry out repetitive tasks like welding and assembly line work.

2. Agriculture
Agricultural robots are used for crop monitoring, planting, and harvesting.

3. Healthcare
Robotics is used in healthcare for surgeries, prosthetics, and physical therapy.

4. Space Exploration
Robots are used to explore planets and gather data.

5. Education
Robotics is also being used in education to teach students about programming, engineering, and problem-solving skills.

Internet of Things (IoT) and Its Applications In Engineering
The Internet of Things (IoT) is changing the world as we know it, and engineering is no exception. IoT can revolutionise how engineers approach design, construction, and maintenance by connecting physical devices and sensors over the internet.
With real-time monitoring and predictive analytics, IoT can help identify inefficiencies and reduce costs while improving safety in various sectors such as manufacturing, transportation, and Energy.

Applications of Iot In Engineering
IoT (Internet of Things) has revolutionised our lives and work and has significantly impacted engineering. Some of the applications of IoT in engineering:

1. Predictive Maintenance
IoT sensors can monitor equipment and machinery in real-time, allowing engineers to detect issues before they become serious problems.

2. Smart Grids
IoT technology can create smart grids that improve energy efficiency and reduce waste.

3. Traffic Management
IoT sensors can monitor traffic flow and optimise traffic management systems.

4. Building Automation
IoT devices can automate building systems such as lighting, heating, and air conditioning, improving energy efficiency and reducing costs.

5. Remote Monitoring
IoT technology can remotely monitor equipment and systems, allowing engineers to troubleshoot issues worldwide.

Engineering product design

Engineering product design combines creativeness, technical design skills, engineering science and analysis to create products to satisfy the functional requirements of an end-user.

The nature of product design and development within engineering companies has changed dramatically as products have become more multifaceted and the engineering supply chain has become more global. The knowledge embedded in a modern products has also grown dramatically because of easy access to digital information. Products such as smart speakers with multiple microphones, Phones with multiple cameras and consumer electronics are revolutionising the technology industry. Due to the growth in consumer electronics and primary & secondary battery technologies have had increased exposure driving knowledge growth.

Challenges facing engineering product design
Engineering product design is changing as people are not satisfied with just functional products anymore. They want it to look good, last longer and be in trend. They also want it to be cheaper. The list is endless and it is changing and evolving all the time along with the technological advancement in every field. For example, such advances in computing power and its miniaturization have made the products smarter.
Due to the rapid speed that modern technology is evolving, the time to market is also getting shorter. Compressing the design cycle and making it work the first time. From an engineers' perspective, the change in product design has resulted in a fusion of mechanical, electrical, electronics and software disciplines. Differences between industrial design and mechanical products are diminishing. This has forced interdisciplinary engineers to work across teams, to find a more efficient ways to work and collaborate and also have the knowledge of other streams to help understand how a product comes together. Hence you see lots of new design management processes, project management techniques etc., to streamline the product development across teams.

Manufacturing

Manufacturing is defined as the conversion of raw materials into the finished goods on a large scale using man and machine whereas manufacturing processes are defined as the methods used for conversion of raw materials into finished products. Based on the

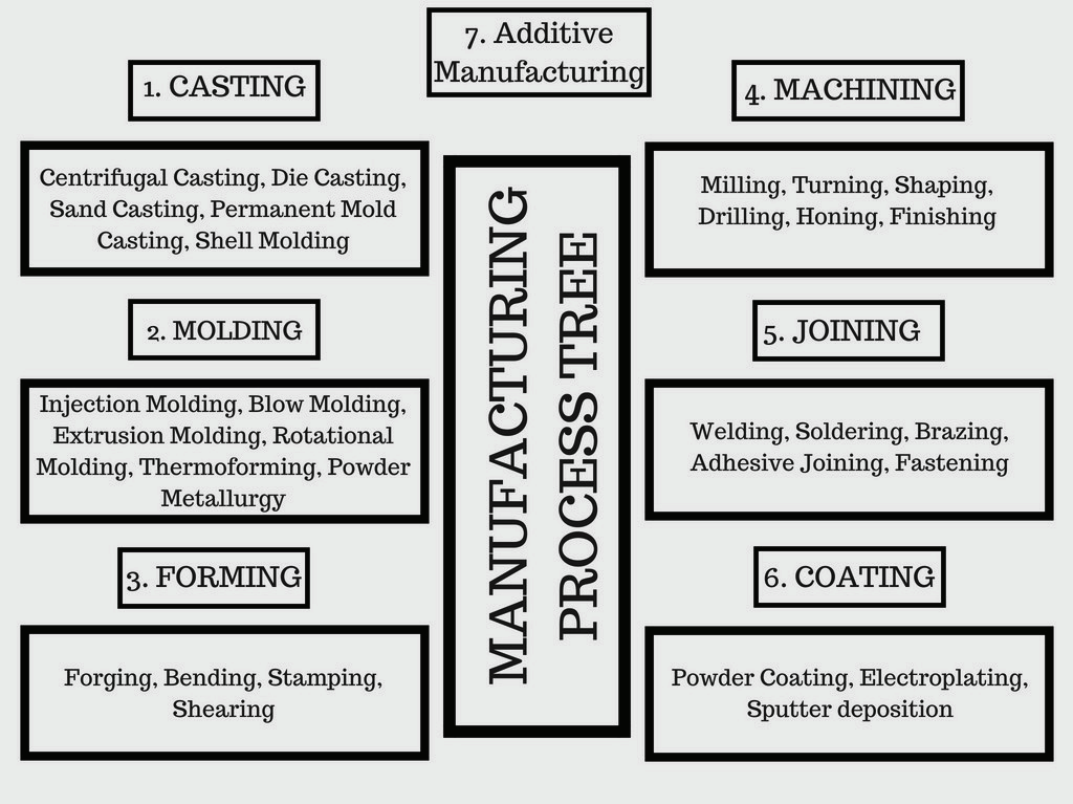
product requirement there are different types of manufacturing processes which are used to get the required output.

There are seven types manufacturing processes and their subtypes with examples.

Types of Manufacturing Processes

There are 7 main types of manufacturing processes which we are going to discuss below.

7 Main types of Manufacturing Processes and their subtypes



1. Casting

Casting is a process of pouring liquid metal into a mold containing the hollow shape of the desired outcome. It uses sprue, gates, and runners to pour the metal. The main types of manufacturing processes under casting are:-

Centrifugal Casting

Centrifugal casting is a process of pouring molten metal into a spinning die. Spinning die creates high g-forces to the molten metal which gives it the cylindrical shape. Moreover, spinning let the impurities (less dense material) to float at the inner dia from where it is removed later. Spinning can either be on a vertical or horizontal axis depending on the

configuration of the desired part such as vertical rotation is used to cast ring and cylinder and horizontal rotation is used to cast tubular shapes.

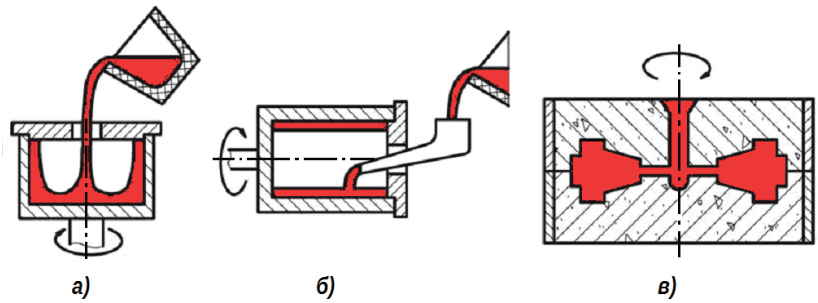


Figure 5.1a. Centrifugal Casting
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Example: Some examples of centrifugal casting include jet engine compressor cases, petrochemical furnace tubes, military products, and other high-reliability applications.

Die Casting

Die casting is a manufacturing process used for producing metal parts where high precision is required. This process is accomplished by forcing molten metal under high pressure into reusable metal dies. High volume production is done using this process.

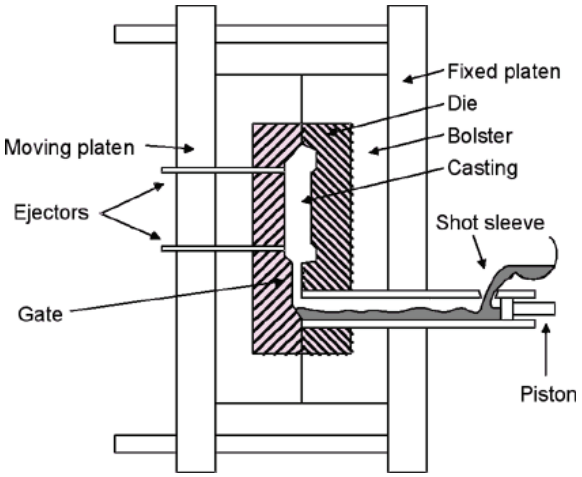


Figure 5.1b. Die Casting
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Process

- Steel molds capable of producing several castings at once are produced.
- Molds are mounted securely in a die casting machine and are arranged so that one is stationary while the other is moveable.

- The die cavity is injected with molten metal and allowed to solidify and the part is ejected.

Example: Die casting process is used for producing precise non-ferrous metal parts. Some examples of die casting include engines, clutch housings, and covers of a four-wheeled vehicle.

Sand Casting

Sand casting is a metal casting process that uses sand as the mold material. This process has a low production rate as the sand mold must be destroyed in order to remove the part. Although, it is a cheap process when low volume production is required.

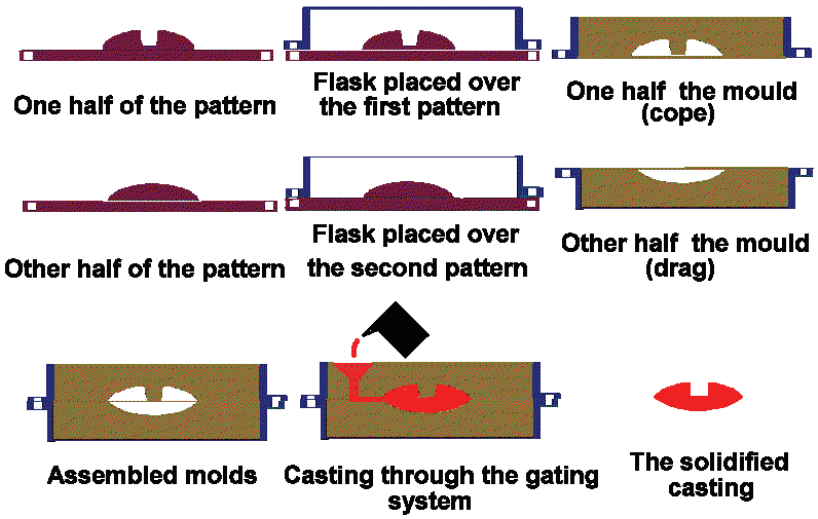


Figure 5.1c. Sand Casting
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Process

- Furnace, metal, pattern, and sand mold are used in the sand casting process.
- The molten metal is poured using ladle into the cavity of the sand mold, which is made from the pattern.
- The casting is allowed to solidify and then removed by breaking the mold.

Example: More than 70% of all metal castings are produced via sand casting process. Some examples of sand casting process include engine blocks, machine tool bases, cylinder heads, pump housings, valves, gears, pulleys, crankshafts, connecting rods, and propellers.

Permanent Mold Casting

Permanent mold casting is a manufacturing process that offers reusability of metal molds which makes it eligible for high volume production. This process uses gravity or vacuum or gas to fill the mold.

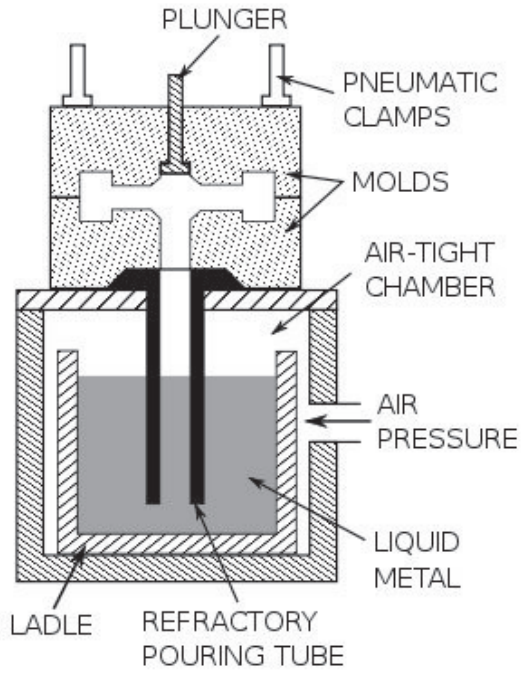


Figure 5.1d. Permanent Mold Casting
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Process

- The mold is preheated and a ceramic coating is applied to the mold cavity surfaces to facilitate part removal.
- The molten metal is poured from a ladle and gravity or vacuum is used to raise the molten metal into the mold assembly.
- The casting is allowed to solidify and then removed by opening the mold assembly.

Example: Some examples of permanent mold casting include gears, pipe fittings, fuel injection housings, splines, wheels, gear housings, engine pistons.

Note the difference: Sand casting uses an expendable mold which is destroyed after each cycle whereas permanent mold casting and die casting uses a metal mold that is reused for several thousand times. Permanent mold casting process is considerably slower, and not as precise as die casting. Also, an external force is used to inject molten metal in die casting as compared to gravity or vacuum in permanent mold casting.

Investment Casting

Investment casting is metal casting process of pouring molten metal into an expendable ceramic mold. This process is also known as “lost-wax casting” as the wax pattern is melted out of the mold when molten metal is poured. Complex parts are made using this process.

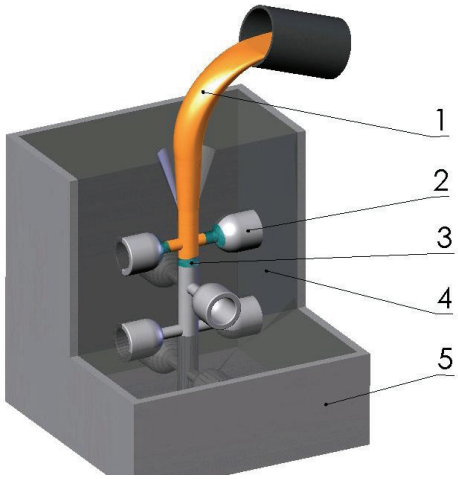


Figure 5.1e. Investment Casting
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Process

- The wax pattern is prepared and surrounded/invested by the ceramic slurry that hardens it and converts it into a mold.
- The mold is preheated to evaporate the wax and the molten metal is poured from a ladle into the mold.
- The casting is allowed to solidify and then the mold is broken and the casting removed.

Example: Some examples of investment casting include turbine blades, airplane parts, firearm components and military equipment.

Shell Molding

Shell molding is a metal casting process that uses a sand covered with resin to form the mold. This process is similar to sand casting process but has better dimensional accuracy, higher productivity rate, and lower labor requirements. Also, the Shell Molds are reusable and expandable.

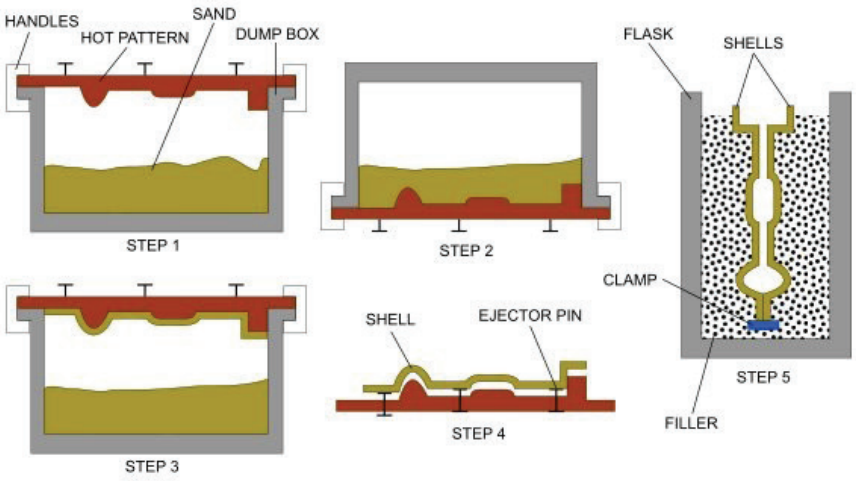


Figure 5.1f. Shell Molding
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Process

- A two-piece metal pattern is created in the shape of the desired part using iron or steel.
- These patterns are clamped to a dump box containing the mixture of sand and a resin binder. This is known as shell preparation method.
- These shells are joined together and clamped to form the complete shell mold and the molten metal is poured from a ladle into the mold cavity.
- After the casting is solidified, the mold is broken and the casting removed.

Example: Shell molding is used for producing high precision parts. Some examples of shell molding include gear housings, cylinder heads, connecting rods, and lever arms.

2. Molding

Molding is a manufacturing process that uses a rigid frame to shape hot liquid or a ductile raw material. It is mostly used to manufacture plastic products. The different types of manufacturing processes under molding are:

Injection Molding

Injection molding is a molding process used for producing parts by injecting molten material into a mold. It is the most commonly used molding process for manufacturing plastic parts. This process requires the use of an injection molding machine, raw plastic pellets, and a mold to get the desired output. The plastic is melted in the injection molding machine with the help of heaters and then a rotating/reciprocating screw injects it into the mold, where it cools and solidifies into the final part.

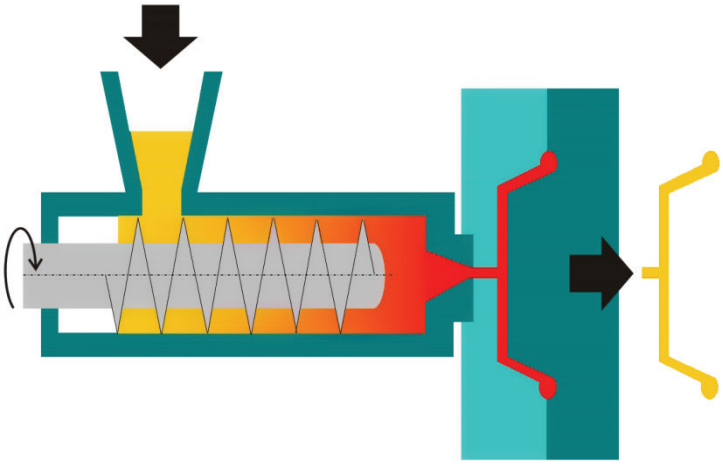


Figure 5.1g. Injection Molding
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Example: Some examples of injection molding include automotive parts and components, game toys, chairs, tables, storage containers, housing for household appliances, consumer electronics, buckets.

Blow Molding

Blow molding is a molding process used to manufacture hollow plastic parts. This process starts with melting down the plastic and forming it into a parison. The parison is then clamped into a mold and air is blown into it. This air pushes the plastic out to match the mold. The plastic is allowed to cool and later the mold opened and the part is ejected. Although the blow molding process is costlier than injection molding, it is still used for manufacturing many plastic products.

Blow molding is divided into three types of manufacturing processes namely extrusion blow molding, injection blow molding, and injection stretch blow molding.

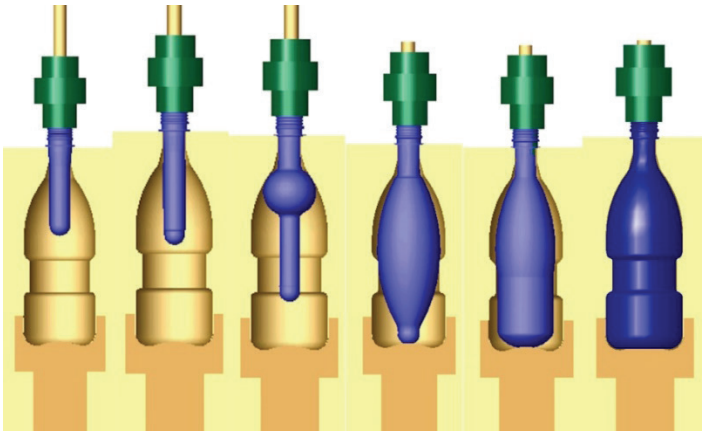


Figure 5.1h. Blow Molding
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Example: Some examples of blow molding include automotive ducts, stadium seating chairs, containers, trays, reservoirs, tanks, coolers, fan housings, panels, doors, toys, sporting goods, watering cans and household products, carrying cases.

Extrusion Molding

Extrusion Molding is a process used to manufacture long tube-shaped products of a fixed cross-section. This process uses an extrusion machine to force the heated plastic through a die with an opening. The machine uses a reciprocating/rotating screw to feed the plastic into the die. The die then forces the material into the desired shape or the shape of the die. Heaters are used to melting the plastic in the extrusion machine. The material is allowed to cooled and then cut down into the required shape.

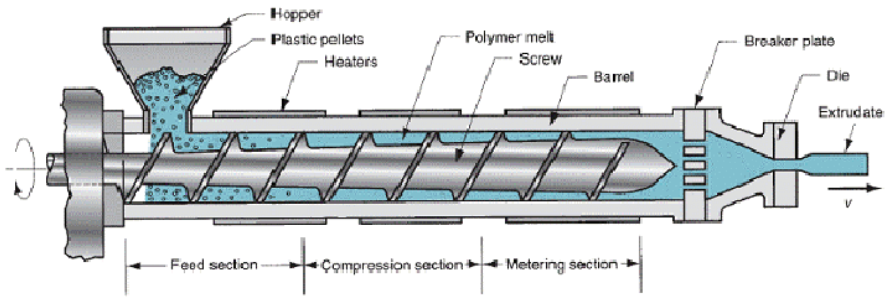


Figure 5.1i. Extrusion Molding
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Example: Some examples of extrusion molding include pipe, tube, plastic films and sheeting, thermoplastic coatings, and wire insulation.

Rotational Molding

Rotational Molding is a molding process used for manufacturing hollow parts. This process is accomplished by placing resin into a hollow mold and then rotating that tool bi-axially in an oven. There is no pressure involved in this technique, unlike other plastic manufacturing processes, thus, making the mold cost cheap and the process economical.

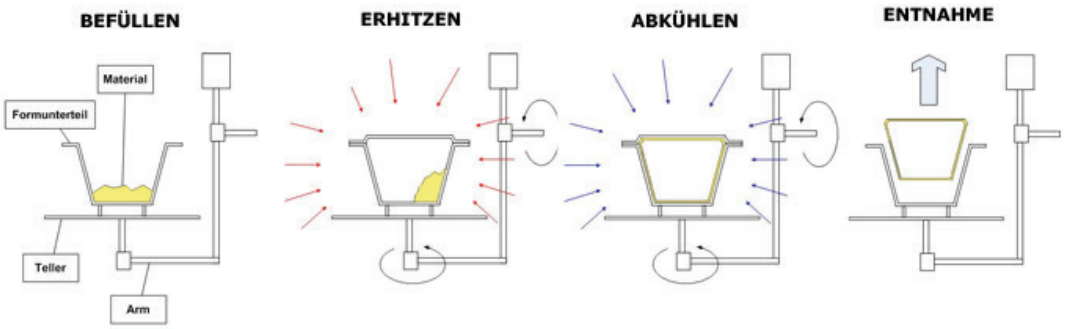


Figure 5.1j. Rotational Molding
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Process

- The mold is filled with a polymer resin and heated in an oven until the resin melts inside of the mold cavity.
- It is then slowly rotated to disperse and stick the soft material inside the mold cavity.
- A cool tool is used to solidify the part and later the part is removed from the mold.

Example: Some examples of rotational molding include water tanks, medical products, consumer's products, toys, leisure craft, sporting equipment.

Thermoforming

Thermoforming is a molding process where a plastic sheet is heated to an elastic forming temperature and formed into the desired shape. This method is often used for sample and prototype parts. It is divided into three types of manufacturing processes namely vacuum forming, pressure forming and mechanical forming.

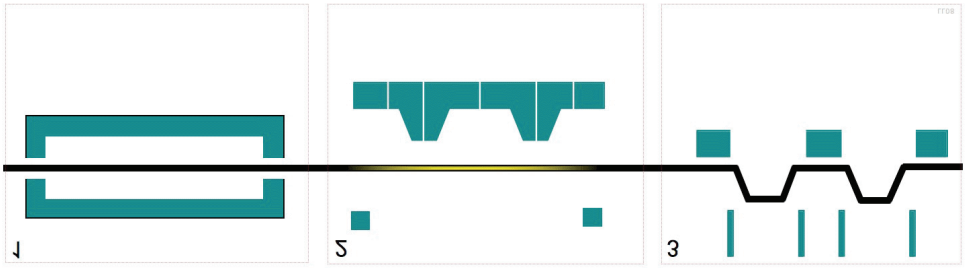


Figure 5.1k. Thermoforming
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Process

- The thermoplastic sheet is heated using either convection or radiation until it gets soften.

- This soft sheet is then pressed against the mold using the vacuum or air pressure or mechanical force.
- The excess material is then trimmed away and the formed part is released.

Example: Some examples of thermoforming include switchgear, motor components, thrust washers, ash cups, valve covers, disc brake pistons, knobs, and handles.

Powder Metallurgy

Powder metallurgy is a molding process used for manufacturing precision metal components from metal powders. The rate of production of parts is quite high in powder metallurgy which makes it economical than the other casting processes.

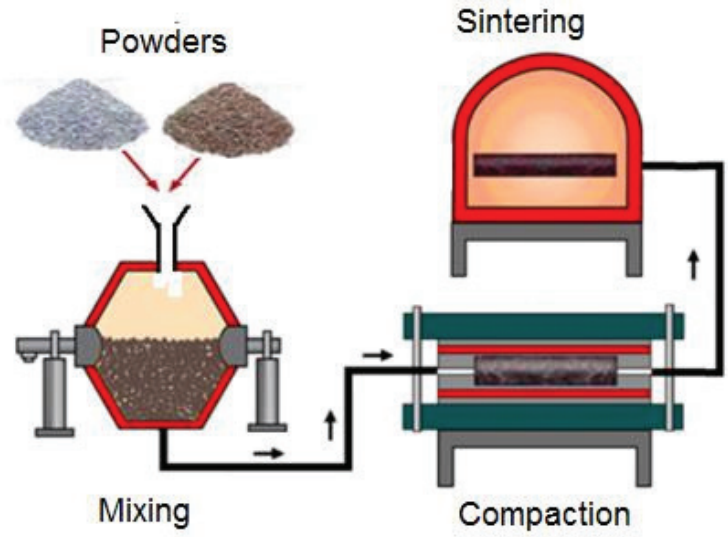


Figure 5.1l. Powder Metallurgy
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Process

- A homogeneous mixture of metal powders or alloy powders is prepared.
- The metal powder is then pressed into the desired shape at room temperature.
- At last, the product is heated that causes the powder particles to fuse together without melting.

Example: Some examples of powder metallurgy include self -lubricating bearings, porous metal filters, gears, cams, brackets, sprockets.

3. Forming

Forming is a manufacturing process that uses suitable stresses such as compression, tension or shear to deform the material and get the desired shape. This process involves deformation and displacement of material leading to no material removal or loss of material. The different types of manufacturing processes under forming are: –

Forging

Forging is a manufacturing process that uses compressive forces to shape the material. This process is accomplished with the help of a hammer, press or a special forging machine. The forged parts have good strength and toughness without the defects of porosity, inclusion or voids; also they can be used reliably for highly stressed and critical applications.

Forging may be carried out on materials in either hot or cold state and therefore, it is divided into types of manufacturing processes i.e. cold forging and hot forging.

Figure 5.1m. Forging
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Example: Some examples of forging include hammers, sleds, wrenches, garden tools, sockets, hardware, hand tools, edged weapons, cymbals, jewelry, rivets, bolts.

Bending

Bending is a manufacturing process used to deform metal into the desired shape by using a die and punch. This process is most commonly used for sheet metal products to get the required U-shape, V-shape or the channel shape. Commonly used bending machines are pan brakes, brake presses, and other specialized machine presses.

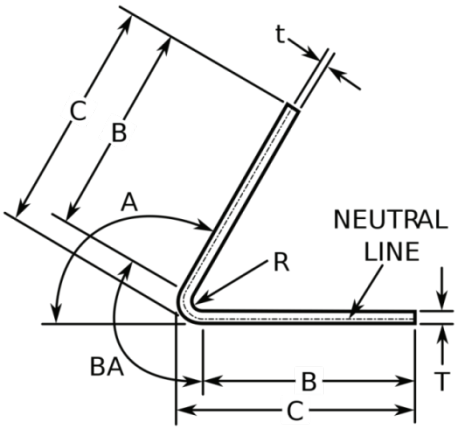


Figure 5.1n. Bending
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Process

- The material is placed on the die and positioned in place with the help of stops.
- The upper part of the press with appropriately shaped punch attached to it descends and forms the V-shaped bend.
- The U-punch forms the U-shape with a single punch.

Example: Some examples of bending operations include electric enclosures, electrical boxes, brackets, rectangular ductwork.

Stamping

Stamping or pressing is a manufacturing process in which thin walled metal parts are shaped desirably with the help of punches and dies. This process is accomplished by placing flat sheet metal into a stamping press where a tool and die surface forms the metal into the desired shape. Stamping uses hydraulic or mechanical press to perform the operations which can be done at a single die station or multiple die stations. Also, this process is usually carried out on sheet metal, but can also be used on other materials, such as polystyrene.

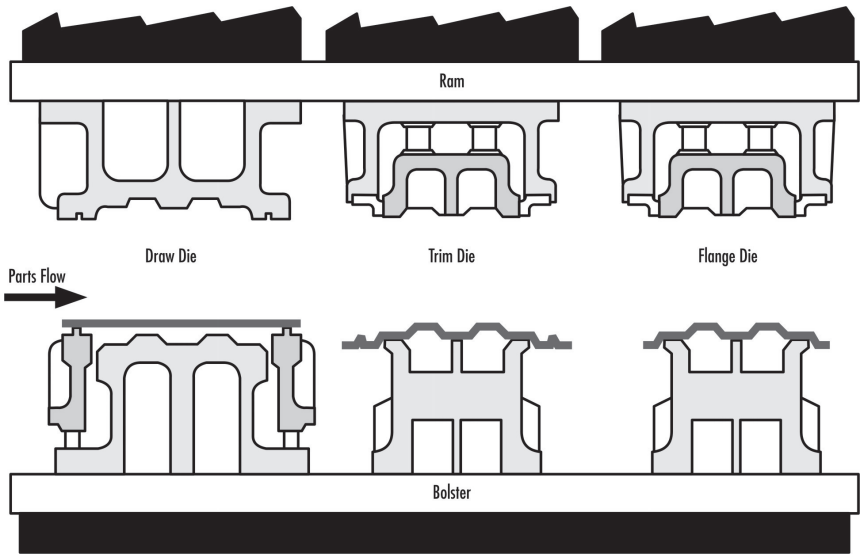


Figure 5.1o. Stamping
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Example: Some examples of stamping include trunks, doors, panels, enclosures, fenders, roof, and hood outer parts.

Shearing

Shearing is a manufacturing process used to remove a blank of required shape and dimension from a large sheet of metal, paper or plastics. This process includes cutting of sheet without the formation of chips or the use of burning or melting. Shearing is divided into following types of manufacturing processes: –

- Blanking
- Piercing
- Roll slitting
- Trimming
- Coining

Process

- The punch applies pressure to the sheet forming cracks on both the top and bottom edges of the sheet.
- The punch goes down further to grow these cracks and eventually separate the slug from the material.

Example

Some examples of shearing include industrial machinery, automobile parts, electronic equipment, knives, scissors.

4. Machining

Machining is a manufacturing process used to cut a piece of raw material into the desired shape and size with the help of controlled material-removal process. These processes are based on a common theme known as subtractive manufacturing. The machining process is used for all the types of product especially metal products. The different types of manufacturing processes under machining are:-

Figure 5.1p. Machining
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

1. MIlling – Milling is a process of removal of material from a workpiece using rotary cutters and getting the desired shape.
2. Turning -Turning is a process of removal of unwanted material from circular parts using a cutting tool. This process requires a lathe, workpiece, fixture, and a cutting tool.
3. Shaping – Shaping process uses a cutting tool that reciprocates against a stationary workpiece producing a plane or a desired surface.
4. Drilling – Drilling process uses a drill bit to make a hole of circular cross-section into the solid material.
5. Honing – Honing process produces a precision surface on a metal workpiece by scrubbing an abrasive stone against it.
6. Finishing – Finishing process is used to improve appearance, adhesion, wettability, wear resistance, hardness or to remove burrs and other surface flaws with the help of sanders.

5. Joining

Joining or assembling process are part of every production processes where two or more parts are combined together to get the required product. The main types of manufacturing processes under joining are:-

Figure 5.1q. Joining
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

1. Welding – Welding process is used to heat and melt two or more parts and force them together making a single functional part. Arc welding, resistance welding, oxyfuel gas welding are few types of welding operations.
2. Soldering – Soldering process is also used to join two or more metal items by melting and putting a filler metal (solder) into the joint. It differs from welding as it does not involve melting of the workpieces.
3. Brazing – Brazing process is used to join two or more metal items together by melting and flowing a filler metal into the joint. Brazing uses higher temperatures for a similar process as compared to soldering. Also, it requires much more closely fitted parts than in soldering.
4. Adhesive Bonding – Adhesive bonding is used to hold multiple closely spaced parts together using a filler material called an adhesive. It is mainly used for a non-metallic substance such as a polymer.
5. Mechanical Assembly – It is a fastening process which uses nut, bolts, and rivets to join the parts together. It is also a reversible joining process.

6. Coating or Plating

This process is defined as a method of covering the part surface with powder or zinc or other chemicals to protect it from corrosion, wear and other defects. It is also done to improve the electrical conductivity or magnetic response of the material. The main types of manufacturing processes under the coating process are powder coating, electroplating, sputter deposition.

Figure 5.1r. Coating or Plating
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

7. Additive Manufacturing

Additive manufacturing is the process reversible to subtractive manufacturing, i.e. machining. It is a manufacturing process that builds 3D objects by adding layer-upon-layer of material, whether the material is plastic, metal or concrete. Additive manufacturing comprises many technologies such as 3D printing, rapid prototyping, direct digital manufacturing, layered manufacturing and additive fabrication. This technology is growing at a very fast speed due to its high-efficiency and accuracy.

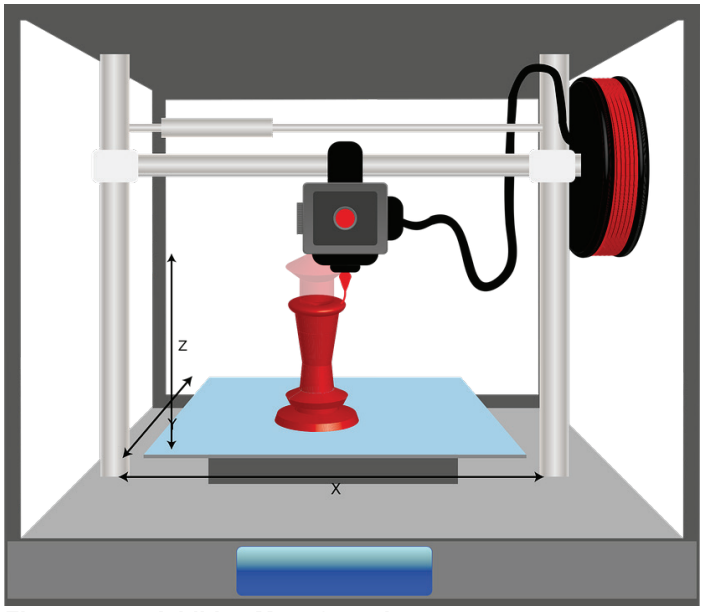


Figure 5.1s. Additive Manufacturing
Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal/

Example: Some examples of 3D printing include jewelry, toys, decorative items, phone cases. (Khan S,A, 2018)

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of scope of engineering. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: General Functions of Engineering Innovations

Teaching Strategies

Engage students in brainstorming exercise on general functions of engineering innovation.
Engage students in the discussion the general functions of engineering innovations and their importance.

Learning Strategies

Discover different general functions of engineering innovation.

Activity 1 Brainstorming activity on general functions of engineering innovation.
Activity 2. Conduct research on general functions of engineering innovation and their importance.
Activity 3. Discussions and presentation of research findings on general functions of engineering innovation and their importance.

Resources

"Front matter" *Structural Engineering Handbook* Ed. By Chen Wai-Fah, Boca Raton
Teacher Notes

Lesson 2: Product Designs

Teaching Strategies

Engage students in brainstorming exercise on the product designs.
Engage students in the discussion the product designs.

Learning Strategies

Discover different the Product designs-

Activity 1. Brainstorming activity on the product designs.
Activity 2. Conduct research on the product designs.
Activity 3. Discussions and presentation of research findings on the product designs-

Resources

"Front matter" *Structural Engineering Handbook* by Ed. Chen Wai-Fah, Boca Raton

Teacher Notes

Lesson 3: Manufacturing Process

Teaching Strategies
Engage students in brainstorming exercise on the manufacturing process
Engage students in the discussion the manufacturing process
Engage students in the research of the manufacturing processes

Learning Strategies
Discover different the manufacturing process
Activity 1 Brainstorming activity on the manufacturing process
Activity 2. Conduct research on the manufacturing process
Activity 3. Discussions and presentation of research findings on the manufacturing process

Resources
"Front matter" *Structural Engineering Handbook* Ed. By Chen Wai-Fah, Boca Raton
Teacher Notes

STEAM Activity Students work in groups to create an activity incorporating manufacturing proceses. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Scope of Engineering. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Analyse and describe the general functions of engineering innovations
2. State and describe the types of innovations
3. List and describe the Product designs
4. Analyse and describe the manufacturing process

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Analyse and describe the general functions of engineering innovations	Correct description of more than 6 general functions of engineering innovations	Correct description of more than 4-5 general functions of engineering innovations	Correct description of more than 2-3 general functions of engineering innovations	Description of 1 type of general function of engineering innovation.
3.List and describe the Product designs	Correct description of more than 6 Product designs	Correct description of more than 4-5 Product designs	Correct description of more than 2-3 Product designs	Description of 1 type of Product design.
4.Analyse and describe the manufacturing process	Analyse and describe correctly the manufacturing process.	Describe correctly the manufacturing process/.	Partially attempt to describe the manufacturing process.	Cannot describe and analyse the manufacturing. Graphics paper Pencils

UNIT 5. Engineering Technology

Content Standard 3.5 Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 10.3.5.2 Differentiate between properties of materials and justify the selection of materials, components and processes in engineering.

Topic 2: Engineering Materials

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and describe the properties of engineering materials.
2. Categorise and describe the classifications of engineering materials.

Essential Questions:

1. What are the Properties of engineering materials?
2. What are the main classifications of engineering materials?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Properties of Engineering materials Classification of engineering materials Engineering tools and equipment	Conduct research on; Properties of Engineering materials Classification of engineering materials Engineering tools and equipment	Importance of design for the betterment of outlook on human lives is appreciated and valued when conducting research on; Properties of Engineering materials Classification of engineering materials Engineering tools and equipment	Eagerly conduct research and collaboratively present findings on; Properties of Engineering materials Classification of engineering materials Engineering tools and equipment

Technology and Industrial Arts Application: Construction Technology: Engineering Technology

Content Background

Engineering materials- Engineering materials are materials that are used by engineers to design and erect the structures. They are various materials that are used by engineers in various discipline.

PROPERTIES OF ENGINEERING MATERIALS

Engineering materials are those which are extensively used in various engineering applications such as those used for construction of bridges, machine tools, automobiles, locomotives, ships,

space crafts and many more. A large number of engineering materials exist such as metals and non-metals (leather, rubber, asbestos, plastic, ceramics, organic polymers, composites and semi-conductor). Engineering materials may also be categorised into metals and alloys, ceramic materials, organic polymers, composites and semiconductors. The metals and alloys have tremendous applications for manufacturing the products required by the customers.

Classification of engineering materials

Metals and alloys

Metals are polycrystalline bodies consisting of a great number of fine crystals. Pure metals possess low strength and do not have the required properties. So, alloys are produced by melting or sintering two or more metals or metals and a non-metal, together. Alloys may consist of two or more components. Metals and alloys are further classified into two major kinds, namely ferrous metals and non-ferrous metals.

A. Ferrous metals

Ferrous metals are those which have iron as their main constituent, i.e. iron base metals, such as pig iron, cast iron, wrought iron and steels. The ferrous metals commonly used in engineering practice are cast iron, wrought iron, steel and alloy steels. The basic principal raw material for all ferrous metals is pig iron which is obtained by smelting iron ore, coke and limestone, in the blast furnace.

The principal iron ores with their metallic contents are shown below:

S.No.	Iron Ore	Colour	Iron %
1.	Haematite (Fe_3O_4)	Red	70 %
2.	Magnetite (Fe_2O_3)	Black	72 %
3.	Limonite	Brown	62. 5 %
4.	Siderite	Brown	48 %

Main Types of Iron
1. Pig iron
2. Cast iron
   a. White cast iron
   b. Grey cast iron
   c. Malleable cast iron
   d. Ductile cast iron
   e. Mehanite cast iron
   f. Alloy cast iron
3. Wrought iron
4. Steel
   a. Plain carbon steels
      i. Dead Carbon steels
      ii. Low Carbon steels
      iii. Medium Carbon steels
      iv. High Carbon steels

b. Alloy steels
    i. High speed steel
    ii. Stainless steel

Alloy steel

For improving the properties of ordinary steel, certain alloying elements are added in it in sufficient amounts. The most common alloying elements added to steel are chromium, nickel, manganese, silicon, vanadium, molybdenum, tungsten, phosphorus, copper, that the titanium, zirconium, cobalt, columbium, and aluminium. Each of these elements induces certain qualities in steels to which it is added. They may be used separately or in combination to produce desired characteristics in the steel. The main purpose of alloying element in steel is to improve machinability, elasticity, hardness, case hardening, cutting ability, toughness, wear resistance, tensile strength, corrosion resistance, and ability to retain shape at high temperature, ability to resist distortion at elevated temperature and to impart a fine grain size to steel.

Stainless steel

Stainless steel contains chromium together with nickel as alloy and rest is iron. It has been defined as that steel which when correctly heat treated and finished, resists oxidation and corrosive attack from most corrosive media. Stainless steel surface is responsible for corrosion resistance. Minimum chromium content of 12% is required for the film's formation, and 18% is sufficient to resist the most severe atmospheric corrosive conditions. Their principal alloying element is **chromium** while some other elements like nickel, manganese etc. can also be present in small amounts. Addition of nickel improves ductility and imparts strength. Corrosion resistance to stainless steels increases with increase in nickel content against neutral chloride solution and weakly oxidizing acids. Addition of molybdenum improves its resistance to sulphuric, sulphurous and organic acids. Addition of manganese increases hot workability of these steels. A steel containing 18% chromium and 8% nickel is widely used and is commonly referred to as 18/8 steel. Stainless steel is highly resistance to corrosion and oxidation. It can be classified into three major categories according to the type of micro structures.

On basis of their structure, stainless steels are classified as follows:

1. Martensitic stainless steels

2. Ferritic stainless steels

3. Austenitic stainless steels

B. Non-Ferrous materials

Non-ferrous metals contain metals other than iron as their main constituents such as aluminium, copper, zinc, magnesium, lead, tin, nickel and their alloys and non-metallic materials. Various non-ferrous alloys are copper base, aluminium

PROPERTIES OF MATERIALS

Properties of materials can be divided into two groups: physical and mechanical: Physical properties are those properties of a material which do not require the material to be deformed or destroyed in order to determine the value of the property.

Mechanical properties indicate a material's reaction to the application of forces. These properties require deformation or destruction tests in order to determine their value. The value of these properties can be altered by subjecting the material to heat treatment and cold or hot working.

Physical properties

1. Coefficient of linear expansion: This is a measure of the amount by which the length of a material increases when the material is heated through a one-degree rise in temperature. Increase in length = original length × temperature rise × coefficient of linear expansion.

Different metals expand or contract by different amounts for a given temperature change; e.g. aluminium expands at a greater rate than cast iron. Those different metals have different values for the coefficient of linear expansion can be useful on some occasions while on other occasions it can be a disadvantage.

2. Specific heat capacity: The specific heat capacity of a material is the amount of heat energy (in joules) required to raise the temperature of unit mass (1 kg) of the material by unit rise in temperature (1°C). Knowledge of this property is required when dealing with heating or cooling operations. Various liquids are used when cooling after heat-treatment operations. The liquid used must be able to absorb the heat energy from the block of metal, and this depends upon the type of liquid and it's mass.

3. Density: Equal volumes of different materials have different masses. The mass in a given volume is a measure of the density. The density of a material is the mass per unit volume. This property must be considered where the mass has to be restricted. In the production of aircraft, for instance, special materials have been developed which are as strong as steel but are only a fraction of its density.

4. Melting point: This is the temperature at which a material changes from the solid to the liquid state. This may be an important consideration in some material applications; e.g. it is important to know the melting point of a solder if it is used on a joint which may be subjected to temperatures approaching the solder's melting point.

5. Thermal conductivity: When one end of a metal bar is heated, the heat will be conducted along the length of the bar. The rate at which the heat is conducted depends on the bar material, some materials being better conductors than others. This heat-conducting ability of a metal is measured by the thermal conductivity. Thermal conductivity is given as a rate of transfer of heat energy, measured in J/(m s °C) – i.e. the number of joules of energy transferred per second through one metre for each degree Celsius rise of temperature. Since one joule per second equals one watt, thermal conductivity can also be quoted in W/(m °C). A good conductor

such as copper has a high thermal conductivity and is used where heat has to be readily transferred, e.g. in a soldering iron or a motor-car radiator.

6. Electrical resistivity: Some materials allow electricity to pass through them very easily and are electrical conductors. These include carbon and most of the metals, such as aluminium, copper, brass and silver. Other materials offer a high resistance to the flow of electricity and are bad electrical conductors, known as insulators – these include non-metallic materials such as plastics, rubber, mica, ceramics and glass.

Mechanical properties

Mechanical properties indicate a material's reaction to the application of forces and their values are determined through a series of standard tests. These tests are carried out on small specimens of the material under test until deformed or destroyed. Such tests are referred to as destructive tests. These tests include tensile, compressive, torsion, bend and impact testing

1. Hardness: A material which is hard is able to resist wear, scratching, indentation and machining. Its hardness is also a measure of its ability to cut other materials. Hard materials are required for cutting tools and for parts where wear must be kept to a minimum.

2. Brittleness: A brittle material will break easily when given a sudden blow. This property is associated with hardness, since hard materials will often be brittle. Brittle materials cannot be used in the working parts of power presses, which are subjected to sudden blows.

3. Strength: A strong material is able to withstand loads without breaking. Loads may be applied in tension, compression or shear, and a material's resistance to these loads is a measure of its tensile strength, compressive strength and shear strength.

4. Ductility: A ductile material can be reduced in cross-section without breaking.

5. Malleability: A malleable material can be rolled or hammered permanently into a different shape without fracturing. This property is required when forging, where the shape of the metal is changed by hammering. Heat may be used to make a material more malleable.

6. Elasticity: A material which is elastic will return to its original dimensions after being subjected to a load. If loaded above a point known as the elastic limit, the material will not return to its original dimensions and will be permanently deformed when the load is removed. Elasticity is essential in materials used in the manufacture of springs.

7. Toughness: A material is tough if it is capable of absorbing a great deal of energy before it fractures. A tough material will withstand repeated flexing or bending before it begins to crack or break. The working parts of power presses must be tough to withstand the repeated blows in pressing operations.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each

topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of engineering materials. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Properties of Engineering Materials

Teaching Strategies
Engage students in brainstorming exercise the properties of engineering materials.
Engage students in the discussion the properties of engineering materials.

Learning Strategies
Discover different properties of engineering materials.
Activity 1 Brainstorming activity on different properties of engineering materials.
Activity 2. Conduct research on different properties of engineering materials.
Activity 3. Discussions and presentation of research findings properties of engineering Materials.

Resources

"Front matter" *Structural Engineering Handbook* Ed. By Chen Wai-Fah, Boca Raton
Teacher Notes

Lesson 2: Classifications of Engineering Material

Teaching Strategies

Engage students in brainstorming exercise the classifications of engineering material
Engage students in the discussion the classifications of engineering material.,

Learning Strategies
Discover different classifications of engineering material.
Activity 1 Brainstorming activity on different classifications of engineering material.
Activity 2. Conduct research on different classifications of engineering material.
Activity 3. Discussions and presentation of research findings on classifications of engineering materials.

Resources
"Front matter" *Structural Engineering Handbook* Ed. By Chen Wai-Fah, Boca Raton
Teacher Notes

STEAM Activity: Students work in groups to create an activity incorporating engineering materials. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to Engineering materials. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Analyse and describe the properties of engineering materials
2. Categorise and describe the classifications of engineering materials

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Analyse and describe the properties of engineering Materials	Analyse and describe correctly	Describe correctly	Few attempt	Not attempted
2. Categorise and describe the Classifications of engineering materials	Correct categorisation and description of more than 5 Classifications of engineering materials	Correct categorisation and description of more than 3-4 Classifications of engineering materials	Correct categorisation and description of more than 2-3 Classifications of engineering materials	Description of 1 Classification of engineering material.

UNIT 5. Engineering Technology

Content Standard 3.5 Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 10.3.5.3 Use mathematical, scientific and graphical methods to solve problems of engineering practice.

Topic 3: Problem Solving in Engineering

Learning Objectives

By the end of this topic, the students will be able to;

1. Discuss and use basic architectural drawing in engineering designs.
2. Employ scientific and graphical methods to solve engineering issues.

Essential Questions:

1. What are Engineering Trade drawing basics?
2. What are the Steps of scientific method?
3. What is 3D free-hand sketching
4. What is the difference between engineering design and Scientific method?
5. What are Graphical methods?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Engineering Applications/practice	Conduct research on; Architectural 3D sketching Comparison of Engineering design and scientific method 3D Free-Hand sketching	Importance of Engineering Applications/practice is valued and appreciated when conducting research on; Architectural 3D sketching Comparison of Engineering design and scientific method 3D Free-Hand sketching	Innovative and open-mindedness of how the practices of science and engineering are integrated into both Inquiry and Design through; Architectural 3D sketching Comparison of Engineering design and scientific method 3D Free-Hand sketching

Technology and Industrial Arts Application: Construction Technology: Engineering Technology

Content Background
Engineering practice-

Throughout the study consider practices both of science and engineering. In many cases, the practices in the two fields are similar enough that they can be discussed together. In other cases, however, they are considered separately.

WHY PRACTICES?

Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science. Participation in these practices also helps students form an understanding of the crosscutting concepts and disciplinary ideas of science and engineering; moreover, it makes students' knowledge more meaningful and embeds it more deeply into their worldview.

The actual doing of science or engineering can also pique students' curiosity, capture their interest, and motivate their continued study; the insights thus gained help them recognize that the work of scientists and engineers is a creative

How the Practices Are Integrated into Both Inquiry and Design

One helpful way of understanding the practices of scientists and engineers is to frame them as work that is done in three spheres of activity, as shown . In one sphere, the dominant activity is investigation and empirical inquiry. In the second, the essence of work is the construction of explanations or designs using reasoning, creative thinking, and models. And in the third sphere, the ideas, such as the fit of models and explanations to evidence or the appropriateness of product designs, are analysed, debated, and evaluated . In all three spheres of activity, scientists and engineers try to use the best available tools to support the task at hand, which today means that modern computational technology is integral to virtually all aspects of their work.

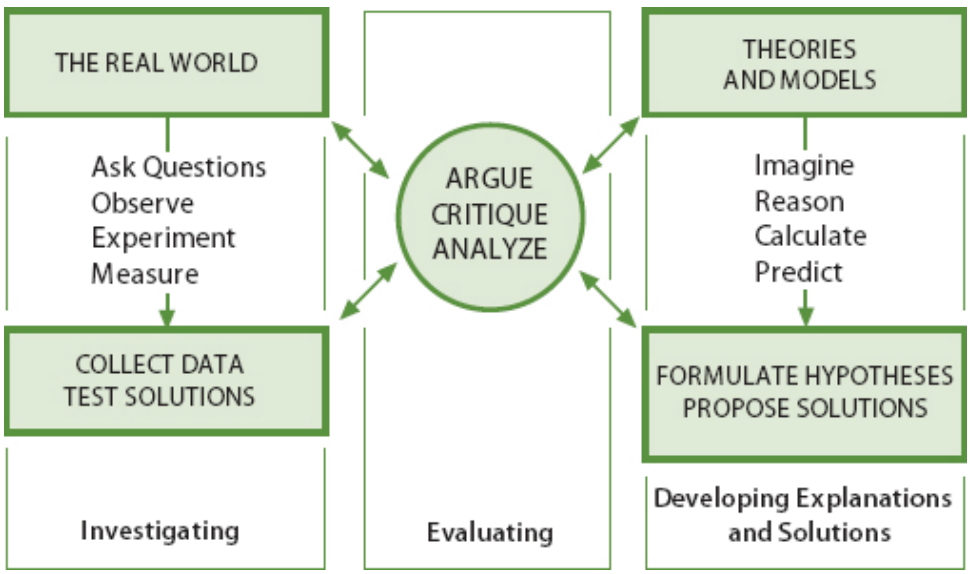


FIGURE 5.3a The three spheres of activity for scientists and engineers.

At the left of the figure are activities related to empirical investigation. In this sphere of activity, scientists determine what needs to be measured; observe phenomena; plan experiments, programs of observation, and methods of data collection; build instruments; engage in disciplined fieldwork; and identify sources of uncertainty. For their part, engineers engage in testing that will contribute data for informing proposed designs. A civil engineer, for example, cannot design a new highway without measuring the terrain and collecting data about the nature of the soil and water flows.

The activities related to developing explanations and solutions are shown at the right of the figure. For scientists, their work in this sphere of activity is to draw from established theories and models and to propose extensions to theory or create new models. Often, they develop a model or hypothesis that leads to new questions to investigate or alternative explanations to consider. For engineers, the major practice is the production of designs. Design development also involves constructing models, for example, computer simulations of new structures or processes that may be used to test a design under a range of simulated conditions or,
at a later stage, to test a physical prototype. Both scientists and engineers use their models—including sketches, diagrams, mathematical relationships, simulations, and physical models—to make predictions about the likely behavior of a system, and they then collect data to evaluate the predictions and possibly revise the models as a result.

Between and within these two spheres of activity is the practice of evaluation, represented by the middle space. Here is an iterative process that repeats at every step of the work. Critical thinking is required, whether in developing and refining an idea (an explanation or a design) or in conducting an investigation. The dominant activities in this sphere are argumentation and critique, which often lead to further experiments and observations or to changes in proposed models, explanations, or designs. Scientists and engineers use evidence-based argumentation to make the case for their ideas, whether involving new theories or designs, novel ways of collecting data, or interpretations of evidence. They and their peers then attempt to identify weaknesses and limitations in the argument, with the ultimate goal of refining and improving the explanation or design.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of engineering practice. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Architectural 3D Sketching

Teaching Strategies

Engage students in brainstorming exercise the Architectural 3D sketching.
Engage students in the discussion the Architectural 3D sketching.

Learning Strategies

Discover different Architectural 3D sketching.

Activity 1 Brainstorming activity on different Architectural 3D sketching.
Activity 2. Conduct research on different Architectural 3D sketching.
Activity 3. Discussions and presentation of research findings of Architectural 3D sketching basics.

Resources
"Front matter" *Structural Engineering Handbook* Ed. By Chen Wai-Fah, Boca Raton
Teacher Notes

Lesson 2: Comparison of Engineering Design and Scientific Method

Teaching Strategies

Engage students in brainstorming exercise the Engineering design and scientific method.
Engage students in the discussion the Engineering design and scientific method.

Learning Strategies
Discover different Engineering design and scientific method.
Activity 1 Brainstorming activity on Engineering design and scientific method.
Activity 2. Conduct research on different Engineering design and scientific method.
Activity 3. Discussions and presentation of research findings on Engineering design and scientific method.

Resources

"Front matter" *Structural Engineering Handbook* Ed. By Chen Wai-Fah, Boca Raton
Teacher Notes

Lesson 3: 3D Free-Hand Sketching

Teaching Strategies

Engage students in brainstorming exercise 3D Free-Hand Sketching in Engineering.
Engage students in the discussion the 3D Free-Hand Sketching in Engineering.

Learning Strategies
Discover 3D Free-Hand Sketching in Engineering
Activity 1 Brainstorming activity on 3D Free-Hand Sketching in Engineering.
Activity 2. Conduct research on different Engineering design and Scientific method3D Free-Hand Sketching in Engineering.
Activity 3. Discussions and presentation of research findings on E3D Free-Hand Sketching in Engineering .

Resources

"Front matter" *Structural Engineering Handbook* Ed. By Chen Wai-Fah, Boca Raton
Teacher Notes

STEAM Activity Students work in groups to create an activity incorporating engineering problem solving skills. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Engineering Practice. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Define and describe the Architectural 3D sketching.
2. Analyse and describe the Steps of scientific method.
3. Categorise and define the difference between engineering design and Scientific method.
4. Define and practice the 3D Free Hand sketching.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Define and describe Architectural 3D sketching.	Correct definition and description of Architectural 3D sketching.	Correct description of Architectural 3D sketching.	Poor description of Architectural 3D sketching.	No description of Architectural 3D sketching.
Analyse and describe the Steps of scientific method	Analyse and describe correctly	Describe correctly	Poor description of the steps of the scientific method	No description of the steps of the scientific method
Categorise and define the difference between engineering design and Scientific method	Correct categorisation and differentiation between engineering design and Scientific method	Correct differentiation between engineering design and Scientific method	Poor differentiation between engineering design and Scientific method	No differentiation between engineering design and Scientific method
Define and practice the 3D free hand sketching	Correct practice of 3D free hand sketching	Practice of 3D free hand sketching	Poor attempt of 3D free hand sketching	No attempt of 3D free hand sketching

UNIT 5. Engineering Technology

Content Standard 3.5 Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 10.3.5.4 Develop and use specialised techniques in the application of graphics as a communication tool.

Topic 4: Engineering Graphic techniques

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and describe the importance of types, functions and applications of graphics in engineering.

Essential Questions:

1. What is the Introduction to graphics technology?
2. What are the Types of graphics technology?
3. What is the Importance of computer graphics?
4. What are some Graphics applications?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Engineering graphics and its applications	Conduct research on; Graphic communication and its elements in engineering Drawing formats and elements(Practice) Graphics applications in engineering	appreciate the contribution and impact of innovation and technologies now and in the future	Value the development of skills and gain satisfaction from their use to solve problems and create quality products.

Technology and Industrial Arts Application: Construction Technology: Engineering Technology

Content Background

Basics of Graphics Communication

One of the best ways to communicate design ideas is through graphical representation such as pictures or drawings. This is especially important for engineering information. It is calculated that in engineering, 92% of the design process is graphically based. Another 8% are distributed between:

- mathematics,
- written, and
- verbal communications.

Graphics Communication is a language, without which efficient communication between engineers, designers or product developers is impossible. Very important concept in graphics communications is drawing – a graphical representation of objects and structures which is done using freehand, mechanical, or computer methods. Technical drawing is used to represent complex technical ideas with adequate precision for the product to be mass-produced and the parts to be easily interchanged.

The key elements of graphics communication are;
1. Drawing Formats and elements
2. Projections and Views
3. Sectioning Technique
4. Principles of Dimensioning
5. Dimensioning Threaded Fasteners
6. Principles of Tolerancing
7. Working Drawings and Assemblies

Drawing Format and Elements
First, we will consider the sheet sizes, drawing format, title blocks, and other parameters of the drawing form.

Standard Sheet Sizes

In Table 1 are shown the most widely used A and B Series of the ISO drawing sheet sizes, with A4 being the most popular size.

Series Designation	Trimmed Size, mm		Inside Border, mm	
	Y	X	H	W
A0	841	1189	821	1159
A1	594	841	574	811
A2	420	594	400	564
A3	297	420	277	390
A4	210	297	190	267
A4 Vertical	297	210	277	180
B1	707	1000	687	970

Table 1A and B Standard Sheet Sizes Series Drawing
Source: https://www.mcgill.ca/engineeringdesign/step-step-design-process/basics-graphics-communication/drawing-format-and-elements

The terms used in the table are clarified here:

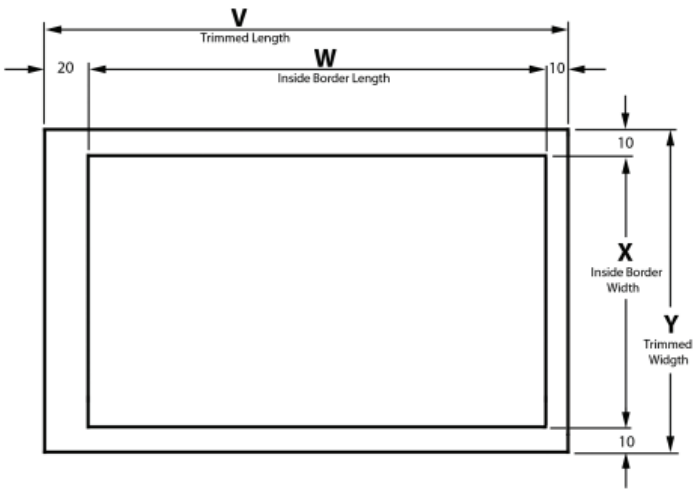


Figure 5.4a Standard Sheet Sizes Series Drawing
Source: https://www.mcgill.ca/engineeringdesign/step-step-design-process/basics-graphics-communication/drawing-format-and-elements

The ***Inside border*** encloses the working area, including the title block and other tables. Traditionally, for the printed drawings the border is 20 mm wide on the binding edge and 10 mm wide on the other three sides, with resulting working area sizes as shown in Table 1. However, when drawings are stored in the electronic format, the wider border is not mandatory and can be 10 mm too.
Title Blocks

Title blocks are used to record all important information necessary for the working drawings. They contain general as well as specific information.
The data may refer to company policy or to the drawing. The form and information vary from company to company. A company that produces large castings, as an example, may have different notes than a company that makes small tools and dies.

Though the arrangement and size of the title block is optional, the following information is considered mandatory:

1. Drawing number;
2. Title or description of the drawing (part name);
3. Name of firm/organization (address, project affiliation – title or number, etc.);
4. Original scale;
5. General specifications and notes area (tolerances, finishes, etc.);
6. Drafter name area; signature, approval, etc.

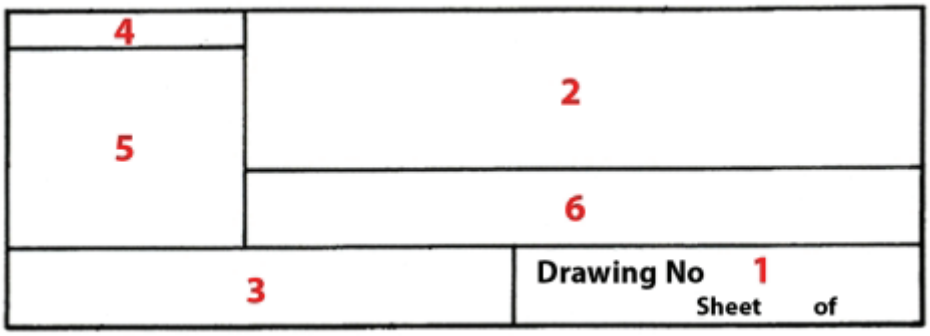


Figure 5.4b Title blocks
Source: https://www.mcgill.ca/engineeringdesign/step-step-design-process/basics-graphics-communication/drawing-format-and-elements

Besides this data *title blocks* may contain the following:

- Design approval when subcontractors are used.
- Federal supply code for manufacturers (FSCM) number.
- Drawing sheet size letter designation.
- Actual or estimated weight of the item.
- Sheet number if there are multiple sheets in the set.
- Date of issue.
- Signatures.
- Professional seals.
- Job, order, or contract number.
- References to this or other documents, or to the file.

Change or Revision Table

Drawings may carry a change or revision table, preferably on the right-hand side (vertical revision table) or at the bottom of the drawing on the left from the title block (horizontal revision table). In addition to a brief description of drawing changes, provision may be made for recording a revision symbol, zone location, issue number, date, and approval of the change.

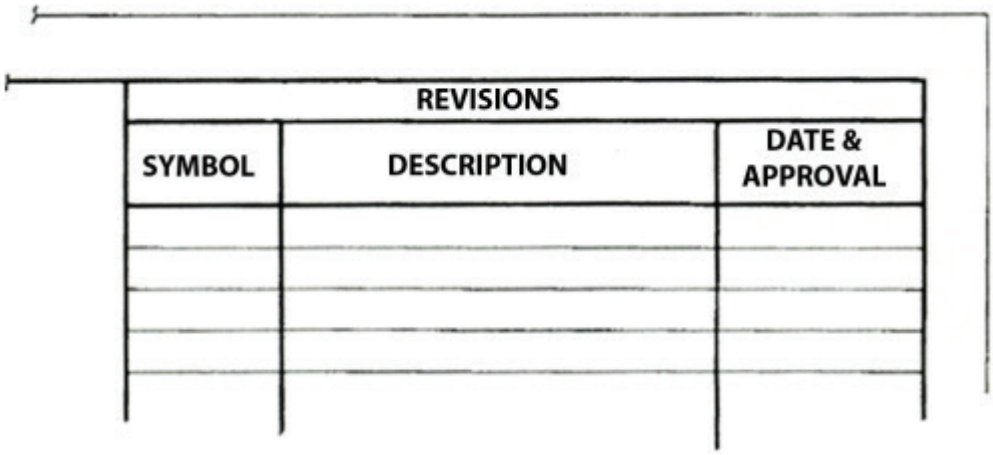
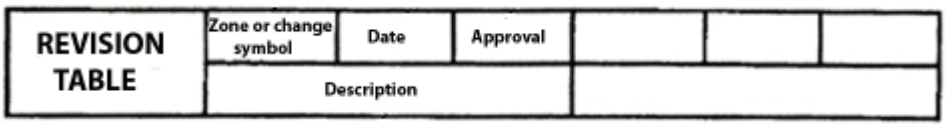


Figure 5.4c Change or revision table
Source: https://www.mcgill.ca/engineeringdesign/step-step-design-process/basics-graphics-communication/drawing-format-and-elements

Typical vertical revision table



Typical horizontal revision table

Drawing Titles

The proper selection of drawing titles is very important. A drawing title

- should be as brief as possible,
- should describe the item depicted,

- should distinguish between similar items.

Two-part titles
Drawing titles may be in two parts.
a) The first part of the title shall be the item name, which may consist of a noun or noun phrase and suitable modifiers. The noun or noun phrase shall describe the item and the use of the item, but not the material or method of fabrication.

General rules
The following general rules should be observed in selecting the first part of a title:
a) The conjunction “or” and the preposition “for” shall not be used.
b) No abbreviation of any portion of the item name (first part of title) shall be made, except those necessarily used for trademarked names and the words ASSEMBLY (ASSY), SUBASSEMBLY (SUBASSY), and INSTALLATION (INSTL).
c) An ambiguous noun or one that designates several classes of items shall not be used alone or as a modifier, but shall be used as part of a noun phrase.

Lettering & numbering
The most important requirements for lettering are legibility, reproducibility, and ease of execution.

Scaling
All drawings should be drawn to scale, and the denomination of the used scale should be shown in the title block of the drawing.
If a drawing has details drawn larger than full size, it should, where practicable, include an undimensioned view of the same details drawn to actual size. This view may be an axonometric projection or may be simplified by showing only the outlines of the object.
If most features of the drawing are not drawn to scale, the abbreviation NTS must be shown in the scale space in the title block. NTS is used on the preliminary drawings or on sketches. The manufacturing drawings must be drawn *to scale*.

Recommended Scale
Drawings should be full scale (1:1) whenever practicable, but when other scales are necessary the recommended scales for use on technical drawings are specified in the Table 2.

Table 2. Recommended scales for manufacturing drawings.

Category	Recommended scales
Enlargement Scales	50:1 20:1 10:1 5:1 2:1
Full Size	1:1
Reduction scales	1:2 1:5 1:10 1:20 1:50 1:100 1:200 1:500 1:1000 1:2000 1:5000 1:10000

The choice of the scale is to your discretion. The scale may differ from the recommended ones; however it must be always shown as rate of the integer numbers.
Where it is necessary to use more than one scale on a drawing, the main scale only should be inscribed in the title block. All other scales should be shown near the detailed drawing.

Notes
Notes are used to simplify or complement the graphic presentation by indicating information on a drawing in a condensed and systematic manner. Types of notes: **general** and **local**.
Common rules for all types of notes
Notes should be

- stated in the present tense, and
- in either imperative or permissive mood as required.

Avoid

- Lengthy,
- complex, or
- indefinite notes.

General Notes are notes that refer to the part or the drawing as a whole. Such notes should be shown in a central position below the view to which they apply, or in a general note column.
Typical examples of general notes:

1. Finish all over $\sqrt{}^{63}$
2. All fillers R4;
3. Tolerances apply after plating

Local notes apply to local requirements only and are connected by a leader to the feature to which the note applies.
Typical examples of local notes:
Ø9.6 4 holes;
C-bore Ø6 x 4 deep;
Cham 2 x 45°.

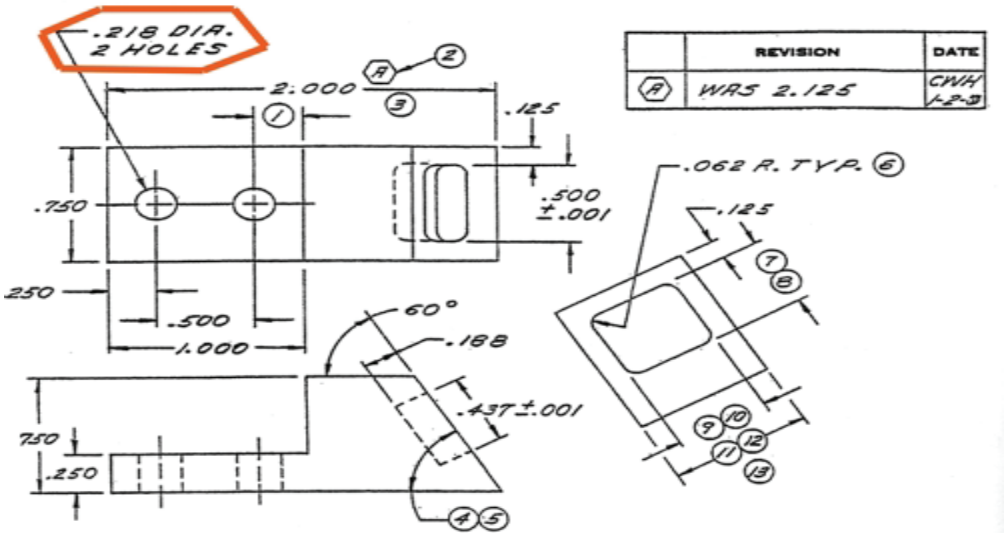


Figure 5.4d Local Notes
Source: https://www.mcgill.ca/engineeringdesign/step-step-design-process/basics-graphics-communication/drawing-format-and-elements

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of engineering graphic techniques. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Graphics Communication

Teaching Strategies

Engage students in brainstorming exercise the Introduction to graphics technology.
Engage students in the discussion the Introduction to graphics technology.

Learning Strategies

Discover different graphics technology.

Activity 1 Brainstorming activity on graphics technology.
Activity 2. Conduct research on graphics technology.
Activity 3. Discussions and presentation of research findings on graphics technology.

Resources

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Teacher Notes

Lesson 2: Elements of Graphics Communication

Teaching Strategies

Engage students in brainstorming exercise the elements of graphics communication.
Engage students in the discussion the Types of graphics technology.

Learning Strategies

Discover different Types of graphics technology.

Activity 1 Brainstorming activity on elements of graphics communication.
Activity 2. Conduct research on elements of graphics communication.
Activity 3. Discussions and presentation of research findings on elements of graphics communication technology.

Resources

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Teacher Notes

Lesson 3: Drawing Formats and Elements (Practice)

Teaching Strategies
Engage students in exercise the Drawing Formats and Elements.
Engage students in the discussion the Drawing Formats and Elements.
Students practice Drawing Formats and the elements involved and create a folio of drawings. They are encouraged to include the other elements as well.

Learning Strategies
Discover Importance of computer graphics.
Activity 1 Discussion activity on Drawing Formats and Elements.
Activity 2. Conduct research on the Drawing Formats and Elements.
Activity 3. Discussions and presentation of research findings on Drawing Formats and Elements.
Activity 4 Practice: Drawing Formats and Elements.

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Teacher Notes

Lesson 4: Graphics Applications

Teaching Strategies

Engage students in brainstorming exercise the graphics applications.
Engage students in the discussion the graphics applications.

Learning Strategies
Discover different Engineering Graphics applications.

Activity 1 Brainstorming activity on different types of engineering graphics applications.
Activity 2. Practice engineering graphics applications.
Activity 3. Create folio of engineering graphics applications.

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Teacher Notes

STEAM Activity Students work in groups to create an activity incorporating graphics communication in engineering. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis on Engineering Graphic techniques .Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Analyse and describe the Introduction to graphics technology
2. Analyse and define the Types of graphics technology
3. Define and describe the Importance of computer graphics
4. Analyse and define Graphics applications

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Analyse and describe the Introduction to graphics technology	High order analysis and description of graphics technology	Competently analysed and described graphics technology	Did not fully analyse and describe graphics technology	Did not analyse and describe graphics technology
Analyse and define the Types of graphics technology	High order analysis and description of the types of graphics technology	Competently analysed and described types of graphics technology	Did not fully analyse and describe types of graphics technology	Did not analyse and describe types of graphics technology
Define and describe the Importance of computer graphics	High order definition and description of the types of graphics technology	Competently defined and described types of graphics technology	Did not fully define and describe types of graphics technology	Did not define and describe types of graphics technology
Analyse and define Graphics applications	Analyse and describe correctly graphics applications with examples	Analyse and Describe correctly graphics applications	Does not fully analyse and describe graphics applications	Does not analyse and describe graphics applications

UNIT 5. Engineering Technology

Content Standard 3.5 Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 10.3.5.5 Select and use appropriate management and planning skills related to engineering.

Topic 5: Planning and Management Skills

Learning Objectives

By the end of this topic, the students will be able to;

1. Discuss and employ planning and management skills in engineering.

Essential Questions:

1. What is analytical thinking?
2. What is teamwork and clear communication?
3. What are the leadership skills?
4. How important are leadership and organizational skills in engineering?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Planning and Management Skills in engineering technology	The following skills will be emphasised and enhanced during the studying of this topic; Analytical thinking skills Teamwork and clear communication skills Leadership skills Organisational skills	The following skills are to be valued during the studying of this topic; Analytical thinking skills Teamwork and clear communication skills Leadership skills Organisational skills	Determination with a desire to learn by showing positive attitude and confidence when Planning, organising and explaining the planning and management skills in engineering technology through collaborative presentations

Technology and Industrial Arts Application: Construction Technology-Engineering Technology

Content Background

Planning and management Skills in engineering

Engineering is one of the most highly sought out career fields in the present world. There is a constant need for dynamic experts in engineering. Creativity, logical reasoning, leadership, and communication skills are some of the top traits that can make one to become a successful engineer across sectors.

Analytical thinking is observing and researching a problem or topic to develop more complex ideas about it. A successful engineer should have outstanding analytical skills to collect the right information and then assemble, visualize, and investigate the information in detail with the help of strategic thinking skills. Analytical skills also require basic mathematical skills for comprehending and evaluating numerical data for making the right decisions. Analytical skills not only enable engineers to consider a problem from different perspectives but also enable them to solve complicated problems in the most effective way.

Other than technical proficiency, as a 21st century engineer, one should be able to write, speak, and communicate your ideas effectively for communicating technical concepts clearly and efficiently to culturally and globally diverse teams consisting of engineers and the non-technical audience. Moreover, strong communication skills enable global engineers to eliminate all barriers arising out of cultural, linguistic, and technical differences. When speaking, be clear and concise. Speak on important matters directly and do not allow the listener's minds to wander, ensuring that there is absolute certainty that what is communicated is clearly understood. A key to verbal communication for engineers is listening. Both written and verbal communication skills are of the utmost importance in business, especially in engineering. Communication skills boost you or your teams' performance because they provide clear information and expectations to help manage and deliver excellent work

In every industry, strong, efficient leadership is necessary to run businesses smoothly. Engineering is no exception. Leadership is more than simply managing a team or making a schedule. Leadership encompasses a number of qualities and abilities, and engineering leadership is a skill an engineer can benefit from at any level.
When a team includes a member with strong leadership skills, resource allocation, personnel assignments and project completion all improve. Leaders, in their efforts to produce their own best work, inspire others to do the same.

Problem-solving is one of the most important attributes of an engineer. Creative potential and the ability to solve problems are identified as essential characteristics for both novice undergraduate engineers and qualified engineering professionals. The complexity of technical problems is increasing with time which requires engineers to apply logical thinking for problem-solving; thus, engineers need to be creative problem solvers. An engineer should approach every task at hand with an analytical mind to develop solutions that can meet all the requirements. Hence, problem-solving skills should be an integral part of engineering education.

Logical Reasoning and Creativity

One of the primary tasks of engineers is to identify and solve complex problems; therefore, engineers should be adept in logical reasoning skills such as hypothesising, inductive/ deductive reasoning, comparing, forecasting, classifying, critiquing, and so on. Additionally, engineers should be creative enough to come up with ground-breaking technical ideas. A balance in logic and creativity enables engineers to materialise their innovative ideas by linking knowledge from diverse areas for solving problems.

Leadership and Teamwork

Since engineers have to work with diverse teams for the accomplishment of different complex projects, they need to have the ability to lead, follow, and working collaboratively with their team. Efficient teamwork and leadership skills are the foundations of all technical operations, be it a

maintenance team, project team, manufacturing cell, or product development team. Thus, a successful engineer needs to be a good team player and an effective leader for directing and influencing his fellow team members for a positive outcome. Leadership qualities of a successful engineer consist of the capability of taking initiatives, assessing risks, decision-making, the ability to relate to others, and willingness to deliver on time and focusing on the projects with discipline, and passion. It is the responsibility of engineering institutes to inculcate team spirit and leadership qualities in young engineers when assigning course projects to them.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of planning and management skills that are related to engineering. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Analytical thinking

Teaching Strategies

Engage students in brainstorming exercise on analytical thinking and how they impact the work of an engineer.
Engage students in the discussion the analytical thinking skills as a trait in engineering.

Learning Strategies

Discover different analytical thinking skills.
Activity 1 Brainstorming activity on different analytical thinking skills.
Activity 2. Conduct research on different analytical thinking skills.
Activity 3. Discussions and presentation of research findings on analytical thinking.

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Teacher Notes

Lesson 2: Teamwork and Clear Communication

Teaching Strategies

Engage students in brainstorming exercise teamwork and clear communication.
Engage students in the discussion the teamwork and clear communication.

Learning Strategies

Discover different teamwork and clear communication.
Activity 1 Brainstorming activity on teamwork and clear communication.
Activity 2. Conduct research on different teamwork and clear communication.
Activity 3. Discuss and present of research findings on teamwork and clear communication.

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Teacher Notes

Lesson 3: Leadership skills

Teaching Strategies
Engage students in brainstorming exercise the leadership skills in building a team with a common goal.
Engage students in the discussion the leadership skills in building a team with a common goal.

Learning Strategies
Discover different leadership skills.
Activity 1 Brainstorming activity on leadership skills.
Activity 2. Conduct research on different leadership skills.
Activity 3. Discuss and present research findings on leadership skills in engineering.

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Teacher Notes

Lesson 4: Organisational Skills

Teaching Strategies
Engage students in brainstorming exercise the organisational skill.
Engage students in the discussion the organisational skills.

Learning Strategies
Discover different organisational skills.
Activity 1 Brainstorming activity on different organisational skills.
Activity 2. Conduct research on different organisational skills.
Activity 3. Discussions and presentation of research findings on organisational skills in engineering.

Resources
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Teacher Notes

STEAM Activity Students work in groups to create an activity on planning and management in engineering incorporating STEAM concepts. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity).

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis on Planning and management Skills .Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define Analytical thinking

2. Analyse and define Teamwork and clear communication
3. Define and describe Leadership skills
4. Analyse and describe Organizational skill

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Define Analytical thinking	High order definition and description of analytical thinking	Competently defined and described analytical thinking	Does not fully define and describe analytical thinking	Does not define and describe analytical thinking
Analyse and define Teamwork and clear communication	Analyse and define correctly team work and communication with examples	Analyse and define correctly team work and communication	Does not fully define team work and communication	Does not define team work and communication
Define and describe Leadership skills	High order definition and description of leadership skills	Competently defined and described leadership skills	Does not fully define and describe leadership skills	Does not define and describe leadership skills
Analyse and describe Organizational skill	Analyse and describe correctly organisational skills with examples	Analyse and describe correctly organisational skills	Describe organisational skills	No correct description of organisational skills

UNIT 5. Engineering Technology

Content Standard 3.5 Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 10.3.5.6 Analyse and synthesise engineering applications in specific fields and report on the importance of these to society.

Topic 6: Engineering Applications

Learning Objectives

By the end of this topic, the students will be able to;

1. Conduct review, research and survey and present findings in professional engineering reports.

Essential Questions:

1. How are engineering applications important to society?

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
Engineering applications in specific fields and its impact of innovations on society	The following skills will be emphasised and enhanced during the studying of this topic; Engineering application skills Engineering innovation skills	Creativity and innovation with calculated design for the betterment of humans is highly valued	Acceptance of change and development of Engineering applications in specific fields and its impact of innovations on society through collaborative presentations

Technology and Industrial Arts Application: Construction Technology-Engineering Technology

Content Background

Engineering applications

What are the applications of engineering to society?

Engineers invent new technologies, such as the telephone or the silicon chip, and they help to make other people's ideas work, such as structural and geotechnical engineers creating technical solutions to make an architect's design for a building stand up.

What is the impact of engineering in society?

Engineering plays a vital role in construction, as engineers design and plan the buildings, roads, and other structures that make up our communities. They ensure that these structures are safe, efficient, and sustainable, while also considering the economic and social impact of their designs.

What are three reasons why engineering is important in society?
They design and implement solutions to everyday problems such as access to water and electricity, safe transport and medicine — things that are needed everywhere. This means you will have opportunities to travel and work in other countries, enjoying all the experiences that come with it.

What is engineering the application of?
Engineering is the application of science and math to solve problems. While scientists and inventors come up with innovations, it is engineers who apply these discoveries to the real world.

What is the goal of engineering in the society?
In an advanced technological world, we need engineers to bring ideas into reality. By applying the principles of mathematics and science, engineers develop solutions to the world's biggest technical issues.

6 sectors of the society where the importance of an Engineer cannot be missed.

The human race has come a long way. From discovering the fire to now building human counterparts in the form of robots - human beings are leaving no stones unturned to make the living easier and sustainable. Engineers play an important part in all of these.
Engineering is considered as one of the most important disciplines of study in the current world. And its importance is felt around by almost everybody across the world. Without the adoption of Engineering practices, no country will evolve and be able to heighten its economy.
An Engineer is a person who develops ways through his/her scientific knowledge, mathematics, experiments, intuition and judgement to use materials or forces of nature economically for a sustainable future of mankind. And their applications are observed anywhere and everywhere. With their innovative, imaginative minds, Engineers give a lot to the betterment of society.

The major contributions of an Engineer can be experienced in the fields of the following -

Healthcare sector
Without any doubt, every health department of the world firmly depends on the achievements of the Engineers. It is also true that without the doctors and pharmacists, the healthcare sector is nothing but, the equipment used for diagnosis or that are there at the hospitals and other healthcare facilities are made by Engineers. From computers, surgical instruments, to the stethoscope, diagnostic instruments, without the Engineers or the Engineering principles, nothing would have been possible. Information technology, Machine learning and other Engineering tools have even made the diagnosis, surgeries and other healthcare applications easy and effective.

Agricultural sector
Earlier, agriculture was about people working hard to grow crops to eat and feed. However, with the evolution of time, tractors, irrigation, fertilizers and agricultural tools came into existence and cultivation has become a lot efficient and easier. Moreover, advanced technologies like drones, vertical farming,

Automobile sector
One of the most impacted areas of society is the automobile sector. A few thousand years ago, one could never imagine travelling from one place to another in a vehicle. Now, one can travel through air transport, water transport and land transport. Engineers have made all of these possible. And technological innovations by the Engineers have come so far that there are bio-gas driven automobiles, autonomous cars and ships. They are being manufactured and tested so that transportation becomes easier and sustainable.

Banking sector
Sometimes people wonder, what an Engineer's job might be at a Bank. Well, banks have advanced and are embracing technological innovations and various software that are founded and maintained by Engineers. Gone are the days where one used to count notes manually or recorded ledgers with pen and paper. Now, from securing theft to money transactions all are done with the help of machines, software and technologies, discovered and implemented by Engineers.

Marketing sector
The marketing sector is the area where a business is promoted. These promotional services are evolving regularly and digitalization is creating a huge impact on the betterment of the sector. This digitalization is brought upon by the Engineers and digital marketing is taking over the world by a storm. Moreover, the spur in the e-commerce industry is also due to the digitalization that has made shopping and selling over the internet easier, cheap and secured.

Educational sector
Engineers have also made a mark in the Educational sector of the world. From the integration of computer and digital learning in various schools across the world for implementation of the study of robotics, various latest technologies, coding and others - Engineers have made study interactive, efficient and fun.
Engineering as a profession is one of the most lucrative opportunities in the 21st century. Engineers have the ability to change the course of the Earth and constantly upgrade modern society to make it more convenient and sustainable for the next generation.

Why Engineering Is Important to Society
Engineering has been a fundamental part of human development and progress for centuries. From the ancient Egyptians building pyramids to the latest advancements in technology, engineering has played a vital role in shaping the world we live in. In this blog article, we'll explore what makes engineering such an important part of our society.

Why Do We Need Engineering?
Engineering is a crucial part of our society because it provides solutions to the problems we face in our daily lives. Engineers use their knowledge, skills, and creativity to design, build, and maintain systems, structures, and technologies that improve our quality of life. From providing clean water and electricity to developing life-saving medical devices, engineering makes a tangible impact on the world around us.

How Do Engineers Impact Our Future?
Engineers play a key role in shaping our future. They design and build the infrastructure and systems that support our communities and economies. As technology continues to evolve, engineers are at the forefront of innovation, developing new and improved solutions to the

challenges we face. From tackling climate change to improving healthcare, engineers are working to create a better future for everyone.

Influence of Engineering Across Various Sectors

Engineering has a significant impact on various sectors of our society, from construction and industry to technology, medicine, and communication. By designing and building new structures and systems, optimizing existing ones, and developing new technologies, engineers are shaping the world around us and improving our daily lives. From improving our health and safety to making it easier to connect with each other, engineering is making a profound impact on our world, and its influence will only continue to grow in the future.

Construction

Engineering plays a vital role in construction, as engineers design and plan the buildings, roads, and other structures that make up our communities. They ensure that these structures are safe, efficient, and sustainable, while also considering the economic and social impact of their designs.

Engineering contributes to the construction industry through:

- **Design and Planning:** Engineers use their expertise to design and plan construction projects, taking into account factors such as safety, functionality, cost, and sustainability.
- **Safety and Structural Integrity:** Engineers ensure that construction projects meet safety standards and have the necessary structural integrity to withstand the elements and wear and tear over time.
- **Innovative Materials and Techniques:** Engineers are always exploring new materials and techniques to make construction projects safer, more efficient, and more sustainable.
- **Building Information Modeling (BIM):** Engineers use BIM technology to create virtual models of construction projects, allowing for better collaboration and visualization of the project before it is built.
- **Sustainability:** Engineers play a key role in ensuring that construction projects are sustainable and minimize their impact on the environment. This includes using eco-friendly materials, designing energy-efficient buildings, and incorporating renewable energy systems.
- **Cost-effectiveness:** Engineers work to minimise costs while maximising the quality and functionality of construction projects, making them accessible and affordable for everyone.
- **Community Impact:** Engineers consider the social and economic impact of construction projects on communities, ensuring that they benefit everyone, not just a select few.

Industry

Engineering is also critical to the industrial sector, as engineers design and develop the products and processes that drive economic growth and competitiveness. From improving manufacturing processes to developing new products, engineers are essential to the success of industry.

Engineering's contributions to industry are numerous. A few of the most significant include:

- **Manufacturing:** Engineers are involved in the design and development of new manufacturing technologies and processes, from automation and robotics to 3D printing and beyond.
- **Industrial Automation:** Engineers are developing new automation technologies that are transforming the industrial sector, from improving efficiency and productivity to reducing waste and improving safety.

- **Industrial Design:** Engineers are involved in the design of products and equipment used in various industries, from consumer goods to heavy machinery.
- **Supply Chain Management:** Engineers are involved in the optimisation of supply chains, from improving transportation and logistics to streamlining production processes.
- **Energy and Utilities:** Engineers are involved in the development of new energy technologies and systems, from renewable energy sources to energy-efficient systems.
- **Process Control and Instrumentation:** Engineers are involved in the design and development of process control and instrumentation systems, ensuring the safe and efficient operation of industrial processes.
- **Materials Science:** Engineers are involved in the development of new materials and the optimization of existing ones, from improving the strength and durability of materials to developing new materials with unique properties.

Technology

In the technology sector, engineers are the driving force behind the latest innovations. From developing new software and hardware to advancing the field of artificial intelligence, engineers are shaping the way we live and work through technology.

Engineering impacts the technology sector in several ways, including:

- **Research and Development:** Engineers play a key role in conducting research and developing new technologies, from hardware and software to artificial intelligence and robotics.
- **Software Engineering:** Engineers design and develop the software systems that power our digital devices, websites, and apps, ensuring that they are secure, efficient, and user-friendly.
- **Hardware Engineering:** Engineers design and develop the hardware systems that power our digital devices, from smartphones to laptops and beyond.
- **Artificial Intelligence:** Engineers are at the forefront of the artificial intelligence revolution, developing new algorithms and systems that enable machines to learn, think, and make decisions.
- **Robotics:** Engineers are developing and refining the robots that are transforming manufacturing, logistics, and other industries, making them more efficient and productive.
- **Internet of Things (IoT):** Engineers are designing and developing the systems and devices that make up the Internet of Things, connecting our physical and digital worlds like never before.
- **Cybersecurity:** Engineers play a crucial role in ensuring the security of our digital systems and networks, protecting against cyberattacks and data breaches.

Medicine

In the field of medicine, engineers are working to improve health outcomes and save lives. They design and develop medical devices and technologies, from artificial organs to medical imaging systems, that help diagnose and treat diseases.

Here are some ways in which engineering impacts the medicine sector:

- **Medical Devices and Equipment:** Engineers play a crucial role in designing and developing the medical devices and equipment used in healthcare, from diagnostic tools to therapeutic devices.
- **Biomedical Engineering:** Engineers are using their expertise to solve complex biological and medical problems, from developing new prosthetics and implants to creating new diagnostic tools and treatments.
- **Drug Development:** Engineers are involved in the development of new drugs and therapies, from researching new compounds to designing and testing new delivery systems.

- **Telemedicine:** Engineers are developing new technologies that enable remote healthcare delivery, such as tele-consultations and remote monitoring systems.
- **Medical Imaging:** Engineers are advancing the field of medical imaging, from developing new imaging technologies to improving the accuracy and reliability of diagnostic tests.
- **Robotics and Automation:** Engineers are developing new robotics and automation technologies that are transforming the field of medicine, from automating routine tasks to performing complex surgeries.
- **Personalized Medicine:** Engineers are involved in the development of personalized medicine, using new technologies and data analytics to tailor treatments to individual patients.

Communication

Finally, engineering plays a crucial role in communication, as engineers design and maintain the networks and systems that connect us. From the internet to telecommunication systems, engineers are responsible for ensuring that we can communicate effectively and efficiently. Here are some ways in which engineering impacts the communication sector:

- **Telecommunications:** Engineers are involved in the development of new telecommunications technologies, from designing and building new networks to improving the speed and quality of our communications.
- **Wireless Technology:** Engineers are developing and improving wireless technologies, from cell phone networks to Wi-Fi and beyond, making it easier for us to connect with each other on the go.
- **Satellite Communication:** Engineers are involved in the design and launch of satellites that enable global communication, from voice and data transmission to television broadcasting.
- **Internet Technology:** Engineers are involved in the development of new Internet technologies, from creating faster and more reliable networks to developing new applications and services.
- **Social Media:** Engineers are involved in the development of social media platforms and apps, from designing user-friendly interfaces to improving the security and privacy of user data.
- **Streaming Media:** Engineers are involved in the development of streaming media technologies, from delivering high-quality video and audio to developing new services like live streaming.
- **Cybersecurity:** Engineers play a crucial role in ensuring the security of our digital communications, protecting against cyberattacks and data breaches.

Engineering is a fundamental part of our society because it provides solutions to the problems we face, shapes our future, and impacts our lives in countless ways. From construction to medicine, engineering is essential to the progress and well-being of humanity.

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Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each

topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of engineering applications. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Engineering Applications

Teaching Strategies
Engage students in brainstorming exercise the Engineering Applications
Engage students in the discussion the Engineering Applications

Learning Strategies
Discover different Engineering Applications

Activity 1 Brainstorming activity on different Engineering Applications
Activity 2. Conduct research on different Engineering Applications
Activity 3. Discussions and presentation of research findings of Engineering Applications

Resources
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Teacher Notes

Lesson 2: Engineering Innovations

Teaching Strategies
Engage students in brainstorming exercise the Engineering Innovations
Engage students in the discussion the Engineering Innovations

Learning Strategies
Discover different Engineering Innovations
Activity 1 Brainstorming activity on Engineering Innovations
Activity 2. Conduct research on different Engineering Innovations
Activity 3. Discussions and presentation of research findings on Engineering Innovations

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Teacher Notes

Lesson 3: Impacts of Engineering Innovations on Society
Teaching Strategies
Engage students in brainstorming exercise the Impacts of Engineering Innovations on Society
Engage students in the discussion the Impacts of Engineering Innovations on Society

Learning Strategies
Discover different Engineering Innovations

Activity 1 Brainstorming activity on Impacts of Engineering Innovations on Society

Activity 2. Conduct research on different Impacts of Engineering Innovations on Society
Activity 3. Discussions and presentation of research findings on Impacts of Engineering Innovations on Society

Resources
"Front matter" *Structural Engineering Handbook* Ed. By Chen Wai-Fah, Boca Raton
Teacher Notes

STEAM Activity Students work in groups to create an activity on the impacts of engineering on medicine, agriculture, building structures incorporating concepts of STEAM. (Follow the DESIGN PROCESS on pages 322 to 326 for this activity)

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Engineering applications. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Conduct a research on the engineering innovations and how they impact society to improve.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Set research questions and a research topic.	Excellent set of research questions to guide the research about the topic.	Very Good set of research questions and research topic	Poor research questions and research topic	No research questions and unclear topic
Conduct the research	Correctly conduct research using available resource with clear use of resources.	Correctly conduct research using available resources	Conduct research using available resources	Fails to Correctly conduct research using available resources
Evidence of anecdotal notes of research done	Keep An excellent record of anecdotal notes taken on notes of the topic.	Keep a good record of record of anecdotal notes taken on notes of the topic.	Keeps a poor record of anecdotal notes of research	Does not keep a record of anecdotal notes.
Present research report.	Excellent Presentation of research with order using a report format with clear texts and graphics.	Very Good Presentation of research with order using a report format with clear texts and graphics.	Does not fully describe the Report preparation and layout	Does not describe the Report preparation and layout

Planning and Programming

The 8 steps in Planning and Programming Process

1. **This planning and programming sample is using grade 9 content but the steps described here will be applied to plan and program grade 10 content.**
   Identify the number of Strands and Units in the subject Syllabus
2. Identify the total number of Content Standards, Benchmarks and Number of Topics (Syllabus and Teacher Guide)
3. Consider the Facts and Considerations in the Planning and Programming Process (subject related)
4. Distribute the Content evenly across the 4 school terms in a Matrix (Proposed Template)
5. Expand and plot the distributed content into the complete Yearly Content Overview for the subject for the grade (Proposed Template)
6. Develop the Termly Programs (Proposed Template)
7. Develop the Weekly Teaching Program (Proposed Template) Daily Lesson Plan (SBC Template
8. Review, Evaluate and Re-plan the yearly, termly, weekly Programs

Planning and Programming Process

The Planning and Programming Process used by the Business and Technology Subjects is an 8 step process. This process begins from Unpacking the Content Standards and Benchmarks and ends with planning a daily lesson plan.

Step 1: Identify the number of Strands and Units in the subject Syllabus
Step 2: Identify the total number of Content Standards, Benchmarks and Number of Topics (Syllabus and Teacher Guide)
Step 3: Consider the Facts and Considerations in the Planning and Programming Process (subject related)
Step 4: Distribute the Content evenly across the 4 school terms in a Matrix (Proposed Template)
Step 5: Expand and plot the distributed content into the complete Yearly Content Overview for the subject for the grade (Proposed Template)
Step 6: Develop the Termly Programs (Proposed Template – 3 part programme)
Step 7: Develop the Weekly Teaching Program (Proposed Template) Daily Lesson Plan (SBC Template)
Step 8: Review, Evaluate and Re-plan the yearly, termly, weekly Programs

TECHNOLOGY AND INDUSTRIAL ARTS PLANNING AND PROGRAMMING PROCESS

Planning and Programming Process involves 8 steps. The steps are outlined and described with samples provided to assist and guide you.

Step 1: Identify the number of Strands and Units in the subject Syllabus (Grade 9&10 TIA Syllabus Page 31)

It is important to first identify the strand and unit names for familiarisation and also the number of strands and units in the Grade 9 Technology and Industrial Arts subject.

Technology and Industrial Arts has 5 strands and 13 Units

Table of Strands and Units

The table below outlines the strands and units for grade 9 Technology and Industrial Arts subject. This helps teachers understand how to deal with units per strand when they are expanded into evidence outcomes and benchmarks at each grade.

The strands and units of content standards explain the progression from Grade 9 to Grade 10, linking to senior high school Technology and Industrial Arts content. The order and linkage of units signifies what the students will achieve from one grade to the next.

Technology and Industrial Arts is organised around five strands – Textile Technology, Food Technology, Construction Technology, Communication Technology and Computer Technology. These strands are comparable with the strands used internationally. The Content Standard of each Strand is based on units. The Strands, Units and Content Standards are outlined in the table below:

Step 1: Identify the number of Strands and Units in the subject Syllabus (Grade 9&10 TIA Syllabus Page 31)

STRANDS	UNITS
Textile Technology	Fibres and Fabrics
	Textiles and Clothing
Food Technology	Food and Nutrition
	Food Science
Construction Technology	Building Technology
	Electrical Technology
	Plumbing Technology
	Welding Technology
	Engineering Technology
Communication Technology	Data Communication and Network
	Computer Security and Safety
Computer Technology	Computer Architecture
	Computer Software

Step 2: Identify the total number of Content Standards, Benchmarks and Number of Topics (Syllabus and Teacher Guide)

- Use the Syllabus to derive the total number of Content Standards and total number of Benchmarks
- Use the unpacking tool to derive your topics and the total number of topics
- Place or slot them in a matrix as in the sample shown below so you are knowledgeable and made aware of the total number of content standards, benchmarks and topics that you will be working with in the planning and programming of teaching and learning for the subject in a school year for that grade.

Grade 9 Technology and Industrial Arts Content Matrix

Consult the Grade 9 Technology and Industrial Arts Content Matrix showing the total number of strands, units, content standards, Benchmarks and topics to be covered in Grade 9.

Total Number Of Strands	Total Number Of Units	Total Number of Content Standards	Total Number Of Benchmarks	Total Number Of Topics
1	2	2	11	11
2	2	2	13	13
3	5	5	29	29
4	2	2	12	12
5	2	2	11	11
Totals	13	13	77	77

Step 3: Consider the Facts and Considerations in the Planning and Programming Process (subject related)

It is important to consider and analyse facts that are worth considering if these facts will help or if these facts will pause a challenge to the planning and programming process.

Facts and Considerations about the Grade 9 Technology and Industrial Arts

1. As per the Matrix, there are a total of 77 Benchmarks and Topics which must be programmed and taught in a school year.

2. TIA is now a subject which requires all students to take all 5 strands in the subject unlike the OBE practice.
3. There are no specialist teachers who are trained to teach all the specialist content in the TIA subject.
4. Current practice has one teacher who can teach Food and Textile (Currently Home Economics), one teacher who can teach Construction Technology (currently Practical Skills) and one teacher who can teach Communication and computer Technology (currently Computer Studies and ICT).
5. With consideration #4, there are 3 personnel who will be required to teach TIA together to deliver the subject. ***Thus, this fact is considered to propose the Planning and Programming Process for TIA subject into a 3-part Teaching and Learning Planning and Programming Process.*** Which means TIA Subject Program is made up of 3 sub-programs.
6. Time Allocation for Grade 9 Technology and Industrial Arts is 200 minutes per week which means it has 5periods/5lessons a week: 1 block of 40 minutes (1period) periods and 1 x 160 minutes (4 periods block).
7. There is a total of 40 teaching weeks in a school year (4 Terms x 10 Weeks each)
8. In a term, there are about 8 weeks of actual teaching weeks which gives us 40 periods/40 lessons of actual teaching in a term (6 periods a week x 8 actual teaching weeks in a term).
9. Using these facts and considerations, we can Plan and Program TIA according to this understanding

Understanding 1:

There are 3 x Teachers who are required to teach the TIA subjects in 40 weeks. Therefore teaching and learning must be programmed using the 3 parts (40 /3 = 13.3 weeks per part).

Understanding 2:

There are 77 Benchmarks for TIA that must be planned and programed for 40 weeks but distributed equally according to the 3-parts: Textile & Food =34 BMs; Construction = 33 BMs; Communication &Computer = 33. (use the strand with the highest BMS to determine the number of BMS per week = 34 /16 = 2.1 BMS week)

Understanding 3:

The 3-factor plan and program for TIA becomes the Yearly plan and Program (meaning to say, the plan and program will be utilised by the teacher for 3 lots of students taking TIA in a rotation approach for a year. The TIA Content distribution will be determined by the 3 parts (3 available personnel) and therefore the content will be distributed.

Understanding 4:

In the instance where the school decides to deliver the Food Technology, Textile Technology, Communication Technology and Computer Technology from term 1-3, then

the Construction Technology gets to be taught in Term 4. This allows for the school to acquire or make available the necessary requirements for the Construction Technology strand. Otherwise, it becomes school-based and students are awarded an attainment certificate- for the strands they have learnt and NOT TIA. TIA is externally examined and certified.

Step 4: Distribute the Content evenly across the 3-Parts (Proposed Template)

The teaching content outweighs the teaching weeks and therefore considerations must be made on teaching and learning approaches for example; integration, project-based learning, etc. we have provided some information to help you distribute the Technology and Industrial Arts subject content to be programmed fairly across the 3-parts. The tables include:

Grade 9 Technology and Industrial Arts Content distribution for the Teaching Year
The Grade 9 TIA has been distributed according to the 3-parts in a 13 week rotation program. *The content standards and Benchmarks according to the Distribution are also written and provided for you in a table (4a).*

Week	Textile Technology and Food Technology	Construction Technology	Communication and Computer Technology
1	**Textile Technology: Fibres and Fabrics:** CS: 9.11 BMs: 9.1.1.1 and 9.1.1.2	**Building Technology** CS: 9.3.1 BMS: 9.3.1.1. 9.3.1.2, 9.3.1.3,	**Communication Technology Data Communication and Network** CS: 9.4.2 BMs: 9.4.1.1, 9.4.1.2, ,
2	**Textile Technology: Fibres and Fabrics**: CS: 9.11 BMs: 9.1.1.3, .1.1.4,	**Building Technology** CS: 9.3.1 BMs: 9.3.1.4, 9.3.1.5, 9.3.1.6,	**Communication Technology Data Communication and Network** CS: 9.4.1 BMs: 9.1.4.3, 9.1.4.4, 9.1.4 .5
3	**Textile Technology: Textile and Clothing:** CS: 9.1.2 BMs:9.1.2.1, 9.1.2.2,	**Electrical Technology** CS: 9.3.1 BMs: 9.3.2.1, 9.3.2.2, 9.3.2.3,	**Communication Technology Computer Security and Safety** CS: 9.4.2 BMs: 9.4.2.1, 9.4.2.2,
	Assessment	Assessment	Assessment
4	**Textile Technology: Textile and Clothing:** CS: 9.1.2 BMs: 9.1.2.3, 9.1.2.4,	**Electrical Technology** CS: 9.3.2 BMs: 9.3.2.4, 9.3.2.5,	**Communication Technology Computer Security and Safety** CS: 9.4.2 BMs: 9.4.2.3, 9.4.2.4
5	**Textile Technology: Textile and Clothing**: CS: 9.1.2 BMs: 9.1.2.5, 9.1.2.6,	**Electrical Technology** CS: 9.3.2 BMs: 9.3.2.6, 9.3.2.7	**Communication Technology Computer Security and Safety** CS: 9.4.2 BMs: 9.4.2.5, 9.4.2.6,
6	**Food Technology: Food and Nutrition:** CS: 9.2.1 BMs: 9.2.1.1. 9.2.1.2	**Plumbing Technology** CS: 9.3.3 BMs: 9.3.3.1, 9.3.3.2	**Computer Technology Computer Architecture** CS: 9.5.1 BMs: 9.5.1.1, 9.5.1.2

	Assessment	Assessment	Assessment
7	**Food Technology:** **Food and Nutrition:** CS: 9.2.1 BMs: 9.2.1.3, 9.2.1.4	**Plumbing Technology** CS: 9.3.3 BMs: 9.3.3.3, 9.3.3.4,	
8	**Food Technology:** **Food and Nutrition:** CS: 9.2.1 BMs: 9.2.1.5, 9.2.1.6,	**Welding Technology** CS: 9.3.4 BMs: 9.3.4.1, 9.3.4.2,	**Computer Technology** **Computer Architecture** CS: 9.5.1 BMs: 9.1.5.3, 9.1.5.4
9	**Food Technology:** **Food and Nutrition:** CS: 9.2.1 BMs: 9.2.1.7	**Welding Technology** CS: 9.3.4 BMs: 9.3.4.3, 9.3.4.4, 9.3.4.	**Computer Technology** **Computer Architecture** CS: 9.5.1 BMs: 9.1.5.5
	Assessment	Assessment	Assessment
10	**Food Technology:** **Food Science:** CS: 9.2.1 BMs: 9.2.2.1, 9.2.2.2	**Engineering Technology** CS: 9.3.5 BMs: 9.3.5.1, 9.3.5.2,	**Computer Technology** **Computer Software** CS: 9.5.2 BMs: 9.5.2.1, 9.5.2.2
11	**Food Technology:** **Food Science**: CS: 9.2.1 BMs: 9.2.2.3, 9.2.2.4,	**Engineering Technology** CS: 9.3.5 BMs: 9.3.5.3, 9.3.5.4,	**Computer Technology** **Computer Software** CS: 9.5.2 BMs: 9.5.2.3, 9.5.2.4
12	**Food Technology:** **Food Science:** CS: 9.2.1 BMs: 9.2.2.5	**Engineering Technology** CS: 9.3.5 BMs: 9.3.5.5, 9.3.5.6, 9.3.5.7	**Computer Technology** **Computer Software** CS: 9.5.2 BMs: 9.5.2.5,
13	Summative Assessment		

Grade 9 Technology and Industrial Arts Content Standards and Benchmarks Overview as per Strands and Units

The five strands – Textile Technology, Food Technology, Construction Technology, Communication Technology and Computer Technology are unpacked into units to Benchmarks as outlined in the table below:

STRAND 1: TEXTILE TECHNOLOGY	
UNIT 1: FIBRES AND FABRICS	
Content Standard	**Benchmarks**
CS1.1 Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.	**9.1.1.1 – 9.1.1.6**
	9.1.1.1 Compare and contrast social, economic, cultural and technological changes to textiles, fashion and clothing
	9.1.1.2 Distinguish the properties and characteristics of fibres and fabrics
	9.1.1.3 Explore the elements of design and the design and construction of fashion ideas
	9.1.1.4 Describe the functions of tools and equipment and their safe usage
	9.1.1.5 Explore the range of textile construction techniques

	9.1.1.6 Apply appropriate safety practices in fashion design and construction
STRAND 1: TEXTILE TECHNOLOGY	
UNIT 2: TEXTILE AND CLOTHING	
CS1.2 Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions	**9.1.2.1 – 9.1.2.6**
	9.1.2.1 Describe historical influences, technological progression and emerging trends as inspirational sources of design
	9.1.2.2. Demonstrate an awareness of the fundamentals of the design process through various artistic versions
	9.1.2.3 Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects
	9.1.2.4 Describe how the properties of textile fibres affect textile wear and care
	9.1.2.5 Apply the design process to respond to needs and opportunities in textile design projects
	9.1.2.6 Select and use appropriate technology to creatively document, communicate and present design and project work
STRAND 2: FOOD TECHNOLOGY	
UNIT 1: FOOD AND NUTRITION	
CS 2.1 Students will be able to examine and analyse the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.1 – 9.2.1.7**
	9.2.1.1 Compare and contrast the nature and properties of food
	9.2.1.2 Practice safety and hygiene procedures in tool and equipment, food handling, meal preparation and food development
	9.2.1.3 Examine the nutritional components of food and food development and the impact of food consumption on nutrition.
	9.2.1.4 Explore nutrition as integral to making food choices
	9.2.1.5 Discuss economic, social and technological influences of food, food product and food sciences
	9.2.1.6 Explore ways of meeting nutritional requirements to maintain optimum nutrition or manage nutritional issues
	9.2.1.7 Apply the design process to create food items using combinations of basic ingredients with variations using a selection of techniques and food preparation equipment
STRAND 2: FOOD TECHNOLOGY	
UNIT 2: FOOD SCIENCE	
CS 2.2 Students will be able to investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (e.g., health, occasions, lifestyle, business)	**9.2.2.1 – 9.2.2.6**
	9.2.2.1 Identify and describe the cultural, physical, biological and nutritional characteristics of food that influence food development
	9.2.2.2 Describe the nutritional and sensory characteristics of food to meet the needs, health and occasions.
	9.2.2.3 Apply management strategies in food selection, meal preparation, product development, storage and preservation
	9.2.2.4 Explore safety and hygiene practices relating to food, and changes that occur in the functional properties of food.
	9.2.2.5 Examine the social, economic and environmental impact of food processing technology, and the role packaging plays in the distribution of food from the point of production to consumption
	9.2.2.6 Apply the design process to create food solutions.
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 1: BUILDING TECHNOLOGY	
CS 3.1 Investigate the history and theory of buildings and	**9.3.1.1 – 9.3.1.6**
	9.3.1.1 Investigate the history and theory of buildings

analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.	**9.3.1.2** Identify and describe a variety of construction materials, components, and processes
	9.3.1.3 Describe the elements of drawings, and their application in technical drawings.
	9.3.1.4 Identify and describe the elements of safety
	9.3.1.5 Describe the scope and purpose of building codes, and identify other regulations and standards that apply to construction projects
	9.3.1.6 Apply mathematical skills and scientific concepts in the planning and building of a variety of construction projects
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 2: ELECTRICAL TECHNOLOGY	
CS 3.2 Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	**9.3.2.1 – 9.3.2.7**
	9.3.2.1 Describe the historical development of electricity
	9.3.2.2 Investigate and communicate OHS legislation and regulation and assess and employ emergency procedures whilst observing safety
	9.3.2.3 Identify, design, develop and evaluate processes and products related to electrical technology and communicate the findings through the use of appropriate electrical and electronic terminology.
	9.3.2.4 Define electricity and conductivity and differentiate insulators from conductors
	9.3.2.5 Identify symbols used and explain the functions of components and devices in electrical circuit diagrams
	9.3.2.6 Identify the different types of circuits and explain the parts and operation of a simple practical circuit.
	9.3.2.7 Investigate the concepts, principles and practices related to electrical
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 3: PLUMBING TECHNOLOGY	
CS 3.3 Investigate and analyse fundamental concepts of plumbing and theories, OHS, Occupational Health and safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in (DWV) Drain, waste, vent system, and water distribution system.	**9.3.3.1 – 9.3.3.4**
	9.3.3.1 Describe and explain the fundamentals, concepts, and their relevance in the plumbing trade
	9.3.3.2 Analyse and describe OHS Regulations and standards in the plumbing trade and work places.
	9.3.3.3 Demonstrate and apply basic plumbing tools and equipment and their specifications and practice in trade math.
	9.3.3.4 Explore and apply basic concepts of trade drawings in plumbing.
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 4: WELDING TECHNOLOGY	
CS 3.4 Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing	**9.3.4.1 – 9.3.4.5**
	9.3.4.1 Investigate safe workshop setup and safety procedures in welding
	9.3.4.2 Explore and interpret welding principles, codes and standards
	9.3.4.3 Demonstrate knowledge in fundamental print reading, measurement and layout or fi t-up techniques
	9.3.4.4 Investigate and analyse the properties of metals

principles and apply fundamentals of fabrication.	**9.3.4.5** Investigate the various welding techniques and cutting processes
STRAND 3: CONSTRUCTION TECHNOLOGY	
UNIT 5: ENGINEERING TECHNOLOGY	
CS 3.5 Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.	**9.3.5.1 – 9.3.5.7**
	9.3.5.1 Describe how history and society has influenced the engineering field and critically analyse innovations.
	9.3.5.2 Investigate the scope of engineering, roles and responsibilities of an engineer and recognise current innovations
	9.3.5.3 Explore and distinguish the different types of the Engineering fields.
	9.3.5.4 Explore and discuss engineering principles and practices and the appropriate materials in engineering.
	9.3.5.5 Explore and analyse the general safety practices in engineering.
	9.3.5.6 Outline management and problem solving skills using the engineering design process.
	9.3.5.7. Explore and utilise communication practices appropriate to engineering.
STRAND 4: COMMUNICATION TECHNOLOGY	
UNIT 1: DATA COMMUNICATION AND NETWORK	
CS 4.1 Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.1 – 9.4.1.7**
	9.4.1.1 Define the elements of data communication system.
	9.4.1.2 Describe the functions of the different components of a computer network.
	9.4.1.3 Define the OSI (Open Systems Interconnect) model and how it functions.
	9.4.1.4 Explore the use of technical terminology, basic scientific concepts, and mathematical concepts used in communications technology and apply them to the creation of media products.
	9.4.1.5 Explore and articulate the core concepts, techniques, and skills required to produce a range of communications media products or services.
	9.4.1.6 Research and apply the design brief to design, configure and manage simple network.
	9.4.1.7 Explore the Authoring Software or Multimedia associate software
STRAND 4: COMMUNICATION TECHNOLOGY	
UNIT 2: COMPUTER SECURITY AND SAFETY	
CS 4.2 Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both hardware, software and information security in society.	**9.4.2.1 – 9.4.2.5**
	9.4.2.1 Investigate and demonstrate appropriate posture in using computer equipment
	9.4.2.2 Identify health hazards associated with the use of ICT and propose good ergonomic practices
	9.4.2.3 Identify effects of the widespread use of computers and associated technologies on society
	9.4.2.4 Evaluate the impact of past, current and emerging technologies on the Individual, society and environments.
	9.4.2.5 Demonstrate an understanding of and apply safe work practices in communications technology activities
STRAND 5: COMPUTER TECHNOLOGY	

UNIT 1: COMPUTER ARCHITECTURE	
CS 5.1 Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	**9.5.1.1 – 9.5.1.6**
	9.5.1.1 Comprehend and explain the Computer System and types of computer.
	9.5.1.2 Explore generations of computer
	9.5.1.3 Investigate and describe the design brief of solving problems.
	9.5.1.4 Identify and describe the functions of, as well as important advances related to, electronic and computer components;
	9.5.1.5 Demonstrate a basic understanding of binary numbers and digital logic
	9.5.1.6 Explore and describe hardware and software troubleshooting principles
STRAND 5: COMPUTER TECHNOLOGY	
UNIT 2: COMPUTER SOFTWARE	
CS 5.2 Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.	**9.5.2.1 – 9.5.2.5**
	9.5.2.1 Explore programming software and applications
	9.5.2.2 Demonstrate the understanding of Operating Systems/ Software and File Management
	9.5.2.3 Apply typing skills with speed (20wpm) and accuracy (80%)
	9.5.2.4 Create documents using Microsoft Office
	9.5.2.5 Explore the Authoring Software or Multimedia associate software

Grade 9 Technology and Industrial Arts Content Standards, Benchmarks and Topics Overview as per the Strands and Units

STRAND 1: FOOD TECHNOLOGY UNIT 1: FIBRES AND FABRICS		
Content Standard	**Benchmark**	**Topic**
CS1.1 Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.	**9.1.1.1** Compare and contrast social, economic, cultural and technological changes to textiles, fashion and clothing	Impact of changes on textiles, fashion and clothing
	9.1.1.2 Distinguish the properties and characteristics of fibres and fabrics	Introduction to fibres and fabrics
	9.1.1.3 Explore the elements of design and the design and construction of fashion ideas	Designing and Construction
	9.1.1.4 Describe the functions of tools and equipment and their safe usage	Functions and safe usage of tools and equipment
	9.1.1.5 Explore the range of textile construction techniques	Techniques in textile construction
	9.1.1.6 Apply appropriate safety practices in fashion design and construction	Safety practices in fashion designing and construction
STRAND 1: TEXTILE TECHNOLOGY **UNIT 2: TEXTILE AND CLOTHING**		
Content Standard	**Benchmark**	**Topic**
CS1.2 Integrate and apply principles and techniques in	**9.1.2.1** Describe historical influences, technological progression and emerging trends as inspirational sources of design	Sources of Design

presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions	**9.1.2.2**. Demonstrate an awareness of the fundamentals of the design process through various artistic versions	Fundamentals of design process
	9.1.2.3 Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects	Tools and techniques in project designs
	9.1.2.4 Describe how the properties of textile fibres affect textile wear and care	Textiles wear and care
	9.1.2.5 Apply the design process to respond to needs and opportunities in textile design projects	Designing a textile project
	9.1.2.6 Select and use appropriate technology to creatively document, communicate and present design and project work	Documenting a project portfolio
STRAND 2: FOOD TECHNOLOGY **UNIT 1: FOOD AND NUTRITION**		
Content Standard	**Benchmark**	**Topic**
CS 2.1 Students will be able to examine and analyse the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.1** Compare and contrast the nature and properties of food	Nature and properties of food
	9.2.1.2 Practice safety and hygiene procedures in tool and equipment, food handling, meal preparation and food development	Safety and hygienic practices in food product development
	9.2.1.3 Examine the nutritional components of food and food development and the impact of food consumption on nutrition.	Food and nutrients
	9.2.1.4 Explore nutrition as integral to making food choices	Food metabolism
	9.2.1.5 Discuss economic, social and technological influences of food, food product and food sciences	Influences on food product development
	9.2.1.6 Explore ways of meeting nutritional requirements to maintain optimum nutrition or manage nutritional issues	Food composition and energy metabolism
	9.2.1.7 Apply the design process to create food items using combinations of basic ingredients with variations using a selection of techniques and food preparation equipment	Food product development
STRAND 2: FOOD TECHNOLOGY **UNIT 2: FOOD SCIENCE**		
Content Standard	**Benchmark**	**Topic**
CS 2.2 Students will be able to investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of	**9.2.2.1 – 9.2.2.6**	
	9.2.2.1 Identify and describe the cultural, physical, biological and nutritional characteristics of food that influence food development	Characteristics and properties of cereals, vegetables, fruits, legumes, fats and oils
	9.2.2.2 Describe the nutritional and sensory characteristics of food to meet the needs, health and occasions.	Sensory characteristics of food

food and how they influence the development and production of food to meet different demands (e.g., health, occasions, lifestyle, business)	**9.2.2.3** Apply management strategies in food selection, meal preparation, product development, storage and preservation	Food management
	9.2.2.4 Explore safety and hygiene practices relating to food, and changes that occur in the functional properties of food.	Food safety and hygienic practices
	9.2.2.5 Examine the social, economic and environmental impact of food processing technology, and the role packaging plays in the distribution of food from the point of production to consumption	Factors influencing food processing and packaging
	9.2.2.6 Apply the design process to create food solutions	The technology design
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 1: BUILDING TECHNOLOGY**		
Content Standard	**Benchmark**	**Topic**
CS 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.	**9.3.1.1** Investigate the history and theory of buildings	The history and theory of buildings
	9.3.1.2 Identify and describe a variety of construction materials, components, and processes	Building construction materials
	9.3.1.3 Describe the elements of drawings, and their application in technical drawings.	Trade drawing
	9.3.1.4 Identify and describe the elements of safety	The Elements Occupational Health and Safety
	9.3.1.5 Describe the scope and purpose of building codes, and identify other regulations and standards that apply to construction projects	Building Codes, Standards and regulations
	9.3.1.6 Apply mathematical skills and scientific concepts in the planning and building of a variety of construction projects	Trade Maths
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 2: ELECTRICAL TECHNOLOGY**		
Content Standard	**Benchmark**	**Topic**
CS 3.2 Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as	**9.3.2.1 – 9.3.2.7**	
	9.3.2.1 Describe the historical development of electricity	History of Electricity
	9.3.2.2 Investigate and communicate OHS legislation and regulation and assess and employ emergency procedures whilst observing safety	Workplace and Electrical safety
	9.3.2.3 Identify, design, develop and evaluate processes and products related to electrical technology and communicate the findings through the use of appropriate electrical and electronic terminology.	Electrical or Electronic processes and products
	9.3.2.4 Define electricity and conductivity	Fundamentals of electricity

a tool for change, improving the quality of life responsive to individual, community and industrial needs.	and differentiate insulators from conductors	
	9.3.2.5 Identify symbols used and explain the functions of components and devices in electrical circuit diagrams	Components and devices used on circuit diagrams
	9.3.2.6 Identify the different types of circuits and explain the parts and operation of a simple practical circuit.	Circuits
	9.3.2.7 Investigate the concepts, principles and practices related to electrical	Electrical Fundamentals

STRAND 3: CONSTRUCTION TECHNOLOGY
UNIT 3: PLUMBING TECHNOLOGY

Content Standard	Benchmark	Topic
CS 3.3 Investigate and analyse fundamental concepts of plumbing and theories, OHS, Occupational Health and safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in (DWV) Drain, waste, vent system, and water distribution system.	**9.3.3.1 – 9.3.3.4**	
	9.3.3.1 Describe and explain the fundamentals, concepts, and their relevance in the plumbing trade	Fundamental concept and relevance of plumbing trade
	9.3.3.2 Analyse and describe OHS Regulations and standards in the plumbing trade and work places.	Topic 2: Occupational Health and Safety regulations and standard
	9.3.3.3 Demonstrate and apply basic plumbing tools and equipment and their specifications and practice in trade math.	Plumbing tool and equipment
	9.3.3.4 Explore and apply basic concepts of trade drawings in plumbing.	Trade Drawing

STRAND 3: CONSTRUCTION TECHNOLOGY
UNIT 4: WELDING TECHNOLOGY

Content Standard	Benchmark	Topic
CS 3.4 Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.	**9.3.4.1 – 9.3.4.5**	
	9.3.4.1 Investigate safe workshop setup and safety procedures in welding	Workshop Organisation
	9.3.4.2 Explore and interpret welding principles, codes and standards	Welding Standards
	9.3.4.3 Demonstrate knowledge in fundamental print reading, measurement and layout or fi t-up techniques	Measurement Techniques
	9.3.4.4 Investigate and analyse the properties of metals	Metals
	9.3.4.5 Investigate the various welding techniques and cutting processes	Cutting and Welding

STRAND 3: CONSTRUCTION TECHNOLOGY
UNIT 5: ENGINEERING TECHNOLOGY

Content Standard	Benchmark	Topic
CS 3.5 Investigate and analyse the historical and societal influences in	**9.3.5.1 – 9.3.5.7**	
	9.3.5.1 Describe how history and society has influenced the engineering field and critically analyse innovations.	Historical aspects of Engineering Design Process

Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.	**9.3.5.2** Investigate the scope of engineering, roles and responsibilities of an engineer and recognise current innovations	Introduction to Engineerin
	9.3.5.3 Explore and distinguish the different types of the Engineering fields.	Engineering Fields
	9.3.5.4 Explore and discuss engineering principles and practices and the appropriate materials in engineering.	Engineering Principles an practices
	9.3.5.5 Explore and analyse the general safety practices in engineering.	Occupational Health & safety
	9.3.5.6 Outline management and problem solving skills using the engineering design process.	Engineering Design Process
	9.3.5.7. Explore and utilise communication practices appropriate to engineering.	Engineering Communication
STRAND 4: COMMUNICATION TECHNOLOGY **UNIT 1: DATA COMMUNICATION AND NETWORK**		
Content Standard	**Benchmark**	**Topic**
CS 4.1 Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.1** Define the elements of data communication system.	Data Communication Systems
	9.4.1.2 Describe the functions of the different components of a computer network.	Computer Networks
	9.4.1.3 Define the OSI (Open Systems Interconnect) model and how it functions.	OSI Model
	9.4.1.4 Explore the use of technical terminology, basic scientific concepts, and mathematical concepts used in communications technology and apply them to the creation of media products.	Communication Technolo Terminologies Basic Scientific and Mathematical Concepts in creating media products
	9.4.1.5 Explore and articulate the core concepts, techniques, and skills required to produce a range of communications media products or services.	Media Communication
	9.4.1.6 Research and apply the design brief to design, configure and manage simple network.	Design Brief-Simple Network
	9.4.1.7 Explore the Authoring Software or Multimedia associate software	Authoring Software Multimedia
STRAND 4: COMMUNICATION TECHNOLOGY **UNIT 2: COMPUTER SECURITY AND SAFETY**		
Content Standard	**Benchmark**	**Topic**
CS 4.2 Investigate and analyse the ergonomics, social and ethical issues and the development of a	**9.4.2.1 – 9.4.2.6**	**9.4.2.1 – 9.4.2.6**
	9.4.2.1 Investigate and demonstrate appropriate posture in using computer equipment	Postures in Computer Equipment Usag
	9.4.2.2 Identify health hazards associated with the use of ICT and propose good ergonomic practices	Health and Safety in ICT

monitoring and control system for both hardware, software and information security in society.	**9.4.2.3** Identify effects of the widespread use of computers and associated technologies on society	Effects of Computer Usage
	9.4.2.4 Evaluate the impact of past, current and emerging technologies on the Individual, society and environments.	Emerging Technological Impact
	9.4.2.5 Demonstrate an understanding of and apply safe work practices in communications technology activities	Safe Working Practices/Habits
STRAND 5: COMPUTER TECHNOLOGY **UNIT 1: COMPUTER ARCHITECTURE**		
Content Standard	**Benchmark**	**Topic**
CS 5.1 Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	**9.5.1.1** Comprehend and explain the Computer System and types of computer.	Computer System
	9.5.1.2 Explore generations of computer	History of Computers
	9.5.1.3 Investigate and describe the design brief of solving problems.	Design Brief
	9.5.1.4 Identify and describe the functions of, as well as important advances related to, electronic and computer components;	Computer Electronics
	9.5.1.5 Demonstrate a basic understanding of binary numbers and digital logic	Binary
	9.5.1.6 Explore and describe hardware and software troubleshooting principles	Troubleshooting
STRAND 5 COMPUTER TECHNOLOGY **UNIT 2: COMPUTER SOFTWARE**		
Content Standard	**Benchmark**	**Topic**
CS 5.2 Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.	**9.5.2.1** Explore programming software and applications	Software Programming
	9.5.2.2 Demonstrate the understanding of Operating Systems/ Software and File Management	Operating System
	9.5.2.3 Apply typing skills with speed (20wpm) and accuracy (80%)	Keyboarding
	9.5.2.4 Create documents using Microsoft Office	Microsoft Office
	9.5.2.5 Explore the Authoring Software or Multimedia associate software	Authoring Software/ Multimedia

Grade 9 Technology and Industrial Arts Topics and Lesson Titles as per Strands and Units

The strand, Units and Benchmarks are further unpacked into Topics and Lesson Titles in the Teacher Guides. These are outlined in the table below:

STRAND 1: TEXTILE TECHNOLOGY **UNIT 1: FIBRES AND FABRICS**	
Topics	**Lesson Titles**
Benchmarks	**9.1.1.1 – 9.1.1.6**
Topic 1: Impact of changes on textiles, fashion and clothing	**Lesson 1**: Exploring Textiles? **Lesson 2:** Origins of textiles, fashion and clothing **Lesson3:** Factors affecting changes in textile, fashions and clothing
Topic2: Introduction to fibres and fabrics	**Lesson 1:** What are fibres and fabrics? **Lesson 2:** Characteristics and properties of fibres and fabrics **Lesson 3:** From fibres to fabrics.
Topic 3: Designing and Construction	**Lesson 1:** Elements of design and design types. **Lesson 2:** Sources of fashion ideas. **Lesson 3:** Basic construction processes.
Topic 4: Functions and safe usage of tools and equipment	**Lesson 1:** Textile Construction methods tools and their functions. **Lesson 2:** Safety when using textile tools and equipment. **Lesson 3:** Care and maintenance of textile products.
Topic 5: Techniques in textile construction	**Lesson 1:** Textile construction methods **Lesson 2:** Colouring and decorating methods **Lesson 3:** Fabric finishes
Topic 6: Safety practices in fashion designing and construction	**Lesson 1:** Differentiating between textile designing and construction processes **Lesson 2:** Safety practices in textile.
STRAND 1: TEXTILE TECHNOLOGY **UNIT 2: TEXTILE AND CLOTHING**	
Benchmarks	**9.1.2.1 – 9.1.2.6**
Topic 1: Sources of Design	**Lesson 1:** Sources of design **Lesson 2:** Technological progression **Lesson 3:** Emerging trends
Topic 2: Fundamentals of design process	**Lesson 1:** Importance of design process **Lesson 2:** Skills in the design process **Lesson 3:** Various artistic version
Topic 3: Tools and techniques in project designs	**Lesson 1:** Fashion and types of garments **Lesson 2:** Transferring patterns from garment to garment **Lesson 3:** Patterning techniques
Topic 4: Textiles wear and care	**Lesson** Types of tools for textile projects **Lesson** Safe uses of special tools **Lesson** Care for tools
Topic 5: Designing a textile project	**Lesson** What is design process **Lesson** Phases in Textile Project development **Lesson** Textile Projects
Topic 6 Documenting a project portfolio	**Lesson** People and textile industry **Lesson** Textile technology equipment **Lesson** Textile Project exhibit
STRAND 2: FOOD TECHNOLOGY **UNIT 1: FOOD AND NUTRITION**	

Benchmarks	**9.2.1.1 – 9.2.1.7**
Topic 1: Nature and properties of food	**Lesson 1:** Introduction to food –(Nature and sources of food) **Lesson 2:** Food groups and dietary guidelines **Lesson 3:** Properties of starch, carbohydrates, fats and oil **Lesson 4:** Introduction to food product development
Topic 2: Safety and hygienic practices in food product development	**Lesson 1:** Personal hygiene and safety practices **Lesson 2:** Kitchen hygiene **Lesson 3:** Hygiene practices and safety in food development (preparation etc.)
Topic 3: Food and nutrients	**Lesson 1:** Functions of nutrients and food sources **Lesson 2:** Eating practices **Lesson 3:** Meal planning
Topic 4: Food metabolism	**Lesson 1:** Digestion and absorption of food **Lesson 2:** Functions of food and nutrients in human body **Lesson 3:** Over nutrition and malnutrition (anorexia, bulimia, obesity, hypertension etc.)
Topic 5: Influences on food product development	**Lesson 1:** Food ingredients **Lesson 2:** Principles of cooking methods **Lesson 3:** Food management **Lesson 4:** Economic, Social and technological influences on food product development
Topic 6: Food composition and energy metabolism	**Lesson 1:** Food composition **Lesson 2:** Food labelling **Lesson 3:** Energy metabolism **Lesson 4:** Meals for special needs
Topic 7: Food product development	**Lesson 1:** Introduction to food product development **Lesson 2:** Design process **Lesson 3:** Design Brief **Lesson 4:** Sensory analysis
STRAND 2: FOOD TECHNOLOGY **UNIT 2: FOOD SCEINECE**	
Benchmarks	**9.2.2.1 – 9.2.2.6**
Topic 1: Characteristics and properties of cereals, vegetables, fruits, legumes, fats and oils	**Lesson 1** Cooking methods in food product development **Lesson 2** Physical and biological properties of cereals, vegetables and fruits **Lesson 3** Physical and biological properties of fruits, legumes, fats and oils
Topic 2: Sensory characteristics of food	**Lesson 1** Sensory analyses of food **Lesson 2** Nutritional functions of food **Lesson 3** Functional foods
Topic 3: Food management	**Lesson 1** Food management **Lesson 2** Trends, fashion and food **Lesson 3** Seasons and food
Topic 4: Food safety and hygienic practices	**Lesson 1** Food borne diseases **Lesson 2** Contamination **Lesson 3** First Aid

Topic 5: Factors influencing food processing and packaging	**Lesson 1** Factors that influence food processing **Lesson 2** The role of food packaging **Lesson 3** Developments in packaging and distribution **Lesson 4** Techniques to evaluate products and processes
Topic 6: The technology design	**Lesson 1** Design brief and the technological process **Lesson 3** Evaluate the new product **Lesson 2** Using a design product to create a new product
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 1: BUILDING TECHNOLOGY**	
Benchmarks	**9.3.1.1 – 9.3.1.6**
Topic 1: The history and theory of buildings	**Lesson 1:** Introduction to Building **Lesson 2:** Definition of Building **Lesson 3:** Different Types of Building **Lesson 4:** Types of material used **Lesson 5:** Importance of building and career paths.
Topic 2: Building construction materials	**Lesson 1:** Define Building materials **Lesson 2:** Timber Building Materials **Lesson 3:** Bricks and Concrete materials **Lesson 4:** Metal and steel materials
Topic 3: Trade drawing	**Lesson 1:** Define trade drawing **Lesson 2:** Types of trade drawing **Lesson 3:** Isometric drawing **Lesson 4:** Pictorial drawing **Lesson 5:** Orthographic drawing **Lesson 6:** Types of lines use
Topic 4: The Elements Occupational Health and Safety	**Lesson 1:** Define occupational Health and safety **Lesson 2:** The regulations of OHS **Lesson 3:** The standards of OHS
Topic 5: Building Codes, Standards and regulations	**Lesson 1:** Define Building legislations and regulations **Lesson 2:** Types of building codes **Lesson 3:** Types of building regulations
Topic 6: Trade Maths	**Lesson 1:** Define Applied maths **Lesson 2:** Formulae to calculate substructure **Lesson 3:** Define sub- structure member (footings, post, bearers) **Lesson 4:** Define super -structure members (Floor joist, studs, roofing frame) **Lesson 5:** Types of building defect
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 2: ELECTRICAL TECHNOLOGY**	
Benchmarks	**9.3.2.1 – 9.3.2.7**
Topic 1: History of Electricity	**Lesson 1:** Electrical Energy Production & Supply **Lesson 2:** Modern Power Generation methods **Lesson 3:** Renewable and sustainable energy practices.
Topic 2: Workplace and Electrical safety	**Lesson 1:** Electrical Energy Production & Supply **Lesson 2:** Renewable and sustainable energy practices. **Lesson 3:** Career Pathway in Electrical Technology
Topic 3: Electrical or Electronic processes and products	**Lesson 1:** OHS legislation & Regulation **Lesson 2:** Personal Safety **Lesson 3:** Emergency procedures.
Topic 4: Fundamentals of	**Lesson 1:** Electrical or Electronic processes

electricity	**Lesson 2:** Electrical or Electronic products
Topic 5: Components and devices used on circuit diagrams	**Lesson 1:** Electricity **Lesson 2:** Conductivity **Lesson 3**: Conductors and Insulators
Topic 6: Circuits	**Lesson 1**: Electrical components & devices **Lesson 2:** Electrical symbols used in circuit diagrams
Topic 7: Electrical Fundamentals	**Lesson 1:** OHMs LAW **Lesson 2**: Kirchhoff's Law **Lesson 3:** Circuit Calculations
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 3: PLUMBING TECHNOLOGY**	
Benchmarks	**9.3.3.1 – 9.3.3.4**
Topic 1: Fundamental concept and relevance of plumbing trade	**Lesson 1:** Introduction to plumbing trade. **Lesson 2:** Importance of plumbing trade. **Lesson 3:** Career pathways of plumbing trade.
Topic 2: Occupational Health and Safety regulations and standard	**Lesson 1:** Define Occupational Health Safety regulations and standards. **Lesson 2:** Types of regulations and standards.
Topic 3: Plumbing tool and equipment	**Lesson 1:** Define plumbing tools and equipment. **Lesson 2:** Types of manual tools and equipment. **Lesson 3:** Types of plumbing materials and specifications.
Topic 4: Trade Drawing	**Lesson 1:** Define trade drawing. **Lesson 2:** Methods of Isometric drawing. **Lesson 3:** Methods of Pictorial drawing. **Lesson4:** Types of lines used.
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 4: WELDING TECHNOLOGY**	
Benchmarks	**9.3.4.1 – 9.3.4.5**
Topic 1: Workshop Organisation	**Lesson 1:** Workshop Set-up **Lesson 2:** Workshop safety procedures
Topic 2: Welding Standards	**Lesson 1:** Welding Principles **Lesson 2:** Welding Codes **Lesson 3:** Welding Standards
Topic 3: Measurement Techniques	**Lesson 1:** Measurement **Lesson 2:** Print reading **Lesson 3:** Layout/ fit-up Techniques
Topic 4: Metals	**Lesson 1:** Types of metals **Lesson 2:** Metal Properties
Topic 5: Cutting and Welding	**Lesson 1:** Types of Welding **Lesson 2:** Thermal cutting, heating and gouging **Lesson 3:** Brazing **Lesson 4:** Welding processes
STRAND 3: CONSTRUCTION TECHNOLOGY **UNIT 5: ENGINEERING TECHNOLOGY**	
Benchmarks	**9.3.5.1 – 9.3.5.7**
Topic 1: Historical aspects of Engineering Design Process	**Lesson 1:** Engineering, past, present & Future **Lesson 2:** Engineering Innovations **Lesson 3:** Influence of Engineering in the society.
Topic 2: Introduction to Engineering	**Lesson 1:** Introduction to Engineering **Lesson 2:** Scope of Engineering **Lesson 3:** Roles and responsibilities of Engineers
Topic 3: Engineering Fields	**Lesson 1:** Types of engineering fields **Lesson 2:** Specific terminologies for the different types of engineering. **Lesson 3:** Processes of manufacturing materials in various engineering discipline

Topic 4: Engineering Principles and practices	**Lesson 1:** Engineering principles **Lesson 2:** Engineering practices **Lesson 3:** Engineering materials
Topic 5: Occupational Health & safety	**Lesson 1:** OHS legislations and regulations for Engineers **Lesson 2:** Hazards & Risk Control Measures **Lesson 3:** Risk Assessment & Management **Lesson 4:** Basic First –Aid and CPR
Topic 6: Engineering Design Process	**Lesson 1:** Steps of Engineering Design **Lesson 2:** Management skills **Lesson 3:** Problem-solving skills
Topic 7: Engineering Communication	**Lesson 1:** Effective communication **Lesson 2:** Interpersonal and intrapersonal communication skills **Lesson 3:** Telephones, emails, directories **Lesson 4:** Report writing, **Lesson 5:** Memorandums **Lesson 6:** Incident reports
STRAND 4: COMMUNICATION TECHNOLOGY **UNIT 1: DATA COMMUNICATION AND NETWORK**	
Benchmarks	**9.4.1.1 – 9.4.1.7**
Topic 1: Data Communication Systems	**Lesson 1:** Introduction to Data Communication Systems **Lesson 2:** Elements of Data Communication systems
Topic 2: Computer Networks	**Lesson 1:** Introduction to Computer Networks **Lesson 2:** Functions of Computer Network Components
Topic 3: OSI Model	**Lesson 1:** Introduction OSI Model **Lesson 2:** Functions of the OSI Model
Topic 4: Communication Technology Terminologies Basic Scientific and Mathematical Concepts in creating media products	**Lesson 1:** Communication Technology Terminologies **Lesson 2:** Application of Terminologies **Lesson 3:** Media Products.
Topic 5: Media Communication	**Lesson 1:** Introduction to Media Communication **Lesson 2:** Techniques and Skills for application purposes
Topic 6: Design Brief-Simple Network	**Lesson 1:** Introduction to Design Brief **Lesson 2:** Research and apply Design **Lesson 3:** Brief in simple Networking
Topic 7: Authoring Software Multimedia	**Lesson 1:** Introduction to Multimedia, Authoring Software **Lesson 2:** Categories of Authoring Software **Lesson 3:** Features of Multimedia, Authoring Software
STRAND 4: COMMUNICATION TECHNOLOGY **UNIT 2: COMPUTER SECURITY AND SAFETY**	
Benchmarks	**9.4.2.1 – 9.4.2.6**
Topic 1: Postures in Computer Equipment Usage	**Lesson 1:** Introduction to Ergonomics **Lesson 2:** Correct Posture or Positions **Lesson 3:** Case Study - Posture
Topic 2: Health and Safety in ICT	**Lesson 1:** Types Health Hazards associated with use of ICT **Lesson 2:** Good ergonomics practices to minimise Health hazards associated in ICT usage
Topic 3: Effects of Computer Usage	**Lesson 1:** Introduction to computer technology **Lesson 2:** Effects of Computer Technology Usage on society
Topic 4: Emerging Technological Impact	**Lesson 1:** The evolution of emerging technologies **Lesson 2:** Impact of emerging technologies on society and environment **Lesson 3:** Case-Study (Music)

Topic 5: Safe Working Practices/ Habits	**Lesson 1:** Introduction to Work Place Safety **Lesson 2:** Safe Work Practices
STRAND 5: COMPUTER TECHNOLOGY **UNIT 1: COMPUTER ARCHITECTURE**	
Benchmarks	**9.5.1.1 – 9.5.1.5**
Topic 1: Computer System	**Lesson 1:** Information-Processing- Cycle **Lesson 2:** Computer Hardware and Software **Lesson 3:** Types of Computer
Topic 2: History of Computers	**Lesson 1:** History of Computers **Lesson 2:** Generation of Computers **Lesson 3:** Classification of Computers
Topic 3: Design Brief	**Lesson 1:** Introduction to Design Brief **Lesson 2:** Stage Design Brief **Lesson 3:** Case Study of Design Brief
Topic 4: Computer Electronics	**Lesson 1:** Fundamentals of Computer Electronics **Lesson 2:** Functions of computer electronic components
Topic 5: Binary	**Lesson 1:** Introduction to Binary Numbers **Lesson 2:** Binary Numbers **Lesson 3:** Digital Logic Circuitry
Topic 6: Troubleshooting	**Lesson 1:** Introduction to Computer Troubleshooting Lesson **Lesson 2:** Troubleshooting **Lesson 3:** Case Study of Troubleshooting
STRAND 5: COMPUTER TECHNOLOGY **UNIT 2: COMPUTER SOFTWARE**	
Benchmarks	**9.5.2.1 – 9.5.2.5**
Topic 1: Software Programming	**Lesson 1:** Introduction to Programming. **Lesson 2:** Types of Programming software and applications **Lesson 3:** Example of Software Programs and associated programming languages
Topic 2: Operating System	**Lesson 1:** Introduction to Operating System **Lesson 2:** Categories of Operating Systems Software **Lesson 3:** File Management
Topic 3: Keyboarding	**Lesson 1:** Introduction to Keyboard **Lesson 2:** Keyboard Techniques **Lesson 3:** Hands on Typing
Topic 4: Microsoft Office	**Lesson 1:** Introduction to Microsoft Word **Lesson 2:** Introduction to Microsoft Excel **Lesson 3:** Introduction to Microsoft PowerPoint/Publisher
Topic 5: Authoring Software/ Multimedia	See **Strand 4**, Benchmark **9.4.1.7**

Step 5: Expand and plot the distributed content into the complete 16 Week 3-Part Yearly Content Overview for the grade

The strand, Units and Benchmarks are further unpacked into Topics and Lesson Titles in the Teacher Guides.Because the Teacher Guide is not available now, the Grade 9 content overview has been adopted and expanded in this facilitators and in-service guide in the absence of the Grade 9 teacher guides to help you plan a Grade 9 Technology and industrial Art Teaching Program

- The Yearly Content Overview for the Technology and Industrial Arts is a 16 week 3-part Content Overview which is Yearly Content Overview for the Technology and Industrial Arts Subject. .
- It outlines the Strands, Units, Content Standards, Benchmarks, Topics and Lessons to be taught in 16 weeks for each part. Teachers have the option of outlining the their Yearly Content Overview in a template that can be easily read and understood by all who will be using the Yearly Overview to derive their Termly teaching programs. (a sample template is provided below)
- In the sample below, the Strands, Units, Content Standards, Benchmarks, Topics and Lesson Titles are distributed evenly across the 16 weeks for each part that must be programmed
- A sample is given below for your convenience to help you plan for your termly program.

GRADE 9 TEXTILE AND FOOD TECHNOLOGY YEARLY CONTENT OVERVIEW

Week	Textile Technology and Food Technology	Content Standard	Benchmark	Topic	Lesson Title
1	Textile Technology: Fibres and Fabrics: CS: 9.11 BMs: 9.1.1.1 and 9.1.1.2, 9.1.1.3,	**CS1.1** Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.	**9.1.1.1** Compare and contrast social, economic, cultural and technological changes to textiles, fashion and clothing	Impact of changes on textiles, fashion and clothing	**Lesson 1**: Exploring Textiles? **Lesson 2:** Origins of textiles, fashion and clothing **Lesson3:** Factors affecting changes in textile, fashions and clothing
			9.1.1.2 Distinguish the properties and characteristics of fibres and fabrics	Introduction to fibres and fabrics	**Lesson 1:** What are fibres and fabrics? **Lesson 2:** Characteristics and properties of fibres and fabrics **Lesson 3:** From fibres to fabrics.
			9.1.1.3 Explore the elements of design and the design and construction of fashion ideas	Designing and Construction	**Lesson 1:** Elements of design and design types. **Lesson 2:** Sources of fashion ideas. **Lesson 3:** Basic construction processes
2	Textile Technology: Fibres and Fabrics: CS: 9.11 BMs: 9.1.1.4, 9.1.1.5, 9.1.1.6	**CS1.1** Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.	**9.1.1.4** Describe the functions of tools and equipment and their safe usage	Functions and safe usage of tools and equipment	**Lesson 1:** Textile Construction methods tools and their functions. **Lesson 2:** Safety when using textile tools and equipment. **Lesson 3:** Care and maintenance of textile products.
			9.1.1.5 Explore the range of textile construction techniques	Techniques in textile construction	**Lesson 1:** Textile construction methods **Lesson 2:** Colouring and decorating methods **Lesson 3:** Fabric finishes
			9.1.1.6 Apply appropriate safety practices in fashion design and construction	Safety practices in fashion designing and	**Lesson 1:** Differentiating between textile designing and construction processes **Lesson 2:** Safety practices

				construction	in textile.
3	Textile Technology: Textile and Clothing: CS: 9.1.2 BMs:9.1.2.1, 9.1.2.2,	**CS1.2** Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions	**9.1.2.1** Describe historical influences, technological progression and emerging trends as inspirational sources of design	Sources of Design	**Lesson 1:** Sources of design **Lesson 2:** Technological progression **Lesson 3:** Emerging trends
			9.1.2.2. Demonstrate an awareness of the fundamentals of the design process through various artistic versions	Fundamentals of design process	**Lesson 1:** Importance of design process **Lesson 2:** Skills in the design process **Lesson 3:** Various artistic version
4	Textile Technology: Textile and Clothing: CS: 9.1.2 BMs: 9.1.2.3, 9.1.2.4,	**CS1.2** Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions	**9.1.2.3** Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects	Tools and techniques in project designs	**Lesson 1:** Fashion and types of garments **Lesson 2:** Transferring patterns from garment to garment **Lesson 3:** Patterning techniques
			9.1.2.4 Describe how the properties of textile fibres affect textile wear and care	Textiles wear and care	**Lesson** Types of tools for textile projects **Lesson** Safe uses of special tools **Lesson** Care for tools
5	Textile Technology: Textile and Clothing: CS: 9.1.2 BMs: 9.1.2.5, 9.1.2.6,	**CS1.2** Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment	**9.1.2.5** Apply the design process to respond to needs and opportunities in textile design projects	Designing a textile project	**Lesson** What is design process **Lesson** Phases in Textile Project development **Lesson** Textile Projects
			9.1.2.6 Select and use appropriate technology to creatively	Documenting a project portfolio	**Lesson** People and textile industry **Lesson** Textile technology equipment

		construction for a variety of needs and occasions	document, communicate and present design and project work		**Lesson** Textile Project exhibit
6	Food Technology: Food and Nutrition: CS: 9.2.1 BMs: 9.2.1.1. 9.2.1.2	**CS 2.1** Students will be able to examine and analyse the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.1** Compare and contrast the nature and properties of food	Nature and properties of food	**Lesson 1:** Introduction to food –(Nature and sources of food) **Lesson 2:** Food groups and dietary guidelines **Lesson 3:** Properties of starch, carbohydrates, fats and oil **Lesson 4:** Introduction to food product development
			9.2.1.2 Practice safety and hygiene procedures in tool and equipment, food handling, meal preparation and food development	Safety and hygienic practices in food product development	**Lesson 1:** Personal hygiene and safety practices **Lesson 2:** Kitchen hygiene **Lesson 3:** Hygiene practices and safety in food development (preparation etc.)
7	Food Technology: Food and Nutrition: CS: 9.2.1 BMs: 9.2.1.3, 9.2.1.4	**CS 2.1** Students will be able to examine and analyse the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.3** Examine the nutritional components of food and food development and the impact of food consumption on nutrition.	Food and nutrients	**Lesson 1:** Functions of nutrients and food sources **Lesson 2:** Eating practices **Lesson 3:** Meal planning
			9.2.1.4 Explore nutrition as integral to making food choices	Food metabolism	**Lesson 1:** Digestion and absorption of food **Lesson 2:** Functions of food and nutrients in human body **Lesson 3:** Over nutrition and malnutrition (anorexia, bulimia, obesity, hypertension etc.)

8	Food Technology: Food and Nutrition: CS: 9.2.1 BMs: 9.2.1.5, 9.2.1.6,	**CS 2.1** Students will be able to examine and analyse the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.5** Discuss economic, social and technological influences of food, food product and food sciences	Influences on food product development	**Lesson 1:** Food ingredients **Lesson 2:** Principles of cooking methods **Lesson 3:** Food management **Lesson 4:** Economic, Social and technological influences on food product development
			9.2.1.6 Explore ways of meeting nutritional requirements to maintain optimum nutrition or manage nutritional issues	Food composition and energy metabolism	**Lesson 1:** Food composition **Lesson 2:** Food labelling **Lesson 3:** Energy metabolism **Lesson 4:** Meals for special needs
9	Food Technology: Food and Nutrition: CS: 9.2.1 BMs: 9.2.1.7	**CS 2.1** Students will be able to examine and analyse the characteristics and properties of difference types of food and the social, economic, political, cultural and technological influences on the production and compliance with ethical principles and standards	**9.2.1.7** Apply the design process to create food items using combinations of basic ingredients with variations using a selection of techniques and food preparation equipment	Food product development	**Lesson 1:** Introduction to food product development **Lesson 2:** Design process **Lesson 3:** Design Brief **Lesson 4:** Sensory analysis
10	Food Technology: Food Science:	**CS 2.2** Students will be able to investigate and analyse the cultural, physical,	**9.2.2.1** Identify and describe the cultural, physical, biological and nutritional characteristics of food that influence	Characteristics and properties of cereals, vegetables, fruits,	**Lesson 1** Cooking methods in food product development **Lesson 2** Physical and biological properties of cereals, vegetables and fruits

	CS: 9.2.2 BMs: 9.2.2.1, 9.2.2.2	chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (e.g., health, occasions,	food development	legumes, fats and oils	**Lesson 3** Physical and biological properties of fruits, legumes, fats and oils
			9.2.2.2 Describe the nutritional and sensory characteristics of food to meet the needs, health and occasions.	Sensory characteristics of food	**Lesson 1** Sensory analyses of food **Lesson 2** Nutritional functions of food **Lesson 3** Functional foods
11	Food Technology: Food Science: CS: 9.2.2 BMs: 9.2.2.3, 9.2.2.4,	**CS 2.2** Students will be able to investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (e.g., health, occasions,	**9.2.2.3** Apply management strategies in food selection, meal preparation, product development, storage and preservation	Food management	**Lesson 1** Food management **Lesson 2** Trends, fashion and food **Lesson 3** Seasons and food
			9.2.2.4 Explore safety and hygiene practices relating to food, and changes that occur in the functional properties of food	Food safety and hygienic practices	**Lesson 1** Food borne diseases **Lesson 2** Contamination **Lesson 3** First Aid
12	Food Technology: Food Science: CS: 9.2.1 BMs: 9.2.2.5	**CS 2.2** Students will be able to investigate and analyse the cultural, physical, chemical, nutritional, biological and	**9.2.2.5** Examine the social, economic and environmental impact of food processing technology, and the role packaging plays in the distribution of food	Factors influencing food processing and packaging	**Lesson 1** Factors that influence food processing **Lesson 2** The role of food packaging **Lesson 3** Developments in packaging and distribution **Lesson 4** Techniques to

	9.2.2.6	sensory characteristics of food and how they influence the development and production of food to meet different demands (e.g., health, occasions,	from the point of production to consumption		evaluate products and processes
			9.2.2.6 Apply the design process to create food solutions.	The technology design	**Lesson 1** Design brief and the technological process **Lesson 3** Evaluate the new product **Lesson 2** Using a design product to create a new product
13	Textile and Food Summative Assessment				

GRADE 9 CONSTRUCTION TECHNOLOGY YEARLY CONTENT OVERVIEW

Week	Construction Technology	Content Standard	Benchmark	Topic	Lesson Title
1	Building Technology CS: 9.3.1 BMS: 9.3.1.1. 9.3.1.2, 9.3.1.3,	**CS 3.1** Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.	**9.3.1.1** Investigate the history and theory of buildings	The history and theory of buildings	**Lesson 1:** Introduction to Building **Lesson 2:** Definition of Building **Lesson 3:** Different Types of Building **Lesson 4:** Types of material used **Lesson 5:** Importance of building and career paths.
			9.3.1.2 Identify and describe a variety of construction materials, components, and processes	Building construction materials	**Lesson 1:** Define Building materials **Lesson 2:** Timber Building Materials **Lesson 3:** Bricks and Concrete materials **Lesson 4:** Metal and steel materials
			9.3.1.3 Describe the elements of drawings, and their application in technical drawings.	Trade drawing	**Lesson 1:** Define trade drawing **Lesson 2:** Types of trade drawing **Lesson 3:** Isometric drawing **Lesson 4:** Pictorial drawing **Lesson 5:** Orthographic drawing **Lesson 6:** Types of lines use
2	Building	**CS 3.1** Investigate the	**9.3.1.4** Identify and describe the	The Elements Occupational	**Lesson 1:** Define occupational Health

	Technology CS: 9.3.1 BMs: 9.3.1.4, 9.3.1.5, 9.3.1.6,	history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.	elements of safety	Health and Safety	and safety **Lesson 2:** The regulations of OHS **Lesson 3:** The standards of OHS
			9.3.1.5 Describe the scope and purpose of building codes, and identify other regulations and standards that apply to construction projects	Building Codes, Standards and regulations	**Lesson 1:** Define Building legislations and regulations **Lesson 2:** Types of building codes **Lesson 3:** Types of building regulations
			9.3.1.6 Apply mathematical skills and scientific concepts in the planning and building of a variety of construction projects	Trade Maths	**Lesson 1:** Define Applied maths **Lesson 2:** Formulae to calculate substructure **Lesson 3:** Define sub-structure member (footings, post, bearers) **Lesson 4:** Define super -structure members (Floor joist, studs, roofing frame) **Lesson 5:** Types of building defect
3	Electrical Technology CS: 9.3.2 BMs: 9.3.2.1, 9.3.2.2, 9.3.2.3,	**CS 3.2** Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth,	**9.3.2.1** Describe the historical development of electricity	History of Electricity	**Lesson 1:** Electrical Energy Production & Supply **Lesson 2:** Modern Power Generation methods **Lesson 3:** Renewable and sustainable energy practices.
			9.3.2.2 Investigate and	Workplace and	**Lesson 1:** Electrical Energy Production &

		entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	communicate OHS legislation and regulation and assess and employ emergency procedures whilst observing safety	Electrical safety	Supply **Lesson 2:** Renewable and sustainable energy practices. **Lesson 3:** Career Pathway in Electrical Technology
			9.3.2.3 Identify, design, develop and evaluate processes and products related to electrical technology and communicate the findings through the use of appropriate electrical and electronic terminology.	Electrical or Electronic processes and products	**Lesson 1:** OHS legislation & Regulation **Lesson 2:** Personal Safety **Lesson 3:** Emergency procedures.
4	Electrical Technology CS: 9.3.2 BMs: 9.3.2.4, 9.3.2.5,	**CS 3.2** Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	**9.3.2.4** Define electricity and conductivity and differentiate insulators from conductors	Fundamentals of electricity	**Lesson 1:** Electrical or Electronic processes **Lesson 2:** Electrical or Electronic products
			9.3.2.5 Identify symbols used and explain the functions of components and devices in electrical circuit diagrams	Components and devices used on circuit diagrams	**Lesson 1:** Electricity **Lesson 2:** Conductivity **Lesson 3**: Conductors and Insulators
5	Electrical	**CS 3.2** Analyse and apply the	**9.3.2.6** Identify the different	Circuits	**Lesson 1**: Electrical components & devices

	Technology CS: 9.3.2 BMs: 9.3.2.6, 9.3.2.7	technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.	types of circuits and explain the parts and operation of a simple practical circuit.		**Lesson 2:** Electrical symbols used in circuit diagrams
			9.3.2.7 Investigate the concepts, principles and practices related to electrical	Electrical Fundamentals	**Lesson 1:** OHMs LAW **Lesson 2**: Kirchhoff's Law **Lesson 3:** Circuit Calculations
6	Plumbing Technology CS: 9.3.3 BMs: 9.3.3.1, 9.3.3.2	**CS 3.3** Investigate and analyse fundamental concepts of plumbing and theories, OHS, Occupational Health and safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in (DWV) Drain, waste, vent system, and water distribution system.	**9.3.3.1** Describe and explain the fundamentals, concepts, and their relevance in the plumbing trade	Fundamental concept and relevance of plumbing trade	**Lesson 1:** Introduction to plumbing trade. **Lesson 2:** Importance of plumbing trade. **Lesson 3:** Career pathways of plumbing trade.
			9.3.3.2 Analyse and describe OHS Regulations and standards in the plumbing trade and work places.	Topic 2: Occupational Health and Safety regulations and standard	**Lesson 1:** Define Occupational Health Safety regulations and standards. **Lesson 2:** Types of regulations and standards.

7	Plumbing Technology CS: 9.3.3 BMs: 9.3.3.3, 9.3.3.4,	**CS 3.3** Investigate and analyse fundamental concepts of plumbing and theories, OHS, Occupational Health and safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in (DWV) Drain, waste, vent system, and water distribution system.	**9.3.3.3** Demonstrate and apply basic plumbing tools and equipment and their specifications and practice in trade math.	Plumbing tool and equipment	**Lesson 1:** Define plumbing tools and equipment. **Lesson 2:** Types of manual tools and equipment. **Lesson 3:** Types of plumbing materials and specifications.
			9.3.3.4 Explore and apply basic concepts of trade drawings in plumbing.	Trade Drawing	**Lesson 1:** Define trade drawing. **Lesson 2:** Methods of Isometric drawing. **Lesson 3:** Methods of Pictorial drawing. **Lesson4:** Types of lines used.
8	Welding Technology CS: 9.3.4 BMs: 9.3.4.1, 9.3.4.2,	**CS 3.4** Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.	**9.3.4.1** Investigate safe workshop setup and safety procedures in welding	Workshop Organisation	**Lesson 1:** Workshop Set-up **Lesson 2:** Workshop safety procedures
			9.3.4.2 Explore and interpret welding principles, codes and standards	Welding Standards	**Lesson 1:** Welding Principles **Lesson 2:** Welding Codes **Lesson 3:** Welding Standards

9	Welding Technology CS: 9.3.4 BMs: 9.3.4.3, 9.3.4.4, 9.3.4.5	**CS 3.4** Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication.	**9.3.4.3** Demonstrate knowledge in fundamental print reading, measurement and layout or fi t-up techniques	Measurement Techniques	**Lesson 1:** Measurement **Lesson 2:** Print reading **Lesson 3:** Layout/ fit-up Techniques
			9.3.4.4 Investigate and analyse the properties of metals	Metals	**Lesson 1:** Types of metals **Lesson 2:** Metal Properties
			9.3.4.5 Investigate the various welding techniques and cutting processes	Cutting and Welding	**Lesson 1:** Types of Welding **Lesson 2:** Thermal cutting, heating and gouging **Lesson 3:** Brazing **Lesson 4:** Welding processes
10	Engineering Technology CS: 9.3.5 BMs: 9.3.5.1, 9.3.5.2,	**CS 3.5** Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.	**9.3.5.1** Describe how history and society has influenced the engineering field and critically analyse innovations.	Historical aspects of Engineering Design Process	**Lesson 1:** Engineering, past, present & Future **Lesson 2:** Engineering Innovations **Lesson 3:** Influence of Engineering in the society.
			9.3.5.2 Investigate the scope of engineering, roles and responsibilities of an engineer and recognise current innovations	Introduction to Engineering	**Lesson 1:** Introduction to Engineering **Lesson 2:** Scope of Engineering **Lesson 3:** Roles and responsibilities of Engineers
11	Engineering	**CS 3.5**	**9.3.5.3** Explore	Engineering	**Lesson 1:** Types of

	Technology CS: 9.3.5 BMs: 9.3.5.3, 9.3.5.4,	Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.	and distinguish the different types of the Engineering fields.	Fields	engineering fields **Lesson 2:** Specific terminologies for the different types of engineering. **Lesson 3:** Processes of manufacturing materials in various engineering discipline
			9.3.5.4 Explore and discuss engineering principles and practices and the appropriate materials in engineering.	Engineering Principles and practices	**Lesson 1:** Engineering principles **Lesson 2:** Engineering practices **Lesson 3:** Engineering materials
12	Engineering Technology CS: 9.3.5 BMs: 9.3.5.5, 9.3.5.6, 9.3.5.7	**CS 3.5** Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.	**9.3.5.5** Explore and analyse the general safety practices in engineering.	Occupational Health & safety	**Lesson 1:** OHS legislations and regulations for Engineers **Lesson 2:** Hazards & Risk Control Measures **Lesson 3:** Risk Assessment & Management **Lesson 4:** Basic First –Aid and CPR
			9.3.5.6 Outline management and problem solving skills using the engineering design process.	Engineering Design Process	**Lesson 1:** Steps of Engineering Design **Lesson 2:** Management skills **Lesson 3:** Problem-solving skills
			9.3.5.7. Explore and utilise communication practices appropriate to engineering.	Engineering Communication	**Lesson 1:** Effective communication **Lesson 2:** Interpersonal and intrapersonal communication skills **Lesson 3:** Telephones, emails, directories **Lesson 4:** Report writing, **Lesson 5:**
					Memorandums **Lesson 6:** Incident reports
13	**SUMMATIVE ASSESSMENT**				

GRADE 9 COMMUNICATION AND COMPUTER TECHNOLOGY YEARLY CONTENT OVERVIEW

Week	Communication and Computer Technology	Content Standard	Benchmark	Topic	Lesson Title
1	Communication Technology Data Communication and Network CS: 9.4.2 BMs: 9.4.1.1, 9.4.1.2, ,	**CS 4.1** Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.1** Define the elements of data communication system.	Data Communication Systems	**Lesson 1:** Introduction to Data Communication Systems **Lesson 2:** Elements of Data Communication systems
			9.4.1.2 Describe the functions of the different components of a computer network.	Computer Networks	**Lesson 1:** Introduction to Computer Networks **Lesson 2:** Functions of Computer Network Components
2	Communication Technology Data Communication and Network CS: 9.4.1 BMs: 9.4.1.3, 9.4.1.4,	**CS 4.1** Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.3** Define the OSI (Open Systems Interconnect) model and how it functions.	OSI Model	**Lesson 1:** Introduction OSI Model **Lesson 2:** Functions of the OSI Model
			9.4.1.4 Explore the use of technical terminology, basic scientific concepts,and mathematical concepts used in communications technology and apply them to the creation of media	Communication Technology Terminologies Basic Scientific and Mathematical Concepts in creating media products	**Lesson 1:** Communication Technology Terminologies **Lesson 2:** Application of Terminologies **Lesson 3:** Media Products.

			products.		
3	Communication Technology Data Communication and Network CS: 9.4.1 BMs: 9.1.4 .5, 9.1.4 .6, 9.1.4 .7	**CS 4.1** Investigate and analyse communication technology utilising multimedia and the practices and systems in designing, installing, configuring and managing networks.	**9.4.1.5** Explore and articulate the core concepts, techniques, and skills required to produce a range of communications media products or services.	Media Communication	**Lesson 1:** Introduction to Media Communication **Lesson 2:** Techniques and Skills for application purposes
			9.4.1.6 Research and apply the design brief to design, configure and manage simple network.	Design Brief-Simple Network	**Lesson 1:** Introduction to Design Brief **Lesson 2:** Research and apply Design **Lesson 3:** Brief in simple Networking
			9.4.1.7 Explore the Authoring Software or Multimedia associate software	Authoring Software Multimedia	**Lesson 1:** Introduction to Multimedia, Authoring Software **Lesson 2:** Categories of Authoring Software **Lesson 3:** Features of Multimedia, Authoring Software
4	Communication Technology Computer Security and Safety CS: 9.4.2 BMs: 9.4.2.1, 9.4.2.2,	**CS 4.2** Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both	**9.4.2.1** Investigate and demonstrate appropriate posture in using computer equipment	Postures in Computer Equipment Usage	**Lesson 1:** Introduction to Ergonomics **Lesson 2:** Correct Posture or Positions **Lesson 3:** Case Study - Posture
			9.4.2.2 Identify health hazards associated with	Health and Safety in ICT	**Lesson 1:** Types Health Hazards associated with

		hardware, software and information security in society.	the use of ICT and propose good ergonomic practices		use of ICT **Lesson 2:** Good ergonomics practices to minimise Health hazards associated in ICT usage
5	Communication Technology Computer Security and Safety CS: 9.4.2 BMs: 9.4.2.3, 9.4.2.4,	**CS 4.2** Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both hardware, software and information security in society	**9.4.2.3** Identify effects of the widespread use of computers and associated technologies on society	Effects of Computer Usage	**Lesson 1:** Introduction to computer technology **Lesson 2:** Effects of Computer Technology Usage on society
			9.4.2.4 Evaluate the impact of past, current and emerging technologies on the Individual, society and environments.	Emerging Technological Impact	**Lesson 1:** The evolution of emerging technologies **Lesson 2:** Impact of emerging technologies on society and environment **Lesson 3:** Case-Study (Music)
6	Communication Technology Computer Security and Safety CS: 9.4.2 BMs: 9.4.2.5,	**CS 4.2** Investigate and analyse the ergonomics, social and ethical issues and the development of a monitoring and control system for both hardware, software and information security in society	**9.4.2.5** Demonstrate an understanding of and apply safe work practices in communication s technology activities	Safe Working Practices/Habits	**Lesson 1:** Introduction to Work Place Safety **Lesson 2:** Safe Work Practices
7	Computer Technology Computer Architecture	**CS 5.1** Explore and analyse computer fundamentals, the skills to manage and	**9.5.1.1** Comprehend and explain the Computer System and types of	Computer System	**Lesson 1:** Information-Processing- Cycle **Lesson 2:** Computer Hardware and Software **Lesson 3:** Types of

	CS: 9.5.1 BMs: 9.5.1.1, 9.5.1.2	maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	computer.		Computer
			9.5.1.2 Explore generations of computer	History of Computers	**Lesson 1:** History of Computers **Lesson 2:** Generation of Computers **Lesson 3:** Classification of Computers
8	Computer Technology Computer Architecture CS: 9.5.1 BMs: 9.5.1.3, 9.5.1.4	**CS 5.1** Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose, troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	**9.5.1.3** Investigate and describe the design brief of solving problems.	Design Brief	**Lesson 1:** Introduction to Design Brief **Lesson 2:** Stage Design Brief **Lesson 3:** Case Study of Design Brief
			9.5.1.4 Identify and describe the functions of, as well as important advances related to, electronic and computer components;	Computer Electronics	**Lesson 1:** Fundamentals of Computer Electronics **Lesson 2:** Functions of computer electronic components
9	Computer Technology Computer Architecture CS: 9.5.1	**CS 5.1** Explore and analyse computer fundamentals, the skills to manage and maintain; diagnose,	**9.5.1.5** Demonstrate a basic understanding of binary numbers and digital logic	Binary	**Lesson 1:** Introduction to Binary Numbers **Lesson 2:** Binary Numbers **Lesson 3:** Digital Logic Circuitry

	BMs: 9.5.1.5, 9.5.1.6	troubleshoot and solve issues that encompass computer systems, networking, interfacing and programming as well as electronics and robotics and be aware of related environmental and societal issues.	**9.5.1.6** Explore and describe hardware and software troubleshooting principles	Troubleshooting	**Lesson 1:** Introduction to Computer Troubleshooting Lesson **Lesson 2:** Troubleshooting **Lesson 3:** Case Study of Troubleshooting
10	Computer Technology Computer Software CS: 9.5.2 BMs: 9.5.2.1, 9.5.2.2	**CS 5.2** Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.	**9.5.2.1** Explore programming software and applications	Software Programming	**Lesson 1:** Introduction to Programming. **Lesson 2:** Types of Programming software and applications **Lesson 3:** Example of Software Programs and associated programming languages
			9.5.2.2 Demonstrate the understanding of Operating Systems/ Software and File Management	Operating System	**Lesson 1:** Introduction to Operating System **Lesson 2:** Categories of Operating Systems Software **Lesson 3:** File Management
11	Computer Technology Computer Software CS: 9.5.2 BMs: 9.5.2.3, 9.5.2.4	**CS 5.2** Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various	**9.5.2.3** Apply typing skills with speed (20wpm) and accuracy (80%)	Keyboarding	
			9.5.2.4 Create documents using Microsoft Office	Microsoft Office	**Lesson 1:** Introduction to Keyboard **Lesson 2:** Keyboard Techniques **Lesson 3:** Hands on Typing

		software.			
12	Computer Technology Computer Software CS: 9.5.2 BMs: 9.5.2.5,	**CS 5.2** Investigate and analyse computer system and application software, programming, algorithm, web design and databases, and develop and apply the skills and knowledge in the various software.	**9.5.2.5** Explore the Authoring Software or Multimedia associate software	Authoring Software/ Multimedia	**Lesson 1:** Introduction to Microsoft Word **Lesson 2:** Introduction to Microsoft Excel **Lesson 3:** Introduction to Microsoft PowerPoint/Publisher
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Step 6: Develop the Termly Programs

- Extract the terms content from the Yearly Overview to expand the content into the termly teaching program.
- Note that the TIA program is developed in 3-parts and 1 of the 3 parts is the program to be used all year around for the different lots of students rotating to take all 5 strand s of TIA. Below is a proposed Template to develop a Teaching Program for a Term.(13 weeks)

Subject: _____Grade _____Term:____ Year: _____

Week	**Content Standards**	**Bench mark**	**Unit**	**Topic**	**Learning Objective**	**Knowledge**	**Skill**	**Attitude / Values**	**Performance Standard**
Write the week number	Write the Coding only	Write the Coding only	Write the Unit number and Name	Write the Topic number and Name	By the end of this Topic, Students will be able to: Write the learning Objectives for the Topic	Write the essential knowledge to be learnt in this topic	Write the essential skill to be learnt in this topic	Write the essential attitude and values to be learnt in this topic	By the end of this Topic, students will be able to; Write the Performance Standard (if the Benchmark carries one)

Note: A Performance Standard will only be included if the Benchmark has been nominated to carry

a Performance Standard (Assessment). Otherwise, it is not very necessary for all Benchmarks to have a Performance Standard.

Step 7: Develop the Weekly Teaching Program (Proposed Template) and Daily Lesson Plan (SBC Template)

Template 1: Using Topics to develop Weekly Teaching Program

- You can use the Topics to develop the weekly teaching program
- Below is a proposed Template to develop a Teaching Program for a week

Subject: _____ Grade: ____ Term:_____ Week: ____ Date: _____Year: _____

CS	BM	Unit	Topic	Learning Objective	Knowledge	Skill	Attitude / Values	Suggested Learning Activities	Performance Standard
Write the Coding only	Write the Coding only	Write the Unit number and Name	Write the Topic number and Name	By the end of this Topic, Students will be able to: Write the learning Objectives for the Topic	Write the essential knowledge to be learnt in this topic	Write the essential skill to be learnt in this topic	Write the essential attitude and values to be learnt in this topic	List down the learning activities that will be done in this topic	By the end of this Topic, students will be able to; Write the Performance Standard (only if the Benchmark carries a performance standard)

Template 2: Using Lesson Titles to develop Weekly Teaching Program

- Use the unpacking process to derive lesson titles and lesson objectives to be able to expand your weekly teaching program.
- Below is a proposed Template to develop a Teaching Program for a week

Subject: _____ Grade: ____ Term:_____ Week: ____ Date: _____Year: _____

CS	BM	Unit	Topic	Learning Objective	Knowledge	Skill	Attitude/ Values	Performance Standard	Lesson Number and Titles	Lesson Objectives	Suggested Learning Activities
Write the Coding only	Write the Coding only	Write the Unit number and Name	Write the Topic number and Name	By the end of this Topic, Students will be able to: Write the learning Objectives for the Topic	Write the essential knowledge to be learnt in this topic	Write the essential skill to be learnt in this topic	Write the essential attitude and values to be learnt in this topic	By the end of this Topic, students will be able to; Write the Performance Standard (if the Benchmark carries one)	Lesson 1:	L1 Objectives	
									Lesson 2:	L2 Objectives	
									Lesson 3: Etc.	L3 Objectives	

Timetabling of Technology and Industrial Arts

The teaching and learning of TIA can be organised in the manner of class rotational basis. There are three teachers who will be teaching the subject TIA.

1: The Home Economics Teacher,
2: The Practical Skills Teacher, and
3. The Math /Science/Computing Teacher.

These three teachers will be timetabled to teach TIA during the term. Then the planning and programming will be organised in this same manner only each strand teacher will extract the strand program for teaching as these are subject specific content. This is to ensure that teachers are on contact throughout the terms and to maintain their teaching loads.

Sample 1st Rotational Program for the First 13 Weeks (Term1 Week 1-10 and Term 2 Week 1-2)

Class	Strand	Content Teacher	
Class 1 and Class 2	Food and Textile Technology	Home Economics Teacher	These classes can be rotated so they all cover all the strands of TIA
Class 3 and 4	Construction Technology	Practical Skills Teacher	
Class 5 and Strand 6	Communication and Computer Technology	Computing ICT Teacher	

Sample 2nd Rotational Program for the Next 13 Weeks (Term 2 Week 4 – Term 3 Week 6)

Class	Strand	Content Teacher	
Class 1 and 2	Construction Technology	Practical Skills	These classes can be rotated so they all cover all the strands of TIA
Class 3 and 4	Communication and Computer Technology	Computing ICT Teacher	
Class 5 and 6	Food and Textile Technology	Home Economics Teacher	

Sample 3rd Rotational Program for the Next 13 Weeks (Term 3 Week 7 – Term 4 Week 9)

Class	Strand	Content Teacher	
Class 1 and 2	Communication and Computer Technology Food and Textile Technology	Home Economics	These classes can be rotated so they all cover all the strands of TIA
Class 3 and 4	Food and Textile Technology	Home Economics Teacher	
Class 5 and 6	Construction Technology	Practical Skills	

Step 8: Review, Evaluate and Re-plan the yearly, termly, weekly Programs.

This Process MUST BE DONE COLLABORATIVELY BY ALL WHO TEACH THE SUBJECT.

IT MUST BE DONE PROGRESSIVELY

Type of Programming: Sequential Programming

Sample

The second type of programming is the Sequential Programming. This is done when the school has limited teachers to teach the subject TIA and cannot teach using the rotational teaching plan. Therefore, all TIA Classes will be learning the same strand at the same time. The Construction Technology strand has been used to show you how a strand is programmed for the term.

Stand: Construction Technology	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Benchmarks	6	7	4	5	7

1. Calculate the total number of Benchmarks for the strand.
2. Divide the total number of Benchmarks by the number of weeks in the term.

3. Distribute the number of benchmarks throughout the weeks.
4. For Construction Technology Grade 9, the total number of Benchmarks is 29 and will be divided by 10 weeks of a term.
   Note that Units will overlap the 3 Benchmarks per week plan.

Term 1	Strand: Construction Technology	Benchmark
Week 1	Uni1 1 Building Technology	9.3.1.1- 9.3.1.3
Week 2		9.3.1.4- 9.3.1.6
Week 3	Unit 2 Electrical Technology	9.3.2.1-9.3.2.3
Week 4		9.3.2.4- 9.3.2.6
Week 5	Unit 3 Plumbing Technology	9.3.2.7, 9.3.3.1 - 9.3.3.2
Week 6		9.3.3.3 - 9.3.3.4
Week 7	Unit 4 Welding Technology	9.3.4.1-9.3.4.3
Week 8		9.3.4.4 – 9.3.4.5, 9.3.5.1
Week 9	Unit 5 Engineering Technology	9.3.5.2 – 9.3.5.4
Week 10		9.3.5.5 – 9.3.5.7

Sample 2 Integration Programming

The Integration programming involves the teaching of the TIA Strands simultaneously within a term. All the benchmarks (BM) are distributed by weeks. In grade 9 there are 77 Benchmarks for all the strands.

1. Collect the total number of Benchmarks for the grade.
2. Divide the total number of Benchmarks by the number of terms.
3. Distribute the 20 Benchmarks to the 4 terms, indicate the Units by the weeks as they are programmed.

Grade 9 Technology and Industrial Arts Content

	Food Technology	Textiles Technology	Construction Technology	Communication Technology	Computer Technology
Unit 1	6	7	6	7	6
Unit 2	6	6	7	5	5
Unit 3			4		
Unit 4			4		
Unit 5			7		
Total no of Benchmarks	12	13	29	12	11
	77				

Example

		Term One	Term Two	Term Three	Term Four
Week	**Strand**	**Units /Benchmarks**	**Units /Benchmarks**	**Units /Benchmarks**	**Units /Benchmarks**
1	1. Food	**Unit 1**	**Unit 1**	**Unit 2**	Unit

	Technology	BM 9.1.1.1 BM 9.1.1.2	BM 9.1.1.5 BM 9.1.1.6	BM 9.1.2.3 BM 9.1.2.4	
2	2. Textiles Technology	**Unit 1** BM 9.2.1.1 BM 9.2.1.2	**Unit 1** BM 9.2.1.5 BM 9.2.1.6	**Unit 2** BM 9.2.2.2 BM 9.2.2.3	**Unit 2** BM 9.2.2.6
3	3. Construction Technology	**Unit 1** BM 9.3.1.1 BM 9.3.1.2	**Unit 1** BM 9.3.1.5 BM 9.3.1.6	**Unit 2** BM 9.3.2.3 BM 9.3.2.4	**Unit 2** BM 9.3.2.7 Unit 3 BM 9.3.3.1
4	4. Communication Technology	**Unit 1** BM 9.4.1.1 BM 9.4.1.2	**Unit 1** BM 9.4.1.5 BM 9.4.1.6	**Unit 2** BM 9.4.2.2 BM 9.4.2.3	Unit
5	5. Computer Technology	**Unit 1** BM 9.5.1.1 BM 9.5.1.2	**Unit 1** BM 9.5.1.5 BM 9.5.1.6	**Unit 2** BM 9.5.2.3 BM 9.5.2.4	Unit
6	1. Food Technology	**Unit 1** BM 9.1.1.3 BM 9.1.1.4	**Unit 2** BM 9.1.2.1 BM 9.1.2.2	**Unit 2** BM 9.1.2.5 BM 9.1.2.6	Unit
7	2. Textiles Technology	**Unit 1** BM 9.2.1.3 BM 9.2.1.4	**Unit 1** BM 9.2.1.7 Unit 2 BM 9.2.2.1	**Unit 2** BM 9.2.2.4 BM 9.2.2.5	Unit
8	3. Construction Technology	**Unit 1** BM 9.3.1.3 BM 9.3.1.4	**Unit 2** BM 9.3.1.5 BM 9.3.1.6	**Unit 2** BM 9.3.2.5 BM 9.3.2.6	Unit
9	4. Communication Technology	**Unit 1** BM 9.4.1.3 BM 9.4.1.4	**Unit 1** BM 9.4.1.7 **Unit 2** BM 9.4.2.1	**Unit 2** BM 9.4.2.4 BM 9.4.2.5	Unit
10	5. Computer Technology	**Unit 1** BM 9.5.1.3 BM 9.5.1.4	**Unit 2** BM 9.5.2.1 BM 9.5.2.2	**Unit 2** BM 9.5.2.5 BM	Unit

Fact: When using the integration programming the strands; Food Technology, Textiles Technology, Communication Technology and Computer Technology contents will have been completed by Term 3 and Term 4 week 2. The remaining 8 weeks must be used to complete the Construction Technology Units 3, 4 and 5 (16 Benchmarks) and Projects for the other strands that needed completion. In doing so the TIA content is covered, thus, completing the content in the required time allocation and qualifying for TIA certification.

Standards-Based Lesson Planning

What are Standards-Based Lessons?

In a Standards-Based Lesson, the most important or key distinction is that, a student is expected to meet a defined standard for proficiency. When planning a lesson, the teacher ensures that the content and the methods of teaching the content enable students to learn both the skills and the concepts defined in the standard for that grade level and to demonstrate evidence of their learning.

Planning lessons that are built on standards and creating aligned assessments that measure student progress towards standards is the first step teacher must take to help their students reach success. A lesson plan is a step-by-step guide that provides a structure for an essential learning.

When planning a standards-based lesson, teacher instructions are very crucial for your lessons. How teachers instruct the students is what really points out an innovative teacher to an ordinary teacher. Teachers must engage and prepare motivating instructional activities that will provide the students with opportunities to demonstrate the benchmarks. For instance, teachers should at least identify 3-5 teaching strategies in a lesson; teacher lectures, ask questions, put students into groups for discussion and role play what was discussed.

Why is Standards-Based Lesson Planning Important?

There are many important benefits of having a clear and organised set of lesson plans. Good planning allows for more effective teaching and learning. The lesson plan is a guide and map for organising the materials and the teacher for the purpose of helping the students achieve the standards. Lesson plans also provide a record that allows good, reflective teachers to go back, analyse their own teaching (what went well, what didn't), and then improve on it in the future.

Standards-based lesson planning is vital because the content standards and benchmarks must be comparable, rigorous, and measurable and of course evidence based and be applicable in real life that we expect students to achieve. Therefore, teachers must plan effective lessons to teach students to meet these standards. As schools implement new standards, there will be much more evidence that teachers will use to support student learning to help them reach the highest levels of cognitive complexity. That is, students will be developing high-level cognitive skills.

Components of a Standards-Based Lesson Plan

An effective lesson plan has three basic components;

- aims and objectives of the course;
- teaching and learning activities;
- assessments to check student understanding of the topic.

Effective teaching demonstrates deep subject knowledge, including key concepts, current and relevant research, methodologies, tools and techniques, and meaningful applications.

Planning for under-achievers

Who are underachieving students?

Under achievers are students who fail or do not perform as expected. Underachievement may be caused by emotions (low self-esteem) and the environment (cultural influences, unsupportive family)

How can we help underachievement?

Underachievement varies between students. Not all students are in the same category of underachievement.

Given below a suggested strategies teachers may adopt to assist underachievers in the classroom.

- Examine the Problem Individually

It is important that underachieving students are addressed individually by focusing on the student's strengths.

- Create a Teacher-Parent Collaboration

Teachers and parents need to work together and pool their information and experience regarding the child. Teachers and parents begin by asking questions such as;

  - In what areas has the child shown exceptional ability?
  - What is the child's preferred learning styles?
  - What insights do parents and teachers have about the child's strengths and problem areas?

- Help student to plan every activity in the classroom

- Help students set realistic expectations
- Encourage and promote the student's interests and passions.
- Help children set short and long-term academic goals
- Talk with them about possible goals.
- Ensure that all students are challenged (but not frustrated) by classroom activities
- Always reinforce students

To help teachers plan effective lessons, there are sample lessons provided here. Teachers are encouraged to study the layout of the different components of these lessons and follow this design in their preparation and teaching of each lesson. Planning a good lesson helps the teacher in maintaining a standard teaching pattern and does not let the class deviate from the topic.

Sample of Standards-Based Lesson Planning

The following sample lesson can help teachers to plan effective lessons. Teachers are encouraged to study the layout of the different components of these lessons and follow this design in their preparation and teaching of each lesson. Planning a good lesson helps the teacher in maintaining a standard teaching pattern which should not deviate students' learning of the concept from the topic.

Strand: Construction Technology

Unit: Building Technology

Content Standards: Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark:10.3.1.1 Describe and analyse components of building and woodwork materials and processes in those material are used.

Topic: The components of building and wood work

Lesson 1: Building Components

Lesson Objective: Students should be able to;

1. Study building structures and identify the components of building and appreciate how each functions in building construction.

Essential Knowledge, Skills, Values Attitudes

Knowledge	Skills	Values	Attitudes
The components of building and woodwork	Describe each of the components of building and woodwork and relate to building construction	Consideration and respect of structures and construction	respectful

Teaching Strategies

- Students engage in brainstorming exercise to discover the components of building structures and woodwork.
- They then are allowed to design guiding questions that will enable them to conduct research on the components of building and woodwork.
- Discussions in groups on the research findings and facilitate students' research findings as a class discussion.

Learning Strategies

Activity 1 Brainstorming activity on the development of electricity and its advancement. Design guiding questions for their research.
Activity 2 Conduct research on components of building structures and woodwork.
Activity 3 Discussions and presentation of research findings on the components of building structures and woodwork..

Teacher **Teaching Strategies**	Students **Learning Strategies**
Introduction	
Introduces the topic and engage students in brainstorming activity by bringing students attention to an actual building structure.	Students engage in brainstorming exercise to define woodwork component They then are allowed to design guiding questions that will enable them to conduct research on definition of woodwork component Discussions in groups on the research findings of Definition of woodwork component
Body	
Lesson Body	***Modelling***
Activity 1 Brainstorming activity on how to design guiding questions for their research on definition of woodwork component	Do brainstorming activity
Lesson Body	***Guided Practice***
Activity 2 Conduct research on woodwork component and process of cabinet making	Conduct research
Lesson Body	***Independent Practice***

Activity 3 Discussions and presentation of research findings of woodwork components and process of cabinet making	Focus discussions on the assigned questions and prepare presentation. Group presentation of the findings
Conclusion	
Conclude lesson with main concepts being explained on the board	Take lesson notes
Assessment	
Assess the research and the presentation activities	Complete assessment task.

Resources

Textbooks
Handouts
Charts for Presentation

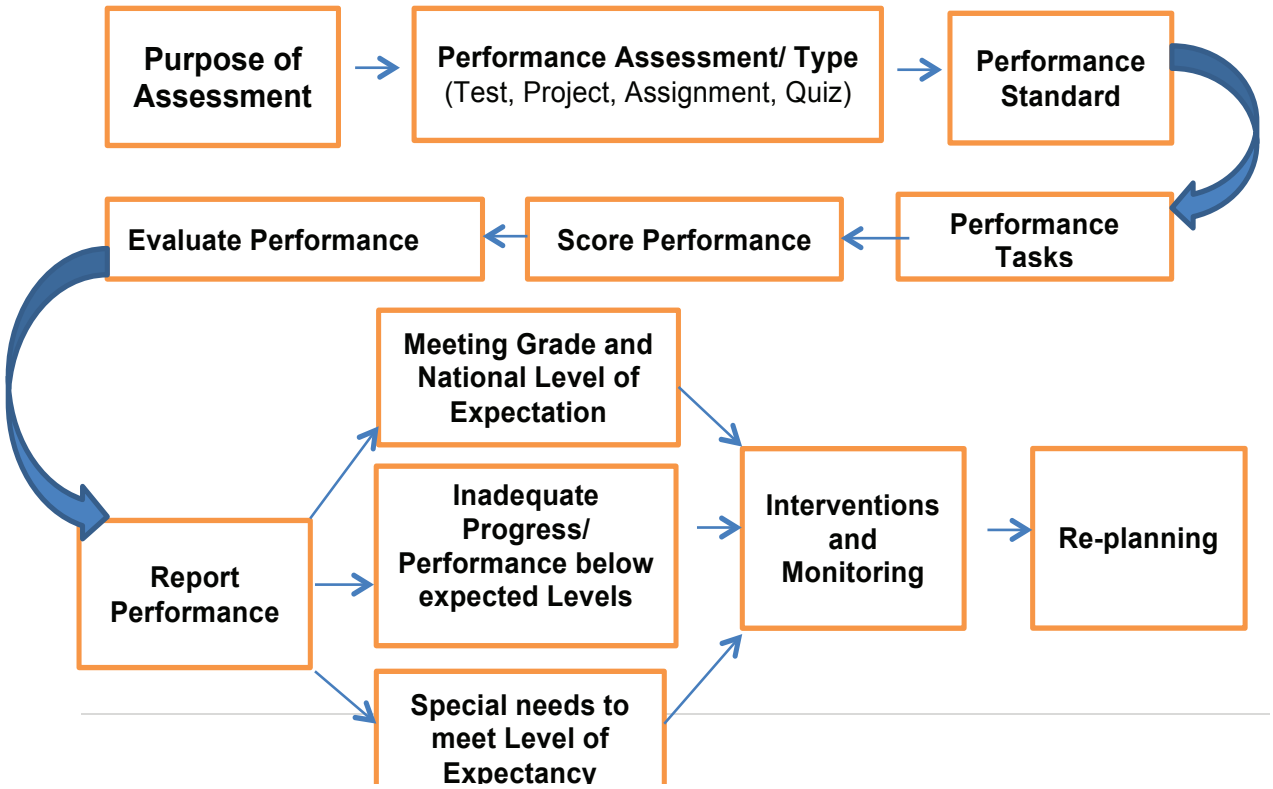
Assessment, Monitoring and Reporting

What is Standards-Based Assessment (SBA)?

Standards-Based Assessment is an on-going and a systematic process of **assessing**, **evaluating, reporting** and **monitoring** students' performance and progression towards meeting grade and national level expectations. It is the measurement of students' proficiency on a learning objective of a content standard and progression towards the attainment of that content standard and benchmark.

Standards-Based Assessment Cycle

The Standards-Based Assessment Cycle begins with the purpose to assess learning. Teachers must always clearly define the purpose and expectations of the assessment tasks or activities before starting the assessment. The cycle consist the delivery of the assessment, scoring of performance, monitoring or learning, evaluating learning and performance, reporting of achievement and underachievement, developing interventions for underachievers and advance learners and replanning assessment as demonstrated below;



Purpose of Standards-Based Assessment

Standards-Based Assessment (SBA) serves different purposes. These include instruction and learning purposes. The primary purpose of SBA is to improve student learning so that all students can attain the expected level of proficiency or quality of learning.

Enabling purposes of SBA is to:

- measure students' proficiency on well-defined content standards, benchmarks and learning objectives.
- ascertain students' attainment or progress towards the attainment of specific component of a content standard.
- ascertain what each student knows and can do and what each student needs to learn to reach the expected level of proficiency.
- enable teachers to make informed decisions and plans about how and what they would do to assist weak students to make adequate progress towards meeting the expected level of proficiency.
- enable students to know what they can do and help them to develop and implement strategies to improve their learning and proficiency level.
- communicate to parents, guardians, and relevant stakeholders the performance and progress towards the attainment of content standards or its components.
- compare students' performances and the performances of other students.

Principles of Standards-Based Assessment

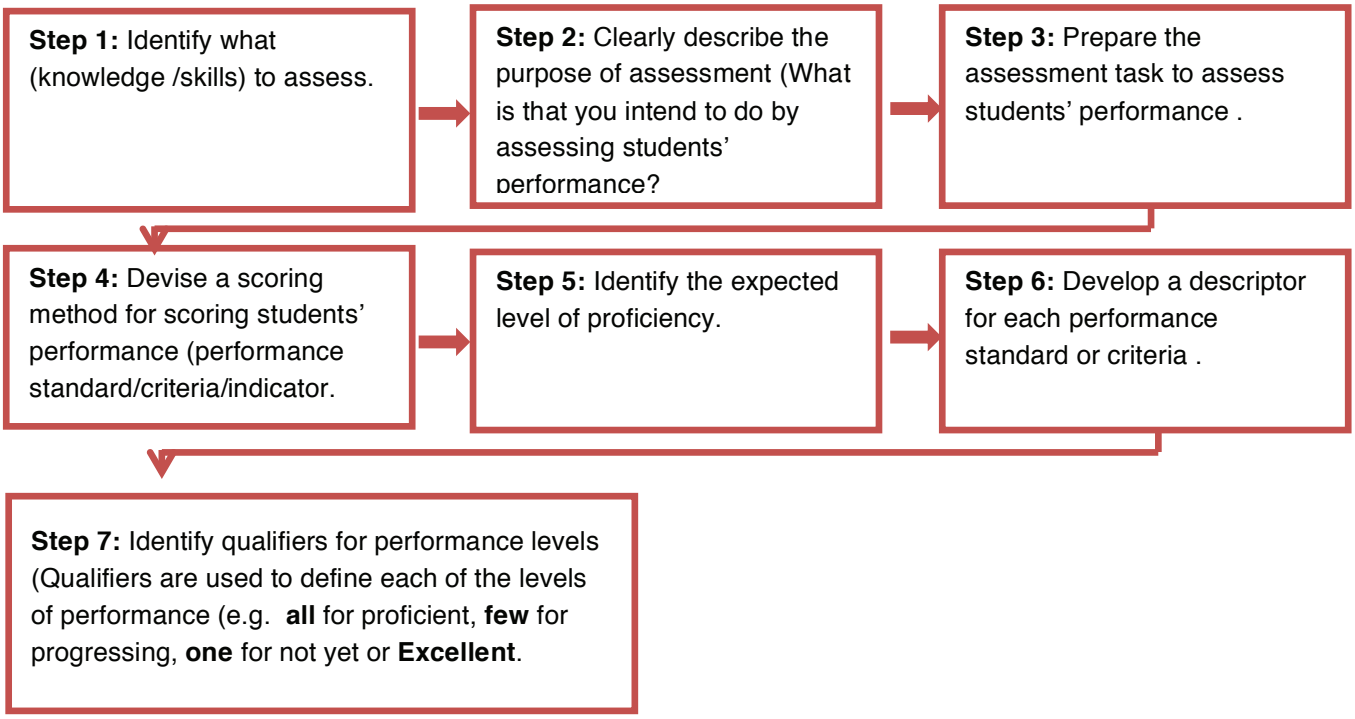
The principle of SBA is for assessment to be;

- emphasing on tasks that should encourage deeper learning,
- be an integral component of a course, unit or topic and not something to add on afterwards,
- a good assessment requires clarity of purpose, goals, standards and criteria,
- of practices that should use a range of measures allowing students to demonstrate what they know and can do,
- based on an understanding of how students learn,

- of practices that promote deeper understanding of learning processes by developing students' capacity for self-assessment,
- improving performance that involves feedback and reflection,
- on-going rather than episodic,
- given the required attention to outcomes and processes,
- be closely aligned and linked to learning objectives, benchmarks and content standards.

Standards-Based Assessment Process

Teachers are required to use the steps outlined below when planning assessment. These steps will guide you to develop effective assessments to improve student's learning as well as evaluating their progress towards meeting national and grade –level expectations.



Authentic Assessment

Authentic Assessments in Standards-based Assessment directly measure student's performance through "real life tasks" or "situations" that resemble "real life situations." Authentic assessment;

- Is performed in a real life context that approximates as much as possible, the use of a skill or concept in the real world.
- Is based on the development of a meaningful *product, performance or process*
- Students develop and demonstrate the application of their knowledge, skills, values and attitudes in real life situations which promote and support the development of deeper levels of understanding.
- Is mostly associated with assessment as or while learning and assessment for learning but occasionally or contextually in summative learning.
- includes assessment activities such as demonstrations, debates, field work, simulations, problem solving, project-based learning, Poster Presentations, Research, Laboratory work, Reflections, Problem-based activities, Role Play, Report/Essay, Field experience, Field report, Recounts etc.

Advantages of Authentic Activities

- Empower students to take ownership in their learning
- Appreciates Learning experience
- enables and encourages the Learning experiences to be used as a basis of learning
- Meaningful, relevant, practical
- Assess the actual learning experience which means; you do not need to "teach" and then assess, rather you assess actual learning experience while it is actually happening

Authentic Assessment Criteria

In standards-based Assessment, teachers are encouraged to step out of their traditional assessment and explore authentic assessment. The criteria in authentic assessment;

- Looks at students actively engaged in completing a task that represents the achievement of a learning objective or standard
- Takes place in real life situations
- Asks students to apply their knowledge, skills, values and attitudes in real life situations
- Students are given the criteria against which they are being assessed

A Comparison of Authentic and Traditional Assessment

Authentic Assessments	Traditional Assessments
• Portfolios, demonstrations, field work, case studies, assignments, lab reports • Students take an active role in process • Qualitative • Interpretive • Focuses on performance, process and product • High level thinking • Use of rubric • Use of criterion levels evaluation • Part of teaching and learning Process • Shows mastery and learning performance • Generally extends over time •	• Multiple choice tests, true-false, fill in the blanks, sentence completion, matching, diagram completions • External –(teacher driven – assessing performance of teacher rather than the student) • Teacher-centered (what is appropriate and convenient for the teacher and what teacher thinks is good for students and decides what should be and should not be learnt) • Quantitative (driven to collect marks) • Objective • End product (only looking for the end product and not concerned about the performance and process) • Standardised or norm referenced • Isolated facts • Low level content • Generally occurs in “one setting

Standards-Based Assessment Types

In standards-Based Assessment, there are three broad assessments types.

1. Formative Assessment

Formative assessment includes ‘assessment *for* and *as’* and is conducted during the teaching and learning of activities of a topic.

Purposes of assessment for Learning

- On-going assessment that allows teachers to monitor students on a day-to-day basis.
- Provide continuous feedback and evidence to the teachers that should enable them to identify gaps and issues with their teaching, and improve their classroom teaching practice.

- Helps students to continuously evaluate, reflect on, and improve their learning

Purposes of assessment as Learning

- Occurs when students reflect on and monitor their progress to inform their future learning goals.
- Helps students to continuously evaluate, reflect, and improve their own learning.
- Helps students to understand the purpose of their learning and clarify learning goals.

2. Summative Assessment

Summative assessment focuses on '*assessment of learning'* and is conducted after or at the conclusion of teaching and learning of activities or a topic.

Purposes of assessment of Learning

- Help teachers to determine what each student has achieved and how much progress he/she has made towards meeting national and grade-level expectations
- Help teachers to determine what each student has achieved at the end of a learning sequence or a unit.
- Enable teachers to ascertain each student's development against the unit or topic objectives and to set future directions for learning.
- Help students to evaluate, reflect on, and prepare for next stage of learning.

Performance Assessment

Performance assessment is a form of testing that requires students to perform a task rather than select an answer from a ready-made list. For example, a student may be asked to explain historical events, generate scientific hypotheses, solve math problems, converse in a foreign language, or conduct research on an assigned topic. Teachers, then judge the quality of the student's work based on an agreed-upon set of criteria. It is an assessment which requires students to demonstrate that they have mastered specific skills and competencies by performing or producing something.

Types of performance assessment;

I. Products-Oriented

This refers to concrete tangible items that students create through either the visual, written or auditory media such as;

- Creating a health/physical activity poster
- Video a class game or performance and write a broadcast commentary
- Write a speech to be given at a school council meeting advocating for increased time for health and physical education in the curriculum
- Write the skill cues for a series of skill photo's
- Create a brochure to be handed out to parents during education week
- Develop an interview for a favourite sportsperson
- Write a review of a dance performance
- Essays
- Projects

II. *Process-Oriented Tasks*

It shows the thinking processes and learning strategies students use as they work such as;

- Survival scenarios
- Problem solving initiative/adventure/ activities
- Decision making such as scenario's related to health issues
- Event tasks such as creating a game, choreographing a dance/gymnastics routine, creating an obstacle course
- Game play analysis
- Peer assessment of skills or performances
- Self-assessment activities
- Goal setting, deciding a strategy and monitoring progress towards achievement

III. *Performances-Oriented*

It deals with observable affective or psycho-motor behaviours put into action such as;

- Skills check during game play

- Role plays
- Officiating a game
- Debates
- Performing dance/gymnastics routines
- Teaching a skill/game/dance to peers

Performance Standards

Performance standards are measurement standards that are observed through evidence outcomes and performance indicators. Evidence outcomes and Performance Indicators are used to measure students' performances, proficiency, competency, progression and achievement of the desired grade or level of expectation.

Performance Standards are concrete statements of how well students must learn what is set out in the content standards and benchmarks, often called the "be able to do" of "what students should know and be able to do." Performance standards indicate the quality that specifies how competent a students' demonstration or performance must be. They include explanations of how well students must demonstrate the content, explaining "how good is good enough."

Performance standards:

- measure students' performance and proficiency (using performance indicators) in the use of a specific knowledge, skill, value, or attitude in real life or related situations,
- provide the basis (performance indicators) for evaluating, reporting and monitoring students' level of proficiency in use of a specific knowledge, skills, value, or attitude,
- are used to plan for individual instruction to help students not yet meeting expectations (desired level of mastery and proficiency) to make adequate progress towards the full attainment of benchmarks and content standards,
- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards,
- A stem statement for Performance Standards will begin with…."Students will be able to……"
- A stem statement for Performance Indicator will begin with …."Students can be able to……."

Assessment Strategies

It is important for teachers to know that, assessment is administered in different ways. Assessment does not mean a test only. There are many different ways to find out about student's strengths and weaknesses. Relying on only one method of assessing will not reflect student's achievement.

Provided in the appendices is a list of suggested strategies you can use to assess student's performances. These strategies are applicable in all the standards-based assessment types. ***Please refer to the Appendices to see the suggested strategies.***

Action Verbs to Assessment Strategies		
Cognitive Learning	**Action Verbs**	**Assessment Strategies**
Knowledge - to recall or remember facts without necessarily understanding them	Arrange, define, duplicate, label, memorise, name, order, recognise, relate, recall, reproduce, list, tell, describe, identify, show, label, collect, examine, tabulate, quote	• Prior knowledge inventory, misconception/preconception check • Focused listing, empty outlines • Pre-post test, quiz, quick poll
Comprehension – to understand and interpret learned information	Classify, describe, discuss, explain, express, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend, translate, review, restate, locate, recognise, report	• Minute paper, muddiest (or clearest) point • Observe and evaluate a student artifact or performance task using a rubric • Directed paraphrasing • Pre-post test, quiz • Interviews
Application – to put ideas and concepts to work in solving problems	Apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, calculate, complete, show, examine, modify, relate, change, experiment, discover	• Observe and evaluate a student artifact, performance, or task using a rubric • Directed paraphrasing, real-world application (apply learning in a new context) • Test, quiz • Job/internship evaluation, skill ratings
Analysis – to break information into its components to see interrelationships and ideas	Analyse, appraise, calculate, categorise, compare, contrast, criticise, differentiate, discriminate, distinguish, examine, experiment, question, test, separate, order, connect, classify, arrange, divide, infer	• Pro and con grid, categorizing grid, compare and contrast, concept maps • Observe and evaluate a student artifact, performance, or task using a rubric • Journaling • Job/internship evaluation, skill ratings

Evaluation – to judge the value of information based on established criteria	Appraise, argue, assess, attach, defend, judge, predict, rate, support, evaluate, recommend, convince, judge, conclude, compare, summarise	• Reflection component of a portfolio or experience • Journaling • Peer evaluation
Affective Learning	appreciate, accept, attempt, challenge, defend, dispute, join, judge, praise, question, share, support	• Reflection component of a portfolio or experience • Journaling • Observe and evaluate group work • Surveys, interviews, focus groups

ASSESSMENT STRATEGIES

Strategy	Description
Analogies	Students create an analogy between something they are familiar with and the new information they have learned. When asking students to explain the analogy, it will show the depth of their understanding of a topic.
Classroom Presentations	A classroom presentation is an assessment strategy that requires students to verbalise their knowledge, select and present samples of finished work, and organise their thoughts about a topic in order to present a summary of their learning. It may provide the basis for assessment upon completion of a student's project or essay.
Conferences	A conference is a formal or informal meeting between the teacher and a student for the purpose of exchanging information or sharing ideas. A conference might be held to explore the student's thinking and suggest next steps; assess the student's level of understanding of a particular concept or procedure; and review, clarify, and extend what the student has already completed
Discussions	Having a class discussion on a unit of study provides teachers with valuable information about what the students know about the subject. Focus the discussions on higher level thinking skills and allow students to reflect their learning before the discussion commences.
Essays	An essay is a writing sample in which a student constructs a response to a question, topic, or brief statement, and supplies supporting details or arguments. The essay allows the teacher to assess the student's understanding and/or ability to analyse and synthesise information.
Exhibitions/Demonstrations	An exhibition/demonstration is a performance in a public setting, during which a student explains and applies a process, procedure, etc., in concrete ways to show individual achievement of specific skills and knowledge.
Interviews	An interview is a face-to-face conversation in which teacher and student use inquiry to share their knowledge and understanding of a topic or problem, and

	can be used by the teacher to explore the student's thinking; assess the student's level of understanding of a concept or procedure and gather information, obtain clarification, determine positions, and probe for motivations.
Learning Logs	A learning log is an ongoing, visible record kept by a student and recording what he or she is doing or thinking while working on a particular task or assignment. It can be used to assess student progress and growth over time.
Observation	Observation is a process of systematically viewing and recording students while they work, for the purpose of making programming and instruction decisions. Observation can take place at any time and in any setting. It provides information on students' strengths and weaknesses, learning styles, interests, and attitudes.
Peer Assessment	Assessment by peers is a powerful way to gather information about students and their understanding. Students can use set criteria to assess the work of their classmates.
Performance Tasks	During a performance task, students create, produce, perform, or present works on "real world" issues. The performance task may be used to assess a skill or proficiency, and provides useful information on the process as well as the product.
Portfolios	A portfolio is a collection of samples of a student's work, and is focused, selective, reflective, and collaborative. It offers a visual demonstration of a student's achievement, capabilities, strengths, weaknesses, knowledge, and specific skills, over time and in a variety of contexts.
Questions And Answers (Oral)	In the question–and-answer strategy, the teacher poses a question and the student answers verbally, rather than in writing. This strategy helps the teacher to determine whether students understand what is being, or has been, presented, and helps students to extend their thinking, generate ideas, or solve problems.
Quizzes, Tests,	A quiz, test, or examination requires students to respond to prompts in order to demonstrate their knowledge (orally or in writing) or their skills (e.g.,

Examinations	through performance). Quizzes are usually short; examinations are usually longer. Quizzes, tests, or examinations can be adapted for exceptional students and for re-teaching and retesting.
Questionnaires	Questionnaires can be used for a variety of purposes. When used as a formative assessment strategy, they provide teachers with information on student learning that they can use to plan further instruction.
Response Journals	A response journal is a student's personal record containing written, reflective responses to material he or she is reading, viewing, listening to, or discussing. The response journal can be used as an assessment tool in all subject areas.
Selected Responses	Strictly speaking a part of quizzes, tests, and examinations, selected responses require students to identify the one correct answer. The strategy can take the form of multiple-choice or true/false formats. Selected response is a commonly used formal procedure for gathering objective evidence about student learning, specifically in memory, recall, and comprehension.
Student Self-Assessments	Self-assessment is a process by which the student gathers information about, and reflects on, his or her own learning. It is the student's own assessment of personal progress in terms of knowledge, skills, processes, or attitudes. Self-assessment leads students to a greater awareness and understanding of themselves as learners.

Scoring Methods for Performance Assessment

Assessment can be scored during or after the students have completed the assessment task. However, it is best done during a lesson- using a checklist, rating scales & rubrics.

A rubric is a coherent set of criteria for students' work that includes descriptions of levels of performance quality on the criteria. Rubrics have two major aspects: coherent sets of criteria and descriptions of levels of performance. Rubrics include;

(1) Descriptions of the of task
(2) The scales to be used
(3) The dimensions of the task
(4) The description of each dimension on the scale

A Rubric

- is a scoring guide that helps teachers evaluate student performance, based on a range of criteria.
- A rubric lists the criteria, or characteristics, that student work should exhibit and describes specific quality levels for those criteria.
- Rubrics are a great way to improve communication, learning, and grading fairness.
- Knowing how to create and use rubrics gives you a better understanding of assessment and another option for assessing student performance.
- are descriptive and not evaluative.
- Of course, rubrics can be used to evaluate, but the operating principle is to match the performance to the description rather than "judge" it.
- Thus rubrics are as good or bad as the criteria selected and the descriptions of the levels of performance under each.
- Effective rubrics have appropriate criteria and well-written descriptions of performance

Purpose of Rubrics

Like any other evaluation tool, rubrics are useful for certain purposes and not for others. *The main purpose of rubrics is to assess performances*. For some performances, you observe the student in the process of doing something, like using an electric drill or discussing an issue. For other performances, you observe the product that is the result of the student's work, like a finished bookshelf or a written report.

1. Support authentic assessment
While traditional tests measure how well students recall content, rubrics measure how well students can apply knowledge to authentic contexts or real-world tasks.

2. Clearly communicate expectations
Because rubrics define student "quality" in terms of objective criteria and standards, they clearly communicate how instructors will evaluate student performance.

3. Improve performance

Rubrics lead to better student performance. When students understand assignments and expectations before they begin, they are more likely to fulfil them. They know what specific criteria and standards of excellence will be used to rate their performance.

4. To inspire fairness
Because rubrics have detailed assessment information, students don't feel that grades are assigned subjectively or arbitrarily. Also, when you have more than one grader, a rubric allows all graders to apply the same criteria in the same way.

Although rubrics have many benefits--and make grading faster and easier--a good rubric takes time, effort and patience to construct. You'll probably need to change (change, not add to) your grading and assessment methods, based on what you believe about learning assessment. Rubrics are best for critical assessments, major projects, and other assignments that require a multi-dimensional performance evaluation. The trick is to know what type of rubric to create for your situation.

Reasons for Creating Rubrics/Marking schemes

Rubrics or marking schemes are created for;

1. Categories to assess-different components or elements that will assess

    - Factual information
    - Application
    - Analysis
    - Writing Skills

2. Criterion for assessment

    - Accuracy
    - Completeness
    - Length or number of examples
    - Supported with research
    - Range of answer
    - Description and support

3. Levels or points 3-5 levels

    - Exemplary. Proficient, acceptable, not acceptable
    - Excellent, good, fair, poor
    - 10 points, 5 points, 1 point

Parts of a Rubric

- A rubric is a matrix of criteria and their descriptors.
- The left side of a rubric matrix lists the **criteria (performance standards)** for the expected product or performance.
- Across the top of the rubric matrix is the **rating scale** that provides a set of values for rating the quality of performance for each criterion.
- **Descriptors** under the rating scale provide examples or concrete indicators for each level of performance.
- The dimensions of the task that **qualifies** the achievement

Criteria	Performance Standards (Descriptors)
BEYOND	**Beyond Standard (s) -*Advanced in Performance and Understanding***
	Consistently demonstrates advanced conceptual mathematical understandings Consistently generates tasks that make connections between and among mathematical ideas Consistently applies strategies to unique situations Consistently demonstrated confidence to approach tasks beyond the proficiency level for grade Consistently initiates mathematical investigations
CONSISTENT	**Meet Standard (s)-*Proficient in Performance and Understanding***
	Consistently demonstrates understanding of mathematical standards and cluster at the grade level Consistently demonstrated conceptual understanding Consistently applies multiple strategies flexibly in various situations Understands and fluently applies procedures with understanding Consistently demonstrates perseverance and precision Constructs logical mathematical arguments of thinking and reasoning Uses mathematical language correctly and appropriately
INCONSISTENT	**Progressing-*Not Yet Proficient in Performance and Understanding***
	Inconsistently uses tools appropriately and strategically Demonstrates inconsistent understanding of key mathematical ideas at grade level Demonstrates inconsistent conceptual understanding of key mathematical ideas at grade level Inconsistent in understanding and application of grade level appropriate strategies Depends upon assistance of teacher and/or peers to understand and complete tasks Needs additional time to complete tasks Applies models of mathematical ideas inconsistently
SELDOM	**Not Yet -*Limited Performance and Understanding***
	Exhibits minimal understanding of key mathematic ideas at grade level Rarely demonstrates conceptual understanding Seldom provides precise response Seldom use appropriate strategies Consistently requires assistance and alternative instruction Use tools inappropriately to model mathematics

Types of Rubrics

1. Analytic Rubric

Analytic rubrics describe work on each criterion separately. For most classroom purposes, analytic rubrics are best. Focusing on the criteria one at a time is better for instruction and better for formative assessment because students can see what aspects of their work need what kind of attention. Focusing on the criteria one at a time is good for any summative assessment (grading) that will also be used to make decisions about the future—for example, decisions about how to follow up on a unit or decisions about how to teach something next year.

Template for Analytic Rubrics

Criteria	Beginning	Developing	Accomplished	Exemplary	Score
Criteria 1	Description reflecting beginning	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	
Criteria 2	Description reflecting beginning level performance	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	
Criteria 3	Description reflecting beginning level performance	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	
Criteria 4	Description reflecting beginning level performance	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	

Sample Analytic Rubric

Qualifier

Descriptor

Performance Standard/Criteria	Advanced	Proficient	Progressing	Not Yet
Identify reasons for developing caring relationships	Identify and explain **all** the reasons for developing caring relationships	Identify **all** the reasons for developing caring relationships	Identify only a **few** of the reasons for developing caring relationships	Identify only **one** reason for developing caring relationships
Explain the reasons for developing caring relationships	Explain all the reasons for developing caring relationships and provide an in-depth justification for some of the reasons	Explain all the reasons for developing caring relationships	Explain only a few of the reasons for developing caring relationships	Explain only one reason for developing caring relationships

Holistic Rubrics

Holistic rubrics describe the work by applying all the criteria at the same time and enabling an overall judgment about the quality of the work. Holistic rubrics are based on criteria for good work and on observation of how the work meets those criteria.

One classroom purpose for which holistic rubrics are better than analytic rubrics is the situation in which students will not see the results of a final summative assessment and you will not really use the information for anything except a grade. Some high school final examinations fall into this category. Grading with rubrics is faster when there is only one decision to make, rather than a separate decision for each criterion.

Decide on type of rubric to be used (Holistic or Analytic)

1. When to use Holistic Rubric
    - There is no single correct answer/response to a task
    - The focus has no the overall quality, proficiency, or understanding of a specific content or skills.
    - You are assessing large numbers (eg. 150 portfolios)

Holistic Rubric						
Score	**5**	**4**	**3**	**2**	**1**	**0**
Description	Demonstrate **complete** understanding of the problem. **All** requirements of task are **included in response**.	Demonstrate **considerate** understanding of the problem. **All** requirements of task are **included**.	Demonstrate **partial** understanding of the problem. **Most** requirements of task are **included**.	Demonstrate **little** understanding of the problem. **Many** requirements of task are **missing**.	Demonstrate **no** understanding of the problem.	**No** response/ **not** attempted task

2. When to use Analytic Rubric
    - Several subjects are assessing the student work.
    - Description promote consistent scoring.
    - Stakeholders will be examining the rubric scores.
    - Substantial feedback to students or the subjects is desired.
    - Outlines of specific strengths/weaknesses are anticipated.

Analytic Rubric				
Criteria	**4**	**3**	**2**	**1**
Criteria # 1	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.
Criteria # 2	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.
Criteria # 3	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.
Criteria # 4	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.

Scoring of Performance for Formative Assessment

(Assessment as/while learning and Assessment for learning)

1. Scoring Assessment using Rating Scale

Rating Scales are a type of checklists that judge the degree to which a criteria is met. They generally have a scale of between 1-6 options.

Types of Rating Scales

A. Frequency Rating Scales

A frequency rating scale scores how often a task is done to meet criteria.

Sample Rating Scale Descriptive Words

1. Words that describe the skill of ***selecting 'the right' information*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
Pertinent	relevant	suitable	trivial
Insightful	meaningful	appropriate	superficial
Significant	relevant	predictable	vague
Perceptive	thoughtful	basic	questionable
Precise	logical	partially correct	confusing
Purposeful	focused	appropriate	irrelevant

2. Words that describe the skill of ***selecting 'enough' information*** at varying levels of quality.

Excellent	Proficient	Adequate	Limited
comprehensive	thorough	cursory	superficial
in-depth	sufficient	partial	incomplete
rich & detailed	specific	simplistic	undeveloped
Extensive	substantial	partial	sketchy

3. Words that describe the skill of ***evaluating product or connecting insights to personal experience*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
insightful	thoughtful	predictable	trivial
astute	relevant	appropriate	unfocused
perceptive	thoughtful	routine	trivial
intuitive	logical	rudimentary	unsubstantiated
innovative	credible	predictable	trite
compelling	meaningful	obvious	tenuous

4. Words that describe the skill of ***designing or constructing*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
efficient	practical	viable	unworkable
innovative	effective	workable	ineffective

5. Words that describe the skill of ***organizing or formatting information*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
skillful	systematic	simplistic	haphazard
purposeful	logical	methodical	disorganised

6. Words that describe the skill of ***analyzing information or data*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
accurate	logical	partially accurate	flawed

insightful	logical	simplistic	unsupported
astute	credible	plausible	inaccurate
precise	relevant	basic	irrelevant

7. Words that describe the skill of ***presenting or communicating information or selecting appropriate visuals*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
vivid	interesting	simplistic	lacks appeal
compelling	effective	predictable	does little to sustain interest
enhances	supports	partially supports	interferes with
engaging	interesting	straightforward	ineffective
skillful	effective	appropriate	inappropriate
intriguing	interesting	predictable	ineffective

Sample Scoring using Rating Scale to assess "Collaboration"

Criteria	Frequency			
	Always = 4	**Sometimes = 3**	**Rarely = 2**	**Never - 1**
1. Embraces everyone's' abilities and encourages participation	Always Embraces everyone's' abilities and encourages participation	Sometimes Embraces everyone's' abilities and encourages participation	Rarely Embraces everyone's' abilities and encourages participation	Never Embraces everyone's' abilities and encourages participation
2. Ensures everyone is tasked to and activity	Always Ensures everyone is tasked to and activity	Sometimes Ensures everyone is tasked to and activity	Rarely Ensures everyone is tasked to and activity	Never Ensures everyone is tasked to and activity
3. Encourages everyone to achieve together	Always Encourages everyone to achieve together	Sometimes Encourages everyone to achieve together	Rarely Encourages everyone to achieve together	Never Encourages everyone to achieve together

2. Scoring assessment using a Checklist

Check lists are one of the easiest methods of scoring assessment tasks. The criteria i.e. skills, cues or tasks are considered separately according to whether they have been accomplished.

Types of Checklists include

- Yes/No
- Tick/Cross
- Circling
- Narrow scale, e.g. Sometimes, rarely, never
- Colouring
- Symbols (signifiers), e.g. pictures, facials, artifacts, signs, drawings, concept maps)

Sample Scoring using Yes/No Checklist Scale to assess "Collaboration"

No	***Criteria***	***Write Yes (score 2) or No (score 1)***
1	*Embraces everyone's' abilities and encourages participation*	
2	*Ensures everyone is tasked to an activity*	
3	*Encourages everyone to achieve together*	

Sample Scoring using Tick/Cross Checklist Scale to assess "Collaboration"

No	***Criteria***	***Place a tick(score 2) or and X (score 1)***
1	*Embraces everyone's' abilities and encourages participation*	
2	*Ensures everyone is tasked to an activity*	
3	*Encourages everyone to achieve together*	

Samples of other scoring methods are in the Appendix Reference. These are based on Business Studies but can be applied in Technology and Industrial Arts

Scoring of Performance for Summative Assessment

Grade rating scales are better scoring tools for summative assessment of students' performance. They indicate students' level of performance using such as; A, B, C, D etc

A Grade is given after the accumulated total for a number of assessments has been completed either at the end of and assessment period, a topic, a term, a grade or year.

The subject assessment components, tasks and weightings should be able to guide the grading of achievements as demonstrated in a rubric designed for this purpose.

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The subject assessment components, tasks and weightings should be able to guide the grading of achievements as demonstrated in a rubric designed for this purpose.

Sample Scenario to score Summative Assessment

For instance; If TIA/BS has an assessment plan for a 100 marks per term, then the grading shall be scored at the end of each term. As per the Assessment weighting, TIA/BS can plan to score assessment of students per term according to this components:

- 1 x Project = maximum of 50marks
- 1 x Moderation = maximum of 50 marks
- 2 x tests = maximum of 30 marks
- 1 x portfolio = maximum of 5 marks
- 1 x participation = maximum of 5 marks

Assessment Components and Task Weighting

The Assessment components and Task Weighting is intended for a Termly Assessment Schedule. It anticipated that the assessment components with their weightings may be changed by the teachers' Business Studies Termly Teaching Programs accordingly but the total scores allocated for the THEORY ASSESSMENT COMPONENTS (TAC) of 40 Marks and PRACTICAL ASSESSMENT COMPONENTS (PAC) 60 Marks should remain as it is the determined as the required 40/60 Moderation Components (i.e. 100 marks) for Business Studies Assessments per Assessment Period.

THEORY ASSESSMENT COMPONENTS (TAC) (40 Marks)	TOTAL SCORE/100	PRACTICAL ASSESSMENT COMPONENTS (PAC) (60 Marks)	TOTAL SCORE/100
		Project Portfolio No. 1	10
		STEAM Project Portfolio No. 1	10
Test No. 1	15	Project No. 1	25
		STEAM Project No. 1	25
Assignment No. 1	10		

Test No. 2	15		
TOTAL THEORY SCORE	**____/40**	**TOTAL PRACTICAL SCORE**	**____/60**
TOTAL SCORES OF TAC + PAC = TOTAL SCORES OUT OF 100	**_____/100**		

Sample subject assessment structure

The internal assessment for the Technology and Industrial Arts/ Business Studies subject is based on the Grade 9 & 10 and Grade 11 and 12 Technology and Industrial Arts Syllabus. The final assessment should be based on a range and balance of assessment strategies and instruments. Assessment must be both normative and criterion.

Component	Weighting	Tasks	Assessment Referencing
Practical Work in response to design brief (Moderation and Projects included here?)	60 % (of mandatory total)	Development and application of design ideas, safe and skillful use of materials, tools and equipment to make a product and the identified processes	Criterion Referencing Rubrics
Design folio with outcomes of research , investigations and planning	20 % (of mandatory total)	Folio showing results of investigation in response to design brief, rough notes or sketches of design ideas, timelines, final drawings or plans, processes used to make the product and evaluation reports	Criterion Referencing Rubrics
Tests	20 % (of mandatory total)	Theory and also applications in theory	Normative
Marks	100 %	A combination of design folios, practical applications, moderations and tests.	

Sample Assessment

SBC embraces standards and as such, standards must also drive the administration of assessments to students. It is important that every student must be given the outline of the

Assessment that has been planned for the term. Each Term will include 6 pieces (can have any number from 4-6) of assessment. Assessment is weighted accordingly.

Assessment Type	Description	Weighting
Topic Tests x 2	Students will be given two topic tests based on the content learnt in the term. 1 will be given mid-term and 1 at end-term. The test will be comprised of 10 multiple choice questions and 5 short written answers.	1 = 15 marks 1=10 marks
Portfolio	Individual Students will be assessed on creating design portfolios	10 marks
Moderation	In groups of four - five, students work to critically engage with one another in the required design process. Students will address criteria provided in class and prepare and deliver a 5-10 minute presentation addressing the criteria.	30 marks
Project (Application)	In groups of three to four, students work to critically engage with one another in the assigned project. Students will address criteria provided in class and prepare and deliver a 5-10 minute presentation addressing the criteria.	20 marks
Participation	2 marks will be allocated each day for attendance. Another 3 marks will be awarded for active participation.	5 marks

STEAM Assessment

Steps in Developing a STEAM Activity

1. Identify the Real/Authentic Situations that can be solved through the STEAM Activity
2. Select a well-defined a Benchmark in your subject area that will carry the STEAM Activity
3. Identify related subject areas with their concepts to be used solve the Authentic Situation
4. Note down the Main parts of the Unit Of Work for the STEAM Activity
5. Write a Description of the Authentic Situation for the STEAM Activity based on the identified Authentic situation.
6. Write down the Task Descriptions for the STEAM Activity in order to approach the Authentic situation.
7. Develop the Rubric to Assess the STEAM Activity

1. Authentic Situation identified for this STEAM Activity

- Students spending too much time using their smart mobile phones on Facebook, WhatsApp and surfing the internet rather than their school work.
- Students still bringing their smart mobile phones to school despite the school rules telling them not to.
- Most schools need to fully utilise their School Rules, Mottos, Missions and Visions which determines the way they want to shape our students' Knowledge, Attitudes and Values, during and after, they leave the school at end of Grade10 and Grade12.
- Our schools in our country have been labeled as 'a very good school to a very bad school' due school student fights and vandalism of school properties.

- Stakeholders of the schools are blaming the school management for the school students behaviour problems and parents are transferring their students out of schools to others school in the country.

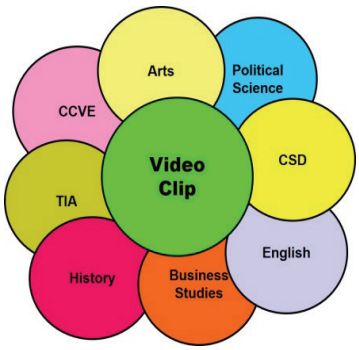
2. ***Select a well-defined Benchmark in your subject area that will carry/drive the STEAM Activity and its associated Big Idea (product, project etc.)***

   - ***Sample:***

     i. **SUBJECT:** BUSINESS STUDIES

     ii. **BENCHMARK 9.2.5.1.** Analyse the impact of information technology on society.

     iii. **Big idea/product:** Video Clip



3. ***Identify other related subject areas with the appropriate concepts to solve the Authentic Situation(s)***

   - Identify related subject areas with their concepts/Knowledge, Skills, Attitudes and Values to be used to solve the Steam Authentic Situation

SUBJECTS	BENCHMARKS	BIG IDEA/ PRODUCT	KNOWLEDGE	SKILLS	ATTITUDES	VALUES
1. Arts (Theatre Arts)	9.2.2.2		Video script	Script Writing		
2. Christian Civic Value Education (CCVE)	9.3.1.3		School Rules, Motto, Vision, Mission	Examine Civic values	Responsibility	Ownership, Love
3. Character Social Development (CSD)	9.1.5.1, 9.1.5.2, 9.1.5.3, 9.1.5.4, 9.1.5.5		School Rules, Motto, Vision, Mission	Asses experiences and mistakes	Caring, Positivity	Respect
4. English	9.2.2.1		Descriptive Writing	Descriptive Writing	Neatness	
5. Social Science (History)	9.2.2.3, 9.2.2.4		School history	Discuss school culture		Ownership
6. Social Science (Political Science)	9.3.3.1, 9.3.3.2		National development aspirations/demands of citizens	Anticipative skills		
7. Technology Industrial Arts (TIA)	9.4.1.4, 9.4.1.5, 9.4.1.6		Range of communications media products	Creative media communication	Alertness	
8. Business Studies	9.2.5.6.	Video clip	Media rich projects	Shooting with mobile	Creativity	Innovative

There must be an anchor subject benchmark for any STEAM assessment.

4. ***Descriptions of the Steam Authentic Situation***

   - Paragraph 1 describes the problem/situation
   - Paragraph 2 describes the solution to the problem/situation and who will be responsible to take up the task
   - Paragraph 3 would mention any rewards/awards for an adequate solution to the problem/situation as a booster to create a competitive competition and a promoter of critical thinking amongst the students so that they can come out with the best products.

5. Write down the Task Descriptions for the STEAM Activity

- Plan and write a short write-up for your video-clip.
- Use the notes to make a 2-minute video clip to advertise and market your school to the public.
- The short video clip must embrace the school rules, motto, and mission and vision statements.
- It must also contain messages of new and competent management.
- This video clip has to have the potential to positively change the image of the school
- This 2-miunte video clip must be captivating and totally convincing to attract students to want to enroll at your school.
- This clip must not be more than 2 minutes (maximum time limit)
- Present your video clip to be assessed
- Submit both your write-up (on a chart) together with your video clip

6. Developing Rubrics to Assess the Steam Video Clips

1) Decide on type of rubric to be used (Holistic or Analytic)
2) Decide what point scale rubric to use (always use 3, 4 or 5 point-scale) and rating scales to use (descriptive words or numerals)
3) Plan the layout to develop the rubric
4) Decide what to assess from the Category of Tasks Description
5) Identify and ist the Category of Tasks Description for the Criteria
6) Reword the Tasks Descriptions to create Criteria

    - Plan and write a short write-up for your video-clip. (***The write up of the video***)
    - Use the notes to make a 2-minute video clip to advertise and market your school to the public. (***The development of the video***)
    - The short video clip must embrace the school rules, motto, and mission and vision statements. (***The content of the video***)
    - It must also contain messages of new and competent management. (***The content of the video***)
    - This clip must not be more than 2 minutes (maximum time limit) (***The presentation of the video***)
    - Submit both your write-up (on a chart) together with your video clip. (***The product***)

7) List the criteria against the Task Descriptions in a table
8) Unpack the Task Descriptions and Identify the essential KSAV that can be assessed
9) Reword the Task Descriptions with the inclusion of KSAVs into a Descriptor statement for each criteria and distribute into each Competency Level/Level of Achievement
10) Determine appropriate variance of Qualifiers for each Descriptors of each Achievement Level

11) Determine the appropriate Descriptive Words or Number for Point Scales of the intended rubric.
12) Completed rubric sample: Video clip Assessment Rubric
13) Consider the Applications of the Steam Rubric

This is a sample for Business Studies and can be used to develop Technology and Industrial Arts Subject STEAM Assessment.

Sample 4

Strand 2: Business Management

Unit 5: Information Technology

Content Standard 2.5: Students will be able to explain the information technology concepts and examine the systems and tools needed to gather, access, analyse, synthesize, evaluate, manage, and disseminate information.

Benchmark: 9.2.5.1. Analyse the impact of information technology on society.

Topic: Impact of information technology on society.

Learning Objective: By the end of this Topic, students will be able to demonstrate a positive impact of information technology on society

Purpose of Assessing the Topic (Benchmark):
To assess whether students can be able to use mobile technology to positively Impact their society and analyse this impacts

How the Performance Task will be done: Group Project Presentation

Performance Standard: By the end of the project**,** students will be able to use mobile technology to positively impact their community/society.

Situation (Authentic)

A school has been faced with the challenge of behavioral issues for some time now and the public has lost its confidence in the school to be a good or genuine school. Most parents fear sending their children to his school and always opt to transfer their children in very first instances. The Board of Governors of the school has decided to raise the Behavior Standards or Benchmarks to a certain degree to improve its image and standards of learning.

To meet the expectations of the BOG, the principal and teachers intend to market the school to the public of NCD to lure students to have the interest to enroll at the school. With such a PAST bad reputation, the school will really need to convince the public that they have raised their

standards and that their school is worth enrolling in it. The Principal and the teachers now have a task on hand to convince the public to enroll their children there and they have to try every means to do so.

To achieve this, the school is now requesting the Business and Technology Department to design an assessment Task for a certain Grade to assist with the situation. The Business & Technology Department has opted to design the task for Grade 9 students as one of their projects towards their assessments. The school principal also announces that the best video assessed by the B&T Department will be rewarded as it is also a competition.

Task Descriptions:

- Plan and write a short write-up for your video-clip.
- Use the notes to make a 2-minute video clip to advertise and market your school to the public.
- The short video clip must embrace the school rules, motto, and mission and vision statements.
- It must also contain messages of new and competent management.
- This video clip has to have the potential to positively change the image of the school
- This 2-miunte video clip must be captivating and totally convincing to attract students to want to enrol at your school.
- This clip must not be more than 2 minutes (maximum time limit)
- Submit both your write-up (on a chart) together with your video clip
- Teacher will present your video clips for the whole class to observe and use the rubric below to assess the video clip.

Materials: Smartphone, butcher papers, markers

1. Developing Rubrics to Assess Video Clips

i. Decide on type of rubrics to be used (Holistic or Analytic)
ii. After you decide, plan the rubrics
iii. Planning to develop the rubric
iv. Categorise the Tasks Description into Criteria's

Sample of Categorising tasks for the rubric

- Plan and write a short write-up for your video-clip. (The write up of the video)
- Use the notes to Make a 2-minute video clip to advertise and market your school to the public. (The development of the video)
- The short video clip must embrace the school rules, motto, and mission and vision statements. (The content of the video)
- It must also contain messages of new and competent management. (The content of the video)
- This video clip has to have the potential to positively change the image of the school (The content of the video)

- This 2-miunte video clip must be captivating and totally convincing to attract students to want to enrol at your school. (The content of the video)
- This clip must not be more than 2 minutes (maximum time limit) (The presentation of the video)
- Present your video clip to be assessed (The presentation of the video)
- Submit both your write-up (on a chart) together with your video clip. (The product)

2. Identify and list down categories of tasks

Category	Task Description
The write up of the video	Plan and write a short write-up for your video-clip.
The development of the video	Use the notes to Make a 2-minute video clip to advertise and market your school to the public.
The content of the video	• The short video clip must embrace the school rules, motto, and mission and vision statements. • It must also contain messages of new and competent management. • This video clip has to have the potential to positively change the image of the school • This 2-minute video clip must be captivating and totally convincing to attract students to want to enrol at your school.
The Presentation of the video	• This clip must not be more than 2 minutes (maximum time limit) • Present your video clip to be assessed
The product	Submit both your write-up (on a chart) together with your video clip.

3. Unpack the Task Descriptions and Identify the essential KSAV that can be assessed

Category	Task Description	Essential KSAVs
The write up of the video script	Plan and write a short write-up for your video-clip.	Skill : Procedural Writing
The development of the video	Use the notes to Make a 2-minute video clip to advertise and market your school to the public.	Values and attitudes: - Teamwork and cooperation - Creativity Knowledge: Know about the school

The content of the video	• The short video clip must embrace the school rules, motto, and mission and vision statements. • It must also contain messages of new and competent management. • This video clip has to have the potential to positively change the image of the school • This 2-minute video clip must be captivating and totally convincing to attract students to want to enrol at your school.	Knowledge: Adequate content about the school Skill: convincing and persuasive Values and attitude: Encouraging and luring
The Presentation of the video	• This clip must not be more than 2 minutes (maximum time limit) • Present your video clip to be assessed	Skill: - Time management - delivery skills (posture, language) and - communication skills - social skills (relativity and connectivity) Values and attitude: confidence
The product	Submit both your write-up (on a chart) together with your video clip.	EKSAVs in the Write up and Presentation :

4. Reword the Task Descriptions with the inclusion of KSAVs into a Descriptor statement for each criteria and distribute into each Competency Level/Level of Achievement

5. Determine the appropriate Descriptive Words or Number for Point Scales of the intended rubric.

Criteria:	Advanced	Progressing	Novice	Mark
The write up of the video script	**Skill:** Procedural Writing **Organised paper of video script writing procedures**	**Organised paper of video script writing procedures**	**Organised paper of video script writing procedures**	/3
The development of the video	Values and attitudes: - Teamwork and cooperation	**The video corresponds to the 2-minutes script and illustrates teamwork**	**The video corresponds to the 2-minutes script and illustrates**	/ 3

	- Creativity **Knowledge:** Know about the school **The video corresponds to the 2-minutes script and illustrates teamwork**		**teamwork**	
Content of the video	**Knowledge:** Adequate content about the school Skill: convincing and persuasive Values and attitude: Encouraging and luring **The short video clip embraces the core ideas of school rules, motto, and mission and vision statements.**	**The short video clip embraces the core ideas of school rules, motto, and mission and vision statements.**	**The short video clip embraces the core ideas of school rules, motto, and mission and vision statements.**	/3
Presentation of the video	**Skill:** - Time management - delivery skills (posture, language) and - communication skills - social skills (relativity and connectivity) **Values and attitude:** confidence **The video clip captures essence of vital messages of the new and competent management with potentials to**	**The video clip captures essence of vital messages of the new and competent management with potentials to positively change the image of the school and captivating and convincing to attract students to want to enrol at the school.**	**The video clip captures essence of vital messages of the new and competent management with potentials to positively change the image of the school and captivating and convincing to attract students to want to enrol at the school.**	/3

	positively change the image of the school and captivating and convincing to attract students to want to enroll at the school.			
The product	**EKSAVs** in the Write up and Presentation: **Video clip submitted at the assessment deadline for presentations**	**Video clip submitted at the assessment deadline for presentations**	**Video clip submitted at the assessment deadline for presentations**	/3

6. Completed rubric sample: Video clip Assessment Rubric

Criteria	Achieved	Progressing	Novice	Marks
Video Script Write up	**Innovative** and **well** organised paper with **clarity** of video script writing procedures	**Well** organised paper with **clarity** of video script writing procedures	Organised paper with some **clarity** of video script writing procedures	/3
Video Development	**Appropriately considered details** for the video are **well** corresponded to the 2-minutes script and illustrates a well-coordinated teamwork	**Considered details** for the video are **mostly** corresponded to the 2-minutes script and illustrates a coordinated teamwork	**Some details** considered for the video are **partially** corresponded to the 2-minutes script and illustrates a less coordinated teamwork	/3
Video Clip Content	• The short video clip **fully** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **mostly** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **somewhat** embraces the core ideas of school rules, motto, and mission and vision statements.	/3
Video Presentation	• The video clip **fully** captures essence of vital messages of the new and competent management with **necessary** potentials to positively change the image of the school and **really** captivating and **totally** convincing to attract students to want to enrol at	• The video clip **mostly** captures the essence of vital messages of the new and competent management with **most** potentials to positively change the image of the school and **mostly** captivating and **partially** convincing to attract students to want to enrol at the school.	• The video clip **somewhat** captures the essence of vital messages of the new and competent management with **some** potentials to positively change the image of the school and **almost** captivating and **less** convincing to attract students to want to enrol at the school.	/3

	the school.			
Video Clip Submission Time	- Video clip submitted **well before** the assessment deadline for presentations	• Video clip submitted **just before** the assessment deadline for presentations	• Video clip submitted **within** the assessment time for presentations	/3

1. How to Score using the rubric

Scoring Rubrics

Criteria	Achieved ~~3~~	Progressing ~~2~~	Novice ~~1~~	Scoring
Video Script Write up -	**Innovative** and **well** organised paper with **clarity** of video script writing procedures	**Well** organised paper with **clarity** of video script writing procedures	Organised paper with some **clarity** of video script writing procedures	2/3
Video Development	**Appropriately considered details** for the video are **well** corresponded to the 2-minutes script and illustrates a well-coordinated teamwork	**Considered details** for the video are **mostly** corresponded to the 2-minutes script and illustrates a coordinated teamwork	**Some details** considered for the video are **partially** corresponded to the 2-minutes script and illustrates a less coordinated teamwork	1/3
Video Clip Content	• The short video clip **fully** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **mostly** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **somewhat** embraces the core ideas of school rules, motto, and mission and vision statements.	3/3
Video Presentation	• The video clip **fully** captures essence of vital messages of the new and competent management with **necessary** potentials to positively change the image of the school and **really** captivating and **totally** convincing to attract students to want to enrol at the school.	• The video clip **mostly** captures the essence of vital messages of the new and competent management with **most** potentials to positively change the image of the school and **mostly** captivating and **partially** convincing to attract students to want to enrol at the school.	• The video clip **somewhat** captures the essence of vital messages of the new and competent management with **some** potentials to positively change the image of the school and **almost** captivating and **less** convincing to attract students to want to enrol • at the school.	3/3

Video Clip Submission Time	- Video clip submitted **well before** the assessment deadline for presentations	• Video clip submitted **just before** the assessment deadline for presentations	• Video clip submitted **within** the assessment time for presentations	2/3
11/15				

2. How to Grade using the rubric

Grading Rubrics

Score Range	Grade	Qualifier (Proficiency)	Descriptor	Percentage
13 – 15	**A**	**Advanced**	Description reflecting **highest** level of performance.	**76 - 100%**
9 - 12	**B**	**Achieved**	Description reflecting **mastery** level of performance.	**46 - 75%**
5 – 8	**C**	**Progressing**	Description reflecting **movement towards** mastery level of performance.	**26 - 45%**
0 - 4	**D**	**Novice**	Description reflecting **beginning** level of performance.	**0 - 25%**

3. How to Report using the rubric

A. Reporting an individual student's performance on the task

Assessment Task Report						
Assessment Task:		**Video Development Project**				
Name:		**Grade:**		**Class:**	**Score and Grade:**	**/15**
Criteria	**Achieved A**		**Progressing B**		**Novice C**	
Video Script Write up	**Innovative** and **well** organised paper with **clarity** of video script writing procedures		**Well** organised paper with **clarity** of video script writing procedures		Organised paper with some **clarity** of video script writing procedures	
Video Development	**Appropriately considered details** for the video are **well** corresponded to the 2-minutes script and illustrates a well-coordinated teamwork		**Considered details** for the video are **mostly** corresponded to the 2-minutes script and illustrates a coordinated teamwork		**Some details** considered for the video are **partially** corresponded to the 2-minutes script and illustrates a less coordinated teamwork	

Video Clip Content	• The short video clip **fully** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **mostly** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **somewhat** embraces the core ideas of school rules, motto, and mission and vision statements.
Video Presentation	• The video clip **fully** captures essence of vital messages of the new and competent management with **necessary** potentials to positively change the image of the school and **really** captivating and **totally** convincing to attract students to want to enrol at the school.	• The video clip **mostly** captures the essence of vital messages of the new and competent management with **most** potentials to positively change the image of the school and **mostly** captivating and **partially** convincing to attract students to want to enrol at the school.	• The video clip **somewhat** captures the essence of vital messages of the new and competent management with **some** potentials to positively change the image of the school and **almost** captivating and **less** convincing to attract students to want to enrol at the school.
Video Clip Submission Time	- Video clip submitted **well before** the assessment deadline for presentations	• Video clip submitted **just before** the assessment deadline for presentations	• Video clip submitted **within** the assessment time for presentations

Note: The shaded is the student's proficiency score for each task.

Related links to this Business Studies Benchmark in Business Studies with other subject areas:

Subjects	Reference Benchmark Codes
1. Arts (Theatre Arts)	9.2.2.2
2. Christian Civic Value Education (CCVE)	9.3.1.3
3. Character Social Development (CSD)	9.1.5.1, 9.1.5.2, 9.1.5.3, 9.1.5.4, 9.1.5.5
4. English	9.2.2.1
5. Social Science (History)	9.2.2.3, 9.2.2.4
6. Social Science (Political Science)	9.3.3.1, 9.3.3.2
7. Technology Industrial Arts (TIA)	9.4.1.4, 9.4.1.5, 9.4.1.6

The anchor subject in this sample STEAM assessment is Technology and Industrial Arts.

Sample Scenario to score Summative Assessment

Moderation in Technology and Industrial Arts

The sample provided is based on Textiles Technology.

What is moderation as assessment?

Moderation is the process of teachers sharing, working through and agreeing to expected standards of student achievement and progress. It supports teachers to compare their own judgments to either confirm or adjust them. The process involves teacher collaboration to establish a shared understanding of what achievement of standards looks like and whether or not the student has demonstrated achievement of the standard through the evidences of performance tasks. Teachers work towards making judgments of assessments of standards that are consistent and comparable.

Moderation Purposes

"Moderation is concerned with the consistency, comparability and fairness of professional judgments about the levels demonstrated by students." *(Maxwell, 2002).* Comparable judgments result from teachers understanding of the curriculum, and agreeing on benchmark assessed. The essence is that, there is common understanding of how to assess progress and achievement within and across schools.
Moderation helps teachers to make dependable, evidence-based decisions and leads to consistency.
There is a need for consistency of teacher judgments:

- over time – same evidence viewed at different times or different contexts leading to same judgment by same teacher
- against standards – equivalent application across different types of evidence
- by a teacher - between his/her students
- between teachers – within the same school and different schools
- between teaching years and levels.

Making consistent, reliable and valid decisions across different points in time is important when schools report on student progress, make decisions on school targets and resourcing, or compare different grades data with past information.

All schools experience variables that challenge the consistency of practice such as staff changes, changes in student numbers or changing education demands. Consistent moderation over time can prevent this in a number of ways.

- Always applying the same standardised criteria ensures consistency over time.
- Where nationally standards criteria or exemplars are available, these become the same external reference used each year or each time.
- Moderators will change over time but the same criteria and associated references will remain and continue to guide decisions.

The benefits of moderation

The benefits of involving students in moderation

- When students are actively involved they can participate in selecting evidence (e.g. samples of their work) that best demonstrate the intended learning outcomes.
- The process of assessment develops students' understanding of the desired outcomes and success criteria or expected rubrics developed.
- Making judgments is closely linked to developing the skills of self and peer-assessment.
- This can lead to shared expectations of learning and understandings of standards between teachers and students.
- Greater student confidence in teacher judgments.
- Provides greater transparency of the assessment process.

The benefits of moderation for teachers

- Brings together collective wisdom, resulting in greater consistency of judgment, and focused teaching.
- Provides greater confidence in teacher judgments and assurance that judgments are consistent with other professionals.
- Leads to shared expectations of learning and understandings of levels and progression of learning.
- Develops deeper understandings about content and progressions of learning.
- Improves quality of assessment.
- Alignment of expectations and judgments with curriculum expectations or progressions, and hence improved teaching and learning.
- Assurance to parents and others that interpretations of students' progress and achievement are in line with other professionals.

Process of Moderation

Purpose, learning area and context of the moderation:
It could be moderation of a proficiency based project or design portfolios or the understanding of how to take a running record or of judgments of student achievement and progress for reporting.

Who is involved?

Who needs to be involved? Who will be the coordinator?
It is preferable that the leader/coordinator has the authority to make decisions?
The timing, duration and frequency of moderation meetings:
Will they be extra meetings, or part of staff or team meetings, or non-contact days?
What is the attainment requirement for the moderation? School based certification?

The evidence of student learning that will be moderated:

- For a piece of writing, student writing samples will be used.

- For moderating a design portfolio, the task, text and questions the student responded to may be used, along with notes of student questions, samples of work done and annotated tasks in line with the assessment task and criteria .
- For supervision of an assessment tool: this could be a student's running record and the teacher
- For judgments of student achievement and progress for reporting to parents, a range will be required, covering both formal and informal collection of evidence.
- Developed rubrics written against national exemplar may be used as assessment tools of moderation which can be maintained and improved every year

When to use moderation in TIA

A. Moderation assessment for TIA will be project based and or evidence based assessment. This can be carried out in a year from grades 9-12. This could mean one project in one of the strands or an incorporation of all the strands of the subject TIA in grade 12 where each school makes the decision to undertake moderation as assessment. This could be the final moderation project that will incorporate all the strands in TIA. For grades 9, 10, and 11, the moderated projects can be strand based.

Sample Grade 9 Moderation

Textiles Technology

Unit 2: Textiles and Clothing

Content Standard: 1.2 Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions

9.1.2.1 Describe historical influences, technological progression and emerging trends as inspirational sources of design
9.1.2.2. Demonstrate an awareness of the fundamentals of the design process through various artistic versions.
9.1.2.3 Demonstrate an understanding of garment patterning techniques
9.1.2.4 Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects
9.1.2.5 Apply the design process to respond to needs and opportunities in textile design projects.
9.1.2.6 Select and use appropriate technology to creatively document, communicate and present design and project work

The main moderation benchmark is BM 9.1.2.5 as it is using the design process. However the moderation project is a combination of all benchmarks in a unit. All the other benchmarks in grade 9 unit 2 will provide the essential knowledge, skills, values

and attitudes for the moderated project. There will be other evidence based assessments that will be carried out in the unit as well. In essence, the moderation for TIA is a unit based project.

Sample work: Textiles Technology Student Textile Project

Description of activity
Students **design**, **produce** and **evaluate** an assigned textile project. The textile item needs to demonstrate a clear link to the inspiration and reflect appropriate ***choice of fabrics*** and ***construction techniques*** including ***tools and equipment.*** The supporting documentation [design portfolio] should include:

- sources of inspiration
- generation of final design ideas
- samples of resources
- an appropriate care label
- experimentation and justification of equipment and construction

Context

Students have a prior knowledge in designing and constructing textile projects and have managed a range of design and production learning experiences to completion. Students can recognise that appropriate time and resource management skills will ensure the production of a quality textile item. With tan upcoming arts production and fashion

Benchmarks

A student

9.1.2.1 Describe historical influences, technological progression and emerging trends as inspirational sources of design
9.1.2.2. Demonstrate an awareness of the fundamentals of the design process through various artistic versions.
9.1.2.3 Demonstrate an understanding of garment patterning techniques
9.1.2.4 Apply a broad range of contemporary and appropriate tools and techniques with competence and in the development of design projects
9.1.2.4 Apply the design process to respond to needs and opportunities in textile design projects.
9.1.2.5 Select and use appropriate technology to creatively document, communicate and present design and project work.

[Even though these are the grade level benchmarks, the essential KSAVS are drawn up in the assessment rubrics to eventually demonstrate proficiencies as having achieved the benchmarks.]

Criteria for assessing learning

(These criteria would normally be communicated to students with the activity.)

Students will be assessed on their ability to:

- produce a quality textile item with consideration to creativity, degree of difficulty, proficiency in manufacture and time management
- select and use appropriate textile equipment, techniques and materials to construct a quality textile item
- document project work and show evidence of:
  - inspiration and evaluation
  - generation of final sketch
  - collection and justification of resources
  - appropriate care label
  - Experimentation with and justification of techniques and equipment.

Assessment Rubrics,

The development of assessment rubrics will cover the three focus areas.

1. Design Portfolio
2. Textile Project Construction
3. The Design Process

1. THE DESIGN PORTFOLIO

As this is an ongoing or running file of student work the assessment criteria is developed formatively. This portfolio will show all evidence of work done in the designing, planning, making and evaluating the project.

The criteria are drawn from the description of assessment activity.

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
sources of inspiration	Shows precise evidence of sources of inspiration of the design selected with meticulous descriptions of design with complete evidence of the elements of design.	Shows evidence of sources of inspiration of the design selected with meticulous descriptions of design with evidence of the elements of design.	Shows minimal evidence of sources of inspiration of the design selected with careless descriptions of design with minimal evidence of the elements of design.	Shows lack of evidence of sources of inspiration of the design selected with careless descriptions of design with sloppy evidence of the elements of design.
generation of final design ideas	Shows precise evidence of final design	Shows precise evidence of final design	Shows minimal evidence of	Shows lack of evidence of final design

	ideas with evidences (sketches) and clear justifications.	ideas with evidences (sketches) and justifications.	final design ideas with evidences (sketches) and minimal justifications.	ideas with sloppy evidences (sketches) and no justifications.
samples of resources	Shows sufficient samples of resources with succinct and correct explanations.	Shows samples of resources with correct explanations.	Shows minimal samples of resources with few correct explanations.	Shows lack of samples of resources with no explanations.
an appropriate care label	Shows sufficient evidence of care label appropriate to the textile project design.	Shows evidence of care label appropriate to the textile project design.	Shows minimal evidence of care label appropriate to the textile project design.	Shows lack of evidence of care label appropriate to the textile project design.
experimentation and justification of equipment and construction	Shows exceptional and deliberate evidences of every step taken to experiment and justify all decisions and the construction of the textile project in the design portfolio.	Shows deliberate evidences of every step taken to experiment and justify all decisions and the construction of the textile project in the design portfolio.	Shows minimal evidences of every step taken to experiment and justify all decisions and the construction of the textile project in the design portfolio.	Shows lack and careless evidences of every step taken to experiment and not justify all decisions and the construction of the textile project in the design portfolio.

2. THE TEXTILE PROJECT CONSTRUCTION

The construction of the Textile product will include;
1. the design of the textile design.
2. inspirations that inspired the design
3. produce a quality textile item with consideration to creativity, degree of difficulty, proficiency in manufacture and time management
4. select and use appropriate textile equipment, techniques and materials to construct a quality textile item

For this phase of the project; an analytic as well as a holistic rubric will be developed.

1. The design of the textile design.

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Relevance to the focus of project	excellent description of	description of item/s	poor description of item/s	no description of item/s

	item/s and individually designed patterns and technical sketches	and individually designed patterns and technical sketches	and individually designed patterns and technical sketches	and no individually designed patterns and technical sketches
Appropriate use of the elements of design	Excellent presentation as either graphic or free, and indicates mood, feel and emotion of the design and provides specific information about the design features	presentation as either graphic or free, and indicates mood, feel and emotion of the design and provide specific information about the design features	Poor presentation as either graphic or free, and poor indications of mood, feel and emotion of the design and provides few information about the design features	No presentation as either graphic or free, and does not indicate mood, feel and emotion of the design and provides lack of information about the design features
Appropriate design including aesthetic and functional aspects	critical analysis of the functional and aesthetic aspects of the design, considering strengths and weaknesses, with reference to the elements and principles of design	Good analysis of the functional and aesthetic aspects of the design, considering strengths and weaknesses, with reference to the elements and principles of design	Poor analysis of the functional and aesthetic aspects of the design, considering strengths and weaknesses, with reference to the elements and principles of design	No analysis of the functional and aesthetic aspects of the design, not considering strengths and weaknesses, with no reference to the elements and principles of design
Creative and innovative design	Outstanding design development reflects research, the process of creative thinking, and development of individual style.	Good development reflects the understanding of research, the process of creative thinking, and the development of individual style,	Design development reflects some attempt at research, creativity and originality. but some inappropriate choices made.	Design development lacks research demonstrate little creative thinking, and no development of individual style.
Presentation and communication of design of the textile design	Excellent presentation of the development of ideas and concepts in a logical and sequential way	Presentation of the development of ideas and concepts in a logical and sequential way	Mediocre presentation of the development of ideas and concepts in less a logical and sequential way	Poor Presentation of the development of ideas and concepts in a non-logical and sequential way

2. Inspirations that inspired the design

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Relevance to focus of project	The product solution shows excellent relevance to the focus of the task	Clear relevance evident in the focus of the product.	The product solution shows minimal relevance to the focus of the project.	The product is not relevant to the focus of the project.
Theme used as inspiration for the design	Excellent representation of inspiration evident in the design chosen.	Clear representation of inspiration evident in the design chosen.	There is minimal representation of theme evident as inspiration for the design.	No representation of inspiration evident in the design
Technological innovations	An excellent use of technology tools and practice that are used to inspire the design	Making full use of technology innovations of colour, design, texture, line and shape to inspire design.	Minimal use of technological innovations to inspire the design.	No clear use of technological innovations in the design.

3. produce a quality textile item with consideration to creativity, degree of difficulty, proficiency in manufacture and time management

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Selection of appropriate Fabrics and materials, colours and textile equipment	An exceptional selection of appropriate fabrics and materials, considering colours and the textile equipment	selection of appropriate fabrics and materials, considering colours and the textile equipment	Poor selection of appropriate fabrics and materials, not much considering colours and the textile equipment	No selection of appropriate fabrics and materials, no consideriation colours and the textile equipment
Pattern Making Use of measurements and calculations to daft basic patterns and with pattern adaptations	Pattern Making Use of measurements and calculations to daft basic patterns and with pattern adaptations are excellently done.	Pattern Making Use of measurements and calculations to daft basic patterns and with pattern adaptations are done well.	Pattern Making Use of measurements and calculations to daft basic patterns and with pattern adaptations are done to minimal expectations	Pattern Making, Use of measurements and calculations to daft basic patterns and with pattern adaptations are strictly not done well.
Construction/ of textile product and the	Excellent construction/ of textile product	Good construction/ of textile product	Poor construction/ of textile product	Very poor construction/ of textile product

Demonstration of sewing techniques, stitches, seams, fastening, pleats and darts	with excellent Demonstration of sewing techniques, stitches, seams, fastening, pleats and darts	and with good demonstration of sewing techniques, stitches, seams, fastening, pleats and darts	and with poor Demonstration of sewing techniques, stitches, seams, fastening, pleats and darts	and with Demonstration of sewing techniques, stitches, seams, fastening, pleats and darts
Issues of challenges overcome and management of time	Issues of challenges are greatly overcome and excellent management of time	Issues of challenges are managed to be overcome and good management of time	Issues of challenges are partially overcome and slack in the management of time	Issues of challenges not overcome and management of time is not evident.
Appropriate for wear and market	Excellently made appropriate for wear and market	Very appropriate for wear and market	acceptable and appropriate for wear and market	Not appropriate for wear and market

4. select and use appropriate textile equipment, techniques and materials to construct a quality textile item

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Selection of the appropriate textile equipment	Excellent selection of the appropriate textile equipment	Good selection of the appropriate textile equipment	Poor selection of the appropriate textile equipment	Very poor selection of the appropriate textile equipment
Correct use of textile equipment	Excellent use of textile equipment	Correct use of textile equipment	Poor use of textile equipment	Incorrect use of textile equipment
Correct techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing	Excellent and correct techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing	Good and correct techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing	Poor techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing	Incorrect techniques used in pattern layout, pinning, cutting, seam allowance, darts, joining, and finishing
Correct construction and fitting of textile product	Excellent and Correct construction and fitting of textile product	Good and correct construction and fitting of textile product	Poor construction and fitting of textile product	Incorrect construction and fitting of textile product

3. THE DESIGN PROCESS

The design process will be assessed as it is the driver of the design portfolio evolving into the textile design project.

Each stage of the design process will be assessed with their specific rubrics developed.

Engineering Design Process

1. Analyse the context and background, and clearly define the problem.

Context and background

There is an arts production and fashion show that is set in contemporary Papua New Guinea. PNG has gone through significant transitions from traditional to the modern with great influences from other cultures. Textiles, clothing and fashion have seen so much change which has also taken inspirations from other cultures, historical eras, fashion trends, street fashion or iconic people in the entertainment industries and sports. There is a need for the design and construction of contemporary textiles project to be showcased during the arts production and fashion show.

Students design, produce and evaluate an assigned textile project. The textile item needs to demonstrate a clear link to the inspiration and reflect appropriate *choice of fabrics* and *construction techniques* including *tools and equipment.* The supporting documentation [design portfolio] should include:

- sources of inspiration
- generation of final design ideas
- samples of resources
- an appropriate care label
- experimentation and justification of equipment and construction

The Design Process

Identify the Problem

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Analyse the context and analyse issue and the problem	Analyse the context and analyse issue and the problem with logical results, justifications and examples	Analyse the context and analyse issue and the problem with clear results and justifications	Analyse the context and analyse issue and the problem with no clear results	Do not analyse the context and analyse issue and the problem
Considerations of ideas, themes,	More considerations of ideas, themes, with examples	A lot of considerations of ideas, themes,	Few considerations of ideas, themes,	No considerations of ideas, themes,
Propose design solutions	Propose design solutions with clear and realistic expectations of results	Propose design solutions with clear expectations of results	Propose design solutions with no clear results	Do not propose design solutions
Selection of the appropriate design solution	Excellent selection of the appropriate design solution	Very good Selection of the appropriate design solution	Poor selection of the appropriate design solution	Do not select of the appropriate design solution

Do Research

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Design research questions	Excellent design of research questions	Very good design of research questions	Poor design of research questions	Do not design research questions
Conduct research	Excellent Conduct of research	Very good Conduct of research	Few research done	Do not conduct research
Evidence of research findings	Excellent Evidence of research findings	Very good Evidence of research findings	Poor evidence of research findings	No evidence of research findings
Evidence of constraints and limits identified	Excellent evidence of constraints and limits identified	Very good evidence of constraints and limits identified	Poor evidence of constraints and limits identified	No evidence of constraints and limits identified
Evidence of critical considerations of how the solution is the most appropriate	Excellent evidence of critical considerations of how the solution is the most appropriate	Very good evidence of critical considerations of how the solution is the most appropriate	Poor evidence of critical considerations of how the solution is the most appropriate	No evidence of critical considerations of how the solution is the most appropriate

Develop Possible Solutions

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Brainstorm possible design solutions to address the problem identified	Excellent and logical brainstorm of possible design solutions to address the problem identified	Logical brainstorm of possible design solutions to address the problem identified	Some brainstorm done for possible design solutions to address the problem identified	No brainstorm of possible design solutions to address the problem identified
Evidence of variations of design solution being proposed	A good collection of evidence of variations of design solution being proposed	Clear and sufficient evidence of variations of design solution being proposed	Some evidence of variations of design solution being proposed	No evidence of variations of design solution being proposed
Identify the pros and cons of a possible design solution	Clearly identify the pros and cons of a possible design solution with checklist done,	Clearly identify the pros and cons of a possible design solution	Does identify the pros and cons of a possible design solution	Do not identify the pros and cons of a possible design solution

Choose One Solution

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Presentation of proposed design solutions in detail	Excellent presentation of proposed design solutions in detail	Very good presentation of proposed design solutions in detail	Poor presentation of proposed design solutions in less detail	No presentation of proposed design solutions in detail
Study of details of proposed design	Meticulous In-depth study of the details of the proposed design	Good and in-depth study of details of the proposed design	Minimal study of the details of proposed design	No study of the details of the proposed design
Considerations of constraints, cost and time in making the design solution	Clear and justified considerations of constraints, cost and time in making the design solution	Clear considerations of constraints, cost and time in making the design solution	Minimal considerations of constraints, cost and time in making the design solution	No considerations of constraints, cost and time in making the design solution
Selecting the appropriate design solution	Clear and justified selection of the appropriate design solution	Clear selection of the appropriate design solution	No clear selection of the appropriate design solution	No selection of the appropriate design solution

Design and Construct a Prototype

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Technical sketches of design product complete with measurements	All technical sketches of design product are complete with and guided explanations	All technical sketches of design product complete with measurements	Few technical sketches of design product with some measurements	No technical sketches of design product
Sketches are in 2D and 3D	All sketches are in 2D and 3D drawings and have very clear details	All sketches are in 2D and 3D drawings with clear details	Not all sketches are in 2D and 3D drawings	Sketches are not in 2D and 3D drawings
Materials are selected	Appropriate materials are selected well considering criteria for performance in making the prototype	Appropriate materials are selected well for good performance when making the prototype	Materials are selected for performance but not considering performance when making the prototype	Materials are not selected for performance in the making of the prototype

The processes in making the prototype	The processes in making the prototype are outlined and followed	The processes in making the prototype are followed	The processes in making the prototype are followed but with some stages missed.	The processes in making the prototype are not followed
Testing the prototype	Complete and successful testing of the prototype	Complete testing of the prototype	Incomplete testing of the prototype	No testing of the prototype done
Design of questions asked when the prototype is tested	Very Clear and well design of questions for testing the prototype	Clear and direct Design of questions for testing the prototype	Few questions designed for testing the prototype	No design of questions for testing the prototype
Keeping a record of the process of testing the prototype	Excellent record kept of the process of testing the prototype	Good and clear record kept of the process of testing the prototype	Incomplete record kept of the process of testing the prototype	No record kept of the process of testing the prototype

Communicate Results

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Communicating the results of the prototype test using detailed diagrams	Very clear and detailed communication of the results of the prototype test using detailed diagrams	Clear communication of the results of the prototype test using detailed diagrams	No clear Communication of the results of the prototype test	No Communication the results of the prototype test
Use of mathematical evidence, sketches, graphs	Clear and detailed use of mathematical evidence, sketches, graphs including conclusions	Clear and detailed use of mathematical evidence, sketches, graphs	Minimal use of mathematical evidence, sketches, graphs	No use of mathematical evidence, sketches, graphs
Evidence of shared learning in analyzing the results of the test	Clear evidence of shared learning in analyzing the results of the test	Good evidence of shared learning in analyzing the results of the test	Minimal evidence of shared learning in analyzing the results of the test	No evidence of shared learning in analyzing the results of the test

Evaluate and Redesign

Performance Standard/Criteria	**Advanced 4**	**Meet Standard 3**	**Progressing 2**	**Not Yet 1**
Evaluate the results of the prototype test	Clear evaluation of the results of the prototype test with details shown	Clear evaluation of the results of the prototype test	No clear evaluation the results of the prototype test	No evaluation of the results of the prototype test
Considerations of what worked and what did not	Clear and confident considerations of what worked and what did not	Clear considerations of what worked and what did not	No clear considerations of what worked and what did not	No considerations of what worked and what did not
Evidence of decisions made after the prototype test, to re-modify or change the design solution	Clear and concrete evidence of decisions made after the prototype test, to re-modify or change the design solution	Very clear evidence of decisions made after the prototype test, to re-modify or change the design solution	No clear evidence of decisions made after the prototype test, to re-modify or change the design solution	No Evidence of decisions made after the prototype test, to re-modify or change the design solution

GRADING

The Grading of the Moderation Project will cover the three components.

Criteria	**A 55-60**	**B 45-54**	**C 30-44**	**D 0-29**
The Design Portfolio	An excellent and orderly compilation of all evidences of the project designing, making and evaluating.	An excellent compilation of all evidences of the project designing, making and evaluating.	A good compilation of evidences of the project designing, making and evaluating.	A poor compilation of evidences of the project designing, making and evaluating.
The Textile Product Construction	Completed construction of the textile product on time with controlled costs and time	Completed construction of the textile product on time	Completed construction of the textile product with no consideration for time, costs	Poorly completed construction of the textile product
The Design Process	Strictly followed the design process fulfilling all the stages.	Followed the design process fulfilling all the stages.	Followed the design process fulfilling some stages but yet incomplete	Not followed the design process and not fulfilling the stages.

CERTIFICATION

a. School based

b. Trade based/accreditation in line with TVET competency and proficiency tests

Practical experiences

To satisfy the requirements of the syllabus and teacher guides students must undertake a range of practical experiences that occupy the majority of course time. Practical experiences will be used to develop knowledge and understanding of and skills in designing, producing and evaluating. Student capability, confidence and expertise at their current stage of development are an important consideration in determining the teaching and learning sequences in the course. Students with disability may require adjustments and/or additional support in order to engage in practical experiences.

Safety

Schools have a legal obligation in relation to safety. Teachers need to ensure that they comply with relevant legislation as well as system and school requirements in relation to safety and risk management when implementing their programs. This includes legislation and guidelines relating to Work Health and Safety, and the handling and storage of chemicals and dangerous goods. Teachers need to be aware of activities that may require notification, certification, permission, permits and licenses.

Schools need to be aware of legal, ethical and cyber security considerations of digital solutions, including copyright and intellectual property, cultural considerations, accessibility, privacy issues and digital footprints.

Reporting, Monitoring and Evaluation

Recording, reporting, monitoring and evaluation are integral part of assessment for students from grades 9 to 12. Therefore, it is commended that recording, reporting, monitoring and evaluation of students achievements for Business and Technology Subjects must be done by grade levels in school based assessment or also referred to as internal school assessment.

The marks awarded to students in their internal assessment will be a combination of the internal assessment mark and the examination mark.

Internal assessment provides a measure of student's achievements based on a wider range of syllabus content and benchmarks than maybe covered by the external examination. Business and Technology subjects provide a summation of each student's achievement in Grades 9-12. The internal assessment mark must comply with the types of tasks and assessment rubrics specified in the holistic or analytic rubrics. The external examination provides a measure of student achievement of those aspects of the content standards that can be reliably measured in an examination setting.

Recording

Standards based recording and reporting is about student understanding and mastering a learning standard and less about grades. A standards based report card can list the most important skills students should learn in each subject at a particular grade level. Instead of letter grades, students receive marks or a code that show how well they have mastered the skills. The marks or codes that schools use to represent student progress are;

A- Advanced
B- Proficient
C- Progressing
D-Novice

The standards are basically the learning standards and expectations for each grade level. SBC requires a new and effective way of recording and reporting to measure progress of student's performance such as in Project Based Learning. Reporting progress is based on the teaching and learning strategies for performance based learning which are accurately assessing the performance towards mastery. The teaching model is changing therefore the performance measurements of Standards-Based Reporting will be more reflective of learning in the classroom. Hence, SBA allows students to be able to know against which criteria they will judge their work, and the standards attached to each of the criteria. It tells students what is required and allows teachers to gain a sense of how students are doing overall based on their achievement of the standards and promotes mastery learning.

Schools must maintain and submit student assessment records according to the school based assessment policy. Teachers can record the evidence of students' demonstrations' of achieving the content standards and benchmarks using assessment instruments that are manageable. Here are some recommended recording methods;

- Individual or class checklists or class grid to record observations
- Comments on students work indicating what they have done well and where they need to improve
- Work samples being added to a portfolio

- Test marks
- Students assessments of their own performances using rubrics or assessment criteria and
- Students assessment of their peers using the assessment criteria

Students are given constructive feedback by the teacher on what they can do well and what they need to improve on. Likewise, teachers are focused on the content they are assessing and are able to apply fair, precise and consistent judgment.

Reporting

Teachers are obliged to report on what students have done or how well they have performed and how they improve further. Formal reporting through written reports and interviews are done to inform parents and guardians of the students learning progress and other related areas such as behavior. Teachers must ensure that the student has demonstrated and achieved the standards independently on a number of occasions. These can be done formally or informally. The achievements are reported to respected stakeholders in relation to;

- Weaknesses in the learner
- Strengths in the learner
- Parent and guardian support and
- Evaluation

Purpose of Reporting

- **Students Are Provided with Appropriate Feedback that Will Improve their Skills**

In a standards-based learning approach, teachers are expected to provide their students with quality feedback that will improve student learning. As opposed to the traditional grading system that only provides students with a single numerical or letter grade, the standards-based grading system requires teachers to provide their students with meaningful and appropriate feedback that will accelerate mastery of learning standards. It is believed that standards-based grading allowed students to identify their areas of growth and to improve on their own competencies. Teachers need to communicate with their students what each proficiency score means and should be explained to the students' parents what each score means and how they can help their children demonstrate mastery of learning standards expected of them for the subject.

- **Students Can Track their Progress**

In a standards-based grading approach, students understand the meaning of each score that they receive. Because there are rubrics that explain the meaning of each proficiency score, students can easily monitor which standards need to be improved further and which learning standards have already been met. as such, students begin to monitor their progress and become accountable for their learning goals.

Interventions and Monitoring

Underachievement is poorer than expected performance. Students who consistently display performance demonstrative of underachievement are identified and interventions for regress

are planned to promote learning. Such interventions should be planned not as a general aspect but should address individual students' limitations in learning and should encourage learning.

- **Monitoring of Students Learning**

Monitoring of students learning is done through strategies that teacher devise to track their teaching and students achievement. This is through the assessment program, classroom teaching, and performance in performance-based learning and students self- assessment in achieving the learning standards.

- **Re-planning**

Re-planning of teaching programs and lesson planning are addressed apart from the planning and programming for all other students. This is specifically addressing underachievers. Re-planning includes teaching and learning strategies, resources, remedial activities which can be planned into the normal teaching times instead of creating extra times after classes.

Certification

Certifying of students must be done through an awarding system which will determine the level of achievement. This will be in a form of achievement statements suggested below;

Levels of achievement

1. Very high achievement
2. High achievement
3. Satisfactory achievement
4. Low achievement
5. Below requirement level

All teachers responsible for grades 9-12 must consider school based assessment levels of achievements to be affected across all Business and Technology Subjects.

GLOSSARY

Building Glossary	
Aesthetics	Characteristics of a product or system that makes it look beautiful and attractive.
artefact	A manufactured object.
anthropometrics	(linked to ergonomics) Measurements of people's shapes and sizes. Such measurements are usually taken when products are designed for human use, e.g. furniture, eating utensils, hairdryers, sporting equipment cars, clothing, etc.
Conventions	Ways of showing information on designs or working drawings that are understood and recognised to have specific meaning.
Craft	The repetitive production of artefacts, usually for sale. It requires skill in planning the production and making of items and needs manual dexterity and artistic skill. Craft occupations include carpentry, sewing and pottery. It typically involves repetition where many items, often using existing patterns or plans, are manufactured during a production run. Although there is common ground, craft should not be confused with Technology, nor with Art
Criteria	Statements of a particular standard or requirement that a solution must satisfy.
design (noun)	The plan, sketch, model, drawing, etc. that outlines or shows the intention of the proposed solution.
design brief	A short and clear statement that gives the general outline of the problem to be solved as well as the purpose of the proposed solutions.
design process	A creative and interactive approach used to develop solutions to identified problems or human needs. The associated skills are investigating, designing (development of initial ideas), making, evaluating and communicating. The design process is utilised by engineers, architects, industrial designers, and many others when developing original ideas to meet needs or wants, and to solve problems.
enabling tasks	Activities used to teach and then practice specific skills in preparation for a more advanced task – sometimes also called resource tasks.
Ergonomics	Features of a product or system that makes it user-friendly.
Findings	Things that have been discovered after a process of investigation or research.
Fitness-for-purpose	A solution should be evaluated in terms of the design brief, specifications and constraints AND whether it will meet the purpose for which it was designed.
Forming	Changing a material's shape without cutting it.
Identify	Establish who/what something is e.g. identify a type of structure.
Illustrate	Explain or make something clear by using examples or words or diagrams.

Input	The command/information entered into a system.
information	Data that has been processed (recorded, classified, calculated, stored, etc.). Knowledge is gained when different kinds of information are compared and conclusions are drawn.
isometric	A 3D drawing where the lines of sight are set at 30 degrees.
machine	A device made up of a combination of simple mechanisms linked so as to form a system for the purpose of doing work. It can be designed to increase the mechanical advantage and decrease the velocity ratio OR to increase the velocity ratio while decreasing the mechanical advantage.
materials	Physical substances used in technology, e.g. wood, textiles, fabric, plastic, food, etc
mechanical advantage	A concept that describes how much easier mechanisms or machines can make a particular task. The amount of work done is the same, and the amount of energy expended is the same, but the effort used (force) is less because it is applied over a greater distance, and for a longer period of time.
mechanism	Parts that can turn one kind of force into another and give mechanical advantage or a distance advantage. Mechanisms can be combined to form a machine. The basic mechanisms are the lever and the wedge/inclined plane. Cams/ cranks and pulleys/gears are adaptations of the wheel and axle – which is itself a special case of the first class lever.
mode	A way or manner in which a thing is done.
modelling	The testing of a solution, (product or system). This could include using small replicas (scale models), and intangible representations of the solution (mathematical models, computer models, etc.).
need	A necessity for basic function, e.g. food is a need.
Oblique	A 3D drawing where the depth of an object is projected at a 45 degree angle to the 2D front view.
opportunity	The chance to do something about a need or a want.
Orthographic	A type of 2D drawing. It usually shows three separate views of the same object (e.g. front, top and left views). The technique is used to draw formal working drawings.
output	The actual result obtained from a system.
Perspective	A 3D artistic drawing in which the lines of sight converge to vanishing points on the horizon. It can be drawn either to a single vanishing point or to double vanishing points (at this level).
technological processes	Any process using technology to perform a task e.g. generating electricity, extracting iron from iron ore, galvanising steel by electroplating, injection moulding a plastic bucket, etc.
tension	A force that stretches an object or material, a pulling force.
technological literacy	technological solution A plan that arises by using a systematic problem solving process (ideas, flowcharts, models, etc.). The ability to use, understand, manage and evaluate technology.
Product	The physical/tangible artefact that results from the process (model, poster, chart, etc.).
Preserving	A process that prolongs the natural life of a product.
Process	The part of a system that combines resources to produce an output that is in response to input.
Problem	Something that leads to a need or want and that can give rise to an

	opportunity.
Pulley	A wheel with a groove on its circumference. It is used to transmit movement and is used with a belt or a rope.
Recycle	To reuse all or part of a substance, including breaking it down to raw material status.
recyclable	A material that can be recycled.
safety	The way that a person works with tools, materials and equipment that does not harm themselves or others physically.
Science	The study and description of natural phenomena.
Shaping	A process used to change the shape or contour of materials – shaping always involves the removal or addition of material.
Specification	An organised, detailed description of the requirements/criteria that the solution or product must meet, e.g. safety, size, material, function, human rights, environment, etc. Note: Once a product has been manufactured, the original design specifications become the features of the product, i.e. specifications before = features after.
structure	Something that has been built, made or been put together in a particular way.
technological capability	The ability to use a combination of skills, knowledge, resources in a variety of contexts, to solve a technological problem. Capability leads to technological literacy.
want	Something that people would like but do not actually need (a convenience or a luxury).

Electrical Glossary	
amplitude modulation (AM)	A process of modulating the carrier wave in which the amplitude of the carrier wave is changed in sympathy with the modulating signal (information)
analogue	A system in which changing values are represented by a continuously variable electrical signal
audio	Relating to a system concerned with frequencies within the range of human hearing
base	One terminal of a transistor through which 2% of the supply current will flow
binary logic	An assembly of digital logic elements which operate with two distinct states
binary number	A number system to the base 2
bandwidth	The range of frequencies to which a system will respond in the required manner
bipolar-transistor	A transistor in which current is carried through the semiconductor both by holes and electrons; it is a current operated device
bistable	A circuit which can have two stable states, and which can remain in either state indefinitely
Boolean algebra	A system of formal logic used for minimising complex digital systems
Capacitor	A component used in electronic circuits that has the ability to store electrical charge for a period of time
class A amplifier	A system of which the output is identical to the input in terms of frequency and shape but not in amplitude

class B amplifier	A system of which the output signal is altered in amplitude and shape representing half of the output signal
class C amplifier	A system of the output signal is altered in amplitude and shape to represent less than half of the input signal
collector	One terminal of a bipolar transistor through which 98% of the supply current will flow
conductor	A material through which an electric current can flow relatively easily
construction	Encompasses the study of residential, commercial, industrial and recreational applications of Technology, including systems required to maintain and service them
conventional current	Electric current, regarded as flowing from positive to negative
central processing unit (CPU)	The main number-processing and control section of a computer. In a microcomputer the CPU will be a microprocessor.
crystal	Usually refers to quartz crystal, used as a precision timing element in many circuits; may refer to the term piezoelectric
Darlington pair	Transistors used in cascade, giving high gain and high input impedance
decibel (dB)	One-tenth of a bell; a measure of power gain, on a logarithmic scale (e.g. a power level equal to 10 times the common logarithm of the ratio of the output power to the input power). The decibel is a convenient unit for representing a very large range of power gain.
delta network	A combination of three components connected to form a triangular configuration like the Greek letter delta; also known as a mesh connection
demodulation	The process of recovery of a modulating signal from a modulated carrier
design	Includes the study of a variety of basic design processes that are used in solving technological challenges
diac	A bi-directional break over diode; often used for triggering a **triac**
digital electronics	The branch of electronics concerned with the processing of digital systems, usually in binary
diode	A component, either semiconductor or thermionic, that permits current to flow through it in one direction only
electron flow	Regarded as the flow of electrons from negative to positive
emitter	one terminal of a bipolar transistor through which 100% of the supply current will flow
energy	Focuses on domestic, industrial, generation and transmission services
farad	Unit of capacitance; a very large unit, the largest practical unit being the microfarad
fibre-optic	A glass or plastic fibre used for the transmission of information through light
field-effect transistor	A type of transistor characterised by a very high input resistance that is a voltage operated device
flip-flop	General term for a **bistable, astable** or **monostable** circuit
frequency	The number of complete repetitions of a wave form in one second, expressed in Hertz
gain	The factor by which the output of a system exceeds the input
gate	A component in a digital logic circuit or one terminal of a field-effect

	transistor, or other semiconductor device
henry	Unit of inductance
integrated circuit	An electronic system, or part of a system, produced on a silicon chip using microelectronic techniques
impedance	The ratio of the voltage applied to a circuit to the current flowing in the circuit; similar to resistance, but applicable to alternating currents and voltages
insulator	A material through which electric current will not easily flow
Karnaugh mapping	A visual technique used in the planning of digital systems for the minimisation of logic circuits
liquid crystal display (LCD)	A reflective display used in digital systems for the presentation of output; characterised by a very low power consumption
light-emitting diode (LED)	An electronic component in which electric current is converted directly into visible or infrared light
logic	The basic principles and applications of truth tables, interconnections of on/off circuit elements, and other factors involved in mathematical computation in a computer; also used as a general term for various types of **gates, flip-flops,** and other on/off circuits used to perform problem-solving functions in a digital computer
manufacturing and materials	Product design, process and production planning, raw materials, manufacturing processes and quality control
microcomputer	A computer in which the central processing unit is a microprocessor
microprocessor	A central processing unit constructed using large-scale integration in which all the CPU circuits are fitted into a single integrated circuit
modulation	Variation of the frequency, phase or magnitude of a high frequency waveform in accordance with a waveform of lower frequency
monostable	A circuit with a single stable state
multimeter	A general-purpose measuring instrument, usually able to measure resistance, current and voltage
negative feedback	Feedback applied to a system in such a way that it tends to reduce the output
NPN	One of the two alternative types of bipolar transistors
Ohm	The unit of resistance (Ù)
operational amplifier	A highly stable, **gain,** DC amplifier, usually produced as a single integrated circuit
opto-electronics	Electronic systems or devices that involve the use of light
Oscillator	An electronic system that produces a regular periodic output
Oscilloscope	An instrument for displaying electrical waveforms on a cathode ray tube
photo-resistor	Also known as an LDR (light-dependent resistor); a resistor whose value depends upon the amount of light falling on it
piezoelectric effect	The direct conversion of electrical to mechanical energy or vice versa in some crystalline materials
programmable logic controller (PLC)	A control device, normally used in industrial control applications, that employs the hardware architecture of a computer and a programming language
PNP	One of the two alternative types of bipolar transistor
power supply	Source of electrical energy
positive feedback	Feedback applied to a system in such a way that it tends to increase

	the output
protective device	A particular type of equipment used in electric power systems to detect abnormal conditions and to initiate appropriate corrective action
rectification	the process of changing an alternating current to a unidirectional current
relay	An electromechanical device in which an electric current controls a switch
resistance	The property of a material that resists the flow of electrical current
speaker	An electromechanical device for converting electrical energy into sound (e.g. a loudspeaker)
star network	A set of three or more branches with one terminal of each connected at a common node to give the form of a star; also known as a Y connection
technological process	The identification, design, development and evaluation of processes and products related to Electrical Technology
thyristor	A component similar to a semiconductor diode but having in addition a gate connection by which the component, normally non-conducting, can be triggered into conduction
tolerance	Generally the amount by which a specified component value can vary from the marked value
triac	Asemiconductor component similar to the **thyristor** but which will conduct in either direction
uni-junction transistor	A semiconductor device used in some oscillators
voltage regulation	A process to maintain the terminal voltage within required limits despite variations in input voltage or load
wavelength	The physical distance between two similar and successive points on an alternating wave
zener diode	A semiconductor **diode**, used for voltage regulation. When the zener diode is reverse-biased, it exhibits a sudden increase in conductivity at a certain specific voltage

Plumbing Glossary	
Back Flow	The act of water traveling from one system back into any part of the main distribution system (usually by siphoning).
Back Flow Preventer	A device to prevent backflow i.e. into a potable water supply. Usually required for sprinkler systems, handheld showers, pullout faucet spouts, kitchen sprayers, etc..
Back Pressure	Pressure that resists the flow of fluid in a piping system
Back Siphonage	The negative pressure that causes backflow..
Back Vent	: Plumbing fixture's separate vent in a building drainage system
Back Wash	The process of cleaning a filter by reversing the flow of water through it. Accumulated sediments are sent to waste.
Black Water	The discharge from water closet and urinal is called Black water.
Building Drain (BD)	The building drain is the part of the lowest horizontal piping of a drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls of the building and conveys it to the building sewer beginning one meter outside the building wall...
Building drainage	consists of plumbing fixtures, drainage pipes & fittings and septic

system	tanks/public sewer
Building Sewer	The building sewer is the part of the horizontal piping of a drainage system which extends from the end of the building drain and which receives the discharge of building drain and convey it to a public sewer, private sewer, individual sewage disposal system or other point of disposal
Check Valve	A type of backflow preventer installed in a pipe run that allows water to flow in only one direction.
Drain/waste/soil pipes	are large pipes that carry waste water and other wastes away from the home and into appropriate places such as septic tanks or sewer mains.
DWV	In modern plumbing, a **drain-waste-vent** (or DWV) is a system that allows air to enter the plumbing system to maintain proper air pressure to enable the removal of sewage and greywater from a dwelling. Drain refers to water produced at fixtures such as sinks, and showers; waste refers to water from toilets. As the water runs down, proper venting is required to allow water to flow freely, and avoid a vacuum from being created. As the water runs down air must be allowed into the waste pipe either through a roof vent (external), or an internal vent
Faucet	a fixture for drawing or regulating the flow of liquid especially from a pipe
Frost Line	The line joining the points of greatest depths below ground level up to which the moisture in the soil freezes.
Galvanizing	The process of applying a coating of zinc to the finished product to provide corrosion protection. The coating can be applied by hot dipping or electrolytic deposition.
Grey Water	The discharge from bathtubs, showers, wash basins, kitchen sink, washing machine which does not contain human excreta is called Grey Water.
Hard Water	Natural water containing impurities in various proportions. Traditional hardness is a measure of calcium or dissolved solids in a solution, measured in parts per million. Hard water generally ranges from 100 to 250 ppm.
High Altitudes	Elevations higher than 1 500 m above mean sea level (MSL).
Hydraulic Pressure	Pressure that exists in a system containing non-compressible liquid.
Invert Level	The distance between the ground surface level to the base interior level of a sewer pipe
Lagging	. Thermal insulation on pipes.
Leach Field	Porous soil area, through which septic tank leach lines run, emptying the treated waste.
Leach Lines	Pipes that carry effluent from the septic system out to the leach field.
Leach pit	Leach pits/ Soak pits/ Seepage pits are used to remove contaminants and impurities from the liquid that emerges from the septic tank and safely disperses the same into the soil.
Leakage	Loss of fluid usually due to mechanical breakdown or gasket wear.
Manhole	Access opening to a hole, usually with a cover, through which a person may enter a sewer, boiler, drain, etc. (usually round to prevent the cover from falling into the opening).
Manhole Cover	A manhole cover is a removable plate forming the lid over the opening of a manhole, to prevent anyone or anything from falling in, and to keep out unauthorized persons and material.
Outlet / Discharge	The opening through which the water exits the pump

Outlet Sewer	Pipe section in a septic system which runs between the septic tank and the drainage field.
Overflow Tube	The vertical tube inside a toilet tank that directs water into the bowl in case the ballcock malfunctions. It is usually part of the flush valve. It prevents potential water damage caused by a tank overflow. A "constant-running" condition alerts the user to a problem. On most toilets, the overflow tube also has a refill tube flowing into it, which directs water from the ballcock through the overflow tube to the bowl, after a siphon break.
Pipes	a hollow cylinder used to move liquids, gases or oil. Pipes come in several types and sizes. They can be divided into three main categories: **metallic pipes, cement pipes and plastic pipes**. Metallic pipes include steel pipes, galvanised iron pipes and cast iron pipes. Cement pipes include concrete cement pipes and asbestos cement pipes
Pipe fittings	A **fitting** or **adapter** is used in pipe systems to connect straight sections of pipe or tube, adapt to different sizes or shapes, and for other purposes such as regulating (or measuring) fluid flow.[1] These fittings are used in plumbing to manipulate the conveyance of water, gas, or liquid waste in domestic or commercial environments, within a system of pipes or tubes.
Plumber	A plumber is a person who installs and maintains piping for water and their drains and waste systems in a dwelling, business or industrial facility. He installs bathroom appliances such as showers, toilets, sinks, kitchen appliances (e.g. dishwashers), water heaters required in a new or remodelled houses or buildings. Plumbers need various skills to perform their jobs successfully like blueprint reading, ability to locate through diagrams locations for installation of pipes, fitting pipes together for the correct functioning of plumbing systems. A plumber shall be aware of basic Plumbing Codes and Standards specified.
Plumbing	Pipes, fixtures and other apparatus inside a building for bringing in water supply and removing the waste water out of the building constitute plumbing system. Plumbing is a skilled trade of working with the above pipes, fixtures and apparatus for use with water and drainage.
Plumbing Fixture	A general term applied to any plumbing receptacle, device or appliance that can be temporarily or permanently fixed in place. It is connected to the drinking-water supply or to the drainage system either by an indirect or direct connection.
Plumbing Vent Pipes	are an integral part of a plumbing system as they allow the piping to "breathe". Air flow is necessary to equalize pressure in plumbing systems and plumbing vents allow for proper flow of air through the pipes.
Pressure Pipes	that carry fresh water to various fixtures.
Raw Water	Water supplied to the plant before any treatment.
Sanitary Fitting	Fitting that joins the assorted pipes in a drain, waste, and vent system, designed to allow solid material to pass through without clogging.
Sanitary Sewer	House drain that carries wastewater away from the house to a sewer system or septic tank.
Scale:	A thin coating or layer, usually calcium on the bottom of a tank or interior parts that may prevent heat transfer.

Sewer Gas:	Gases, esp. methane, which may be combustible and poisonous from the decay of organic materials in the sewer system.
Septic Tank (ST)	A Septic Tank is a watertight concrete box, buried in the ground just outside the home. The septic tank acts as a small-scale sewage treatment system common in areas where no connection to main sewerage system provided by the local body. It helps in disposing of household sewage / wastewater safely.
Septage	Black Water which undergoes treatment in septic tank is called Septage
Sewage	is the water, carrying body wastes including human excreta and other house hold waste. a) The discharge from water closet and urinal is called Soil or Black Water. b) The discharge from bathtubs, showers, wash basins, kitchen sink, washing machine which does not contain human excreta is called Waste Water / Sullage / Grey Water.
Sewerage system	Sewerage system is a closed system of pipes from the waste receptacle to the final disposal point either on land or into a body of water and the flow is gravitational or free flow and not under pressure as in the case of water supply pipes
Sovent Single Stack DWV System	The Sovent System is an engineered single stack drainage system. It offers a different concept of waste and venting by slowing the velocity of liquids and solids through a series of aerator fittings and double offsets. Before entering the building drain a deaerator fitting is placed at the base of the stack to minimize solid build up and slow the drainage before entering the building drain.
Stack	Any vertical pipe in the system like vertical soil or vent pipe is called stack.
Vent Stack	Upper portion of the soil stack above the topmost fixture through which gases and odours escape

Welding Glossary	
acceptable weld	A weld that meets the applicable requirements.
acetone	A colorless, flammable, volatile liquid used as a paint remover and as a solvent for oils and other organic compounds. Used in acetylene cylinders to saturate the monolithic filler material to stabilize the acetylene
acetylene feather	The intense white, feathery-edged portion adjacent to the cone of a carburizing oxyacetylene flame.
actual throat	The shortest distance between the weld root and the face of a fillet weld.
adhesion	A state of being stuck together. The joining together of parts that are normally separate.
aluminum	One of the chemical elements, a silvery, lightweight, easily worked metal that resists corrosion
ampere	A unit of electrical current measuring the rate of flow of electrons through a circuit. One ampere is equivalent to the current produced by one volt applied across a resistance of one ohm.
annealing	A process of heating then cooling metal to acquire desired qualities such as ductility
anode	The positive terminal of an electrical source.

alloy	A substance with metallic properties, composed of two or more chemical elements of which at least one is a metal
alloying element	Elements added in a large enough percentage to change the characteristics of the metal. Such elements may be chromium, manganese, nickel, tungsten, or vanadium; these elements are added to produce specific physical properties such as hardness, toughness, ductility, strength, resistance to corrosion, or resistance to wear.
alloy steel:	A plain carbon steel to which another element, other than iron and carbon, has been added in a percentage large enough to alter its characteristics
alternating current (AC)	An electric current that reverses its direction periodically.
alternative fuels	Propane, methylacetylene propadiene (MPS), natural gas, or fuel gases, other than acetylene, used for welding or cutting.
arc blow	The deflection of an arc from its normal path because of magnetic forces.
arc force	The axial force developed by an arc plasma.
arc gap	A nonstandard term used for the arc length.
arc gouging	Thermal gouging that uses an arc cutting process variation to form a bevel or groove.
arc plasma	A gas that has been heated by an arc to at least a partially ionized condition, enabling it to conduct electric current.
arc spraying	A thermal spraying process using an arc between two consumable electrodes of surfacing materials as a heat source and a compressed gas to atomize and propel the surfacing material to the substrate
arc strike	A discontinuity resulting from an arc, consisting of any localized re-melted metal, heat-affected metal, or change in the surface profile of any metal object.
arc time	The time during which an arc is maintained in making an arc weld.
arc welding	Arc welding is a group of welding processes in which fusion is produced by heating with an electric arc or arcs with or without the application of pressure and with or without the use of filler metal.
arc voltage	The voltage across the arc.
axis of a weld:	A line through the length of a weld, perpendicular to and at the geometric center of its cross-section.
backing	A material or device placed against the back side of the joint, or at both sides of a weld in electroslag and electrogas welding, to support and retain molten weld metal. The material may be partially fused or remain unfused during welding and may be either metal or nonmetal.
backstep sequence	A longitudinal sequence in which weld passes are made in the direction opposite to the progress of welding.
bare electrode	A filler metal electrode consisting of a single metal or alloy that has been produced into a wire, strip, or bar form and that has had no coating or covering applied to it other than that which was incidental to its manufacture or preservation.
base metal (material)	The metal (material) to be welded, brazed, soldered, or cut
butt joint	A joint between two members aligned approximately in the same plane.
concavity	The maximum distance from the face of a concave fillet weld perpendicular to a line joining the weld toes.

convexity	The maximum distance from the face of a convex fillet weld perpendicular to a line joining the weld toes.
covered electrode	A composite filler metal electrode consisting of a core of a bare electrode or metal cored electrode to which a covering sufficient to provide a slag layer on the weld metal has been applied. The covering may contain materials providing such functions as shielding from the atmosphere, deoxidation, and arc stabilization and can serve as a source of metallic additions to the weld.
crater	In arc welding, a depression at the termination of a weld bead or in the molten weld pool
depth of fusion	The distance that fusion extends into the base metal or previous pass from the surface melted during welding.
DC or direct current	Electric current which flows only in one direction. In welding, an arc welding process wherein the power supply at the arc is direct current.
fillet weld	A weld of approximately triangular doss section joining two surfaces approximately at right angles to each other in a lap joint, T-joint or corner joint.
fillet weld leg	The distance from the joint root to the toe of the fillet weld.
flat position	The welding position used to weld from the upper side of the joint; the face of the weld is approximately horizontal.
flux	Material used to prevent, dissolve, or facilitate removal of oxides and other undesirable surface substances
gas metal arc welding(GMAW)	An arc welding process that produces coalescence of metals by heating them with an arc between a continuous filler metal (consumable) electrode and the work. Shielding is obtained entirely from an externally supplied gas or gas mixture.
gas tungsten arc welding (GTAW)	An arc welding process that produces coalescence of metals by heating them with an arc between a tungsten (non-consumable) electrode and the work. Shielding is obtained from a gas or gas mixture. Pressure may or may not be used and filler metal may or may not be used. (This process has sometimes been called TIG welding, a non-preferred term.)
groove weld	A weld made in the groove between the work pieces.
heat-affected zone	That portion of the base metal that has not been melted, but whose mechanical properties or microstructure have been altered by the heat or welding, brazing, soldering, or cutting.
horizontal position	(a) fillet weld - The position in which welding is performed on the upper side of an approximately horizontal surface and against an approximately vertical surface. (b) groove weld - The position of welding in which the weld axis lies in an approximately horizontal plane and the weld face lies in an approximately vertical plane.
joint penetration	The depth a weld extends from its face into a joint, exclusive of reinforcement.
lap joint	A joint between two overlapping members in parallel planes
machine welding	Welding with equipment that performs the welding operation under the constant observation and control of a welding operator. The equipment may or may not load and unload the work pieces.
manual welding	A welding operation performed and controlled completely by hand.
melting rate	The weight or length of electrode melted in a unit of time
open circuit voltage	The voltage between the output terminals of the welding machine

	when no current is flowing in the welding circuit.
overhead position	The position in which welding is performed from the underside of the joint.
overlap	The protrusion of weld metal beyond the weld toe or weld root.
peening	The mechanical working of metals using impact blows.
porosity	Cavity type discontinuities formed by gas entrapment during solidification.
post heating	The application of heat to an assembly after welding, brazing, soldering, thermal spraying or cutting operation.
pre heating	The application of heat to the base metal immediately before welding, brazing, soldering, thermal spraying, or cutting
root opening	A separation at the joint root between the work pieces.
root penetration	The depth that a weld extends into the joint root.
seal weld	Threaded joint sealed, without thread compound, by back welding.
semiautomatic arc welding	Arc welding with equipment that controls only the filler metal feed. The advance of the welding is manually controlled
shielded metal arc welding	(SMAW) An arc welding process that produces coalescence of metals by heating them with an arc between a covered metal electrode and the workpieces. Shielding is obtained from decomposition of the electrode covering. Pressure is not used and filler metal is obtained from the electrode.
spatter	The metal particles expelled during fusion welding which do not form a part of the weld.
stress relief heat treatment	Uniform heating of a structure or a portion thereof to a sufficient temperature to relieve the major portion of the residual stresses, followed by uniform cooling.
stringer bead	A type of weld bead made without appreciable weaving motion.
tack weld	A weld made to hold parts of a weldment in proper alignment until the final welds are made.
tungsten electrode	A non-filler metal electrode used in arc welding or cutting made principally of tungsten
underbead crack	A crack in the heat-affected zone generally not extending to the surface of the base metal.
undercut	A groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by weld metal
vertical position	The position of welding in which the weld axis is approximately vertical.
	weave bead A type of weld bead made with transverse oscillation.
weld	A localized coalescence of metals or non-metals produced either by heating the materials to welding temperature, with or without the application of pressure, or by the application of pressure alone, and with or without the use of filler material.
weld face	The exposed surface of a weld on the side from which welding was done.
weld metal That	portion of a weld which has been melted during welding.
weld pass	A single progressional of welding or surfacing along a joint or substrate. The result of a pass is a weld bead, layer, or spray deposit.
weld pool	The localized volume of molten metal in a weld prior to its solidification as weld metal. weld root: The points, as shown in cross section, at which the back of the weld intersects the base metal surfaces
weld size	(a) groove weld size - The joint penetration of a groove weld. (b) fillet

	weld size - For equal leg fillet welds, the leg lengths of the largest isosceles right triangle which can be inscribed within the fillet weld cross section For unequal leg fillet welds, the leg lengths of the largest right triangle that can be inscribed within the fillet weld cross section.
weld toe	The junction of the weld face and the base metal
welding procedure	The detailed methods and practices involved in the production of a weldment.
welding rod	A form of welding filler metal, normally packaged in straight lengths, that does not conduct electrical current.
weldment	An assembly whose component parts are joined by welding.

Engineering Glossary	
Acceptance	The process of assessing whether a system satisfies all its requirements
Acceptance test	A test that assesses whether a system satisfies all requirements.
Activity Diagram	A diagram type in UML which models the flow of actions in a system or in a component including the data flows and areas of responsibility where necessary.
Actor	Generally in Requirements Engineering, a person, a system or a technical device in the context of a system that interacts with a system.
Adequacy (of a requirement)	The degree to which a requirement expresses the stakeholders true desires and needs.
Application domain	Those parts of the real world that are relevant for determining the context of a system.
Artifact	An intermediate or final result of system development; for example, a requirements specification.
Attribute	A characteristic property of an entity.
Baseline	A stable, change-controlled configuration of artifacts
Behaviour model	A model describing the behaviour of a system or component
Bug	A defect
Changeability (of an artefact)	The degree to which an artifact enables a required modification of the artifact.
Checking (requirements)	Comprises requirements validation and checking requirements for qualities such as unambiguity or comprehensibility.
Class	Represents a set of objects of the same kind by describing the structure of the objects, the ways they can be manipulated and how they behave.
Completeness (of requirements)	For a single requirement: the degree to which a requirement contains all necessary information which is necessary to for developing a system that satisfies a stakeholders' desires and needs.
Compliance	The capability of an artifact to adhere to standards, regulations, laws, or other formally imposed documents.
Component	In general; a delimit able part of a system.
Configuration	A consistent set of logically coherent units. The units are individually identifiable artifacts in at most one version per unit.
Conformity (of requirements)	A degree to which a requirements specification conforms to regulations given in some standard.
Consistency (of requirements)	The degree to which a set of requirements is free of contradicting statements.

Constraint	A requirement that limits the solution space beyond what is necessary for meeting the given functional requirements and quality requirements and quality requirements.
Context	In general; the network of thoughts and meanings needed for understanding phenomena. It is also the part of a system's environment being relevant for understanding the system and its requirements.
Context boundary	Boundary between the context of a system and those parts of the application domain that are irrelevant for the system and its requirements.
Context diagram	A diagrammatic representation of a context model.
Context model	A model describing a system in its context.
Correctness	The degree to which the information contained in an artifact is proven as true this is also a synonym of adequacy.
Customer	A person or organisation who receives a product or service.
Customer requirements specification	A course description of the required capabilities of a system from the customer's perspective.
Dataflow diagram	A diagram modelling the functionality of a system or component by processes (also called activities), data stores and data flows. Incoming data flows trigger processes which then consume the received data, transform them, read/write persistent data held in data stores and then produce new data flows which may be intermediate results that trigger other processes or final results that leave the system.
Defect	A spot in an artifact that is incorrectly described or crafted. It can also be called a fault or a bug.
Domain	A range of relevant things (for some given matter),
Effectiveness	The degree to which something actually happens in the way it ought to happen.
Efficiency	The degree to which a result is achieved with minimum consumption of resources.
End user	User
Entity	In general; an element or set of elements that may stand for any conceivable item, e.g., a system, a part of a reality, a thing, an organisation, a process etc.
Entity relationship diagram	A graphic representation of an entity relationship model.
Error	A discrepancy between an observed or result and the specified behaviour or result. AN error is typically a symptom for the existence of a fault or defect in some artifact. Though there may be not much distinction between the notions of error and fault.
Fault	Defect
Fault tolerance	The capability of a system to continue normal operations despite the presence of (hardware and software)faults.
Feature	A delimitable characteristic of a system that provides value for stakeholders.
Goal	A desired state of affairs that a stakeholder wants to achieve. They describe the intentions of stakeholders that may conflict with one another.
Inspection	A kind of review where the artifact under review is inspected by a group of experts according to given criteria. The experts' findings are

	then collected and consolidated.
Language	A structured set of signs for expressing and communicating information. Signs are elements that are used for communication; expressions in a language, symbols, gestures etc.
Model	An abstract representation of an existing reality or a reality to be created.
Modeling language	A language expressing models of a different kind. Maybe textual, graphic or a combination thereof.
Performance requirement	A requirement describing a performance characteristic (timing, speed, volume, capacity,)
Prototype	In manufacturing; apiece which is built prior to the start of mass production.
Quality	The degree to which a set of inherent characteristics of an entity fulfills requirements.
Redundancy	Multiple occurrence of the same information or resource.
Reliability	The capability of a system to maintain a specified level of functionality and performance when used under specified conditions.
Requirement	A condition or capability needed by a user to solve a problem or achieve an objective.
Requirements analysis	Analysis of elicited requirements in order to understand and document them.
Requirements baseline	A baseline for a set of requirements.
Requirements engineer	A person who- in collaboration with stakeholders-elicits, documents, validates and manages requirements.
Review	A formally organised endeavour for checking an artifact by a group of experts. Checking may be performed with respect to both contents and conformance.
Risk	AN event that threatens the success of an endeavour. A risk is assessed in terms of its probability and potential damage.
Safety	The capability of a system to achieve an acceptable level of probability that operating the system will not result in harming people, property or the environment.
Scope (of a system)	The range of things that can be shaped and designed when developing a system.
Security	The capability of a system to protect (a) its data and resources against unauthorised use and (b) its legitimate users against denial of service.
Sequence diagram	A diagram type in UML which models the interactions between a selected set of objects and/ or actors in the sequential order that those interactions occur.
Specification	A systematically represented description of the properties of an entity (a system, a device, etc.) that satisfies criteria.
Stakeholder	A person or organisation that has a (direct or indirect) influence on a systems requirements.
Standard	A uniform regulation for perceiving, manufacturing or executing something.
System context diagram	A diagram that defines the boundary between the system or parts of a system showing the entities that interact with it.
System requirements specification	A requirements specification pertaining to a system.
Tool (in software engineering)	A (software) system that helps develop, operate and maintain systems.

Traceability (of requirements)	The ability to trace a requirement(1) back to its origins, (2) forward to its implementation in design and code,(3) to requirements it depends on (and vice-versa). Origins maybe stakeholders, documents, rationales, etc.
UML	Abbreviation for Unified Modeling Language, a standardised language for modelling problems or solutions
Useability	The capability of a system to be understood, learned, used, and liked by its users.
Use case	A description of the interactions possible between actors and a system. The boundary between the actors and the use cases constitutes the system boundary.
Use case diagram	A diagram type in UML that models the actors and the use cases of a system.
User	A person who uses the functionality provided by a system. Also called an end user.
Validation (of requirements)	The process of checking whether documented requirements match the stakeholders' needs.
Verifiability (of requirements)	The degree to which the fulfilment of a requirement by an implemented system can be checked. E.g. by defining acceptance test cases, measurements or inspection procedures.
Version (of an entity)	If an entity exists in multiple exists in multiple, time ordered occurrences, where each occurrence has been created by modifying one of its predecessors, every occurrence is a version of that entity.
View	An excerpt from an artefact, containing only those parts one is currently interested in. A view can abstract or aggregate parts of the artefact.
Viewpoint	A certain perspective on the requirements of a system.
Walkthrough	A kind of review where the author of an artefact under review walks a group of experts systematically through the artefact. The experts' findings are then collected and consolidated.

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APPENDICES

APPENDIX 1: BLOOM'S TAXONOMY

LEVEL OF UNDERSTANDING	KEY VERBS
CREATING **Can the student create a new product or point of view?**	Construct, design, and develop, generate, hypothesise, invent, plan, produce, compose, create, make, perform, plan, produce, assemble, formulate,
EVALUATING **Can the student justify a stand or decision?**	Appraise, argue, assess, choose, conclude, critique, decide, defend, evaluate, judge, justify, predict, prioritise, provoke, rank, rate, select, support, monitor,
ANALYSING **Can the student distinguish between the different parts?**	Analysing, characterise, classify, compare, contrast, debate, criticise, deconstruct, deduce, differentiate, discriminate, distinguish, examine, organise, outline, relate, research, separate, experiment, question, test,
APPLYING **Can the student use the information in a new way**	Apply, change, choose, compute, dramatise, implement, interview, prepare, produce, role play, select, show, transfer, use, demonstrate, illustrate, interpret, operate, sketch, solve, write,
UNDERSTANDING **Can the student comprehend ideas or concepts?**	Classify, compare, exemplify, conclude, demonstrate, discuss, explain, identify, illustrate, interpret, paraphrase, predict, report, translate, describe, classify,
REMEMBERING **Can the student recall or remember the information?**	Define, describe, draw, find, identify, label, list, match, name, quote, recall, recite, tell, write, duplicate, memorise, recall, repeat, reproduce, state,

APPENDIX 2: 21ST CENTURY SKILLS

WAYS OF THINKING	**Creativity and innovation** • **Think creatively** • **Work creatively with others** • **Implement innovations** **Critical thinking, problem solving and decision making** • **Reason effectively and evaluate evidence** • **Solve problems** • **Articulate findings** **Learning to learn and meta-cognition** • **Self-motivation** • **Positive appreciation of learning** • **Adaptability and flexibility**
WAYS OF WORKING	**Communication** • Competency in written and oral language • Open minded and preparedness to listen • Sensitivity to cultural differences **Collaboration and teamwork** • Interact effectively with others • Work effectively in diverse teams • Prioritise, plan and manage projects
TOOLS FOR WORKING	**Information literacy** • Access and evaluate information • Use and manage information • Apply technology effectively **ICT literacy** • Open to new ideas, information, tools and ways of thinking • Use ICT accurately, creatively, ethically and legally • Be aware of cultural and social differences • Apply technology appropriately and effectively
LIVING IN THE WORLD	**Citizenship – global and local** • Awareness and understanding of rights and responsibilities as a global citizen • Preparedness to participate in community activities • Respect the values and privacy of others **Personal and social responsibility** • Communicate constructively in different social situations • Understand different viewpoints and perspectives **Life and career** • Adapt to change • Manage goals and time • Be a self-directed learner • Interact effectively with others

APPENDIX 3: TEACHING AND LEARNING STRATEGIES

STRATEGY	TEACHER	STUDENTS
CASE STUDY **Used to extend students' understanding of real life issues**	Provide students with case studies related to the topic of the lesson and allow them to analyse and evaluate.	Study the case study and identify the problem addressed. They analyse the problem and suggest solutions supported by conceptual justifications and make presentations. This enriches the students' existing knowledge of the topic.
DEBATE **A method used to increase students' interest, involvement and participation**	Provide the topic or question of debate on current issues affecting a bigger population, clearly outlining the expectations of the debate. Explain the steps involved in debating and set a criteria/standard to be achieved.	Conduct researches to gather supporting evidence about the selected topic and summarising the points. They are engaged in collaborative learning by delegating and sharing tasks to group members. When debating, they improve their communication skills.
DISCUSSION **The purpose of discussion is to educate students about the process of group thinking and collective decision.**	The teacher opens a discussion on certain topic by asking essential questions. During the discussion, the teacher reinforces and emphasises on important points from students responses. Teacher guide the direction to motivate students to explore the topic in greater depth and the topic in more detail. Use how and why follow-up questions to guide the discussion toward the objective of helping students understand the subject and summarise main ideas.	Students ponder over the question and answer by providing ideas, experiences and examples. Students participate in the discussion by exchanging ideas with others.
GAMES AND SIMULATIONS **Encourages motivation and creates a spirit of competition and challenge to enhance learning**	Being creative and select appropriate games for the topic of the lesson. Give clear instructions and guidelines. The game selected must be fun and build a competitive spirit to score more than their peers to win small prices.	Go into groups and organise. Follow the instructions and play to win
OBSERVATION	Give instructions and monitor	Students possess instinct of curiosity

Method used to allow students to work independently to discover why and how things happen as the way they are. It builds curiosity.	every activity students do	and are curious to see the things for themselves and particularly those things which exist around them. A thing observed and a fact discovered by the child for himself becomes a part of mental life of the child. It is certainly more valuable to him than the same fact or facts learnt from the teacher or a book. Students Observe and ask essential questions Record Interpret
PEER TEACHING & LEARNING ***(power point presentations, pair learning)*** **Students teach each other using different ways to learn from each other. It encourages; team work, develops confidence, feel free to ask questions, improves communication skills and most importantly develop the spirit of inquiry.**	Distribute topics to groups to research and teach others in the classroom. Go through the basics of how to present their peer teaching.	Go into their established working groups. Develop a plan for the topic. Each group member is allocated a task to work on. Research and collect information about the topic allocated to the group. Outline the important points from the research and present their findings in class.
PERFORMANCE-RELATED TASKS ***(dramatization, song/lyrics, wall magazines)*** **Encourages creativity and take on the overarching ideas of the topic and are able to recall them at a later date**	Students are given the opportunity to perform the using the main ideas of a topic. Provide the guidelines, expectations and the set criteria	Go into their established working groups. Being creative and create dramas, songs/lyrics or wall magazines in line with the topic.
PROJECT (individual/group) **Helps students complete tasks individually or collectively**	Teacher outline the steps and procedures of how to do and the criteria	Students are involved in investigations and finding solutions to problems to real life experiences. They carry out researches to analyse the causes and effects of problems to provide achievable solutions. Students carefully utilise the problem-solving approach to complete projects.
USE MEDIA & TECHNOLOGY to teach and generate engagement <u>depending on the age of the students</u>	Show a full movie, an animated one, a few episodes form documentaries, you tube movies and others depending on the lesson.	Viewing can provoke questions, debates, critical thinking, emotion and reaction. After viewing, students engage in critical thinking and debate
	Provide questions for students to answer before viewing	

APPENDIX 4: STEAM

This Sample STEAM Lesson Planning is for Business Studies but can be applied to Technology and Industrial Arts.

Strand 2: Business Management

Unit 5: Information Technology

Content Standard 2.5: Students will be able to explain the information technology concepts and examine the systems and tools needed to gather, access, analyse, synthesize, evaluate, manage, and disseminate information.

Benchmark: 12.2.5.2. Explain the steps involved in entering and manipulating text and data using a variety of input technologies.

Topic: Steps in entering and manipulating text and data using a variety of input technologies

Learning Objective: By the end of this topic, students will be able to explore the steps in entering and manipulating text and data using a variety of input technologies.

Purpose of Assessing the Topic (Benchmark):
To assess whether students can be able to use the MS Excel to positively explore the steps in entering and manipulating text and data using a variety of input technologies

How the Performance Task will be done: Group Project Presentation

Performance Standard: By the end of the project, students will be able to use the MS Excel application to positively explore the steps in entering and manipulating text and data using a variety of input technologies.

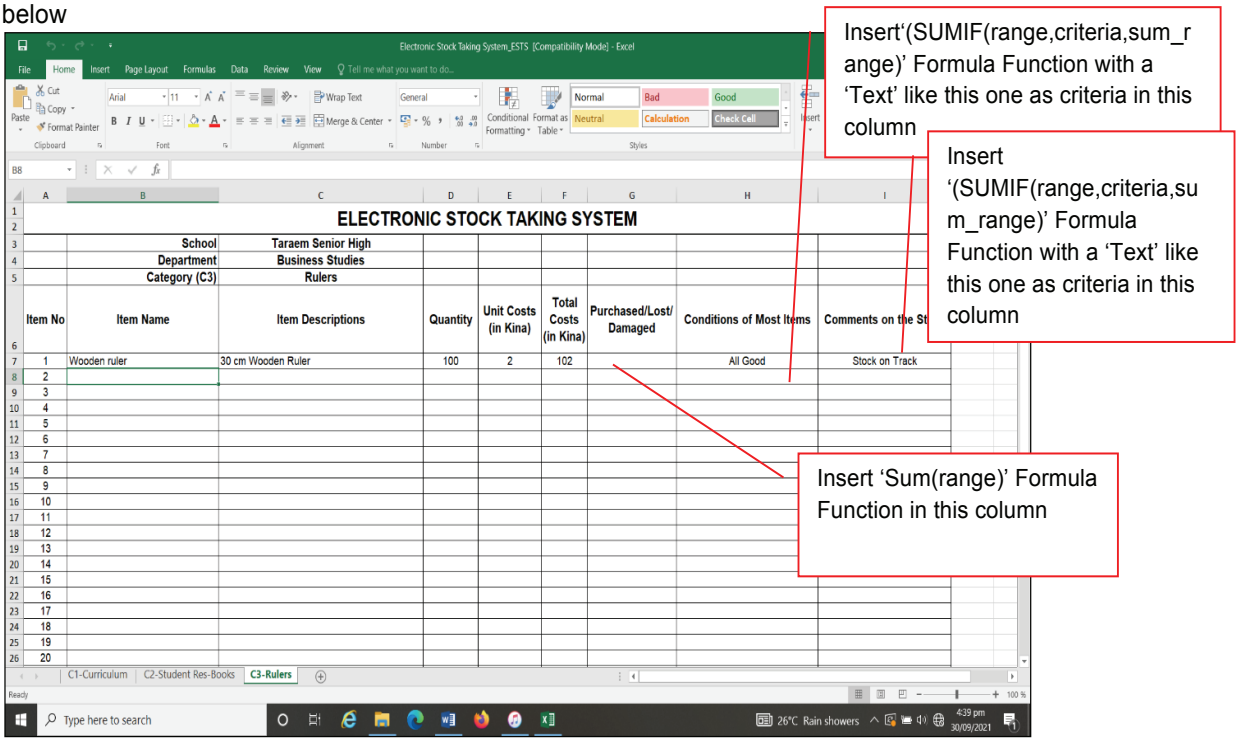
Situation (Authentic)

Your school should have been accounting for all the stock of the materials it has. The stocks of materials may include the materials like all the electronic equipment, the tools in the tool store, the sports equipment and materials and the departmental equipment and materials. There is a manual stock taking system (stock book) to take stock of all the equipment and materials in the school. With the manual stock taking system currently used in schools, the Principal and the teachers have experiences with improper stocks quantity checks and stocks updates.
When this was report by the Principal in a BOG meeting, the BOG moved a motion for the development of a functional Electronic Stock Taking System (ESTS) using the current available technology. In order to meet the expectations of the BOG, the principal and teachers task the Grade 12 students to participate in the creation of the ESTS using the MS Excel application.

To achieve this, the school is now requesting the Business Studies Department to design an Assessment Task for a grade to assist and guide the activity. The Business Studies Department has opted to design the Task for Grade 12 students as one of their projects towards their assessments. The school principal also announces that the best ESTS assessed by the Business Studies Department will be rewarded as it is also a competition.

Task Descriptions:

- Select a Subject Department or a Specialist Room (Store-room, Tool-room) in your school to Collect Data of different items for your Electronic Stock Taking System (ESTS) project.
- Plan and write the steps of creating the Electronic Stock Taking System.
- Use the steps to design and create the ESTS using the MS Excel application like the sample format below



- The ESTS must contain appropriate contents and formulae functions.
- It must also contain comments to justify the status of the individual stocks.
- This ESTS has to be user-friendly to the school officials to use.
- Presentation of the MS Excel of ESTS must not be more than 2 minutes (maximum time limit)
- Submit your MS Excel ESTS for assessment.
- Whole class to observe and use the rubric below to assess the Presentation of the MS Excel of ESTS.

Materials: Computer, Tablets, Smartphones, MS Excel Application

Related Benchmarks to this Business Studies Benchmark in Business Studies and other Subject areas:

Subjects	Reference Benchmark Codes
8. Arts (Visual Arts)	12.3.2.2
9. Character Social Development (CSD)	12.1.5.2, 12.1.5.3
10. English	12.2.1.2

11. Business Studies	12.2.5.1
12. General Mathematics	12.4.1.3
13. Technology Industrial Arts (TIA)	12.4.1.4

A Sample Scoring Rubric

Annotation 1
A statement (descriptors) describing the expected the level of competency for each prescribed criteria

Annotation 2
Rating scales includes either numerical or descriptive labels

Annotation 3
Indicators or qualifiers ensures that the levels reflect variance in quality

Annotation 4
Shaded descriptors indicating Student's Marks for the corresponding

Criteria	Achieved 3	Progressing 2	Novice 1	Scoring
Collecting Data for Electronic Stock Taking System (ESTS)	**Well** organised paper with **clarity** identifying, classifying and enumerating the different items.	Organised paper with some **clarity** identifying, classifying and enumerating the different items.	**Poorly** organised paper that lacked **clarity** identifying, classifying and enumerating the different items.	2/3
Development of ESTS	**Collaboratively organise** and categorise data of different items. Illustrate the **most likeable** way the Data can displayed in the MS Excel Application format.	Display **some collaboration** to organise and categorise data of different items. Illustrate a **likeable** way the Data can displayed in the MS Excel Application format.	Display **very little collaboration** to organise and categorise data of different items. Illustrate a way the Data can displayed in the MS Excel Application format.	1/3
Content and Formulae Functions in ESTS	Typed **accurately all the appropriate contents** for each columns and typed in the **all correct** formulae function symbols for the 'SUMrange function' and 'SUMIF function' in **all** their correct MS Excel cell references	Typed **most contents** in their **appropriate** columns and typed in **most** of the **correct** formulae function symbols for the 'SUMrange function' and 'SUMIF function' in **some** of their MS Excel cell references	Typed **very few contents** in their **appropriate** columns and typed in **very few** formulae function symbols for the 'SUMrange function' and 'SUMIF function' in **very few** of their MS Excel cell references	3/3

Presentation of ESTS	**Displayed time consciousness** with **adequate** delivery skills (posture, language), **expected** communication skills and social skill (relativity and connectivity)	**Mostly** time consciousness with **some adequate** delivery skills (posture, language), **some** expected communication skills and **some** social skill (relativity and connectivity) displayed	**Very little** time consciousness with **little adequate** delivery skills (posture, language), **little** expected communication skills and **little** social skill (relativity and connectivity) displayed	3/3
Portfolio of ESTS Developments and MS Excel ESTS – The Product	A **comprehensive** portfolio with **all** the Steps in planning, designing and developing the ESTS with a **complete** and **functional** MS Excel of the ESTS.	A portfolio with **most** of the Steps in planning, designing and developing the ESTS with a **complete** and **malfunctioned** MS Excel of ESTS.	A portfolio with **very few** of the Steps in planning, designing and developing the ESTS with an **incomplete** and **malfunctioned** MS Excel of ESTS.	3/3
				12/15

A Sample Portfolio

1. Idea Generation

a. Inform the students that most the projects (like shirt, bowl, furniture) are based on existing ideas to solve a problem. Ask the students to choose from these list words/phrase (**substitute, combine, adapt, modify, put to another use, eliminate, reverse/rearrange**) one word/phrase that provokes your thoughts about their project idea to solve an existing problem. The word/phrase selected by students will direct the approach the students take towards the ideas of the students projects.

Write this word/phrase in the space provided below.

_____

b. Guide the students to explain how this word/phrase is in line with their ideas of a project.

_____

_____

_____

c. Assist students to develop an inquiry question based on their project idea.

_____

2. Research

Inform the students that their project idea needs to be validated to ensure that the product get the people who will pay for it and that they won't waste time, money, and effort on an idea that won't sell.

a. Students to validate the product ideas by to conducting a survey to get feedbacks from the potential buyers. The students will have to prepare a survey questionnaire with a number of essential questions on their product ideas like the one below.

***Survey on Project Idea**: (Name of the project idea)*

1) *Explain how useful is the furniture/garment to you?*

_____

2) *Explain how often do you have this dish?*

_____

3) *How much would you like to spend on this garment/furniture if you intend to buy it?*

_____

b. At this stage, students should consider the **Safety precautions** to be taken in the stages of **Planning, Prototyping, Production and Marketing**. They can do this by responding to related questions as show in the examples below.

1) *What is the First aid symbol?*

Students draw the FIRST AID SYMBOL here

2) *Explain what is workshop safety?*

_____
_____
_____

3) *How can safety be enforced in working practices to minimize the risks associated working environment?*

_____
_____
_____

4) In the following stages (**Planning, Prototyping, Production and Marketing**), the students will draw 2 items/tools and describe the type of injury that may occur through the incorrect use of each of the items/tools

1. Planning Stage	
Item/Equipment/Tool	***Injury that may occur***

Name: _____ *(Drawing of the item/equipment/tool)*	*1.*
	2.
	3.
Name: _____ *(Drawing of the item/equipment/tool)*	*1.*
	2.
	3.
2. Prototyping Stage	
Name: _____ *(Drawing of the item/equipment/tool)*	*1.*
	2.
	3.
Name: _____ *(Drawing of the item/equipment/tool)*	*1.*
	2.
	3.

5) The students will have state what action they should take to assist the teacher next to each of the injuries described below.

Injury	***Action taken by student***
A student using knife a cuts his/her finger.	*1.*
	2.
A student cooking burns his/her hand on a hot pot	*1.*
	2.

3. Planning

Explain to the students that it is important to take the time to plan carefully before they begin to build your prototype. They need to decide on a number thing when building their prototype. Inform the students characteristics of materials/food to be used texture, design, hardness, durability and colour) etc. All of these is determine by the purpose and the function of the project.

a. Tasting

1) In terms food, students need to actually taste ingredients separately first and after the different ingredients are combined. They will also identify the various ways to cook them. Students will have find out ways to improve the taste for their intended project dish.

b. Sketching

1) In terms of fabric garments and construction technology projects, students have to sketches of the various prototypes needs to prepared and evaluated for their practicality and usefulness. They also need to consider the purpose and function of their project for they will determine the materials to be used, the characteristics for the materials to be used. Students have to determine ways to improve the design of their fabric garment and construction technology projects.

4. Prototyping

a. For Fabrics and construction technology, the students will have to select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards. Students evaluate their prototype and make appropriate changes on the detailed working diagrams/patterns/templates to meet the ergonomics standards.

b. As for food, students written up a recipe and cook sample dishes various ways. Students will make appropriate taste evaluation of each dish to select the one to use as the project.

5. Production

a. Students need to be selective gathering the required materials and food ingredients as per their materials/recipe list to for the project based on their prototypes and the ergonomics standards. This is because of the conditions of the raw materials to be used for their project. The materials have to be evaluated for defects or damages acquired by the materials to select the appropriate materials. Students should select the materials according to the descriptions of materials needed for their project.

b. For Food, students have to use the confirmed recipe from the prototype to prepare and create the dish.

c. Students will use the confirmed outlined garment patterns/templates to measure and cut out the material list for their project. For technology construction, students utilise the confirmed cutting list and the detailed working diagram to cut out the materials for their project like the one below.

Project Name	
Total Unit (No of Project)	

Material List

Quantity	Name of Material(s)	Description(s)	Unit Cost	Total Cost

d. While working on the projects, the students will have to fill in and complete the table of the Procedures in the Production of their project

Procedure (How to make my Project)

NO	OPERATIONS	NEEDED TOOLS/EQUIPMENT
1		
2		
3		
4		
5		
6		
7		

6. Costing

a. The students are required to calculate the cost of their project. To calculate their project, they have to calculate the cost of all the materials used in their project, the labour cost (based on their rate per hour) and these adds up to the selling/marketing cost. Students have to add 30% markup of the selling/marketing cost to determine the selling price.

b. Students should also evaluate the responses from product research survey as they could influence the cost the project.

c. The cost for making the project are:

4) Material costs: K____

5) Labor costs (No of Hours Spent X Your Rate): 10 hrs x K ___ = K____

6) Selling/Marketing cost: K____

g. Students will use the simple formula below to calculate a good markup percentage for their project:

MARKUP PERCENTAGE = (SELLING PRICE – UNIT COST) / UNIT COST x 100%

h. They simply take the sales price minus the unit cost, and divide that number by the unit cost. Then, multiply by 100 to determine the markup percentage.

For example, if the project costs K50 to make and the selling price is K75, then the markup percentage would be 50%: (K75 – K50) / K50 = 0.50 x 100 = 50%.

7. Marketing

a. Students need to review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project.

b. Students could put out flyers, brochures and posters to promote the completed project to the public.

c. Students could create promotional webpages on social media to market the product

A Sample Student Self-Assessment

Student Self-Assessment/Teacher Assessment						**Date: / /**			
Project Name:						**Term:**			
Student Name:		**Grade:**		**Class:**		**Total Score:**			
		Give yourself a score of 3, or 2, or 1, or 0 for performances				Teacher scores of students' performances			
	CRITERIA	**Students' scores**				**Teacher's scores**			
		3	**2**	**1**	**0**	**3**	**2**	**1**	**0**
1	**Idea Generation** a. Selection of word/phrase in								

	line with project idea								
	b. Explanation of the word/phrase in-line with project and development of main issue question								
2	**Research** a. Development of a survey questionnaire with a number of essential questions on their project ideas								
	b. Safety for stages of **Planning, Prototyping, Production and Marketing**. i. Draw safety precaution sign								
	ii. Tool/items and injuries that may occur								
	iii. Injuries and actions taken by students								
3	**Planning** a. Identify the various ways to cook them and find out ways to improve the taste for their intended project dish								
4	**Prototyping** a. Select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards								
5	**Production** a. Select the materials according to the descriptions of materials needed for their project.								
6	**Costing** a. Calculate their project, they have to calculate the cost of all the materials used in their project, the labour cost (based on their rate per hour) and								

	these adds up to the selling/marketing cost.								
7	**Marketing** a. Review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project. b. Create promotional webpages on social media to market the product								

A Sample Peer Student Assessment

Student Self-Assessment/Teacher Assessment									**Date: / /**			
Project Name:									**Term:**			
Student Name:					**Grade:**				**Total Score: /**			
Peer's Name:					**Class:**							
		Give yourself a score of 3, or 2, or 1, or 0 for performances				Give your peer a score of 3, or 2, or 1, or 0 for performances				Teacher scores of students' performances			
	CRITERIA	**Students' scores**				**Peer's scores**				**Teacher's scores**			
		3	**2**	**1**	**0**	**3**	**2**	**1**	**0**	**3**	**2**	**1**	**0**
1	**Idea Generation** c. Selection of word/phrase in line with project idea												
	d. Explanation of the word/phrase in-line with project and development of main issue question												
2	**Research** c. Development of a survey questionnaire with a number of essential questions on their project ideas												
	d. Safety for stages of												

	Planning, Prototyping, Production and Marketing. iv. Draw safety precaution sign												
	v. Tool/items and injuries that may occur												
	vi. Injuries and actions taken by students												
3	**Planning** b. Identify the various ways to cook them and find out ways to improve the taste for their intended project dish												
4	**Prototyping** b. Select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards												
5	**Production** b. Select the materials according to the descriptions of materials needed for their project.												
6	**Costing** b. Calculate their project, they have to calculate the cost of all the materials used in their project, the labour cost (based on their rate per hour) and these adds up to the selling/marketing cost.												
7	**Marketing** c. Review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project.												

	d. Create promotional webpages on social media to market the product												

Samples of Student Response System Applications

These are web based apps that work with a multitude of devices and operating systems. Here are the 4 best student response systems that interface with multiple devices.

1. Kahoot

Kahoot is a utility that allows teachers to create quizzes and surveys, and then send them to students. Teachers may allow students an unlimited amount of time to respond to questions, or they may set a time limit on each questions. Points are awarded to students both for correct answers and for responding quickly with those correct responses. Teachers can track students as they make progress.

2. Socrative

Socrative works excellently both for students working on their own or for students who are collaborating with one another. Socrative offers several different ways for instructors to engage their students. There are space races in which students can compete in teams or as individuals to answer questions as quickly and accurately as possible. Polls allow instructors to receive student feedback.

3. Infuse Learning
Infuse learning is (was!) an excellent student response system for teachers who must support students with a variety of learning styles. With infusion a teacher can create questions, quizzes and writing prompts and send them to students who are participating in virtual classrooms or in an online learning program. What makes Infuse Learning unique is that it allows the teacher to give the student multiple response options.

4. Verso

This is a free utility that teachers can use to create virtual classrooms. Verso works with the teacher's Google Drive account. This means that links, files, videos, images, and documents from the instructor's Google Drive can be added to the Verso classroom for students to access. Students who enter the classroom will be shown new items that have been added to the classroom since their last visit.

https://www.emergingedtech.com/2015/09/top-5-multi-platform-student-response-systems/

APPENDIX 5: LESSON PLAN TEMPLATE

Strand: …….

Unit: ……..

Content Standard: .....

Benchmark: ……..

Topic 1: ……..

Lesson Topic: ……

Instructional Objective (s): By the end of the lesson, students will be able to;

- ……
- ……
- ……

Essential Questions:

- ……..
- ……..
- ……....

Knowledge:

- ……..
- ……..

Skill(s):

- ……
- ……

Values:

- ……
- ……..

Attitudes:

- ……...
- ……...

Teaching and Learning Strategies

Teacher will …..	Student will ….
Introduction (time in minutes)	
Body (time in minutes)	
Modeling	
Guided Practice	
Independent Practice	
Conclusion (time in minutes)	

APPENDIX 6: ASSESSMENT TEMPLATE

Performance Assessment Template

Subject: _____

Strand:_____

Unit: _____

Content Standard: _____

Benchmark: _____

Topic: _____

Learning Objective: _____

Purpose of Assessment: _____

Assessment Strategy: _____

Duration: _____

Time/Date of Administration: _____

Due Date/Time: _____

Performance Standard: _____

Performance Tasks

Performance Assessment Criteria:_____

Assessment Scoring: _____

Scoring Tool: _____

APPENDIX 7: Portfolio

(Business Studies, Technology & Industrial Arts and CCVE subject Specific)

This refers to a collection of student work and additional information gathered over a period of time that demonstrates learning progress.

Sample Student Portfolio Template

STUDENT PROJECT PORTFOLIO NO: _____

NAME: _____ **CLASS**: _____ **TERM**: _____ **DATE**: ___/___/___

SUBJECT: _____

STRAND: _____

UNIT: _____

CONTENT STANDARD #: _____

_____

_____

_____

BENCHMARK #: _____

_____

_____

_____

5. **NAME OF PROJECT:** _____
6. **PURPOSE OF THE PROJECT**: (State briefly the reason why you will make the project. Have a complete visualization of any project you wish to make so as to know its usefulness)

   a) _____

   b) _____

7. **Idea Generation**

   a. Most projects are based on existing ideas. Choose from these list words/phrase (**substitute, combine, adapt, modify, put to another use, eliminate, reverse/rearrange**) one word/phrase that provokes your thoughts about your project and goes in line with your own ideas about your project. Write this word/phrase in the space provided below.

   _____

   b. Explain how this word/phrase is in line with your ideas about your own project.

_____

_____

_____

8. Research

Your project idea needs to be validated to ensure you're creating a product people will pay for and that you won't waste time, money, and effort on an idea that won't sell. There are several ways you can validate your product ideas, including:

a. Talking about your idea with family and friends. If you decide to use this validation method, prepare a sheet to record your feedbacks like the one below.

Your Project Idea:	(*Write down your project idea*)

Family and friends Names	**Feedbacks/Responses**
1.	
2.	
3.	
4.	

b. Sending out a survey to get feedback. If you decide to use this validation method, prepare a survey questionnaire like the one below.

Survey on Project Idea: (*Write down your project idea*)

i) Explain how useful is the furniture/garment to you?

_____

ii) Explain how often do you have this dish?

_____

iii) How much would you like to spend on this garment/furniture if you intend to buy it?

_____

c. Consider **Safety precautions** to be taken in the stages of **Planning, Prototyping, Production and Marketing**.

i) Elementary first aid and procedures: What is the First aid symbol?

Draw the FIRST AID SYMBOL here

ii) Explain what is workshop safety?

_____
_____

iii) How can safety be enforced in working practices to minimise the risks associated working environment?

_____
_____

d) For each of the following stages (**Planning, Prototyping, Production and Marketing**), draw 2 items/tools and describe the type of injury that may occur through the incorrect use of each of the items/tools

3. Planning Stage	
Item/Tool	**Injury that may occur**
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.
4. Prototyping Stage	
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.

e) For each of the injuries described below, state what action you should take to assist the teacher.

Injury	**Action taken by student**

A student using knife a cuts his/her finger.	1.
	2.
A student cooking burns his/her hand on a hot pot	1.
	2.

9. Planning

It's important to take the time to plan before you begin to build your prototype.

Tasting

In terms food, ingredients have to be tasted separately and combination of different ingredients needs to tasted together to select a prototype.

Sketching

In terms of fabric garments and technology projects, sketches of the various prototypes needs to prepared and evaluated for their practicality and usefulness

10. Prototyping

a. Selected projects sketches will be made into prototypes, be sampled and detailed.
b. As for food, a recipe would be outlined and cooked to make a sample dish. Make appropriate taste evaluation to improve the dish
c. Fabric garments and technology projects create detailed working diagrams from the prototype for patterns or templates if required.

11. Production

a. Gather the required materials and food items as per your list to for the project idea.

b. For Food, use the confirmed recipe from the prototype to prepare and create the dish.

c. Use the confirmed outlined garment patterns/templates to measure and cut out the material pieces for your project idea.

d. For technology construction, use the confirmed cutting list and the detailed working diagram to cut out the materials for your project

Product Name	
Total Unit (No of Project)	

Material List				
Quantity	**Name of Material(s)**	**Description(s)**	**Unit Cost**	**Total Cost**

e. Complete the table of the Procedures in the Production

Procedure (How to make my Project)

NO	OPERATIONS	NEEDED TOOLS/EQUIPMENT
1		
2		
3		
4		
5		
6		
7		

12. Costing

d. The cost for making the T-shirt are:

7) Material costs: K____

8) Labor costs (No of Hours Spent X Your Rate): 10 hrs x K ___ = K____

9) Selling/Marketing cost: K____

You could add a ____% markup on top of the K___ total it cost to make your product as the "plus" of cost-plus pricing. Here's what the formula looks like:

Cost (K____) x Markup (K____) = Selling price (K___)

13. Marketing

a. Review the responses/feedback from the Surveys done for the project idea and inform the interested people of the completed project

b. Put out fliers to advertise the project to public

c. Use social media to market the product

Scoring of Performance for Formative Assessment

(Assessment as/while learning and Assessment for learning)

1. Scoring Assessment using Rating Scale

Rating Scales are a type of checklists that judge the degree to which a criteria is met. They generally have a scale of between 1-6 options.

Assessment Performance Records for Term to give grading

Student's performance in any assessments must be recorded to obtain a final score to be able to give a grading.

Subject/Strand: _____Grade/Class:_____ Term____

NO	Name	Project 20 marks	Test 1 15 marks	Test 2 10 marks	Portfolio 10 marks	Moderation 30 marks	Participation 5 marks	Total Raw Score
1	Gill							/ 100
2	Jill							/ 100
3	Zill							/ 100
4	Bill							/ 100
Etc.								/ 100

‘ISSUE FREE NOT FOR SALE’