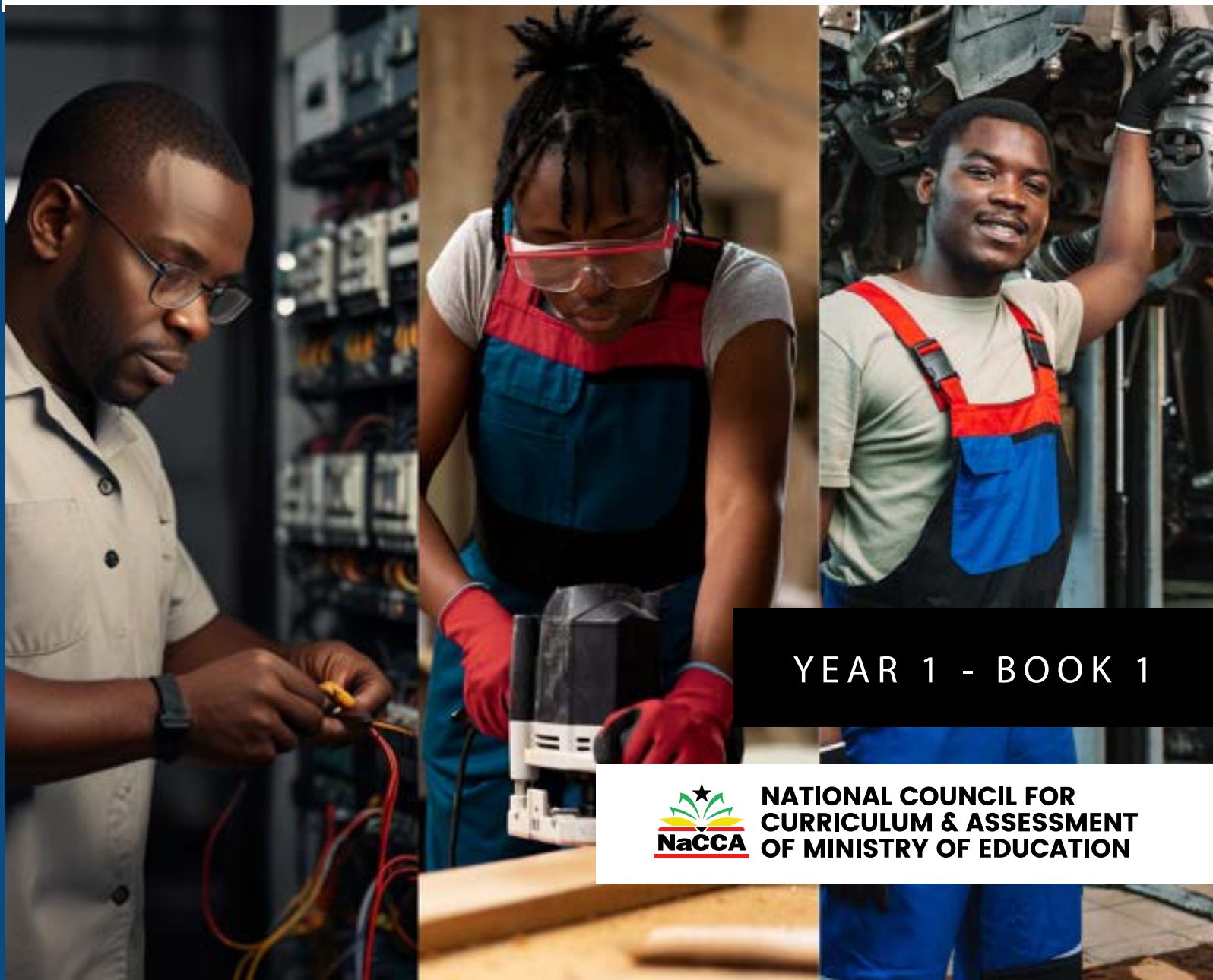
MINISTRY OF EDUCATION

Applied Technology

TEACHER MANUAL



YEAR 1 - BOOK 1

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

REPUBLIC OF GHANA

Applied Technology

Teacher Manual

Year One - Book One

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

APPLIED TECHNOLOGY TEACHERS MANUAL

Enquiries and comments on this manual should be addressed to:
The Director-General
National Council for Curriculum and Assessment (NaCCA)
Ministry of Education
P.O. Box CT PMB 77
Cantonments Accra

Telephone: 0302909071, 0302909862
Email: info@nacca.gov.gh
website: www.nacca.gov.gh

CONTENTS

INTRODUCTION

The National Council for Curriculum and Assessment (NaCCA) has developed a new Senior High School (SHS), Senior High Technical School (SHTS) and Science, Technology, Engineering and Mathematics (STEM) Curriculum. It aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, competencies, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, further their education and enter the world of work.

This is the first time that Ghana has developed an SHS Curriculum which focuses on national values, attempting to educate a generation of Ghanaian youth who are proud of our country and can contribute effectively to its development.

This Teacher Manual for Applied Technology covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year One of the new curriculum. It contains this information for the first 13 weeks of Year One, with the remaining 11 weeks contained within Book Two. Teachers are therefore to use this Teacher Manual to develop their weekly Learning Plans as required by Ghana Education Service.

Some of the key features of the new curriculum are set out below.

Learner-Centred Curriculum

The SHS, SHTS, and STEM curriculum places the learner at the center of teaching and learning by building on their existing life experiences, knowledge and understanding. Learners are actively involved in the knowledge-creation process, with the teacher acting as a facilitator. This involves using interactive and practical teaching and learning methods, as well as the learner's environment to make learning exciting and relatable. As an example, the new curriculum focuses on Ghanaian culture, Ghanaian history, and Ghanaian geography so that learners first understand their home and surroundings before extending their knowledge globally.

Promoting Ghanaian Values

Shared Ghanaian values have been integrated into the curriculum to ensure that all young people understand what it means to be a responsible Ghanaian citizen. These values include truth, integrity, diversity, equity, self-directed learning, self-confidence, adaptability and resourcefulness, leadership and responsible citizenship.

Integrating 21st Century Skills and Competencies

The SHS, SHTS, and STEM curriculum integrates 21st Century skills and competencies. These are:

- **Foundational Knowledge:** Literacy, Numeracy, Scientific Literacy, Information Communication and Digital Literacy, Financial Literacy and Entrepreneurship, Cultural Identity, Civic Literacy and Global Citizenship
- **Competencies:** Critical Thinking and Problem Solving, Innovation and Creativity, Collaboration and Communication
- **Character Qualities:** Discipline and Integrity, Self-Directed Learning, Self-Confidence, Adaptability and Resourcefulness, Leadership and Responsible Citizenship

Balanced Approach to Assessment - not just Final External Examinations

The SHS, SHTS, and STEM curriculum promotes a balanced approach to assessment. It encourages varied and differentiated assessments such as project work, practical demonstration, performance assessment, skills-based assessment, class exercises, portfolios as well as end-of-term examinations and final external assessment examinations. Two levels of assessment are used. These are:

- Internal Assessment (30%) – Comprises formative (portfolios, performance and project work) and summative (end-of-term examinations) which will be recorded in a school-based transcript.
- External Assessment (70%) – Comprehensive summative assessment will be conducted by the West African Examinations Council (WAEC) through the WASSCE. The questions posed by WAEC will test critical thinking, communication and problem solving as well as knowledge, understanding and factual recall.

The split of external and internal assessment will remain at 70/30 as is currently the case. However, there will be far greater transparency and quality assurance of the 30% of marks which are school-based. This will be achieved through the introduction of a school-based transcript, setting out all marks which learners achieve from SHS 1 to SHS 3. This transcript will be presented to universities alongside the WASSCE certificate for tertiary admissions.

An Inclusive and Responsive Curriculum

The SHS, SHTS, and STEM curriculum ensures no learner is left behind, and this is achieved through the following:

- Addressing the needs of all learners, including those requiring additional support or with special needs. The SHS, SHTS, and STEM curriculum includes learners with disabilities by adapting teaching and learning materials into accessible formats through technology and other measures to meet the needs of learners with disabilities.
- Incorporating strategies and measures, such as differentiation and adaptative pedagogies ensuring equitable access to resources and opportunities for all learners.
- Challenging traditional gender, cultural, or social stereotypes and encouraging all learners to achieve their true potential.
- Making provision for the needs of gifted and talented learners in schools.

Social and Emotional Learning

Social and emotional learning skills have also been integrated into the curriculum to help learners to develop and acquire skills, attitudes, and knowledge essential for understanding and managing their emotions, building healthy relationships and making responsible decisions.

Philosophy and vision for each subject

Each subject now has its own philosophy and vision, which sets out why the subject is being taught and how it will contribute to national development. The Philosophy and Vision for Applied Technology is:

Philosophy: The present and future generations of learners will apply technology to solve problems in their environment through creativity and innovative application of concepts for the production of artefacts. This will be done through the support of skilled and innovative teachers who are to prepare learners for life-long learning as well as introducing them to the world of work and adult life.

Vision: Equips the learners with 21st century skills: critical thinking, creativity, collaborations and innovation as well as good citizenship and competencies to identify increasingly complex societal problems and use appropriate technological skills to solve them. Thus, it prepares learners for life-long learning and introduces them to world of work and adult life.

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The writing team was made up of the following members:

Subject	Writer	Institution
Home Economics	Grace Annagmeng Mwini	Tumu College of Education
	Imoro Miftaw	Gambaga Girls' SHS
	Love Boateng	Juaso SHS
	Jusinta Kwakyewaa (Rev. Sr.)	St. Francis SHTS
Religious Studies	Richardson Addai-Mununkum	University of Education Winneba
	Dr. Bonsu Osei-Owusu	West Africa SHS
	Prince Osei Adjei	Adventist SHS, Bantama
	Dr Francis Opoku	Valley View University College
	Yaw Sarkodie Agyemang	University of Cape Coast
	Aransa Bawa Abdul Razak	Uthmaniya SHS
	Godfred Bonsu	Prempeh College
RME	Anthony Mensah	Abetifi College of Education
	Joseph Bless Darkwa	Volo Community SHS
	Clement Nsorwineh Atigah	Tamale SHS
Arabic	Murtada Mahmoud Muaz	AAMUSTED
	Abas Umar Mohammed	University of Ghana
	Adam Abubakar	Uthmaniya SHS
	Mahey Ibrahim Mohammed	Tijjaniya Senior High School
French	Osmanu Ibrahim	Mount Mary College of Education
	Maurice Adjetey	
	Mawufemor Kwame Agorgli	Akim Asafo SHS
Performing Arts	Latipher Osei Appiah-Agyei	University of Education Winneba
	Desmond Ali Gasanga	Ghana Education Service
	Yaw Owusu Asiamah	Adventist SHS, Bantama
	Chris Ampomah Mensah	Bolgatanga SHS, Winkogo

Subject	Writer	Institution
Art and Design Studio and Foundation	Dr. Ebenezer Acquah	University for Education Winneba
	Dr. Osuanyi Quaicoo Essel	University for Education Winneba
	Seyram Kojo Adipah	Ghana Education Service
	Jectey Nyarko Mantey	Kwame Nkrumah University of Science and Technology
	Yaw Boateng Ampadu	Prempeh College
	Kwame Opoku Bonsu	Kwame Nkrumah University of Science and Technology
	Dzorka Etonam Justice	Kpando SHS
Applied Technology & Design and Communication Technology	Joseph Asomani	AAMUSTED
	Dr. Prosper Mensah	AAMUSTED
	Dr. Sherry Kwabla Amedorme	AAMUSTED
	Esther Pokuah	Mampong Technical College of Education
	Wisdom Dzidzienyo Adzraku	AAMUSTED
	Kunkyuuri Philip	Kumasi SHTS
	Antwi Samuel	Kibi SHTS
	Gabriel Boafo	Kwabeng Anglican SHTS
	Josiah Bawagigah Kandwe	Walewale Technical Institute
	Emmanuel Korletey	Benso SHTS
	Isaac Buckman	Armed Forces SHTS
	Daniel K. Agbogbo	Kwabeng Anglican SHTS
	Tetteh Moses	Dagbon State SHS
	Awane Adongo Martin	Dabokpa Technical Institute
Business Studies	Emmanuel Kodwo Arthur	ICAG
	Dr. Emmanuel Caesar Ayamba	Bolgatanga Technical University
	Ansbert Baba Avole	Bolgatanga SHS, Winkogo
	Faustina Graham	Ghana Education Service, HQ
	Nimako Victoria	SDA SHS, Akyem Sekyere
Agriculture	Dr Esther Fobi Donkoh	University of Energy and Natural Resources
	Prof. Frederick Adzitey	University for Development Studies
	Eric Morgan Asante	St. Peter's SHS

Subject	Writer	Institution
Agricultural Science	David Esela Zigah	Achimota School
	Prof J.V.K. Afun	Kwame Nkrumah University of Science and Technology
	Dr. Kwadwo Amankwah	Kwame Nkrumah University of Science and Technology
	Alex Adu Frimpong	Benso SHTS
	Mrs. Benedicta Foli	
Government	Josephine Akosua Gbagbo	Ngleshie Amanfro SHS
	Augustine Arko Blay	University of Education Winneba
	Samuel Kofi Adu	Fettehman SHS
Economics	Peter Anti Partey	University of Cape Coast
	Charlotte Kpogli	Ho Technical University
	Joseph Agbevanu	Kinbu SHS
	Adams Abdul-Somed	Kalponin SHS
	Benjamin Agyekum	Mangoase SHS
Geography	George Boateng	Berekum College of Education
	Dr. Esther Yeboah Danso-Wiredu	University of Education Winneba
	Dr. Matthew Krusah	University of Education Winneba
	Raymond Nsiah Asare	Methodist Girls' High School
History	Kofi Adjei Akrasi	Opoku Ware School
	Anitha Oforiwah Adu-Boahen	University of Education Winneba
	Prince Essiaw	Enchi College of Education
Ghanaian Language	David Sarpei Nunoo	University of Education Winneba, Ajumako
	Catherine Ekua Mensah	University of Cape Coast
	Ebenezer Agyemang	Opoku Ware School
Physical Education and Health	Paul Dadzie	Accra Academy
	Sekor Gaveh	Kwabeng Anglican SHTS
	Anthonia Afosah Kwaaso	Junkwa SHS
	Mary Aku Ogum	University of Cape Coast
Social Studies	Mohammed Adam	University of Education Winneba
	Simon Tengan	Wa SHTS
	Jemima Ayensu	Holy Child School

Subject	Writer	Institution
Computing and Information Communication Technology (ICT)	Victor King Anyanful	OLA College of Education
	Raphael Dordoe Senyo	Ziavi SHTS
	Kwasi Abankwa Anokye	Ghana Education Service, SEU
	Millicent Heduvor	STEM SHS, Awaso
	Mohammed Abdul-Samed	Dagbon State SHS
	Dr. Gaddafi Abdul-Salaam.	Kwame Nkrumah University of Science and Technology
English Language	Esther Armah	Mangoase SHS
	Kukuaa Andoh Robertson	Achimota School
	Cecilia Amponsah	Presbyterian Boys' SHS
	Alfred Quaittoo	Kaneshie SHTS
	Benjamin Orsoo	Islamic SHS
	Fuseini Hamza	Tamale Girls' SHS
Intervention English	Roberta Emma Amos-Abanyie	Ingit Education Consult
	Prof. Charles Owu-Ewie	University of Education Winneba
	Perfect Quarshie	Mawuko Girls SHS
	Sampson Dedey Baidoo	Benso SHTS
Literature in English	Blessington Dzah	Ziavi SHTS
	Angela Aninakwah	Ghana Education Service
	Dr. Emma Sarah Eshun	University of Education Winneba
	Samuel Kwame Kassah	St. Peter's SHS
	Juliana Akomea	Mangoase SHS
General Science	Dr. Comfort Korkor Sam	University for Development Studies
	Saddik Mohammed	Ghana Education Service
	Robert Arhin	SDA SHS, Akyem Sekyere
Chemistry	Ambrose Ayiku	St. Francis College of Education
	Awumbile Patrick Nsobila	Bolgatanga SHS, Winkogo
	Bismark Tunu	Opoku Ware School
	Gbeddy Neurus Anthony	Ghanata SHS
Physics	Linus Labik	Kwame Nkrumah University of Science and Technology
	Henry Benyah	Wesley Girls' SHS
	Sylvester Affram	Kwabeng Anglican SHS

Subject	Writer	Institution
Biology	Damoah Paul	Prempeh College
	Maxwell Bunu	Ada College of Education
	Ebenezer Delali Kpelly	Wesley Girls' SHS
	Doris Osei-Antwi	Ghana National College
Mathematics	Edward Dadson Mills	University of Education Winneba
	Zacharia Abubakari Sadiq	Tamale College of Education
	Faustina Nana Ackob	Mfantsiman SHS
	William Ababu	Swedru SHS
	Collins Kofi Annan	Mando SHS
Additional Mathematics	Dr. Nana Akosua Owusu-Ansah	University of Education Winneba
	Gershon Mantey	University of Education Winneba
	Very Rev. Prof. William Obeng Denteh	Kwame Nkrumah University of Science and Technology
	Charles B. Ampofo	Kibi College of Education
	Bismark Twum	SDA SHS, Akyem Sekyere
	Innocent Duncan	KNUST SHS
Intervention Mathematics	Florence Yeboah	Assin Manso SHS
	Mawufemor Adukpo	Ghanata SHS
	Jemima Saah	Winneba SHS
	Mohammed Shani Abdulai	Yendi SHS
Robotics	Dr. Eliel Keelson	Kwame Nkrumah University of Science and Technology
	Dr. Nii Longdon Sowah	University of Ghana
	Kwabena Osei-Kusi	Prempeh College
	Michael Wilson	CSIR
	Isaac Nzoley	Wesley Girls' SHS
Engineering	Daniel K. Agbogbo	Kwabeng Anglican SHTS
	Prof. Abdul-Rahman Ahmed	Kwame Nkrumah University of Science and Technology
	Dr. Griffth Serlorm Klogo	Kwame Nkrumah University of Science and Technology
	Japheth Kwadwo Bumusi	Mawuli School
	Valentina Osei-Himah	Atebubu College of Education

Subject	Writer	Institution
Aviation and Aerospace Engineering	Opoku Joel Mintah	Altair Unmanned Technologies
	Dr. Eunice Akyereko Adjei	Kwame Nkrumah University of Science and Technology
	Dr. David Kofi Oppong	Kwame Nkrumah University of Science and Technology
	Sam Ferdinand	Afua Kobi Ampem Girls' SHS
Biomedical Science	Dr. Dorothy Yakoba Agyapong	Kwame Nkrumah University of Science and Technology
	Jennifer Fafa Adzraku	Université Libre de Bruxelles
	Dr. Isaac Acquah	Kwame Nkrumah University of Science and Technology
	David Ayah	St. John's Grammar School
	Dr. Eric Worlawoe Gaba	Br. Tarcisius Prosthetics and Orthotics Training College
Manufacturing Engineering	Benjamin Atribawuni Asaaga	Kwame Nkrumah University of Science and Technology
	Dr. Samuel Boahene	Kwame Nkrumah University of Science and Technology
	Issahaku Iddrisu	Ada SHS
	Dr. Mizpah Ama D. Rockson	Kwame Nkrumah University of Science and Technology
	Prof Charles Oppon	Cape Coast Technical University
Spanish	Setor Donne Novieto	University of Ghana
	Franklina Kabio	University of Ghana
	Mishael Annoh Acheampong	University of Media, Art and Communication
Assessment	Benjamin Sundeme	St. Ambrose College of Education
	Victor Gideon Obeng	Retired
	Prof. Eric Francis Eshun	Kwame Nkrumah University of Science and Technology
	Dr. Ruth Annan-Brew	University of Cape Coast
	Dr. Isaac Amoako	Atebubu College of Education

Subject	Writer	Institution
Curriculum Writing Guide	Paul Michael Cudjoe	Prempeh College
	Prof. Winston Abroampa	Kwame Nkrumah University of Science and Technology
	Cosmos Eminah	University of Education Winneba
	Ahmed Amihere	University of Education Winneba
	Evans Odei	Achimota School
	Ellen Abakah	CEGENSA, University of Ghana
	Hasiyatu Abubakari	CEGENSA, University of Ghana
	Eyram Eric Kwasi Fiagbedzi	CEGENSA, University of Ghana
	Deborah Atobrah	CEGENSA, University of Ghana
	Ayine Akoglo	CEGENSA, University of Ghana
	Theodora Akweley Asiamah	CEGENSA, University of Ghana
NaCCA	Matthew Owusu	Ebenezer Ankamah
	Reginald Quartey	Alice Abbiw Donkor
	Rebecca Abu Gariba	Abigail Birago Owusu
	Anita Collision	Samuel Owusu Ansah
	Joachim Honu	Richard Teye
	Joana Vanderpuije	Joseph Barwuah
	Uriah Otoo	Anthony Sarpong
	Nii Boye Tagoe	Jephtar Adu Mensah
	Eric Amoah	Nancy Aseiduwaa Gyapong
	Francis Agbalanyo	Godwin Senanu
	Dennis Adjasi	Godfred Mireku
	Samuel Amankwa Ogyampo	Juliet Owusu-Ansah
	Sharon Antwi Baah	Thomas Kumah Osei
	Ayuba Sullivan	Seth Nii Nartey

SCOPE AND SEQUENCE

Applied Technology Summary

S/N	STRAND	SUB-STRAND	YEAR 1			YEAR 2			YEAR 3		
			CS	LO	LI	CS	LO	LI	CS	LO	LI
1	Design and Communication Technology	Graphic Communication	5	5	23	5	5	17	4	4	12
		Designing Process	1	1	3	1	1	3	-	-	-
2	Automotive Technology	Introduction to Engine Technology	1	1	3	1	1	3	1	1	4
		Introduction to Vehicle Technology	1	1	3	1	1	4	1	1	3
3	Building Construction Technology	Pre –Construction Activities	2	2	7	-	-	-	-	-	-
		Substructure and Superstructure	-	-	-	2	2	7	2	2	7
4	Electrical And Electronics Technology	Electrical Systems Design	1	1	3	1	1	3	1	1	3
		Electronic Devices and Circuits	1	1	3	1	1	3	1	1	3
5	Metal Technology	Engineering Materials, Tools and Machines	1	1	2	1	1	4	1	1	3
		Welding Technology	1	1	4	1	1	4	1	1	3
6	Woodwork Technology	Tools and Machines in Woodwork	1	1	1	1	1	4	1	1	3
		Materials and Artifact Production in Ghana	2	2	5	2	2	8	1	1	3
Total			**17**	**17**	**56**	**17**	**17**	**60**	**15**	**15**	**48**

Overall Totals (SHS 1 – 3

Content Standards	**49**
Learning Outcomes	**49**
Learning Indicators	**165**

SECTION 1

This section covers the following units (strands): woodwork technology, automotive technology, building construction technology, electrical and electronic technology as well as metal technology. Woodwork technology as a unit seeks to help learners understand and apply the appropriate safety measures in the workshop environment. Automotive technology seeks to enhance the practical application of the working principles of engines amongst the same learners. By the end of the section learners will, under the building construction unit, gain knowledge and understanding of the roles of building construction personnel. Learners will also acquire knowledge and understanding about safety principles in power transmission under electrical and electronic technology. Under metal technology, learners will be able to apply knowledge in the use of engineering materials, tools, machines and their associated safety precautions. All the above will be treated from Unit 1 to Unit 5.

UNIT 1

Strand: **Woodwork Technology**

Sub-Strand: **Tools and Machines in the Woodwork Industry**

Learning Outcome: *Demonstrate knowledge and understanding in health and safety and apply the appropriate safety measures in the workshop environment*

Content Standard: Demonstrate knowledge and understanding of health and safety in the industry

INTRODUCTION AND UNIT SUMMARY

This unit looks at health and safety as it applies in the workshop environment and in the industry where the learners will eventually be working. It is designed to help learners to ensure a safe working environment, protect individuals from accidents and promote efficiency and quality of work at the workshops. The unit will help learners to use proper personal protective equipment, implement safe operating procedures and prioritise safety in the workshop as fundamental for a successful and fulfilling working experience. Again, the unit will help learners to explore key safety guidelines, best practices, and preventive measures to cultivate a culture of safety and well-being in the workshop environment.

The unit covers only week 1: ***Workshop Safety***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners are to participate in practical demonstrations of how to utilise safety kit in a safe working environment including the workshop. Teachers should employ varied pedagogies such as talk for learning, group work/collaborative learning, role-play and experiential learning to enhance teaching and learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning to cater for all learners, irrespective of their learning abilities and styles. Again, learners should be encouraged to participate fully in investigations as well as presentation of findings. Teachers should employ differentiation strategies to accommodate diverse learning needs of the learners.

ASSESSMENT SUMMARY

The concepts under this unit require learners' ability to demonstrate understanding relating to their real-life applications. Hence, the assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports and home tasks to collect information about learners' progress and give prompt feedback to them. Teachers should administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the various safety kit used at the workshop and document learners' results in continuous assessment records.

WEEK 1

Learning Indicator(s): *Apply the Appropriate Safety Measures in the Workshop*

Theme or Focal Area: Workshop Safety

Workshops are lovely working places where artisans enjoy and produce crafted artefacts but can be dangerous if the right precautions are not taken in the approach to work. Specific skills, attitudes and knowledge relating to the world of work are being developed. Hence, learning activities should be concerned with safety principles. Modern tools and machines are designed to be as safe as possible. By developing safe work habits and an awareness of good safety practices accidents may be avoided.

Fig 1.1: *Safety gears*
(Source: *Safety gears - Search Images (bing.com)*)

Safety practices to prevent injury to oneself and co-workers, damage to tools and hand operated power tools, and machines

Personal protective equipment (PPE), proper ventilation, proper handling of equipment machine guards, lockout/tagout procedures, fire prevention, hazard communication, ergonomic design, first aid, and training.

Personal Safety: Workers should wear appropriate personal protective equipment such as safety glasses or goggles, gloves, safety shoes or boots, earplugs, helmets and aprons to protect themselves from fire outbreak, falling objects, flying debris, loud noise, and sharp tools.

Danger to others:

1. Keep the workplace clean and organised to prevent tripping hazards and accidents. Clear away sawdust, wood chips, and debris from the work area frequently for free movement.
2. Do not run in the workshop. You could run into somebody and cause an accident.

Machines safety:

1. Always use the guards and push-sticks provided on any machine that you use. They are there to protect you from any dangerous moving parts and keep hands away from the running cutters.
2. Always switch off a machine before making any adjustments to it to avoid injury and damage to the machine.
3. Ensure that machines are properly adjusted before using them. A badly adjusted machine can cause an accident.

Safety of tools and hand operated power tools:

1. Use tools properly and only for the intended purpose. Avoid excessive force or speed when operating tools and avoid altering tools in any way.
2. Regularly check the electrical connection and wiring. A badly connected or frayed wire can cause an electrical short circuit or electrocution.

Other safety measures:

1. Be aware of emergency procedures and the location of fire extinguishers and First Aid kits such as (*lint, iodine, cotton wool, scissors, plasters, methylated spirit, gloves).*
2. Always follow combustible material guidelines and store them in appropriate locations for fire prevention.

Learning Tasks

1. Identify two safety precautions in the workshop.
2. Demonstrate the safe use of machine tools in the workshop.

Pedagogical Exemplars

Teachers should consider the following activities:

Talk for learning approaches: Guide learners through watching a video of an operational workshop, to co-operatively brainstorm the meaning of health and safety in the workshop with open-mindedness. Teachers should target questions to learners as they discuss with one another, to push thinking on. Teachers should pull all learners back in for whole-class feedback and to collect definitions.

Group work/Collaborative learning: Place learners into mixed-ability groups and task them to co-operatively discuss the causes of accidents in the workshop with open-mindedness and patience. Teachers should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

Role-play: Teachers should model to learners' safe use of tools in the classroom, workshop and ask learners questions to ensure understanding of safe use of machine tools. From here learners can use role-play to practice safe use of machine tools prior to using the actual equipment. As teachers assess learners' confidence, they can move to demonstrating safe use of machine tools on the equipment.

Key Assessment

Level 1: List two items of safety equipment used on machines in the workshop

Level 2: Describe how can accidents be prevented by the safe use of machine tools in the workshop?

Level 3: Describe why is it necessary to ensure protection of the eyes when using machinery?

Level 3: Explain what accidents can occur when the safety guards are not in place?

Unit 1 Review

This unit exposed learners to the concept of utilising safety kits in safe working environments including the workshop. The pedagogical exemplars used in this unit included talk for learning, group work/collaborative learning and role-play which helped to meet varied needs of all learners. These strategies are envisaged to enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentations, class exercises, homework, practical group activities are structured to cater for the varied activities of learning. These assessments are classified under the DoK level 1, 2 and 3.

Reflection:

1. Are ways of protection from injury whilst working in a workshop observed by learners?
2. Can learners ensure that injury is not caused to other people?

Resources: Charts, pictures, videos and real object (nose mask, goggles, safety boots, overcoat, gloves and helmet).

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UNIT 2

Strand: **Automotive Technology**

Sub-Strand: **Introduction to Engine Technology**

Learning Outcome: *Analyse and use relevant principles underlying engines to service and repair spark ignition (SI) and compression ignition (CI) engines*

Content Standard: Demonstrate the knowledge and application of the working principles of engines

INTRODUCTION AND UNIT SUMMARY

This unit introduces learners to various types of engines with varying, components as well as functions found in motor vehicles. Mechanical energy is created by the internal combustion engine from chemical energy. The teacher will guide learners to examine the fundamentals of engine construction in this section, as well as distinguish between different engine types and their component parts. They will also explain the operational and structural differences between gasoline and diesel engines and show how safety precautions are taken when servicing, repairing, and maintaining engines.

The unit covers only week 2: ***Identify types of engines and describe the main component parts of the engine systems***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must fully participate in the identification types of engines and describe the main component parts of the engine. Teachers should employ pedagogies such as, group work/collaborative learning, experiential learning and project-based learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in identification and description of the main component parts of the engine. Teachers should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

To demonstrate conceptual understanding of the ideas covered in this section, learners must show how they apply the concepts in real-world situations. As a result, levels 1, 2, and 3 of the DOK should be substantially covered in the assessments. To gather data regarding learners' progress and provide timely feedback, teachers should utilise a range of formative assessment tools, including pairs of tasks, reports, oral and written presentations, and home assignments. Teachers should administer assessments such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the various types of engines and description of the main component parts of the engine systems. Teachers should document learners' results in continuous assessment records.

WEEK 2

Learning Indicator(s): *Identify types of engines and describe the main component parts of the engine*

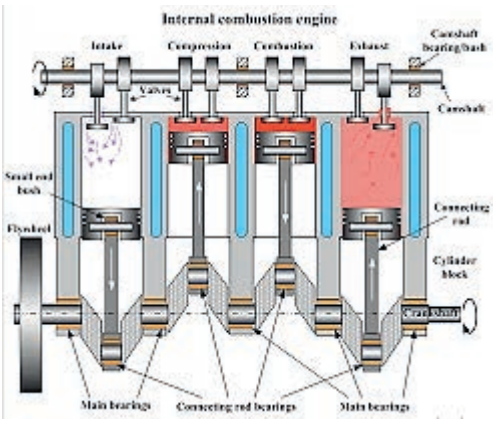
Theme Or Focal Area: introduction to Engines

The engine is the motor vehicles main source of power it transforms chemical energy from the fuel into mechanical energy through an internal combustion process that produce power to drive the road wheels or any other machine that is coupled to the engine.

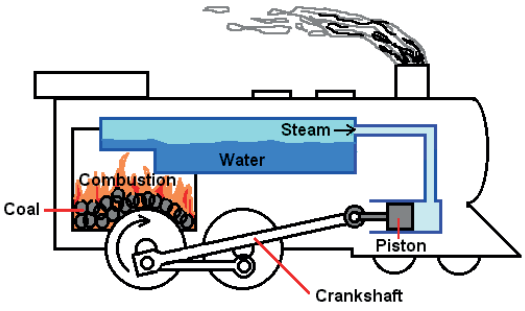
Types of heat engines

Engines are divided into two groups, which include:

1. **External combustion engine**: Prior to the twentieth century, the burning or combustion of fuel occurred outside of the engine. To generate heat, the fuel, which was frequently coal, was burned. This heat was then utilised to heat water and create steam. The steam was compressed before being injected into the engine, where it pushed the piston down into the cylinder. This is known as an External Combustion Engine, often known as a steam engine.
2. **Internal combustion engine**: The Internal Combustion Engine, which is used in today's vehicles, is an engine in which the fuel is burned directly within. As the air-fuel mixture burns, it rapidly expands, increasing the pressure inside the cylinder. This rise in pressure drives the piston down the cylinder, causing the connecting rod to turn the crankshaft, allowing us to drive the car and other components in a continuous revolving motion. The petrol engine, also known as spark ignition (SI) engine and diesel engine, also known as compression ignition (CI) engine, are all examples of internal combustion engines based on the method of igniting the mixture in the engine.



Internal combustion engine



External combustion engine

Fig. 1.2: *Types of engines*

(Source: *Types of engines - Search Images (bing.com))*

Features of petrol and diesel engines

There are two kinds of internal combustion engines currently in production: the spark ignition engine (petrol) and the compression ignition engine (diesel). Most of these are four-stroke cycle engines, meaning four piston strokes are needed to complete a cycle. Aside from the type of fuel used, engines are classified based on a variety of factors, including the existence of a spark plug in petrol engines

and a fuel injector in diesel engines. We also know that lighter vehicles like motorcycles, scooters, and cars utilise petrol in their engines, but diesel is used in much bigger machines like tractors, trucks, and buses. Thus, the type of fuel utilised also plays a significant part in distinguishing petrol and diesel engines. More distinctions between these sorts of engines are detailed in the table below.

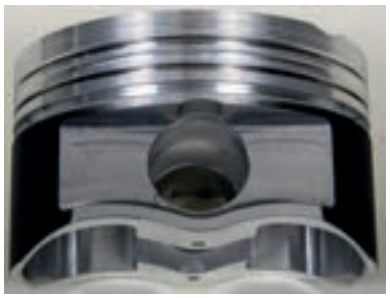
Table 1.1: *Difference Between Petrol and Diesel Engine*

Difference Between Petrol and Diesel Engine	
Diesel Engine	**Petrol Engine**
1. These engines work on the principle of diesel cycle	1. Works on the principle of Otto cycle
2. Fuel is mixed with air inside the cylinder	2. Air and fuel are mixed in a carburettor
3. Ignition is achieved with the help of the hot compressed air	3. Fuel is ignited with an electric spark
4. High compression ratio	4. Low compression ratio
5. High power production	5. Low amounts of power are produced in a petrol engine
6. These engines work with fuels that have low volatilities	6. Highly volatile fuels are used in these internal combustion engines
7. Generally used in heavy vehicles such as trucks and buses	7. Used in light vehicles such as motorcycles and cars
8. Low fuel consumption	8. High fuel consumption
9. High initial and maintenance costs	9. Comparatively low initial cost and maintenance cost

Engine components and their functions:

Table 1.2: *Engine components and their functions*

S/N	COMPONENT PART	FUNCTION
1	 **Cylinder Block**	The cylinder block acts as the main structure of the engine on which various parts are mounted. 1. It also has coolant galleries that help to cool the engine components. 2. It also holds the oil sump or reservoirs at the bottom. 3. It withstands combustion pressure and temperature. 4. It acts as rigid support to all moving components.

S/N	COMPONENT PART	FUNCTION
2	 **Cylinder Head**	Its main role is to enclose the top of the cylindersand its component parts are subject to high temperatures and pressures. Technical faults in the cylinder head compromise the operation of the entire engine.
3	 **Crankshaft**	The crankshaft is the backbone of the automotive engine. Crankshafts should have very high fatigue strength and wear resistance to ensure long service life. The crankshaft is responsible for the proper operation of the engine and converting a linear (reciprocating) motion to a rotational motion.
4	 **Camshaft**	The camshaft is a mechanical component of an internal combustion engine. It is driven by the crankshaft by way of gearwheels, a toothed belt, or a timing chain. It opens and closes the inlet and exhaust valves of the engine at the right time, with the exact stroke and in a precisely defined sequence.
5	 **Piston**	The piston acts as a movable gas tight plunger in the engine cylinder during the four-stroke cycle. It also converts the energy released during combustion into a mechanical action and transfers it to the crankshaft in the form of a torsional force through the gudgeon pin and the connecting rod.
6	 **Connecting Rod**	A connecting rod, also called a ‘con rod’, is the part which connects the piston to the crankshaft. Together with the crank, the connecting rod converts the reciprocating motion of the piston into the rotation of the crankshaft.

(Source: *Engine components and their functions - Search Images (bing.com)***)**

Types of cylinder arrangement

1. **In-line Engine Block:** are most found in smaller cars thanks to their reduced footprint and simplicity. They have cylinders arranged in a single line, making them more efficient with fuel use and often smoother in operation. One of the main drawbacks of in-line engine blocks, however, is their lower performance compared with V and flat engine blocks.

Fig 1.3: *in-line Cylinder arrangement*

(Source: *in-line Cylinder arrangement - Search Images (bing.com))*

2. **V Engine Block:** as a slightly more intricate piece of machinery, V engine blocks build on the foundations of the in-line engine block by adding an additional line of cylinders. These lines are presented in a V-shape to maximise space and the influence behind the name of the block. Such a design allows for the engine block to be made even smaller, while continuing to provide room for more cylinders. Such engine blocks are therefore found more commonly on high performance, mid-range cars thanks to their ability to produce an even greater amount of power. Because of their clever design, V engine blocks are inherently more expensive than in-line engine blocks, while also being heavier.

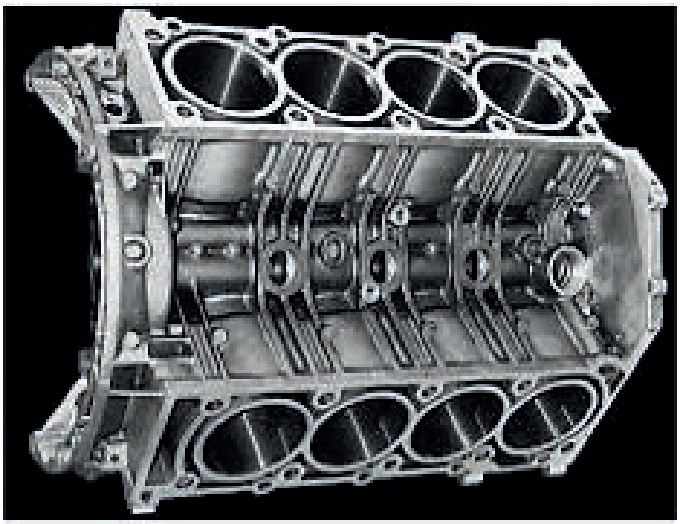


Fig 1.4: *V-engine cylinder block*

(Source: *V-engine cylinder block - Search Images (bing.com)***)**

3. **Flat Engine Block:** The third and final type of engine block is the flat engine block. Flat engine blocks have similarities to in-line blocks in the sense that cylinders are arranged in a specific location, horizontally. This allows them to have a greater weight distribution and lower centre

of gravity. Because of this, flat engine blocks are of a slightly smaller size than V engine blocks, and for this reason are exclusively found in high performance vehicles.

Fig 1.5: *Flat cylinder block*

(Source: *Flat cylinder block - Search Images (bing.com)***)**

Types of cylinder heads

The cylinder head may be classified depending upon the layout of valves and ports. There are three types – Loop-flow type, offset crossflow type or in-line crossflow type. In the loop-flow design, the inlet and exhaust manifolds are on the same side which helps pre-heating of the intake air.

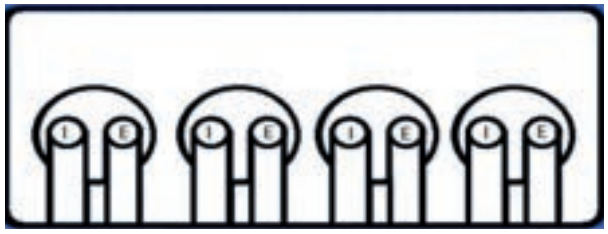


Fig 1.6:

(Source: *Loop-flow type cylinder heads - Search Images (bing.com)***)**

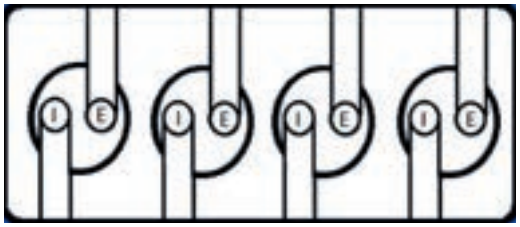


Fig 1.7: *Offset cross flow*

(Source: *Offset cross flow cylinder heads - Search Images (bing.com)*

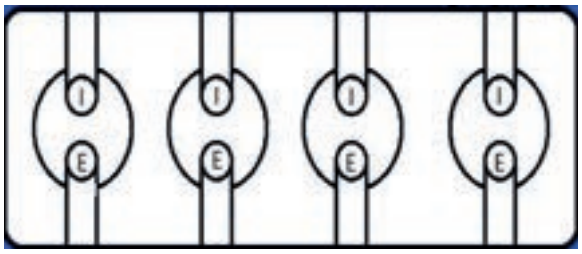


Fig 1.8: *In-line crossflow*

(Source: *In-line crossflow cylinder heads - Search Images (bing.com)***)**

Types of crankshafts

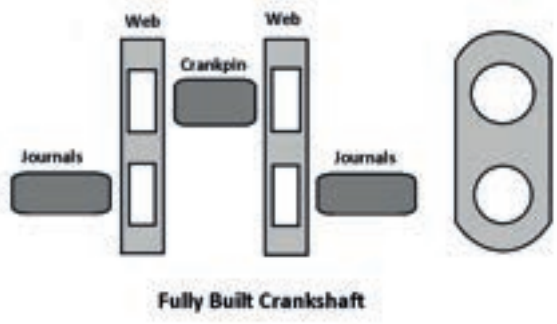


Fig. 1.9: *Fully Built*
(Source: *Fully Built Crankshaft - Search Images (bing.com))*

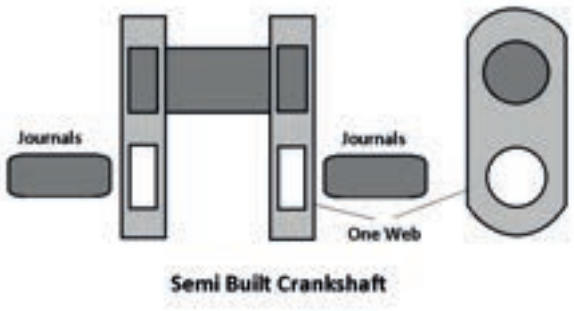


Fig. 1.10: *Semi Built Crankshaft*
(source: *Semi Built Crankshaft - Search Images (bing.com)***)**

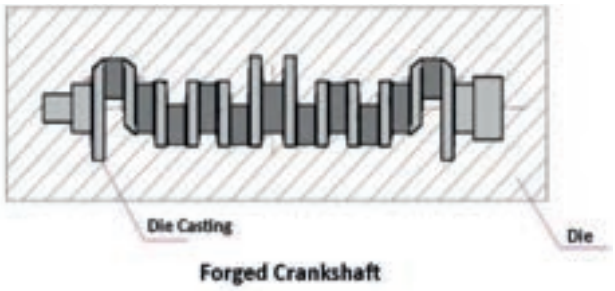


Fig 1.11: *Forged Crankshaft*

(source: *Forged Crankshaft - Search Images (bing.com))*

Types of camshafts

1. Flat Tappet Camshaft	2. Roller Tappet Camshaft
	

Table 1.3: *Flat Tappet with roller profile*

(Source: *Flat Tappet Camshafts with roller profile - Search Images (bing.com)***)**

Features of cylinder block

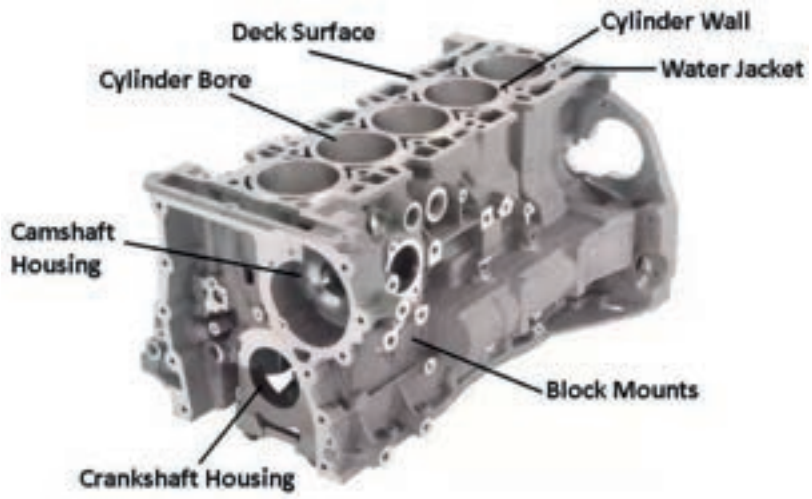


Fig 1.12: *Cylinder block*

(Source: *Cylinder Block: Diagram, Parts, Types, Functions, Material [PDF] (theengineerspost.com)*

Features of cylinder head

Fig 1.13: *Cylinder head*

(Source: *cylinder head (automobile310.blogspot.com)*

Learning Tasks

1. Identify two types of engines use in motor vehicle
2. Describe three functions of the motor vehicle engine
3. Arrange and evaluate five features each of petrol and diesel engines

Pedagogical Exemplars

Teachers should consider the following activities:

Problem-based learning: Guide learners in working groups with the aid of real objects, videos, models of engines (Petrol and diesel engines) to co-operatively brainstorm to identify types of engines use in motor vehicle with open-mindedness. Teachers should target questions to learners as they discuss with one another, to push thinking on. Teachers should pull all learners back in for whole-class feedback and to collect definitions.

Group work/Collaborative learning: Place learners into mixed-ability groups and task them to co-operatively describe functions of the motor vehicle engine, with open-mindedness and respect for each other's view. Teachers should circulate the classroom ensuring all learners are supported/participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

Experiential learning: Teacher should task learners to arrange and evaluate the features of petrol and diesel engines, *using real objects, videos and internet surfing.* Teachers should supervise to ensure that the whole class participate in the lesson. Teachers should pull all learners back in for whole-class feedback.

Key Assessment

Level 1: Identify two types of engines use in a motor vehicle

Level 2: Describe three functions of the motor vehicle engine

Level 3: Arrange and evaluate five features each of petrol and diesel engines

Unit 2 Review

This unit exposed learners to the various types, differences, components, and functions of engines found in motor vehicles. The pedagogical exemplars included problem-based learning, group work/collaborative learning role-play and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Reflection: Types of engines, function of engine parts.

Resources: Models of engines, petrol and diesel engines, charts/sketches, video/YouTube, Real engines, local vehicle repair workshop, simulated activities, real objects.

References

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UNIT 3

Strand: **Building: Construction Technology**

Sub-Strand: **Pre-Construction Activities**

Learning Outcome: *Demonstrate knowledge of human resource requirements in building construction*

Content Standard: Demonstrate knowledge and understanding roles of building construction personnel

INTRODUCTION AND UNIT SUMMARY

Learners at the end of the unit will understand the major stakeholders involved in any building construction project. Major stakeholders include individuals representing various interest groups such as the Client Group, the Design Team, the Building Team, the Statutory Authorities and the Civil Society. Learners after having understood the detailed roles played by these interest groups will appreciate how their presence and active participation in the projects bring about sustainability to the building projects.

The unit covers only week 2: ***Explain the stakeholders involved in building construction project***

SUMMARY OF PEDAGOGICAL EXEMPLARS

The Pedagogical Exemplars that can be used may include conducting experiential learning by organising field trips to construction sites or offices of stakeholders where learners will observe and interact with the relevant stakeholders to understand them. To help learners develop a deeper understanding of the concept of stakeholders. Teachers may also use role play and the use of research on the internet. Teachers may put learners in mixed-ability groupings to meet the needs of learners Approaching Proficiency, the Proficient and Highly Proficient, learner needs will also be met using this strategy. Learners will all be capacitated as they engage in critical thinking and brainstorming without any form of inhibition. The collaborative environment which will be made tolerant of GESI, SEL and National Values is expected to enhance the brainstorming sessions which will in turn capture the diverse knowledge that the groups have.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction should be formative and this should include quizzes and short oral and written responses to questions. Teachers must keep track of performance of each learner given the different levels of performance of the learner in class and provide the relevant motivation or scaffolds to enhance understanding of the concept. The assessment will also serve as a tool to evaluate levels 1, 2 and 3 of the DoK amongst learners Approaching Proficiency, the Proficient and Highly Proficient. In this way the pedagogical differentiation strategies adopted will also be complemented under the assessment.

WEEK 2

Learning Indicator(s): *Explain the stakeholders involved in building construction project*

Theme or Focal Area: Construction Stakeholders

A stakeholder in any construction project is an individual or group with vested interests in the project. Stakeholders can come from various backgrounds and organisations, including:

1. **Client Entities:** These may include government agencies, corporate bodies, and private individuals who initiate and fund the project.
2. **Design Team:** This group typically consists of architects and quantity surveyors who are responsible for the project's design and cost estimation.
3. **Building Team:** The building team comprises the contractor and the clerk of works, who oversee the construction process.
4. **Statutory Authorities:** Officers from the District Assembly are responsible for ensuring that the project complies with local regulations and safety standards.
5. **Civil Society:** This category involves individuals, journalists, advocacy groups, and others who may represent the broader community's interests.

Stakeholders in construction projects often represent different aspects of society, each with its own interests to protect. These interests can impact budgetary arrangements, town and country planning, and environmental protection. For instance, if a project uses banned materials like asbestos and poses health hazards, civil society may protest. Statutory authorities are responsible for city planning and human dwelling safety and may withhold building permits if a project development doesn't meet acceptable standards. The presence and active participation of stakeholders from various backgrounds are essential for well-rounded construction project management.

Learning Tasks

1. Outline the different stakeholder groups one is likely to encounter on a building project
2. How do stakeholder groups such as the design team and the civil society contribute to the success of construction projects they associate with?
3. What strategies do stakeholders put in place to ensure that the project becomes sustainable?

Pedagogical Exemplars

Teachers should consider the following activities:

Experiential learning: organise field trips to construction sites or offices of stakeholders where learners will observe constructional activities and interact with relevant personnel to gain understanding of the concept of a Stakeholder for building construction projects. Guide learners to watch videos on construction activities and task them to identify the stakeholders they encounter.

Digital learning: Encourage research on the internet to help learners develop a deeper understanding of the categories of stakeholders involved in building construction projects.

Collaborative learning: Deliberately place learners in mixed-ability groupings where the different needs of learners Approaching Proficiency, the Proficient and Highly Proficient will be met and

where they will all be encouraged to engage in critical thinking and brainstorming to explain the relevance of stakeholders.

Key Assessment

Level 1: Identify five different groups of stakeholders one can find on a building construction project

Level 2: Describe how different stakeholder groups, such as the client entity and the building team, contribute to a successful construction project

Level 3: Discuss a scenario where statutory authorities might need to withhold a building permit due to safety concerns. What strategic steps can they take to address the situation effectively?

Unit 3 Review

This unit provided the learner with a deeper understanding of the concept of stakeholders within the building construction industry. The pedagogical exemplars used in this section included group work/collaborative learning, role-play, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Charts, pictures, videos and real object (nose mask, goggles, safety boots, overcoat, gloves and helmet).

References

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2. The Applied Technolgy Secondary Education Curriculum (1.X.3.1.LO.1, 1.X.3.1.CS.1, 1.X.3.1.LI.1, 1.X.3.1.AS.1)
3. Walton, D. (2003) Building Construction: Principles and Practices. Macmillan Publishers Limited

UNIT 4

Strand: **Electrical and Electronic Technology**

Sub-Strand: **Electrical Systems Design**

Learning Outcome: *Explain clearly safety principles to follow in the use of electricity, analyse the key steps in power transmission and link it to power distribution to other substations, homes and industries*

Content Standard: Demonstrate knowledge and understanding of power transmission and distribution and its associated safety

INTRODUCTION AND UNIT SUMMARY

This unit explores the foundational principles of electricity and emphasises workshop safety. Learners will delve into electricity's indispensable role in modern life, powering our homes, workplaces, and industries. Understanding these key concepts is crucial as mishandling poses significant risks, from electrical shocks to fires. Negligence or ignorance can have severe consequences. Upon completion of this section, learners are expected to prioritise safety in electricity usage. Furthermore, this introduction provides essential guidelines, practices, and principles to mitigate risks and promote safe electrical practices. By recognising potential hazards, implementing preventive measures, and adhering to safety standards, both individuals and organisations can safeguard against accidents, preserving lives and property.

The unit covers only week 3: ***Safety in the use of electricity***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must practically demonstrate their knowledge and understanding of power transmission and distribution and its associated safety. Teachers should employ pedagogies such as, problem based and collaborative learning, experiential learning and project-based learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. Identifying electrical and electronic symbols helps learners interpret diagrams and schematics, essential skill in understanding electrical system. By incorporating these strategies, teachers can create engaging and effective learning experiences for learners studying electricity and electrical safety concepts. Active participation collaboration, hands-on projects, and teacher guidance all contribute to a comprehensive and enriched learning environment.

ASSESSMENT SUMMARY

To demonstrate conceptual understanding of the ideas covered in this section, learners must show how they apply the concepts in real-world situations. As a result, levels 1, 2, and 3 of the DoK should be substantially covered in the assessments. To gather data regarding learners' progress and provide timely feedback, teachers should utilise a range of formative assessment tools, including pairs of tasks, reports, oral and written presentations, and home assignments. Teachers should administer assessments such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the various safety in the use of electricity. Teachers should document learners' results in continuous assessment records. Tasks should encompass the significance, diverse branches, career prospects, and dispelling of misconceptions surrounding applied technology. This ensures learners grasp the broader context and relevance of technology across different domains.

WEEK 3

Learning Indicator(s): *Discuss safety in the use of electricity*

Theme or Focal Area: Safety in the Use of Electricity

Electrical shock

Electric shock occurs when any part of the body gets in contact with *live parts of an electrical supply while at the same time, touching ground, neutral or another live*. When this happens, an electric current flow through the tissue of the body and causes electric shock.

Electrocution is death caused by electric shock. Depending on the severity of the electric shock, other injuries may occur. These injuries may include:

1. Burns to the skin
2. Burns injuries affecting the internal tissues and organs.

Fig 1.14: *Person experiencing an electric shock*

Causes of Electric Shock

Some causes of electrical shock may include:

1. Faulty appliances
2. Damaged extension leads
3. Electrical appliances, in contact with water
4. Incorrect, damaged or deteriorated household wiring
5. Downed power lines
6. Lightning strikes

Effects of electric shock: The effects of an electric shock on the human body depends upon the voltage or current. Low-voltage electrical shocks may have no effect, but higher voltages are likely to cause death. Injuries depend on the length of time the current flows as this can block signals to the brain, stopping the heart from beating. The passage of an electrical current though the human body

causes tissue to heat up along the length of the current flow, causing severe internal burns in less than a second.

Typical symptoms or effects of electric shock include:

1. Unconsciousness
2. Difficulties in breathing or no breathing at all
3. A weak, erratic pulse or no pulse at all
4. Burns, particularly at the place where electricity entered and left the body
5. Cardiac Arrest

How to prevent electric shocks

Fig 1.15: *Clothing to prevent electric shock*

(Source: *HRC 4 Arc Flash Kits (40 cal/cm²), Arc Flash Switching Suit | Shanghai C&G (cgprotection.com)*

The following preventive measures can reduce the risk of electric shock:

1. Do not attempt to do your own electrical work
2. Do not remove a plug from a power point by pulling on the cord - pull the plug instead
3. Keep electrical appliances away from wet areas
4. Wear rubber or plastic-soled shoes when using electrical appliances
5. Have safety switches installed by an electrician
6. Insert safety plugs into unused power points to stop children from inserting objects into them

First Aid for Electric shock:

Fig 1.16: *Electric shock victim being given First Aid*

(Source: electric-shock.jpeg (1498×1000) (firstaidforlife.org.uk)

When a person is electrocuted, their heart may stop beating due to the electrical shock. Cardiopulmonary resuscitation (CPR) can be used in an attempt to revive an electrocuted victim by providing artificial circulation and oxygenation until professional medical help arrives. CPR is typically administered in such situations:

1. **Assess the scene for safety:** Ensure that the scene is safe for both you and the victim before approaching.
2. **Check responsiveness**.: Gently shake the victim and shout 'Are you okay?' to check for responsiveness.
3. **Activate emergency response**: If the victim is unresponsive, immediately call emergency services or instruct someone else to do so.
4. **Check for normal breathing:** Place your ear near the victim's mouth and nose while looking at their chest to check for breathing. If the victim is not breathing normally or not breathing at all, begin CPR.

Learning Tasks

1. What are the common sources of electric shock in household settings?
2. How can faulty electrical appliances lead to electric shock?
3. What are some of the effects of electric shock on the human body?
4. How should burns and other injuries be treated after an electric shock?

Note:

1. *Learners with special needs should be given more time to complete a given task.*
2. *During presentations, ensure that anyone regardless of the background i.e. gender, physical abilities and intellectual abilities be encouraged to present on behalf of the groups as well as becoming a group leader.*

Pedagogical Exemplars

Teachers should consider the following activities:

Talk for learning: Engage the entire class in a discussion aimed at encouraging learners to actively participate and collectively brainstorm to define electric shock, delve into its root causes, and analyse its effects.

Group work/Collaborative learning: In small mixed-ability groups, task learners to identify protective clothing needed when working with electricity. Encourage learners to pool their knowledge and skills to brainstorm and research for the necessary protective clothing needed when working with electricity. Learners should also explore the various precautions and safety measures essential for working with electricity safely.

Note: Through this group work, learners not only enhance their understanding of protective measures but also develop teamwork and communication skills. Each group member can contribute their unique perspectives, fostering a collaborative learning environment where everyone learns from each other's experiences and insights.

Experiential learning: Engage learners in an experiential learning process by inviting them to engage in role playing scenarios depicting how to treat a victim of electric shock. Following this, challenge them to identify essential precautions to observe when such situations, such as always switching off circuits before beginning any task.

Through active participation in these role playing activities, learners will gain first-hand experience and understanding of the necessary steps to take when encountering an electric shock incident.

Additionally, they will collaboratively brainstorm and discuss preventive measures, drawing from their simulated experiences to reinforce safety protocols. This experiential learning approach not only enhances learners' practical knowledge but also fosters critical thinking skills as they analyse and apply safety precautions in real-world contexts. By actively engaging in role playing and discussions, learners develop a deeper understanding of electrical safety practices, ensuring they are better prepared to avoid potential hazards in the future.

Key Assessment

Level 1:

1. Identify four dangerous situations and behaviours likely to cause electric shocks.
2. List the procedures involved when treating an electrocuted victim.

Level 2:

1. Why do we have insulation around electrical workshop tools?
2. Explain how electrical wiring issues in buildings can cause electric shocks.
3. Describe the safety precautions to be taken to prevent electric shocks in the workplace.

Level 3:

1. How can a severe electric shock cause damage to internal organs and tissues?
2. What role does the current intensity plays in determining the severity of an electric shock?
3. How can safety be ensured while providing first aid to an electric shock victim?
4. What is the correct way to disconnect the power source when someone is being electrocuted?
5. How should burns and other injuries be treated after an electric shock?

Unit 4 Review

This unit introduced learners to the concept of safety in the use of electricity. It emphasised the importance of these technologies in society and the world as a whole. The unit provided a comprehensive introduction to electricity and electronics design technology, highlighting its importance, benefits, challenges, and safety considerations. The use of varied pedagogical approaches and assessment methods facilitated active learning and engagement among learners with diverse learning needs and abilities.

Resources: Overcoat**,** Goggles, Protective shoes**,** Hand gloves.

References

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UNIT 5

Strand: Metal Technology

Sub-Strand: **Engineering Materials, Tools and Machines**

Learning Outcome: *Apply health and safety to the use of tools and machines as well as use properties of metals and non-metals to select the right materials for a given application*

Content Standard: Demonstrate knowledge in the use of engineering materials, tools and machines

INTRODUCTION AND UNIT SUMMARY

Hand tools such as measuring tools, marking out tools, holding tools, striking tools and cutting tools are fundamental tools in metalwork and their proper use is essential for achieving precision and efficiency in various metalworking processes. Engineers often use a combination of these tools to measure, mark, cut, shape, join and finish metal components for different applications. Teaching hand tools in metalwork involves various pedagogical approaches to ensure effective learning. By combining these pedagogical approaches used in the lesson, learners can acquire a comprehensive and effective learning experience in studying the hand tools. By incorporating a mix of DoK levels, teachers can tailor their instruction to different learning needs of the learners and ensure that the learners develop a deep understanding of the various types of hand tools and their practical use and applications.

The unit covers only week 3: ***Safe use of hand tools in metal work***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must identify hand tools such as measuring tools, marking out tools, holding tools, striking tools and cutting tools their safe use in the metal workshop. For learners to appreciate the hand tools and explain the uses, teachers should employ a variety of pedagogical strategies such as talk for learning approaches, group work/collaborative learning, digital literacy learning, experiential learning and project-based learning.

ASSESSMENT SUMMARY

To demonstrate conceptual understanding of the ideas covered in this section, learners must show how they apply the concepts in real-world situations. As a result, levels 1, 2, and 3 of the DoK should be substantially covered in the assessments. To gather data regarding learners' progress and provide timely feedback, teachers should utilise a range of formative assessment tools, including pairs of tasks, reports, oral and written presentations, and home assignments. Teachers should administer assessments such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the safety in the use of electricity. Teachers should document learners' results in continuous assessment records. Tasks should encompass the significance, diverse branches, career prospects, and dispelling of misconceptions surrounding applied technology. This ensures learners grasp the broader context and relevance of technology across different domains.

WEEK 3

Learning Indicator(s):

1. *Explain health and safety related to workshop, tools, materials and machines*
2. *Explain the uses of various types of measuring, marking out, holding, striking and cutting tools*

Theme or Focal Area: Safe Use of Hand tools in Metal Work

Review of health and safety issues in a metal workshop are crucial to address to ensure the well-being of learners, teachers and the overall functioning of tools, equipment and machines. Regular inspections, training of teachers and learners, and a strong commitment to safety policies are essential to maintaining a healthy and safe mechanical workshop in schools. It's important to comply with local regulations and standards related to workplace safety. Some basic health and safety issues that should be considered:

1. **Personal Protective Equipment (PPE):** Ensure that learners are provided with and wear appropriate PPE, such as safety glasses, gloves, hearing protection, and steel-toed boots, to protect against potential hazards.
2. **Machine safety**: Develop and enforce strict safety procedures for using machinery, including lockout/tagout procedures during practical sessions and maintenance work.
3. **Machine guarding**: Machines should have proper guards in place to prevent accidental contact with moving parts. Regular maintenance and inspection of these guards is essential.
4. **Material safety:** Educate learners on the properties of metals and materials they may be working with, including potential hazards and safe handling practices.
5. **Tool safety:** Regularly inspect tools and equipment for damage or wear. Ensure that they are well maintained and promptly repair or replace any faulty equipment. Guide learners to use the right tool for the job. Using improper tools can lead to accidents and damage to both tools and workpieces. Ensure that tools are stored properly when not in use to prevent tripping hazards and to maintain a clean and organised workspace.
6. **Electrical and welding safety:** Regularly inspect and maintain electrical equipment. Learners should be trained in electrical safety procedures, and outlets should be properly grounded. Learners should be educated about the hazards of welding fumes, which may contain harmful substances.
7. **Manual handling:** Train learners in proper lifting techniques to prevent musculoskeletal injuries. Use mechanical aids when possible, to reduce the risk of manual handling injuries.
8. **Fire safety:** Have adequate fire prevention and control measures in place, including fire extinguishers, emergency exits, and proper storage of flammable materials.
9. **Chemical handling:** Proper storage, labelling, and handling of hazardous chemicals. Learners should be trained on the correct use of chemicals
10. **Noise control:** Implement measures to control noise levels in the workshop, such as providing hearing protection and isolating noisy machinery.
11. **Ventilation:** Ensure adequate ventilation to prevent the build-up of harmful fumes and dust. Install effective exhaust systems where necessary.

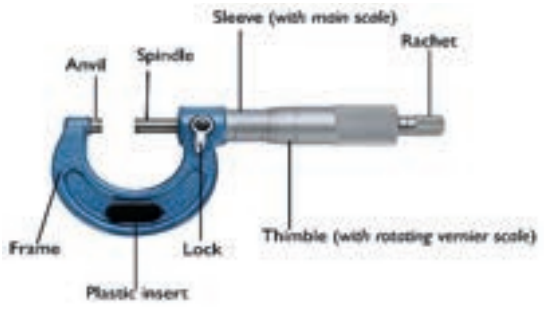
12. **First aid and emergency response:** Have well-equipped first aid kits readily available, and ensure that learners are trained in basic first aid. Establish emergency response protocols and conduct regular drills.
13. **Training and awareness:** Regular safety training must be provided for all users of the workshop to keep them informed about potential hazards and the proper procedures for maintaining a safe working environment.
14. **Housekeeping:** Keep the workshop clean and organised to minimise tripping hazards and ensure a safe working environment.

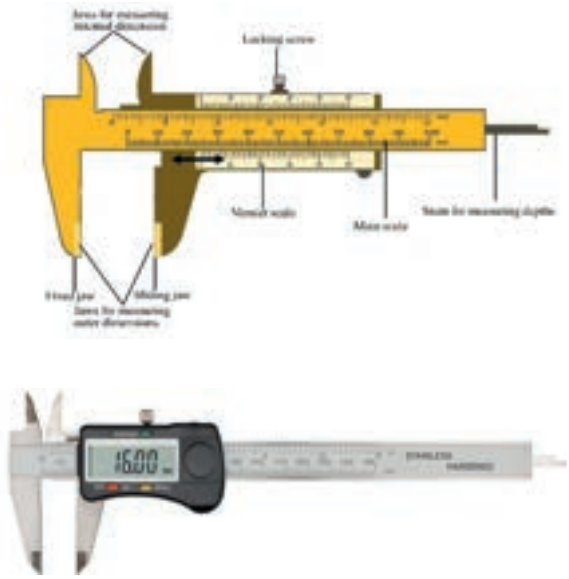
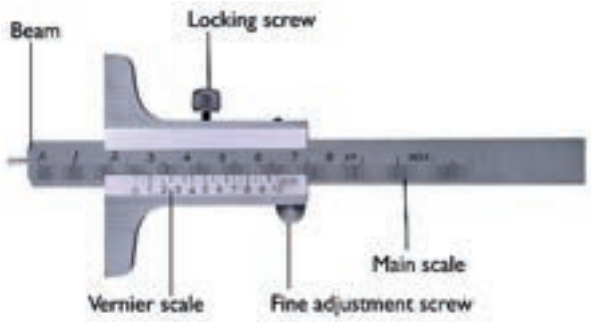
Measuring tools

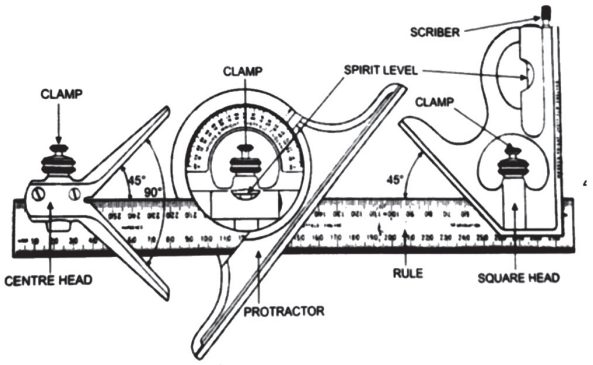
Measuring tools are instruments or devices used to accurately determine specific dimensions, angles, depths, levels, volumes, temperature etc. Measurements can be linear or angular. They can be used in various fields in engineering such as manufacturing and many others. These tools help ensure accuracy and precision in measurement, leading to more reliable and consistent data and results.

Table 1.1: shows some types of measuring tools and their uses.

Table 1.1: *Measuring tools*

S/N	Type of measuring tool	Uses
1	Outside calliper 	Used in conjunction with the steel rule to measure and transfer readings of outside or external dimensions of objects (e.g. bolts and nuts, round pipes and bars).
2	Inside calliper 	Used in conjunction with the steel rule to measure and transfer readings of inside or internal dimensions of objects.
3	Micrometre screw gauge 	Used to measure the diameter of wires, cables and other objects.

S/N	Type of measuring tool	Uses
4	Vernier calliper 	Used to measure outside and inside diameters of objects.
5	Depth gauge 	Used to measure the depth of a bored hole, drilled hole or a recess.
6	Measuring tape 	It has blades made of flexible steel, which are spring-loaded into a case. It is longer than steel rule.
7	Steel rule 	It is made of springy steel. The common lengths are 150mm and 300mm. It is graduated in millimetres and centimetres.

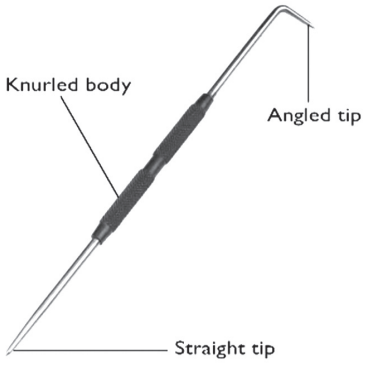
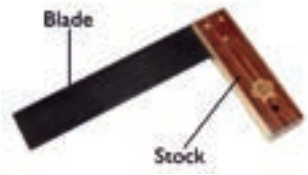
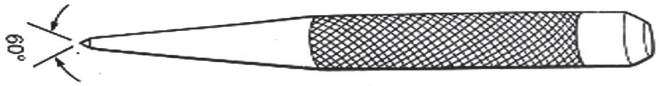
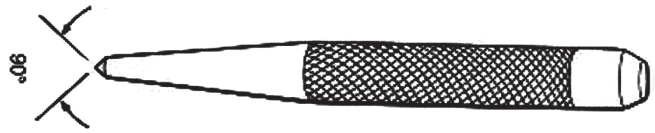
S/N	Type of measuring tool	Uses
8	Combination set  	The combination set consists of scale, squaring-head, protractor and a centre-head. It consists of a heavy scale, which is grooved all along its length. It is on this groove that the sliding squaring head is fitted. There are three heads (protractor, square and centre) which slide onto a rule, which can be fixed at any position using the nut provided. The try square has angles of 45^0 and 90^0 which can be used to mark out or check that a surface is vertical. It can also be used as a square. The centre is used to find the centre of circular pieces.
9	Dial gauge and indicator 	Dial gauges are used to measure the flatness and inclination of objects. Used to check round bar roundness. It checks the flatness of an object as compared to the flatness of the standard object. In the mechanical field, dial gauges are used to check the flatness and alignment of various jobs and workpieces.

(Sources: *types of marking out tools and their uses. ~ welcome to myfurniturezworld blog***)**

Marking out tools

Marking out tools are tools used to transfer dimensions from working drawings onto a workpiece before cutting or shaping. Table 1.2 shows some types of marking out tools and their uses.

Table 1.2: *Marking out tools*

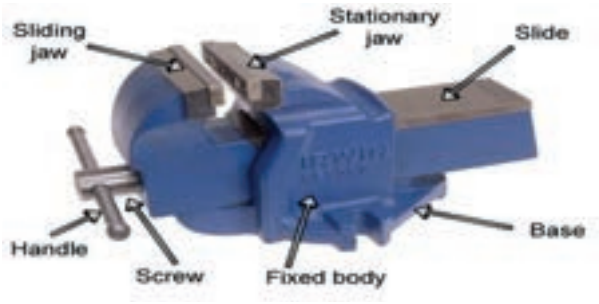
S/N	Type of marking out tool	Uses
1	Scriber 	Used in conjunction with the try square to mark out lines on a workpiece.
2	Try square 	Used for marking out lines at right angles to an already finished edge. It is also used for checking squareness of workpieces.
3	**Dot punch** 	Has a point angle of 60^0. Used to dot-punch an outline of a workpiece to make it visible when the marked-out shape of the material is to be cut later.
4	Centre punch 	It has a point angle of 90^0. Used for punching the position of holes to be drilled. The punched hole enables the drill to make a good start.
5	**Vee block** 	Made of cast iron and it is supplied in pairs. It is used to clamp round or rectangular bar when testing it or marking it out.

S/N	Type of marking out tool	Uses
6	Surface plate 	A surface used for testing the flatness of other surfaces or to provide a truly flat datum surface in marking off work for machining.
7	Scribing block or surface gauge 	Used to 'scribe' parallel lines on the end part of a rod to determine the centre.
8	Angle plate 	Used to hold workpieces perpendicular to the surface plate during marking out operations.

(Sources: types of marking out tools and their uses. ~ welcome to myfurniturezworld blog**)**

Holding tools

Holding tools are support devices used to securely position a tool or a workpiece in a specific spot or orientation. Table 1.3 shows some holding tools and their uses.

S/N	Type of holding tool	Uses
1	Engineers vice 	Used for holding workpieces when filing, chiseling, cutting and bending.
2	Hand vice 	Used to hold small objects tightly while grinding, drilling, filing, hammering, sanding and shaping.
3	Leg vice 	A holding tool used during forge work.
4	Machine vice 	Fixed to a drilling machine or the power hacksaw to hold work when cutting or drilling.

(Sources: *Holding and Clamping Tools - Search Images (bing.com)***)**

Striking tools

Striking tools are tools used for delivering an impact or blow to a workpiece. Table 1.4 shows some examples of striking tools and their uses.

Table 1.4: *Striking tools*

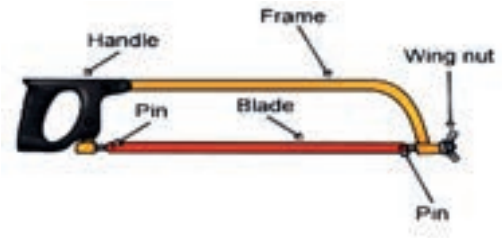
S/N	Type of striking tool	Uses
1	Sledge hammer 	Used for forge work.
2	Ball pein hammer 	For general use for striking and riveting.
3	Straight pein hammer 	Used for bending sheet metals.
4	Cross pein hammer 	Used to make the metal fuller when forging and hammering in corners.
5	Raw hide mallet 	Used for flattening and bending sheet metal.

(Sources: *Striking tools - Search Images (bing.com)*

Cutting tools

Cutting tools are wedge-shaped and sharp-edged devices used for removing excess layers of material from workpieces to obtain the desired shape, size and accuracy. Table 1.5 shows some cutting tools and their uses.

Table 1.5: *Cutting tools*

S/N	Type of cutting tool	Uses
1	**Chisels** (flat chisel, crosscut chisel, round-nosed chisel, diamond point chisel). 	Used for cutting metals in either cold or hot state. Cold chisels have a point angle of 60°. Hot set chisels have a point angle of 30°.
2	Hacksaw 	A general-purpose tool for cutting mild steel plates and rods.
3	Hand shears or snips 	Types of hand shears are straight, curved and universal. They are used for cutting thin sheet metals.
4	Files 	Used for removing small amounts of material from the surface of a metal part. Types of files include: hand file, square file, flat file, half-round file, triangular file, round file and needle files.

(Sources: Cutting tools - Search Images (bing.com)

Learning Tasks

1. Define measuring tools, marking out tools, holding tools, striking tools and cutting tools used in metalwork.
2. Identify at least three tools for each of the following: measuring, marking-out, holding, striking and cutting tools and present their answers with the aid of sketches, orally or in writing.
3. Describe the process of using a particular tool in measuring, marking out, holding, striking and cutting.
4. Discuss the applications of measuring tools, marking-out tools, holding tools, striking tools and cutting tools at the workshop in completing a given project.

Pedagogical Exemplars:

Teachers should consider the following activities:

Pre-assessment: Begin by conducting a pre-assessment with oral questions to understand the prior knowledge, skills and experiences of each learner regarding hand tools in metalwork. This will help the teacher tailor instructions to meet the specific needs of individual learners or groups of learners.

Research and collaboration: Learners in mixed-ability groups and in a fair manner are shown samples of measuring tools, marking out tools, holding tools, striking tools and cutting tools in metalwork and tasked to brainstorm their uses.

Group work/Collaborative learning: Group learners flexibly based on their learning needs and abilities. The teacher can create mixed-ability groups where learners can learn from and support each other or can group learners homogeneously for targeted instruction based on their skill levels. Guide learners to discuss effectively with respect for others the various ways of avoiding accidents in the workshop, tools, materials and machines. Learners watch safety videos to identify and use the appropriate safety clothing for workshop activities and demonstrate the right safety measures in the use of hand tools and machines.

Scaffolded learning: The teacher can scaffold the learning process by breaking down complex tasks in measuring, marking out, holding, striking and cutting tools in metalwork into smaller, manageable steps. Provide more support and guidance for struggling learners as learners progress through each step, gradually increasing the level of challenge as they become more proficient.

Key Assessment

1. **Level 1:** Identify at least three tools for each of the following: measuring, marking-out, holding, striking and cutting tools and present their answers with the aid of sketches, orally or in writing.
2. **Level 2:** Describe the process of using a particular tool in measuring, marking out, holding, striking and cutting.
3. **Level 3:** Discuss the applications of measuring, marking-out, holding, striking and cutting tools at the workshop in completing a given project.

Unit 5 Review

This unit looked at hand tools such as measuring, marking-out, holding , striking and cutting tools which plays a crucial role in metalwork offering precision, versatility, portability, safety,

and opportunities for skill development. They are essential for beginners learning the basics in metal work tools to create detailed and intricate metalwork project. The unit equips the learners with the various types of measuring tools, marking-out tools, holding tools, striking and cutting tools and their uses. Examples were given for learners to recognise and identify the tools. A given workshop project is undertaken to appreciate and practice the use of the various basic tools.

Reflection:

1. What was my best moment in today's lesson and how can I create more of such situations?
2. Were learners able to identify the measuring tools, marking-out tools, holding tools, striking and cutting tools?
3. Were learners able to explain the uses of the hand tools used in metalwork?
4. Were the learners able to apply the hand tools in a given metalwork project?
5. Which resources best supported the delivery of hand tools used in metalwork?
6. Did learners find the resources useful in using the hand tools?
7. Were the different subgroups in the class catered for?

Resources: Pictures of the hand tools, /YouTube videos showing how the tools are being used, real objects (measuring tools, cutting tools, marking out tools, holding tools and striking tools), sketches, charts and drawings of the hand tools.

References

1. Amoakohene, S. K., & Sackey, J. K. N. (2007). Metalwork Technology (Motivate series) Macmillen Education.
2. Fowler, P. & Hershey, M. (1998). Craft, Design and Technology. Glasgow, Harper Collins.
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4. Love, G. (1980). The Theory & Practice of Metalwork: London & Edinburgh, Longman.
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SECTION 2

The section covers the following units (strands): woodwork technology, automotive technology, building construction technology, electrical and electronic technology as well as metal technology.

The section will help learners acquire knowledge and understanding in the classification of timber in the woodwork industry. Learners will also be able to apply the working principles of engines under automotive technology.

Under the unit of building construction technology learners will gain knowledge of human resource requirements in building construction**.** Under the unit of electrical and electronic technology learners will acquire knowledge and understanding of power generation, transmission, distribution and its associated safety precautions. Knowledge in the use of engineering materials, tools and machines will also be acquired in the automotive technology unit. All the above are treated from Unit 1 to Unit 5.

UNIT 1

Strand: **Woodwork Technology**

Sub-Strand: **Material and Artefacts Production Woodwork Industry in Ghana**

Learning Outcome: *Demonstrate knowledge and understanding in the classification of timber and its processing phases in the woodwork industry.*

Content Standard: Demonstrate knowledge and understanding of classification and processing phases of timber in the woodwork industry

INTRODUCTION AND UNIT SUMMARY

This unit will help learners to explore the two main types of timber: hardwood and softwood. By delving into their unique anatomical features, uses and technological differences, we aim to provide a comprehensive overview of how these classifications play a vital role in the selection and application of timber in various industries.

The unit covers only week 4 & 6: ***Classify the two main types of timber***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in practical demonstrations of how to classify the two main types of timber. Teachers should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. Learners should be encouraged to participate fully in investigations as well as the presentation of findings. Teachers should employ differentiation strategies to accommodate diverse learning needs of the learners.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 1, 2 and 3 of the DoK. Again, teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback to them. Teachers should administer assessment such as class exercises

(including individual worksheets) after each lesson, homework, scores on practical group activities on how to classify the two main types of timber in the workshop. Teachers should document learners' results in continuous assessment records.

WEEK 4 & 6

Learning Indicator(s): *Classify the two main types of timber*

Theme or Focal Area: Timber

A timber is a natural product of solid wood obtained from trees, which has been sawn into sizes suitable for construction purposes, furniture and other fitments.

There are two main types of wood, softwood and hardwood:

1. Softwood comes from evergreen (coniferous) trees that have needle-like leaves and cones seed, trees like pine, spruce, and cedar.
2. Hardwood: comes from broad-leaved (deciduous) trees that drop their leaves according to season, trees like mahogany, sapele, and teak.

It is important to remember that not all hardwoods are deciduous (wawa) and not all softwoods are evergreen (ebony).

The Living Tree

A study of a timber must begin with the living tree from which the timber is obtained. A living tree basically has three main parts: the **roots,** the **trunk** (**stem** or **bole**) and the **crown,** which is composed of the branches and the leaves.

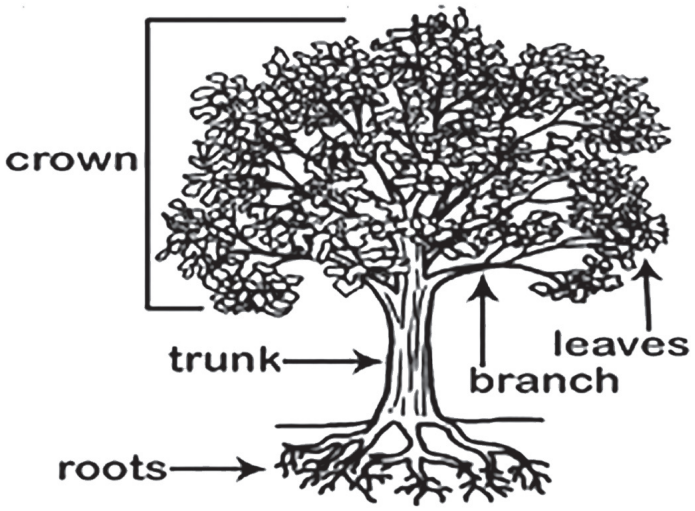

Fig 2.1: *Diagram of a living tree*

(Source: *bing.com/images/search?q=Diagram of a living tree &FORM=IQFRBA&id=9332274B7A64E351C09238A61D963B265B792833)*

Structural parts of a tree

These include pith (medulla), heartwood (duramen), sapwood (alburnum), cambium layer, bast (phloem), bark (cortex), medullary rays, and growth rings.

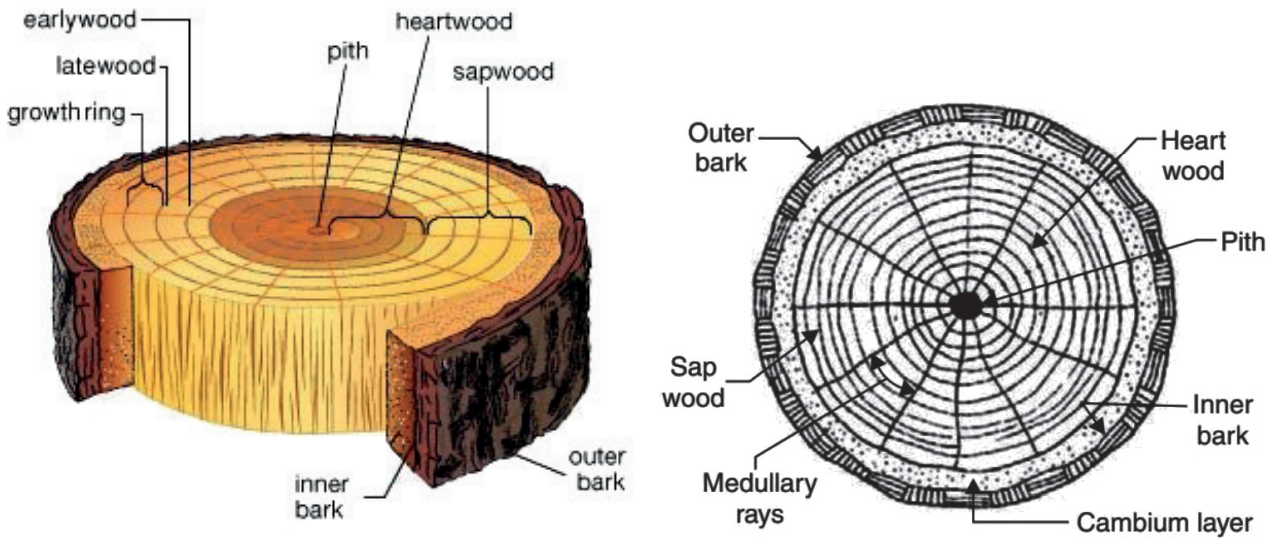

Fig 2.2: *Structural parts of a tree*
(Source: *Structural parts of a tree - Search (bing.com)*

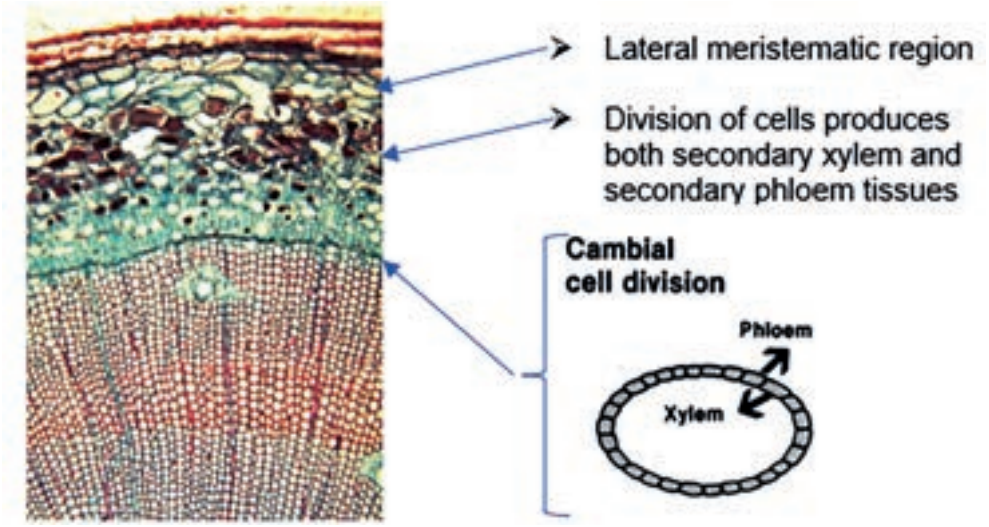

Fig 2.3: *Relationship of xylem and phloem*
(Source: *Microscopic Wood meristematic region - Search Images (bing.com)*

Classification of the tree

Botanically, the timber we use are obtained from the wood of two classes of seed producing trees: Softwood (**conifers)** and the Hardwood (**deciduous)** trees.

1. **Softwood/Conifers:** the softwood/coniferous trees, which are botanically known as **Gymnosperm** are identified by tall slender trunks, narrow or needle-like leaves, naked seeds in cones, trees like pine, spruce, and cedar.

   Difference in Structure of Softwood

   These include: tracheid, rays

   Cell arrangement in softwood:

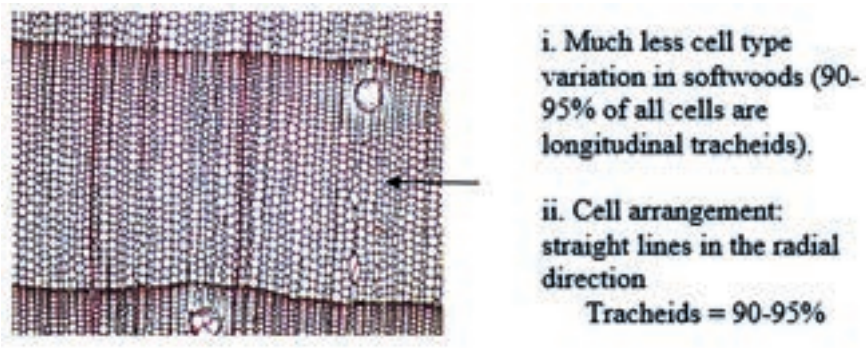

Fig 2.4:*Tangential section of softwood*
(Source: *wood anatomy - Search Images (bing.com)*

Softwood/Gymnosperms (Gymnospermae): We have about 250 species in this group.

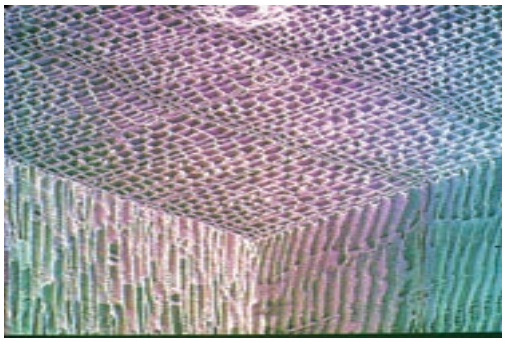

Fig 2.5: *Cross-section/Tangential section of softwood*
(Source: *wood anatomy - Search Images (bing.com)*

2. **Hardwood/ Deciduous:** The botanical name for this class of trees is **Angiosperms**. Deciduous trees bear a great variety of flowers and fruits containing seeds, often called dicotyledon seeds, broad leaves, bigger girth truck, trees like mahogany, sapele, and teak.

   Difference in Structure of Hardwood

   These include: *pores (vessels), fibres, soft tissue (parenchyma), rays.*

   Cell arrangement in hardwood

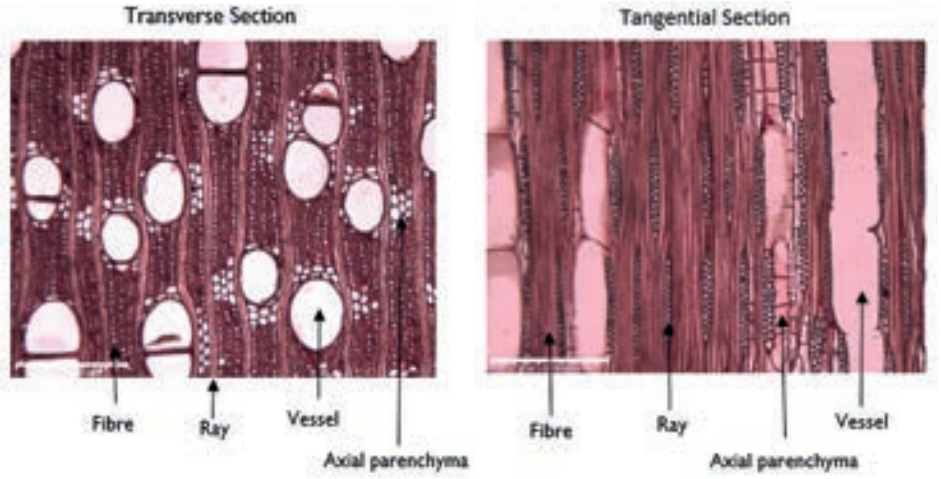

Fig 2.6: *Structure of ring-porous/diffuse-porous hardwood*
(Source: *Owusu et al., 2020)*

Hardwood: Angiosperms (Angiospermae): There are about 30,000 species in this group.

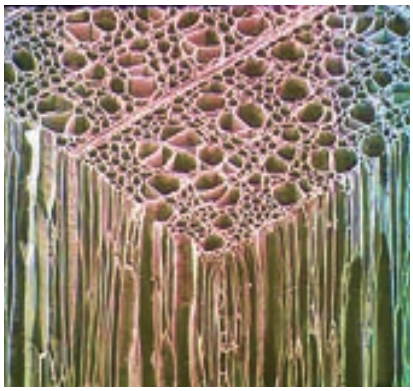

Fig 2.7: *Cross-section/Tangential section of hardwood*
(Source: *wood anatomy - Search Images (bing.com)*

Learning Tasks

1. Identify the three main parts of the living tree.
2. Explain what is meant by the terms pored woods and non-pored woods.
3. Differentiate between the anatomical structure of hardwood and softwood and give three examples each.

Pedagogical Exemplars

Teachers should consider the following activities**:**

Critical thinking and talk for learning approaches: Guide learners through a video demonstration of a timber conversion process in action, to co-operatively brainstorm the meaning and methods of conversion of timber with open-mindedness and faithfulness. Teachers should target questions to learners as they discuss with one another, to push thinking on. Teachers should pull all learners back in for whole-class feedback and collect explanations from learners.

Group work/Collaborative learning /Digital literacy learning: Place learners into mixed-ability groups and task them to co-operatively discuss the differences between hardwoods and softwoods with open-mindedness, patience and work ethics. Teachers should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

Experiential learning: Display samples of different types of wood species and task learners in mixed-ability groups to carefully identify and passionately explain softwoods and hardwoods with open-mindedness. As teachers assess learners' confidence, they can use a magnify lens to differentiate between the anatomical structure of hardwood and softwood with the wood samples.

Key Assessment:

Level 1: Identify different items made of wood in our environment.

Level 2: Describe a typical cross section of a tree trunk.

Level 3: Differentiate between the anatomical structure of hardwood and softwood and give two examples each.

Level 4: Differentiate between the anatomical structure of hardwood and softwood and give three examples each.

UNIT 1 REVIEW

Unit 1 of week 4 & 6 exposed learners to the concept of the two main types of timber and how they are classified. The pedagogical exemplars used in this section included critical thinking, talk for learning, group work/collaborative learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Reflection:

1. Can learners distinguish between coniferous tree from those of the deciduous group?
2. Can learners describe pored woods and non-pored structuring features, with sketches?

Resources: Pictures, real object (wood species), YouTube videos on timber conversion/Flip chart, Computer/Smart phone, Wood anatomy laboratory/Visit a xylarium/collection of timber species specimens.

References

1. Owusu, F. W., Adam, K.A., Seidu, H., Mensah, P., & Govina, J. (2020). Lesser-Known Species; Utilizing Ghana's Sustainable Timber Resources. *BVRio, Forestry Commission, CSIR-Forestry Research Institute of Ghana:* Responsible Timber Exchange.
2. Rundmo, T., & Hale, A. R. (2003). Managers' attitudes towards safety and accident prevention. Safety science, 41(7), 557-574. https://doi.org/10.1016/S0925-7535(01)00091-1
3. Walton, J., (1970). Woodwork in Theory in and Practice (metric edition). www.booktopia.com.au

UNIT 2

Strand: **Automotive Technology**

Sub-Strand: **Introduction to Engine Technology**

Learning Outcomes: *Analyse and use relevant principles underlying engines to service, and repair spark ignition (SI) and compression ignition (CI) engines*

Content Standard: Demonstrate the knowledge and application of the working principles of engines

Learning Indicators: *Explain the constructional and operational difference between petrol and diesel engines*

INTRODUCTION AND UNIT SUMMARY

This unit introduces learners to the various types, differences, components, and functions of engines found in motor vehicles. Mechanical energy is created by the internal combustion engine from chemical energy. The teacher will guide learners to examine the fundamentals of engine construction, as well as distinguish between different engine types and their component parts. They will also explain the operational and structural differences between gasoline and diesel engines and show how safety precautions are taken when servicing, repairing, and maintaining engines.

The unit covers only week 4 & 7: ***Explain the constructional and operational difference between petrol and diesel engines***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must fully participate in the identification types of engines and describe the main component parts of the engine. Teachers should employ pedagogies such as, group work/collaborative learning, experiential learning and project-based learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in identification and description of the main component parts of the engine. However, make considerations and accommodations for the different groups. Offer below average/approaching proficiency learners the opportunity to make oral presentations and use samples of real objects in identifying types of engines and describing the main component parts. Extend activities for the above average/highly proficient learners.

ASSESSMENT SUMMARY

To demonstrate conceptual understanding of the ideas covered in this section, learners must show how they apply the concepts in real-world situations. As a result, levels 1, 2, and 3 of the DoK should be substantially covered in the assessments. To gather data regarding learners' progress and provide timely feedback, teachers should utilise a range of formative assessment tools, including pairs of tasks, reports, oral and written presentations, and home assignments. Teachers should administer the following assessments and document learners' results in continuous assessment records:

1. Class exercises (including individual worksheets) after each lesson
2. Homework
3. Scores on practical group activities on the various safety kits used at the workshop

WEEK 4 & 7

Learning Indicators: *Explain the constructional and operational difference between petrol and diesel engines*

Theme/Focal Area: Construction and Operational Difference Between Petrol and Diesel Engines

Petrol engines are mostly used in cars, scooters, machines, it is an internal combustion engine with spark ignition, also known as a petrol engine. It was invented in Europe in 1876. In petrol engines, air and fuel are mixed before compression and then an electric spark is used for ignition. Ignition temperature is the lowest temperature at which a fuel or combustible substance, when heated, catches fire. It works on the Otto cycle. The Otto cycle explains how in petrol engines, chemical energy is converted into thermal energy and then into motion.

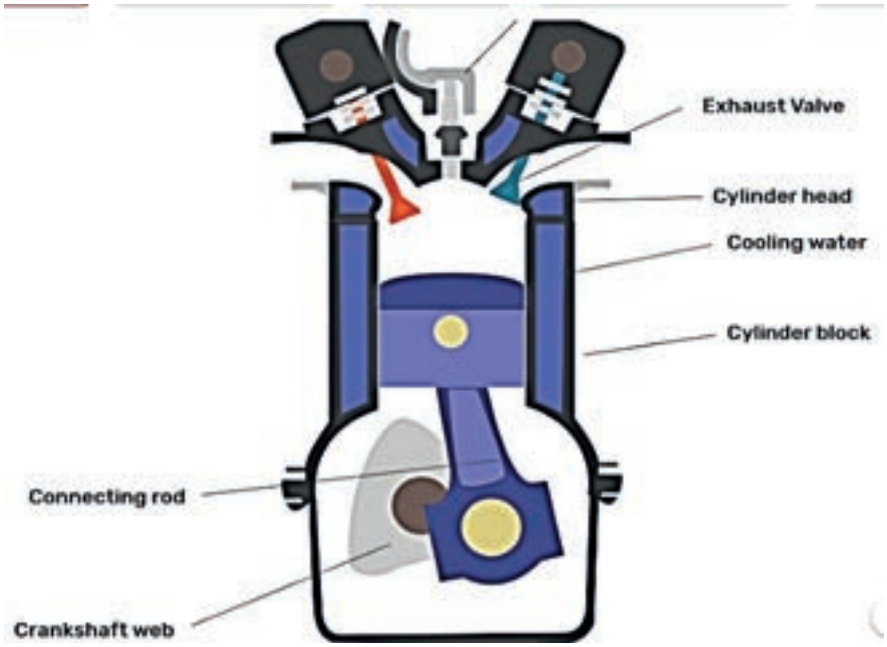

Fig 2.8: *Petrol engine at fuel inlet position.*

(Source: *Petrol engine at fuel inlet position - Search Images (bing.com)*

Working of a four stroke Petrol Engine

1. **Induction stroke**: This stroke of the piston begins at top dead centre. The piston descends from the top of the cylinder to the bottom of the cylinder, increasing the volume of the cylinder. A mixture of fuel and air is forced by atmospheric pressure into the cylinder through the intake port.
2. **Compression stroke**: With both intake and exhaust valves closed, the piston returns to the top of the cylinder compressing the air or fuel-air mixture into the cylinder head.
3. **Power stroke**: This is the start of the second revolution of the cycle. While the piston is close to Top Dead Centre (TDC), the compressed air–fuel mixture in a petrol engine is ignited, by a spark_plug in petrol engines, or which ignites due to the heat generated by compression in a diesel engine. The resulting pressure from the combustion of the compressed fuel-air mixture forces the piston back down toward Bottom Dead Centre (BDC).

4. **Exhaust stroke**: during the exhaust stroke, the piston once again returns to top dead centre while the exhaust valve is open. This action expels the spent fuel-air mixture through the exhaust valve(s).

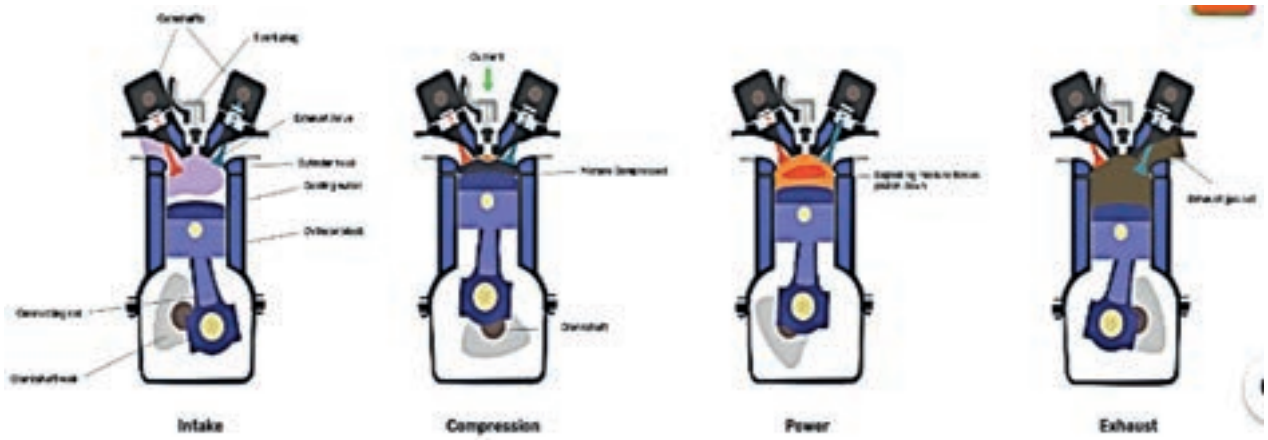

Fig 2.9: *Petrol engines*

Source: *Four stroke cycle petrol engines - Search Images (bing.com)*

Diesel Engine

Generally, trucks and other heavy vehicles run on diesel engines. It is also an internal combustion engine that works on diesel. In these engines, the air is compressed, so it becomes very hot and then fuel (diesel) is injected into it. Thus, diesel reaches its ignition temperature by the heat of compressed air. It is also known as a compression-ignition engine. It was 1st developed by Rudolf Diesel in 1893 in Germany. Diesel engines were mainly used in trains at that time.

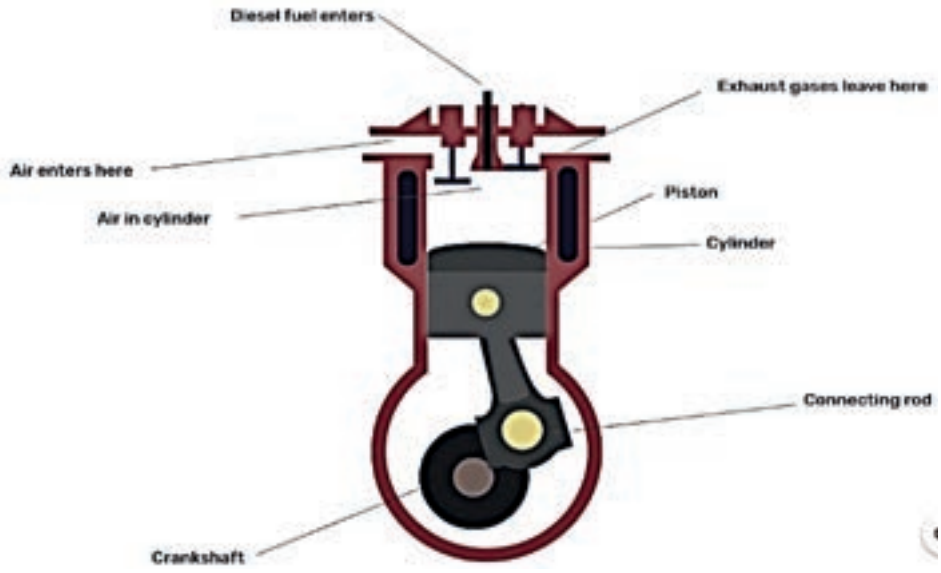

Fig 2.10: *Diesel Engine.*

Source: *diesel engine induction, compression, power and exhaust - Search Images (bing.com)*

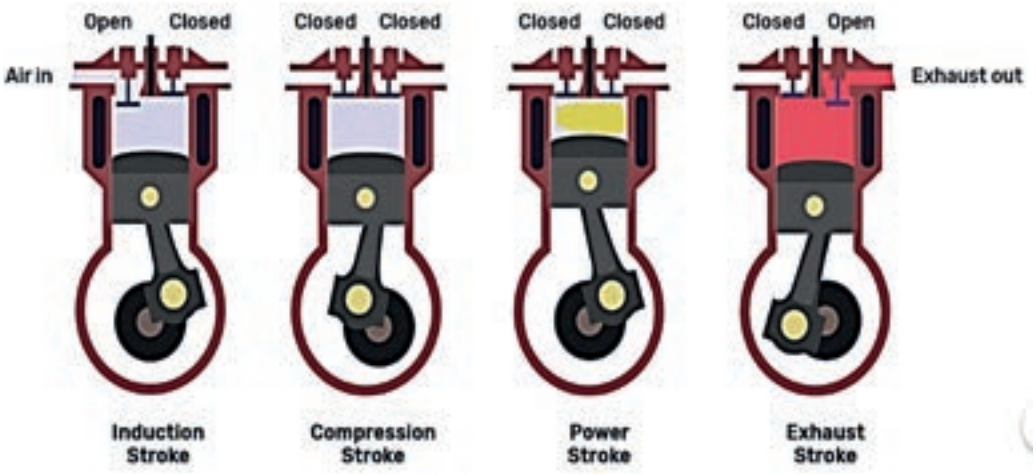

Fig 2.11: *Diesel Engine.*

Source: *diesel engine induction, compression, power and exhaust - Search Images (bing.com)*

1. **Step 1**: Induction Stroke – Piston of the engine goes down to create suction that pulls air into the cylinder.
2. **Step 2:** Compression Stroke – Piston goes up and compresses the air. Now the air is getting hot.
3. **Step 3:** Power Stroke – Fuel or diesel is added and starts burning due to ignition temperature provided by hot air.
4. **Step 4:** Exhaust Stroke –The burnt gases go out through the exhaust valve in readiness for the next cycle.

Two-stroke cycles

In the two-stroke cycle, the valves are replaced by three ports namely: inlet, exhaust, and transfer ports. The two strokes of the cycle are completed once during each revolution of the crankshaft. The strokes are upward and downward. The upward stroke is a combination of induction and compression, and downward stroke is the combination of power and exhaust. Below are the features of the two-stroke spark ignition engine.

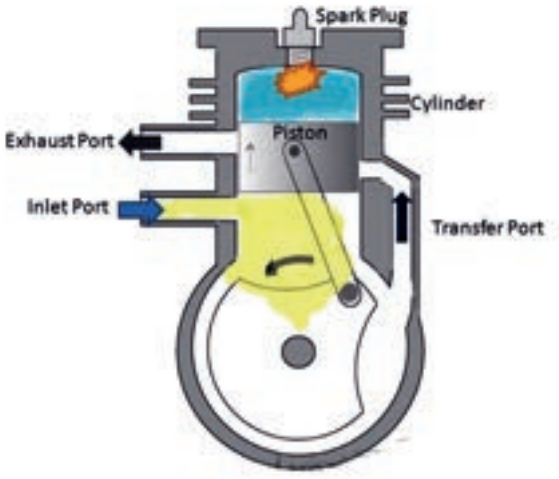

Fig 2.12: *two-stroke cycle.*

Source: *two stroke cycle diesel engine - search images (bing.com)*

Learning Tasks

1: Explain briefly how a petrol engine generates power in its cylinder.

2. Describe how burning is initiated in a diesel engine.

3. Illustrate with sketches the operation of four-stroke cycle CI engine.

4. Illustrate with sketches the operation of two-stroke cycle SI engine.

Pedagogical Exemplars

Teachers should consider the following activities:

Problem-based learning: Working in groups, guide learners, with the aid of real objects, videos, models of engines (petrol and diesel engines) to co-operatively brainstorm to differentiate between the construction of petrol and diesel engines. Teachers should target questions to learners as they discuss with one another, to encourage them to contribute to the discussion. Teachers should pull all learners back in for whole-class feedback.

Group work/Collaborative learning: Place learners in mixed-ability groups and give them the assignment of respectfully and openly differentiating between the operation systems of petrol and diesel engines. Teachers should go around the classroom making sure that every learner is getting help and contributing to the conversation. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

Experiential learning: Using real objects, videos and internet surfing, task learners to demonstrate the operation of the two-stroke petrol engine. Teachers should supervise to ensure that the whole class participate in the lesson. Teachers should pull all learners back in for whole-class feedback.

Key Assessment:

Level 1: Explain briefly how a petrol engine generates power in its cylinder.

Level 2. Describe how burning is initiated in a diesel engine.

Level 3. Illustrate with sketches the operation of four-stroke cycle CI engine.

Level 3. Illustrate with sketches the operation of two-stroke cycle SI engine.

Unit 2 Review

This unit covers lessons taught in week 4 & 7. The unit exposed the learner to the constructional and operational difference between petrol and diesel engines. The pedagogical exemplars used in this section included problem based-learning, group work/collaborative learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Reflection:

1. Key knowledge, skills and competencies.
2. Engines**:** types of engines, function of engine parts.

Resources: Models of engines, petrol and diesel engines, charts/sketches, video/YouTube, real engines, local vehicle repair workshop, simulated activities, real objects.

References:

1. (https://www.tutorialspoint.com/difference-between-petrol-engine-and-diesel-engine
2. Hillier, V. A. W. (2004). Fundamentals of motor vehicle technology (5th ed.).
3. https://byjus.com/chemistry/difference-between-diesel-and-petrol-engine/)
4. https://www.howacarworks.com/basics/the-engine
5. https://www.mechanicalbooster.com/2016/08/different-types-of-engine.html
6. Rajput, R. K. (2013). A textbook of automobile engineering. New Delhi: Laxmi

UNIT 3

Strand: **Building Construction Technology**

Sub-Strand: **Pre-Construction Activities**

Learning Outcome: *Demonstrate knowledge of human resource requirements in building construction*

Content Standard: Demonstrate knowledge and understanding of roles of building construction personnel

INTRODUCTION AND UNIT SUMMARY

Learners at the end of the unit will understand the diverse roles stakeholders play to ensure the success of building construction projects. Beginning with Stakeholders' Forums where they collaborate to assess the viability of the projects prior to the design and construction phases. The client comprising of an individual, a corporate entity or a government body provide the brief and funding for the project. The Design Team comprising professionals such as architects, structural engineers, quantity surveyors, and services engineers are responsible for providing the design proposals which ensure a good price, good quality and good time. The Building Team comprise of the contractors responsible for the actual building processes. The Statutory Authorities ensure safety and compliance with building codes. As stakeholders, the Civil Society serve as watchdogs and advocates addressing critical issues such as environmental protection.

The unit covers only week 5 & 7: ***Describe the roles of stakeholders in building construction projects***

SUMMARY OF PEDAGOGICAL EXEMPLARS

The Pedagogical Exemplars may include conducting experiential learning by organising field trips to construction sites or offices of stakeholders where learners will observe and interact with the relevant stakeholders to understand them. Teachers may guide learners to do role-play in the form of Mork Value Engineering where learners can explore issues, make decisions, and understand the interconnected nature of the roles of stakeholders. Guiding learners to conduct research on the internet is also another pedagogical strategy to use. Teachers may put learners in mixed-ability and mixed-gender groupings to meet the needs of learners Approaching Proficiency, the Proficient and Highly Proficient. Learners will all be capacitated as they engage in critical thinking and brainstorming without any form of inhibition. The collaborative environment which will be made tolerant of GESI, SEL and National Values is expected to enhance the brainstorming sessions which will in turn capture the diverse knowledge that the groups have.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction should be formative and this should include quizzes , short oral and written responses to questions.

Teachers must keep track of performance of each learner given his or her unique level as Approaching Proficiency, the Proficient and Highly Proficient and provide the relevant motivation or scaffolds to enhance understanding of the roles of stakeholders on building projects. The assessment should also serve as a tool to evaluate depth of knowledge amongst learners Approaching Proficiency, the Proficient and Highly Proficient. In this way the pedagogical differentiation strategies adopted will be mirrored under assessment as well.

WEEK 5 & 7

Learning Indicators: *Describe the roles of stakeholders in building construction projects*

Theme or Focal Area(s): The Roles of Stakeholders in Building Construction Projects

The roles of stakeholders in a building construction project are diverse and vital in ensuring the success and sustainability of the project. These roles commence with Stakeholders' Forums where they collaborate to assess the viability of the building project before the design and construction phases.

Key stakeholders and their roles are as follows:

1. **The Client:** Whether an individual, a corporate entity, or a government body, the client is responsible for funding the project. They refine project briefs and allocate funds to ensure the project's completion.
2. **The Design Team:** Comprising professionals such as architects, structural engineers, quantity surveyors, and services engineers, the design team plays a critical role in refining design proposals. They set design guidelines and may organise competitions to obtain designs that meet the client's needs while ensuring cost-effectiveness, quality, and timeliness.
3. **The Building Team:** This group, including contractors and sub-contractors, participate in Stakeholders' Forums and Value Engineering Sessions. They provide valuable insights to make building designs more practical, cost-effective, and buildable. This includes advice on avoiding complex shapes and structures that require extensive resources, form work, and effort. They also offer strategies for efficient resource management, including labour, materials, equipment, funds, and site management.
4. **Statutory Authorities:** These authorities contribute to the project's sustainability by ensuring safety and compliance with building codes. They provide guidelines that align with the city's planning scheme, ensuring that new buildings fit into designated zones. For example, tall buildings may be limited to specific areas and certain land uses are regulated to ensure congruent development.
5. **Civil Society:** As watchdogs and advocates, civil society groups organise community actors to influence policy changes through strategic communication. They address critical issues such as environmental protection, pollution, and the use of banned materials like asbestos, all of which may affect the community. They also advocate for opportunities for local small-scale subcontractors to participate in the project.

Learning Tasks:

1. Explain the relevance of the Stakeholders' Forum
2. Categorise the stakeholders into the group of those who function directly on design and construction and into the group of those who do not function directly on design and construction.
3. What strategies do the Client, Design and Building Teams put in place to have a good price, good quality and good time duration for the building project?

Pedagogical Exemplars

Teachers should consider the following activities:

Experiential learning: Conduct field trips to construction sites or offices of stakeholders where learners will observe constructional activities and interact with relevant personnel to gain understanding of the roles played by different stakeholders on building construction projects.

Digital learning: Encourage research using the internet to help learners develop a deeper understanding of the different roles played by different stakeholders involved in building construction projects both directly through design and construction as well as indirectly through contributions such as serving as advocates or watchdogs.

Collaborative learning: Deliberately place learners in mixed-ability groupings where the different needs of learners Approaching Proficiency, the Proficient and Highly Proficient will be met and where they will all be encouraged to engage in critical thinking and brainstorming about activities of different stakeholders in the construction industry leading to cost and time savings as well as how various stakeholders can contribute to the sustainability of the projects.

Key Assessment

Level 1: List the various stakeholders and the roles they play in the building construction industry.

Level 2: Distinguish between the stakeholders involved in building construction projects directly through design and construction from those not involved directly through design and construction.

Level 3: Discuss the different roles different stakeholders can play to bring about a good price, good quality and good time for the building design and construction project?

UNIT 3 REVIEW

This unit covers the lesson taught in week 3. Unit 3 exposes learners to deeper understanding of the roles of stakeholders in building construction projects. The pedagogical exemplars used in this section included group work/collaborative learning, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Charts, pictures, videos and real objects (nose mask, goggles, safety boots, overcoat, gloves and helmet).

References:

1. Hackett, M.; Robinson, I. and Statham, G. (2007). The Aqua Group Guide Procurement, Tendering and Contract Administration. Blackwell Publishing
2. The applied technology secondary education curriculum (1.X.3.1.LO.1, 1.X.3.1.CS.1, 1.X.3.1.LI.1, 1.X.3.1.AS.1)
3. Walton, D. (2003) Building Construction: Principles and Practices. Macmillan Publishers Limited

UNIT 4

Strand: **Electrical and Electronic Technology**

Sub-Strand: **Electrical Systems Design**

Learning Outcome: *Explain clearly safety principles to follow in the use of electricity, analyse the key steps in power generation and transmission as well as link it to power distribution to other substations, homes and industries*

Content Standard: Demonstrate knowledge and understanding of power generation, transmission, distribution and its associated safety

INTRODUCTION AND UNIT SUMMARY

This unit will help learners to explore into the various forms of generating, transmission and distributing electric power in Ghana. Electricity generation in Ghana encompasses a diverse mix of energy sources, each contributing to the nation's power supply. Electricity is produced through various methods, including burning fossil fuels and harnessing renewables, converted into electrical energy in power plants via turbines connected to generators, typically generating alternating current (AC). Transmission occurs through high-voltage lines, reducing energy losses due to resistance. Transformers adjust voltage levels for transmission and distribution to substations, where voltage is further reduced for consumer distribution. Substations ensure grid stability by regulating voltage. Distribution networks deliver electricity to homes, businesses, and industries via lower-voltage lines, often using transformers for safety. Finally, electricity powers diverse devices and appliances, meeting the energy needs of individuals and organisations. This integrated process underscores electricity's vital role in modern Ghanaian life, emphasising the importance of a balanced approach to generation, transmission, and distribution to sustainably meet energy demands.

The unit covers only week 5 & 8: ***Describe the process of electrical power generation, transmission and distribution***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must practically demonstrate their knowledge and understanding of the process of electrical power generation, transmission and distribution. Learners will gain insight into the importance of efficient energy infrastructure for sustaining modern life and fostering technological advancement. Teachers should employ pedagogies such as, problem based and collaborative learning, experiential learning and project-based learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in describing of the process of electrical power generation, transmission and distribution. Teachers should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

To demonstrate conceptual understanding of the ideas covered in this section, learners must show how they apply the concepts in real-world situations. As a result, levels 1, 2, 3 and 4 of the DoK should be substantially covered in the assessments. To gather data regarding learners' progress and provide timely feedback, teachers should utilise a range of formative assessment tools, including pairs of tasks, reports, oral and written presentations, and home assignments. Teachers should administer assessments such as class exercises (including individual worksheets) after each lesson,

homework, scores on practical group activities on the process of electrical power generation, transmission and distribution. Teachers should document learners' results in continuous assessment records. Tasks should encompass the significance, diverse branches, career prospects, and dispelling of misconceptions surrounding applied technology. This ensures learners grasp the broader context and relevance of technology across different domains.

WEEK 5 & 8

Learning Indicator: *Describe the process of electrical power generation, transmission and distribution*

Theme or Focal Area: Concept of Power Generation, Transmission and Distribution in Electricity Supply

Electricity Generation in Ghana

Electricity generation in Ghana involves a combination of different sources to meet the country's energy needs. Ghana has diversified its electricity generation portfolio to include both conventional and renewable energy sources.

Electricity generation

Electricity does not just exist on its own for us to pick and use. Rather, other forms of energy must be converted into electrical energy. These include:

1. **Electrochemistry:** The conversion of chemical energy into electricity, as in a cell or battery and finds wide applications in portable devices like mobile phones and lamps.
2. **Photovoltaic effect:** The conversion of light energy into electrical energy, as in solar cells. Photovoltaic panels convert sunlight directly into DC electricity. If AC is required, inverters are employed for that purpose.
3. **Generator:** The generator converts mechanical energy into electrical energy. Its operation is based on Faraday's laws of electromagnetic induction and achieved by rotating a magnet within closed loops of conductors or rotating a conductor within the magnetic field.

   The generator is the most common device used in electricity generation and almost all commercial electricity generation utilises it. A number of methods are employed in producing the mechanical energy required by the generator to produce the electricity. They include Thermal, Hydro, Biomass, waste water systems etc.

Thermal Power Plants

Thermal power plants in Ghana primarily rely on fossil fuels, including crude oil, natural gas, and diesel. These power plants generate electricity by burning the fossil fuels to produce steam, which drives turbines connected to generators.

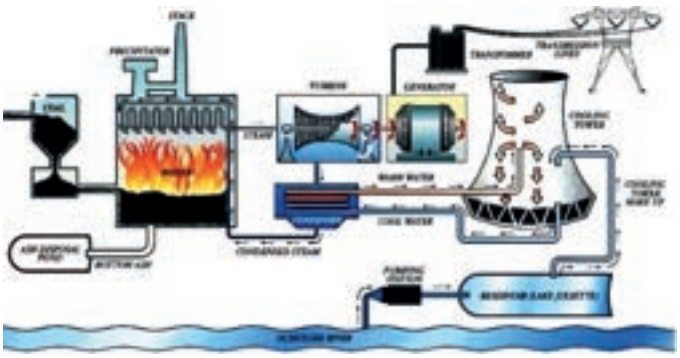

Fig 2.13: *A Thermal Power Plant*

(Source: *https://mechanicaljunglecom.b-cdn.net/wp-content/uploads/2021/05/Coal-Power-Plant-Working.jpg)*

Hydroelectric Power

Ghana has significant hydroelectric power generation capacity. The country has several hydropower dams, including the Akosombo Dam on the Volta River, which is the largest hydropower facility in Ghana. Hydropower plants harness the potential energy of water stored in reservoirs behind the dams.

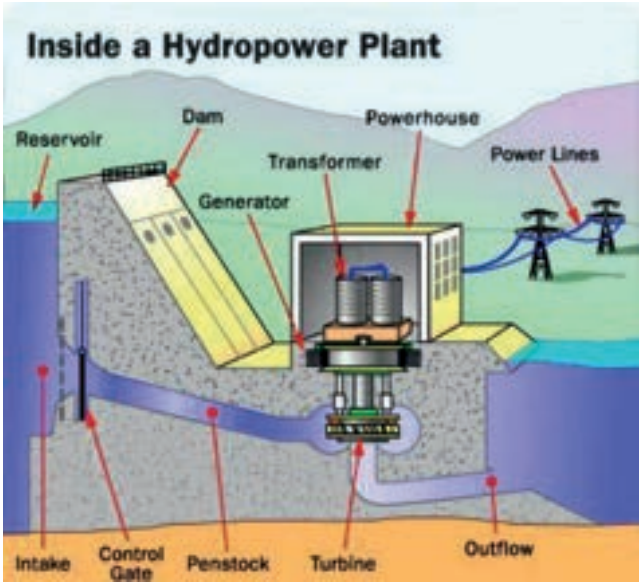

Fig. 2.14: *Hydroelectric Power Station*

(Source: *A Thermal Power Plant - Search Images (bing.com)***)**

The water is released, and its kinetic energy drives turbines to generate electricity.

Renewable Energy Sources

1. **Solar Power:** Ghana has been making efforts to harness solar power. Solar energy is predominantly utilised in off-grid and decentralised systems, such as solar home systems and solar lanterns, to provide electricity to rural areas without access to the national grid.

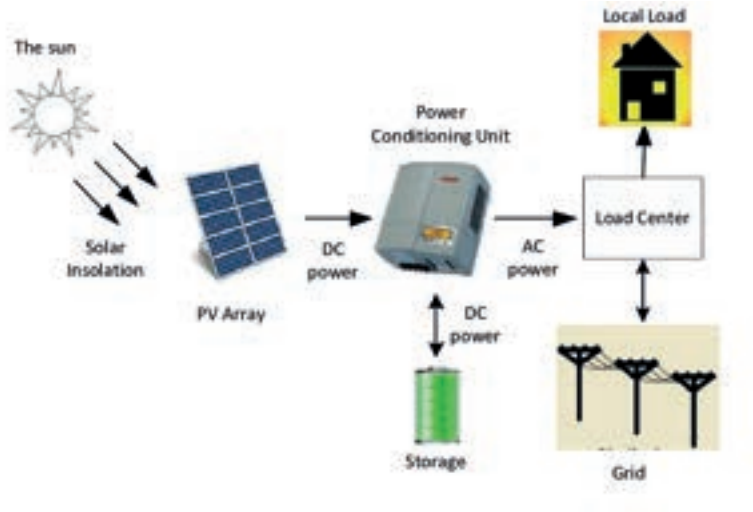

Fig. 2.15: *Solar Power Plant*

(Source: *https://www.researchgate.net/profile/Ms-Elnozahy-2/publication/276410886/figure/fig3/AS:669527893352478@1536639297872/1-Main-components-of-grid-connected-PV-systems-ii-PV-array-The-solar-array-is-the.png)*

2. **Biomass**:

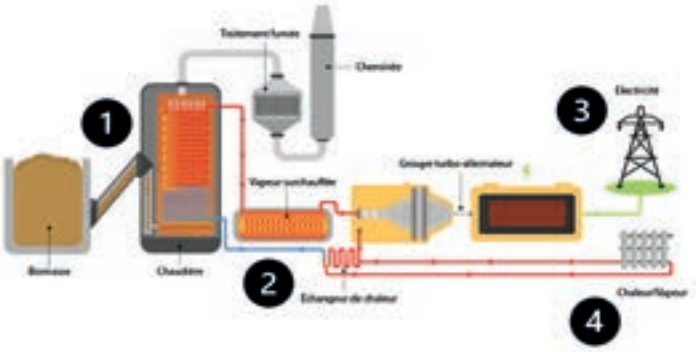

Fig. 2.16: *Biomass Generation Station*

(Source: *https://media.licdn.com/dms/image/D4D12AQGpFZCA4Kl77g/article-cover_image-shrink_600_2000/0/1691730028135?e=2147483647&v=beta&t=42Vd-tZiXXJBgB9A_QbTfeyRghSQpyn5YY4d0D6yJ5c*)

3. **Waste-to-Energy:** Ghana is exploring waste-to-energy technologies to generate electricity from municipal solid waste. The Accra Compost and Recycling Plant is an example where organic waste is converted into biogas, which is then used to generate electricity.

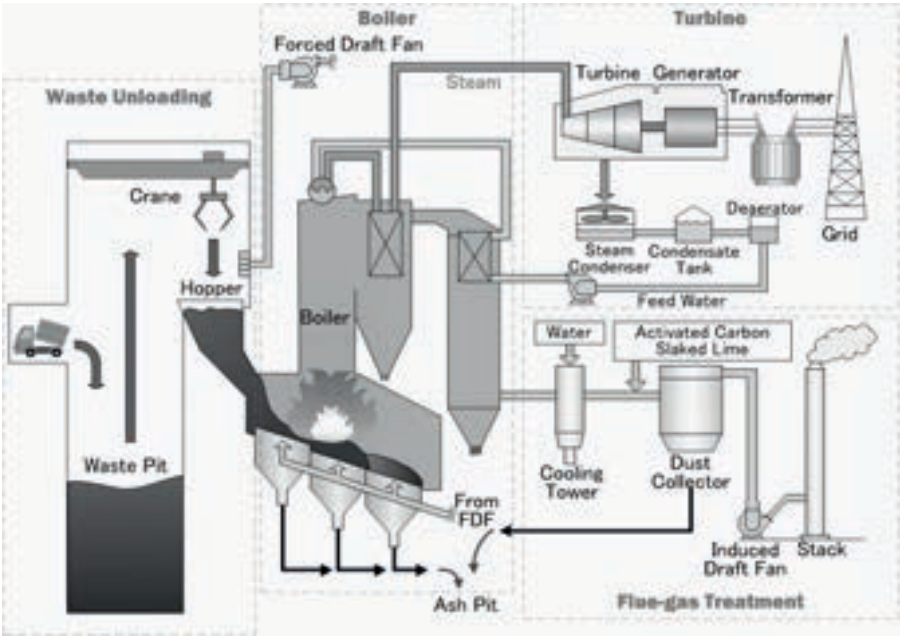

Fig 2.17: *Waste Energy Generation Station*

(Source: *https://www.researchgate.net/profile/Mihai-Bratu/publication/336744860/figure/fig1/AS:817234461093888@1571855287568/Scheme-of-the-technological-process-of-waste-incineration-Pollutants-discharged-into-the.ppm*)

Electricity Transmission

In Ghana, the Ghana Grid Company Limited (GRIDCo), which operates and maintains the national transmission grid, oversees electricity transmission. The transmission voltages in Ghana are typically categorised into three levels. These are:

1. **High-voltage Transmission (400 kV and 330 kV):** The highest voltage level used in Ghana's transmission system is 400 kilovolts (kV), although some sections operate at 330 kV. This voltage level is employed for long-distance transmission of electricity over major power corridors.

Fig 2.18: *High-voltage Transmission Line (33 kV)*

(Source: *ECG Network)*

2. **Medium Voltage Transmission (161 kV and 132 kV):** Medium voltage transmission in Ghana operates at 161 kilovolts (kV) and 132 kilovolts (kV). It is used to distribute electricity from major substations to regional or local distribution networks.

Fig 2.19: *Medium Voltage Transmission Line*

(Source: *Medium Voltage Transmission Line - Search Images (bing.com)***)**

3. **Low-voltage Transmission (33 kV and 11 kV):** Involves the delivery of electricity from distribution substations to industrial, commercial, and residential areas. It is important to note that these voltage levels can vary depending on specific projects, locations, and system requirements.

Fig 2.20: *Low-voltage Transmission Line*

Why power transmission is done on high voltage and low current

Transmission of electrical power is typically done using high-voltages and low currents for several reasons:

1. Reduced power losses
2. Increased efficiency
3. Voltage regulation
4. Cost-effectiveness
5. Flexibility and interconnection

Electric Power Distribution in Ghana

Electric power distribution is the final stage in the delivery of electricity. Electricity is carried from the transmission system to individual consumers by the Electricity Company of Ghana (ECG) for the southern sector and the Northern Electricity Distribution Company (NEDCo) for the northern sector.

In Ghana, the power distribution voltage levels are standardised and regulated by the Energy Commission and the Public Utilities Regulatory Commission (PURC). The primary distribution voltage levels used in Ghana's electrical power system are as follows:

1. **High-voltage Distribution (HV):** The high-voltage level in Ghana refers to voltages above 33kV. These voltages are primarily used for long-distance transmission of electricity from power generation plants to primary substations. High-voltage transmission lines are designed to minimise power losses during transmission over extended distances.

Fig 2.21: *High-voltage Distribution Substation*

***(Source:** High-voltage Distribution Substation - Search Images (bing.com))*

2. **Medium distribution network:** The medium voltage level in Ghana is typically categorised as voltages between 11kV and 33kV. This level is used for distributing power from the primary substations to secondary substations, industrial areas, and larger commercial establishments. The medium voltage distribution system plays a crucial role in supplying power to the bulk of consumers and supporting the overall power infrastructure.

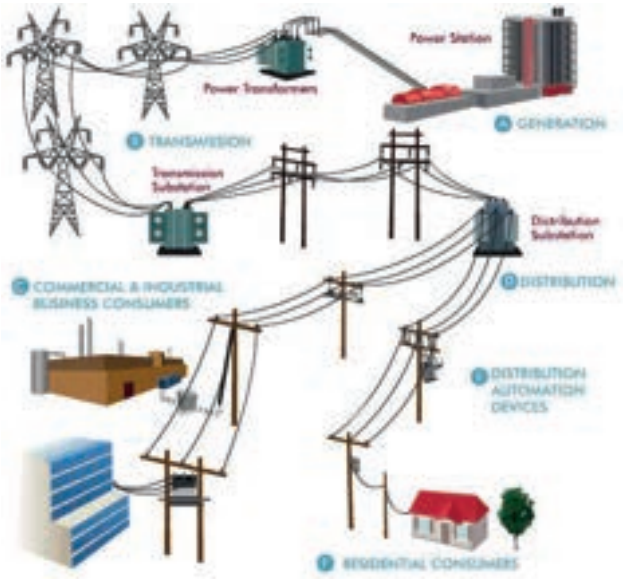

Fig 2.22: *Medium Distribution Network*

(Source: *https://engineeringtutorial.com/wp-content/uploads/2016/01/engineeringtutorial.com_electrical-power-distribution.jpeg***)**

3. **Low-voltage Distribution (Low-voltage):**

   The low-voltage level in Ghana is typically defined as a voltage of 415/240V in a three-phase system and 240V in a single-phase system. This level is commonly used for supplying power to residential buildings, small commercial establishments, and small-scale industrial units. The low-voltage level is suitable for powering lighting, household appliances, and other low-power devices.

   It is important to note that specific voltage levels may vary depending on the region, the capacity of the distribution infrastructure, and the type of consumer being served.

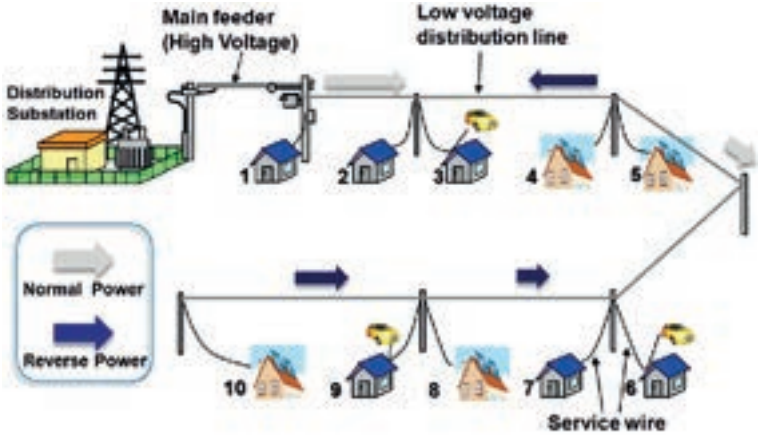

Fig 2.23: *Low-voltage Distribution Network*

(Source:** https://th.bing.com/th/id/OIP.tHRaGSacYp1u7mchT1eFEQHaEq?pid=ImgDet&w=231.00000000000003&h=145.56164383561645&c=7&dpr=2**)

4. **The Distribution Substation:** A distribution substation is an important component of an electrical power system that plays a crucial role in the transmission and distribution of electricity to end-users. It is a facility where high voltage electricity from a transmission substation is transformed into lower-voltages suitable for distribution to consumers.

The primary function of a distribution substation is to distribute electric power to residential, commercial, and industrial areas within a local region or community. It receives electricity from the transmission system, typically at high-voltages ranging from 69 kV to 500 kV, and steps it down to lower-voltages such as 11 kV or 33 kV. The exact voltage levels depend on the specific requirements and infrastructure of the distribution network. The key aspects and components typically found in a power distribution substation are as follows.

Fig 2.24: *Low-voltage Distribution Substation*

(Source: *Low-voltage Distribution Substation - Search Images (bing.com)*)

5. **Incoming Power Lines:** The substation receives power from the transmission lines, which carry high voltage electricity over long distances from power generation plants or other transmission substations.

Fig 2.25: *Power Lines to a Substation*

(Source: *ECG Substation)*

6. **Circuit Breakers and Disconnect Switches:** These devices are installed to protect the substation equipment and the distribution system from overloads, faults, and short circuits. Circuit breakers

can interrupt the flow of electricity, when necessary, disconnect switches provide a means to isolate specific sections of the substation for maintenance or repairs.

Fig 2.26: *Circuit Breakers and Disconnect Switches*

(Source: *ECG Substation)*

7. **Power Transformers:**These devices are responsible for voltage transformation. The incoming high voltage electricity is stepped down to lower-voltages suitable for distribution. Power transformers are typically oil-filled and use electromagnetic induction to transfer power from one voltage level to another.

Fig 2.27: *Power Transformer in a Substation*

(Source: *ECG Substation)*

8. **Busbars:** Busbars are conductive bars or pipes that carry electric current within the substation. They act as the main distribution point for power within the substation, allowing for the interconnection of various components such as transformers, circuit breakers, and other devices.

Fig 2.28: *Busbars in a Substation*

(Source: *ECG Station*)

9. **Switchgear:** Switchgear comprises a combination of circuit breakers disconnect switches, and protective relays housed in metal enclosures. It controls and isolates the electrical equipment within the substation, allowing for safe operation, maintenance, and protection of the system.

Fig 2.29: *Switchgear in a Substation*
(Source: *ECG Substation)*

10. **Distribution Feeders:** These are outgoing power lines that distribute electricity from the substation to consumers. Distribution feeders typically operate at lower-voltages and branch out to various neighbourhoods or areas, connecting to distribution transformers located closer to the end consumers.

Fig 2.30: *Distribution Feeder in a Substation*

11. **Distribution Transformers:** These transformers are located near the consumers and further step down the voltage to levels suitable for domestic or commercial use. They are responsible for supplying electricity to individual buildings or groups of consumers.

Fig 2.31: *Distribution Transformer on a H pole*
(Source: *ECG Station)*

12. **Monitoring and Control Systems:** Power distribution substations are equipped with various monitoring and control systems to ensure safe and efficient operation. These systems include protection relays, meters, remote terminal units (RTUs), and supervisory control and data acquisition (SCADA) systems. They provide real-time monitoring, data collection, and remote-control capabilities for the substation operators.

Fig 2.32: *Monitoring and Control Panel of a Power Distribution Substation*

(Source: *ECG Station)*

13. **Instrument Transformers:** Electrical instrument transformers are devices used in power systems to measure and monitor electrical quantities such as voltage and current. They are designed to transform high currents or voltages to lower, more manageable levels suitable for measurement, protection, and control purposes. Instrument transformers are widely used in power generation, transmission, and distribution systems. Examples include the current and voltage transformers.

Fig 2.33: *Electrical Instrument Transformers*

(Source: *ECG Substation)*

Distribution of Power from the service Line to the Local Area

Power is distribution from the service lines to local areas through a network of transformers and distribution lines. Services lines, owned by utility companies, carry electricity from substation to transformer located closer to residential or commercial areas. These transformers then step down the voltage to safer level for local use. From there, distribution lines distribute electricity to homes, businesses and other local facilities, ensuring a reliable power supply to the community. This process allows for efficient and controlled delivery of electricity to meet the demands of various local area.

The voltage provided to consumers is typically 120V to 240V. There are primarily two common systems of AC power distribution single-phase and three-phase.

1. **Single-Phase System:** In a single-phase AC power distribution system, power is transmitted using a single alternating current waveform. It is commonly used for residential and small commercial applications. In this system, a single-phase transformer is used to step-down the voltage from the transmission level to a lower-voltage suitable for distribution. The voltage provided from transmission level to a lower-voltage suitable for distribution. The voltage provided to consumers is typically 240V in Ghana.

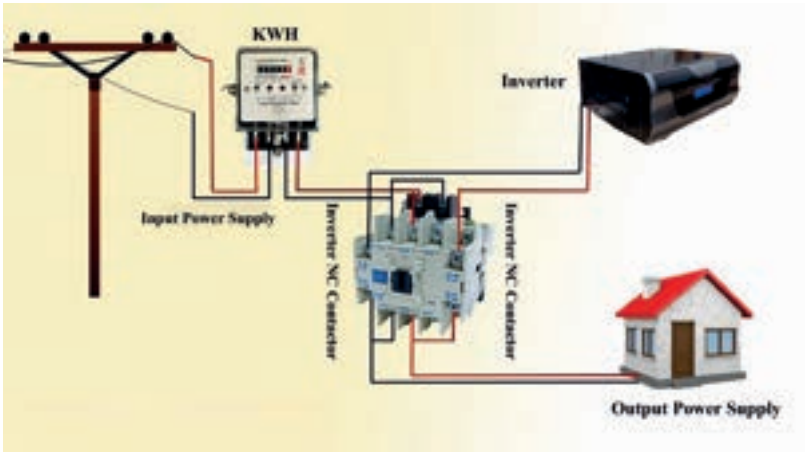

Fig 2.34: *Single-Phase Distribution line. It is commonly used for residential and small commercial application.*

(Source: *https://i.pinimg.com/originals/6f/71/fa/6f71fa386f2c9c901deebe8faebd7aee.png)*

2. **Three-Phase System:** In a three-phase system, power is transmitted using three conductors: three hot wires and one neutral wire (in some cases, the neutral wire is not required for certain loads). The voltage between any two hot wires is referred to as line voltage, and the voltage between a hot wire and the neutral wire is referred to as phase voltage.

   Three-phase power distribution offers several advantages, including higher power transmission capacity, reduced line losses, improved motor performance, and the ability to connect both single-phase and three-phase loads. It is commonly supplied at voltages such as 240V and 415V or higher, depending on the specific application and regional standards. Three-phase system comes with phase sequence (red, yellow, and blue).

Fig 2.35: *Three-phase line connected to a House*

(Source: *Three-phase line connected to a House - Search Images (bing.com)***)**

Note: The components in the various substations are inexhaustible. Others can be discussed as well.

Effects of illegal Connection

Overloading power systems refers to a situation where the demand for electrical power exceeds the capacity of the power system to deliver it. This can occur due to various factors such as increased electricity consumption, faulty equipment, inadequate infrastructure, or improper load management. Overloading power systems can have several significant effects, including:

1. Voltage Instability
2. Power Outages
3. Equipment Damage
4. Reduced System Efficiency
5. Safety Hazards
6. Economic Impact

Learning Tasks:

1. Identify at least two methods of electrical power generation used in the Ghana today?
2. How does a thermal power plant work, and what are its key components?
3. How is alternating current (AC) used for long distance power transmission, and why is it preferred over direct current (DC)?
4. Describe the process of power distribution from substations to residential and industrial consumers.

Pedagogical Exemplars

Teachers should consider the following activities:

Talk for learning: Through a whole class discussion, guide learners to discuss the fundamental aspects of power generation, distribution, and transmission networks, emphasising their significance in our daily lives. Also discuss the various methods of power generation, including fossil fuels and renewables, and highlight the roles of distribution and transmission networks in delivering electricity efficiently. Identify key companies involved in these operations, showcasing their importance in shaping the energy landscape. Through this exploration, learners are encouraged to consider the broader implications of energy choices and their role in building a sustainable future.

Experiential learning and collaborative learning: *Engage learners in mixed-ability groupings and use the internet and YouTube to undertake the following activities. Groups present back on their findings:*

1. List typical transmission voltages e.g., 132kV, 275kV, 400kV and distribution voltages in Ghana and state the application of each e.g. 33kV, 11kV, 415/240V
2. State the advantages and disadvantages of High-voltage transmission e.g. losses are minimised

Learners with additional needs should be given more time to complete a given task. During presentations, ensure that anyone, regardless of the background i.e. gender, physical abilities or intellectual abilities, is encouraged to present on behalf of the groups. Any person at all can be selected as a leader of a group.

Experiential learning: Embark on a field trip to any of the energy providers (ECG or NEDCo) to have a look at their substations to:

1. Describe a distribution substation and identify/list equipment at the substation
2. Describe the systems of power distribution e.g. single-phase, 3-phase
3. Explain the consequences of illegal power connections, cautioning learners to be patriotic enough to avoid illegal connections.
4. List companies responsible for power transmission (e.g. GRIDCo) and those responsible for power distribution in Ghana
5. List companies responsible for power distribution in Ghana e.g. ECG, NEDCo

Note: Where applicable, consider virtual field trips.

Key Assessment:

Level 1: Identify two companies responsible for electrical power transmission and distribution in the Northern and Southern Ghana.

Level 2: Describe the differences and similarities between transmission and distribution substations.

Level 3: Describe the major challenges faced during the transmission of electrical power over long distances?

Level 4: Justify the use of high-voltage low current in power transmission instead of the vice versa.

Unit 4 Review

The unit introduced learners to the concept of electrical power generation, transmission and distribution in Ghana. The process of electrical power generation, transmission, and distribution is a critical aspect of modern infrastructure. This unit provides a comprehensive overview of each stage, highlighting the interconnectedness of the process. Power generation encompasses various methods, including fossil fuels, renewables, and nuclear energy, with turbines and generators converting energy sources into electrical energy. Transmission involves high-voltage lines transporting electricity over long distances, while substations regulate voltage levels for distribution. Distribution networks deliver electricity to consumers via lower -voltage lines, with transformers ensuring safety and efficiency. Evaluation of comprehension in electrical power generation, transmission, and distribution employs various methodologies such as multiple-choice questions, short answer questions, diagram labelling, problem-solving scenarios, critical thinking tasks, hands-on activities, and group discussions. These assessments gauge knowledge regarding energy sources, transmission methods, distribution components, and their interdependencies. The outcomes provide valuable insights into learners' comprehension levels, facilitating the identification of areas requiring further study or skill refinement. Effective assessments foster active learning, emphasising the importance of electricity in contemporary society.

Resources: Overcoat, Goggles, Protective shoes, Hand gloves.

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5. Ghana Energy Commission: https://www.energycom.gov.gh/
6. Ghana Grid Company Limited (GRIDCo): https://www.gridcogh.com/
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10. Link: https://www.amazon.com/Electrical-Power-Systems-C-Wadhwa/dp/8122417926
11. Public Utilities Regulatory Commission (PURC), Ghana: https://www.purc.com.gh/
12. Renewable Energy Act, 2011 (Act 832)

UNIT 5

Strand: **Metal Technology**

Sub-Strand: Engineering Materials, Tools and Machines

Learning Outcome: *Apply health and safety to the use of tools and machines as well as use properties of metals and non-metals to select the right materials for a given application*

Content Standard: Demonstrate knowledge in the use of engineering materials, tools and machines

INTRODUCTION AND UNIT SUMMARY

This unit covers the basics of ferrous and non-ferrous metals as well as non-metallic materials. The importance of distinguishing between the two metals cannot be overemphasised when selecting materials for a given metal work project. As such the section highlights some common examples of ferrous metals and their uses such as cast iron, wrought iron, carbon steel, stainless steel etc. It presents to the learners some common non-ferrous metals such as aluminium, copper, brass, bronze etc. It also reviews the uses of non-metallic materials. Teaching these categories of metals in metalwork involves various pedagogical approaches to ensure effective learning. By combining these pedagogical approaches, learners can acquire a comprehensive and effective learning experience in studying these metals. By incorporating a mix of DoK levels, teachers can accommodate different learning needs of the learners and ensuring that the learners develop a deep understanding of metal and non-metallic materials with their engineering applications.

This unit covers only week 6 & 8: ***Explain ferrous and non-ferrous metals with engineering applications and state the uses of non-metallic materials***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this section to be accomplished, learners must study ferrous and non-ferrous metals with engineering applications and uses of non-metallic materials. For learners to appreciate and be able to explain ferrous and non-ferrous metals with engineering applications and uses of non-metallic materials, Teachers should employ a variety of pedagogical strategies such as talk for learning approaches, group work/collaborative learning, digital literacy learning, experiential learning and project-based learning.

ASSESSMENT SUMMARY

To demonstrate conceptual understanding of the ideas covered in this section, learners must show how they apply the concepts in real-world situations. As a result, levels 1, 2, and 3 of the DoK should be substantially covered in the assessments. To gather data regarding learners' progress and provide timely feedback, teachers should utilise a range of formative assessment tools, including pairs of tasks, reports, oral and written presentations, and home assignments. Teachers should administer tests such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the ferrous and non-ferrous metals with engineering applications and uses of non-metallic materials. Teachers should document learners' results in continuous assessment records. Tasks should encompass the significance, diverse branches, career prospects, and dispelling of misconceptions surrounding applied technology. This ensures learners grasp the broader context and relevance of technology across different domains.

WEEK 6 & 8

Learning Indicator(s): *Explain ferrous and non-ferrous metals with engineering applications and state the uses of non-metallic materials*

Theme or Focal Area: Ferrous and Non-Ferrous Metals with Engineering Applications and Uses of Non-Metallic Materials

Ferrous Metals

Ferrous metals refer to any metal that contains iron. The presence of iron causes the metals to rust. They have many uses in engineering and construction. They are used in shipping containers, industrial piping, cars, railroad tracks, domestic tools etc. Table 1.6 shows some specific ferrous metals and their uses.

Table 2.1: *Ferrous metals and their uses*

S/N	Ferrous metal	Uses
1	Mild steel	Agricultural tools, ironmongery (door hinges, tower bolts).
2	Wrought iron	Anvils, swage block, crane hooks and chains, rails and railway couplings.
3	Cast iron	Centre lathe bed, Engineers vice. Anchor for ships, engine blocks.

Non-Ferrous Metals

Non-ferrous metals refer to any metal that does not contains iron. They therefore do not rust. Examples of non-ferrous metals are copper, aluminium, tin and zinc.

Table 2.2: *Non-ferrous metals and their uses.*

S/N	Non-ferrous metal	Uses
1	Copper	Electrical cables, soldering bits or soldering iron, alloying with other metals (copper and tin – bronze, copper and zinc – brass), refrigerator pipes linings.
2	Aluminium	Manufacture of aeroplane bodies, cooking utensils, electric cables, refrigerators.
3	Tin	Coating metals to prevent rusting, alloying with copper to produce bronze, alloying with lead to produce solder.
4	Zinc	Used to galvanise mild steel and iron sheets to prevent them from rusting.

Properties of metals

It is essential to understand the properties of metals as the selection and uses of metals is largely dependent on such characteristics. The properties of metals are quoted by manufacturers to assist design engineers select appropriate metals for each use.

1. **Hardness** - The ability of the metal to resist scratching and wear. e.g. cast iron.

2. **Ductility** - The ability of a metal to be stretched cold without breaking. It is an essential property for wire and tube drawing. e.g. copper and aluminium.
3. **Brittleness** - This is the ability of the metal to break easily without bending. e.g. cast iron.
4. **Colour** - This is the appearance of a metal which helps in identifying it. The colour enhances the appearance when polished. It is useful in decorative work such as beaten metalwork and jewellery. e.g. copper: - brownish pink in colour, gold: - yellow.
5. **Conductivity** - The ability of the metal to allow heat and electricity to flow through it. This makes the metal a good conductor. e.g. copper and aluminium.
6. **Malleability**- The ability of a metal to be hammered, rolled or bent without breaking. e.g. Forging a hoe using mild steel or wrought iron.
7. **Fusibility** - The property of a metal becoming liquid when heated and combine with other metals to form alloys. It is important when considering metals for casting. e.g. lead and tin melt at temperature as low as 160°F (70°C) making them useful in various safety devices.
8. **Toughness** - This is the ability of a metal to withstand shock without breaking. e.g. an anvil**.**
9. **Elasticity** - The ability of the metal to return to its original shape or size after being stretched, compressed or deformed. e.g. stainless steel for making springs.
10. **Tenacity**- The ability of a metal to resist a direct pull without rupturing. This describes the tensile strength of metals. e.g. mild steel, wrought iron are some examples of tenacious metals.
11. **Magnetism** – The ability of a metal to be attracted by magnets. e.g. iron, cobalt, nickel, steel etc.

Types of plastics (Non-metallic materials)

1. **Thermosetting plastics:** Are plastics that when heated and moulded cannot be reheated and remoulded. Examples of thermosetting plastics and their uses are shown below:

Table 2.3: *Thermosetting plastics and their uses.*

S/N	Examples of thermosetting plastics	Uses
1	Bakelite	Switches, sockets.
2	Urea formaldehyde	Adhesive for particle board, fibre-glass mats, electric iron handles.
3	Melamine resin	Used as additives in the manufacture of paints, papers and flame-resistant textiles.

2. **Thermoplastics:** are plastics that can be reheated and reshaped in various ways. Examples of thermoplastics and their uses is shown below:

2.4: *Thermoplastics and their uses.*

S/N	Example of thermoplastic	Uses
1	Polyvinyl chloride (PVC)	Water service pipes, cable and wire insulation, automotive interiors and seat coverings.
2	Nylon	Used for screws, bolts, washers, nuts and circuit boards.
3	Polypropylene	Used for packaging trash, grocery bags, wire and cable insulation, squeeze bottle, toys and houseware.

Learning Tasks

1. Describe the properties of ferrous metals, non-ferrous metals and non-metallic materials (plastics).
2. Describe at least five engineering applications of each of ferrous metal, non-ferrous metals and non-metallic materials (plastics).
3. Discuss the advantages and disadvantages of ferrous and non-metal and non-metallic materials.
4. What is the difference between ferrous and non-ferrous metals?
5. For each of the following metals, name one use and explain why its properties make it suitable for that use.
   a. Aluminium
   b. Wrought iron
   c. Mild steel

Pedagogical Exemplars

Teachers should consider the following activities:

Talk for learning: The teacher provides information about ferrous and non-ferrous metals using a variety of instructional modalities. This can include visual aids such as charts, diagrams, and videos, hands-on demonstrations with actual metal samples and verbal explanations to cater for different learning styles for approaching proficient, proficient and highly proficient learners. Offer individualised support and assistance to learners who may require extra help understanding concepts related to ferrous and non-ferrous metals as well as non-metallic materials. Provide opportunities for one-on-one instruction, additional explanation and targeted interventions as needed.

Scaffolded Learning: The teacher breaks down complex concepts about ferrous and non-ferrous metals into smaller, manageable chunks. Provide scaffolding such as guided notes, graphic organisers, and step-by-step instructions to support learners as they learn about the properties, uses and characteristics of these metals.

Project-based learning: Learners are guided to use the appropriate charts or samples of items made of ferrous and non-ferrous metals to identify and fairly discuss the various types. Assist learners to discuss the properties of various ferrous and non-ferrous metals using charts or real objects and present a report. Learners also brainstorm to identify products made from plastics and types of plastics as well as the manufacturing of plastics products. Group learners based on their learning needs and abilities when conducting activities or projects related to ferrous and non-ferrous metals. Consider mixing learners of different abilities to promote peer learning and collaboration, or group learners homogeneously for targeted instruction based on their level of understanding.

Key Assessment:

Level 2: State the difference between ferrous and non-ferrous metals?

Level 3: For each of the following metals, name one use and explain why its properties make suitable for that use:

1. Aluminium
2. Wrought iron
3. Mild steel

Level 3: Describe at least five engineering applications for each of the following:

1. Ferrous metals
2. Non-ferrous metals
3. Non-metallic materials (plastics).

Unit 5 Review

This unit covered ferrous metals and non-ferrous metals with their engineering applications and uses of non-metallic materials. They are essential for beginners learning of the engineering materials in metal work to create detailed and intricate metalwork projects. The lesson equipped the learners with the types of ferrous and non-ferrous metals with engineering applications and uses of non-metallic materials (plastics). Examples are given for learners to recognise and identify. A given workshop project is undertaken to appreciate and practice the use of the various engineering materials.

Reflection:

1. Were learners able to explain the meaning of ferrous, non-ferrous metals and non-metallic materials (plastics)?
2. Were learners able to explain the uses ferrous, non-ferrous metals and non-metallic materials (plastics)?
3. Were the learners able to apply ferrous, non-ferrous metals and non-metallic materials (plastics) under certain conditions in a given project?
4. Which resources best supported the delivery of ferrous, non-ferrous metals and non-metallic materials (plastics) used in metalwork?
5. Did learners find the resources useful in learning the ferrous metals, non-ferrous metals and non-metallic materials (plastics)?
6. Were the different subgroups in the class catered for?
7. What was my best moment in today's lesson and how can I create more of such situations?

Resources: Models, charts, LCD Projector, videos, Engineering Tool Box, YouTube, Textbooks, real object. Pictures of the ferrous, non-ferrous metals and non-metallic materials (plastics), videos/YouTube showing the usage of the ferrous, non-ferrous metals and non-metallic materials (plastics).

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SECTION 3

The section covers the following units (strands): woodwork technology, automotive technology, building construction technology, electrical and electronic technology as well as metal technology.

The section will help learners acquire knowledge and understanding in the processing phases in the woodwork industry. Learners will be able to apply the working principles of engines in automotive technology. Under the unit of building construction technology learners will gain knowledge on roles of building construction personnel in building construction**.** Under the unit of electrical and electronic technology learners will acquire knowledge and understanding of power generation, transmission, distribution and its associated safety precautions. Knowledge in the use of tools and equipment for welding will also be acquired under the unit of metal technology. All the above are treated from Unit 1 to Unit 5.

UNIT 1

Strand: **Woodwork Technology**

Sub-Strand: **Materials and Artefacts Production Woodwork Industry in Ghana**

Learning Outcome: *Demonstrate knowledge and understanding in the classification of timber and its processing phases in the woodwork industry*

Content Standard: Demonstrate knowledge and understanding of classification and processing phases of timber in the woodwork industry

INTRODUCTION AND UNIT SUMMARY

This unit will help learners explore the two main types of timber: hardwood and softwood. By delving into their unique anatomical features, uses and technological differences, we aim to provide a comprehensive overview of how these classifications play a vital role in the selection and application of timber in various industries.

This unit covers only week 9 & 11: ***Outline the processing phases of timber in the woodwork industry***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must take part in hands-on demonstrations of the of the timber processing phases in the woodwork industry. Teachers should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. Learners should be encouraged to participate fully in investigations as well as presentation of findings. Teachers should employ differentiation strategies to accommodate diverse learning needs of the learners.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt

feedback to them. Teachers should administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the various safety kits used at the workshop and, document learners' results in continuous assessment records.

WEEK 9 & 11

Learning Indicator(s): *Outline the processing phases of timber in the woodwork industry*

Theme or Focal Area: Processing Phases of Timber

There are several processing phases in timber production. These phases outline the various activities from the tree in the forest, logs in the log yard, and the lumber at the timber market through to the furniture and construction uses. The phases include:

1. Primary phase
2. Secondary phase
3. Tertiary phase

1. Primary processes phase

This includes:

a. Identification of tree and physical inspection

b. Harvesting**:** the felling of the trees

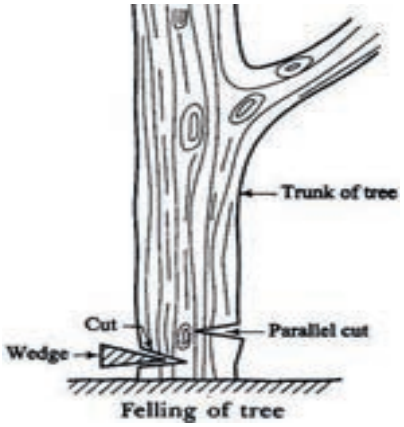

Fig 3.1: *Felling of tree*

(Source: *Felling of tree - Search Images (bing.com)*)

Freight: The process of transporting bulk logs, from the forest to the industry either by surface transport or sea/ocean transport.

Fig 3.2: *Track loaded with processed timber for transport*

Log sorting: Log sorting is the first step in the saw milling processes. The logs received from the forest are sorted by size (***top and bottom diameter, length, tapering, bend, ovality, volume***) and quality with manual/automatic sorting systems at the log yard.

Fig 3.3: *Log yard*

(Source:*Pictures produced by the authors)*

Debarking: Debarking is the process of removing bark from log.

Fig 3.4: *Process of debarking*

2. Secondary Processes Phase: This includes;

a. **Saw mill/Lumber mill:** In this phase logs are sawn into rough-squared sections, beams, planks or boards. A wood miser is a type of sawing machine used to convert forest logs into timber lengths. The picture below shows a portable wood miser being used in the felling area.

Fig 3.5: *Wood miser operation*

(Source: *Wood miser operation - Search Images (bing.com))*

b. Conversion of timber: Is the cutting up of **logs** into standard marketable sizes for commercial utilization. This involves three methods:

i. **Live sawing** (Slab or Through and Through Sawing): The log is sawn into planks about halfway through on the opening face and then turned once to the opposite face for sawing until the log is finished.

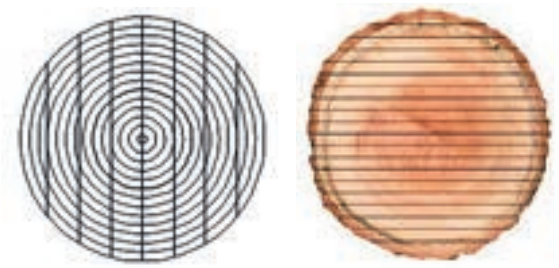

Fig 3.6: *Live sawing method*

(Source: *Live sawing method - Search Images (bing.com)*)

ii. **Back sawing** (Tangential Sawing): The log is sawn so that the width of the board is tangential to the growth rings and produce pleasant figure making suitable for cabinet work.

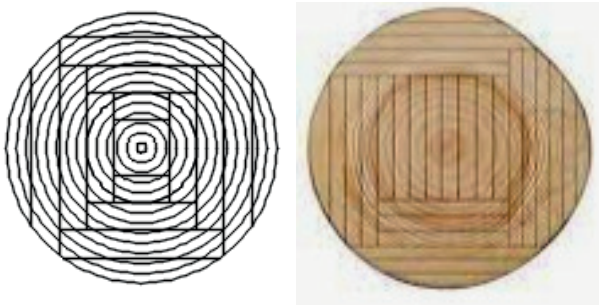

Fig 3.7: *Tangential sawing*

(Source: *Tangential sawing - Search Images (bing.com)*)

iii. **Quarter sawing** (Rift/Radial): This method is used to convert logs into boards which have their width in the general direction of the rays. Boards which are quarter sawn show decorative **medullary ray** figures called **silver grain**.

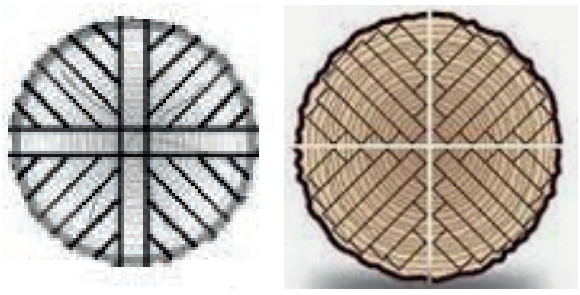

Fig 3.8: *Quarter sawing*

(Source: *Quarter sawing - Search Images (bing.com)*)

Standard marketable sizes of timber

The following are the terms used to describe and identify the various marketable sizes of timber: baulk, half-timber, flitch, plank, deal, batten. board, scantling strips (laths or fillets), square (quartering) and waney-edge.

Seasoning of timber

Seasoning of timber is the drying-out of the excess moisture from wood so that the timber is ready for working.

Methods of seasoning: there are two methods of seasoning timber. They are the **Natural method** and the **Artificial (Accelerated) method - (kiln seasoning).**

1. **Natural method - (air season):** The timber is stacked in the open air, where it is dried by the prevailing weather conditions.

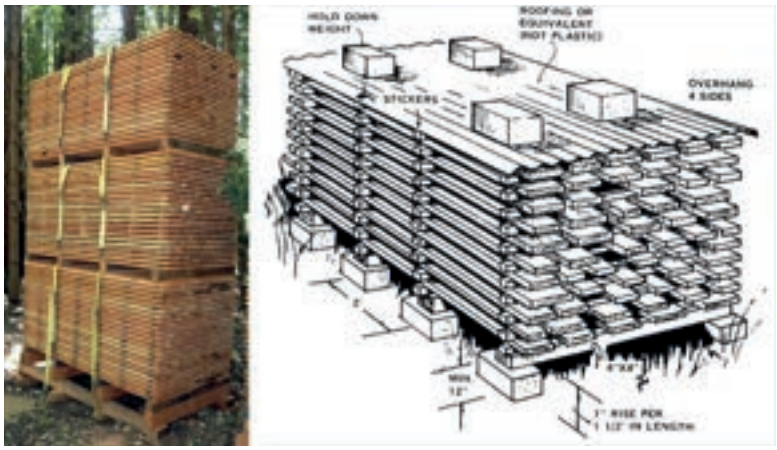

Fig 3.9: *Timber air drying method.*

Source: *https://journeymansjournel.wordpress.com/wp-content/uploads/2016/09/wood-drying-03.jpg?w=760)*

2. **Artificial (accelerated) method – kiln seasoning:** The timber is stacked as for air drying, and placed in an oven called a kiln, where the temperature, humidity and air circulation are accurately controlled.

   Types of seasoning Kiln

   1. **Compartment kilns:** The conditions at any time are the same throughout the kiln.

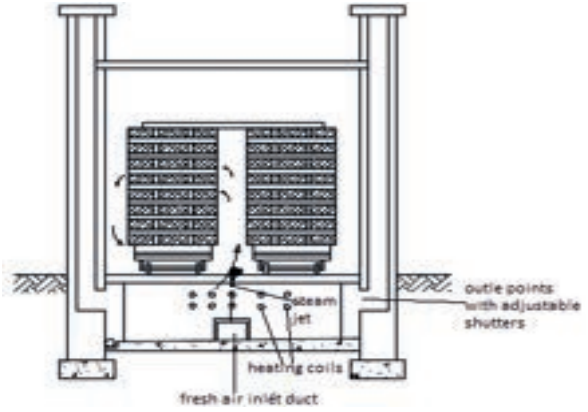

Fig 3.10: *Compartment/Natural draught kiln.*

Source: *Compartment/Natural draught kiln - Search Images (bing.com)*

2. **Progressive kiln:** In this type of kiln, the conditions at one end of the kiln differ from those at the other end.

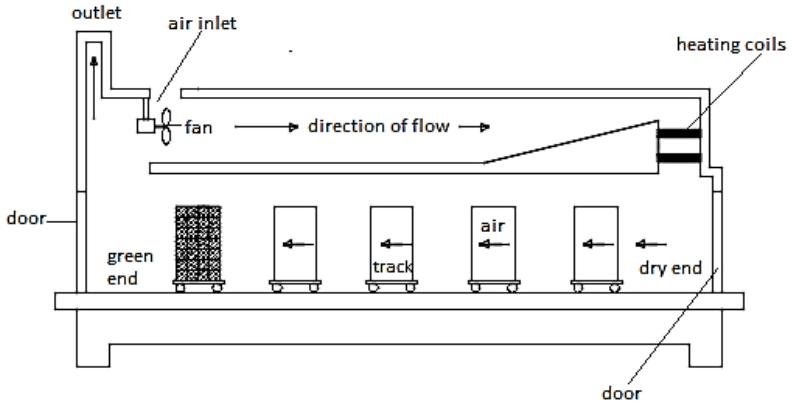

Fig 19: *Progressive kiln.*

Source: *Progressive kiln - Search Images (bing.com)*

Methods of calculating percentage moisture content (%Mc): There are two main methods namely the:

1. oven dry method
2. moisture meter method

Properties of timber

1. **Surface quality of timber:** The surface quality of timber depends on the visible nature and arrangement of the wood elements such as **fibres** and **vessels**, which are characteristic of each species of timber (e.g. straight grains, diagonal grains).
2. **Working qualities**: This refers to the ease or difficulty of sawing chiseling, curving, shaping, bending, turning, gluing and nailing.
3. **Mechanical properties:** These include; tensile strength, compressive strength, shearing strength, bending strength, stiffness, toughness, elasticity, hardness, and durability.

Defects in Timber

A defect in timber is any irregularity appearing in or on the wood which may cause it to be less strong and durable when used for construction work.

1. **Natural and artificial defects:** These include knots, shakes, surface splits, checks, warp (bow, cup, spring, twist), case-hardening, honeycombing, collapse, wet rot and dry rot.
2. **Insect attack:** When insects attack and destroy the usefulness of timber, the insects are declared pests and the damage described as a defect. The two groups of insects which cause the greatest amount of damage to timber are **termites** and **beetles**.

Wood preservation

In general, existing wood preservatives may be divided into three, ***Tar-oil, Water-Borne and, Organic solvent.***

Methods of application: These include **the** pressure method/treatment and the non-pressure method/ treatment.

3. Tertiary processes phase

Generally, these technological properties; surface quality, working qualities, mechanical properties, defects and preservation methods, come in the tertiary processing phase because they are considerations which need to be taken into account when, for example, selecting timber to make artefacts.

These tertiary processes phase includes:

1. Artefact production: such as furniture, joinery, cabinet making, mold builders.
2. Finishes and finishing
3. Quality control
4. Packaging and shipping

Learning Tasks

1. Identify the three phases of timber processing in the woodwork industry.
2. With the aid of a sketch, show which method of conversion of timber brings out the best figure of timber.
3. Describe why is seasoning necessary?

Pedagogical Exemplars

Teachers should consider the following activities**:**

Critical thinking and talk for learning approaches: Guide learners through a video demonstration of the three phases of timber processing in the woodwork industry, to co-operatively brainstorm the meaning of the phases of timber processing in the woodwork industry with open-mindedness and faithfulness. Teachers should target questions to learners as they discuss with one another, to push thinking on. Teachers should pull all learners back in for whole-class feedback and collect meaning explanations from learners.

Guide learners through a video demonstration of a timber conversion process in action, to co-operatively brainstorm the meaning and methods of conversion of timber with open-mindedness and faithfulness.

Experiential learning: The teacher takes learners on a field trip to a woodwork industry to observe the log yard activities, conversion of timber, seasoning kilns, artefact production etc. Task learners in mixed-ability groups to carefully identify and passionately explain phases of timber processing in the woodwork industry with open-mindedness. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

Group work/Collaborative learning /Digital literacy learning: Place learners into mixed-ability groups and task them to co-operatively discuss the technological properties (surface quality, working qualities, mechanical properties, defects and preservation methods) with open-mindedness, patience and work ethics. Teachers should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

Key Assessment:

Level 1: Name the three-processing phases of timber in the woodwork industry?

Level 2: Describe the meaning of the term 'conversion' when referring to timber.

Level 3: Describe, with the aid of sketches, the natural method of seasoning?

Level 4: Differentiate between the three phases of timber processing in the woodwork industry?

Unit 1 Review

This unit covered the lessons taught in week 9 & 11. This unit exposed learners to the concept of processing phases of timber in the woodwork industry. The pedagogical exemplars used in this section included talk for learning, group work/collaborative learning, experiential learning which helped to meet varied needs of all learners. These strategies enabled learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for the varied activities of learning. These assessments were classified under the DoK level 1, 2, 3 and 4.

References

1. Rundmo, T., & Hale, A. R. (2003). Managers' attitudes towards safety and accident prevention. Safety science, 41(7), 557-574. https://doi.org/10.1016/S0925-7535(01)00091-1
2. Walton, J., (1970). Woodwork in Theory in and Practice (metric edition).
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4. www.engineeringenotes.com
5. www.wagnermeters.com

UNIT 2

Strand: **Automotive Technology**

Sub-Strand: **Introduction to Engine Technology**

Learning Outcome: *Analyse and use relevant principles underlying engines to service, and repair spark ignition (SI) and compression ignition (CI) engines*

Content Standard: Demonstrate the knowledge and application of the working principles of engines

INTRODUCTION AND UNIT SUMMARY

This unit introduces learners to the practical demonstration of safety measures applied to servicing, repair and maintenance of engine systems. Mechanical energy is created by the internal combustion engine from chemical energy. The teacher will guide learners to examine the fundamentals of engine construction as well as distinguishing between different engine types and their component parts. They will also explain the operational and structural differences between gasoline and diesel engines and show how safety precautions are taken when servicing, repairing, and maintaining engines.

This unit covers only week 9 & 12: ***Demonstrate safety measures applied to servicing, repair and maintenance of engine systems***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must fully participate in the identification of types of engines and describe the main component parts of the engine. Teachers should employ pedagogies such as, group work or collaborative learning, experiential learning and project-based learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in identification and description of the main component parts of the engine. However, make considerations and accommodations for the different groups. Offer below average/approaching proficiency learners the opportunity to make oral presentations and use samples real objects in identifying types of engines and describing the main component parts of the engine. Then, extend activities for the above average/ highly proficient learners,

ASSESSMENT SUMMARY

To demonstrate conceptual understanding of the ideas covered in this unit, learners must show how they apply the concepts in real-world situations. As a result, levels 1, 2, and 3 of the DoK should be substantially covered in the assessments. To gather data regarding learners' progress and provide timely feedback, teachers should utilise a range of formative assessment tools, including pairs of tasks, reports, oral and written presentations, and home assignments. Teachers should administer the following tests and document learners' results in continuous assessment records:

1. class exercises (including individual worksheets) after each lesson
2. homework
3. scores on practical group activities on the various safety kits used at the workshop

WEEK 9 & 12

Learning indicator: *Demonstrate safety measures applied to servicing, repair and maintenance of engine systems*

Theme/Focal Area(s): Personal Protective Equipment

General personal safety rules and regulations in the workshop include:

1. Wear appropriate personal protective equipment as recommended.
2. Wear good clothes with tight sleeves and trouser legs when working.
3. Wear no ties.
4. No sharp or angular tools, stored in the pocket.
5. Wear no jewellery like bangles, wedding ring or necklace while working.
6. Clean the workshop every morning and after the daily work is finished.
7. Keep all collected waste in a container or refuge box.
8. Oil on the floor should be cleaned immediately using either a duster, saw dust, etc.
9. Always use the correct tool for the job.

Fig 3.11: *Protective Equipment.*

Customer safety tips in the workshop:

Fig 3.12: *Safety tips in the workshop*

Source: *Safety tips in the workshop - Search Images (bing.com)*

Workshop safety tips:

Fig 3.13: *Safety tips in the workshop.*

Workshop safety floor marking:

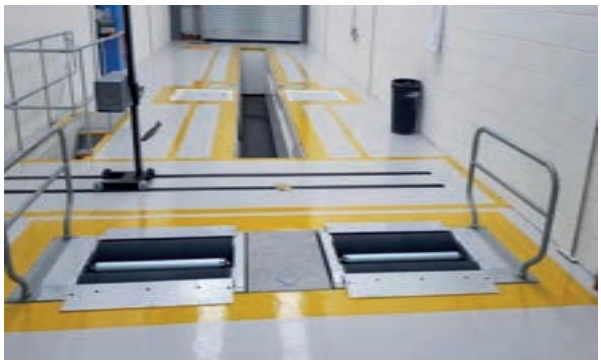

Fig 3.14: *Workshop safety floor marking.*

Source: *Workshop safety floor marking - Search Images (bing.com)*

Learning Tasks:

1. Outline personal protective equipment (PPE) used in a vehicle servicing and repair workshop.
2. Explain the general safety rules and regulations that ensures personal, customer and vehicle safety in the workshop.
3. Visit an efficient vehicle repair and maintenance shop and observe safety measures in their operations and present a report.

Pedagogical Exemplars

Teachers should consider the following activities:

Problem-based learning: Place learners in groups to voluntarily develop a list of personal protective equipment (PPE) utilized in a vehicle repair and maintenance business by using real objects and videos. To induce learners to participate in the discussion, Teachers should direct questions at them while they are having the discussion amongst themselves. When the class is back together, Teachers should gather all the learners for feedback.

Group work/Collaborative learning: Place learners in mixed-ability groups. Ask each group to explain the general safety rules and regulations that ensure personal, customer, and vehicle safety in the workshop in a respectful and open manner. Teachers should go around the classroom making sure that every learner is getting help and contributing to the conversation. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

Experiential learning: Guide learners in GESI responsive groups of five to an efficient vehicle repair and maintenance shop, observe safety measures in their operations and present a report. Teachers should ensure that learners obey and abide by the rules and regulations of the workshop, as well as provide feedback to learners on their reports and emphasise the application of safety measures in real-life situations.

Key Assessment:

Level 1: Outline five items of personal protective equipment (PPE) used in a vehicle servicing and repair workshop.

Level 2: Explain three general safety rules and regulations that ensures personal, customer and vehicle safety in the workshop.

Level 3: Present a report on safety measures and operations following a visit to a vehicle repair and maintenance shop.

Unit 2 Review

This unit covered the lessons taught in week 9 & 12. This unit exposed learners to the safety measures applied to servicing, repair and maintenance of engine systems. The pedagogical exemplars used in this section included problem-based learning, group work/collaborative learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Reflection:

1. Safety in the workshop
2. Personal safety
3. Customer safety

Resources: Models of engines, petrol and diesel engines, charts/sketches, video/YouTube, Real engines, local vehicle repair workshop, simulated activities, real objects.

References

1. https://ukindustrialflooring.co.uk/commercial-vehicle-workshop-in-nottingham/
2. https://ukindustrialflooring.co.uk/commercial-vehicle-workshop-in-nottingham/

UNIT 3

Strand: **Building Construction Technology**

Sub-Strand: **Pre-Construction Activities**

Learning Outcome: *Demonstrate knowledge of human resource requirements in building construction.*

Content Standard: Demonstrate knowledge and understanding of roles of building construction personnel

INTRODUCTION AND UNIT SUMMARY

Building construction professionals are individuals who have careers in construction related disciplines. They require a prolonged period of education to attain the knowledge, expertise and skills necessary to carry out their roles. Belonging to Professional Associations is their greatest attribute. Professional Bodies are established by law and, as legal entities they regulate the Associations by ensuring that only those who qualify and have registered can practice. Members normally carry membership certificates and professional seals as proof of authenticity. Codes of professional conduct observed by the professionals include the use of recommended fee scales, standard performance and ethics among others. Professional associations based in Ghana include Ghana Institute of Architects (GIA) founded in 1962 for Architects and The Ghana Institution of Engineering (GhIE) founded in 1968 for Engineering Professionals in the fields of Civil, Mechanical, Electrical, Chemical, Agricultural, Marine, Mining, Computer engineering as well as the Ghana Institution of Surveyors (GhIS) established in 1969 for Quantity Surveyors, Land Surveyors and Estate Valuers.

This unit covers only week 10 & 12: ***Identify the professionals involved in building construction project***

SUMMARY OF PEDAGOGICAL EXEMPLARS

Teachers may put Learners in mixed-ability groupings where the different needs of learners Approaching Proficiency, the Proficient and Highly Proficient would be met and where they will all be capacitated as they engage in critical thinking and brainstorming without any form of inhibition about what building professionals are. The collaborative environment which will be made tolerant of GESI, SEL and National Values is expected to enhance brainstorming and acquisition of diverse knowledge.

Teachers should take Learners through experiential learning by facilitating field trips to sites and consultants' offices to learn first-hand about professionals, their educational and professional achievements, professional bodies they belong to as well as codes of ethics they observe. Learners may work in mixed ability-groups to mimic the working environments they will have observed on the field trips.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction should be formative and this should include quizzes and short oral and written responses to questions. Teachers must keep track of performance of each learner given his or her unique level as Approaching Proficiency, the Proficient and Highly Proficient and provide the relevant motivation or scaffolds to enhance identification of professionals within the building construction industry.

The assessment should also serve as a tool to evaluate depth of knowledge amongst learners Approaching Proficiency, the Proficient and Highly Proficient. In this way the pedagogical differentiation strategies adopted will be mirrored under assessment as well.

WEEK 10 & 12

Learning Indicators: *Identify the professionals involved in building construction projects.*

Theme or Focal Area: Professionals in The Building Construction industry

Building construction professionals are individuals who have careers in construction-related disciplines. They require prolonged period of education to attain the knowledge, expertise and skills necessary to carry out their roles effectively. Belonging to Professional Associations is their greatest attribute.

Professional Bodies are established by law and as legal entities. They regulate the Associations by:

1. Ensuring that only those who are qualified and have registered as members can practice in the country. Members normally carry membership certificates and professional seals as proof of authenticity.
2. Setting Codes of Professional Conduct including competence, recommended fee scales, standard performance and ethics among others.
3. Professional associations based in Ghana include:

1. The Ghana Institute of Architects (GIA) founded in 1962.
2. The Ghana Institution of Engineering (GhIE) founded in 1968 for Engineering Professionals in the fields of civil, mechanical, electrical, chemical, agricultural, marine, mining and computer engineering etc.
3. The Ghana Institution of Surveyors (GhIS) established in 1969 for Quantity Surveyors, Land Surveyors and Estate Valuers.
4. The Royal Institute of British Architects (RIBA) founded in 1837 is an international body accredited to all commonwealth countries including Ghana.

Learning Tasks

1. Explain the steps to take to become a professional in the building construction industry.
2. Outline the major professions practising in the Ghanaian building construction industry.
3. Discuss how professionals acting in the building construction industry can influence good price, good quality and good time for building construction projects?

Pedagogical Exemplar

Teachers should consider the following activities:

Experiential learning: Organise field trips to construction sites or offices of consultants where learners will interact with the professionals and understand professional practice.

Digital learning: Encourage research on the internet to help Learners develop a deeper understanding of different professional practices applicable to the Ghanaian building construction industry.

Collaborative learning: Deliberately place Learners in mixed-ability groupings where the different needs of learners Approaching Proficiency, the Proficient and Highly Proficient would be met and where they will all be encouraged to engage in critical thinking and brainstorming about professional practice in Ghana.

Teachers should move about encouraging both verbal and non-verbal feedback from learners at the brainstorming sessions on challenges they may be encountering. Learners Approaching Proficiency may be referred to practical experiences they may have had at the field trips as solutions or illustrations to some of these challenges.

Key Assessment

Level 1 - List the major steps to be taken for an individual to become a professional in the building construction industry.

Level 2 - Explain how Professional Bodies control their members by subjecting them to codes of professional conduct.

Level 3 - Describe the effects of using Codes of Professional Conduct in the building construction industry.

Unit 3 Review

This unit covered the lessons taught in week 10 & 12. This unit provided learners with a deeper understanding of the professionals involved in building construction projects. The pedagogical exemplars used in this section included group work/collaborative learning, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Visits to the Construction Industry, Surfing the internet to find out about Stakeholders.

Reference

1. Hackett, M.; Robinson, I. and Statham, G. (2007). The Aqua Group Guide Procurement, Tendering and Contract Administration. Blackwell Publishing
2. The Applied Technology Secondary Education Curriculum (1. X.3.1.LO.1, 1. X.3.1.CS.1, 1. X.3.1.LI.1, 1.X.3.1.AS.1)
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UNIT 4

Strand: **Electrical and Electronic Technology**

Sub-Strand: **Electrical Systems Design**

Learning Outcome: *Explain clearly safety principles to follow in the use of electricity, analyse the key steps in power transmission and link it to power distribution to other substations, homes and industries*

Content Standard: Demonstrate knowledge and understanding of power transmission and distribution and its associated safety

INTRODUCTION AND UNIT SUMMARY

This unit emphasises the critical importance of ensuring a smooth supply of electricity and why this is paramount for the smooth functioning of modern society. The transmission and distribution of power play pivotal roles in maintaining an uninterrupted flow of electricity to consumers. This concept encompasses a series of intricate processes and technologies aimed at efficiently transporting electrical energy from power plants to end-users across vast distances. Transmission involves the movement of high-voltage electricity over long distances through transmission lines, typically from power generation facilities to substations. Here, transformers step down the voltage for safer distribution. Distribution then involves the conveyance of electricity from substations to homes, businesses, and industries through a network of lower-voltage power lines and distribution transformers.

This unit covers only week 10 & 13: ***Apply the concept of power transmission and distribution in electricity supply***

SUMMARY OF PEDAGOGICAL EXEMPLARS

The pedagogical approach to teaching the of maintaining uninterrupted electricity by applying the concept of power transmission and distribution in electricity supply, it is essential to engage learners actively in discussions and activities that foster communication skills. By initiating talk for learning, learners can explore and articulate their understanding of the topic. The transmission of electricity involves the transportation of high-voltage power from generation sources to substations, where is then transformed to lower-voltages for safer distribution. Teachers can employ visual aids, simulations, and hands-on activities to enhance learners' understanding of power transmission and distribution concepts. Real-world case studies and examples of power grid failures can provide valuable insights into the importance of maintaining uninterrupted electricity supply and the consequences of system disruptions. Moreover, discussions on renewable energy integration, grid modernisation, and energy storage technologies can foster critical thinking about sustainable energy solutions.

ASSESSMENT SUMMARY

To demonstrate conceptual understanding of the ideas covered in this section, learners must show how they apply the concepts in real-world situations. As a result, levels 1, 2, 3 and 4 of the DoK should be substantially covered in the assessments. To gather data regarding learners' progress and provide timely feedback, teachers should utilise a range of formative assessment tools, including pairs of tasks, reports, oral and written presentations, and home assignments. Teachers should administer tests such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the process of electrical power generation, transmission and distribution. Teachers should document learners' results in continuous assessment records. Tasks should encompass the

significance, diverse branches, career prospects, and dispelling of misconceptions surrounding applied technology. This ensures learners grasp the broader context and relevance of technology across different domains.

WEEK 10 & 13

Learning Indicator(s): *Apply the concept of power transmission and distribution in electricity supply*

Theme Or Focal Area: Application of The Concept of Power Transmission and Distribution in Electricity Supply

The Effects of Overloading a Distribution Network caused by Illegal connection

Overloading the distribution network, which refers to supplying more electrical load than the network is designed to handle, can have several adverse effects, including:

Voltage fluctuations: Excessive demand can cause voltage levels to drop below acceptable limits, leading to brownouts or blackouts in extreme cases. Conversely, voltage spikes can occur when the network struggles to cope with sudden increases in demand.

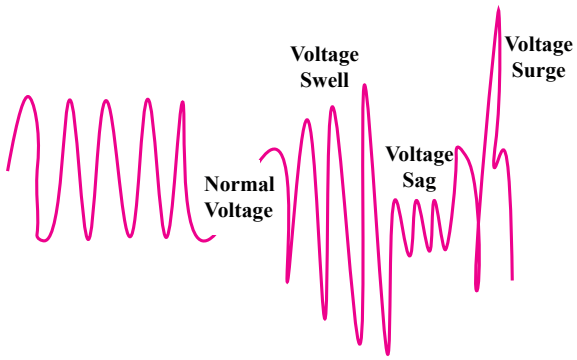

Fig.3.15: *S Voltage fluctuations in a distribution network*

Equipment damage: Overloading can cause damage to transformers, switches, and other electrical equipment due to overheating or excessive stress. This can result in costly repairs and downtime for maintenance.

Fig. 3.16: *A picture showing a damaged transformer caused by overloaded network.*

Source: *A picture showing a damaged transformer caused by overloaded network - Search Images (bing.com)*

Power quality issues: Overloading may lead to poor power quality, including voltage sags, surges, and harmonic distortions. This can affect the performance and lifespan of sensitive electronic devices connected to the network.

Increased energy losses: Higher loads can result in increased energy losses due to resistive heating in power lines and equipment. This reduces the overall efficiency of the distribution network and contributes to higher energy costs.

Revenue loss for utility companies: One of the most significant effects of illegal connections is the financial impact on utility companies. Power theft leads to a substantial loss of revenue for the utility, as the electricity consumed through illegal connections is not billed or accounted for.

Increased tariffs for legitimate consumers: The revenue loss incurred by utility companies due to illegal connections can lead to an increase in electricity tariffs for legitimate consumers. The burden of covering the cost of stolen electricity may be passed on to law-abiding customers, resulting in higher bills.

Safety hazards: Overloaded distribution networks pose safety risks to both the public and utility workers. Overheating equipment can create fire hazards, while voltage fluctuations may damage appliances and electronics or cause injury to individuals.

Service interruptions: Overloading can lead to frequent service interruptions and outages as the network struggles to cope with demand spikes. This can disrupt business operations, inconvenience consumers, and impact essential services such as healthcare and emergency response.

Diminished reliability: Overloading compromises the reliability of the distribution network, undermining its ability to deliver consistent and uninterrupted power supply to consumers. This can erode customer satisfaction and trust in the utility provider.

To mitigate these effects, utilities often invest in upgrading infrastructure, implementing demand management strategies, and promoting energy efficiency measures to better match supply with demand and ensure the stability and reliability of the distribution network.

Hindrance to network management: Illegal connections make it challenging for utility companies to accurately monitor and manage the distribution network. This hampers their ability to plan for upgrades, expansions, and maintenance, leading to inefficiencies in the system.

Legal consequences: Power theft is a criminal offense in many jurisdictions. Utility companies actively work to detect and prevent illegal connections, and those caught stealing electricity can face fines, penalties, and legal actions, including prosecution.

Other effects of overloading the distribution network includes:

1. High-voltage drops, leading to low-voltages experienced by consumers.
2. High power losses leading to low efficiency of the system.
3. Frequent power outages.

Note: *Overheating of conductors, Dimming Lights or Flickering, Voltage Drops, Electrical Fires and Damaged Appliances and Electronics should also be discussed.*

Simulation of the Effects of overloading in power supply

Fig. 3.16: *Loads connected to a substation.*

Source: *Search Images (bing.com)*

Overloading occurs when the amount of load connected to a substation transformer exceeds the capacity of the transformer, the effect is that high-voltage drop occurs in the conductors leading to low-voltage being experienced by consumers. Power loss in the conductors increase, leading to low efficiency in the system. There are also frequent power interruptions.

The effect of overloading can be simulated using VPLab (Virtual Physics Laboratory)

Simulation, in the context of engineering and science, refers to the process of creating a virtual model or representation of a real-world system or phenomenon to study its behavior, performance, or characteristics.

1. **Install VPLab:** If you don't have it already installed, you can download it from the official website.
2. **Use the VPLab:** To simulate an overload situation, by gradually increasing the load.
3. **Observe effects:** Run the simulation and observe the effects of the overloaded network.

Learning Tasks:

What happens to the voltage across a circuit when it is overloaded?

1. How does overloading a circuit affect the current flowing through it?
2. What are the potential consequences of overloading a circuit in terms of overheating and fire hazards?
3. How does overloading affect the reliability and stability of the distribution system?
4. What are the safety implications for both utility personnel and consumers due to overloading?
5. How can predictive analytics and modeling be used to assess the impact of future load growth on distribution network capacity?

Pedagogical Exemplars

Teachers should consider the following activities:

Talk for learning approaches: Guide learners through watching a video to demonstrate the consequences of overloading the distribution network. Teachers should target questions to learners as they discuss with one another to mention some of the effects of an overloaded network they observed to push thinking on. Teachers should pull all learners back in for whole-class feedback and to collect ideas.

Experiential learning: In mixed-ability groups. Guide each group to explore the simulation of an overloaded network using a VPLab software and present their findings to gain insights into the challenges of overloading distribution networks. This hands-on experience will deepen learners understanding of safety regulations and the crucial role of distribution networks in maintaining reliable electricity supply. Learners embark on this interactive journey together to understand the real-world impact of illegal connections on our power infrastructure.

Note: Additional needs learners should be given more time to finish a task. During presentations, make sure that everyone is encouraged to speak on behalf of the groups, regardless of background, such as gender, physical capabilities, or intellectual ability. Any individual can be chosen as the group's leader.

Key Assessment

Level 1:

1. What are the potential safety hazards and risks associated with illegal gas connections?
2. What are the primary factors that contribute to overloading in a distribution network?

Level 2:

1. What measures can be implemented to raise public awareness about the negative consequences of illegal connections?
2. What measures can be taken to prevent or mitigate the effects of overloading in a distribution network?

Level 3:

1. Task learners to discuss their observation during simulation period and present their findings.
2. How does overloading affect power quality for end-users connected to the distribution network?
3. How does overloading affect the lifetime and operational efficiency of distribution equipment?

Level 4:

1. Analyse the consequences of illegal connection on the distribution network.
2. How do weather conditions and seasonal variations affect the likelihood of overloading in distribution networks?
3. Are there specific industries or regions that are more susceptible to distribution network overloading, and if so, why?

Unit 4 Review

This unit provided an in-depth exploration of the key principles and technologies involved in ensuring a smooth flow of electricity from generation sources to end-users.

The unit delved into the fundamentals of power transmission, clarifying the processes of transporting high-voltage electricity over long distances through transmission lines and step-down transformers at substations. It also highlighted the importance of efficient distribution networks in conveying electricity safely and reliably to consumers, utilizing lower-voltage power lines and distribution transformers.

Moreover, the unit discussed the significance of advanced technologies, such as smart grids, in optimising the monitoring, control, and management of the electricity supply. It emphasised the role of infrastructure upgrades and grid modernisation in enhancing the resilience and capacity of power transmission and distribution systems.

Furthermore, the unit underscored the importance of integrating renewable energy sources and energy storage solutions into the grid to mitigate risks associated with power outages and reduce dependency on fossil fuels.

This unit provided a comprehensive overview of the strategies and technologies driving the maintenance of uninterrupted electricity supply, laying the groundwork for further exploration of sustainable energy solutions and resilience-building measures.

Resources: Computers installed with VPLab software and internet access.

References

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UNIT 5

Strand: **Metal Technology**

Sub-Strand: **Welding Technology**

Learning Outcome: *Apply the principle of gas and arc welding to produce artefacts and solve problems in sheet metal and metal plate fabrication*

Content Standard: Demonstrate knowledge and understanding of tools and equipment for welding

INTRODUCTION AND UNIT SUMMARY

This unit presents the basic process in gas welding and its tools and equipment which is a valuable and widely used welding process due to its versatility, portability, cost-effectiveness, and ease of operation. Gas welding can be used to join a wide range of metals, including steel, stainless steel, aluminium, copper, and brass, making it a versatile process in various industries such as automotive, construction, and manufacturing. The unit highlights the use of the various tools and equipment in gas welding. This equipment is relatively lightweight and portable, allowing it to be used in remote locations or areas where electricity may not be readily available. Gas welding tools and equipment are relatively simple to set up and operate, making it accessible to beginners in metalwork technology.

This unit covers only week 11 & 13: ***Identify and explain the use of various tools and equipment for gas welding***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must identify and explain the use of various tools and equipment for gas welding. Teachers should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning, experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. Again, learners should be encouraged to participate fully in investigations as well as presentation of findings. Teachers should employ differentiation strategies to accommodate diverse learning needs of the learners.

ASSESSMENT SUMMARY

To demonstrate conceptual understanding of the ideas covered in this section, learners must show how they apply the concepts in real-world situations. As a result, level 1, 2, and 3 of the DoK should be substantially covered in the assessments. To gather data regarding learners' progress and provide timely feedback, teachers should utilise a range of formative assessment tools, including pairs of tasks, reports, oral and written presentations, and home assignments. Teachers should administer tests such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities covering the basic processes in gas welding and the tools and equipment which are valuable and widely used in the welding process. Teachers should document learners' results in continuous assessment records. Tasks should encompass the significance, diverse branches, career prospects, and dispelling of misconceptions surrounding applied technology. This ensures learners grasp the broader context and relevance of technology across different domains.

WEEK 11 & 13

Learning Indicator(s): *Identify and explain the use of various tools and equipment for gas welding.*

Theme or Focal Area: Tools and Equipment for Gas Welding

Gas Welding

Gas welding is a hot flame joining process for metals using fuel gases and oxygen. Metal joining can take place both with or without the use of filler material.

Tools and equipment for gas welding:

1. **Oxygen cylinders:** Oxygen cylinders are made of steel. They are used for storing liquified oxygen gas under pressure. They are fitted with right-hand screw threads. They are identified by being painted black.
2. **Acetylene cylinders:** Acetylene cylinders are made of steel and are used for storing acetylene gas. They have a concave bottom. Acetylene cylinders are fitted at the top and bottom with fusible plugs to relieve any excess pressure when subjected to greater heat or undue pressure. They are fitted with left-hand screw threads and are painted red or blue.

Fig. 3.17: *Oxygen and acetylene cylinders*

(Source: *Oxygen and acetylene cylinders - Search Images (bing.com))*

3. **Pressure regulators:** Pressure regulators reduce the high storage pressure to a suitable working pressure and also maintain a constant pressure at the blowpipe. Pressure regulators used are acetylene pressure regulator and oxygen pressure regulator. Pressure regulators have two gauges: supply pressure gauge and working pressure gauge. Regulators for fuel acetylene gas and oxygen gas are designed to be non-interchangeable. All oxygen fittings have plain nuts and right-hand threads. All acetylene fittings have grooved nuts and left-hand threads.

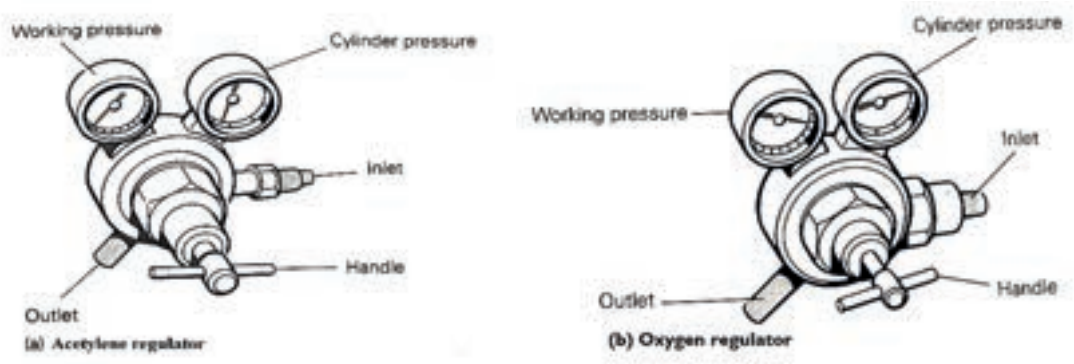

Fig. 3.18: Pressure regulators.

4. **Hoses:** The hoses are of two types; the acetylene hose and the oxygen hose. In oxy-acetylene gas welding the oxygen gas and the acetylene gas are carried from the oxygen and acetylene cylinders to the welding torch through hoses. Colour coding is used in identifying the hose carrying the gas. The hose having blue colour carries oxygen and red colour is used for acetylene hose.
5. **Welding torch or blowpipe:** A welding torch is the main component of the oxy acetylene equipment where the oxygen and acetylene gases are mixed in the mixing chamber. It has a mixing chamber and the nozzle(tip). Regulated outflow of the mixed gases when struck with a spark lighter produces flame. The flame produced is used to weld or cut the materials. A high temperature flame is produced by adjusting the oxygen and acetylene valves, according to the welding material. There are two types of torches:
   a. Low pressure or injector torches.
   b. Medium pressure or equal pressure torches.

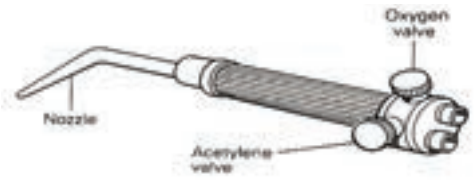

Fig. 3.19: *Welding torch.*

Source: *Welding torch - Search Images (bing.com)*

6. **Goggles:** Gas flames produce high intensity light & heat rays, which are harmful to the naked eye. To protect the eyes from these rays, goggles are used. Goggles also protect the eyes from flying sparks.

Fig. 3.20: *Welding goggles.*

Source: *Welding goggles - Search Images (bing.com)*

7. **Spark Lighter:** For starting the flame, the spark should be given by a lighter. Match sticks should not be used, as there is risk of burning hand.

Fig. 3.21: *Spark lighter.*

Source: *Spark lighter - Search Images (bing.com)*

8. **Welding rods:** Welding rods are used to provide the filler material in the welding process. They are designed to melt at a lower temperature than the metal being welded, allowing them to fuse

with the metal and form a strong bond. The welding rod also helps to control the size and shape of the weld, ensuring that it is uniform and consistent.

Fig. 3.22: *Oxyacetylene equipment set-ups.*

Source: *Oxyacetylene equipment set-up - Search Images (bing.com)*

Learning Tasks:

1. Explain the uses of the following equipment in gas welding:
   - **a.** Acetylene cylinders
   - **b.** Oxygen cylinders
   - **c.** Pressure regulators
2. Distinguish between acetylene cylinders and oxygen cylinders.

Pedagogical Exemplars:

Teachers should consider the following activities:

Pre-Assessment: The teacher begins by assessing learners' prior knowledge and experience with gas welding tools and equipment. Use pre-assessment tools such as quizzes, surveys, or informal discussions to gauge learners' familiarity with welding processes, safety protocols and equipment usage.

Group work/collaborative learning: Learners in mixed-ability groups are given appropriate charts and guided to brainstorm to identify with safety guidelines the precise gas welding tools and equipment. Group learners flexibly based on their skill levels, prior experience and learning needs. The teacher can create mixed-ability groups for collaborative learning activities or can group learners homogeneously for targeted instruction and practice sessions based on their proficiency in tools and equipment used in gas welding.

Varied instructional modalities: The teacher provides instruction using a variety of modalities to accommodate different learning styles. Incorporate visual aids such as diagrams, charts, and videos to demonstrate welding techniques and equipment usage. Offer hands-on demonstrations and practice opportunities for different categories of learners and use verbal explanations and discussions in supporting the learners who are unable to achieve the target in the use of tools and equipment for gas welding.

Key Assessment:

Level 3:

1. Distinguish between the acetylene regulator and the oxygen regulator.
2. How are the hoses connected to the gas cylinders taking into consideration the colour of the hoses?
3. Explain the function of the blowpipe.
4. Describe with the aid of a diagram at least five of the following tools used in gas welding and demonstrate their uses.
   a. Oxygen cylinders
   b. Acetylene cylinders
   c. Pressure regulators
   d. Hoses
   e. Welding rods
   f. Spark lighter
   g. Welding torch or blowpipe
   h. Welding goggles

Unit 5 Review

This unit covered the various tools and equipment for gas welding. They are essential for beginners in metalwork technology. The unit equipped the learners with the knowledge and understanding relating to the tools and equipment, their uses and how to recognise and identify specified items for gas welding. A given workshop project is to be undertaken to appreciate and practice the use of the various gas welding tools and equipment.

Reflection:

1. What was my best moment in today's lesson and how can I create more of such situations?
2. Were learners able to identify the various tools and equipment for gas welding?
3. Were learners able to explain the uses of the various tools and equipment for gas welding?
4. Were the learners able to apply the tools and equipment for gas welding?
5. Which resources best supported the teaching and learning of the tools and equipment for gas welding?
6. Did learners find the resources useful for gas welding?
7. Were the different subgroups in the class catered for?

Resources: Pictures of the tools and equipment for gas welding, videos/YouTube showing how the tools and equipment for gas welding are being used, real objects (oxyacetylene cylinder, oxygen cylinder, pressure regulators, welding torch or blowpipe, hoses, goggles, spark lighter, welding rods), sketches, charts and drawings of the tools and equipment for gas welding.

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