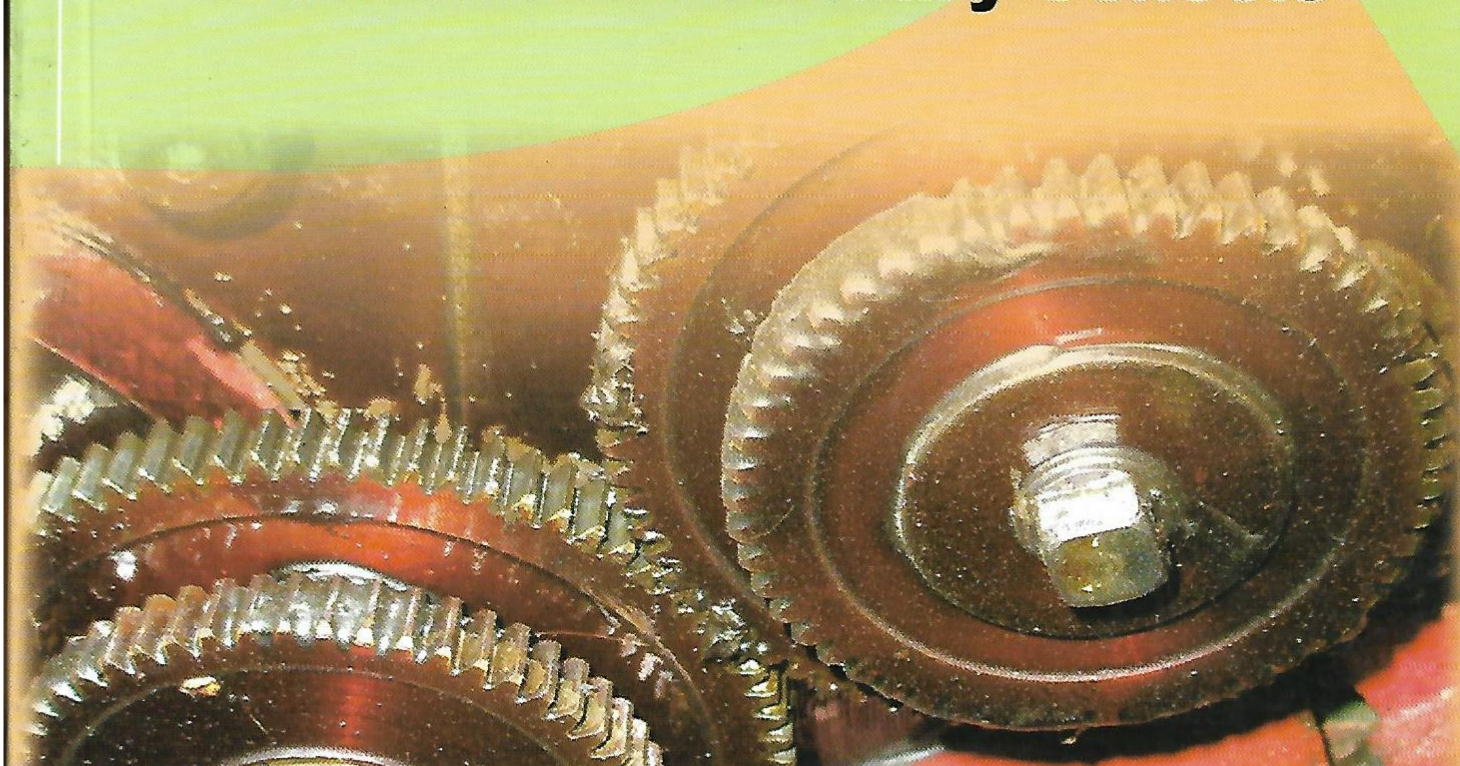
UBE Edition

NERDC BASIC TECHNOLOGY 1

For Junior Secondary Schools



LearnAfrica

NERDC Basic Technology

for Junior Secondary Schools

Textbook 1

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Contents

Chapter 1

You and technology

Introduction

We live in the World of technology. All around us are things made through technology or by technological ways of doing or using things. Things made with technology are products of technology. The bicycle and motorcycle for instance are products of technology. Similarly, the aircraft, farm tractor, wristwatch, cooking pots, lantern, computer, camera, electric pressing iron, motor vehicle, aircraft, etc. are all products of technology. Almost all artificial or man-made things around us are products of technology. Some specified scientific ways of doing things as in accountancy, management, building construction, medical practice, engineering, information and communication, are regarded as technology. Nowadays, a lot of people study accounting technology, management technology or information technology as their profession. As you study along, you will be able to choose a technological profession for your career.

Technology makes things possible, makes things happen and produces things for the comfort and ease of human life. As you study, you will learn more about technology: the meaning, what it does and what it can still do.

Objectives

At the end of this chapter you should be able to:

1 define technology;

2 list the benefits of technology;

3 identify some products of technology around you;

4 describe ways in which technology has improved standards of living; and

5 state who should study technology.

1.1 The concept of technology

Different people hold different views about technology. There are those who think that technology comprises those things produced by technology and there are those who think that technology is the idea behind or the idea used in producing or using things.

The correct meaning is perhaps easy to know. If technology means the products of technology, then some countries would become technologically developed by simply buying those products. But practical experience shows that a country that buys the products of technology does not become automatically technologically developed. Rather, it is the ability to produce technologically that makes a country to be technologically developed.

Again, some people think that technology means the complex and wise things done or made with high scientific ideas. This is not completely true. Technology can be simple or complex; it can be high or low. But always, it has to do with wise work that has a scientific idea behind it.

With this understanding, we may now define technology as: ***open knowledge or ideas, skills and procedures for making, doing or using things in specifiable and repeatable ways.***

You should be able to point out the key words in this definition and explain them in your own word. For example, 'open', 'skill', 'idea', 'doing', 'specifiable', repeatable. Study some technology products around you to understand the scientific ideas and skill behind their making.

1.2 Products of technology

High level technology products include motor vehicle, aircraft, satellite and submarine while products of low level technology include the bellows used by blacksmiths, traditional weaving and dyeing crafts, traditional grains storage and preservation methods.

A technology is high-level or low-level depending on the level of scientific ideas and skills that are involved in it. Generally, technology is about work:. how work is imagined and how work is done to produce goods and services for better ways of living.

The products of technology abound around us: the food we eat, the clothes we wear, the modern houses we build, means of transportation, means of entertainment,

Fig. 1.1: Products of technology

means of communication, electricity power generation, etc. We can say that technology makes the modern world.

Technology is characterised by:

1 scientific ideas and findings in its practice. This means that scientific ideas and findings guide activities in technology;
2 a certain wise way of making, doing or using things;
3 open ideas, skills and procedures. That is, it is open to people of every race and place provided they have a ready mind to study and the right attitude to practise.

Activity 1.1

If technology is open knowledge and not restricted or limited to a race or place, why do some countries remain technologically undeveloped or under-developed? Discuss this with your teacher.

1.3 Life application of technology

The development of technology depends on people who love creative change and the use of wisdom with the right attitude as their general way of life. A people with inquiring and creative minds and good attitude to seek what is good for everyone will always develop technologically. They will always use technology and the right attitude to overcome the limitations of their environment. Nowadays, the economic power of a country does not depend on its having a large population or abundant natural resources but rather on technology. Examples of economically powerful countries are Japan, Germany, USA, and the United Kingdom.These countries are known for their industrial production. Nigeria will soon join them if young persons like you will determine to study and make progress in technological occupations.

1.4 Historical development of technology

Every type of technology we have today started as a low level idea and kept on advancing. Examples of advancing technology are: the technology of automobiles, telephone, X-ray, surgery, medicine, highways, computer and telecommunication. Technology does not stand still; it grows and changes because it is derived from ideas and skill.

The technology of GSM (Global system of mobile telecommunication) telephoning is the technology of radio waves, which has a long history of development. The technology of rockets and satellites developed from the technology of airplanes. Modern technology is still advancing. Computer, the Internet and satellite technologies have made the world to be a global village. In agriculture, technology has led to the development of crops with high yields. Indeed, in all aspects of life, technology leads. However, some countries are being left far behind and some are being carried along as **consumer countries** in the race for technological development because of their poor attitude to technology. These are called **'third world' or 'least developed countries'.**

The benefits of technology

So far, we have seen that it is the level of technology that separates countries into the class of developed or undeveloped countries. This is because it is impossible to imagine development without technology. The function of technology is to keep extending the limits of human possibilities in making the earth a better place for human life. Even sometimes when technology is used in fighting war, it is ultimately meant to create lasting peace.

Technology is primarily meant for human good, to create comfort, ease, peace, wealth and environmental sustainability. If technology fails, human life would return to the primitive and be at risk of extinction. As we have seen already, the world is now a global village owing to the growing computer and Internet technologies. Travelling around the world has been made easy and comfortable by airplanes; irrigation technology has made all season farming in the tropics possible; genetic technology has made it possible to have genetically improved crops. You can name other examples of the benefits of technology to mankind.

1.5 Technology and society

We have learnt much already about technology. Modern living cannot exist without technology. All aspects of human life have been taken over and improved by technology. It is impossible to imagine any civilisation without technology. We have seen already that it is technology that now provides us with food, shelter, clothing, water, healthcare, education, entertainment, transportation, etc. Enlightened human societies live on their technologies.

Nowadays, it is technology that creates work to enable every person to have occupational calling and identity. In Nigeria, technology is raising the standards of living for all. It is changing paper civilization to paperless civilization. Very soon, businesses would be done without paper work; offices would operate without paper. Electronic modes of life: e-government, e-commerce, e-learning, e-medicine, e-banking, etc, would become universal. Technology has changed social life; to live successfully in this age of technology, one must be skilled in the use of common technological devices. Technological literacy has become compulsory for all. This means that one must have basic understanding of technology and skills.

1.6 Who should study technology

The fact that we are living in the world of technology implies that everyone must acquire technological life skills which include technological literacy. Technological literacy implies the ability for one to understand and use basic technology for everyday living.

Such understanding is for all: children, boys and girls, men and women. If everyone can carry out basic technological duties like house painting, minor electrical installation practice (house wiring, changing bulbs), appliances maintenance, minor repair of furniture, minor carpentry work, etc, the society would be a better place to live in. This level of skill acquisition in technology enables everyone (boy or girl, man or woman) to be generally versatile. These are life skills for all.

Besides the general study of technology for life skills, some people choose technological studies for their life career as engineers, builders, architects, physicians, managers, quantity surveyors, etc. Some people may also choose to be at the craft or technician level of their technological professions. Such people may have technician certificates or diplomas in fields such as catering, fashion designing, welding, plumbing and carpentry. The choice of one's career as you will learn later, should depend on one's aptitude and interest.

It is good to remember that any occupation that is based on scientific knowledge is a technology.

Summary

In this chapter, you should have learnt that:

1 We live in a world of technology. Almost all the artificial things we use are products of technology. These include: modern houses, highways, motor vehicles, airplanes, clothes, etc.

2 Technology is better seen as the idea behind technological product. Technology is characterised by:
   a) its scientific nature;
   b) its making, doing or using of things; and
   c) its public (open) nature.

3 Technology may be defined as:
   open knowledge, skills and procedures for making, doing or using things in specifiable and repeatable ways.

4 The development of technology depends not on a country's natural resources or large population but on the mind and attitude of the people.

5 Technology could be high or low depending on the level of scientific idea upon which it is based. However, every technology develops from low-level to high-level ideas. Automobile, computer, satellite and telephone technologies started from low ideas and advanced to their very high-level ideas today.

6 Technology does not stand still, it grows and changes.

Exercise

1 Identify five things in the environment that are products of technology and state why you chose them.

2 Identify two things in the environment that are not products of technology and state why you chose them.

3 State five benefits of technology to the society.

4 Explain the meaning of technology.

Chapter 2

Workshop safety rules and regulations

Introduction

Basic technology lessons will be very exciting because emphasis will be more on practical activities. We shall be involved in various projects in the workshop as we study basic technology. Since this is perhaps your first time in a workshop, we must study the conditions dangerous to ourselves, others around, tools, equipment and other facilities in the workshop. You must also understand the importance of observing safety rules and regulations in a basic technology workshop.

This chapter aims to increase your awareness of workshop safety. It will also outline the safety precautions that must be taken during practical activities in workshops.

Objectives

At the end of this chapter, you should be able to:

1 list workshop safety rules and regulations;

2 state some accident prevention measures;

3 list types of workshop fire fighting materials and equipment; and

4 observe safety rules and regulations in workshop.

2.1 Meaning and causes of workshop accidents

Accidents are defined as events occurring by chance, which result in injury to people or damage to property. You should not panic if an accident occurs in a workshop. Rather, tell your teacher immediately so that you will get first aid or be taken to the hospital.

Causes of accidents in the workshop can be grouped under two major headings: **unsafe actions** and **unsafe conditions.**

Unsafe actions

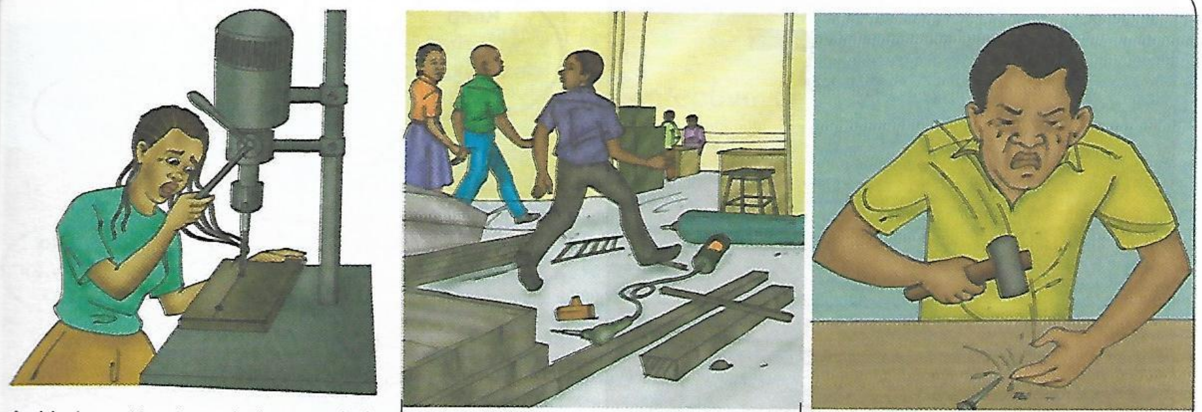
Many accidents happen because people are careless in the workshop. When you attempt to do the wrong thing or when laid-down procedures are not followed, accidents often happen. Examples of unsafe actions include:

1 entering the workshop in a disorderly manner;

2 failure to use safety devices;

3 failure to follow laid-down procedures for handling tools, machines, and other facilities; and

4 failure to obey workshop rules and regulations.



A girl who got her loose hair entangled in a machine

Students entering a workshop in a careless and disorderly manner

A student who mistakenly hit a hammer on his finger

Fig. 2.1 Some causes of accidents in a workshop

Unsafe conditions

When a tool or equipment is faulty, or the working environment constitutes a danger to the users, an unsafe condition exists.

Examples of unsafe conditions are:

1 slippery or wet floors;

2 the absence of safety devices;

3 non-maintenance of tools, equipment and other facilities and

4 working in the workshop when one is sick or tired.

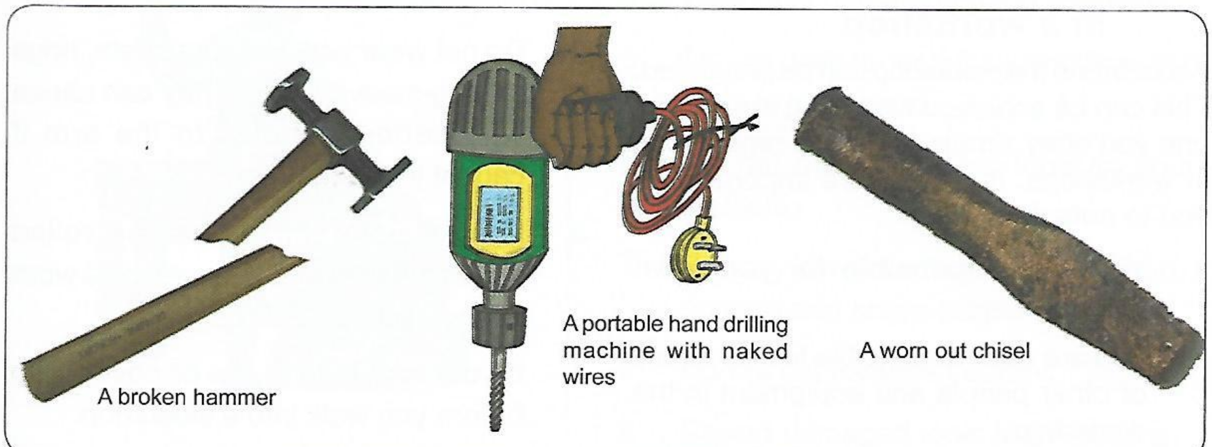


Fig. 2.2 Examples of poorly maintained tools or equipment

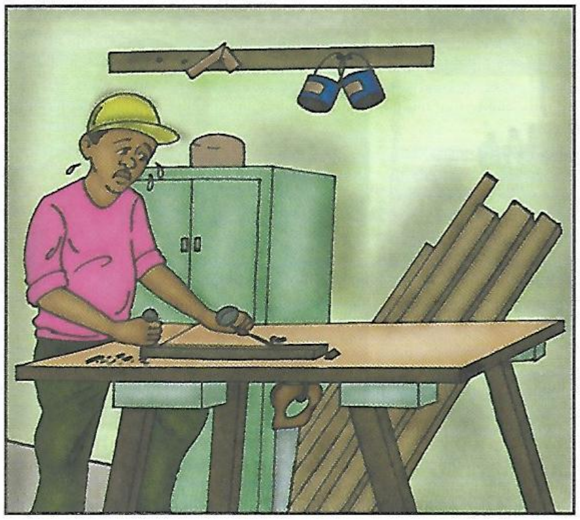


Fig. 2.3 A sick and tired person trying to work in a workshop

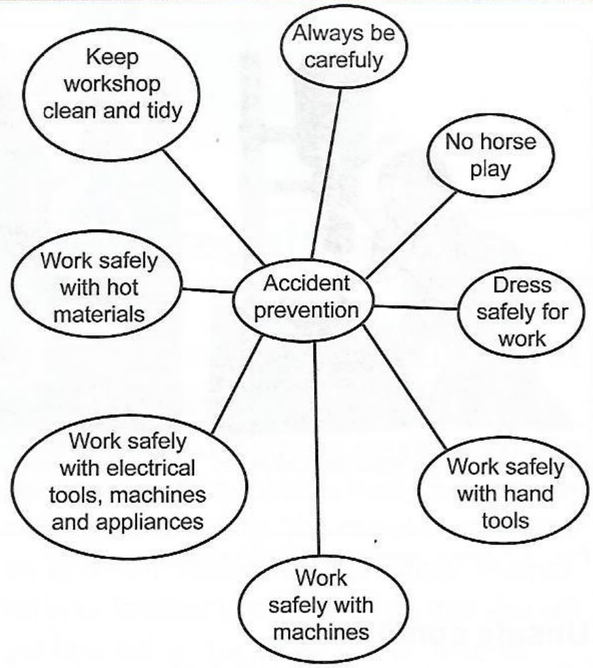


Fig. 2.4 Accident prevention

It is advisable to be careful in the workshop since accidents can result in permanent deformity or loss of life.

2.2 How to prevent accidents in a workshop

Accidents in the workshop can be prevented. This can be achieved when you are careful and you obey simple rules and regulations in workshops. It is therefore important for you to note that:

1 You are responsible for your own safety.

2 You are also responsible for the safety of other people and equipment in the workshop.

Dressing safely for work

You should observe the following dressing safety rules:

1 Dress correctly for workshop practice.

2 Do not wear watches, bracelets, rings or long-sleeve shirts. They can cause very serious injuries to the arm if caught in the machine.

3 Long-sleeve shirts must be rolled above the elbows if they are to be worn in a workshop.

4 If your hair is long, tie or cover it up before you walk into a workshop.

5 Wear special shoes for foot protection.

6 Wear gloves for hand protection.

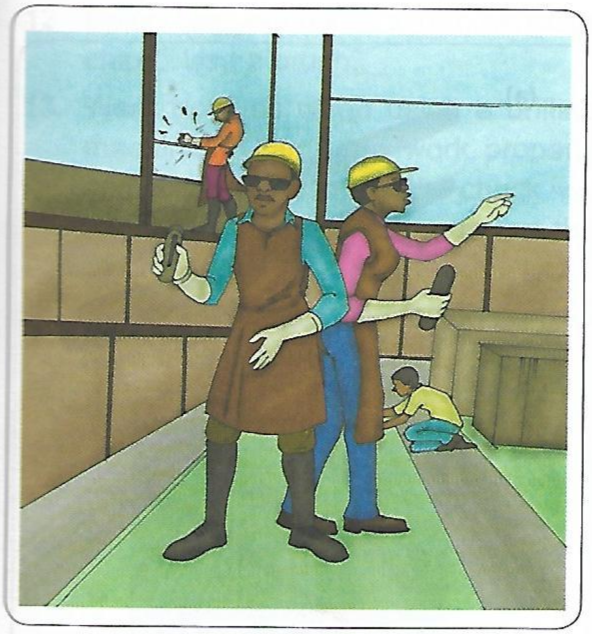


Fig. 2.5 Dressing correctly for the workshop

Fig. 2.6 How to hold tools safely

A student who keeps himself clean and neat is usually regarded as a safe worker.

Activity 2.1 Demonstrating proper dressing

Protective devices such as gloves and goggles should be provided.

1. Bring your overalls or apron and shoes to the class.
2. Dress properly for workshop activity.
3. Show yourself to the teacher.

Working safely with hand tools

You should observe the following safety rules when you are working with hand tools.

1. Make sure that your hands and tools are clean and free of oil or grease.
2. Carry tools safely.
3. Use cutting tools that are sharp. Blunt tools may cause accidents because greater force is needed to use them.
4. Use tools that are in good condition.
5. Do not walk around the workshop with tools in your hand.
6. Do not put any sharp tools in your pockets.
7. Be very careful when handling sharp, pointed and sharp-edged tools.
8. Do not cut towards yourself.
9. Report damaged tools to the teacher.
10. Clean tools after use and return them to their shelf or box.

Working safely with machines

Machines make work easier. They can also be dangerous if not properly handled. The following safety rules will guide you in the use of workshop machines.

1. Do not use any machine unless you have been taught how to use it.
2. You should operate machines only when your teacher or workshop attendant authorises you to do so.
3. Ask the teacher or attendant when in doubt of what to do.
4. Do not operate a machine until the cutting tools and the workpiece are securely and properly mounted.
5. Always start and stop the machine yourself.
6. Wait for a person to finish operating a machine before you attract the person's attention.
7. Do not touch moving parts of a machine like belts or pulleys.
8. If a group of students are assigned to work on a certain machine, only one student should operate the switches or controls.
9. Do not leave a machine while it is switched on, to attend to other things.
10. Do not talk to anyone while operating the machine.
11. Stop the machine before you clean, oil, grease, make adjustment or take measurements.

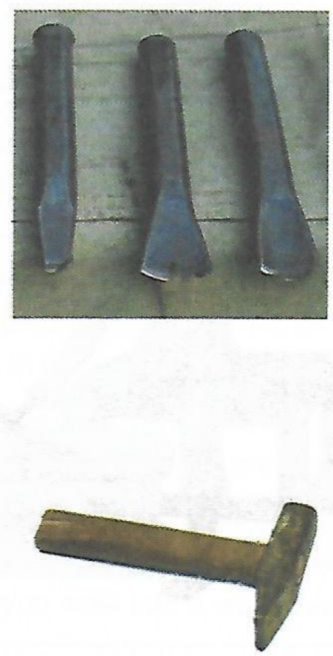
(a)

(b)

Tools in good condition—(a) and (b)

(c)

(d)



Tools in bad condition—(c) and (d)

Fig. 2.7 Tools in bad and good conditions

12 Do not use your hands to remove metal chips. Use a brush.

13 Wear goggles when using a drilling machine. Clamp the work properly and securely. Remove the chuck key from the chuck before you start the machine.

14 Do not try to stop the moving parts of machines with your hands.

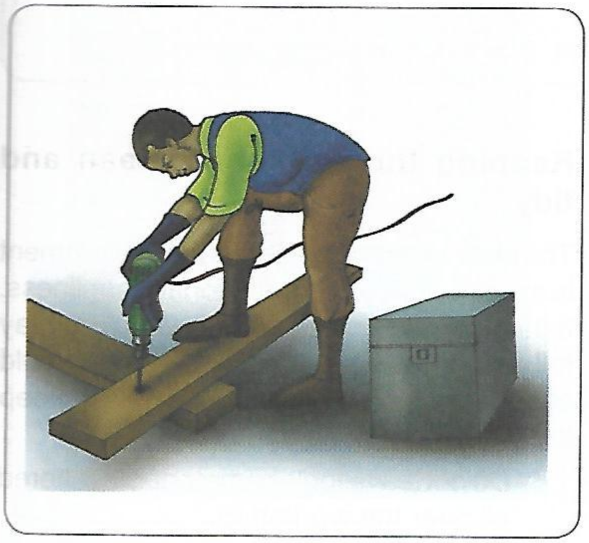


Fig. 2.8 Safety in using a drilling machine

Fig. 2.9 Safety in using a cutting machine

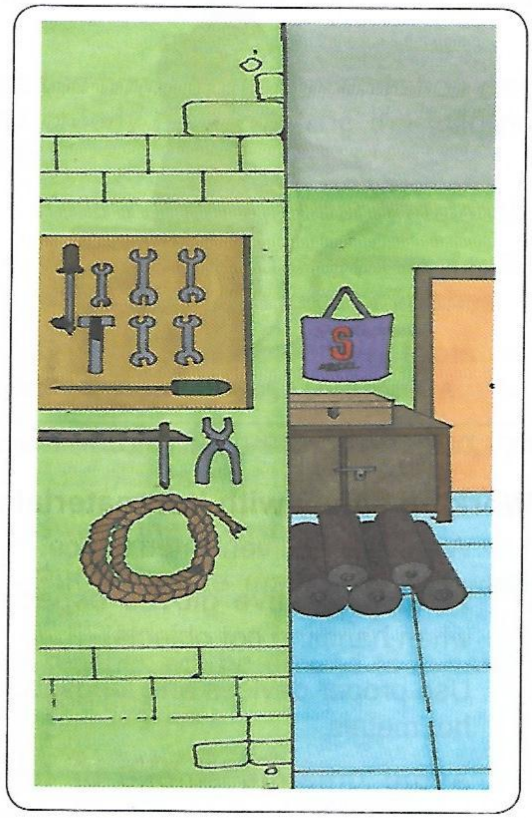


Fig. 2.10 Work piece properly clamped

Working safely with electrical tools, machines and appliances

You should observe the following safety rules when working with electrical tools, machines and appliances.

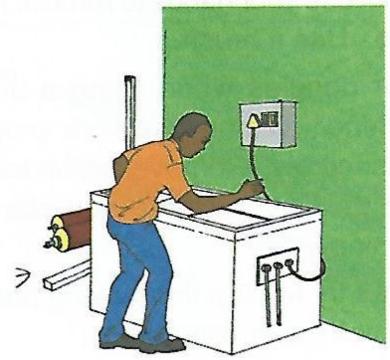
1 Be careful not to contact any live (naked) wire or terminal.

2 Keep in mind always that it is possible to experience a surprising electric shock.

3 Know the locations of the emergency stop switches.

4 Do not lean on electrical machines and appliances.

a) A person using a power tool with a good cable.



b) Do not lean on electrical machines.

Fig. 2.11 Safety in the use of electrical machines

Working safely with hot materials

1 Work in a well ventilated space.

2 Wear protective gloves especially when handling hot objects.

3 Use proper devices and tongs to hold hot metals.

4 Avoid inhaling smoke or fumes produced by heat.

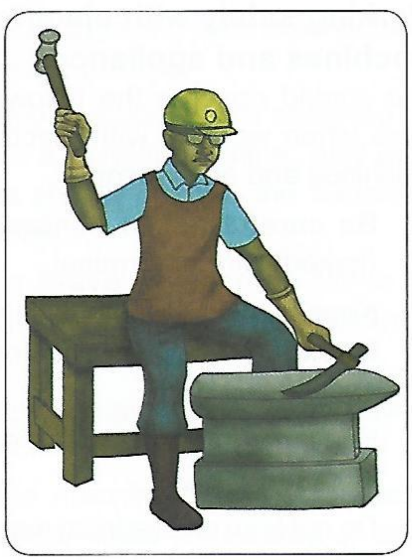


Fig. 2.12 How to work safely with hot materials

Keeping the workshop clean and tidy

The cleanliness of the workshop environment is as important as your personal cleanliness. If the floor of the workshop is wet, you may fall and break your leg or arm. You should observe the following rules on how to keep the workshop clean and orderly.

1 Do not leave tools or materials scattered all over the workshop.

2 Keep the passage clear and free.

3 Keep the floor clean and dry at all times.

4 Always keep your work bench, tools and machines clean.

5 Sweep the floor and put wood shavings, saw dust and metal scraps in the waste bins.

6 Return hand tools to their shelves or cupboards after use.

7 Always place inflammable materials such as solvents, lacquers and paint thinners in a metal cabinet away from open flames.

8 Clean up your work area at the end of the workshop activity.

9 Close lockers, drawers and doors after work.

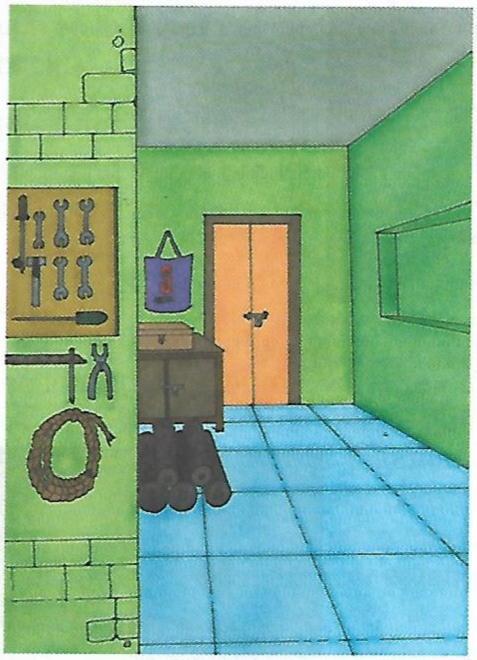


Fig. 2.13 A clean and tidy workshop

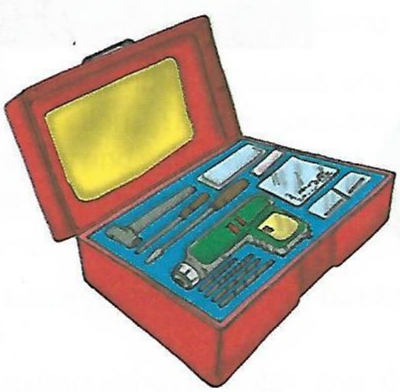


Fig. 2.14 Well arranged tools

Activity 2:2 Keeping workshop clean and tidy

Practise how to keep the workshop clean and orderly by performing the following tasks:

1 Keep the passage clear of materials.

2 Wipe the floor and keep it free of spilled water, oil, grease, glue or finishes.

3 Clean the workbench, tools and machines after use.

4 Keep all tools and materials in their right places after use.

5 Sweep the workshop.

6 Put all waste materials in a waste bin.

Your teacher will be around to supervise what you do.

2.3 Safety devices

We shall learn simple and common safety devices. Some of these devices are used to protect human beings while others are used to protect material things such as buildings, equipment and machines. The following are some safety devices found in workshops:

1 Overalls or apron

2 Goggles and visors

3 Gloves

4 Shoes

5 Fire extinguishers

6 Water-hoses and water

7 Fire alarm

8 Sand bucket and sand

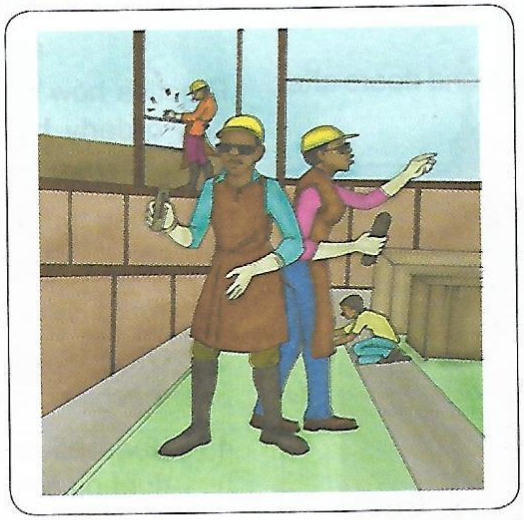


Fig 2.15 Dressing well for practical work

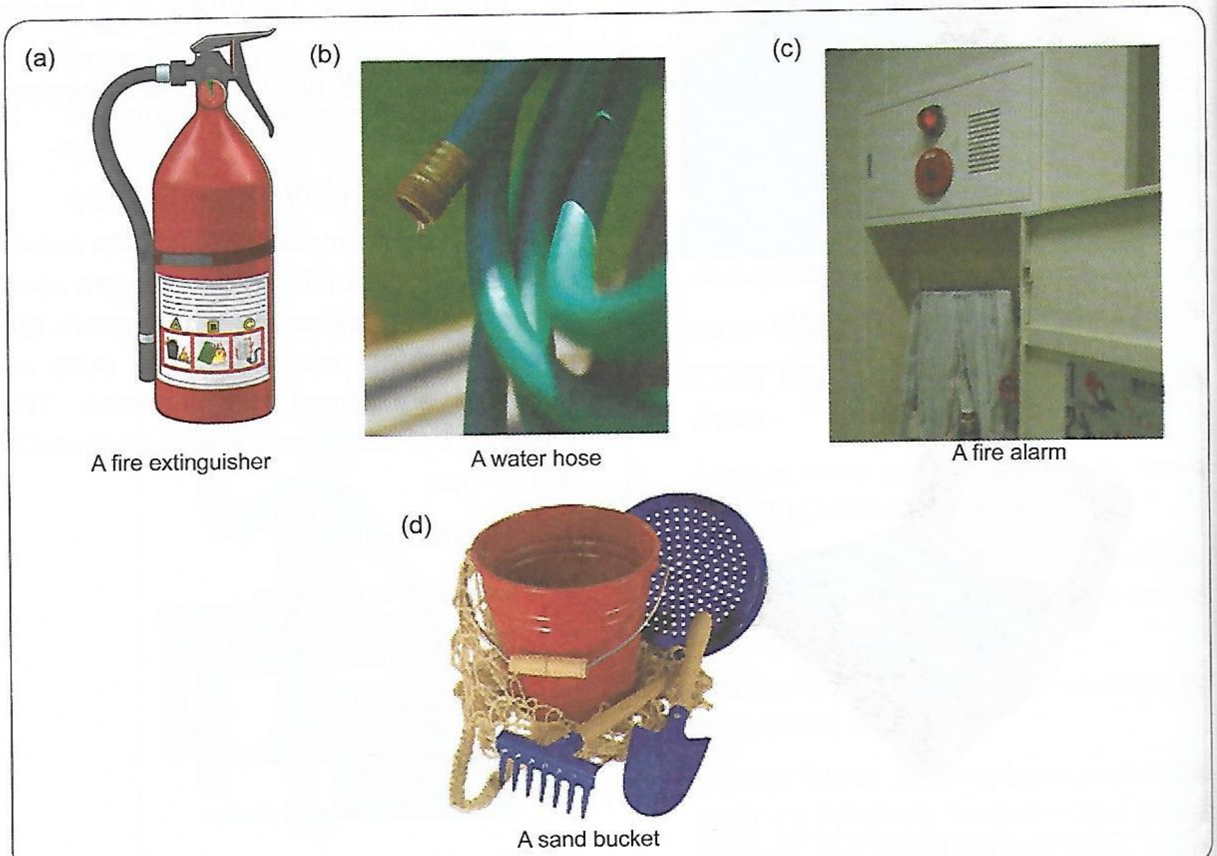


Fig. 2.16 Safety devices

Aprons/Overalls

An apron/overall is for protecting clothes from dirt. It should not be used to wipe dirty hands or sweat. You should wear a clean apron or overall at all times.

Apron strings should be strong and long enough so that they can be tied properly at the back.

Goggles and visors

Goggles and visors are for eye protection against metallic objects, high intensity light, fluid and dust.

Gloves

Gloves are generally used for hand protection against burns, cuts, electric shock and skin contamination due to corrosive substances. It is important to stress that one must be very careful in wearing gloves around a rotating machine because they may be caught, or entangled in the parts of the machine.

Shoes

Some injuries, which may occur are piercing of the feet by broken glass or sharp objects and crushing of the foot by falling objects.

Special workshop shoes are used for foot protection. These shoes are made of thick soles and some with metal caps so as to give protection to the foot.

Fire extinguishers, sand buckets and sand

Fire extinguishers, water and dry sand are fire fighting equipment and materials used to control fire outbreak. They should be kept at strategic locations where they can be easily accessed. Your teacher must teach you how you can use these equipment to fight fire outbreak.

2.4 Types of fire

There are basically two types of fire which can occur in a workshop. These are:

1 electrical fire

2 chemical fire

An electrical fire may result from sparks due to short circuit or partial contact. It can also occur as a result of poor wiring, wrong electrical connections and overloading. Fire can equally be caused when electrical appliances are not switched off after use.

Whenever there is an electrical fire, the first thing to do is to switch off the control switch and notify every worker in the workshop by setting off the fire alarm.

A chemical fire is caused by chemical substances used or stored in the workshop. Examples of chemical substances are gas, oil and grease. These substances must be handled with care and they should be properly stored.

Fire extinguishers, water and dry sand are used to control fire in workshops. You should also note that it is wrong to try to use water to put out fire caused by chemicals. The best things to use to put out a chemical fire are dry sand and foam or gas from a fire extinguisher.

You must have noticed posters placed in buildings captioned: **SWITCH OFF ALL ELECTRICAL APPLIANCES AFTER USE.** This is to avoid an electrical fire.

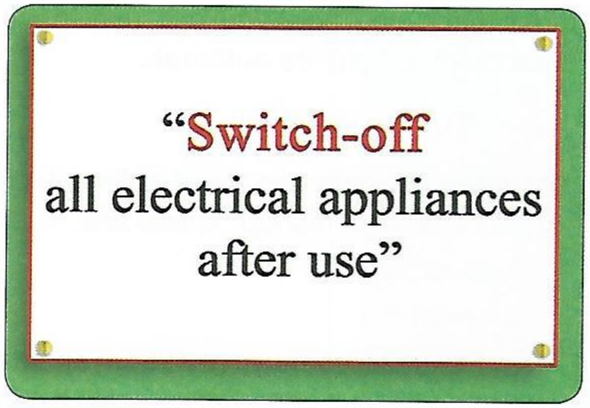


Fig. 2.17 A safety instruction on a notice board

Activity 2.3 : A visit to a fire station

1 Visit a fire station in your location.

2 Examine the fire-fighting equipment and make a sketch of some of the equipment.

3 Watch fire-fighters demonstrate fire fighting.

4 Ask questions on the types of fire and types of equipment used to fight them.

5 Report and submit your sketches to your teacher.

Summary

In this chapter, you should have learnt that:

1 Accidents in a workshop are caused by unsafe actions and unsafe conditions.

2 Accidents in the workshop can be prevented by

a) observing safety rules and regulations;

b) wearing proper clothes;

c) using hand tools, machines, and appliances properly.

d) working safely with hot materials;

e) keeping the workshop clean and tidy.

3 Gloves, shoes, overalls and aprons; goggles and visors, fire extinguishers, sand and sand buckets, etc. are safety devices.

4 There are two types of fire, namely: **electrical fire** and **chemical fire**. Electrical fire is fought with fire extinguishers, water and dry sand. Chemical fire is fought with foam, dry sand or gas from a fire extinguisher.

Exercise

1 List five safety rules which must be applied in a basic technology workshop.

2 How can we prevent accidents in a workshop?

3 List three unsafe acts which can cause accidents in a workshop.

4 List three unsafe conditions which can cause accidents in a workshop.

5 State five safety measures you should observe when using a machine.

6 State five safety measures you should observe when using a hand tool.

7 You are expected to dress properly before you carry out practical activities. List five things you must do to be regarded as having dressed properly.

8 Name three types of fire fighting materials and equipment.

9 Why is it important that a student in a

workshop should keep himself clean and neat?

10 Why should sleeves be rolled up above the elbows when in the workshop?

11 How can you keep long hair from getting caught in a machine?

12 List three most common foot injuries that could occur in a workshop.

Fill in the gaps

13 Accidents may occur as a result of ________ and ________________

14 Goggles and visors protect the ________________ against injury ________________

15 Aprons and overalls protect the ________________ from________

16 Gloves protect the ________________ against injury.

17 Gloves protect the ________________ against ________________, ________________, ________________ and ________________.

18 Shoes protect the ________________ against injury.

19 We use ________________, ________________ and ________________ to put out fire in the workshop.

Chapter 3

Wood and metals

Introduction

In your homes, you will notice that many household items are made from wood, metal, glass, plastic and clay. Items, such as tables, buckets, bowls, plates, chairs, etc. are made from different materials. It is important that, at this point in your basic technology study, you learn about how to identify and classify these materials. You will also learn about their properties. Knowledge of the properties of the materials will help you to choose the right materials for the right job during your project activities.

In this chapter, you will learn more about wood and metal.

Objectives

At the end of this chapter, you should be able to:

1 identify, classify and describe the properties of wood;

2 identify, classify and describe the properties of metals.

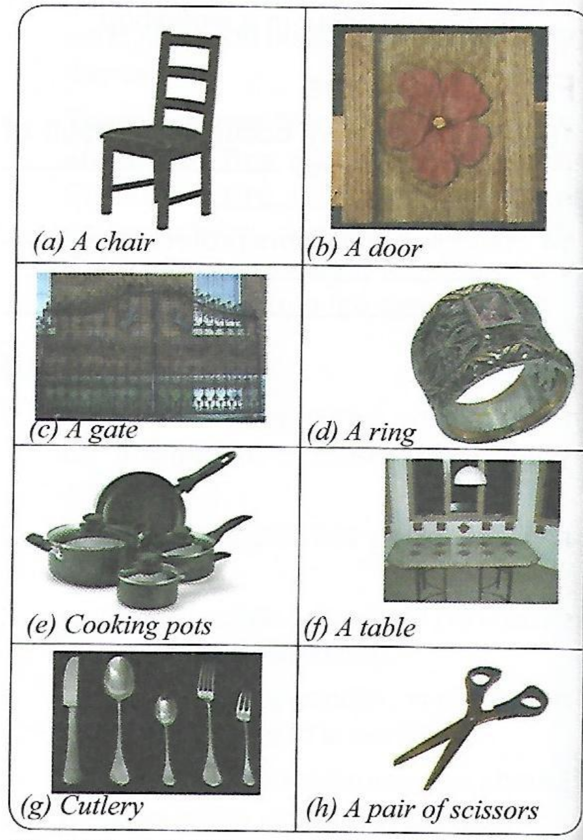


Fig. 3.1 Household items made from wood and metals

3.1 Wood

Wood is one of the earliest materials used by man. The early man used wood to build houses, make fire and make tools for farming and hunting. Today, we still use wood to build houses, bridges, ships, as well as make fire for cooking.

The wood that is used for making things

comes from trees. Trees usually grow in the forest. To obtain wood from a tree, the fully grown tree is first cut down. The next stage is cutting off the branches. The trees are cut into logs.

Huge saws are used to cut the logs into planks of different sizes. In Nigeria, the cutting of the logs into planks can take place inside the forest where the trees are felled or in sawmills.

Fig. 3.2 How wood is produced from trees

You will learn about timber growth, felling, conversion and seasoning in Book three.

Identification of materials

This is the process of recognising a class of material from another class of the same material and or a material from other materials. You can identify wood, metal, plastic, rubber and ceramics on their physical properties.

Identification of wood

It is important that you are able to identify wood from other materials, and one type of wood from another type. We use colour, appearance, weight, hardness, leaves and seeds of trees to identify wood.

There are two types of wood, namely hardwood and softwood. Examples of hard wood are mahogany, afara, obeche, opepe, mansonia, abura, oak and iroko.

Pine, cedar, semidoloro, fir and spruce are examples of soft wood. You will learn about their uses in Book 2.

Fig. 3.3 A hardwood tree

Fig. 3.4 A soft wood tree

Properties of hardwood

Hardwood has the following properties:

1 It is dark in colour.
2 It has a complex cellular structure.
3 It is heavy.
4 It has annual rings, which are not visible.
5 Hardwood trees have broad leaves, which are shed at a particular time of the year.
6 The seeds of hardwood trees are enclosed in a pod.

Properties of softwood

Softwood has the following properties:

1 It has lighter colour than hardwood.
2 It is not heavy.
3 It is easy to work on.
4 Trees of softwood have narrow and needle like leaves.
5 Trees of softwood produce naked seeds, that is, the seeds are not in a pod.
6 Softwood trees are usually evergreen.

Activity 3.1 Identification and classification of wood by name and colour

1 Visit a timber shade or yard where various wood like mahogany, opepe, abura, iroko, black and white afara, and pine are staked.
2 Examine displayed specimens of various wood types.
3 Ask for the names of all the displayed wood.
4 Note the colours of the various types of wood.
5 Write down the names and colours of the various types of wood you identified.
6 Classify the displayed wood under hardwood and softwood.

Activity 3.2 Differentiating between hardwood and softwood

Obtain specimens of hardwood and softwood measuring 60 cm square each. Label the hardwood A and the softwood B.

1 Lift each piece of wood. Which of them is lighter?
2 Use a sharp knife or a divider to scratch the faces of the piece of wood. Note the depth of penetration into each piece of wood.
3 Use a saw to cut a small piece of each piece of wood. Record your observations.

4 Use a small hammer to drive a nail into each type of wood. What are your overall findings? What conclusion will you draw on the two types of wood?

3.2 Metals

Metals are natural materials found in rocks. Rocks which contain metals are called **ores**. An ore is made up of metal and some non-metal compounds called **gangue**. We can find different metals in different types of ores.

There are various methods by which we can extract metals from their ores. Fig. 3.5 shows how pure iron is extracted from its ore.

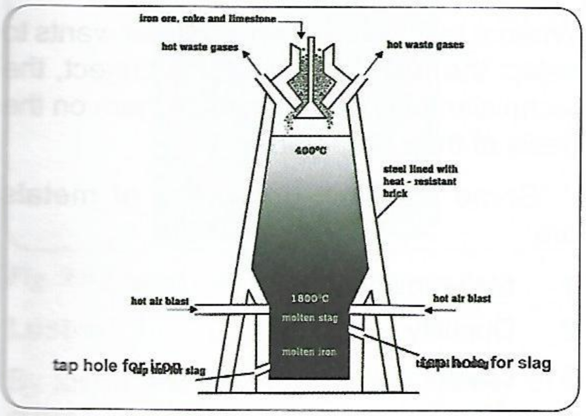


Fig. 3.5 A blast furnace for the extraction of iron

A detailed explanation of how metals are extracted from their ores will be treated in year three. At this level, you are expected to be able to identify and classify metals, as well as know their properties and forms.

Identification of metals

Metals can be identified by their physical properties. For example, metals do not break when they are pressed, hammered or rolled into sheets whereas other materials like wood, ceramics and plastics will break. Another way to identify metals from other materials is that most metals are heavier than other materials such as wood, plastic and rubber. However, it is important to know that some ceramics are heavier than the light metals such as magnesium. When you polish metals, their surfaces shine very well, while other materials are not as shiny as metals when polished. Metals can further be identified from other materials because metals are good conductors of electricity and heat; whereas wood, ceramics, plastic and rubber are poor conductors.

Metals can be grouped into two main classes namely **ferrous** and **non-ferrous** metals. Ferrous metals can be identified with magnets because they are attracted to magnets. Non-ferrous metals are not usually attracted by magnets. Ferrous metals will rust when exposed to air and water; whereas, non-ferrous metals will not rust.

You should know that wrought iron is the purest form of iron in commercial use. It contains only about 0.04% carbon. We sometimes say that wrought iron contains no carbon. Examples of ferrous metals therefore are iron, cast iron, pig iron, wrought iron, steel, mild steel and tool steel.

Ferrous metals are said to be magnetic substances because they are attracted by magnets.

Metals are used in industries and construction work. For example, mild steel is used for making car bodies, gates, cabinets and metal containers, while many tools are made from tool steel. We use wrought iron for work which needs much hammering, bending, twisting and stretching, such as wire, nails, chains and links.

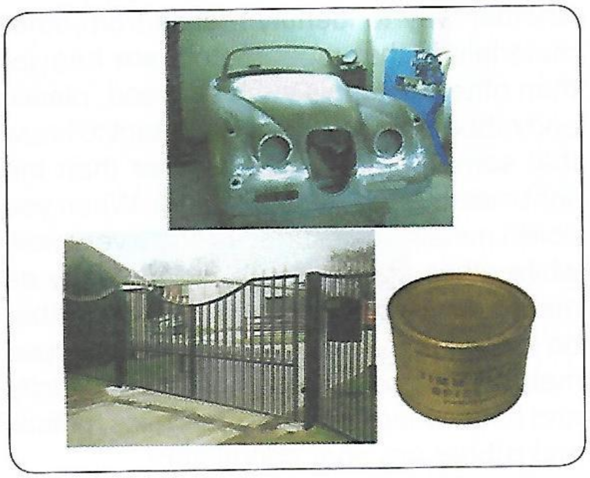


Fig. 3.6 Materials made of mild steel

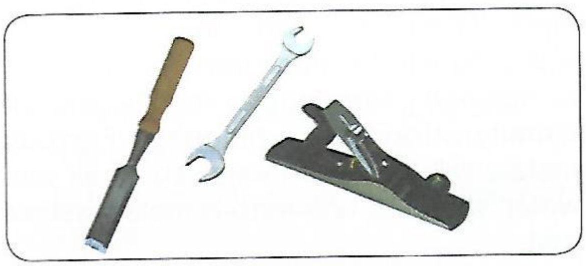


Fig. 3.7 Tools made of tool steel

Non-ferrous metals are those which have some metal or metals other than iron, as their main component. Such metals are not magnetic.

Examples of non-ferrous metals are aluminium, copper, lead, tin, zinc, brass, gold, silver, bronze, magnesium and nickel.

Activity 3.3 Identification and classification of ferrous and non-ferrous materials

1 Collect some pieces of metals such as iron, mild steel, tool steel, aluminium, copper, and brass. Your teacher will provide you with a magnet.

2 Try to use the magnet to lift or attract each piece of metal.

3 Record your observation.

4 Group and label those pieces of metals you were able to lift or attract with the magnet as ferrous metals.

5 Group and label those pieces of metals you could not lift or attract with the magnet as non-ferrous metals.

6 Notice that all the metals can be classified under two groups.

Properties of metals

When a technician or an engineer wants to select the metals to use for a project, the technician or engineer selects them on the basis of their properties.

Some common properties of metals are:

1 Malleability
2 Ductility
3 Lustre
4 Sonorous sound
5 High relative density
6 Toughness
7 Hardness
8 Brittleness
9 Conductivity of heat and electricity

Malleability

Metals are malleable. This means they do not break when they are pressed, hammered or rolled into sheets. Such metals are copper, tin and aluminium etc.

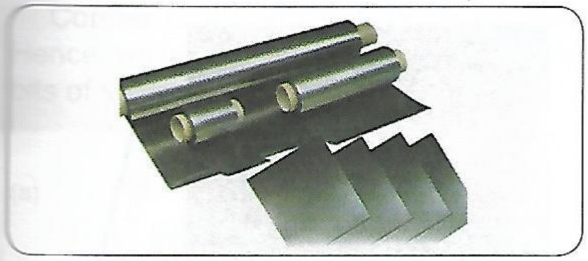


Fig. 3.8 Rolls and sheets of a metal

Ductility

Some metals can be stretched into thin wires. Such metals are said to be ductile. Examples are aluminium and copper.

Fig. 3.9 Copper wire

Lustre

By lustre we mean the shiny quality of a surface. Metals have very good shiny quality. This quality makes metals special in a way that they are exciting. Examples of metals with such a quality are copper, tin, gold and aluminium.

Fig. 3.10 Things produced from shiny metals

Sound

Metals give a sonorous sound when struck. Other materials like wood, glass, plastic and rubber do not give such a sound. By sonorous we mean that metals have a pleasant full deep sound.

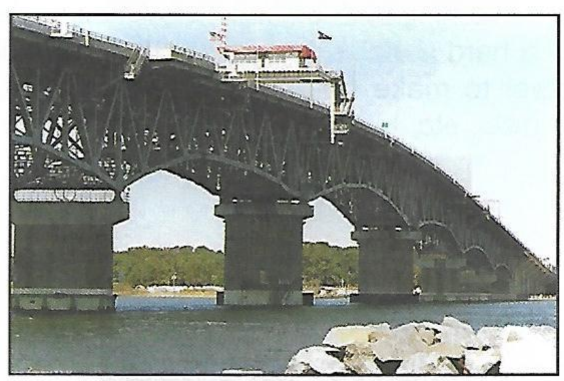
Density

Density refers to the weight of the metal. Most metals are heavier than other materials such as wood, plastic and rubber of the same size and dimensions.

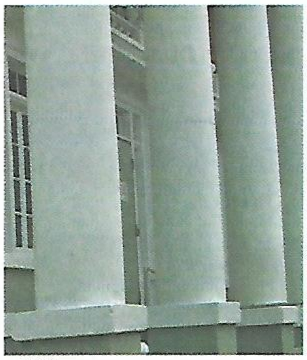
It is also important to note that some materials like glass and refractory bricks, are heavier than some very light metals such as magnesium. Steel is nearly three times as dense as aluminium. Hence, steel is also nearly three times as heavy as aluminium of the same volume.

Toughness

Toughness of metal refers to the ability to withstand physical shock or bending without breaking. An example of a tough metal is steel used for building houses and for casting beams and pillars in buildings.



(a) A bridge



(b) Beams/Pillars

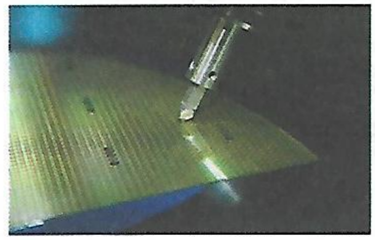
(c) Rods made of steel

Fig 3.11 Uses of steel

Hardness

This means resistance to penetration. Metals which are hard can withstand cutting or scratching by another metal. An example of a hard metal is tool steel. We use tool steel to make hammer heads, scribers, chisels, etc.

(a)



(a)

(b)

Fig. 3.12 Some hard tools

Brittleness

Some metals can easily break or crack when they are mistakenly dropped or struck. Such metals are said to be brittle. Cast iron is a good example of a brittle metal. We use cast iron to make major parts of a bench vice and surface plate

(a)

(b)

Fig. 3.13 Things made of cast iron

Conductivity

This is a property that allows heat or electricity to pass through a material easily. Aluminium is a very good conductor of electricity. This is one of the reasons why we use aluminium in making electricity wires (cables).

Copper is a good conductor of heat. Hence, we use copper in making soldering bits of soldering irons.

(a)

An aluminium pot

(b)

Copper wire

Fig. 3.14 Aluminium and copper materials are good conductors of heat

Corrosion of metals

By corrosion, we mean ability to destroy slowly especially as a result of chemical action. When a metal wears slowly through the action of chemicals or rusting, this is called corrosion. Iron and steel corrode easily, while bronze and tin do not corrode easily. Bronze and tin are thus, referred to as metals that are resistant to corrosion. Because of this good quality, tin is commonly used for coating food containers such as milk cans, while bronze is used for making outdoor sculpture.

Fig. 3.15 Food containers coated with tin

Fig. 3.16 Sculpture made of bronze

Metal forms

Metals come in different shapes and sizes. They can be in form of rods, bars, pipes, plates, sheets, wires, etc

Fig 3.17 shows common forms in which metals are produced.

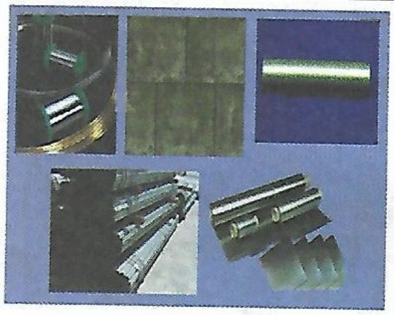


Fig. 3.17 Common forms in which metals and alloys are available commercially

Summary

In this chapter, you should have learnt that:

1. Wood and metals are the commonest and the most widely used materials for producing household items and for construction work.
2. Wood is classified under two groups: hardwood and softwood. Examples of hardwood are mahogany, afara and iroko while examples of softwood are pine, cedar and fir.
3. Softwood trees have needle-like leaves and naked seeds.
4. You can differentiate between hardwood and softwood by comparing their weights, appearances of their leaves and seed cases and ease of penetration of sharp objects through them.
5. Metals are classified into two main groups, ferrous and non-ferrous metals.
6. Ferrous metals contain iron and are magnetic. Examples of ferrous metals are cast iron, wrought iron, steel and alloy steel.
7. Non-ferrous metals do not contain iron, and are not attracted by magnets. Examples are copper, nickel, aluminium, tin and gold brass.
8. Metals are malleable, ductile, lustrous, brittle and good conductors of electricity. Some metals are better than others in the exhibition of these properties and for some uses. Knowledge of these properties assists engineers and technicians to choose correct materials for their work.
9. Metals are found or produced in the following forms: rods, bars, plates, wire, etc.

Exercise

1. Name the **two** classes of wood.
2. List the properties of hardwood and softwood.
3. Name **three** examples each of hardwood and softwood.
4. List **five** uses of wood.
5. Define ferrous and non-ferrous metals.
6. List **four** examples each of the two types of metals.
7. Explain the term wrought iron.
8. What does 'malleable' mean?
9. For what is malleable iron used?

10 Name **five** forms of metals.

11 State **five** properties of metals that a worker can use for identifying them.

12 How can you compare the density of given metals?

13 Ferrous metals contain iron and can be attracted by magnets. True or False?

14 Non-ferrous metals do not contain iron, and are attracted by magnets. True or False.

15 Trees with broad leaves are called deciduous trees, while those with needle-like leaves are called coniferous trees. True or False?

Chapter 4

Ceramics, plastics and rubber

Introduction

Man is always in search of new materials and new ways of making things. The previous chapter teaches the properties of wood and metals. You must have realised that wood does not last very long because of certain properties, and that some metals rust easily when in contact with water or chemicals.

In this chapter, you will learn about ceramics, glass, plastics and rubber materials.

Objectives

At the end of this chapter, you should be able to:

1 identify the properties of ceramics and glass;

2 state the uses of ceramics and glass;

3 identify the properties of plastics and rubber; and

4 state the uses of plastics and rubber.

4.1 Identification of ceramics, plastics and rubber

You can identify materials through their properties. Ceramics break easily when dropped or hit on something. Other materials like wood, metal, plastic and rubber do not. Ceramics are also resistant to high temperature.

Plastics are lighter than other materials, like wood, metal and ceramics. Another good quality of plastics is that they do not rust like metal.

Rubber is more elastic than other materials. This property easily distinguished rubber from wood, metal, ceramics and plastic.

4.2 Ceramics

Ceramics is a material made of clay and cement that has been made permanently hard by heat.

Properties of ceramics

Ceramics are

1 heat-resistant (they do not allow heat to pass through easily);

2 brittle (they break easily);

3 heavy; and

4 resistant to corrosion (they do not rust).

Ceramics are used in producing things and these properties are applied to advantage in the process. We therefore use ceramics in making the following:

1 bakery ovens

2 furnace

3 bricks

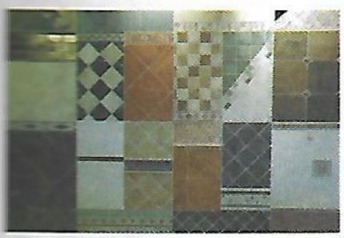
4 tiles

5 tea cups, plates and flower vases

6 sculpture

7 electric plugs

8 sink units
9 wash basins
10 toilet



(a) Tiles

(b) A cup

(c) A bath tub

(d) A toilet

Fig. 4.1 Products of ceramics

Activity 4.1 Examination and identification of various types of ceramic products

1 Display a piece of clay brick, floor tile and broken wash basin on a table.
2 Examine each of the materials.
3 Sketch and name the various materials.
4 Lift each material with one hand.
5 Gently hit each material with a hammer.

How do the four types of ceramics compare in weight, resistance to heat penetration, strength and hardness?

4.3 Glass

Glass is a type of ceramics. Glass is a hard, usually transparent material made from sand, lime, potash, soda and lead oxide. To produce glass, these raw materials are mixed and placed in a furnace and melted. It is then formed into the desired objects and shapes.

Properties of glass

Glass has many properties. It is

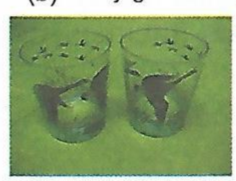
1 brittle,
2 transparent and
3 resistant to corrosion.

Manufacturers take advantage of these properties of glass when they produce certain items. Examples of glass products are cups, bottles, mirrors, glass tubes, electric bulbs, glass windows, glass doors, eye glasses and lenses.

(a) A door

(b) A jug

(c) A bottle



(d) Cups

Fig. 4.2 Materials made of glass

Activity 4.2 Identification of products of glass

1 Display a tumbler, mug, bottle, flower vase and a piece of broken window glass on a table.

2 Examine each of the products.
3 Try to look through each product. Record your observations.
4 Pour water inside or on each product and leave them for three days. Look through them. Also, record whether the objects have started to rust or corrode.
5 Gently heat each product with a small metal object. Note whether there is a crack in any of the products.

How do the types of glass products compare in transparency, resistance to corrosion and brittleness?

4.4 Plastics

Plastics are made from chemicals we get from crude oil. We get different types of plastics by mixing these chemicals in different ways.

Plastics can be divided into two main groups: **thermoplastics** and **thermosets**. Thermoplastics become soft and melt when heated. They can then be formed into desired shapes. The plastics harden when cooled. The heating and cooling can be done over and over again. Examples of thermoplastics are nylon, polythene, polyethylene and polyvinyl chloride (PVC).

Thermosets (thermosetting) only char at high temperature but do not melt. Once the material softens on heating, it can be moulded. Thermosets can be moulded only once. Examples are: phenol formaldehyde, polyester resin, epoxy resin and bakelite.

Properties of plastics

Plastics are:

1 resistant to corrosion
2 elastic
3 flexible
4 light
5 transparent
6 attractive and easy to clean
7 resistant to electricity and
8 can take complex shapes

Fig. 4.3 Things made of plastics

Applications of properties of plastics

Plastics are now being used to manufacture items used in the home because of their properties. Plastics are used at home as:

- kitchen utensils
- basins
- screw tops of bottles
- insulation
- plumbing
- packaging materials
- carrier bags

Engineers also use plastics to manufacture some car parts such as:

- switches
- upholstery fabric
- wire coating
- carpets
- bumpers

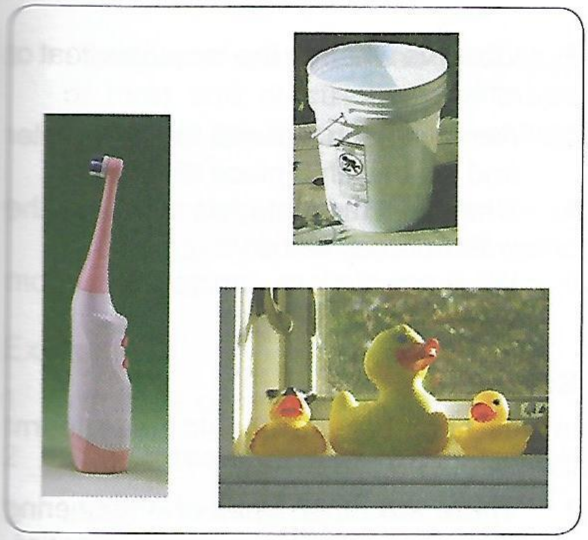


Fig. 4.4 Plastic products

Activity 4.3 Demonstrating the effect of pressure and heat on plastics

1 Place small sheets of nylon, polyvinyl chloride (PVC), polyethylene and polyester resin on a table.

2 Put each of them in a burner for a maximum of 10 minutes and record your observations.

3 Observe what happens to the nylon. Does it burn easily?

4 Record the colour of the flame and the smell of the materials.

5 Use a hammer to hit each of the sheets.

6 Record the effects of heat and pressure on the plastic materials.

4.5 Rubber

Rubber is a material which can be compressed or stretched. You must have observed that a compressed or stretched piece or strip of rubber returns to its original size when you remove the applied force on it. The main reason for this is that rubber is more elastic than other engineering materials.

There are two types of rubber, namely **natural rubber** and **synthetic rubber**. In Nigeria, natural rubber is made from the milky white liquid of rubber trees called **latex**. Synthetic rubber is made from petroleum. Synthetic rubber is also known as **elastomer**.

Properties of rubber

Rubber is

1 elastic

2 water resistant

3 light and will float when put in water

4 a poor conductor of electricity.

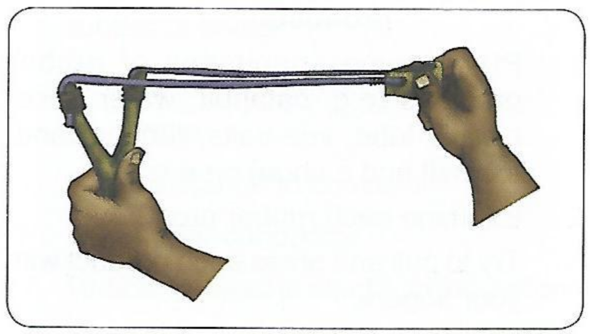


Fig. 4.5 A catapult

Products made from rubber are found in our homes and they vary. These include the following

- football
- shoe heels and soles
- tyres
- vee-belts
- water hoses
- shock-dampers and engine mountings.

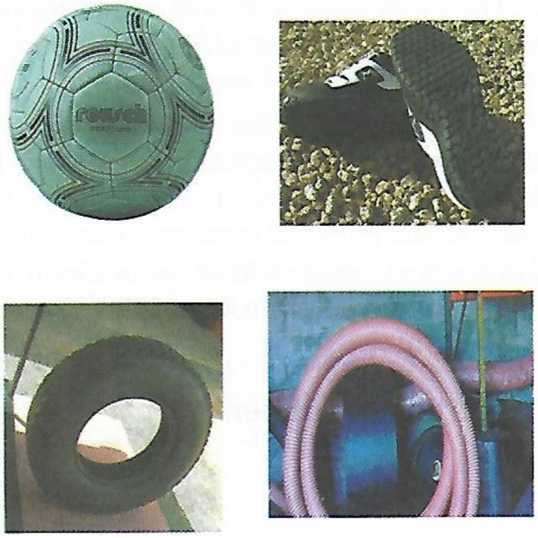


Fig. 4.6 Products of rubber

Activity 4.4 Using specimens of rubber products

1 Place some specimens of rubber products (e.g. catapult, water hose, bicycle tube, vee-belts, rubber band, football and a shoe) on a table.
2 Examine each rubber product.
3 Try to pull and press each product with your fingers.
4 Record your observations

What are the similarities and differences between the various rubber products you examined and used?

Activity 4.5 Demonstrating the effects of water on plastic and rubber

1 Pour some water in a bucket or basin.
2 Drop some pieces of plastic and rubber materials inside the water.
3 Observe whether the materials float or sink.
4 Remove each material from the water and clean with a piece of cloth.
5 Observe if the materials still retain the water or they are dry.
6 What conclusions can you draw from your findings?

Summary

In this chapter, you should have learnt that:

1 There are other types of engineering materials namely ceramics, plastics, glass and rubber.
2 Solid objects or shapes made from clay and cement through heat treatment are called ceramics.
3 Ceramics resist heat and are therefore used to produce things that may need very high melting points (high temperatures).
4 Glass is made from sand, lime, potash, soda and lead oxide. These materials are put in a furnace, melted and formed into the desired objects or shapes.
5 Ceramics and glass break easily if dropped or hit on something because they are brittle.
6 There are two types of plastics, namely thermoplastics and thermosets. Many plastics are made from chemicals that we get from crude oil.
7 There are two types of rubber. They are natural rubber and synthetic rubber. While natural rubber is made from the milky-white liquid of rubber trees, (latex), synthetic rubber is produced from petroleum.

8 Plastics and rubber are bad conductors of heat and electricity, and these properties are used to the advantage of mankind.

9 Many products are now made of plastics and rubber instead of wood and metals .

Exercise

1 What are ceramics and glass?

2 State **three** properties of ceramics.

3 List **five** uses of ceramics.

4 State **three** properties of glass.

5 List **five** uses of glass.

6 Name the **two** types of plastics and distinguish between them.

7 List **five** plastic products in everyday use.

8 Working in a chemical or damp environment does not affect plastics. True or False?

9 Plastics can take a range of forms. True or False?

10 Explain the terms **natural rubber** and **synthetic rubber**.

11 Name five uses of rubber in engineering applications.

12 Which of the following **is not** used in making glass?

A Sand B Lime
C Potash D Clay

13 Glass is used to manufacture eye glasses and lenses because of this property. Choose from the options.

A Brittleness
B Resistance to corrosion
C Transparency
D Resistance to heat

14 Which of the following is not used in making ceramics?

A Lime B Clay
C Cement D Mud

15 The following are products of ceramics, except

A flower vase
B tiles
C wash basin
D electric bulb

16 A major property which distinguishes ceramics from wood, metal, plastic and rubber is being

A a good conductor
B brittle
C resistance to corrosion
D a poor conductor

17 Rubber is used in electrical insulations because it is a poor conductor of electricity. True or False?

18 Rubber is used for water proofing because it is water resistant. True or False?

19 Synthetic rubber is obtained from

A ore B plants
C petroleum D palm oil

Chapter 5

Drawing instruments and materials

Introduction

Technical drawing is a language used by technical men and women to communicate. Generally speaking, people communicate through written or spoken words. However, in engineering it is not always possible to pass enough accurate information using spoken or written words, because certain technical details are difficult to express in written or spoken words. For instance, to describe technological products like radios, television sets, motor cars and aeroplanes will be tedious. This is because these products were conceived in the mind of engineers before they were manufactured and cannot be described accurately except by representing them on a paper. It is the representation of these ideas/products on paper that is called technical drawing. For example the simple bolt (Fig. 5.1) will be difficult to describe accurately in words for it to be produced, but this is easy using technical drawing. Once a careful technical drawing of the object is made, an identical bolt can be produced in the workshop.

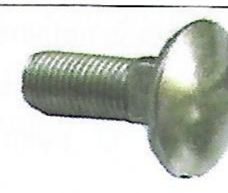


Fig. 5.1 A bolt

Objectives

At the end of this chapter you should be able to:

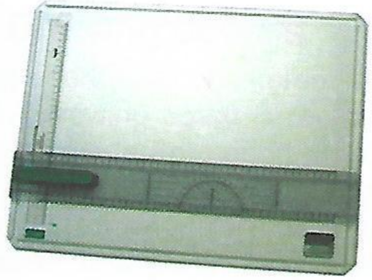
1 define technical drawing accurately;
2 identify drawing instruments and materials;
3 use the instruments to draw; and
4 state necessary precautions in the use, care and storage of drawing instruments and materials.

5.1 Drawing instruments and materials

There are specialised instruments used in technical drawing. These are

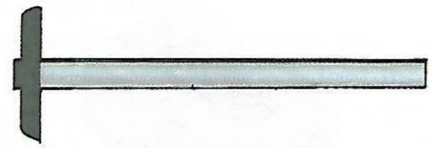
1 drawing boards
2 tee-squares
3 setsquares (45°, 60°/30°)
4 pairs of compasses
5 pairs of dividers
6 protractors
7 rulers
8 french curves or flexible curves
9 stencils
10 sharpeners
11 drawing paper
12 erasers
13 masking tape/draughting or sellotape
14 clips
15 pins
16 pencils
17 erasing shields

(a)



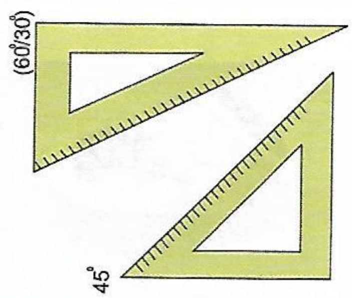
A drawing board

(b)



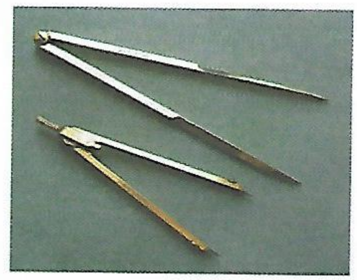
A tee square

(c)



Setsquares

(d)

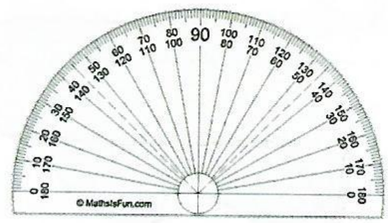


Two pairs of dividers

(e)

relur A

(f)

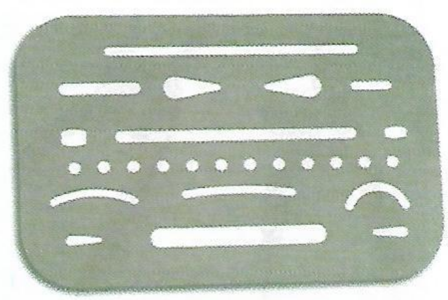


rotcartorp A

(g)

French curves

(h)



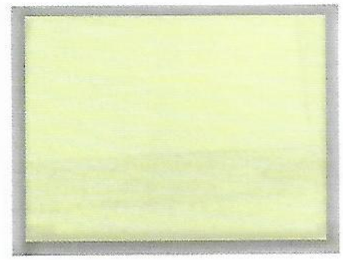
Stencils

Fig. 5.2 Drawing instruments

(i)

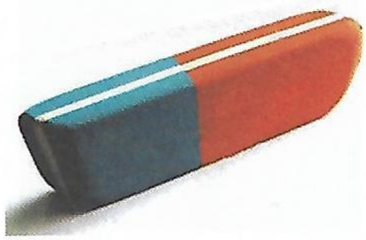
A sharpener

(j)



Drawing paper

(k)

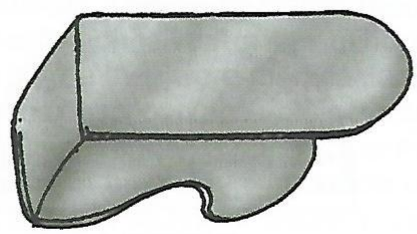


An eraser

(l)

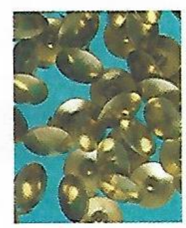
Masking tape

(m)



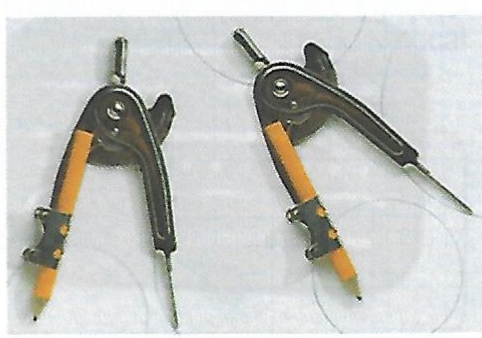
A clip

(n)



Pins

(o)



Compasses

(p)

A pencil

Fig. 5.2 Drawing instruments

5.2 Drawing boards

Drawing boards are of different sizes and types. A drawing board is rectangular in shape and made from good quality wood with a smooth, flat surface. Sometimes it is made from non-ferrous metal, like aluminium. It is on drawing boards that we place drawing papers. The left edge is used to guide the tee-square, as illustrated in Fig. 5.3.

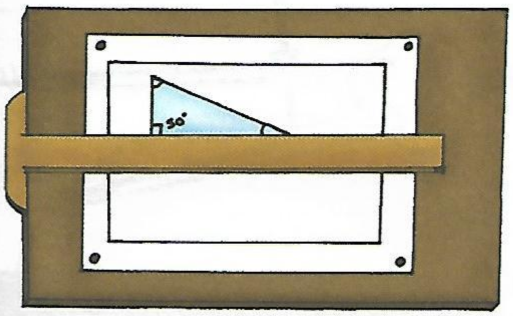


Fig. 5.3 A drawing board with a tee square

Some drawing boards carry metal or ebony strips fitted to the left and right edges which perform three functions. The functions are :

1 they protect the wooden edges;

2 they provide a perfect straight edge to guide the tee-square;

3 they make sliding movement of the tee-square against the edge easy.

Drawing boards are commonly found in five standard sizes of A0, A1, A2, A3, A4. Size A1 with dimensions 420 mm x 594 mm is appropriate for the use of students in junior secondary schools.

5.3 The tee square

The tee square is a T-shaped instrument, usually made of wood or Perspex. It has two parts – the stock and the blade. The blade is fixed at 90° to the stock. See Fig. 5.4(a). The tee square is always used with the drawing board.

The blade is a straight edge and is placed on the drawing board such that the stock presses firmly against the left edge while the blade is used to draw lines that are at 90° to the left edge of the drawing board as in Fig 5.4(b).

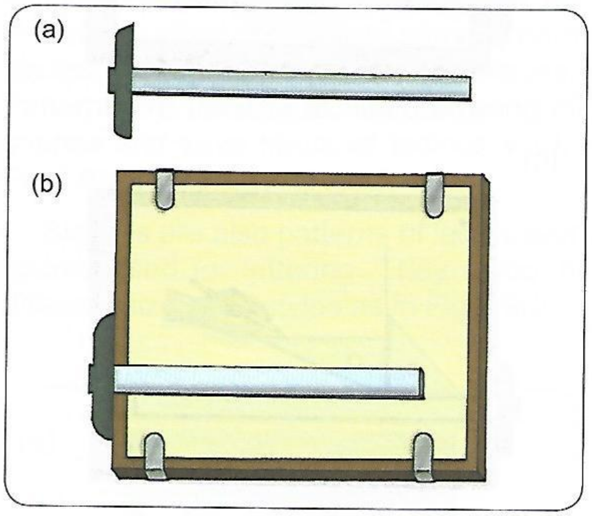
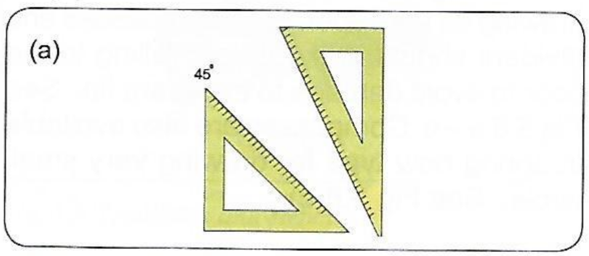


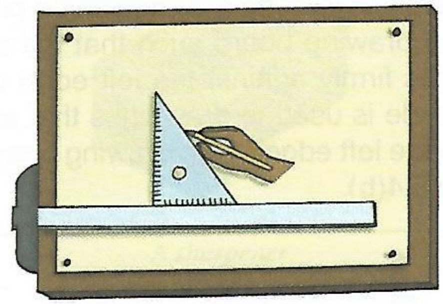
Fig. 5.4 The tee square is always used with the drawing board

5.4 Setsquares

Setsquares are right-angled triangular flat drawing instruments usually made of transparent material. They are available in two types, 45° and 60°/30°. See Fig 5.5(a). In conjunction with the tee square, they are used to draw inclined lines to vertical or horizontal directional lines as in Fig. 5.5(b).



(b)



(c)

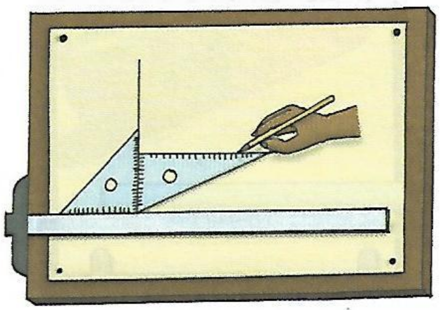


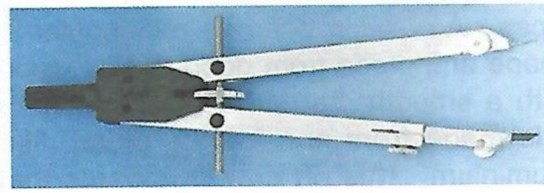
Fig. 5.5 Adjustable setsquares

Setsquares are also available in adjustable types. The adjustable type has the 45° and 60°/30° combined in one piece. See Fig 5.5(c).

5.5 Compasses and dividers

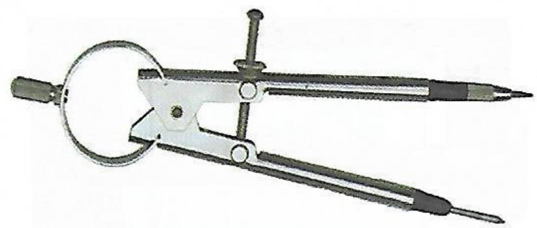
A pair of compasses is used for drawing circles of different diameters. On the other hand a pair of dividers is used for transferring dimensions from the ruler to the drawing on the paper. Both compasses and dividers should be kept from falling to the floor to avoid damage to the sharp tip. See Fig 5.6 a – c. Compasses are also available in spring bow type for drawing very small circle. See Fig 5.6(c).

(a)



A pair of compasses

(b)



Spring bow compasses

(c)

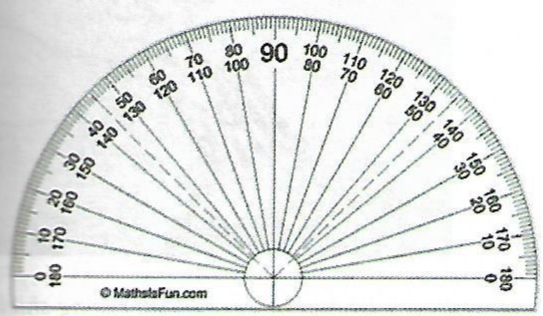
Dividers

Fig. 5.6 Compasses and dividers

5.6 The protractor

The protractor is made from celluloid and it is semi-circular in shape. It is used for measuring angles. Sometimes it is available in full circle form. Care should be taken when using a protractor to avoid dragging it on the floor or rough surfaces. See Fig 5.7(a) and (b).

(a)



(b)

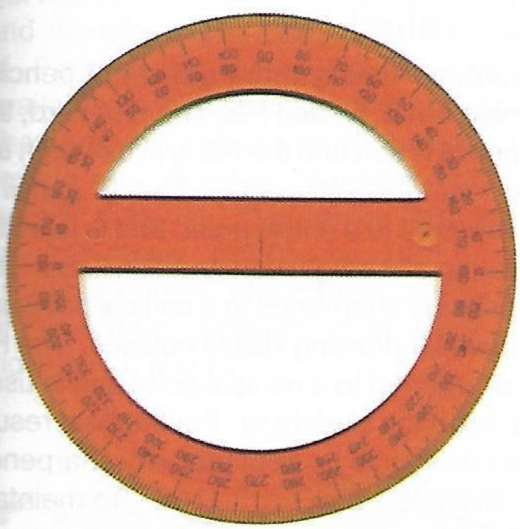


Fig. 5.7 Protractors

5.7 Rulers

Rulers are used for measuring dimensions of objects. They are made from plastics, metal and wood. Rulers are usually graded in metric units – millimetres (mm) or centimetres (cm). In using rulers measurement starts from 0 mm to whatever length is required and this should be ensured if accuracy is to be attained in drawing. See Fig 5.8.

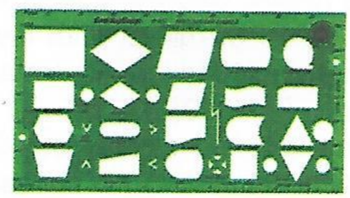
Fig. 5.8 A ruler

5.8 Templates and stencils

These are already formed patterns of various geometrical shapes. Templates are in various sizes and shapes ranging from circles, hexagons, squares, to ellipses. Patterns are used to facilitate drawing of shapes and save hours of tedious work. Fig 5.9(a).

Stencils are also patterns of letters and figures used for lettering. They come in different sizes and styles as in Fig 5.9(b).

(a)



Templates

(b)

Stencils

Fig. 5.9 Templates and stencils

Activity 5.1 Learning how to use and make templates

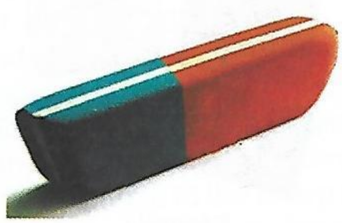
1 Use your stencil and your pencils to trace out:
   a) a circle
   b) a square
   c) a triangle
   d) a hexagon
   e) a rectangle
2 Use a razor blade to cut out the shapes.
3 What drawing instrument have you made from this activity?

5.9 Erasers and erasing shields

Erasers are useful during drawing. Erasers must be of good quality in order to erase mistakes neatly. A good quality eraser is soft and made of rubber with the quality of erasing pencil lead without making the paper dirty. Fig 5.10(a).

An erasing shield may be used to protect lines which are not to be rubbed off by erasing through the openings in the shield especially if lines are drawn close to each other. Fig 5.10(b).

(a)



An eraser

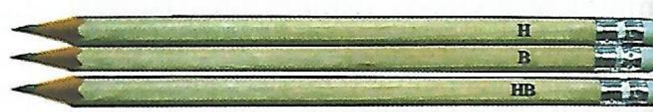
(b)

Fig. 5.10 An eraser and an erasing shield

5.10 Pencils and glass paper block

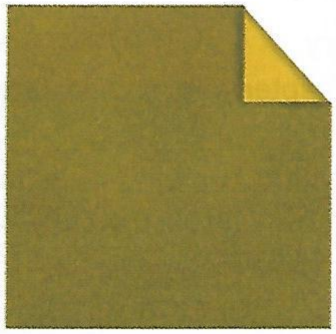
There are mainly three grades of pencils. These are B, H, and HB. The H is hard, the B pencil is soft and the HB is in between the hard and the soft pencil. The 'B' pencil is sharpened to a chisel point, and is used for drawing all straight construction lines. The H pencil is sharpened to a conical point and is used for drawing visible outlines. The HB is sharpened to a conical point and is used for freehand sketching. For the best result, pencils should be kept properly sharpened at all times. See Fig 5.11(a) To maintain this sharpness, a block of glass paper is required for grinding the lead as occasion demands.(See Fig 5.11(b).

(a)



Pencils

(b)



Fine glass paper

Fig. 5.11 Pencils and fine glass paper

5.11 Curves

Curves are available in two types, rigid and flexible. The rigid types are made of Perspex or polyvinylchloride, and are available in different shapes and sizes. They are also called French curves. The flexible type is made of rubber and light metallic material. This can be bent to any required shape and can be used to draw irregular curves other than circles and circular curves because of flexibility. See Fig 5.12 (a) and (b).

(a) French curves

(b) The flexible curve

Fig. 5.12 Curves

5.12 The pencil sharpener

The pencil sharpener as the name implies is used for sharpening pencils. This instrument is available in two types: the mechanical sharpener and the small, handy sharpener. It is important to have them very close when drawing, so as to sharpen the pencil from time to time as the lead gets used up. See Fig 5.13.

(a)

A small, handy sharpener

(b)

A mechanical sharpener

Fig. 5.13 Sharpeners

Activity 5.2 Learning to use the pencil sharpener

1 Use your sharpener to sharpen your pencil and show it to your teacher.

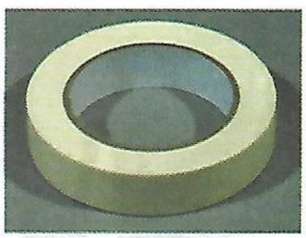
2 Ask your teacher to help you if you can not get the required protrusion of the lead.

5.13 Drawing paper

The drawing paper is usually the cartridge type because it can withstand erasing without necessarily tearing. It is usually white and it is purchased in rolls or sheets of different sizes.

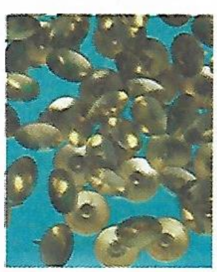
5.14 Masking/draughting tape

It is important to hold the paper down to the drawing board. In order to do this, a masking/draughting tape is used. However, in holding the paper to the drawing board, sellotape can be used in the absence of the masking/draughting tape. Clips and pins may also be used to achieve the same purpose. See Fig 5.14 (a–c).



(a) Masking tape

(b) A clip



(c) Pins

Fig. 5.14 Masking/draughting tape, a clip and pins

Summary

In this chapter you should have learnt that:

1 Technical drawing is a language used by technical men and women to communicate.

2 Specialised instruments used in technical drawing are the drawing board, tee squares, setsquares (45^0, $60^0/30^0$), pairs of compasses, pairs of dividers, protractors, rulers, French curves, stencils, etc.

3 Drawing instruments should be kept in a safe place, free from dust, fire/heat and should not be dragged on the floor.

Exercise

1 In your own words briefly explain why technical drawing is important in engineering.

2 Make a list of all the equipment and materials needed for technical drawing.

3 Briefly explain how to care for each instrument and material.

4 Draw at list ten of the listed equipment and materials.

5 Sharpen and grind a **2H** pencil to be used for drawing straight lines with a mechanical sharpener.

6 Grind an **HB** pencil to be used for free hand sketching on a glass paper block.

7 State the characteristics of a good eraser and the purpose of an erasing shield.

Chapter 6

Board practice

Introduction

A good drawing must not only be neat, it must be accurate. Neatness and accuracy can be achieved when correct instruments are used in the proper way. Most importantly, good board practice is necessary for producing good drawings. Board practice is therefore, the ability of students to use drawing instruments and materials to produce good drawings.

Objectives

At the end of this chapter you should be able to:

1. fix drawing paper correctly on the drawing board;
2. draw boarder lines correctly;
3. place and draw the title block correctly;
4. write freehand legible letters and numerals; and
5. demonstrate safe, clean and correct ways of using and storing drawing instruments and materials.

6.1 Setting the paper on the board

The first thing to do before starting any drawing is to set the paper on the drawing board and fasten it with masking/draughting tape. To fasten a sheet of drawing paper follow these procedures:

1. Cut out four pieces of masking tape and place them at the top right hand corner of the board.
2. Place the paper on the board.
3. Set the left vertical edge to be about 25mm from the left edge of the board.
4. Set the bottom edge of the paper to be at a convenient distance from the bottom edge of the board to allow for sufficient room to use the tee-square at the bottom of the paper.
5. Align the top edge of paper with the edge of the tee-square.
6. Hold down the paper with the right hand, move the tee-square down with the left hand.
7. Secure diagonally the four corners of the paper with draughting/masking tape or sellotape.

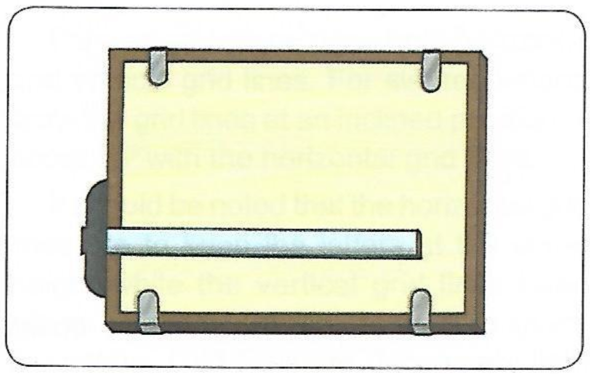


Fig. 6.1 Setting paper on drawing board

6.2 Drawing of border lines

Border lines are lines drawn round the four edges of the drawing paper. They are drawn immediately the paper has been set on the drawing board.

Procedure

1 Measure 10mm from the four edges of the drawing paper already fixed on the board.

2 With the aid of the tee-square and the set-square draw a vertical line at 10mm from the left edge of the drawing paper. Repeat same at the right hand side of the paper.

3 With the aid of the tee-square draw a horizontal line at the marked 10mm point from the bottom edge of the paper. Repeat same at the top edge of the paper.

4 Clean off the excess construction lines at the four corner of the drawing paper, (if necessary) See Fig. 6.2.

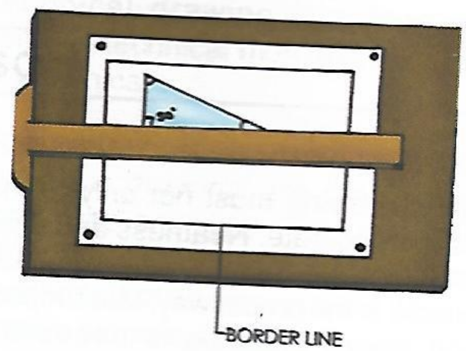


Fig. 6.2 Drawing border lines

6.3 Preparation of title block

The title block contains all the information necessary to identify a drawing. The information needed to identify a drawing includes the name, date, title of drawing, class, school and scale. The title block is drawn at the bottom right hand side of the paper within the border line.

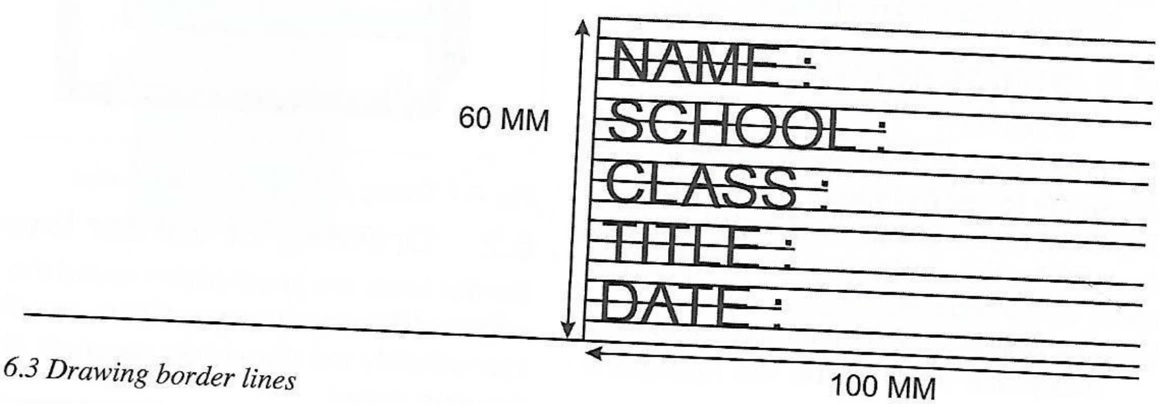


Fig. 6.3 Drawing border lines

Procedure

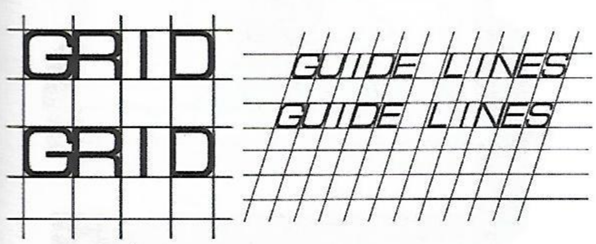
1 Draw, with the aid of the tee square and set square a rectangle with dimension 100mm x 50mm at the bottom right hand corner of the drawing paper.

2 Divide the square within the block and print inside information relative to the drawing as shown in Fig 6.3.

3 Line in the title block outlines.

6.4 Writing freehand legible letters and numbers

After the title block is laid out as shown above, it is then necessary to fill in some information. The process of doing that is called lettering. There are basically two styles of lettering: upright and slanting. The upright lettering is usually recommended and should be done in capital letters. Lettering should be done freehand and drawn between a pair of faint horizontal lines. See Fig. 6.4(a - b) .



(a) Upright style letters (b) Slanting style letters

Fig. 6.4 Freehand letters

An important point about lettering generally is that the letter should be uniform and easy to read.

Grid for lettering

At times grid lines could be used to assist beginners so that they can letter appropriately. These grid lines could be drawn horizontally, or verticaly as in Fig 6.5 (a-b).

(a)

(b)

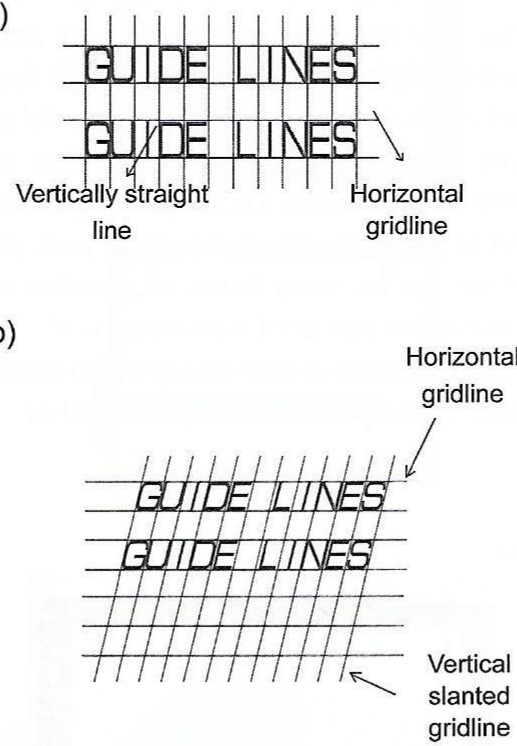


Fig. 6.5 Grid lines for lettering

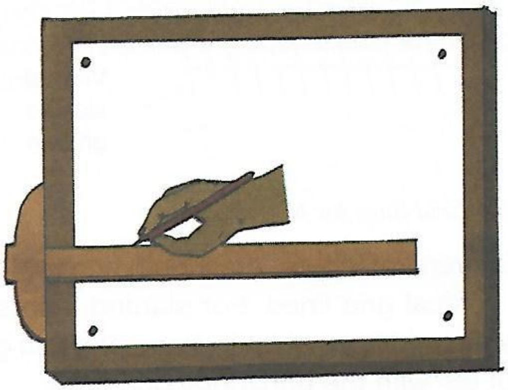
For vertical letters, draw both horizontal and vertical grid lines. For slanted letters, draw the grid lines at an inclined position of about 68° with the horizontal grid lines.

It should be noted that the horizontal grid lines are to keep the letters at the same height while the vertical grid lines keep letters in vertical position and not to space the letters. Grid lines are drawn very light so that they are hardly seen at arms length. However, a lot of practice is required to be able to letter nicely. Finally good lettering is important as a drawing cannot be said to be good if the lettering is poor.

Activity 6.1 Drawing grid lines for lettering

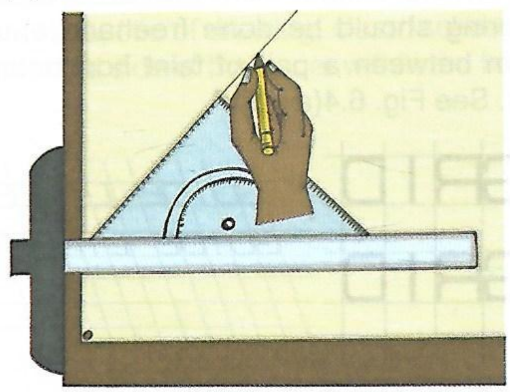
Set your paper on the drawing board, draw your title block and divide your paper horizontally into two rectangles. In the upper part of the rectangle draw 10 horizontal grid lines 3mm apart for lettering inside and 5mm as clearance. Do same on the lower part of the rectangle. In the upper part, print letters, a-z as many times as possible and in the lower part print numerals 1-10. This should be done in both straight and slanted style. Show your work to your teacher.

(a)



Drawing a horizontal line

(b)



Drawing a vertical line

Fig. 6.6 Uses of the tee-square

6.5 Uses of setsquares

Setsquares are used to

1 draw vertical, perpendicular and inclined lines in combination with the tee square;

2 draw angles 90^0, 60^0, 45^0 and 30^0; and

3 measure dimensions.

6.6 Uses of the tee square

The tee square is used to :

1 set the drawing paper on the drawing board;

2 draw horizontal lines and

3 draw vertical line in conjunction with the setsquare.

When drawing horizontal lines, hold the stock of the tee square firmly against the left vertical edge of the drawing board and draw the line from left to right. When using the tee-square to draw vertical lines, place the setsquare against the tee square blade and draw your vertical line from up to down. See Fig 6.6.

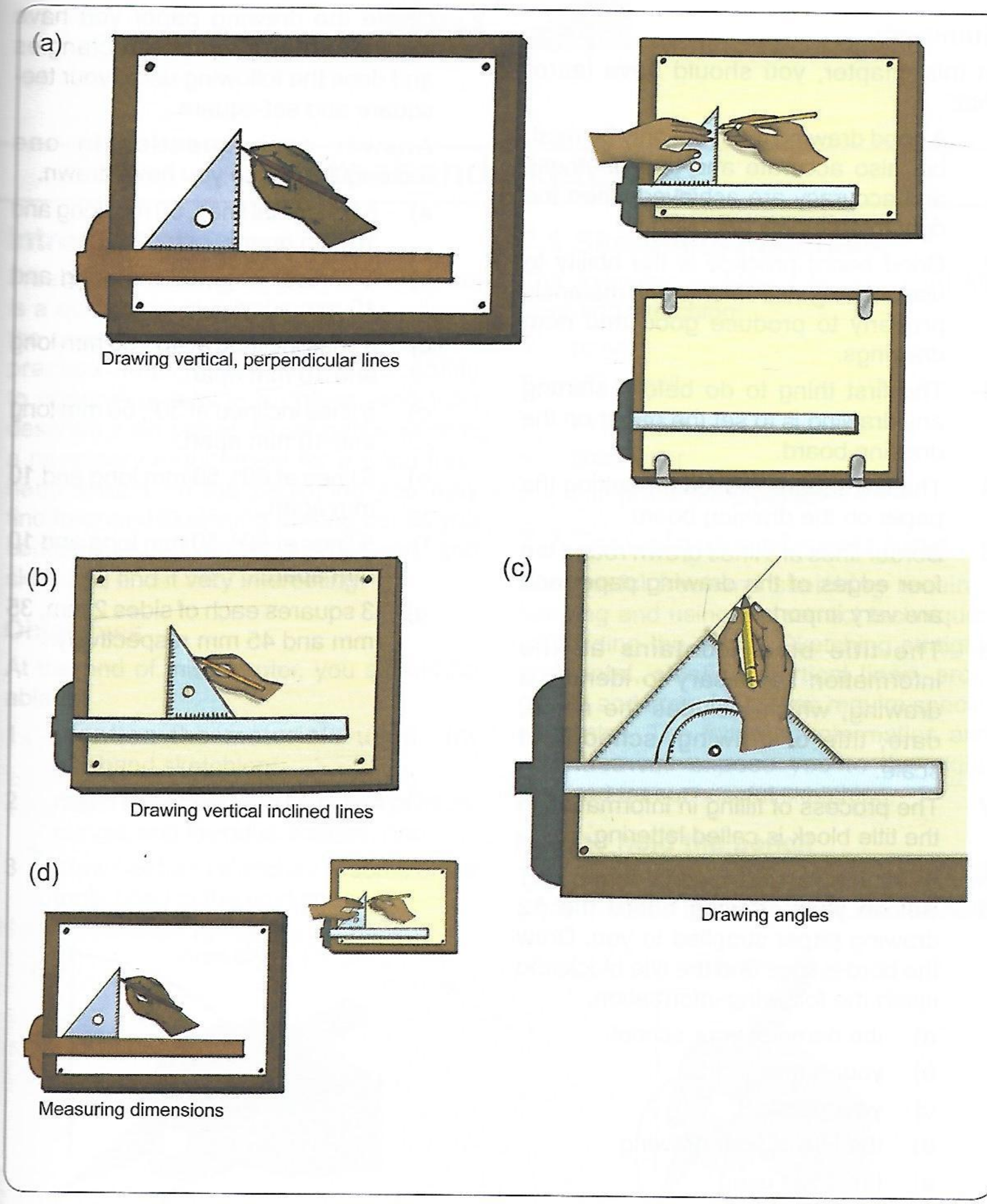


Fig. 6.7 Uses of setsquares

Summary

In this chapter, you should have learnt that:

1 A good drawing must not only be neat, but also accurate and that neatness and accuracy are achieved when the right instruments are used.

2 Good board practice is the ability to use drawing instruments and materials properly to produce good and neat drawings.

3 The first thing to do before starting any drawing is to set the paper on the drawing board.

4 The tee square is used for setting the paper on the drawing board.

5 Border lines are lines drawn round the four edges of the drawing paper and are very important.

6 The title block contains all the information necessary to identify a drawing, which includes the name, date, title of drawing, school and scale.

7 The process of filling in information in the title block is called lettering.

Exercise

1 Set on your drawing board the A2 drawing paper supplied to you. Draw the border lines and the title block and insert the following information.

a) the name of your school:

b) your name

c) your class

d) the title of your drawing

e) the scale used

f) the date

2 Divide the drawing paper you have set into six appropriate rectangles and draw the following using your tee-square and set-square.

Answer each question in one rectangular space you have drawn.

a) 5 horizontal lines, 50 mm long and 10 mm apart.

b) 5 vertical lines, 50 mm long and 10 mm apart

c) 5 lines inclined at 45^0, 50 mm long and 10 mm apart.

d) 5 lines inclined at 30^0, 50 mm long and 10 mm apart.

e) 5 lines at 60^0, 50 mm long and 10 mm apart.

f) 5 lines at 60^0, 50 mm long and 10 mm apart.

g) 3 squares each of sides 2 mm, 35 mm and 45 mm respectively.

Chapter 7

Freehand sketching

Introduction

Freehand sketching as the name implies is a quick way of drawing objects without the use of drawing instruments. Regular practice helps to develop one's ability to observe details in an object and then describe it on paper. Good pencil work is a necessary requirement for a good free-hand sketch. At the beginning you may find freehand sketching tasking but as you continue you will master the concept and skills and find it very interesting.

Objectives

At the end of this chapter, you should be able to

1. mention the materials used for freehand sketching;
2. make neat freehand sketches of lines, curves and irregular shapes; and
3. draw freehand sketches of some of the tools used in the workshop.

7.1 Sketching materials

The following materials are required for freehand sketching:

1. paper
2. HB pencil
3. soft eraser
4. sharpener
5. fine grade sand paper

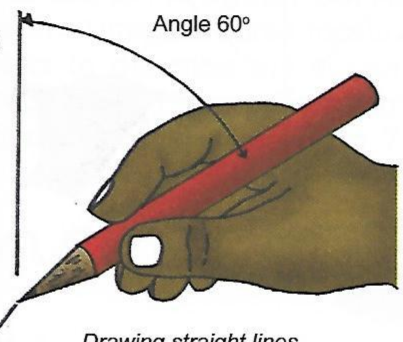
7.2 Techniques of sketching

Successful freehand sketching requires learning and using the correct techniques for holding the pencil. Sketching straight, horizontal, slanting, vertical lines, arcs, circles and irregular curves require special skills also. The following information and activities will expose you to the skills required for successful sketching.

How to hold the pencil

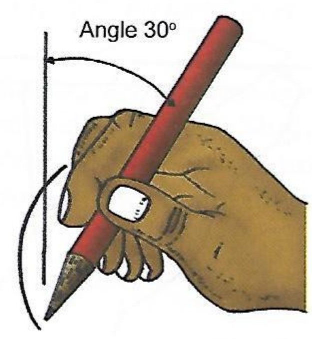
The pencil should be held lightly 40mm away from the point. It should also be held

(a)



Drawing straight lines

(b)



Drawing arcs and circles

Fig. 7.1

at a slanting position of about 60° from the vertical when drawing straight lines, and about 30° when drawing arcs and circles. In the process of drawing, the pencil should be rotated slightly to achieve clean and even spread of the lead as the line is being drawn. See Fig. 7.1(a) and (b).

How to sketch squares and rectangles

1) To sketch a square, draw horizontal and vertical center lines as in Fig. 7.2.
2) Locate equally-spaced points on the lines.
3) Sketch thin horizontal and vertical lines through the outer points to form the square. Correct mistakes, then thicken the square. Follow the same procedure in sketching a rectangle.

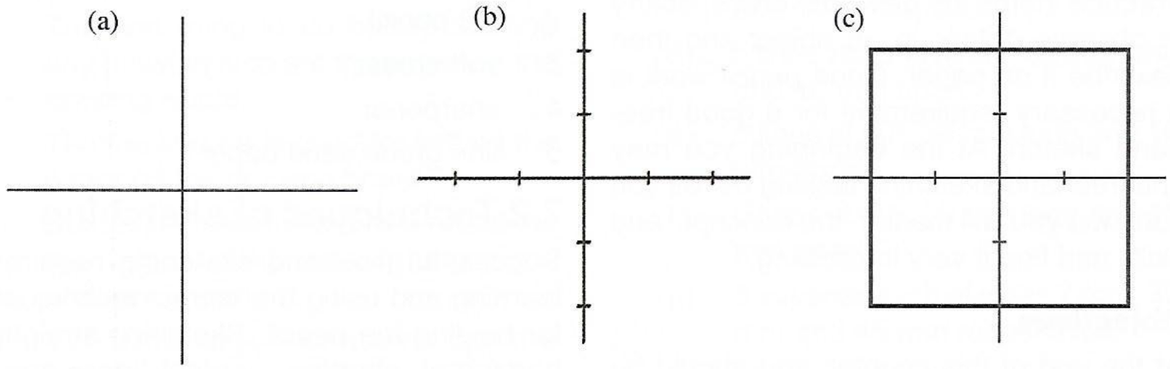


Fig. 7.2 Sketching squares

How to sketch circles and arcs

1 To sketch a circle, the first step is to locate its center with a point. See Fig. 7.3(a).

2 Sketch the vertical and horizontal center lines through it and add four other radial lines, as shown in Fig. 7.3(b).

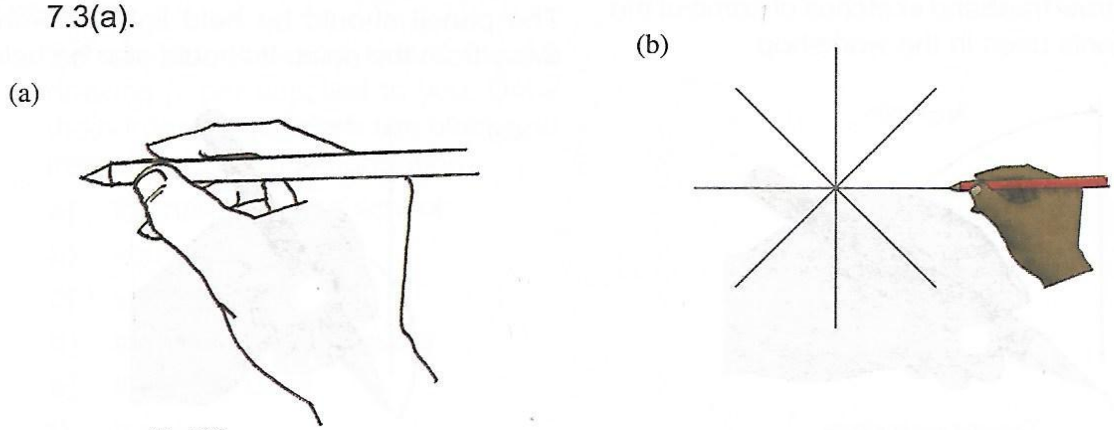
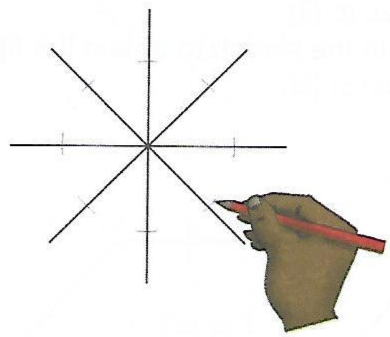


Fig 7.3

3 The radius is then estimated and laid off on the radial lines in the eight directions from the center. Through these eight points, short lines are drawn to intersect the lines at right angles. See Fig. 7.3(c).

(c)



4 Then sketch arcs to touch the perpendiculars at the points of intersection. The circle is completed by filling in the gaps between the arcs as in Fig. 7.3 (d).

(d)

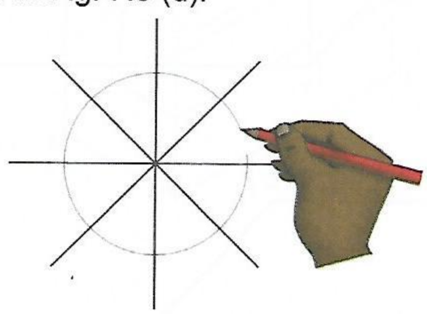


Fig 7.3

How to sketch irregular curves

To sketch an irregular curve, locate a series of points to describe the shape of the required figure. Then, proceed to sketch arcs through the points as in Fig. 7.4

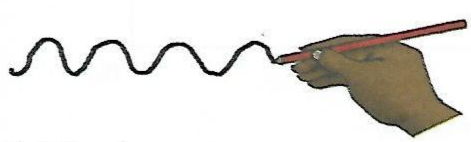


Fig. 7.4 Sketching an irregular curve

Activity 7.1 Freehand sketching of utensils

Sketch the following domestic utensils

a) spoon

b) cup

c) frying pan

7.3 Pictorial sketching

A pictorial sketch is one that shows the length, width and height of an object. This type of sketching is very useful because the shape of an object described in pictorial form is much easier to understand. Pictorial drawings are done on three main axes known as vertical axis, left receding axis and the right receding axis as shown in Fig 7.5.

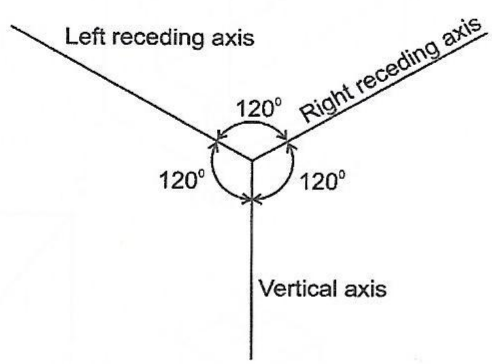


Fig. 7.5. Pictorial axes

The following are examples of how to produce pictorial sketches. Study the solid blocks shown in Fig. 7.6 to understand the procedure in producing their freehand sketches.

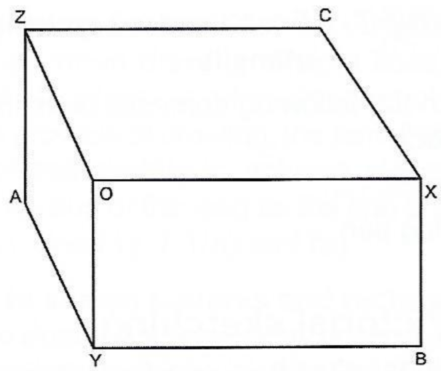


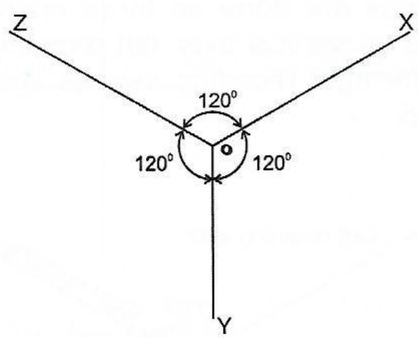
Fig. 7.6

Example 1

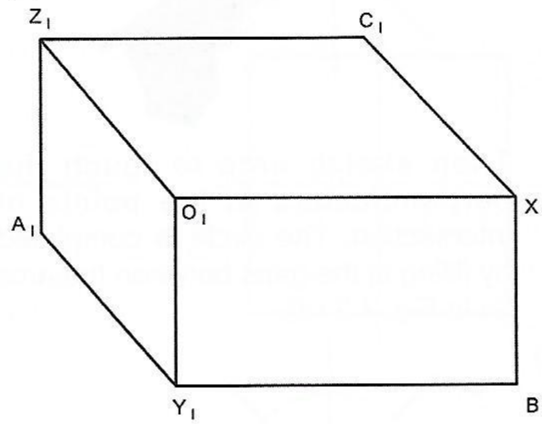
To make a freehand sketch of Fig. 7.6 follow these steps:

1 Sketch the three axes XYZ 120^0 apart labelled as shown.
2 On the axes, mark off O_1 Z_1, O_1X_1, O_1Y_1, and complete the figure as shown in (ii).
3 Line in the sketch to obtain the figure shown in (iii).

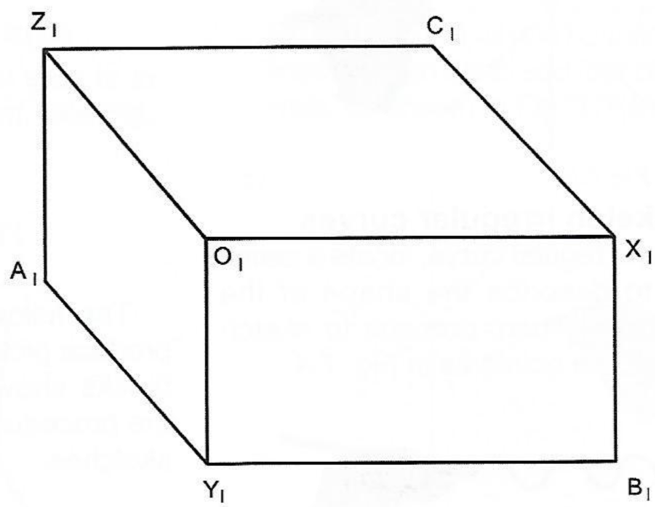
(i)



(ii)

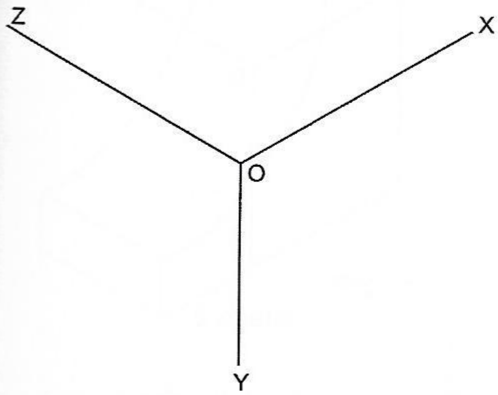


(iii)

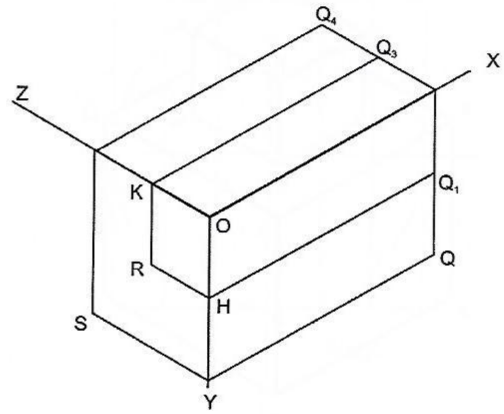


A freehand sketch of Fig. 7.6

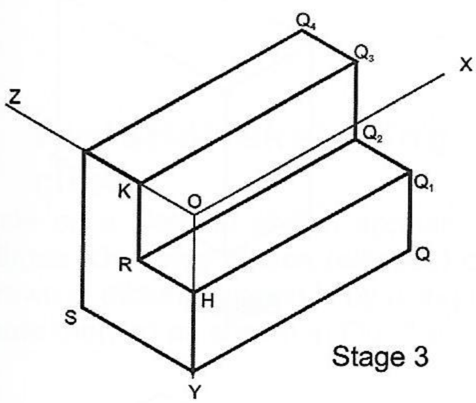
Example 2: Study Fig. 7.6b(i) to sketch the block as shown in stage 4. Do the same for Fig. 7.6(ii)



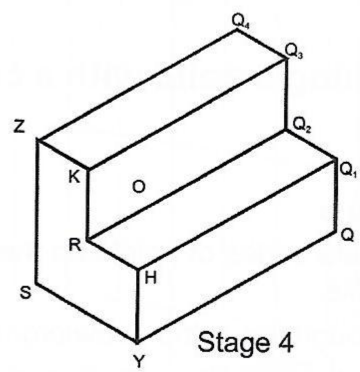
Stage 1



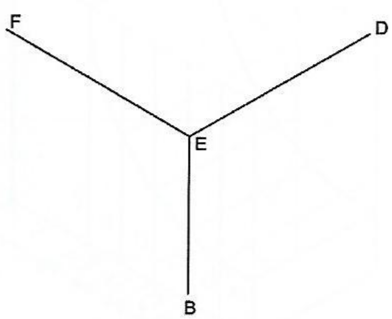
Stage 2



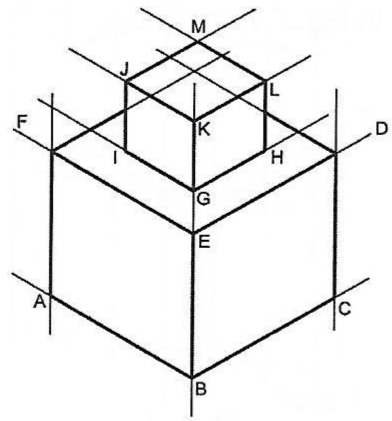
Stage 3



Stage 4

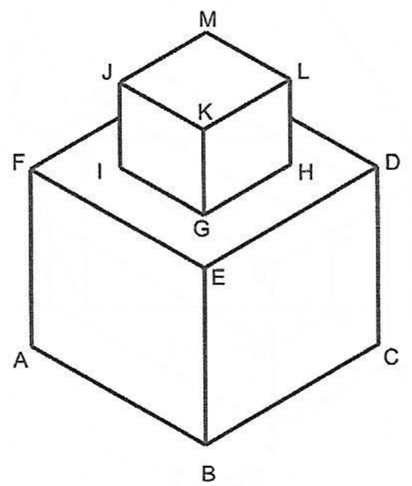


Stage 1



Stage 2

Fig. 7.6(ii)

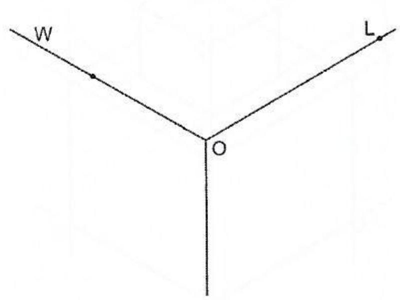


Stage 3

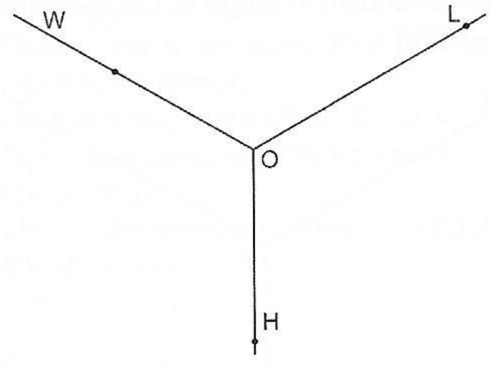
Sketching a solid with a curved profile

Procedure

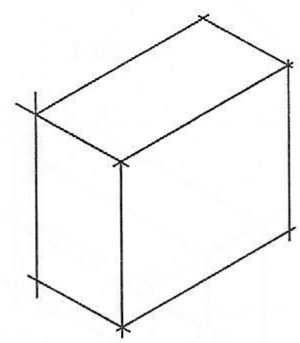
1. Locate series of points on the curved profile.
2. Through the points draw ordinates.
3. With the aid of the ordinates, sketch the points and join them to give the curve as in Fig. 7.7



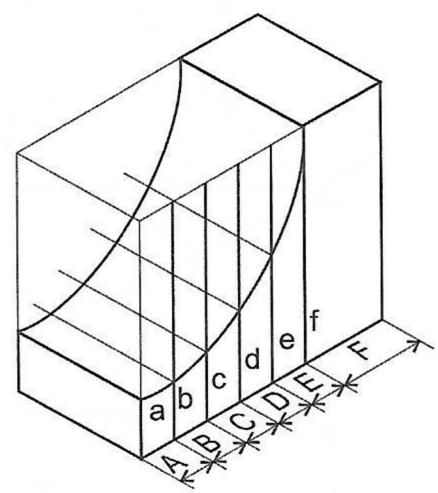
Stage 1



Stage 2



Stage 3



Stage 4

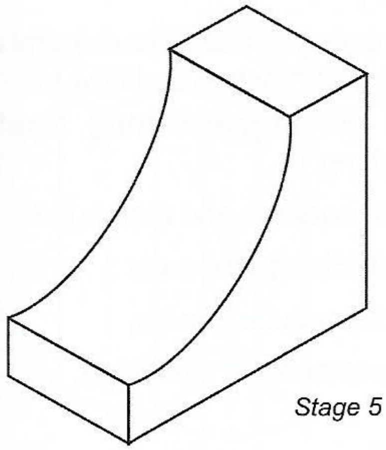
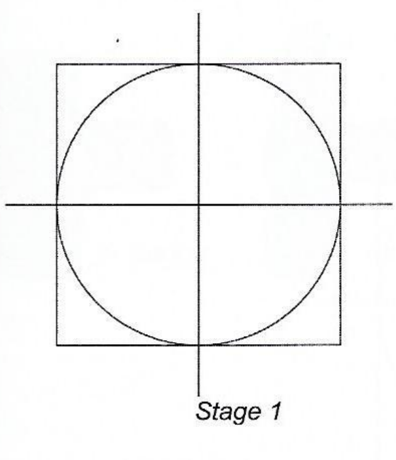
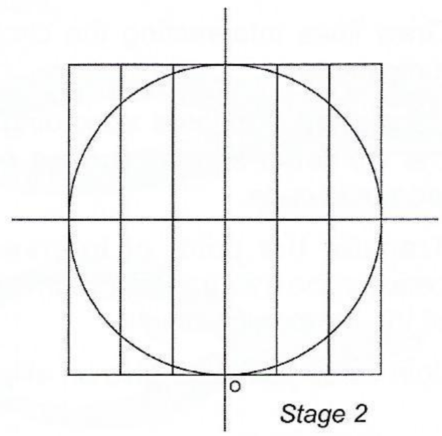


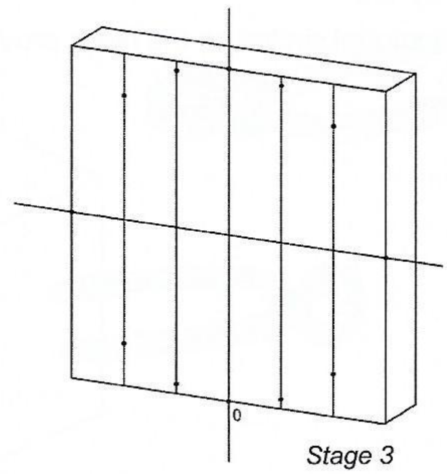
Fig. 7.7 Sketching a solid with curved profile

7.4 Pictorial sketching of circles

A circle on a pictorial sketch appears as an ellipse. One way circles (ellipses) can be drawn in pictorial sketch is by using the ordinate method as shown in Fig. 7.8.







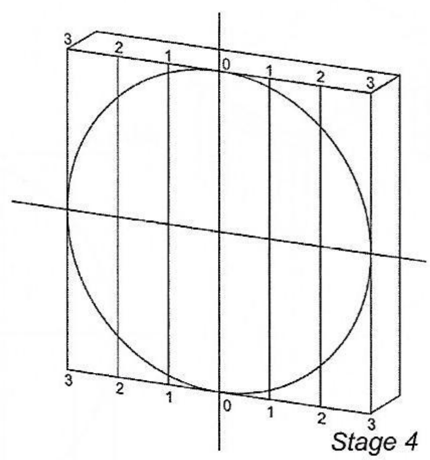


Fig. 7.8 Steps in the pictorial sketch of a circle.

Procedure

1 Draw lines intersecting the circle as indicated.

2 Locate the ordinates accordingly on the isometric square surface of the isometric cube.

3 Transfer the point of intersection between the lines and the circumference of the circle accordingly.

4 Join these points, to give an ellipse.

Activity 7.2

Draw pictorial circles on the block provided in Fig. 7.9.

Summary

In this chapter, you should have learnt about general board practice and how to

1 hold the pencil during freehand sketching;

2 sketch squares and rectangles;

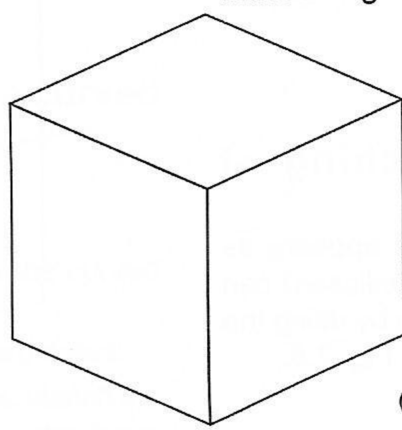
3 sketch circles and arcs;

4 sketch irregular curves;

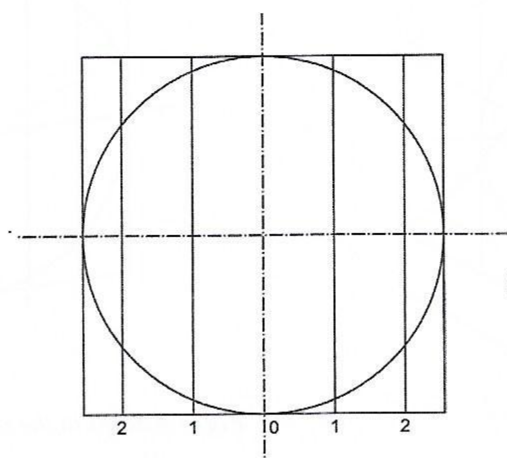
5 produce pictorial sketching.

Exercise

Make a free hand sketching of each of the items in Fig. 7.10 below.



(a)



(a)

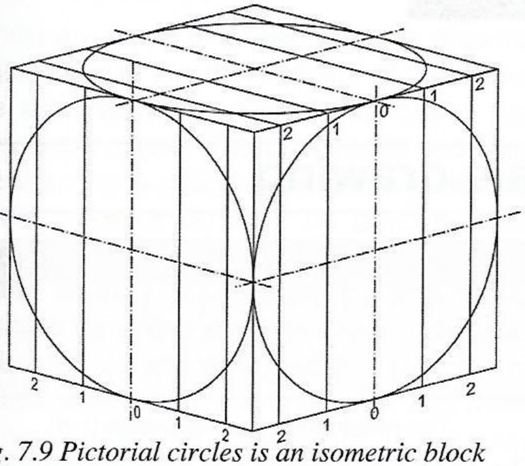
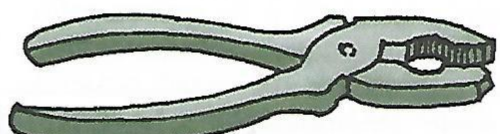
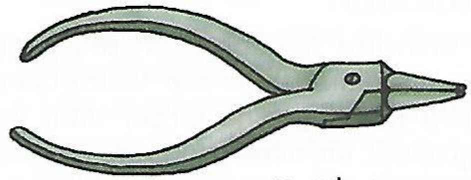


Fig. 7.9 Pictorial circles is an isometric block

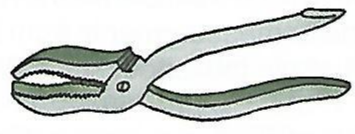
Pliers



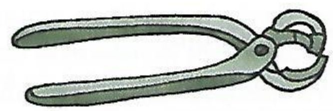
general purpose



round nose

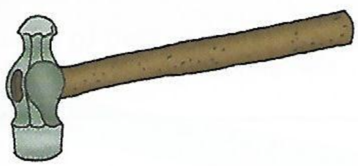


gas



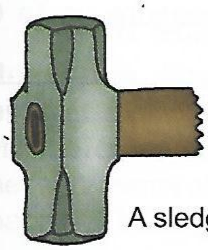
pincers

Hammer

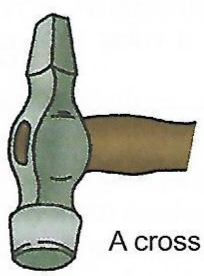


ball pein

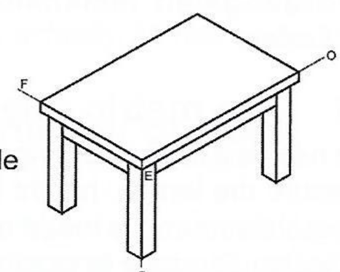
Fig. 7.10



A sledge



A cross pen



A table

Chapter 8

Scales and scale drawing

Introduction

When drawing an object in technical drawing, its dimensions are taken using a ruler. If the object is larger than the drawing paper, the dimensions are reduced proportionally. It is important for you to be able to read a simple metric rule and also to transfer measurements from it to a drawing before we talk about scale drawing.

Objectives

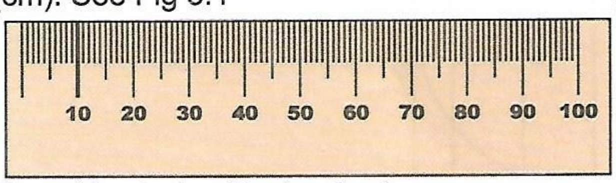
At the end of this chapter you should be able to:

1 read the metric rule;
2 use the metric rule to measure lengths and compare sizes;
3 identify scales used in drawing; and
4 draw given dimensions to given scales.

8.1 The metric ruler

The ruler is a flat measuring device used to measure the length, height or width of an object. It is normally made of wood, metal or plastic. The ruler is graduated in metric units - millimetres (mm) and centimetres (cm). See Fig 8.1

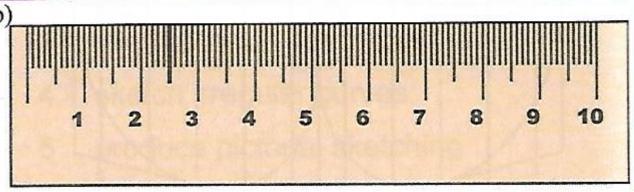
(a)



The metric ruler in millimetres (mm)

Fig 8.1

(b)



The metric ruler in centimetres (cm)

The metric system is the conventional unit of measurement in Nigeria. In the metric system 10 mm = 1 cm

Activity 8.1

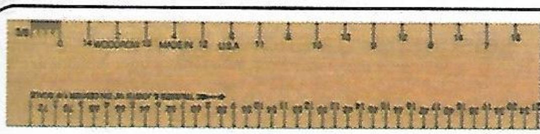
Draw a ruler that can be used to measure 50 mm.

Activity 8.2

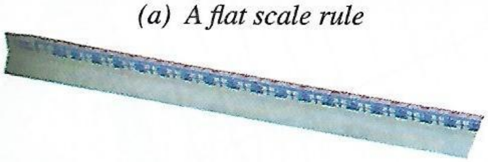
Draw a ruler that can measure up to 6 cm.

8.2 Scale rules

When an object is larger than the drawing paper in use, the dimensions of the object are reduced proportionally so that it can fit into the paper. The process of reducing the drawing is called scaling down. Scaling down is done directly by calculations. Sometimes too when the object to be drawn is too small, it is enlarged proportionally. A scale can thus be seen as a means of reducing or enlarging dimensions. For complicated objects, it is quicker and more convenient to use a scale rule. Scale rules are available in both flat and triangular forms as in Fig. 8.2.



(a) A flat scale rule



(b) A triangular scale rule

Fig. 8.2 Scale rules

8.3 Guidelines for measuring with scale rules

Measuring dimensions requires some level of skill. The following guidelines will therefore be helpful in carrying out measurements accurately in an appropriate manner. These guidelines are as follows:

1 Measurements should not be taken directly off the scale with compass or dividers. This will mar the subdivisions and ruin the rule.
2 Always place the scale along the line to be measured.
3 Always make a short dash (use a sharp pencil) at right angles to the scale.
4 After setting off a dimension, always double-check with the scale to make sure the distance is accurate.
5 For vertical measurements, place the scale on the paper so that the scale in use is on the left.
6 Small letters are used for the various units of measurements.
7 The decimal sign could either be a comma e.g. 1,25 cm, or a decimal point e.g. 1.25 mm. The decimal point is preferable and will be used in this book.
8 For dimensions less than one, the comma or decimal point should be prefixed with a zero, e.g. 0,75 or 0.75.
9 Under normal circumstances, metres (m) or millimetres (mm) are not written beside individual dimensions, but a note is made on the drawing stating the units of the dimension. For Example, 'All dimensions are in millimetre.' This means the unit of each of the dimensions is mm. Thus, 25 on the drawing is actually 25 mm and 125 is 125 mm.

8.4 Construction of plain scales

There are two types of scales: the plain scale and the diagonal scale. But we shall limit ourselves to the plain scale at this level. Scales are represented in two ways:

1 By fully describing the scale, e.g. scale: 100 mm to 1 m. This means 100 mm on the drawing represents 1 m of the object, thus an object of length 1.5 m will be drawn 150 mm or (15 cm) on the drawing, and an object of 2 m will

be drawn 200 mm or 20 cm on the drawing.

2 By writing it as a ratio e.g. scale 1 to 10 or 1:10. This means that each unit length on the drawing represents ten units of the full size, thus an object of 30 mm will be drawn 3 mm on the drawing. However, before we construct the scale we must first learn how to divide a line into equal number of parts as this principle will be applied in the construction of scales.

How to divide a given line into a given number of equal parts

1 Draw a line AB

Fig. 8.3

2. At any convenient angle draw line AO

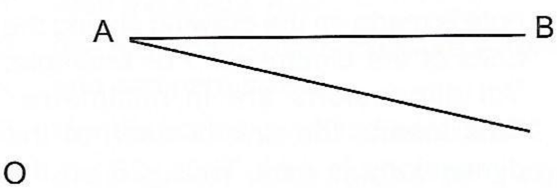


Fig. 8.4

3 With a pair of dividers pick any convenient length A1, step out ten times on AO, starting from point A.

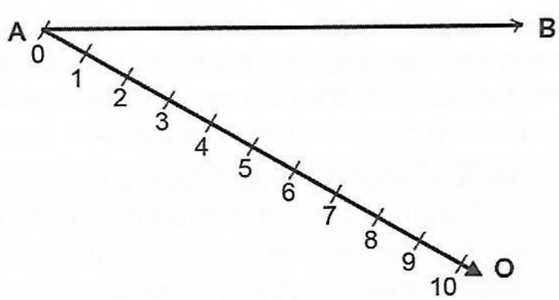


Fig. 8.5

4 Join point 10 to point B as in Fig. 8.6 below.

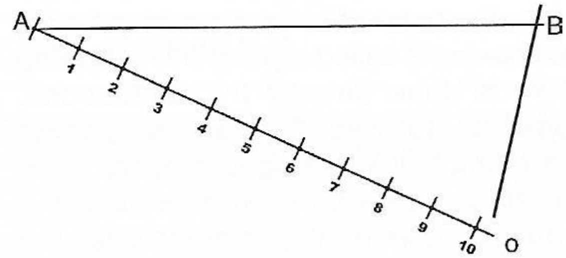


Fig. 8.6

5 Draw parallel lines at points 1- 9 to line 10B to touch line AB with the aid of setsquares as shown below.

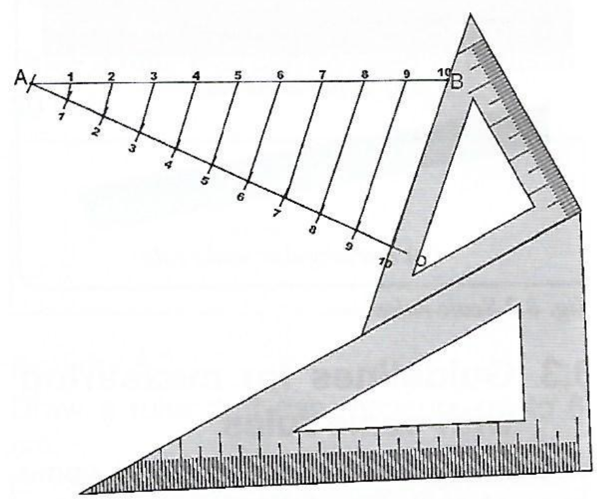


Fig. 8.7

The parallel lines have divided line AB into 10 equal parts.

Steps in constructing a plain scale and dividing it into equal parts

1 Use the line to complete a rectangle as shownin Fig. 8.8

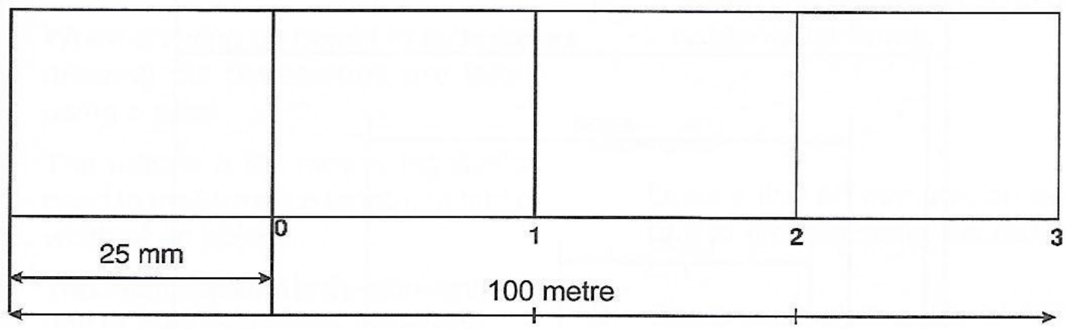


Fig. 8.8

2 Divide the first division into 10 equal parts as in Fig. 8.10

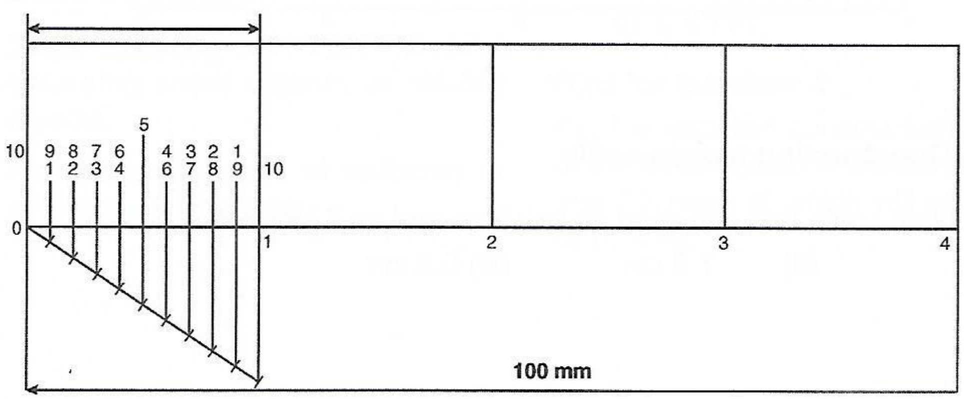


Fig. 8.9

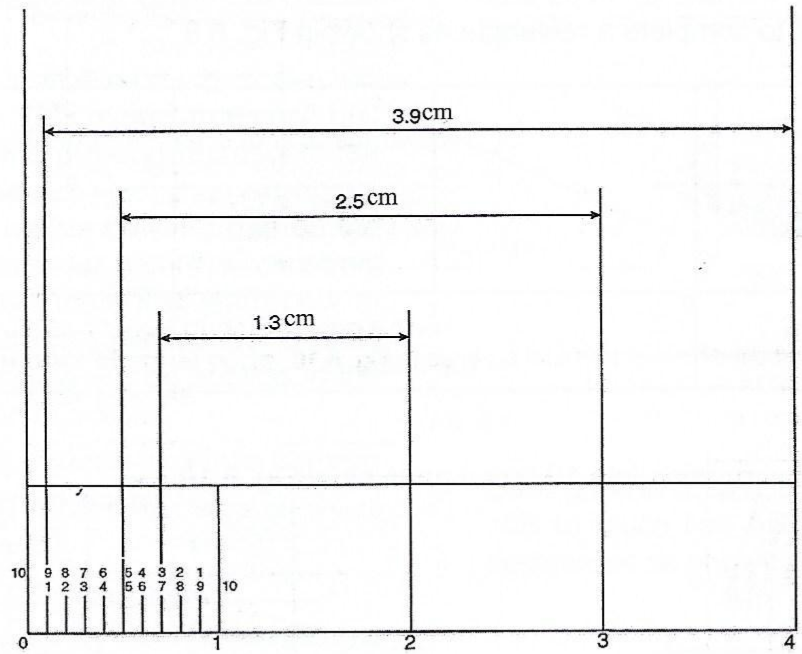


Fig. 8.10

Activity 8.3 Constructing a plain scale

Construct a plain scale that can read up to 15cm and on it indicate

(i) 10.2 cm (ii) 7.8 cm (iii) 0.5 cm

Summary

In this chapter, you should have learnt that:

1 When drawing an object in technical drawing, its dimensions are taken using a ruler.

2 The ruler is a flat measuring device used to measure the length, height or width of an object.

3 The metric system is the conventional unit of measurements in Nigeria.

4 Scale drawing is done so that large objects can fit into paper during drawing.

5 The process of reducing drawing is called scaling down.

6 Scale drawing too, may involve enlarging small objects to sizable objects.

7 A scale is a means of reducing or enlarging dimensions.

8 There are two types of scales: plain and diagonal scales.

9 Scale rules are available in either flat or triangular forms.

Exercise

1 Draw a line 80 mm and an equivalent of it in cm indicating the dimension in cm.

2 Construct a plain scale of 100 m to 1 m to read to 3 m. Indicate the following dimensions on the scale:

a) 1.15 m

b) 1.35 m

c) 2.55 m

d) 2.85 m

Hint for question 2

For the required construction in 2, the first of the three divisions should be subdivided into 20, each of which will represent 5 cm or 0.05 m.

Chapter 9

Woodwork hand tools

Introduction

Tools are needed to work on wood. The production of good wood products or jobs is made possible by good and functional tools. Tools can be hand or power tools. Hand tools are those used without electricity. Power tools are operated with electricity. Woodwork hand tools are classified into the following: measuring, setting and marking out, driving, boring and cutting tools. To work efficiently with these tools, holding and supporting devices are also needed.

In this chapter, we shall discuss woodwork hand tools.

Objectives

At the end of this chapter, you should be able to:

1 identify, sketch, describe and use appropriate measuring tools for specific purposes;

2 identify, sketch, describe and use setting and marking out tools;

3 identify, sketch, describe and use driving tools;

4 identify, sketch, describe and use boring tools;

5 identify, sketch, describe and state the uses of common holding and supporting devices; and

6 identify, sketch and use cutting and paring tools.

9.1 Measuring tools

The metric ruler

This is usually made of wood or steel. It can also be made of plastic. It comes in different lengths such as 150 mm and 300 mm. Some rulers can be folded. All rulers have a straight edge and are calibrated. Rulers are used to measure lengths, widths or breadths of objects.

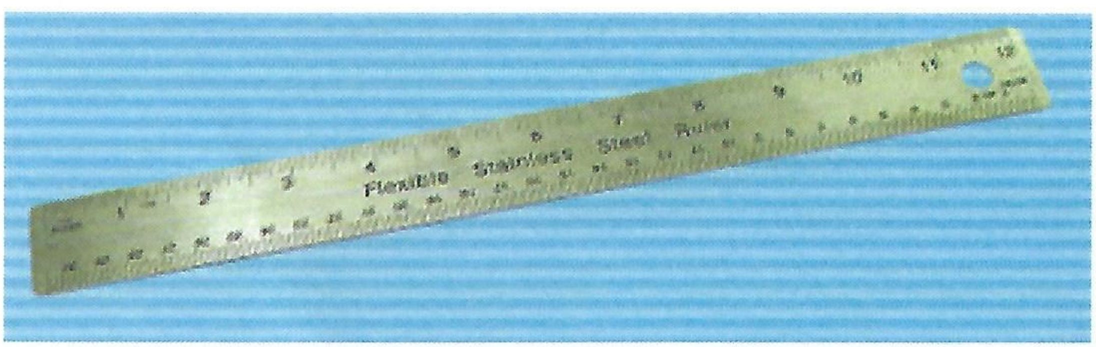


Fig. 9.1 A metric steel rule

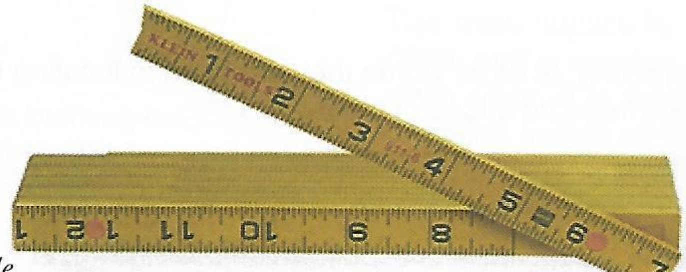


Fig. 9.2 A folding rule

Callipers

There are three types of callipers. They are inside callipers, outside callipers and odd-leg callipers. Inside callipers are used to measure the inside diameter of a hole. They measure the inside dimensions of any object within their capacity.

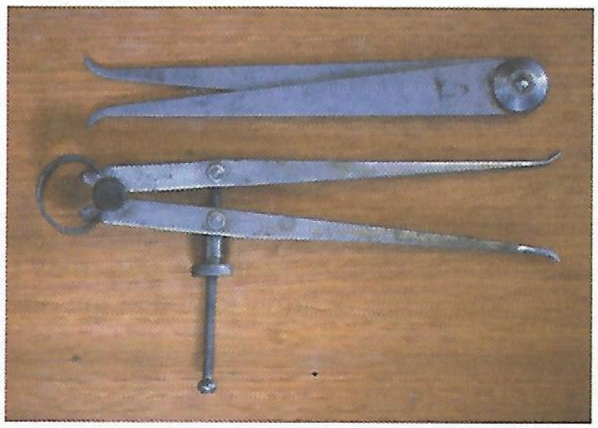


Fig. 9.3 Inside callipers

Outside Callipers

They measure the outside dimensions of any object within their capacity.

Fig. 9.4 Outside callipers

Odd-leg callipers

They are used for centering. In other words they are used in locating the centre of bars and in taking distances from the edges of holes.

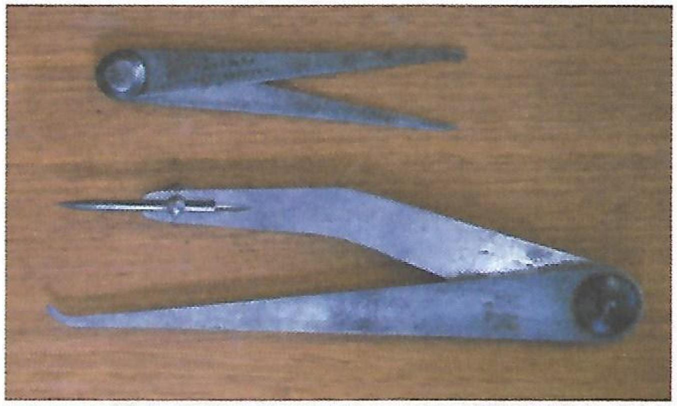


Fig 9.5 Odd-leg callipers

Dividers

Dividers are two-legged steel instruments used for scribing arcs, circles, curves and for setting off distances. They are made in various sizes. Dividers may be spring loaded at the upper part with a fine adjustment screw or firmly joined at the head.

Fig. 9.6 Dividers

9.2 Setting and marking out tools

The try square

The try square is a marking out tool, made of a stock and a blade fixed at right angles to each other. It is used for checking the squareness of edges. It is also used to mark out straight lines at right angles to a given edge.

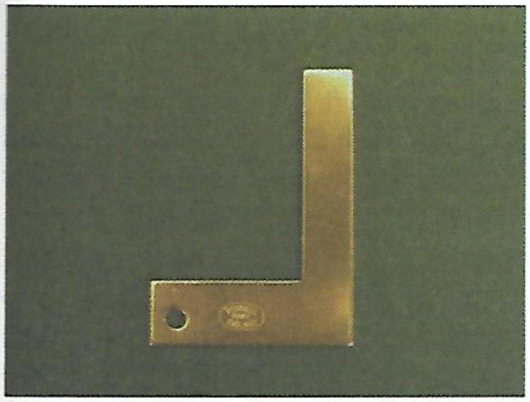


Fig. 9.7 The try square

The sliding bevel

This is made up of a steel blade and a wooden stock. It can be adjusted and set to any angle. It is used to mark out lines that cross at an angle and to check bevels.

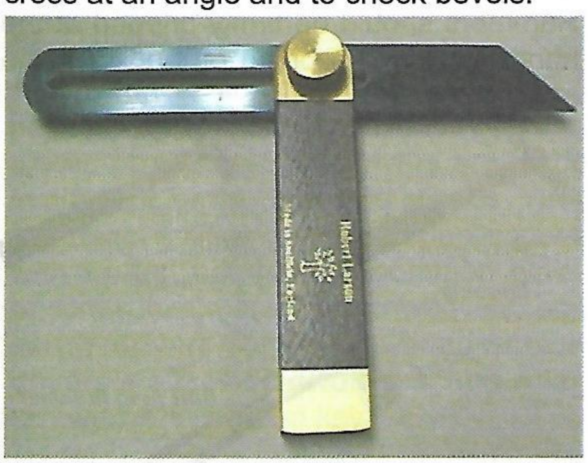


Fig. 9.8 The sliding bevel

The mitre square

The mitre square is made up of a steel blade and a wooden stock fixed at 45° to each other. It is used for setting out and checking angles of 45° and 135°.

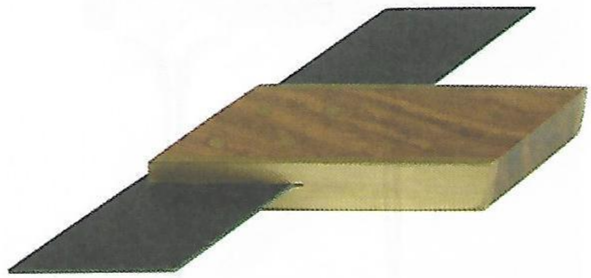


Fig. 9.9 The mitre square

Compasses

They are made of steel. These are used for scribing circles and arcs and marking out distances.

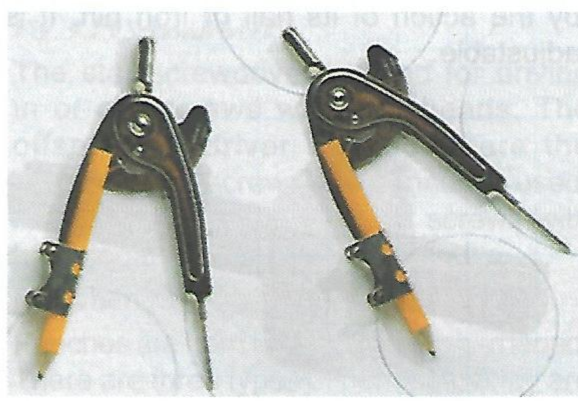


Fig. 9.10 Two pairs of compasses

Trammels

Trammels are made of a combination of both wood and metal. They are used for marking out large diameters where compasses cannot serve.

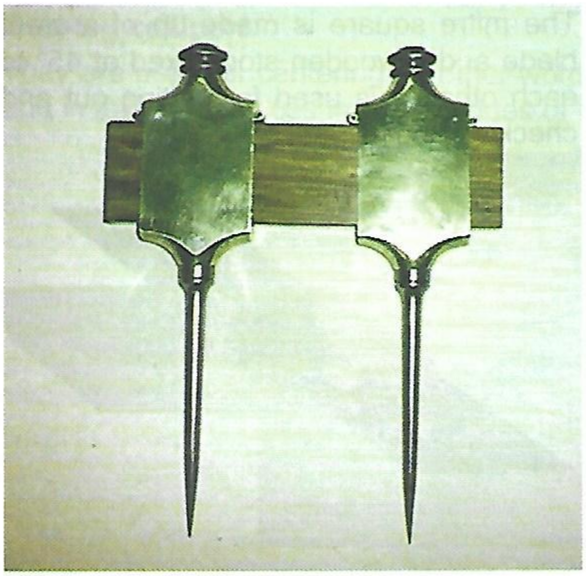


Fig. 9.11 Trammels

The marking gauge

The marking gauge is made of wood and a metal pointer. It is used to mark off lengths by the action of its nail or iron pin. It is adjustable.

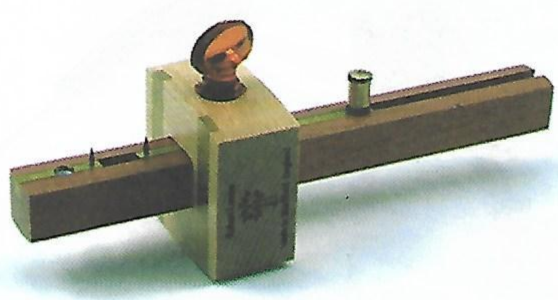


Fig. 9.12 The marking gauge

Activity 9.1 Identification of setting and marking out tools and their uses

1 Examine the setting and marking out tools in your school tool store.
2 Check the try-square, sliding bevel, mitre square, etc.
3 Note their names.
4 Draw and label them.
5 State their uses.
6 Use a piece of wood and test the squareness.
7 Mark out two parallel lines on it.
8 What tools did you use for 6 and 7 in Activity 9.1?

9.3 Driving tools

Hammers, screwdrivers and punches are classified as driving tools. They are used for driving in or driving out nails and other objects.

The hammer

The hammer is one of the most commonly used of all hand tools. It consists of a metal head and a wooden handle. There are many types of head shapes with a common striking face and special pein for riveting. The head is hardened and tempered. The common types of hammer are ball pein, cross pein, straight pein, blocking head and planishing head. There is also the claw hammer that has claws for extracting nails. Hammers should be firmly gripped at the handle to avoid slipping off and to make striking easier.

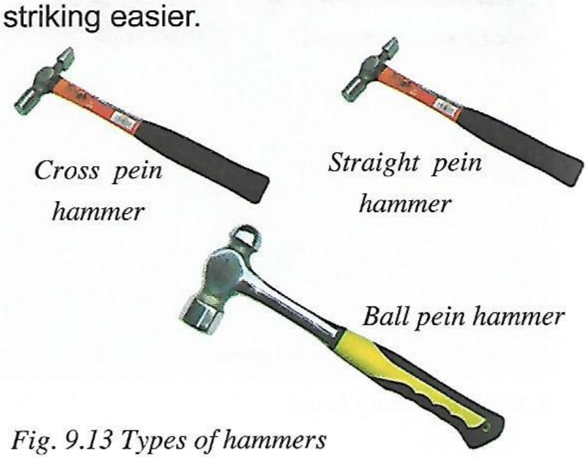


Fig. 9.13 Types of hammers

Mallets

Steel head hammers may be too strong for certain types of work. To avoid damage to the work, soft-faced hammers are used. Soft-faced hammers are generally called mallets. The faces of mallets are made of lead, copper, raw hide, wood, plastic or rubber. Mallets should be treated with care since they are not as strong as steel-head hammers. This is to avoid damage.

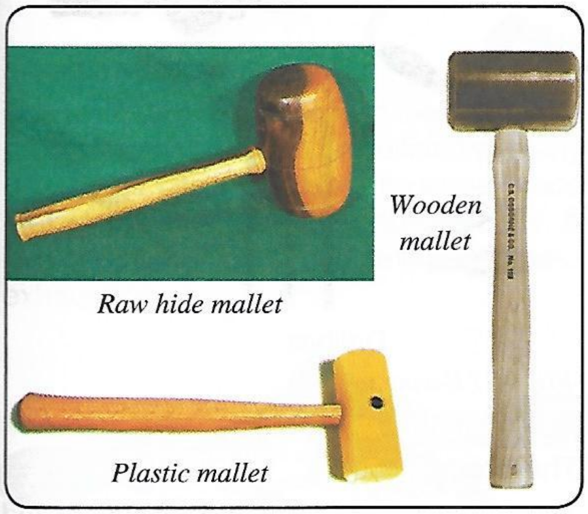


Fig. 9.14 Mallets

Screwdrivers

A screwdriver consists of a metal and a handle. The handle may be made of wood, plastic or rubber. Screwdrivers are made in different forms, sizes and shapes. They are used for fixing or removing screws with slotted heads. The common types of screwdrivers are flat screwdrivers, star screw drivers (or Philips-head screw-drivers), offset screwdrivers and Allen screwdrivers (or Allen key) .

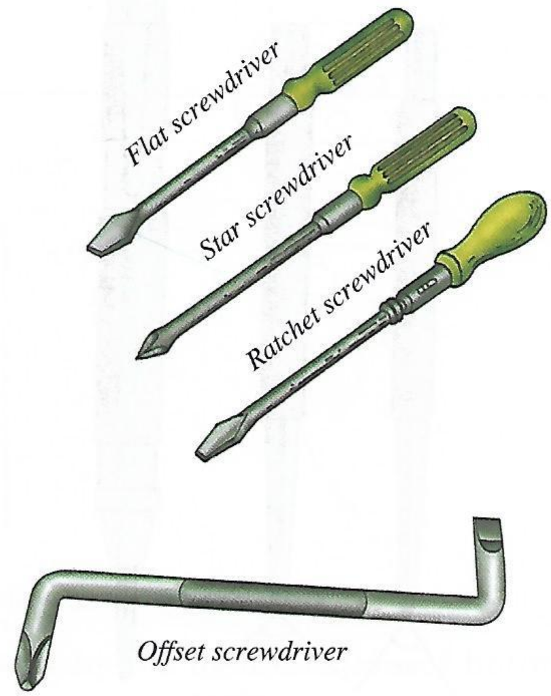
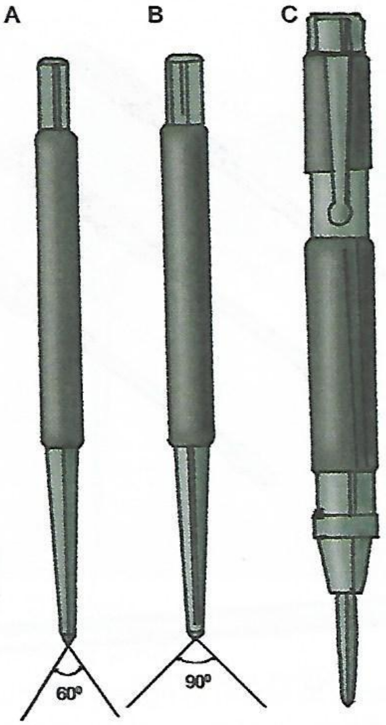


Fig. 9.15 Screwdrivers

The star screwdriver is used for driving in or out screws with star heads. The offset screwdriver is used where the straight or flat screwdriver cannot be used. Allen screwdriver is used on screws with hexagonal or square slotted heads.

Punches

Punches are from tool steel that is hardened. There are three types of punches. They are dot, centre and pin punches. The dot punch point is ground at 60° inclined angle while the centre punch is 90°. The dot punch is used in marking out jobs, for striking small dots on scribed lines. It is also used for locating hole-centres for drilling operations. The centre punch is used in enlarging points before drilling. The pin punch is used for driving out tapered pins, rivets, cotters, etc.



A=Dot punch (centre pop)
B=Centre punch
C= Automatic centre punch

Fig. 9.16 Punches

Activity 9.2 Identification and use of driving tools

1 Visit the tool store in your school.
2 Check and observe different types of hammers, screwdrivers and punches.
3 Note the names and shapes of all available driving tools.
4 Draw and label different types of driving tools and state their uses.
5 Get a piece of wood, drive in a nail into it with a hammer and try to drive it out using the hammer head pein.

9.4 Boring tools

Boring tools are tools used for making holes on wood. The major types are the ratchet brace, the wheel brace, the bits, twist drills, the bradawl and gimlets.

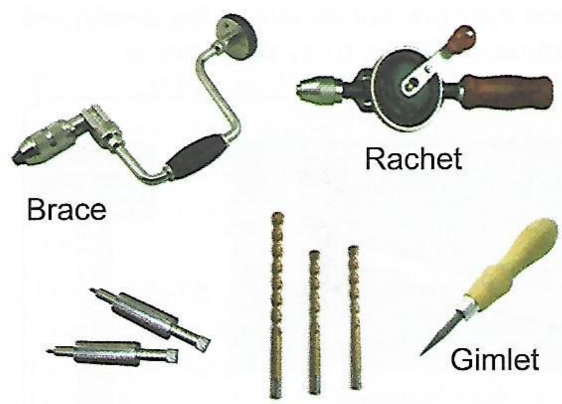


Fig. 9.17 Boring tools

The brace

The brace is a tool used for holding and turning the drill bits or twist drill when boring a hole. There are two types of brace. They are the plain brace and the ratchet brace.

The brace has four main parts, namely, the head, crank, chuck and ratchet. The head is a block of hardwood shaped to fit the hand. Other parts of it are made of metal. The ratchet is a mechanical device fitted to the brace so that holes can be bored in confined places such as close corners where it is not possible to make a complete sweep of the crank. The ratchet may be set to allow the bit to rotate in one direction, either on the forward or return stroke.

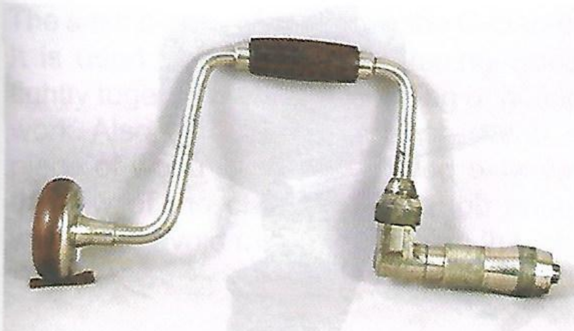


Fig. 9.18 The ratchet brace

The wheel brace

The wheel brace functions in the same way as the ratchet brace. It can be fitted with any of the drills' bits and twists. The wheel brace makes the task of boring holes easier. A large number of holes can be bored without exhaustion.

Fig. 9.19 The wheel brace

Gimlets and bradawls

Gimlets and bradawls perform the same function. They are used manually to bore holes before inserting screws and nails. They are most useful when the wood is hard. A screw would be difficult to drive in without the aid of an initial small hole. To be effective, the holes made with the gimlet or bradawl should be smaller in diameter than the size of the nail or screw.

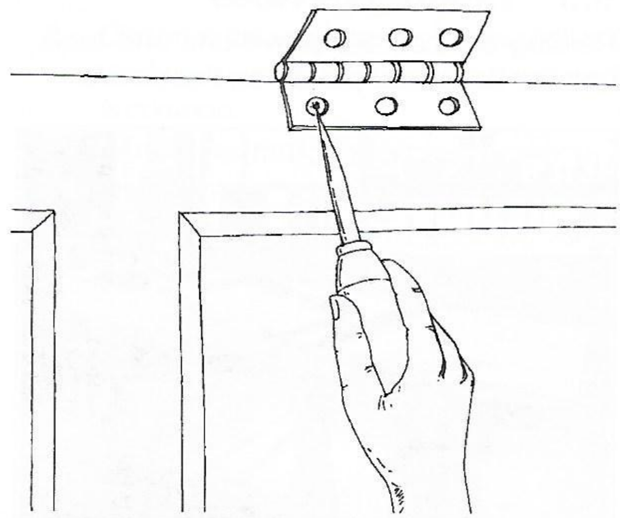


Fig. 9. 20 The bradawl in use

Activity 9.3 Identification of boring tools

1 Get a brace and fix the bits.

2 Use the brace and bore holes on a piece of wood.

3 Use the gimlet or bradawl to bore hole in another piece of wood.

4 Insert a screw in one of the holes.

5 With a screwdriver, tighten the screw.

6 Put a nail in one of the holes, drive down gently with a hammer.

7 Did you notice the ease in carrying out activities 5 and 6?

8 Repeat 5 and 6 without boring holes first.

9 What do you observe?

9.5 Holding devices

Holding devices are provisions and tools used to hold work pieces on the bench.

Fig. 9.21 The work bench and its appliances

Workbenches are usually designed to be about 2.0 metres long, 0.8 metres high and 0.9 metres wide. The centre of the bench is made lower to create a depth for keeping hand tools while working. This depth is called a well. It runs from one end to the other. Hand tools in use, such as planes, measuring tools, saws and gauges, are kept in the well. Tools which are not being used are kept away from the bench. Other bench appliances include the vice and bench hook.

The bench vice

The bench vice is fixed to the side of the bench. It is used for clamping wood in place before working on it. It is made of cast iron. The bench vice has a release lever, which allows quick adjustment and grip.

Fig. 9.22 The bench vice

The bench hook

This is used for holding jobs during cutting and chiselling on the bench. It is made up of two pieces of planed wood fixed on the workbench.

Clamps

Clamps unlike the well, bench vice and hook are not permanently fixed on the bench. The three main types of clamp are G-clamp, F-clamp, and Sash-clamp. All clamps are made of metal.

The G-clamp

This is called the G-clamp because its shape is like letter 'G'. It is advisable to place scrap of wood between the jaws and work to prevent making marks on the work. It is used for holding smaller work pieces together when assembling or gluing.

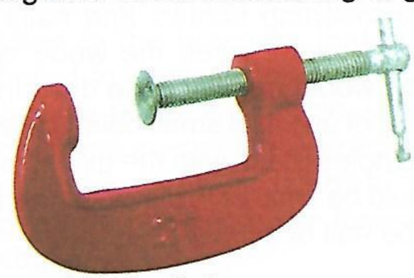


Fig. 9.23 The G-clamp

The sash clamp

The sash clamp is larger than the G-clamp. It is used for holding or clamping wood tightly together when assembling or gluing work. Also, when using the sash-clamp, a piece of wood should be placed between the jaw of the clamp and the job being worked to avoid making marks on the job.

Fig. 9.24 The sash clamp

The F-clamp

This is so called because it is shaped like letter 'F'. It is used just like the G-clamp. It has a quick action adjustment.

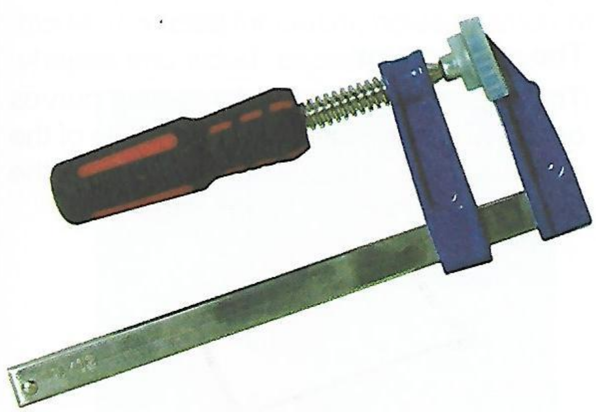


Fig. 9.25 The F-clamp

Activity 9.4 Identification of holding and supporting devices

1. Observe the workbench in your school workshop or visit any carpentry/wood workshop.
2. Note the fixed appliances on the workbench.
3. Look at tools in your school tool store or ask a carpenter/woodworker to show you his tools.
4. Can you identify the clamps?
5. Draw them and state their respective use(s).

9.6 Cutting tools

Saws

Saws are cutting tools made of high quality tool steel. The teeth of saws are set alternately left and right to allow for clearance. There are different types of saws designed to perform different jobs. These are the rip saw, cross-cut saw, tenon saw, bow saw, dovetail saw, coping saw and fret saw.

The rip saw

The rip saw is used for cutting timber into thin sections such as planks. It cuts wood along the grain. It is long, broad and slender.

Fig. 9.26 A rip saw

The cross-cut saw

This is just like the rip saw in appearance except that the blade is thicker. It also has a sharper taper blade than the rip saw. The cross-cut saw is used to cut wood across the grain such as in cutting wood into logs.

Fig. 9.27 The cross-cut saw

The tenon saw

The tenon saw is used for cutting tenon joints and other small jobs on the bench. The non-cutting edge of the tenon saw is thickened with metal. This gives it stiffness and weight when cutting. It is smaller than both the rip saw and the cross-cut saw.

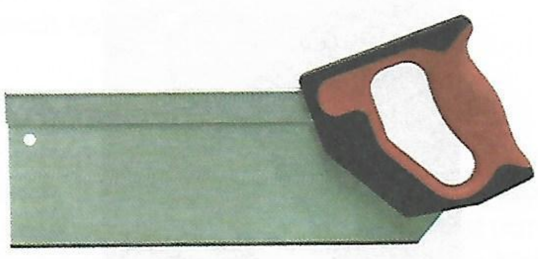


Fig. 9.28 A tenon saw

The bow saw

This saw is used for cutting circular or semi-circular curves. The deep-bow shape of the frame provides this advantage.

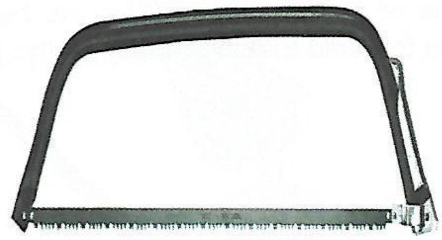


Fig. 9.29 A bow saw

The dovetail saw

This saw looks like the tenon saw but it is smaller in size and has an open handle. It is used for cutting dovetail joints and other small jobs on the bench.

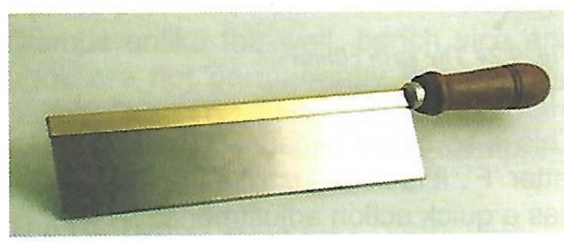


Fig. 9.30 A dovetail saw

The coping saw

The coping saw is used for cutting curves on the wood and plywood. The blade of the coping saw is slender and this allows the blade to be adjusted in any direction.

Fig. 9.31 A coping saw

The fret saw

This is used for cutting complex shapes and curves in plywood and veneer. The blade is finer than the coping saw's blade. It has a high frame which allows it to be used over a wide area.

The panel saw

The panel saw is capable of doing the work of both the rip saw and cross-cut saw. It is an all-purpose saw. Its shape is similar to that of the cross-cut saw but it is much smaller in size.

Fig. 9.32 A panel saw

The keyhole saw

The keyhole saw has a slender but rugged blade. It is used for cutting holes of different shapes into wood, especially key-holes.

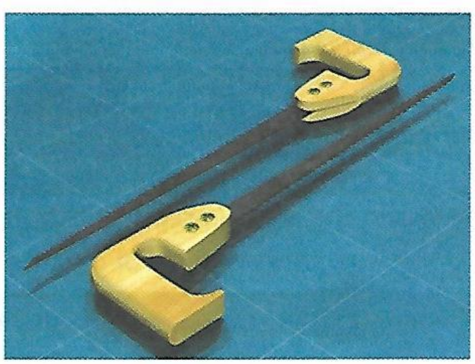


Fig. 9.33 The key hole saw

Planes

Planes are cutting tools used for planing wood to a smooth and fine finish. The cutting edge is made of metal, while the body may be made of metal or wood. Planes are gripped with one hand and guided with the other hand for smooth operations. The common planes used in woodwork are the jack plane, fore plane, smoothing plane, trying plane and spoke shave.

The jack plane

The jack plane is a general purpose plane. It is used to plane rough surfaces of timber. It produces a surface that is not very smooth. The jack plane has a wooden body and handle for grip.

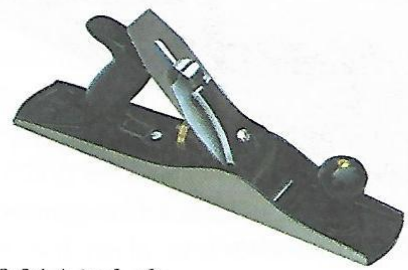


Fig. 9.34 A jack plane

The smoothing plane

This plane is used after the jackplane for final cleaning up of the surfaces of wood. In other words it is used for smoothening the surface of wood. It is similar to the jack plane in shape but shorter **in length.**

Fig. 9.35 A smoothing plane

The fore plane

This plane just like the jack plane is used for roughening out wood and for straight planning. The fore plane has a metal body, with a firm grip. The shape tapers from the middle to both sides of the cutting edge. It is smaller in size than the jack plane.

The trying plane

The trying plane is used for levelling the surface of wood. It has a wooden frame just like the jack plane, but it is slender and smaller in size.

Fig. 9.36 A trying plane

The spoke shave

This is used for removing light wooden particles from wood surface. It is also used for shaping curved edges. It is smaller than other planes.

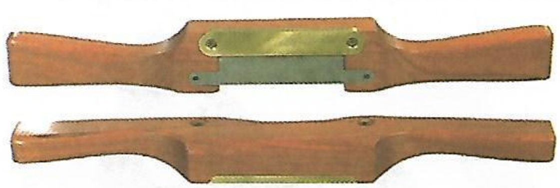


Fig. 9.37 A spoke shave

The chisel

A chisel is a chipping tool made from high carbon steel. It is used for shaping wood where finishing by other means, such as filing can be carried out. There are basically four types of chisels. These are the flat nose, round-nose, cross-cut and diamond-nose chisels.

The flat chisel

This is used for general work in the workshop such as levelling surfaces and removing rough surfaces.

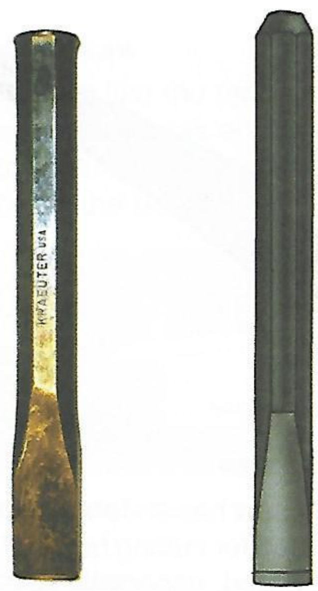


Fig 9.38 Flat chisels

The cross-cut chisel

This is used for making narrow grooves, key ways and slots in a shaft or in a hole.

Fig. 9.39 The cross-cut chisel

The round-nose chisel

This chisel is used for making oil grooves in shaft or in a hole.

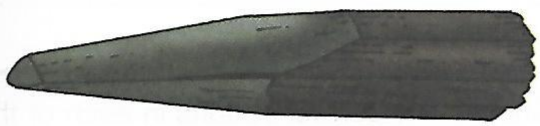


Fig 9.40 A round-nose chisel

The diamond-nose chisel

This is used mainly for chiselling inside corners and cutting 'Vee' grooves.

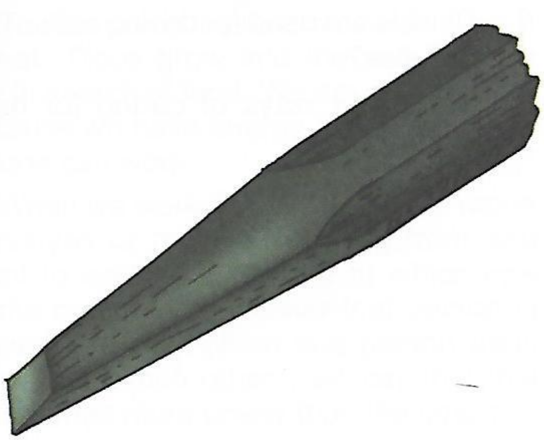


Fig. 9.41 A diamond-nose chisel

9.7 Care of hand tools

Hand tools need to be properly cared for and stored well for future use. Here are some guidelines:

1 Always use the right tool for the right operation. Using the wrong tool can damage the tool and the work.. It can also lead to an accident.
2 Clean the tools after use and store very well. They should be stored in a tool rack if one is available.
3 Store them in an orderly manner. Arrange tools in proper order to make it easy to pick them for use in future.
4 Store tools away from pathways so that they do not cause obstruction to free movement.
5 Do not keep tools in a damp place as this will make them to spoil fast.

Summary

In this chapter, you should have learnt that:

1 Woodwork hand tools are classified into measuring, marking out, setting out, drawing, boring and cutting tools.
2 Measuring tools are used to determine lengths and widths of wood. They include metric rule, callipers, dividers and marking gauge.
3 Setting and marking out tools include the try square, mitre square, compasses, sliding level and marking gauge.
4 Driving tools are used for driving in or out nails and other objects. They include hammers and mallets.
5 Boring tools are used for making holes on wood. They include braces, ratchets, drill bits, gimlets and bradawls.
6 Holding devices are provisions and tools used to hold work pieces on the bench. They include bench work clamps and bench vices.
7 Cutting tools are used in cutting or reducing wood to required sizes. Cutting tools include planes, saws and chisels.
8 Hand tools should be well stored and cared for. They should be used well and stored in a tools rack to avoid damage and loss.

Exercise

1 What are the fixed workbench appliances?

2 State the uses of fixed workbench appliances

3 Which of these is a cutting tool?
   A Try square
   B Saw
   C Metre square
   D Hammer

4 State the functions of the following
   a) Spoke shave
   b) Jackplane
   c) Smoothing plane

5 Which of these is not a measuring tool?
   A Divider
   B Callipers
   C Metric rule
   D Bradawl

Choose the correct options in each of the following statements (6-8):

6 The trammel is a boring tool. True or False?

7 Odd-leg callipers are used for centering. True or False?

8 Chisels are used for driving nails. True or False?

9 State four ways of caring for hand tools.

Chapter
10

Energy and power

Introduction

We work everyday of our lives from birth to death. Without work, life becomes meaningless because it is by working that we provide for ourselves the good things of life. Human beings and other animals move from place to place in search of what to eat. Trees grow into the soil and the sky in search of food. We are able to work because we have energy. Without energy, no one can work.

When we work, we use energy to move ourselves or move something from one point to another. The rate at which one works determines whether that person is powerful or not. When one person does work faster than others, we say that that person has more power than the others.

Force is applied when work is done. Without applying force, we cannot run, push, lift objects, carry load; vehicles cannot move, birds cannot fly etc. The force we use in doing work is supplied by the energy in us.

Objectives

At the end of this chapter, you should be able to:

1 define energy, work and power, and state their units;

2 list the forms of energy and their sources; and

3 state the relationship between energy, work and power.

10.1 The concept of energy and power

Energy is defined as the ability to do work. Both living and non-living things can do work. Work is done when something is moved through a distance.

Animals, including human beings need energy to run, walk, jump, push, pull, eat, talk, fly, etc. Non-living things like wind need energy to sway tree branches and leaves or pull down a tree or blow off rooftops. Vehicles need energy to move. The energy is supplied by fuel in the tank. Fire needs energy to boil water. Without energy, birds cannot fly. Even flowing water has energy and this is why it is able to carry things, especially dirt along its path of flow. Sound is able to travel because it has an energy called sound energy. No action can take place without energy being used.

Fig. 10.1

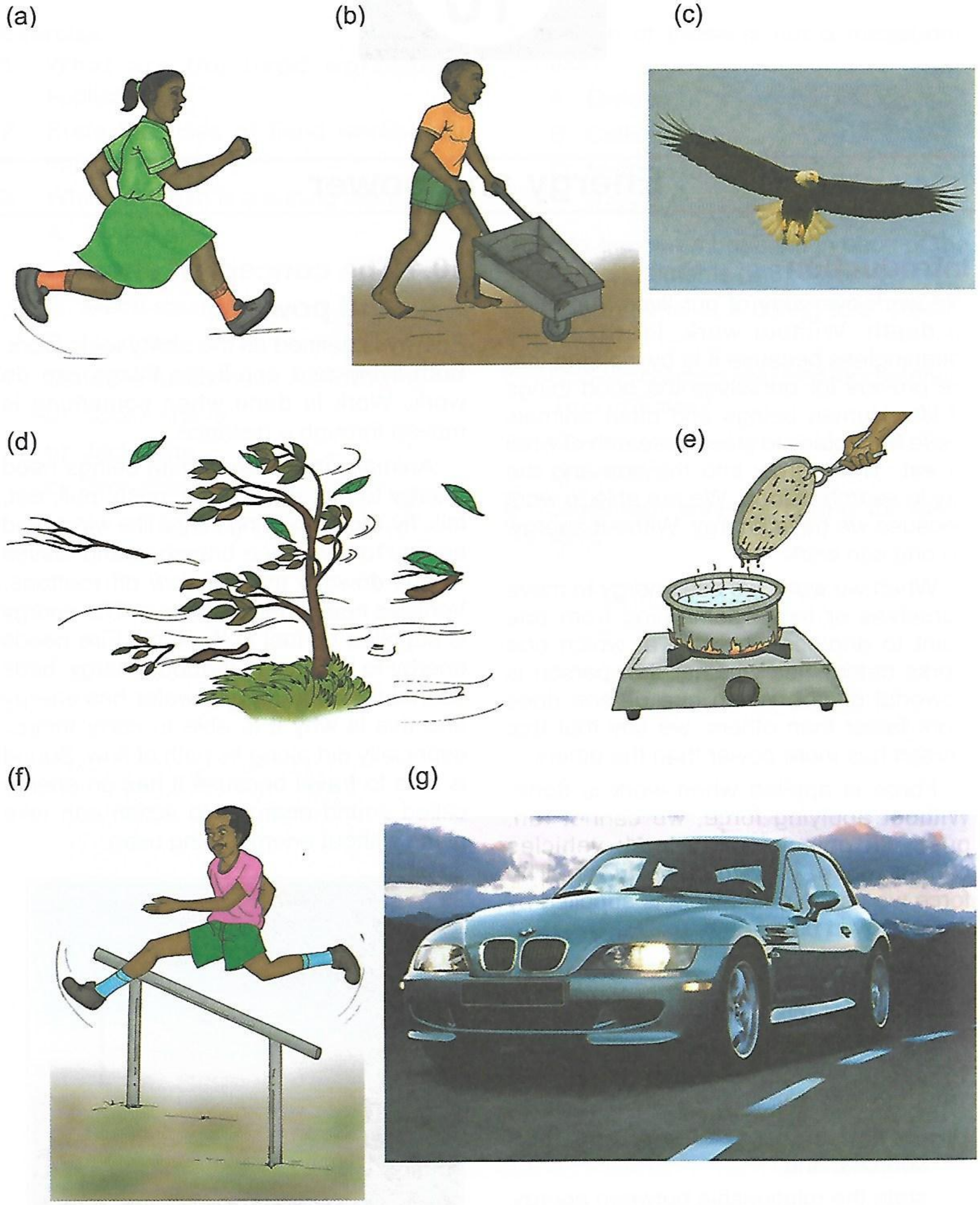


Fig. 10.2 Energy in use

Naturally, energy is never destroyed. Using an energy to do work does not mean that after use, the energy is exhausted. When energy is used to do work, that energy changes form. For example, when wind energy blows off sand from the ground, the sand particles will hit a person with another form of energy called mechanical energy. So wind energy would have been converted into mechanical energy. Energy is never destroyed. It can only be converted into another form. It can also be stored in a place until it is required.

Activity 10.1 Identifying energy consuming activities

1. List ten activities of animals in which energy is used.
2. List ten activities of non-living things in which energy is used.

10.2 Measuring energy

Energy is not something we can touch or see. We can only see its effect. For example we know that somebody running is using energy. But we cannot see the energy that is making him or her to run. We can however measure energy and quantify it by using appropriate instruments.

We use an energy meter to measure energy. What we commonly call 'PHCN meter' is an energy meter because it measures the amount of electrical energy consumed in a building. Fig. 10.3 shows an energy meter.

Fig. 10.3 An electrical energy meter

The standard unit for measuring energy is the joule (j). It can also be measured in kilojoule (kj). One kilojoule is equal to one thousand joules. The higher the amount of energy a person has, the greater the amount of work that person can do. In the case of the energy meter, the higher the amount of energy it can hold the greater the amount of electrical energy from it. A three - phase meter supplies more energy than a single - phase meter. So it can carry more electrical load than a single - phase meter.

Activity 10.2 Observing the energy meter

1. Observe the energy meter in your school or home at different times of the day.
2. At what time is the meter reading faster than other times?
3. What causes the fast reading?

10.3 Forms of energy

We have said that energy cannot be destroyed but can be converted form one form to another. We have also said that even though energy exists, it cannot be seen or touched. But its action can be seen.

The major forms of energy are:

1 heat energy
2 mechanical energy
3 electrical energy
4 chemical energy
5 sound energy
6 light/solar energy
7 nuclear energy

These forms of energy and their various sources and uses are described below.

Heat energy

Heat energy is that form of energy which leads to the rise in temperature of a body. Heat as a form of energy has been in use since ancient times. Heat energy can be obtained from:

1 Rubbing two bodies like our palms over a period of time.
2 Making fire by striking a match stick on a matchbox, burning fire wood, coal, charcoal, gas or kerosine in a stove or lamp. Heat generated from these sources is used mostly in cooking food.
3 Plugging electrical appliances such as iron, kettle, cooker, boiling ring and soldering iron to a source of electricity. These appliances are able to convert electric current into heat energy, which is then used to cook food or boil water.
4 Burning petrol and diesel in the engine of motor vehicles and other machines that use petrol or diesel. The heat generated in the engines of the machines causes the vehicles to move.

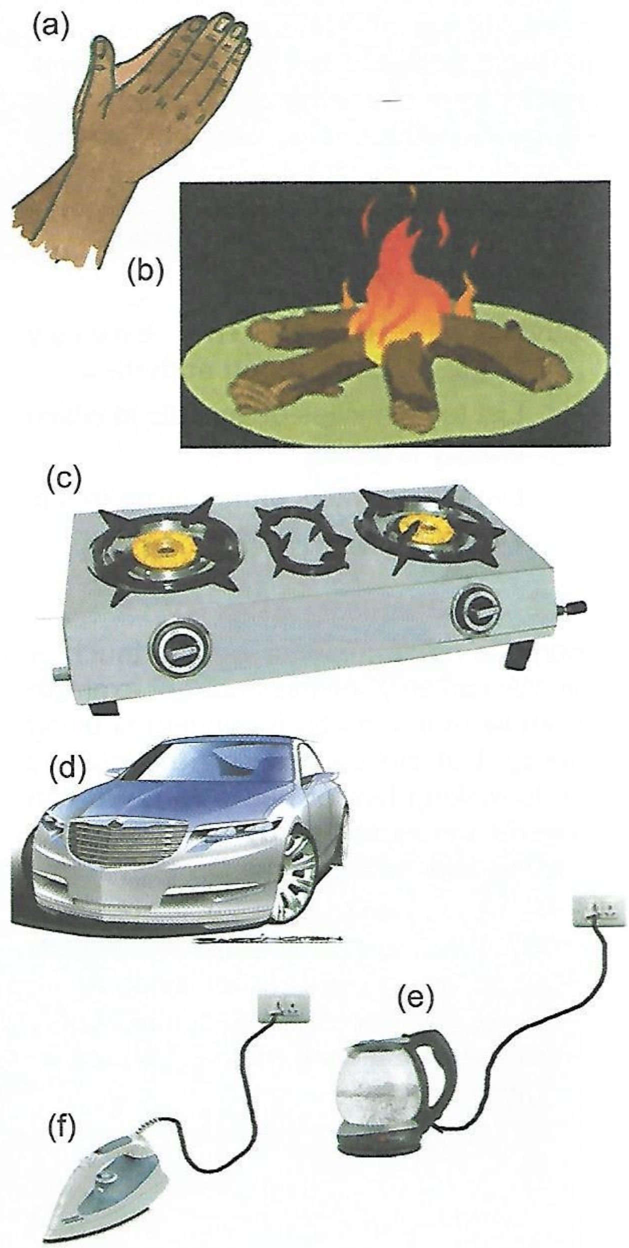


Fig. 10.4: Sources of heat energy

We have said that the temperature of a body rises when heat energy is applied to it. This means that the more the heat energy applied, the higher the temperature. It is not all the time that this happens. When water starts to boil, additional heat does not raise its temperature. This is because the moment water reaches the boiling point the temperature does not rise again.

Activity 10.3 Generating heat energy

1 Rub your palms together. Look at the time before you start. Look at the time again when you start to feel the heat. How long did it take you to generate the heat? Compare your time with those of your classmates.

2 Visit a motor mechanic and ask him to start an open engine so that you can see how the heat generated by burning petrol causes the engine parts to move.

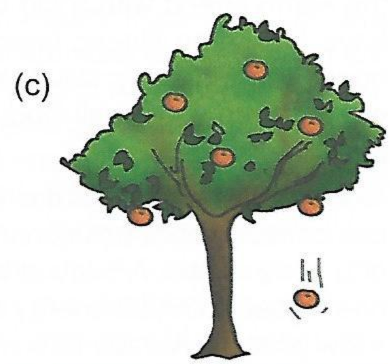
Mechanical energy

Mechanical energy is the energy of motion or potential for motion. A mango fruit that falls from a mango tree has mechanical energy. It is mechanical energy that helps one to jump. We use mechanical energy to walk from place to place. So mechanical energy is used by the following:

1 Falling objects e.g. fruits from trees;

2 Flying objects e.g. aeroplanes, birds, kites, balls in air, etc;

3 Flowing objects e.g. sea, ocean, river, and tap water.



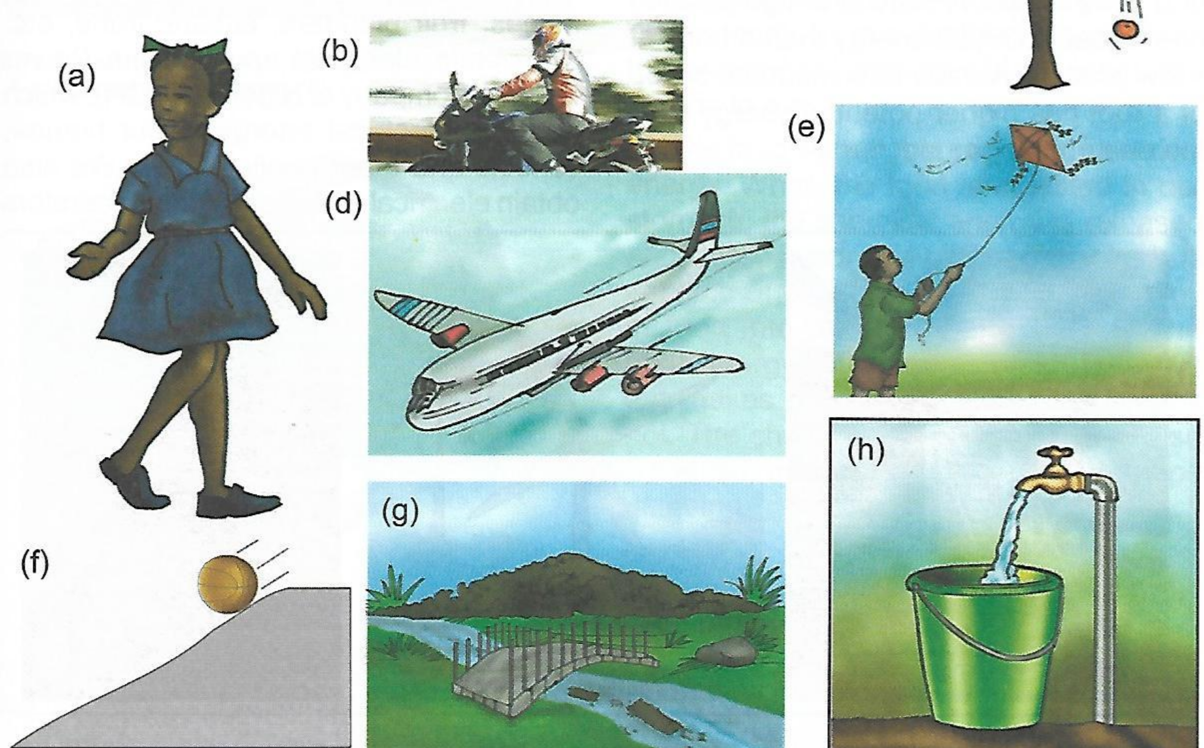


Fig. 10.5 Sources of mechanical energy

There are two types of mechanical energy. These are **kinetic energy** and **potential energy.**

Kinetic energy is the energy possessed by a moving object. Every moving object has kinetic energy. Kinetic energy is energy in motion. A hammer descending on a nail to drive it into wood has kinetic energy. A ball rolling down a slope has kinetic energy.

A girl running has kinetic energy. Kinetic energy increases as the mass of the moving object increases. A small body moving at the same speed with a big body does not have the same kinetic energy as the big body. The big body still has more kinetic energy than the small body though they have the same speed.

Potential energy is the energy a body has because of its position. It is the energy of a body at rest. A body at a high position has higher potential energy than a body at a low position. A water tank mounted on top of a roof has higher potential energy than the one on the ground.

A boy moving down the hill has kinetic energy as we already know. But when the boy is standing at the top of the hill, he has potential energy. When the boy comes down to the foot of the hill, he still has potential energy but this time, the potential energy is smaller than the one he had at the top of the hill. Potential energy can become kinetic energy and kinetic energy can become potential energy. Thus the boy standing on top of the hill has potential energy, which is stored until it is released. When the boy starts walking down the hill, the potential energy becomes kinetic energy.

Electrical energy

Electrical energy is the energy we use to operate electrical appliances and equipment like fans, radios, television sets, computers, GSM handsets, electric kettles, fruit blenders, electric irons, etc. We obtain electrical energy from Power Holding Company of Nigeria (PHCN), which supplies electrical energy to our homes, schools and other public places. We also obtain electrical energy from the generators

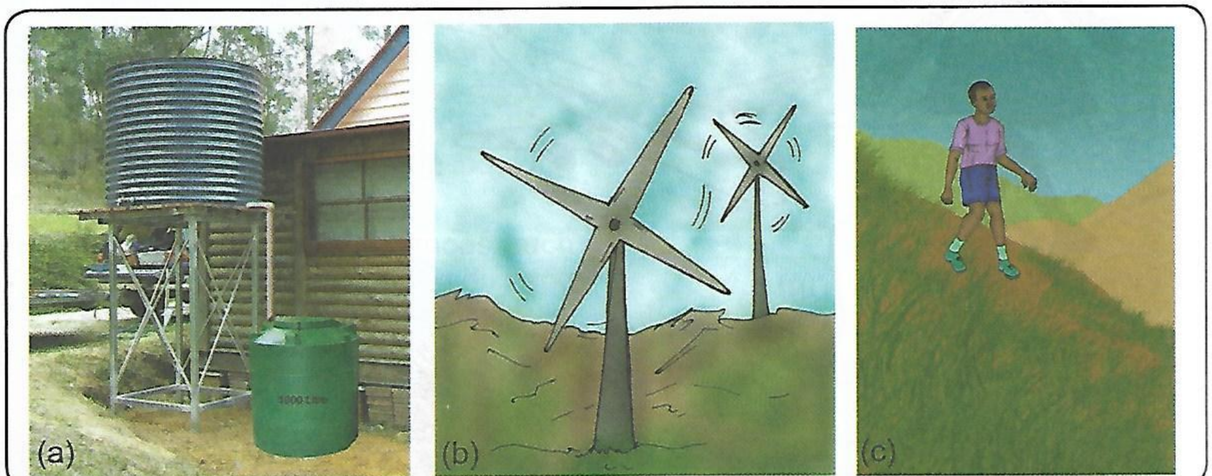


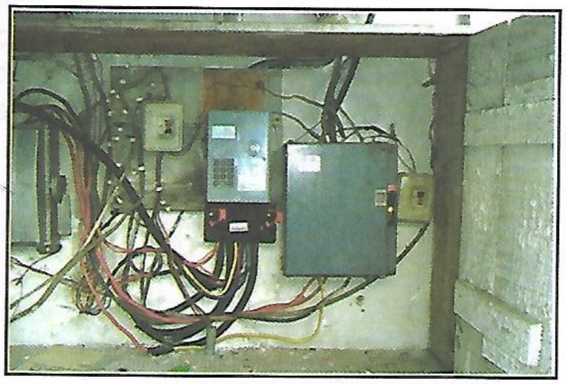
Fig. 10.6 Potential energy

we use in our homes. Motor batteries, torch batteries, GSM batteries, and rechargeable lamp batteries also supply electrical energy. Electrical energy in action gives other forms of energy like heat energy. Also other forms of energy are used to produce electrical energy. You will learn how this is done when we study energy conversion in detail.

Chemical energy

Chemical energy is the energy stored in chemical substances like food, kerosine, wood, animal dung, petrol, coal, sawdust and charcoal. Apart from food, all the other chemical substances mentioned are capable of burning in air. When they burn, the chemical energy in them is changed to mostly heat energy. The heat we use in cooking is obtained through the release of chemical energy, by burning. It is either we burn wood, sawdust, kerosine, gas, coal or charcoal. In the vehicle, petrol burns to release heat energy which makes the engine to run.

The food we eat is a source of chemical energy. When the food is digested in our stomach, the chemical energy is released and stored in our body. The human body is capable of changing the chemical energy in food into other kinds of energy. The heat energy produced from the food we eat makes us feel warm and sometimes hot. The chemical energy in the food also produces muscular energy, which keeps us going.

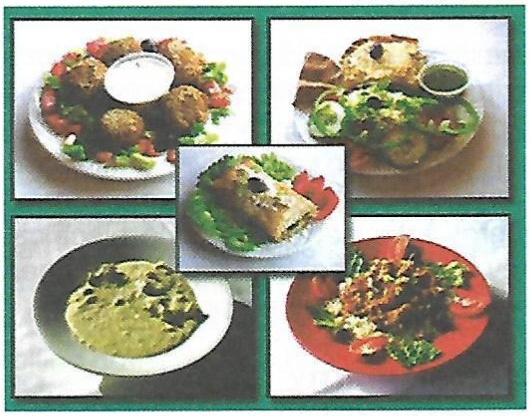


a) A PHCN installation

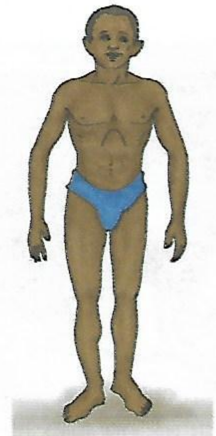
b) Batteries: motor battery, GSM battery and rechargeable lamp battery

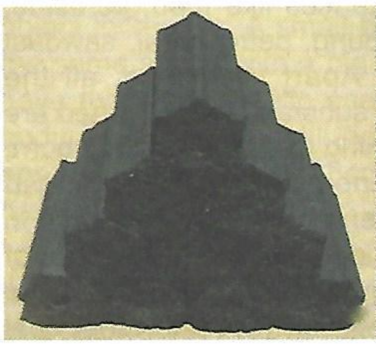
c) A generator

Fig. 10.7 Sources of electrical energy



a) Food





b) Charcoal c) Saw dust d) Animal dung

Fig. 10.8. Sources of chemical energy

Activity 10.4

1 Use a cutlass to cut grass in the school field until you start to sweat.
2 List the forms of energy that are involved in the grass cutting activity.

Sound energy

Sound energy stimulates our ear and vibrates the air. Sound comes from talking, clapping, blowing musical instruments like the flute, trumpet, saxophone; beating drums, playing keyboard and piano. Thunder produces sound. Animals also produce sound. Sound is energy because it vibrates the air and the vibrated air strikes our ears, which hear the sound. Hearing is work and the energy that enables us to hear comes from sound. Some moving objects equally produce sound. When objects collide with one another sound is produced.

Sound travels through a medium and the main medium that carries sound is the air. If sound is not carried by a medium it does not go far and cannot be heard. So sound cannot travel in a vacuum. A person who is talking through a megaphone produces louder sound than the person who is talking ordinarily. Production of sound involves the use of mechanical energy. Talking for example involves the movement of the tongue in the mouth. Remember that mechanical energy is energy from a moving object. The stick used in beating musical drums posseses kinetic (mechanical) energy.

(a)

An accordion

(b)

The use of a megaphone

(c)

A girl shouting

(d)

A dog barking

Fig. 10.9 Sources of sound energy

Activity 10.5

1 In your home or at a music shop, place your hand on the front of a loud speaker while music is on. What do you notice?

2 Let your friend gently ring the school bell near your ear.

3 Describe how you feel.

Light/solar energy

Light or solar energy comes from the sun. which releases the energy through its rays. Solar energy from the sun dries clothes after they are washed. Solar energy enables tree leaves to manufacture food for the tree. Without solar energy, photosynthesis cannot occur in leaves. Photosynthesis is the process by which green plants use solar energy, chlorophyll (the green pigment in the leaves), carbon dioxide and water to produce food (carbohydrate). Without photosynthesis, plants cannot grow and without plants, human beings and other animals will not have food too.

Standing under the sun makes one feel hot. Thus solar energy generates heat.

a)

b)

Fig. 10.10 Solar energy in action

Nuclear energy

All matter is made up of particles. The smallest particle of any matter is called an atom, which in turn is made up of its own part. These parts are electron, proton and neutron. You will learn more about an atom and its parts in the next chapter. Atoms are really small and cannot be seen with naked eyes. To split an atom therefore is not easy but when atoms are split, they give out tremendous energy called nuclear energy. An instrument called cyclotron is used to split atoms. Nuclear energy is used to generate electricity in a nuclear power generating station. However nuclear energy is very dangerous because if not controlled, it can cause harm to both animals and plants. Hence nuclear power stations are not commonly used in generating electricity.

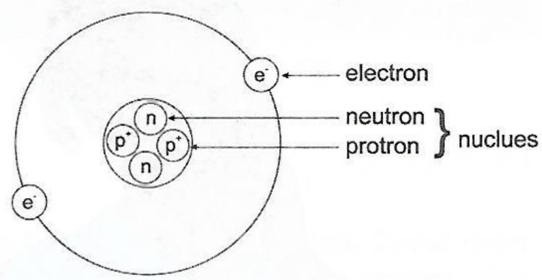
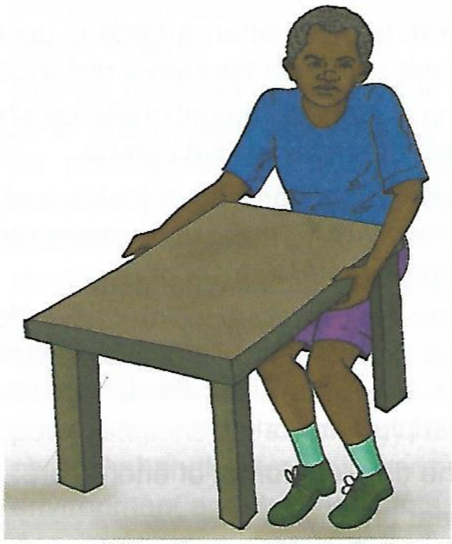


Fig. 10.10 An atom and its parts

10.4 Work

Work is done when energy is used. To say that work is done means that a force has been used to move something through a distance. For instance, force is needed to lift an object. The object being lifted has moved up (a distance) as a result of the force used in lifting it.

The force applied determines the amount of work done and the distance moved in the



direction of the force. Work (w) is then a product of force (f) and distance (d).

Fig. 10.11 A boy lifting a table

It can be expressed as W = F x d. The unit of force is the Newton (N) while distance is measured in meters (m). Work is then measured in Newton meters (Nm) which is also called joule (j).

Example : Calculate the work done when a force of 10 N moves a body through a distance of 30 m.

Solution :

Work = force x distance
= 10 N x 30 m
= 300Nm (or 300 joules)

Note that the force is in Newton and the distance is in meters.

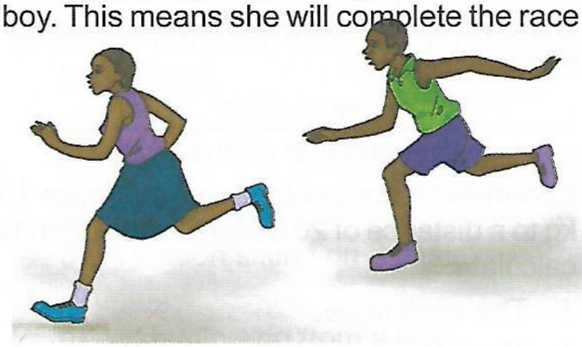
10.5 Power

We often hear that somebody or something is powerful. Think of somebody or something you know that is powerful. What does the person or thing do that shows power?

Power is the rate at which work is done. A powerful person takes less time to do work than a weak person. Power is therefore determined by the work done and the time taken to do it. It can be expressed as

$$\text{P (power)} = \frac{\text{wok done}}{\text{time taken to do the work}}$$

Fig. 10.12(a) shows a boy and a girl running. The girl is running faster than the boy. This means she will complete the race



a) A boy and a girl running

b) A wattmeter

Fig. 10.12

in less time than the boy. She has more power than the boy.

Power is measured in watts (w) with the instrument called wattmeter. One watt is a unit of work done in a unit of time. The more energy one has, the more power the person has and the more work the person can do.

How energy, power and work are related.

Energy is required to do work. That is why work and energy have the same unit. Power is expressed as

$$\frac{\text{work done}}{\text{time taken to do the work}}$$

Example : A boy pushes a load of mass 10 kg to a distance of 20 meters in 10 seconds calculate

1 The work done.

2 The energy used.

3 The boy's power ($g = 10\ m/s^2$).

Solution

1 Work done = Force x distance

Remember that,

force = mass x g = 10 x 10 = 100N.

□ work done = 100N x 20m = 2000 joules

2 Energy needed = work done

= 2000 joules

3 $$\text{power} = \frac{\text{work done}}{\text{time taken to do the work}}$$

$$= \frac{2000}{10} = 200 \text{ watts}$$

Summary

In this chapter, you should have learnt that:

1 Energy is the ability to do work.

2 Work is done when a force is used to move an object through a distance.

3 The higher the amount of energy a body has, the more work it can do.

4 Energy is measured in joules and the instrument for measuring energy is the energy meter.

5 Power is the rate at which work is done, and it is measured in watts. The more the power, the less the time taken to complete a work.

6 The different forms of energy are:

Heat energy

Mechanical energy

Chemical energy

Electrical energy

Sound energy

Solar energy

Nuclear energy.

7 Heat energy comes from burning fuel substances in air. Energy from heat is used in cooking and moving parts of machines like motor cars and generators.

8 Mechanical energy is the energy of an object in motion and it is used to move objects.

9 The two types of mechanical energy are kinetic and potential energy.

10 Electrical energy comes from Power Holding Company of Nigeria (PHCN), generators and batteries, and the energy is used in powering electronic and electrical appliances and equipment.

11 Sound energy vibrates the air, which in turn strikes our ear. Talking, clapping

and playing musical instruments provide sound energy.

12 Energy provided by sunlight is called solar energy, which is used by plants for photosynthesis. Solar energy is also used to dry clothes and evaporate water from the earth's surface.

13 Nuclear energy comes from splitting the nucleus of atoms of material substances. This energy is used in the generation of electricity in nuclear power stations but the energy has to be carefully handled to avoid harm to the environment and its inhabitants.

14 Energy supplies power with which work is done.

Exercise

Choose **Yes** or **No** to answer questions (1-3)

1 Both living and non-living things have energy. Yes/No

2 Energy can be destroyed. Yes/No

3 Energy from the sun is called solar energy. Yes/No

4 A boy running has .... types of mechanical energy.

5 Power is measured in ....

6 ...., ..., and .... are three sources of heat energy.

7 Name 4 forms of energy. ...., ..., ..., and ....

8 Name two appliances that make use of electrical energy. .... and ....

9 Define the term 'Work'.

....

....

10 What is photosynthesis?.....................

....

11 Why does the temperature of boiling water remain constant ? ....

....

12 State the form of energy from the underlisted.

a) Wood ....

b) Atom ....

c) Motor battery ....

d) A person sitting on a chair ....

e) Water flowing from a tap ....

13 Name the forms of energy involved when a farmer is tilling the soil. .... and ....

14 Name the forms of energy involved when a generator supplies light. ...., ..., ...

15 How are energy, power and work related ? ....

16 Three examples of fuel substances are ...., ... and ....

17 When a motorcar moves from the top to the foot of a hill, ... energy becomes .... energy.

18 PHCN means ....

Chapter 11

Basic electronic devices

Introduction

In our daily lives, we make use of electronic appliances like radio, television, GSM handsets, computers, compact disc players, radio cassette players and the organ. Electronic appliances are made up of parts called electronic devices or components. Without these devices working together, the appliances will not give out a good service to the users.

A simple electronic appliance like the walkman can have a few components while a complex appliance like a computer has many components.

The basic component devices we shall study in this chapter include resistors, capacitors, inductors, diodes, transistors integrated circuit and circuit boards. These devices work when electron emission occurs in them. Electron emission occurs when heat, sunlight, electron collision, electromagnetic field and surface bombardment are used to release electrons from a metal surface.

In this chapter, we shall learn about electron emission, electronic devices and how they work to form electronic appliances.

Objectives

At the end of the chapter, you should be able to:

1 sketch the structure of an atom;

2 state the processes of electron emission;

3 identify basic electronic devices and their symbols;

4 list the uses of the devices; and

5 explain the operation of the devices.

11.1 Basic emission theory

Matter as you already learnt is anything that has weight and occupies space. All matter is made up of many elements. An element is that part of matter which cannot be split into simpler matter by an ordinary chemical method. The smallest part of an element is the atom. Atoms in matter join together to form a molecule. Atoms are very small and cannot be seen with the ordinary eye except with the aid of a powerful microscope.

The structure of an atom

Hydrogen is one of the simplest forms of matter that exist. Its atom looks like Fig. 11.1.

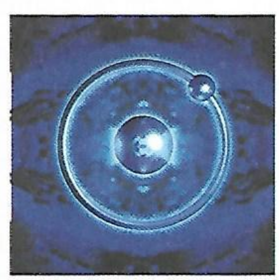


Fig. 11.1 A hydrogen atom

A typical atom has three parts namely **electron, proton and neutron.** The electron carries a negative charge (sign) and is always revolving around the atom. It has the lightest weight among the three parts of the atom. The path along which the electron revolves around the atom is called an **orbit** or **shell**. Generally, the number of electrons in an atom is equal to the number of protons.

The proton is the positive part of the atom. The proton and the neutron form the neucleus of the atom. While the electron revolves around the atom, the proton is at the centre of an atom. The number of protons is equal to the number of electrons. It is for this reason that the atom itself has no positive or negative charge. It is just stable.

The neutron and the proton form the neucleus of an atom. The neutron has neither charge on it i.e. it is neither positive nor negative. It can be said to have a neutral charge. Find below, the structure of the atom of helium.

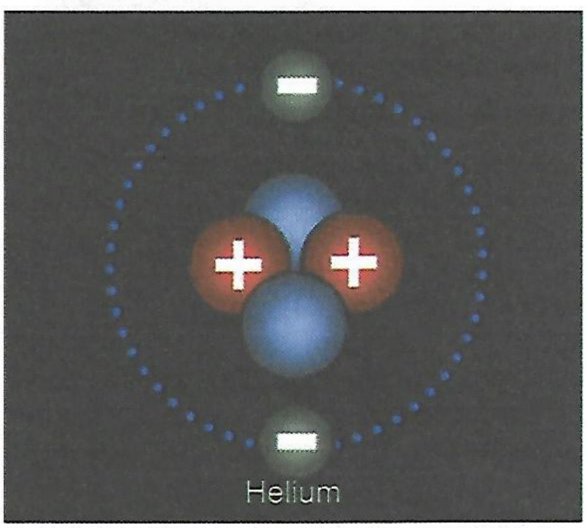


Fig. 11.2 Helium atom

Activity 11.1 Looking at the structure of the atoms

1 Look at the structure of the atom in Fig. 11.2.

2 How many electrons does the atom of helium has?

Electron emission

All forms of matter have particles that are always moving randomly within the matter. The movement of the particles within the matter increases with increase in temperature. At very high temperature, the movement becomes very fast and so intense that the electrons at the outermost shells are thrown off. This process is known as **electron emission.** The energy that emits the electrons can come from sunlight, heat, chemical reaction, electromagnetic field or mechanical friction as in surface bombardment. There are four methods of electron emission. These are:

* Thermionic emission
* Photo emission
* Field emission
* Secondary emission

Thermionic emission (primary emission)

In thermionic emission, heat is used to emit electrons from the surface of a metal. When heat is applied to a metal, the electrons at the outmost shell escape from the metal surface and go into conduction. Electron movement within a conductor constitutes flow of current.

Activity 11.2 Demonstrating thermionic emission

1 Insert a piece of metal in a fire and explain why it becomes hot after a while.

2 Use wire to connect a touch light bulb to a 1.5 volts battery.

3 Explain why there is light.

Photo electric emission

When light from the sun is used to emit electrons from a metal surface, photo emission has occurred.

Many metals can emit electrons easily when the rays of the sun fall on them. However the number of electrons that can be emitted through photo emission depends on the intensity of the light rays. The stronger the intensity, the higher the emission. Photo emission is used in solar panels and automatic door openers.

Field emission (cold emission)

An electric field is the area within which the effect of electricity can be felt. Electrons can be emitted by the use of electric field. This process is known as field emission or cold cathode emission. When two electrodes (conductors); one positive and the other negative are placed in a high electric field, the free electrons from the negative electrode will move over to the positive electrode.

Field emission is used in the operation of electron microscopes.

Fig. 11.3 Solar panels

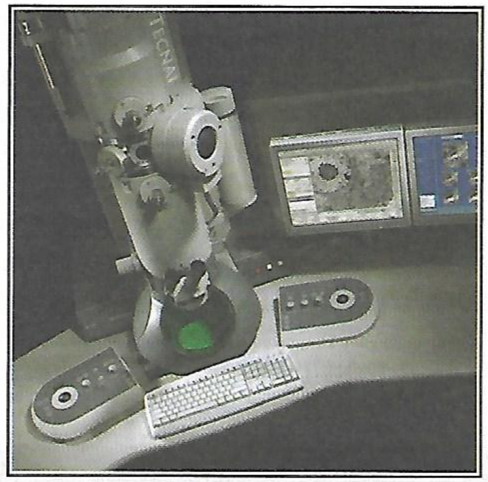


Fig. 11.4 Electron microscope

Secondary emission

In secondary emission, a metal surface is struck by particles (electrons) that move in a straight line at very high speed. Electrons are emitted from the struck metal surface. This is what happens in the fluorescent tube, the screen of a television receiver and computer monitors. The inner surfaces of the tubes are coated with phosphorous substances that can emit light when electrons from other sources strike on them. For instance, electrons are emitted from the terminals of the fluorescent tube when the fluorescent lamp is connected to a power source. The emitted electrons will travel in a straight line at a high speed and strike the inner part of the tube, which is coated with phosphorous. The phosphorous coating will then emit electrons, which then glow as light.

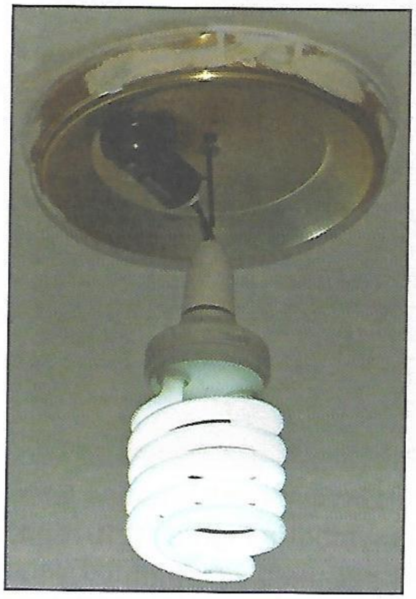


Fig. 11.5 A fluorescent lamp

11.2 Basic electronic devices

Electronic devices depend on electron movement for their operations. The basic electronic devices we find in basic electronic appliances are

1 resistors;
2 capacitors;
3 diodes;
4 transistors;
5 integrated circuits (IC);
6 inductors; and
7 circuit boards.

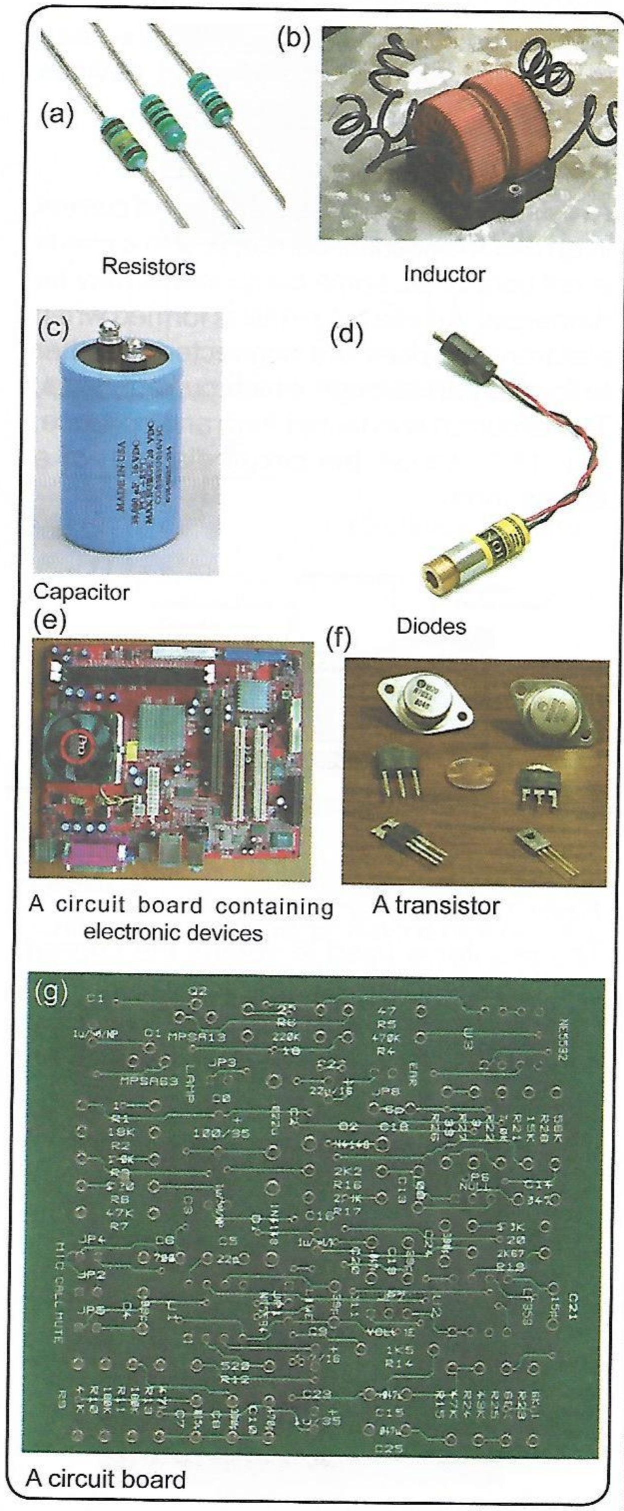


Fig. 11.6 Basic electronic devices

Activity 11.3 Visiting a TV technician

Visit a radio/television technician's shop to see the different component devices mentioned in Fig11.6.

Resistors

A resistor is used to control the flow of current in an electric circuit.If current flow in a circuit is not controlled, some components may be damaged. An electric circuit is formed when electronic devices are connected together to form a part through which current flows. The circuit so connected form an appliance. Fig. 11.7 shows the circuit diagram of a simple torch.

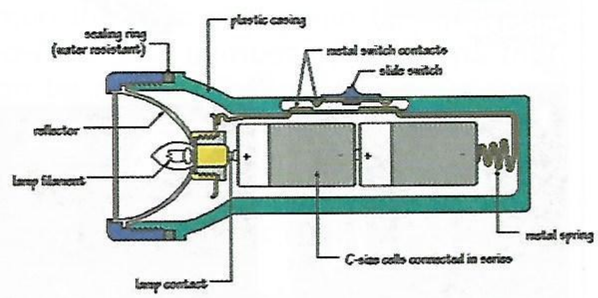


Figure 11.7 The circuit diagram of a torch

The resistor is used to control the current that flows to the bulb. Resistors made from carbon are called **carbon resistors**. Most carbon resistors have their values written on them.

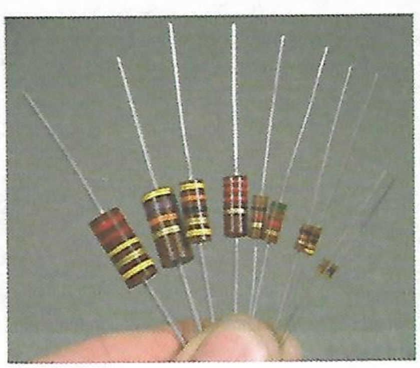


Fig. 11.8 Carbon resistors

The ability of a resistor to control the flow of current is called **resistance**, and it is measured in ohms (Ω). We use an instrument called **ohmmeter** to measure the value of a resistor.

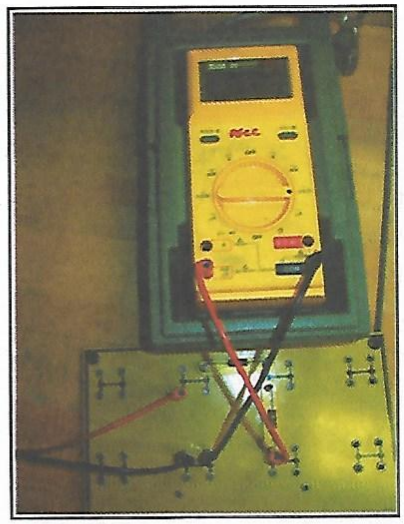


Fig. 11.9 An ohmmeter

This symbol in Figure 11.10 represents a resistor with fixed value. If the value is not fixed, it is called a variable resistor and the symbol is as shown in Fig 11.11

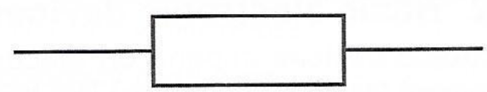


Fig 11.10 A fixed resistor

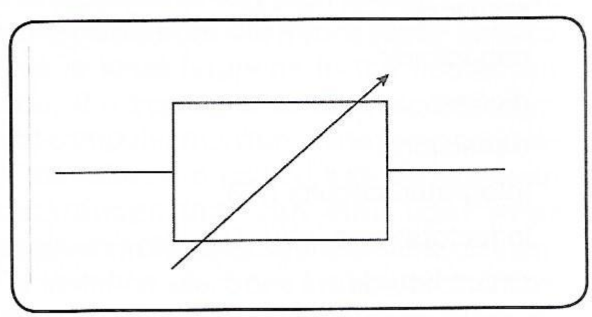


Fig. 11.11 A variable resistor

Capacitors

A capacitor is a device that stores up electrical energy in a circuit. It is generally made up of two metals, which are separated by an insulating material called a **dielectric material.** The dielectric material is usually made from paper, ceramics, mica, electrolyte or air. It is in the dielectric that the capacitor stores the energy.

A typical example of a capacitor is what is generally called a condenser or starter in a fluorescent fitting. The function of the starter is to build up electrical energy (charges) that starts the fluorescent lamp.

The ability of a capacitor to store electrical energy is called **capacitance** and this is measured in a unit called **farad** (F). The capacitance of a capacitor depends on the type of dielectric material used, the area of the metal part and the distance between the plates.

Capacitors come in different shapes and sizes. Some are rectangular in shape and some can have circular or cylindrical shapes.

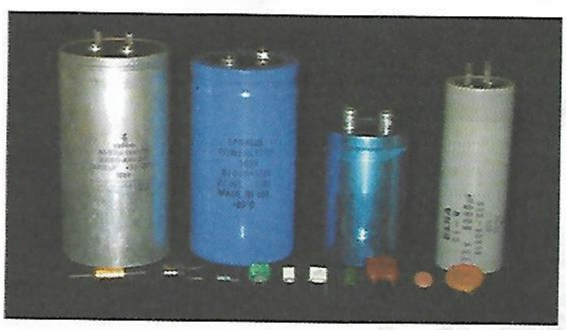
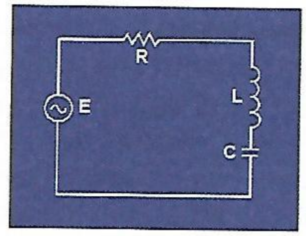
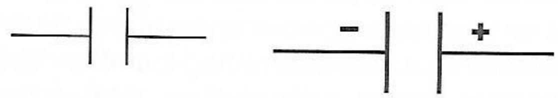


Fig. 11.12 Various capacitors

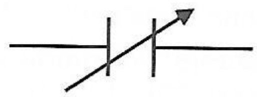
Capacitors can have fixed or variable values. The symbols of the different types of capacitors are shown in Fig. 11.13.



A capacitor in a circuit



A fixed capacitor A polarised capacitor



A variable capacitor

Fig. 11.13 Symbols of capacitors

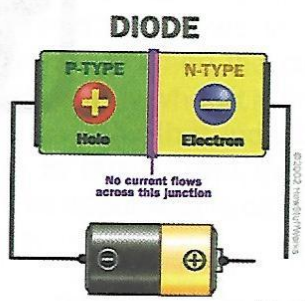
Activity 11.4

1 Obtain some capacitors from your school shop.

2 Examine the capacitors to identify the dielectric materials used in making them.

Diodes

A diode is an electronic device that has two terminals called electrodes. One electrode is positive (+) while the other is negative (-).Diodes come in different shapes and sizes but all perform the same function. When a diode is connected in a circuit, it allows current to pass in only one direction.



Symbol

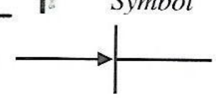


Fig. 11.14 A diode

How the diode works

There are two types of current– **alternating current (a.c) and direct current (d.c).** We get alternating current from the public power supply (Power Holding Company of Nigeria), and a.c generators. Direct current comes from batteries and d.c generators. Most electronic devices operate with direct current and not alternating current. The diode is one of such devices. When the diode is connected in a circuit, it allows current to flow only in one direction.

The current that enters the diode is the alternating current but the current that comes out of it is a direct current. In this way we say that the diode converts alternating current into direct current. This process is called **rectification**. For the diode to pass current in only one direction, its positive terminal must be connected to the positive terminal of the supply (positive half cycle) and its negative terminal to the negative terminal of the supply (negative half cycle). This arrangement is called forward biasing.

Fig. 11.15 Sources of direct current

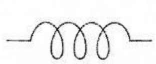
Uses of diodes

The diode is used for the following purposes.

1 It is used for rectification (conversion of a.c to d.c).
2 It is used as a light-emitting device.
3 Diodes are used to detect radio and television signals in radio and television receivers.
4 Zener diodes are used to stabilise current supplied to other devices.
5 Diodes are also used as matches.

Inductors

Fig. 11.16 shows inductors in different forms. An inductor is made up of coils of wire and sometimes wound on a material called core. Inductors are used to store energy in the form of a magnetic field. Inductors wound on a core store more energy than inductors without a core. Iron is the commonest core material use in inductors.



the symbol of an inductor

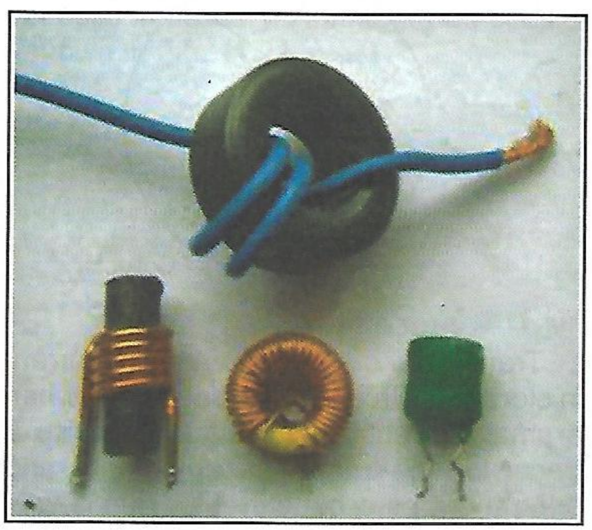


Fig. 11.16 Inductors and their symbol

Inductance is the ability of an inductor to store energy in its magnetic field. When inductors carry current, they behave like magnets. The magnetic field is the area around a coil (inductor) carrying current in which the magnetic effect is felt.

When a material like iron (ferrous) is used as a core for an inductor, the inductance is higher than when a nonferrous material is used. Another factor that determines the inductance of an inductor is the number of turns of coil. The higher the number of turns the higher the inductance of a coil.

An inductor can have a fixed value or a variable values as shown in Fig. 11.17

Inductance is measured in a unit called

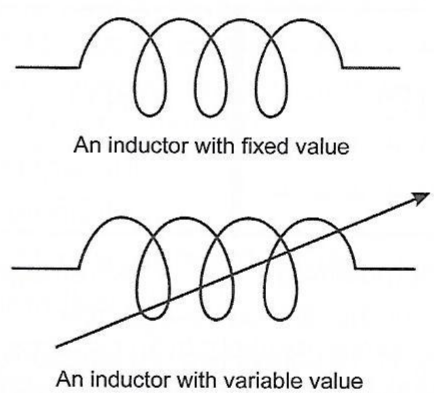


Fig. 11.17 Symbols of fixed and variable inductors

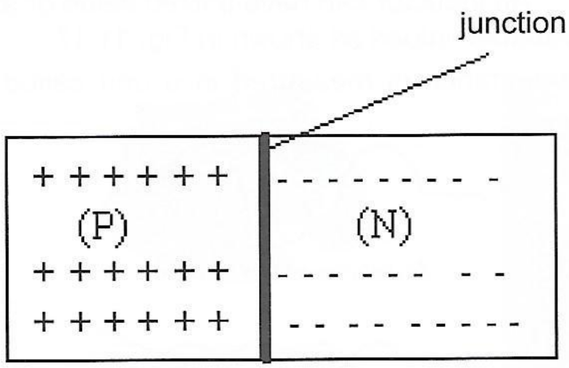
Henry (H). Inductors react to changes in the current that flows in a circuit by supplying energy when the current is low and storing energy when it is in excess. We can therefore say that inductors oppose a change in the current that flows in a circuit. This opposition is called **inductive reactance.**

Activity 11.5 Identifying the inductor with the highest inductance

1. Obtain different inductors to identify the core materials.
2. Which of the inductors examined has the highest inductance?
3. Why do you say so?

Transistors

The diode we have just discussed has positive (p) and negative (n) sides. Between the p-side and the n-side, a junction is formed. We can therefore call a diode, a p-n junction as illustrated in Fig. 11.18.

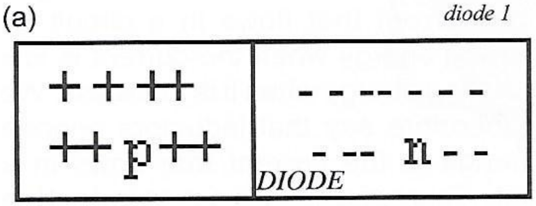


p- side(positive) n - side(negative)

Fig.11.18 The diode as a p-n junction

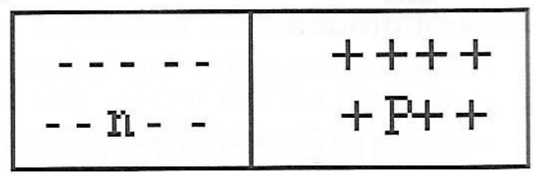
Fig. 11.19 shows two p-n junction diodes joined back to back. What we get by joining the two junction diodes back to back is the transistor. A transistor is made up of two p - n junction diodes joined back to back.

(a) *diode 1*



P-n junction

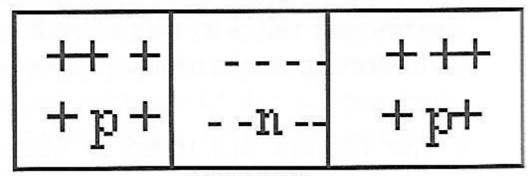
(b) *diode*



p - n junction

a and b ionised back to back (diode1 + diode 2)

(c)



TRANSISTOR

p - n junctions 1 & 2

Fig. 11.19 Formation of a transistor from two p-n junction diodes.

Notice that the n-sides of diodes I and 2 have been brought together to form one n-side of the transistor.

The transistor formed in Fig. 11.18c has three terminals pnp. This is called a pnp transistor.

A transistor has three terminals namely **emitter, base and collector** as shown in the PNP transistor symbol in Fig. 11.20.

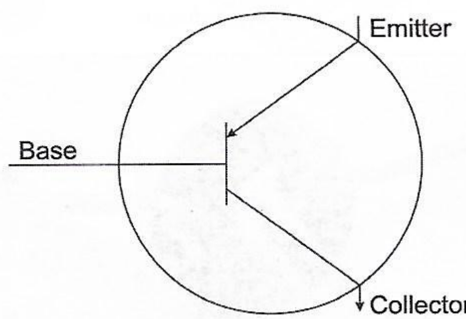


Fig. 11.20 The symbol of a PNP transistor

Transistors are used to amplify current in electronic circuits. This means that when a small current is allowed to flow into a transistor, the transistor will increase and bring it out as a big current. This is why transistors are used as amplifiers.

Transistors come in different sizes and shapes. But all of them have three **electrodes: emitter, base and collector.**

Activity 11.6 Forming an npn transistor

1 Follow the process in Fig. 11.18 to form an npn transistor

2 Draw its symbol.

3 Obtain different shapes of transistors and draw what you see.

Integrated circuits (IC)

An integrated circuit is an electronic device that contains some other electronic devices in one single unit. In an integrated circuit, we have resistors, capacitors, diodes, inductors, transistors, etc., all combined to form one device. The devices are integrated into one, hence the name **integrated circuit.** By this arrangement, the space occupied by the individual devices in an electronic appliance has been reduced and integrated circuits have made electronic appliances smaller in size. So, it was the need to reduce the sizes of electronic equipment that made integrated circuits necessary. An integrated circuit is shown in Fig. 11.21

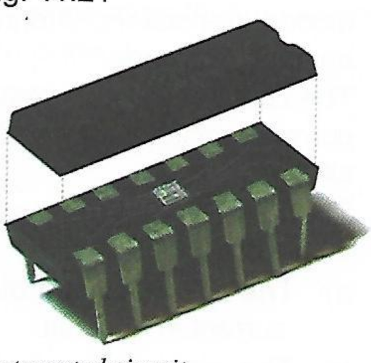


Fig. 11.21 An integrated circuit

Electronic devices such as amplifiers, power supply, signal detectors which used to contain many components now come as a unit that is sometimes smaller than one of the former component parts.

Activity 11.7 Examining ICs

1 Visit a radio/TV technician. Let him show you some ICs. You will notice that the ICs have many pins.

2 Watch the technician solder the ICs to circuit boards.

Circuit boards

You would have observed when you visited a radio/television technician that the electronic devices we have discussed are assembled on a board. This board is called a circuit board. A circuit is formed when electronic devices are connected together and usually on a circuit board. A circuit board is mostly made from conducting materials such as copper.

Three types of circuit boards are used in electronics. These are

1 Breadboard

2 Perfboard

3 Printed circuit board (PCB)

The breadboard

The breadboard is made from plastic. Rows of holes are drilled on the board and it is in these holes that the electronic devices are fitted. Flexible wires are then used to interconnect the devices to form a circuit. The connections are made on the reverse side of the board.

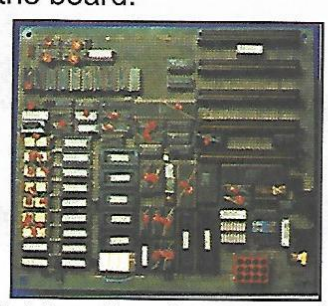


Fig. 11.22 A breadboard

The perfboard

A perfboard looks like the breadboard but it is different. A thin sheet of an insulating material that has been laminated is used to make the perfboard. The holes made on the perfboard are at regular intervals. To form a circuit, metal pins are pushed into the holes where a device is to be connected. It is on the pins that the wires are soldered to form the circuit.

The printed circuit board (PCB)

The printed circuit board is the commonest circuit board used in the manufacturing of electronic equipment. It is made from sheets of insulating material and on this material, thin lines made of copper are bonded to form the circuit path. It is on this circuit path that electronic devices are soldered to form a circuit. Remember that in the perfboard and breadboard, wire is used to connect the devices but in the printed circuit board, devices are soldered on the copper lines. Printed circuit boards are shown in Fig. 11.23.

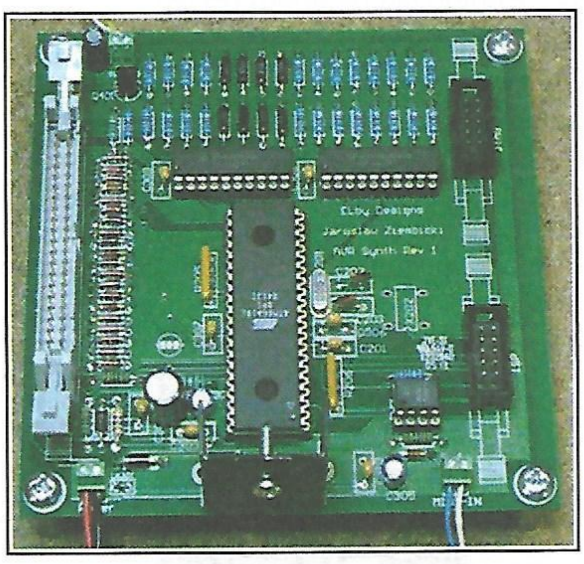


Fig. 11.23 A PCB

Activity 11.8 Making a breadboard

— Use a piece of paper to make a breadboard.

Summary

In this chapter, you should have learnt that:

1. The parts of an atom are electrons, protons and neutrons.
2. The electrons in an atom move about randomly.
3. Electrons can be boiled off (set free) from metal surfaces through electron emission.
4. Heat, electric field, sunlight and secondary bombardment of a surface can be used to emit electrons from metal surfaces.
5. The different forms of electron emission are thermionic emission, photo emission, cold emission and secondary emission.
6. Electronic devices function as a result of electron movement.
7. Common electronic devices found in electronic appliances and equipment include resistors, capacitors, inductors, diodes, transistors, integrated circuits and circuit boards.
8. The connection of the devices so that current can flow through them forms a circuit.
9. The devices used in a circuit are as follows:
    a) **The resistor:** controls the flow of current in a circuit.
    b) **The capacitor:** stores electrical energy.
    c) **The diode:** converts alternating current into direct current.

d) **The inductor:** stores energy in the form of a magnetic field.

e) **The transistor:** amplifies current.

f) **The integrated circuit:** combines electronic devices in one small unit to reduce the size of electronic appliances.

10 Electronic devices are assembled, connected and soldered on a circuit board.

Exercise

Choose the correct option that answers the question.

1 The lightest part of an atom is the

A proton

B orbit

C electron

D neutron

2 The nucleus of atom contains

A electron, proton and neutron

B electron and neutron

C electron and proton

D proton and neutron

3 The part of the atom that moves round the atom is the

A electron

B orbit

C proton

D neutron

4 Electron emission can be done with

A heat

B sunlight

C electric field

D all of the above

5 Which of these is an electronic device?

A A resistor

B A torch

C A walkman

D An amplifier

Complete the following sentences with the right words.

6 ______________ stores energy in the magnetic field.

7 The three parts of a transistor are (a)__________ (b) ______________ (c) ________.

8 Rectification is the conversion of _____ ________ into _______________

9 IC means ____________________.

10 PCB means ____________________.

Chapter 12

Types of buildings and building materials

Introduction

We all live in houses or buildings. Houses provide us shelter, which is one of the most important things we need in life. There are different types of buildings. The type of building one builds depends on how rich the person is and what the building will be used for. Certain materials are needed to construct a building. These materials are called building materials. Different materials are needed for different purposes in a building.

Objectives

By the end of this chapter, you should be able to:

1 identify various types of buildings and common building materials;

2 state five uses of buildings.

12.1 Types of buildings

Buildings are generally classified according to their uses. The following are different types of buildings:

1 **Residential buildings** are houses we live in.

2 **Commercial buildings or stalls** are those buildings where buying and selling activities are done.

3 **School buildings** are buildings where teaching and learning take place.

4 **Hospital buildings** are buildings where healthcare services are rendered.

5 **Hotel buildings** are where hospitality is given. That is where strangers and visitors are taken care of.

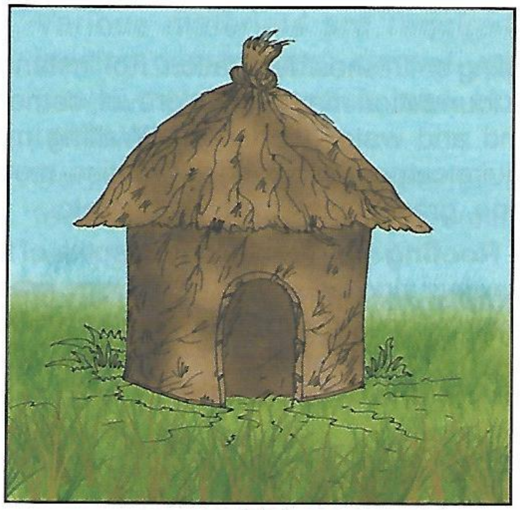
6 **Office buildings** are buildings where people do their office work.

7 **Church/mosque buildings** are buildings where religious activities are performed.

Apart from classifying them according to their uses, buildings are also classified according to the number of floors they have. For instance, a building with only the ground floor is called a **bungalow** while those with one or more floors are called **storey buildings.** Very tall storey buildings with many floors are sometimes called **skyscrapers.**

Fig. 12.1 A traditional thatched house

(a)

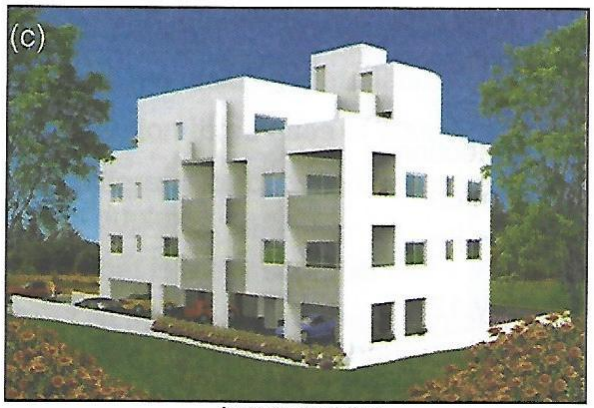


A hut

(b)

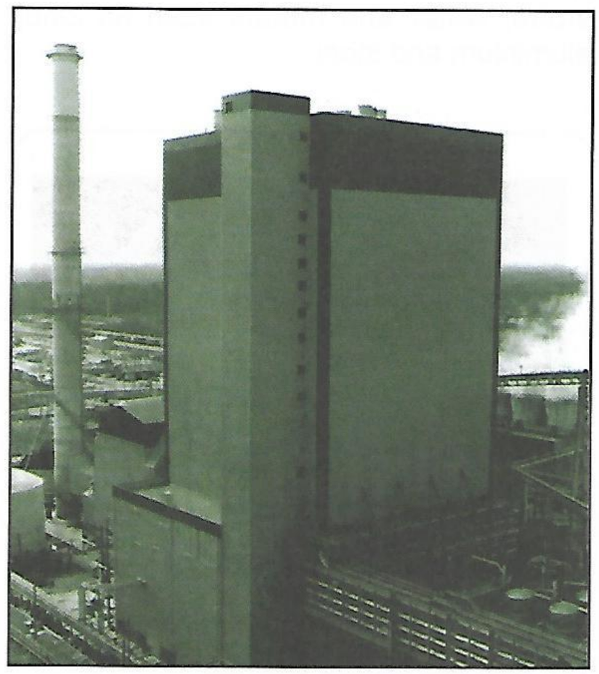
A modern bungalow

(c)



A storey building

(d)



An industrial building

(e)

Skyscrapers

Fig. 12.2 Types of buildings

Sometimes, residential buildings (bungalows and duplexes) are given such names as detached, semi detached or terraced building. A detached building is a residential building standing alone. Semi - detached/twin or terraced buildings are series of unit buildings along a line joined together with common dividing walls. A duplex is a unit of a two - floor residential building.

12.2 Building materials

Many types of materials are required in building construction. Some of these materials are cement, sand, gravel, glass, plastics, wood, ceramics, grass, mud, stone, water and metals such as zinc, aluminium and steel.

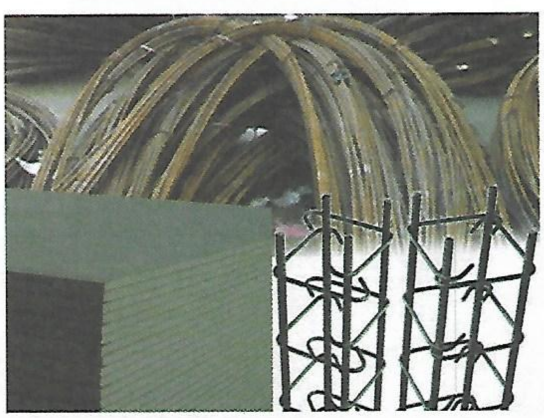


Fig. 12.3 Some building materials

Uses of building materials

Different building materials are required for different purposes in a building. Some materials are needed for the **foundation,** while others may be needed for walling, roofing or finishes/decoration. For instance, the foundation may require gravel, cement, sand and water (concrete). Walling may require cement, block/brick, plastics, metal, stone, grass, glass, zinc, timber, etc.

Roofing may require any or some of the following: zinc, asbestos, aluminium, grass, concrete, timber, etc. **Finishes/decoration** may need any or some of the following: paint, cement for plastering, ceramics, tiles, etc.

12.3 Uses of buildings

A building provides us with the following:

1 shelter
2 privacy
3 protection
4 comfort
5 security.

Activity 12.1

1 Look around your school and home environment and list the types of building you can see.
2 Mention other building materials not mentioned in this chapter.
3 Examine your classroom block. Make a list of all the materials used in its construction from foundation to finishes.

Summary

In this chapter, you must have learnt that

1 There are various kinds of buildings, such as residential buildings, commercial buildings, schools, hospitals, hotels, offices, churches and mosques. These are classified according to their uses.

2 Various materials are required in buiding construction: cement, sand, gravel, metals, ceramics, mud, stone, bricks, etc.

3 Some materials are needed for foundation, others are for walling, roofing and finishes.

4 Buildings give us shelter, comfort, privacy, protection and security.

Exercise

1 List three types of buildings.

2 Mention two classes of buildings according to the number of floors.

3 List ten building materials.

4 Mention three uses of buildings.

5 Differentiate between a bungalow and a duplex.

6 What is a sky scrapper?

7 List five building materials required for walling.

Chapter 13

Simple blueprint reading

Introduction

The building industry, (like other fields of technology) works with ***blueprints*** *as* the means of communication between the builders and building designers(architects). Blueprints are finished plans of what is to be produced or built. That is, blueprints are the complete drawings builders use at their building sites to build. Builders interpret the architect's floor or ground plan and mark it exactly on the ground prepared for the purpose at the site. When this is done and checked to ensure that it is done correctly, the builder can proceed to dig the trenches for the foundation. The whole process of marking on ground what is in the drawing is called 'setting-out'. You will soon learn more about the setting-out process.

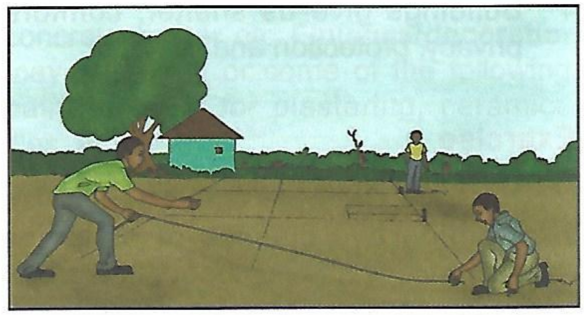


Fig. 13.2 Builders in the setting-out process at a site

In the building industry, the blueprint is also called the working drawing. While the blueprint is made by the architect, it is the duty of the builder to interpret it correctly. Mistakes or errors could be too costly. Therefore, blueprint reading requires high-level knowledge of architectural and engineering drawings. It also requires ability to understand measurements and to measure accurately.

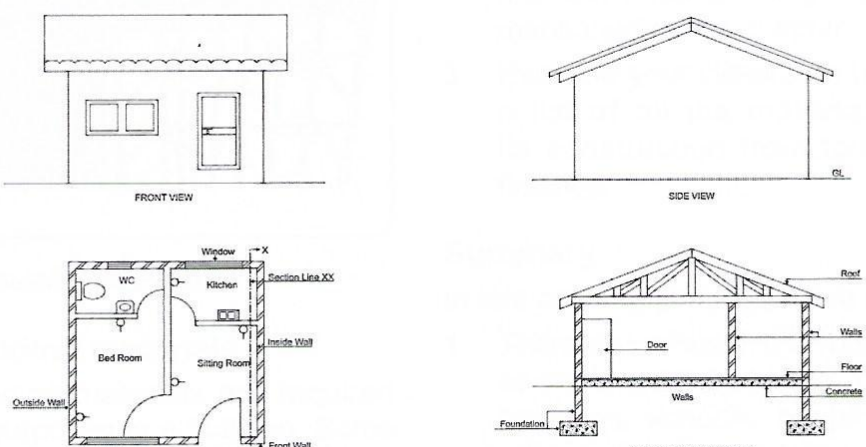


Fig. 13.1 A building plan

In this chapter, you will learn only the elementary aspects of blueprint reading. As you study further, you will be excited by what you learn.

Objectives

As you study this chapter, you should be able to:

1 interpret simple building plans; and

2 identify important components of a simple domestic building.

13.1 Drawing as a language

Language is a means of communicating one's idea to another who understands the language. This could be in spoken or written form. Written form of language uses codes and symbols to communicate. For one to understand a written language, one must first understand the codes and symbols. Building design is done by written language in codes and symbols. These codes and symbols must first be understood. The language of lines must be understood first before the understanding of codes and symbols.

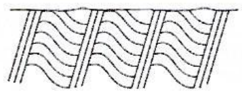
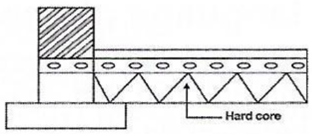
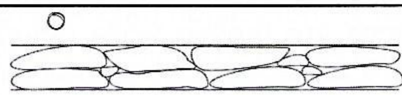
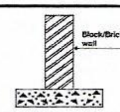
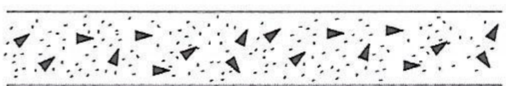
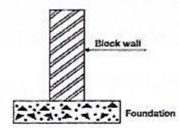
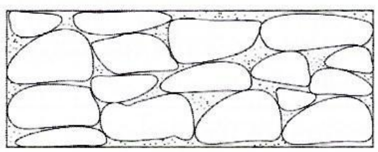
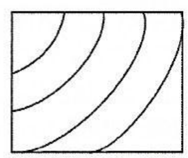
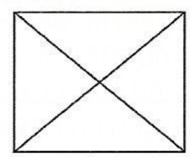
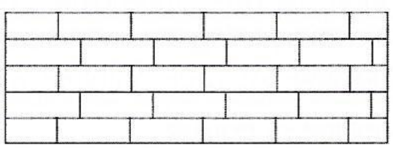
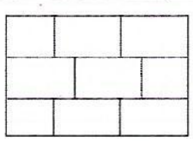
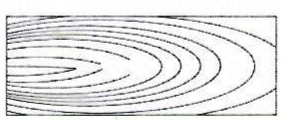
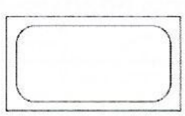
13.2 The language of lines

Study the building plan at the beginning of this chapter. You will find that some lines are thick or broad while others are thin. Some lines are broken while others are not. There are some that are not straight lines. They say different things. Look at their meanings here:

Table 13.1 Lines and their uses.

Types of lines	Uses
	Thin line is used for sectional cut, construction lines and projection lines.
THIN LINE (thin) DOTTED LINE (thin)	Thin short dashes for hidden detail.
CENTER LINE (thin)	Thin long chain for center lines and path lines indicating movement.
THICK LINE (thick)	Thick line for outline or border.
SECTION LINE (thick)	Thick angle line with view direction arrow for cutting plane.
LONG BREAK LINE (thin)	Ruled line with short zigzags for cut-off sections.
WAVY LINE (thick)	Thick wavy line for breaks and irregular boundary.
DIMENION LINE (thin)	Thin line with dot or arrow head used for dimension lines.
SHORT (thick) DASHES (could be curved)	Drain and pipe lines.

Building symbols

Symbols	Meaning
	Earth or soil
	Strip foundation
	Hardcore 
	Mass concrete floor slab 
	Stone work  
	Brickwork
	Block work
	Timber
	Bath

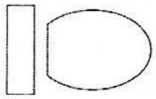
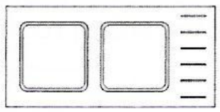
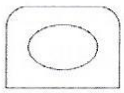
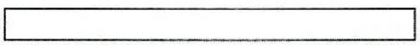
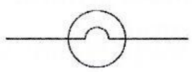
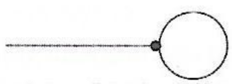
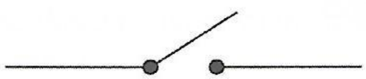
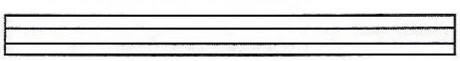
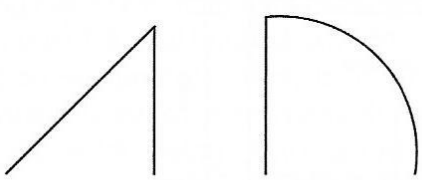
	Toilet
	Sink
	Wash basin
	Fluorescent tube
	Filament bulb
	Socket outlet
	Switch
	Electricity meter
	Window
	Door

Fig. 13.3 Building symbols and their meanings

13.3 Reading a building plan

Study the building plan in this chapter and identify the building, electrical and plumbing symbols shown.

Reading dimensions

A simple building has two main parts:

1 The part underground or the foundation or sub-structure and

2 The part above the ground or the real building or super-structure.

The upper part or super-structure of a simple building has the following components:

1 Floor

2 Walls

3 Roof

4 Doors and windows

Activity 13.1

Now, identify these components in the building plan. Also find out the following:

1 Overall length and breadth of the building;

2 Wall thickness;

3 The length, breadth and area of the bed room and the sitting room.

Summary

In this chapter, you should have learnt that:

1 A building design is done by written langauage in codes and symbols.

2 Different lines and symbols are used for representing different parts of a building.

3 A simple building has two main parts: the part underground and the part above the ground.

Exercise

Draw a building plan of your house, church or mosque. Make good use of lines and symbols.

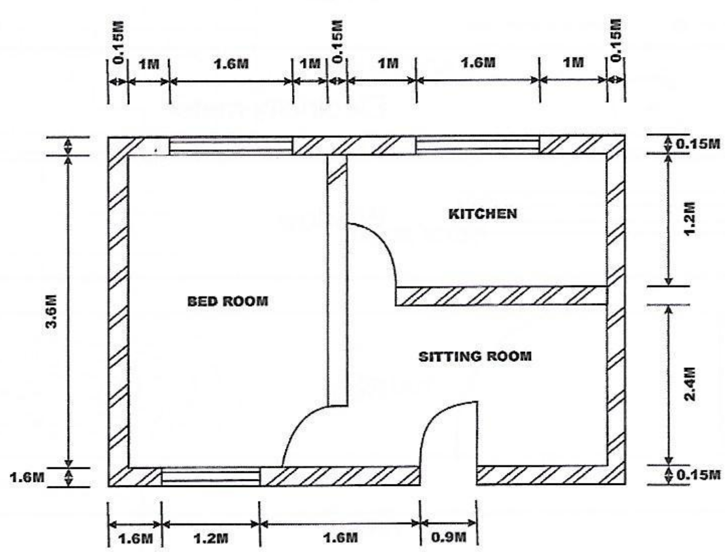


Fig. 13.4 The plan of a one-bedroom building

Chapter 14

Maintenance

Introduction

Everything we have in our school and home need to be taken care of. Equipment, tools, furniture, dress, books, etc need to be kept in good order. If our school chair, locker or desk become dirty or shaky, we need to dust, clean or repair them as the case may require. Why do we need to take care of our things?

Objectives

At the end of this chapter, you should be able to:

1 define maintenance;
2 explain the importance of maintenance; and
3 list and describe types of maintenance practices.

14.1 The concept of maintenance

Maintenance is an action taken on anything to keep it working or to restore it to a good working condition. If an item is not properly taken care of, it may break down. Where the item is an equipment or tool, its breakdown will cause a lot of inconveniences and delay the work being done. Sometimes, an item can cause loss of life. To prevent item breakdown, there should be regular maintenance.

14.2 The need for maintenance

Maintenance is very necessary to ensure that a piece of equipment/item remains functional and serves us better. Specifically, maintenance is carried out to:

1 make the item or equipment function properly;
2 avoid preventable breakdown;
3 reduce chances of accidents and ensure safe use;
4 avoid the inconvenience of equipment failure;
5 make the item or equipment last longer; and
6 reduce loss of time and thereby save money.

14.3 Types of maintenance

There are various types of maintenance that can be carried out on an equipment at different times. These include:

1 Preventive maintenance

This is the type of maintenance carried out on an equipment before breakdown occurs. For instance, a sewing machine may need oiling every two weeks. So, every two weeks, oiling is applied to prevent breakdown. Vehicles may need oil every two to three months just to ensure that they run smoothly. These are preventive maintenance activities since neither the sewing machine nor the vehicle is allowed to break down before maintenance takes place. This type of maintenance prevents the possibility of any major breakdown.

Some equipment such as electronic gadgets come with manuals having preventive maintenance guidelines. Most preventive maintenance activities are regular, predetermined and planned in advance. Preventive maintenance usually involves activities like cleaning, oiling, greasing, checking, adjusting and servicing

2 Corrective maintenance

Corrective maintenance involves actions taken to restore or correct a broken down equipment to a functional state. An equipment can break down suddenly without any prior signal. Corrective maintenance is usually expensive and time consuming. In this type of maintenance, the equipment may need a total overhaul and some parts may need to be replaced or repaired, and both require money and time. Just as the name suggests, it is corrective in nature.

3 Predictive maintenance

This is the type of maintenance carried out on an equipment when there is a breakdown signal. Such signals are change in sound, noise, red light (indicating danger) increase or decrease in speed (signalling impending breakdown). Any action taken to forestall total breakdown when a breakdown signal is noticed is ***predictive maintenance***. Breakdown signals help to forecast or predict possible breakdown and then steps are taken towards avoiding it. Predictive maintenance involves such actions like checking, adjusting, replacement of parts, servicing, etc.

Summary

In this chapter you should have learnt that:

1 Maintenance is very necessary for all items and equipment.

2 Maintenance helps an item or equipment to look better, last longer and function better.

3 There are three types of maintenance, they are preventive, corrective and predictive maintenance.

4 Preventive maintenance is carried out to prevent breakdown of an equipment.

5 Corrective maintenance is carried out to restore an already broken down equipment.

6 Predictive maintenance involves taking action to prevent an impending breakdown. Such breakdown is usually noticed through signals.

Exercise

1 State four benefits of maintenance.

2 Differentiate between preventive and predictive maintenance (give examples).

3 Restoring broken down equipment is ___________ maintenance.

4 What do you understand by the term maintenance?

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