ACCELERATED LEARNING PROGRAM

SCIENCE

LEVEL 3

SECRETARIAT OF EDUCATION
NEW SUDAN

ACCELERATED LEARNING PROGRAM

SCIENCE

LEVEL 3

Secretariat of Education
New Sudan

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SUDAN BASIC EDUCATION PROGRAM

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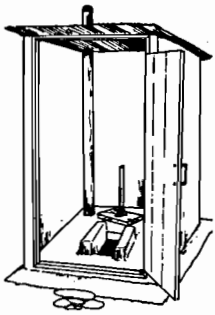
UNIT 1 Health Education

Sanitation

Sanitation refers to the systems and equipment used to keep places clean, especially in regard to human waste. Human waste includes urine and faeces. Other kinds of waste are waste water from cleaning and bathing and rubbish.

Where do we dispose of these wastes? Waste water must be drained away from places where people live. Rubbish must be collected and put in special areas for disposal, and urine and faeces are disposed in pit latrines and toilets. Waste water from bathing and from toilets is called "sewage". Modern towns and cities have sewage pipes for disposing of sewage. In other towns and villages faeces and urine are collected in pit latrines.

Look at the pictures of the two types of toilets. Which do you think is more sanitary? Which requires more water? How can pit latrines be made sanitary?



Pit latrine

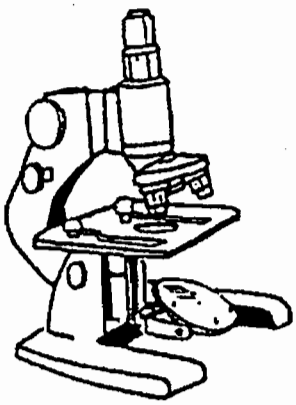
Flush toilet

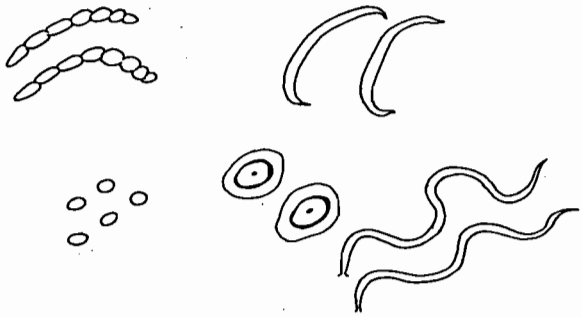
Questions:

1. In your home or school, where do you dispose of faeces and urine?
2. Check the pit latrine at your school. Does it look sanitary? How can sanitation be improved at your school?

Sanitation and Germs

Diseases make us ill and may even cause death. Many common diseases are caused by germs. The scientific word for "germ" is "micro-organism". Germs are very tiny living things that can make us ill if they enter our bodies. They can only be seen with a microscope, and hospitals have microscopes to look for germs in samples of blood, urine, or faeces of people who are ill.

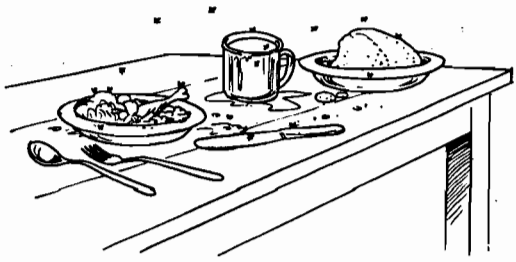




Germs are found everywhere in the environment. Not all germs are harmful, in fact, some are beneficial to us. Germs that cause disease are called "disease germs". There are different kinds of disease germs that cause different diseases such as cholera, typhoid, and dysentery.

Disease germs are spread from person to person in several ways. Some kinds of germs are found in the faeces of people who have a disease. They multiply rapidly in the faeces and are present in the faeces when the person visits the toilet. The germs can enter another person's body if the faeces aren't disposed of in a sanitary way. For example, if a person is ill and doesn't wash his or her hands after visiting the toilet, a small amount of faeces may come into contact with food and the germs can be passed to another person who then becomes ill.

Flies may land on the faeces where they may pick up disease germs. They then fly to uncovered food. When we eat the food the germs enter our bodies and we become ill.



Questions:

1. What is a germ? What is a disease germ?
2. Explain two ways in which disease germs are spread.
3. Look at the picture of the table and food. What is wrong with the way the table is laid?
4. Explain why it's important to keep pit latrines covered in relation to germs and flies.
5. What are the common diseases in your area? Can you relate them to the sanitation in your locality?

Other Ways Germs are Spread

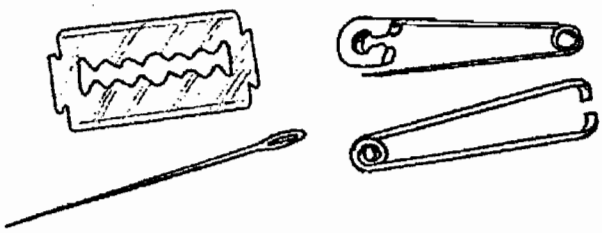
We have seen how germs are spread from one person to another when we eat food or drink water that has come into contact with the germs. There are several other common ways that germs are spread.

First, if we are injured and there is a cut in our skin, germs in the soil, dust or air can enter our bodies through the open wound. The wound will then become infected which requires strict cleaning of the area or antibiotics for it to heal.

Secondly, germs can be spread through the air. For example, a person with a cold or tuberculosis can spread the disease when he or she breathes, coughs, spits, or sneezes. If another person is standing nearby, he or she can breathe in disease germs and catch the disease.

Another way germs are spread is by sharing razor blades, needles, and ear-piercing instruments. If an ill person uses the instrument first some disease germs may be on it, and they will be spread to the next person who uses it. This is one of the ways HIV/AIDS is spread, so you should always be careful not to share such instruments with other people.

This is why sharing syringes in hospitals can spread disease. The syringe may transfer germs from the blood of a sick person to a healthy person. Syringes must always be sterilized. Sterilization requires heating the instrument to a high temperature so that all the germs are killed. In well-equipped hospitals a new syringe is used with each patient.



Look at the picture. What happens after the leg has been injured? What do you think could be done to prevent germs entering the body of the injured person?

In this picture how is the boy spreading germs? What do you think could happen to the girl? How can the boy avoid spreading germs to other people?

Look at this picture. What is the doctor doing to the patient? How could the doctor spread disease germs to the boy?

The Importance of Clean Water

Water that is not clean has many germs in it which can make people and animals sick. Water that is dirty is called "contaminated water". Contaminated water needs to be cleaned before it can be used. It should never be used for drinking or washing.

Look at the picture below. In the picture you can see:

(i) A girl drawing drinking water
(ii) A woman washing clothes
(iii) A person bathing
(iv) An animal drinking
(v) A boy urinating

Answer these questions:

1. What is each person or animal doing?
2. How is the water being contaminated?
3. Should the girl drink the water she is collecting?

Things to think about:

1. What happens if people don't use latrines, toilets or rubbish pits?
2. How can you be sure your food is safe from flies?
3. Think about your own habits. Could you be spreading disease germs to other people?

Hygiene: Ways to prevent the spread of germs

Hygiene refers to the rules of keeping yourself and the things around you clean to prevent the spread of disease. Hygiene is very important to everyone. Can you think of ways to keep yourself and the things around you clean? From what you learned about germs can you think of ways to stop them from spreading? Here are some of the rules of hygiene:

1. Keep yourself and your clothes clean. Take a bath every day and wash your clothes often.
2. Using clean, boiled water for drinking and washing.
3. Clean and cook your food well and keep it covered after cooking so that flies can't touch it.
4. Ventilate your room and house. Keep fresh air moving in every room.
5. Follow proper rules when visiting the toilet. Never go to the toilet outside. Wash your hands after visiting the toilet, and keep pit latrines covered.
6. Dispose of rubbish properly.

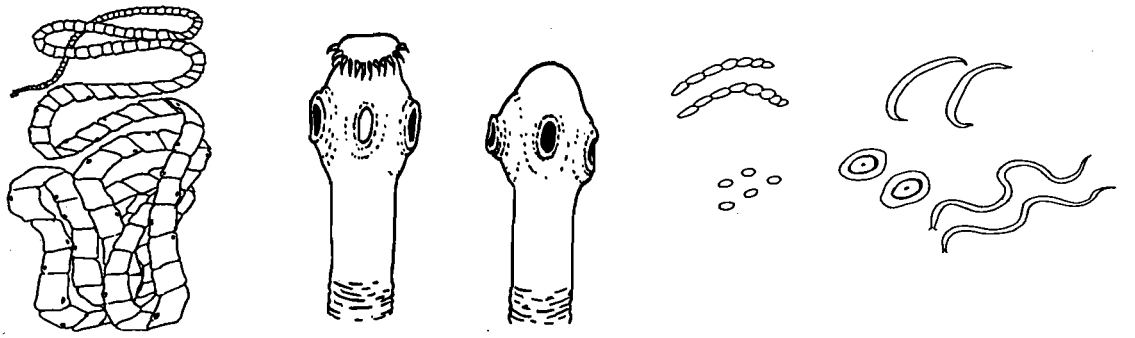
Parasites and Diseases they Cause

What is a parasite? A parasite is an animal or a plant that lives on or in another animal or plant and takes its food from that animal or plant. Here we're discussing human parasites: tiny animals that live in your body and feed from your body.

Examples of parasites that live in humans are tapeworms, guinea worms, hookworms and threadworms. The person whom the parasite is living in is called the "host".

1. Tapeworms: The life cycle of a tapeworm

Do you know what a tapeworm is? Have you or someone you know ever had a tapeworm? Look at the pictures below. Tapeworms live in people's intestines. They begin as a tiny animal but grow as they eat food from the person's intestines. People who have tapeworms often become thin and weak because the tapeworm is taking some of the food that they have eaten. The tapeworm grows longer and longer and the person can become very weak and may die.



A tapeworm living in a human produces up to 80 million eggs a year. The eggs pass out of the human's body in the faeces. If the person goes to the toilet outside, the eggs go into the bodies of cows, sheep, or other animals, and the egg develops into a bladder worm that lives in the muscles of the animal. These bladder worms can pass into another human if he or she eats the meat of the animal, but only if the meat hasn't been properly cooked to kill the worms. The bladder worms then develop into tapeworms in the human.

Can you understand why it's important to use latrines and toilets, and why it's important to cook meat well before you eat it?

Questions:

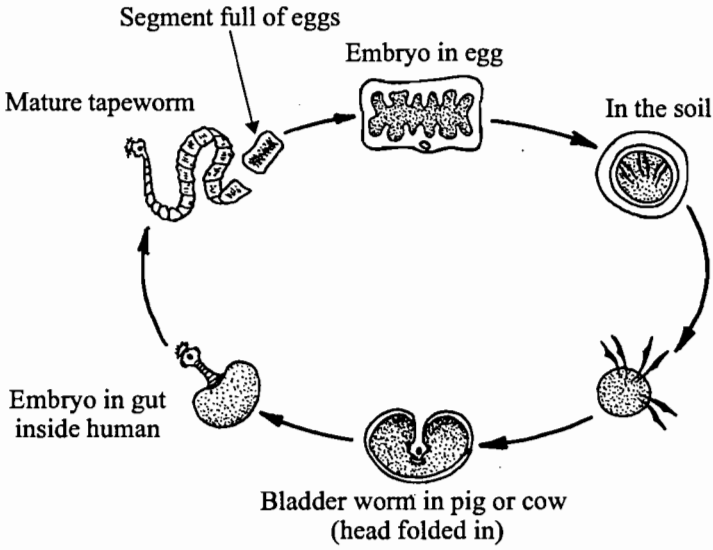
1. What are two ways of preventing the spread of tapeworms?
2. What happens to someone who has tapeworms in his or her body? Why does this happen?
3 How can you help your family to remain free of tapeworms?

Hydatid Disease

Once inside the new host, a tapeworm's eggs develop inside cysts (blister-like pouches or sacs) which can grow in any part of the body. This is called hydatid disease and is very serious to both humans and animals like dogs,

goats, sheep, and cows. The hydatid sac can grow as large as a football and can kill the host. The sacs have to be removed by surgery. Hydatid disease can cause cows to have greatly reduced yields of meat and milk.

The only way to prevent the disease in humans is to be very careful with hygiene. Young children should not play on the ground around dogs. Mothers need to wash their little ones' hands very carefully, and clean under their fingernails. Dogs should be fed cooked rather than raw meat to stop them from being infested.



Life cycle of a tapeworm

Do you always wash your hands and clean under your fingernails? Remember that the ball you have been playing with could have picked up tapeworm eggs from the soil.

There is medicine that can kill tapeworms if you think you have them in your body. A doctor should check a sample of your faeces (a "stool sample") to see if the eggs are present.

Questions:

1. What are the ways that humans and animals get tapeworms?
2. How are tapeworms dangerous?
3. Why is a tapeworm called a tapeworm?
4. What should you do if you think you have tapeworms?

2. Guinea worms

Guinea worms are another type of parasitic worm. Look at these pictures and explain how people get Guinea worms.

1. Man infected with Guinea worm

2. Infected man enters pool. Guinea worm babies enter water.

3. Cyclops eat Guinea worm babies in the water

4. Woman collecting infected water

5. Boy drinking infested water

6. 1 year later boy sick from Guinea worm

What do you think about the water this woman is collecting?
Could there be anything wrong with the water she is drinking? Why?

Preventing the spread of Guinea worms

It's important that people with Guinea worm do not step or swim in a water supply. The worm must be stopped from laying its eggs in the water. Once the blister forms on the skin water can be poured on it. This will help cool the skin and it will encourage the worm to come out.

Any water you drink should be filtered through a cloth or boiled to remove the larvae or to kill them. Water from wells and bore-holes and also rainwater is safer to drink than water from streams, rivers, and ponds.

Problems caused by Guinea worms

Guinea worms cause a lot of suffering to the person affected and his/her family:

(i) He cannot work in the fields, etc.
(ii) Pupils suffering from Guinea worms cannot go to school.
(iii) Family members spend a lot of money to treat the victim.

a. What does the man have on his leg?

b. What does a Guinea worm do when it gets into contact with water?

Questions:

1. What are Guinea worms?
2. How do people get Guinea worms?
3. At what stage can we prevent the infection by Guinea worms?
4. Name some problems caused by Guinea worm disease to the victim and family.
5. Describe the stages of the Guinea worm cycle.
6. Work in groups to prepare a talk and pictures you can show to a meeting in your community. The aim is to educate people about the Guinea worm disease and its prevention.
7. Now go through the following pictures and discuss the answers to the questions in your group:

3. Hookworms

Hookworms are another type of parasitic worm, but unlike tapeworms they feed on the blood of their host. Like other worms the eggs are passed out of the host's body in their faeces. The larvae crawl into a new host's body through their feet, enter the intestines, and attach themselves to the lining of the alimentary canal. There they suck the blood of the host.

To prevent hookworms from entering your body you should always wear shoes. It's also important to use a latrine or toilet. Never go to the toilet outside.

Questions:

1. How are hookworms spread?
2. Why does wearing shoes stop hookworms from entering your body?
3. How does using a latrine stop hookworms from being spread to other people?

4. Threadworms

Threadworms or roundworms are very tiny worms that are long and thin in size. They can enter a new host if the eggs are eaten with unwashed food.

Children who have very bloated (swollen) abdomens and thin arms and legs are often suffering from threadworm infestation. Threadworms live in the small intestines and pass out of the body with the faeces.

There is good medicine for all of these types of worms. If you suspect that someone has worms you should see a doctor.

Questions:

1. What do threadworms (roundworms) look like?
2. How are they spread?
3. What are the symptoms of threadworms?
4. Is there medicine for parasitic worms?

UNIT 2 Water

Water is necessary for life. We need water in our bodies for the cells and blood, and also for digestion, transport of digested food and excretion. Plants also need water for growth. We use water for many things like cooking and washing.

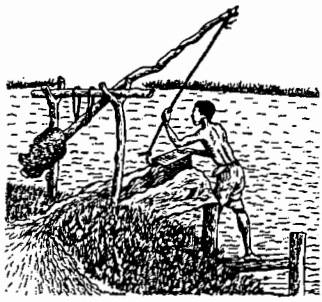
Irrigation

What is irrigation? In which areas in your country do you use irrigation? Irrigation refers to watering plants with water from a source like a river or lake through ditches or pipes. Areas that don't receive enough rainfall can be irrigated so that people can plant crops. Irrigation is done during the dry season in some areas where two crops are planted per year.

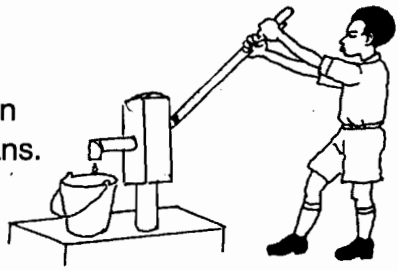
Methods of irrigation

Following are common methods of irrigation. Water is taken from a river, lake, or dam for irrigating plants by:

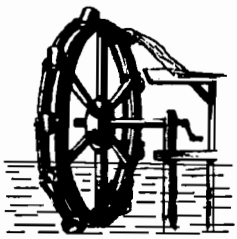
1. Carrying it by hand in buckets or watering cans.



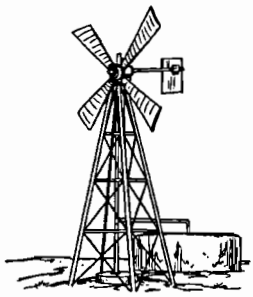
2. Use of a shadoof



4. Use of water pumps



3. Use of water wheels (Sagia)



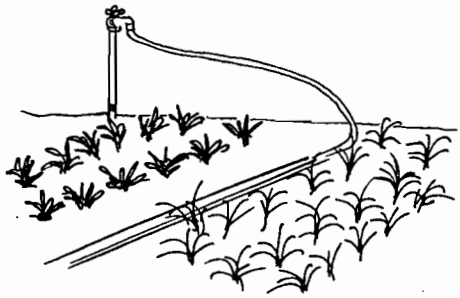
5. Use of windmills.

Drip Irrigation

Water runs under pressure through pipes that have small holes. Water drips slowly through the small holes.

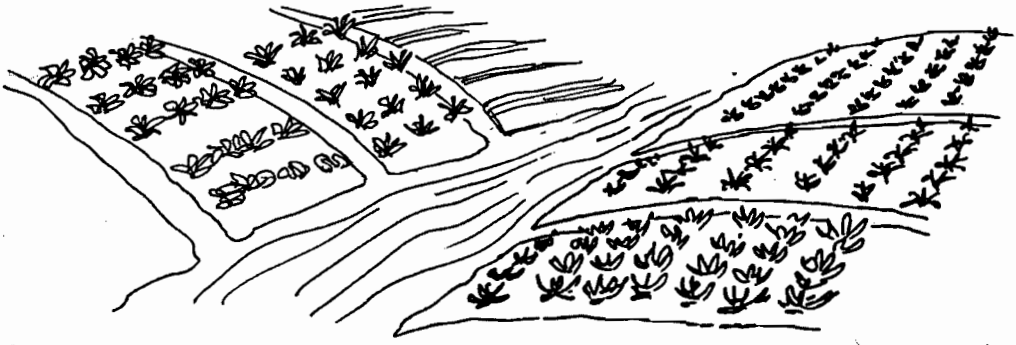
Furrow or canal irrigation

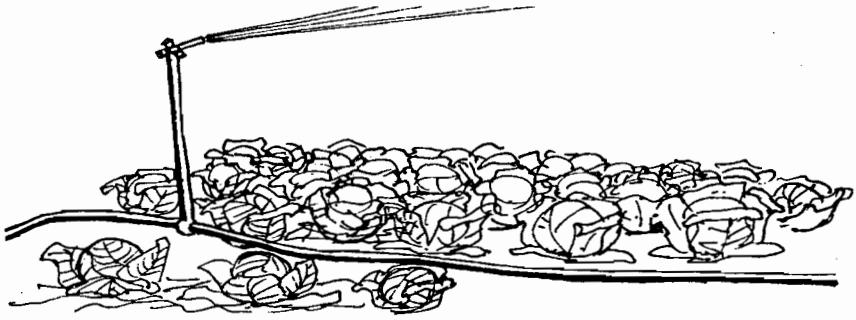
Crops are surrounded with furrows or small canals full of water. The water seeps down through the soil to the roots of the plants.



Flood Irrigation

The whole bed where the plants are growing is flooded with water.





Overhead Irrigation

This refers to using sprinklers, hoses and watering cans. The water falls on the plants from above as fine drops.

Activities:

1. In your school, farm and compound:
   a) collect water from a nearby source using buckets, watering cans, tins or any other suitable container. Use the water to irrigate plants in the school, farm or school compound.
   b) learn to practise watering plants with a hose or sprinkler if your school or nearby place has piped water flowing under pressure.
2. Explain how you use irrigation on your farm or in your garden.
3. Visit an irrigation project:
   a) How do they collect water from its source?
   b) What types of irrigation methods do they use?

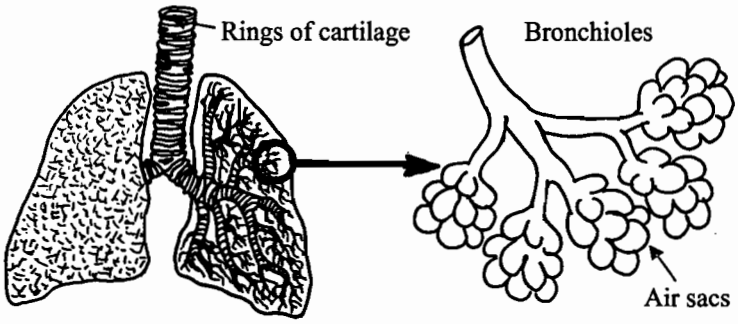
UNIT 3 The Human Body

The Respiratory System

All living things need air to live. Plants take in air through their leaves. Human beings breathe air in and out through their lungs. Breathing refers to the movement of air into the lungs to supply oxygen to the body, and out of the lungs to remove carbon dioxide and water vapour from the body.

Following are the parts of the body involved in breathing:

a. The nose
b. The windpipe
c. The lungs
d. The diaphragm and rib muscles.



The Lungs

Air is breathed through the nose and mouth. It then passes through the windpipe to the lungs. Dust and germs are filtered out in the nose. In the lungs are tiny air sacs where oxygen passes into the blood which carries it to all parts of the body.

When we breathe in, the diaphragm contracts and flattens so that the lungs can be completely filled. When we breathe out, the diaphragm relaxes and forces the lungs into a smaller space so that they push the air out. When we breathe in, we take in oxygen. When we breathe out, the lungs remove carbon dioxide and water vapour.

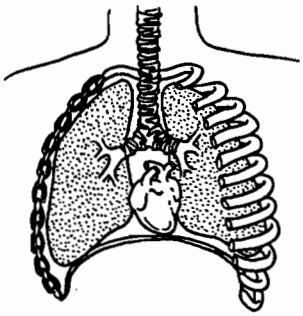


Diagram showing the lungs, heart and diaphragm in the thorax

Activities:

1. Hold your chest with both hands, then breathe in and out. What do you feel in your chest?
2. Run from one goal post of the football ground to the other as fast as you can, then stop and hold your chest with both hands. What has happened to your breathing? Why do you think this happens?

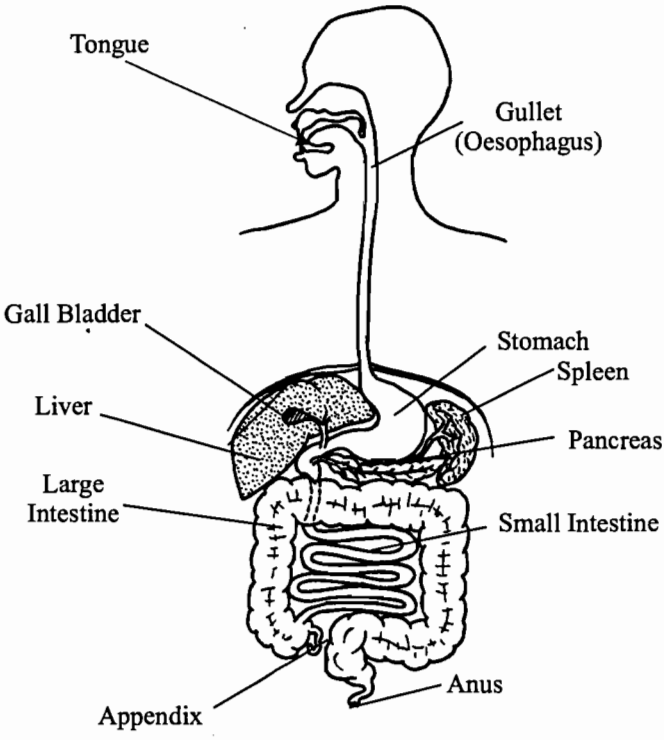
Questions:

1. The gas that is needed by the body is _____.
2. The unwanted gas that is breathed out is _____.
3. The two sets of muscles needed for breathing are the _____ and the _____.

The Digestive System

The digestive system breaks down the food we eat and absorbs it into the body. Following are the parts of the digestive system:

a. the mouth
b. the gullet or oesophagus
c. the stomach
d. the small intestine
e. the large intestine (colon)



How does the food we eat become part of our bodies? Does it all happen in the stomach? How can foods such as sugar, maize and meat all be used by the body? To find the answers to these questions we will look at:

- the structure of the digestive system
- the functions of each part.

The mouth

Food is chewed in the mouth, breaking it down into smaller pieces. As it is chewed it is mixed with saliva (spit), which helps break it down. The tongue is important in moving the food around in the mouth so it can be chewed properly. The saliva contains substances that change starch into a form of sugar. Starch is found in foods such as potatoes, maize, dura and rice.

The oesophagus

The oesophagus or gullet is a tube that passes through the thorax and diaphragm into the stomach. The walls of the oesophagus are muscular and their movement pushes the food down through the alimentary canal (digestive tract).

The stomach

At the entrance to the stomach is a circular band of muscle which relaxes to allow food to enter. In a healthy person the food stays in the stomach but if the person is ill, the strong stomach muscles force the band of muscle to open and the food is forced out as vomit.

When the food first enters the stomach, saliva continues to break it down. The food then moves down further in the stomach where gastric juices digest proteins which are found in meat, eggs, fish, beans and milk. The contraction and relaxation of the stomach muscles mixes the food together until It is ready to leave the stomach. Food usually stays in the stomach for one to four hours depending on the amount and the type of food. After it is digested it looks like a watery paste.

The small intestine

The muscular band at the bottom of the stomach opens, and the food passes into the small intestine. The diagram of the digestive system here is simplified. In fact, the small intestine is the longest part of the alimentary canal. In adults it is between 6 and 7 metres long. In the first part of the small intestine digestive juices from the gall bladder and pancreas help complete the process of digestion, completing the breakdown of sugars, starches and proteins, and breaking down fats and oils.

The food is now in a soluble form and can be absorbed into the blood. In the small intestine the digested food is absorbed into the bloodstream.

The large intestine

The large intestine is also called the colon. Anything that was not digested and absorbed from the small intestine passes into the colon. This includes roughage (indigestible fibrous material), bacteria, waste materials from the blood and worn out cells from the lining of the alimentary canal. Because most of the water has been absorbed in the small intestine, the roughage is fairly dry. The muscles of the colon send the roughage to the anus where it is passed out of the body as faeces (stools). It is important to eat roughage in order to remain healthy. Roughage is found in fruit, vegetables and grains. It is also important to drink plenty of water. A lack of roughage and water can result in constipation (difficulty in passing stools regularly).

Complete the table below:

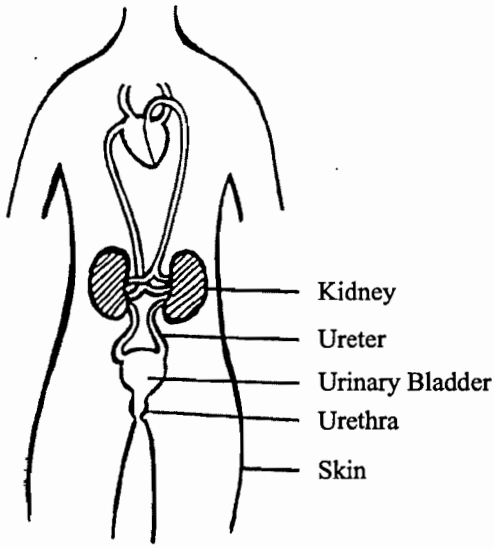
Organ	Function
1.The mouth	
2.The gullet or oesophagus	
3.The stomach	
4.The small intestine	
5.The large intestine	
6.The liver	
7.The pancreas	
8.The anus	

Activities:

1. Copy the diagram of the digestive system into your exercise book and label it.
2. Answer these questions in your exercise book.
   a. What is another name for the gullet?
   b. What is another name for the digestive tract?
   c. In which part of the digestive tract are proteins digested?
   d. What foods are broken down by juices from the gall bladder and pancreas?
   e. What is roughage? Why is it important?

The Excretory System

"Excretion" refers to removing wastes from the body. The human excretory system consists of the kidneys and urinary bladder. These organs remove wastes in the form of urine. The skin is also part of the excretory system. It removes wastes in the form of sweat (or "perspiration"). Look at this drawing to locate the parts of the human excretory system.



The kidneys are located in the lower back. The kidneys filter wastes and excess water from the blood as it flows through them. The wastes collect in the bladder, and when the bladder is full a person feels the need to urinate. Wastes that are removed include nitrogenous wastes and poisonous wastes from the liver.

You know that when you exercise on a hot day sweat will come out of your body onto your skin. This helps to cool the body. Sweat contains mineral salts. If you have ever tasted sweat you know that it tastes salty. On very hot days you should eat extra salt because your body loses a lot of salt from sweating.

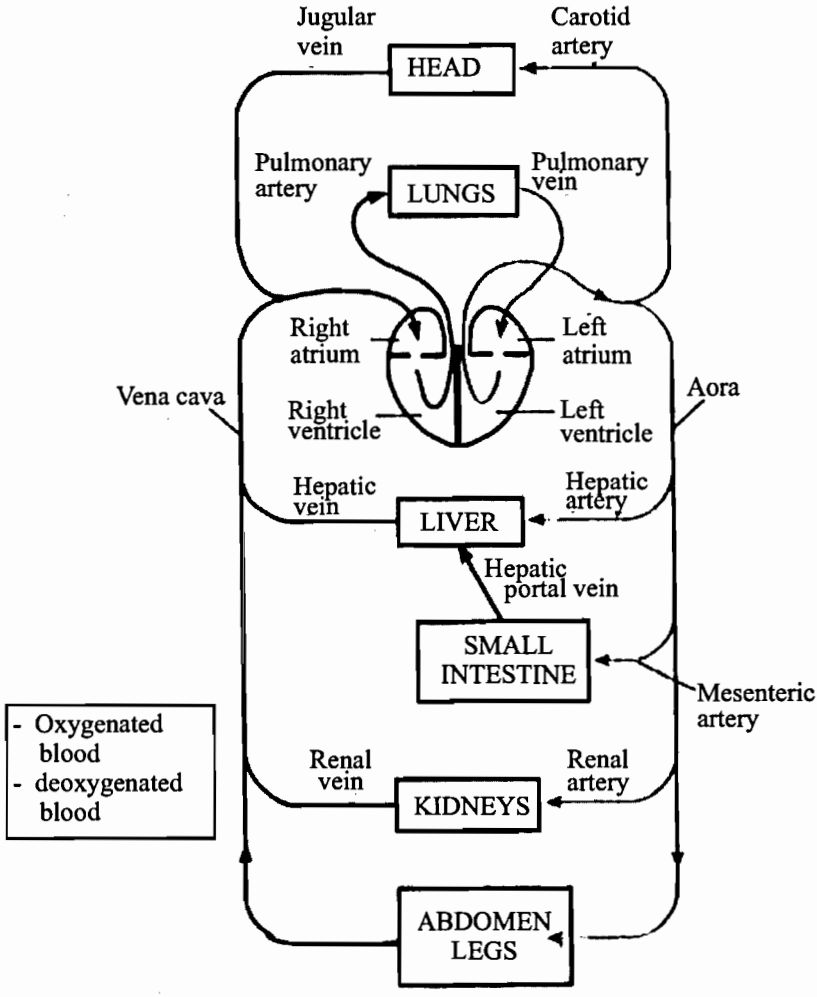
Questions:

1. What is the function of the excretory system?
2. What do the kidneys do?
3. What is the function of the bladder?

The Circulatory System

The human circulatory system includes the following:

a) The heart
b) The blood vessels (arteries, veins, and capillaries)
c) The blood (plasma, red blood cells, whites blood cells and platelets)



The heart is a muscular organ that pumps blood around the body. The heart pumps continuously: it never stops. When blood is pumped out of the heart it first goes to the lungs to pick up oxygen. This is the most important function of the circulatory system: to carry this oxygen to all the parts of the body. The red blood cells carry the oxygen. Red blood cells contain iron, and it's important to have iron in your diet because red blood cells are constantly dying and have to be replaced.

Blood with oxygen goes to every part of the body in blood vessels called arteries. Arteries become very small and the smallest ones are called capillaries. It's in the capillaries that the oxygen moves into the muscles and organs of the body and carbon dioxide and other wastes are transferred into the blood.

On its return trip to the heart, the blood flows through blood vessels called veins. Blood in the veins has no oxygen in it and must be pumped through the lungs again to receive oxygen. While circulating in the body blood also picks up nutrients and water from the intestines which are carried to all parts of the body.

White blood cells are the defence system of the body. They go to infected parts of the body and kill foreign germs and viruses. Platelets are involved in blood clotting. Clotting refers to blood becoming thick and hard. This happens when you cut your skin: the blood at first flows out, but then it clots and stops flowing.

Look at the diagram of the human circulatory system and try to understand how blood flows through the body. (Note that "pulmonary" refers to the lungs and "renal" refers to the kidneys.)

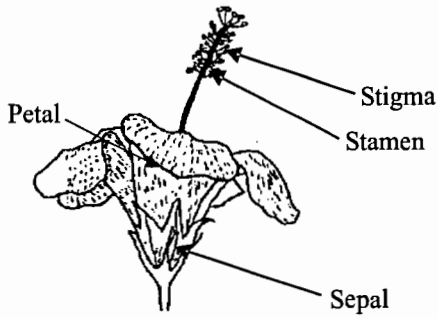
Questions:

1. What does the heart do?
2. Why does blood go to the lungs?
3. What's the difference between arteries, veins, and capillaries?
4. Where does the blood pick up nutrients?
5. What's the function of red blood cells?
6. Why is iron important to the body?
7. What's the function of white blood cells?
8. What's the function of platelets?

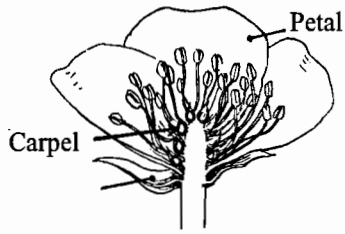
UNIT 4 Plants

The Structure of Flowers

There are flowers all around us. Can you find any flowers in your school compound? Look at the flowers and find the parts shown in these pictures.



Hibiscus flower (Okra or Bamia)



Section of buttercup flower

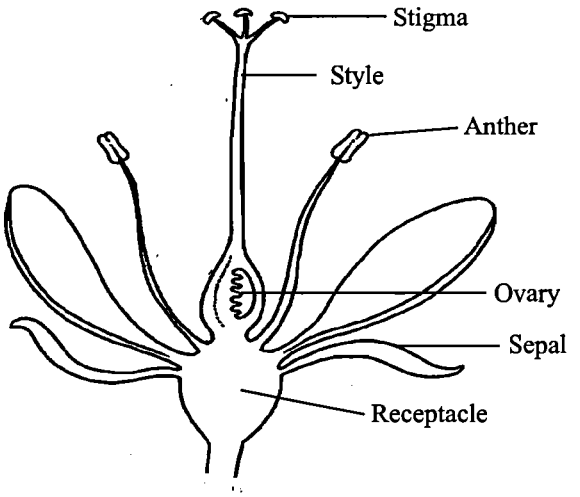
To study a flower more carefully you need to dissect it, which refers to cutting it apart and examining each piece. Start from the outside and use a pair of tweezers and a razor blade to cut it apart. Find the following parts:

a) **Sepals** - These are green. They cover the flower bud before it opens.

b) **Petals** - These are the coloured part of the flower. The colour attracts insects, which carry the pollen to other flowers to fertilise them. The pollen grains stick to the hairy bodies of the insects and are brushed off onto the stigma for fertilisation.

c) **Stamens** - These are in the centre of the flower and are the male sex organs which produce pollen. At the top of the stamen is the anther. It is inside the anther that the male reproductive cells forms. When the anther is ripe it bursts open and sets the pollen grains free.

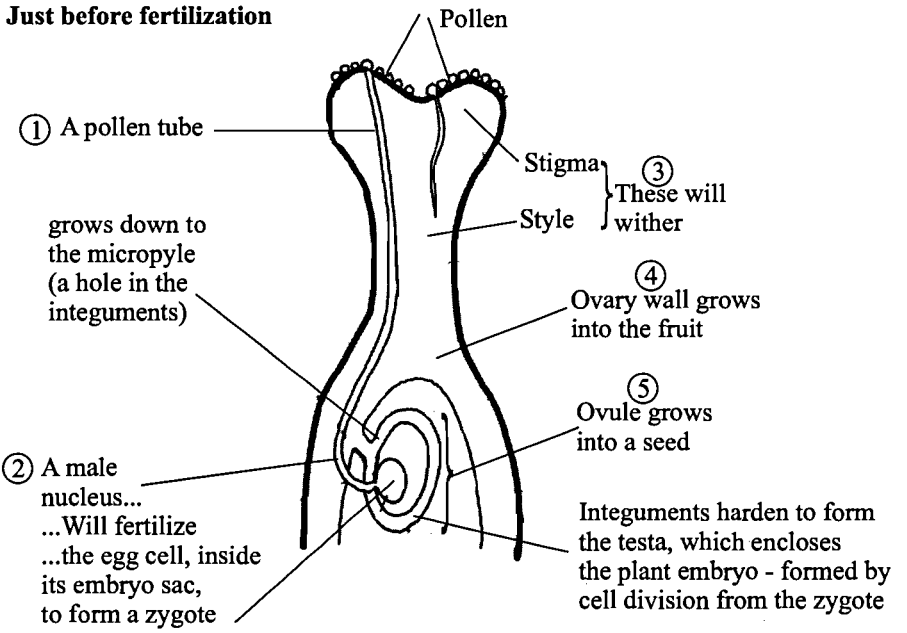
d) **The stigma** - This is the female sex organs. Together with the style and the ovary they form the carpel.



Reproduction in flowering plants

The flower is the reproductive part of the plant. The male part are the stamens, which produce pollen grains. The female part is the carpel. After fertilisation the carpel becomes the fruit, which contains the seeds. Look at this diagram as you read about pollination and fertilisation.

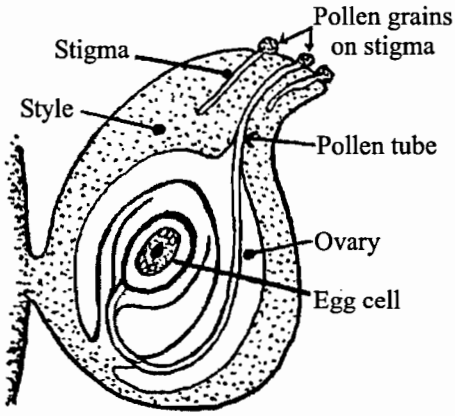
Pollination refers to grains of pollen moving from the stamens to the stigma to fertilise the ovule. The ovule then grows into a seed. There are two kinds of fertilisation:



a. self pollination - This refers to a plant fertilising itself, that is, the pollen moves from the stamen to the stigma of the same flower.

b. cross pollination - This refers to the pollen moving from one flower to a different flower, either by the wind or insects.

After the pollen grain moves to the stigma a pollen tube grows down the style. The male nucleus from the pollen moves down the tube and meets the female egg. Fertilisation takes place when they combine, and the embryo seed starts to grow.



Wind and Insect Pollination

Flowers that are pollinated by wind, such as grass, are different in structure from those pollinated by insects. Look at this table to find the main differences.

Part	Wind-pollinated	Insect-pollinated
petals	often green or absent	brightly coloured to attract insects
stamens	hang outside the flower	found inside the flower
stigmas	long and hangs outside the flower to catch pollen grains as they blow by	small and found inside the flower
pollen grains	smooth, dry and light	rough and sticky
nectar and scent	no nectar or scent	most produce nectar and scent

Activities:

1. Collect samples of as many different flowers as possible.
2. How does each part match the table above?
3. Use a razor blade to cut through each flower lengthwise. Identify each part and look at it closely through a hand lens if you have one.

Questions:

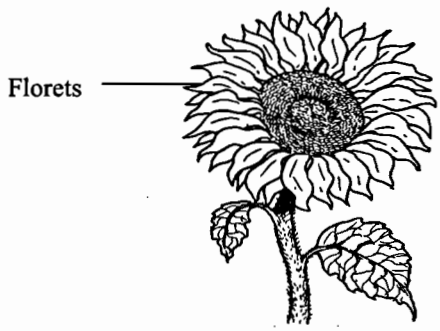
1. What attracts insects to flowers?
2. How do insects carry pollen to another flower?
3. What is left on the flower after the petals die and fall off?
4. What is the function of the pollen grains?
5. What is the anther?
6. Where in the flower does fertilisation take place?
7. What is the stigma?
8. What is the ovary?
9. What is a fruit?

Types of flowers

The hibiscus and buttercup flowers shown at the beginning of this unit are both examples of **simple** flowers. The sunflower shown below is an example of a compound (or composite) flower. How do you think they are different?

A simple flower has one flower within the flower head. A compound flower has a number of flowers within the one head. These small flowers are called florets.

Can you find any samples of composite flowers growing in your neighbourhood or school compound? Try to list as many simple flowers and compound flowers as you can.



The Structure of Fruit

After fertilization, the ovary grows into a fruit while the ovules develop into seeds. The seeds are therefore found inside the fruit. Sometimes it's difficult to tell a seed from a fruit. An easy way to tell is to look at the number of scars. A ripe seed has got only one scar while a ripe fruit has two scars. The scar shows the point of attachment to the stalk.

Mango

Pawpaw

Banana

Functions of different parts of the fruit

Following are parts of fruit and their function:

a) The pericarp - This is the outer covering of the fruit. It protects the fruit and the seeds inside.
b) Some kinds of fruit have an air space to make them lightweight. This air space enables the fruit to float during dispersal
c) Some kinds of fruit have hairs or hooks to enable them to attach to animals during dispersal
d) The fleshy soft part attracts animals, and as they eat it they discard the seeds or swallow them and pass them in their stools.

Seed and fruit dispersal

When seeds are mature, the whole fruit or individual seeds fall to the ground where they germinate. Seeds are dispersed, that is, they are moved to different places to grow. There are many ways that seeds or fruit are dispersed. Following are some of them:

a) Some fruits split and fling out their seeds by the force of the splitting.
b) Wind carries away lightweight fruits, especially those with "parachutes".
c) Fruit can stick to the fur of animals or human clothing.
d) Fruit is eaten and the seeds are discarded or passed through the stool.

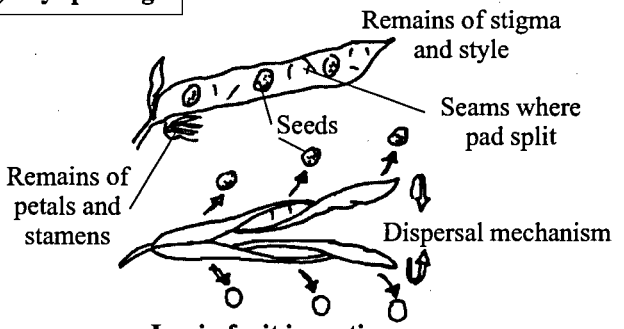
This chart shows ways that seeds are dispersed.

Plants are dispersed to:

(a) Avoid overcrowding so that they don't have to compete for food, light and water.

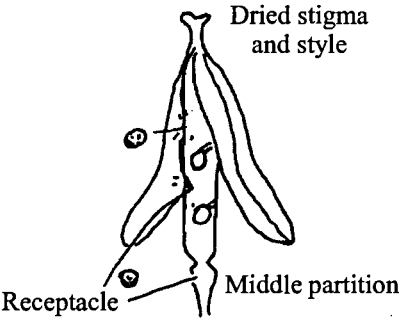
(b) Colonize new places or areas

Ⓐ By splitting



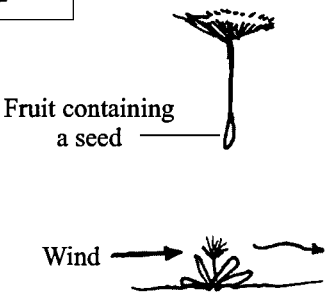
Lupin fruit in section

Wall flower
Seeds fall out when fruit splits

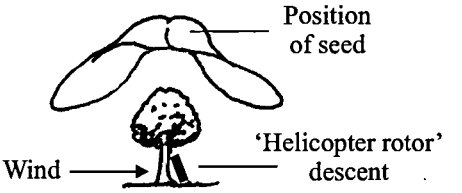


Seeds flung out by sudden splitting apart and spilling of the two halves of the pad

Ⓑ By wind

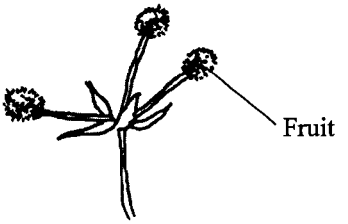


Dandellon
'Parachute' of hairs catches wind

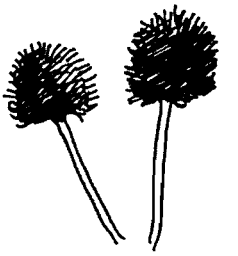


Sycamore
Wing of fruit delays descent

Ⓒ By catching on fur



Goosegrass



Burdock

UNIT 5 Soil

When you use soil for growing plants the fertility of the soil if very important. Soil that is fertile has the nutrients that plants need to grow. Good soil has humus in it. Humus comes from dead plants and leaves that have released their nutrients into the soil. We can make soil more fertile by adding manure or compost to it. Manure is the waste matter of animals. Compost is made by mixing manure and dead plants.

Good soil is also loose. Plants need loose soil because roots need air to grow, and they also have to penetrate into the soil as they grow. Dead plant matter helps make soil loose, as do animals living in the soil like earthworms. Have you ever tried to grow plants in sand or clay? Sand and clay have no nutrients so plants can't grow in them. Clay is also too hard-packed for the roots of plants to grow.

Natural places like forests have fertile soil, but when we grow crops the nutrients are taken from the soil every year until the soil is no longer fertile. When this happens it's necessary to add nutrients to the soil with compost, manure, or fertilizer.

Making Compost

Compost and manure can be added to soil to make it more fertile. They are important to the soil because

- They are a source of plant nutrients.
- They enables soil to hold enough water for plant growth
- They loosen the soil to hold enough air.

Compost is prepared by piling plant and animal waste in a heap on the ground or in a pit.

1. Choose a spot that is sheltered from the rain.
   Gather plant materials and bring them to the place where you're making the compost.
   These materials may include:

a) Coarse plant materials like maize stalks
b) Green vegetation and uncooked kitchen waste
c) Animal manure
d) Soil

2. Clear the area. The area needed for the compost heap is 1.5m x 1.5m.

3. Loosen the floor of the compost pile by digging 30cm deep using a forked toria.

4. Sprinkle water on the spot.

5. Put the gathered composting materials into layers in a heap as follows:

i. First layer (10cm thick): Coarse materials like chopped maize stalks, dry grass and leaves.
ii. Second layer (15cm thick) Green vegetation and kitchen waste such as tea leaves, bones and vegetable peels.
iii. Third layer (5cm thick) Any type of animal manure (cow dung, chicken droppings, etc)
iv. Fourth layer (2cm thick) This layer consists of good soil.

6. Add more layers onto the heap in the same order (from i to iv above) until the pile is over 1m high. Each time you put on a dry layer, sprinkle on some water. The topmost layer should be of soil.

7. Protect the heap from rain and sun (cover it with materials like dry grass, banana leaves or mats).

8. Push a strong stick into the middle of the pile to act as a thermometer. Pull the stick out after a week. If the stick is hot, it means the heap is decaying. Return the stick to the pile after checking the temperature.

9. Two weeks after making the compost heap turn it over with a fork. Continue turning it every 2 weeks until the compost has decomposed.

10. Harvest the compost 3 to 4 months after the time you started. Well-decayed compost is:
    a) Uniform in appearance
    b) Dark in colour
    c) Spongy to the touch
    d) Sweet smelling (it has an earthy smell).

11. Store compost that is not being used immediately in a rainproof, cool, shaded place.

Activities:

1. Make a compost heap with your class and teacher. Use it to grow crops in the school farm. Your teacher will show you how to apply the compost to the crops.
2. At home, help your parents prepare some compost. Use it to grow crops on the your farm. You can include animal bedding (dry grass put on the luak/muraa floor or poultry house litter).

Other Ways to Improve Soil Fertility

There are other methods used in agriculture that improve the fertility of soil.

1. Green manure: This refers to growing a crop (usually a legume) and when it is still green ploughing it into the soil where it rots into humus. Legumes are good for soil fertility because they fix nitrogen in the soil, and other crops need this nitrogen when they grow.
2. Organic mulch: This is dry plant material like grass or leaves which is used as a cover for the soil. Mulch keeps the soil cool and reduces loss of water from the soil. The mulch also decays, adding organic matter and plant nutrients to the soil
3. Commercial Fertiliser: This is prepared in factories and sold to farmers. Commercial fertiliser contains the nutrients that plants need.

Questions:

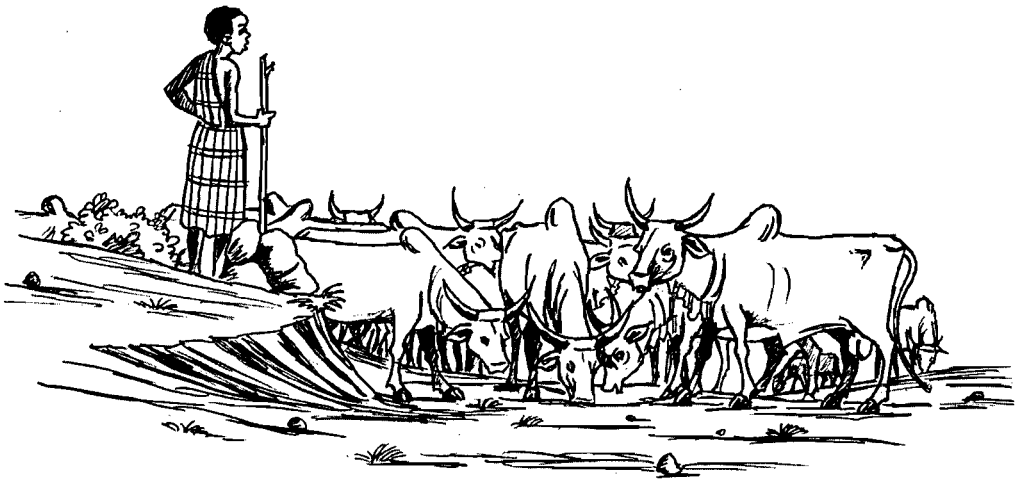
1. What is topsoil?
2. Why is topsoil good for growing plants?
3. Explain how to make compost and why it is good for agriculture.

Soil Erosion

The top-most layer of soil that is the most fertile is called "topsoil". Topsoil is very important in agriculture. If this layer is lost the soil isn't fertile enough for crops. Topsoil is lost from the land by erosion. Erosion refers to the slow removal of topsoil by natural forces such as rain and wind.

Soil Erosion

Have you ever noticed how streams and rivers become brown when it rains? This is from soil that has been washed into the water. Soil erosion is a serious problem in many areas, and thousands of square kilometers of land aren't usable for agriculture because the soil is infertile from loss of topsoil.



Overgrazing

Soil erosion is caused by the following things:
a. rain: The main cause of erosion is rainwater washing topsoil down sloping land into streams and rivers. This happens when land is cleared for agriculture. There is little erosion on land covered by forest.

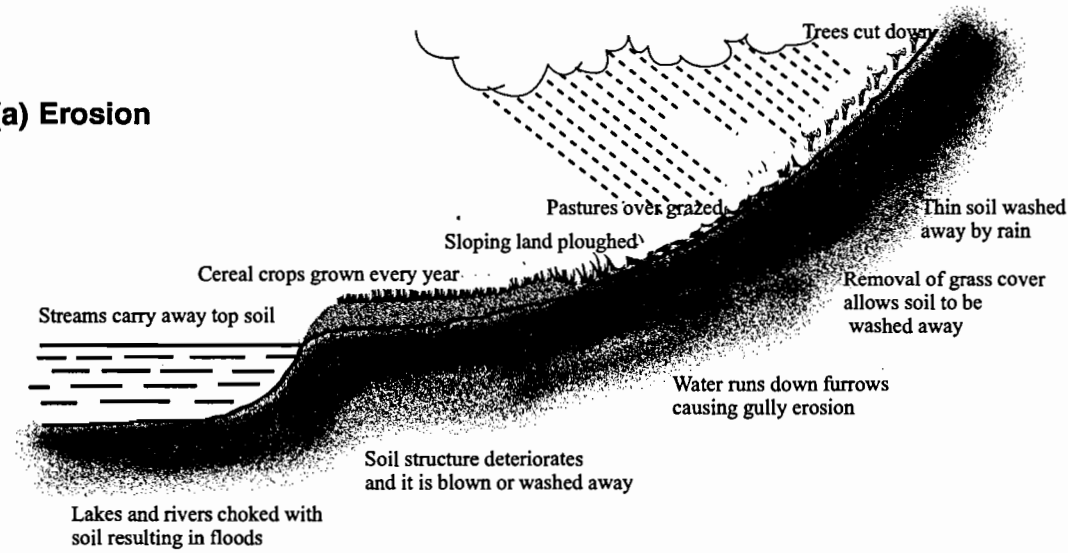
b. wind: Wind is also a major cause of erosion. When plants are cut down and the soil becomes dry the wind can blow it away.

Human activities cause most erosion. The main activities that cause erosion are cutting down forests and plants and grazing animals. Animals like cows and goats may overgraze and area, causing the topsoil to be exposed to the sun and become dry. The topsoil is then blown away by the wind.

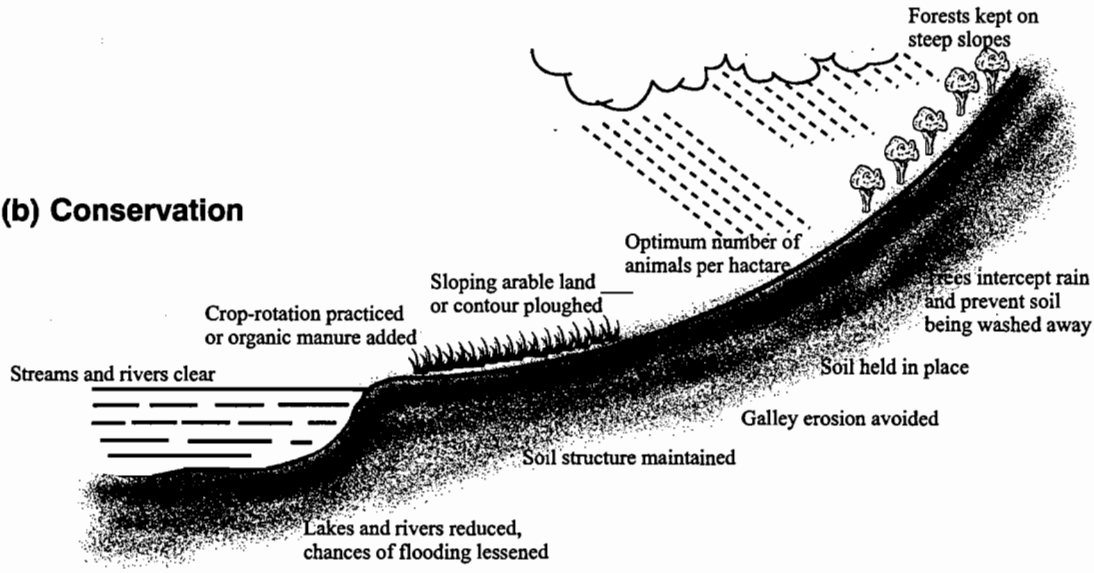
The Effects of Soil Erosion

Look at this diagram and the one on the next page. The first shows the causes and effects of soil erosion. The second shows ways to conserve soil. Explain and compare the two diagrams.

(a) Erosion



(b) Conservation



Erosion has the following effects on agriculture:

a) Loss of fertile soil for crop production.
b) Erosion leaves the soil surface bare and hard which makes the soil difficult to plough.
c) Erosion can cause crops to be washed away
d) Water erosion causes crops at the bottom of slopes to be buried by debris carried by the running water.
e) Gully erosion causes fields or farmlands to be cut into irregular pieces making ploughing difficult.

Questions:

1. What is soil erosion?
2. What are the main causes of erosion?
3. How does erosion affect agriculture?
4. Look at the diagrams on the previous page and explain them.

UNIT 6 Weather

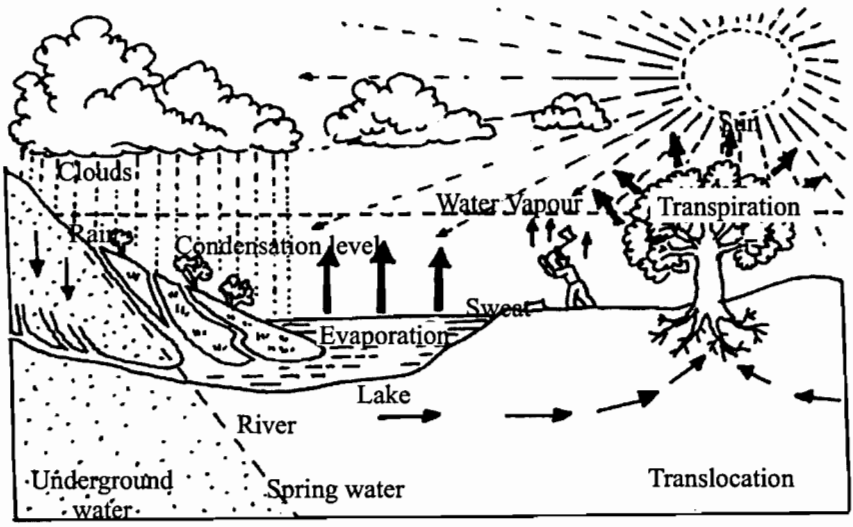
What is weather? Following are the elements of weather:

1. Wind
2. Sunshine
3. Relative humidity
4. Air pressure
5. Temperature
6. Precipitation (rain and snow)
7. Storms
8. Visibility

Humidity

The amount of moisture in the atmosphere is called humidity. Where does the moisture come from?

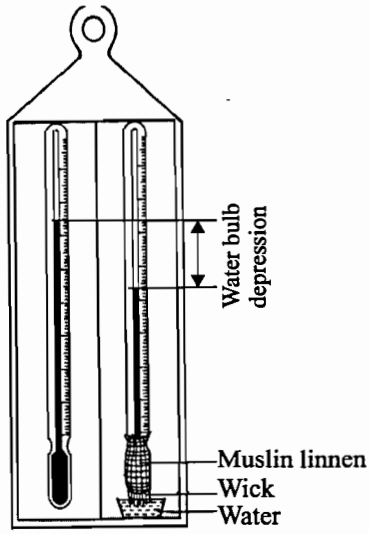
Moisture enters the atmosphere by evaporation from bodies of water like lakes, dams, rivers, and oceans. It also comes from transpiration of vegetation, especially from dense forests. Look at this diagram and explain how moisture is moving in and out of the atmosphere.



Measuring Humidity

The instrument used to measure humidity is called a hygrometer. A hygrometer has two thermometers: a wet bulb thermometer and a dry bulb thermometer. When the humidity is high (when there is a lot of moisture in the air) the temperature of the wet bulb thermometer is high. If the air is dry, with little moisture, the wet bulb thermometer shows a lower temperature. The dry bulb thermometer shows the normal temperature. To find the relative humidity measure the difference between the wet bulb and dry bulb thermometers.

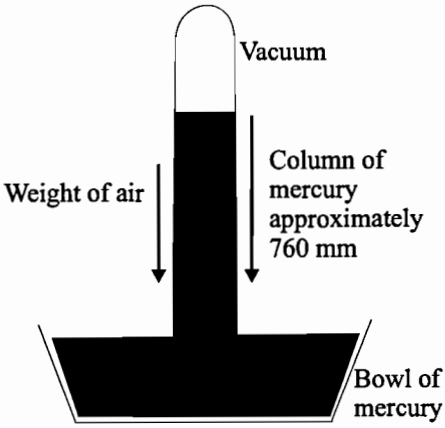
Here is a simple hygrometer. Two thermometers are used, and one is covered with muslin linen dipped in water.



Measuring Air Pressure

Air pressure is the force exerted by air downwards against the earth's surface. Air pressure decreases as we move higher above the earth. The air pressure on a mountain top is less than in the valley below the mountain.

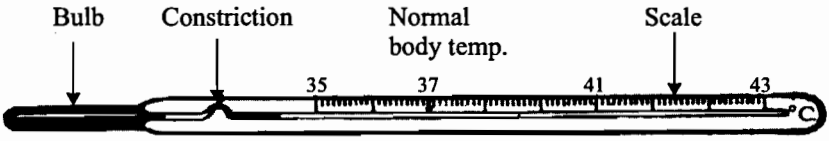
The instrument used to measure air pressure is a mercury barometer The normal height of mercury in the glass tube of the barometer is 760 mm. If the air pressure is low, the height of the mercury in the tube drops lower than 760 mm, but if the air pressure is high, the height of the mercury in the tube increases to more than 760 mm. The unit of air pressure is millibars (mb).



Measuring Temperature

Temperature refers to the coldness or hotness of the atmosphere. We can also measure the temperatures of our bodies, which is important when we feel ill. The instrument used to measure temperature is a thermometer. A thermometer is a glass tube filled with mercury attached to a piece of metal that has temperature gradations written on it.

When the weather is hot the mercury expands and rises in the tube. When the weather is cold the mercury contracts and goes down. In New Sudan and most of the world the Centigrade scale is used for temperatures. Water boils at 100 degrees centigrade (at sea level) and freezes at 0 degrees. The boiling and freezing temperatures of different things vary.



A Clinical Thermometer

Forecasting Weather

On the radio and television there are daily weather forecasts. Weather forecasts predict the weather for the coming days. To make these forecasts, data on the weather is gathered.

There are three ways that data is gathered and used for predicting weather. First, weather satellites orbit the earth taking pictures of cloud patterns and measurements of the atmosphere. This data is sent to central weather stations. The second way is more traditional. Data is collected at weather stations in every country. This data includes temperature, wind, air pressure, precipitation (amount of rainfall) and cloud cover. The data from satellites and weather stations is combined with the third type of data: records of the weather going back 50 or 100 years. Computers analyze the data and produce the forecasts.

Almost everyone is interested in weather forecasts. They're especially important to farmers, aeroplane pilots, and ships at sea. People who are travelling or going on holiday are also interested in how the weather will be in the coming days.

A Weather Station

There are weather stations all over the world that take measurements of the weather and send the data to a central location. Weather stations are located at government institutions, on mountains, in the desert, and even in the ocean.

There are many different kinds of instruments that stations use. If you want to have a basic weather station at your school you would need the following instruments:

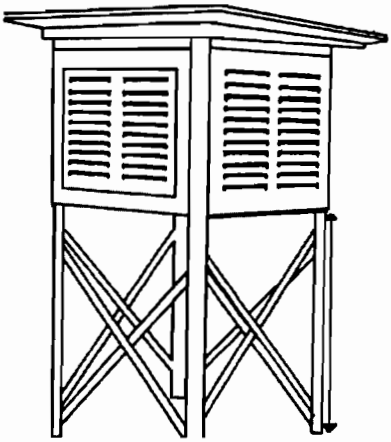
1. a rain gauge
2. a barometer
3. a sunshine recorder
4. a wind vane
5. an anemometer (to measure wind speed)
6. an evaporameter (to measure the rate of evaporation)

These instruments are arranged in or around a screened box. The weather station should be located in a place where it is exposed to the atmosphere but isn't disturbed by people and animals.

Keeping Records of the Weather

Three types of records are kept at weather stations.

1. A daily record of measurements and observations taken.
2. Monthly records obtained as summary of the daily records.
3. A record book for plotting graphs of weather elements like rainfall and temperature on a monthly and annual basis. The graphs are very important because they show trends of weather elements over a period of time.



Here is a chart that may be used to record weather data.

Month	Year	Place .....

DAYS	TEMPERATURE						RAIN	EVAPORATION	WIND		CLOUD		PRESSURE	DURATIONS OF SUNSHINE
	max	min.	mean	dry	wet	humidity	mm	rate	dir.	speed	amount	type	mb	hours
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

Following are graphs showing rainfall and temperatures at Entebbe (Uganda) and Songea (Tanzania). Look at the charts and ask each other questions about them.

Figure 1: Mean monthly rainfall and temperature at Entebbe Uganda

	J	F	M	A	M	J	J	A	S	O	N	D
Temp (°C)	22	23	22	21	19	18	17	18	21	22	23	23
Rain (in mm)	275	212	225	100	10	-	-	-	-	3	25	185

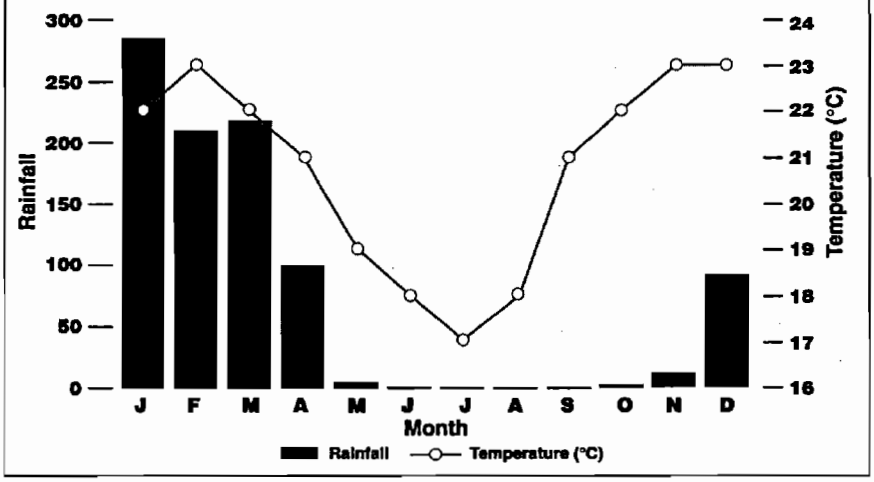
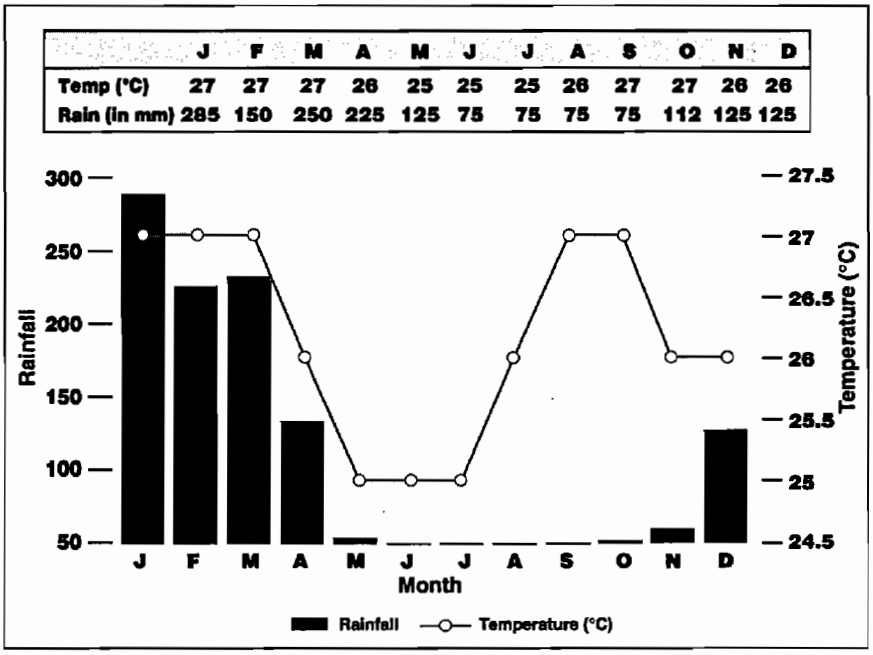


Figure 2: Mean monthly rainfall and temperature at Songa Tanzania

	J	F	M	A	M	J	J	A	S	O	N	D
Temp (°C)	27	27	27	26	25	25	25	26	27	27	26	26
Rain (in mm)	285	150	250	225	125	75	75	75	75	112	125	125



UNIT 7 Air

You already know that air is a mixture of gases. The components of air are oxygen, nitrogen, carbon dioxide and other minor gases. Air is very important for life. Animals and plants cannot live without air.

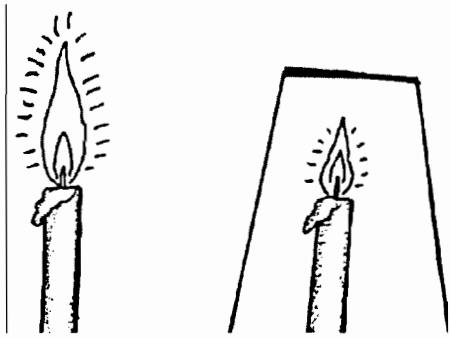
Carbon dioxide

Carbon dioxide is one of the components of air. Humans and other animals breathe out carbon dioxide as a waste product while plants use it to produce food during photosynthesis. Carbon dioxide is also produced in the burning process. When a fire burns it uses the oxygen in the air, leaving the carbon dioxide. This is one of the reasons why people and animals die in house fires: the fire has consumed all the oxygen, leaving only carbon dioxide, and the people have no oxygen to breathe.

Science Experiment:

Do the following steps to see how carbon dioxide can put out a fire.
a) Light two candles.
b) Fill a glass with carbon dioxide by inverting it over another burning candle.
c) Cover one candle with the glass full of carbon dioxide.
d) Observe which candle continues to burn.

You will see that the candle covered with a glass full of carbon dioxide will go Out. This experiment shows that carbon dioxide doesn't support burning. Therefore, it can be used for putting out fires, particularly oil or petrol fires.



Testing for carbon dioxide in the air

Carbon dioxide turns calcium hydroxide solution (lime water) milky or cloudy. This property of carbon dioxide is used to test its presence in the air. If you bubble air through a solution of lime water, the water will turn milky. This is an indication of the presence of carbon dioxide in the air.

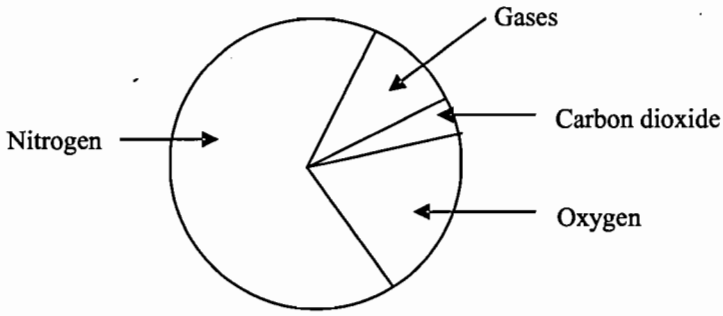
Components of Air

Air is made up of a mixture of gases. Gases are formed of tiny particles called molecules. Some of the things that make up air are:

a) Gases like nitrogen, carbon dioxide, oxygen and other minor gases
b) Water vapour as well as tiny dust particles are also present in the air but are not part of the air. They are just carried in the air.

The average composition of dry air by volume is shown in the diagram below.

(i) Oxygen, 20%
(ii) Nitrogen, 78 %
(iii) Carbon dioxide, 0.03%
(iv) Water vapour, variable 1-4 %
(v) Inert gases or rare gases 1%



1) Nitrogen

Nitrogen is the major component of air, but it isn't used by animals when they breathe it in. Nitrogen is needed by plants but they don't take it from the air. They absorb it through their roots and use it for growth. Without nitrogen in the air, processes like burning and rusting would happen much faster. Nitrogen dilutes the oxygen and makes these processes happen more slowly.

2) Oxygen

Most living things need oxygen to survive. Oxygen is important for burning and rusting. Oxygen is also a major component of water.

3) Carbon dioxide

Green plants take carbon dioxide from the atmosphere and use it to form their food. The breathe out oxygen which is used by animals.

4) Other gases (rare gases)

They are called rare gases because they are found in nature in very small amounts. They are argon, neon, helium, krypton and xenon. These gases don't react with any substances: they neither burn nor support combustion.

Neon is used in coloured electrical signs for advertising. Helium is a very light gas and is used in balloons to make them float.

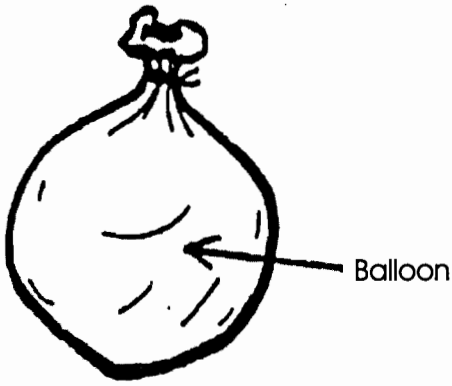
Questions:

a) What are the components of air?
b) Which gas makes up the largest proportion of air?
c) Give two uses of oxygen.
d) Give the reasons why nitrogen is an important gas.
e) How is carbon dioxide used by plants?

Effect of changes in temperature on volume of air.

Air changes volume according to the temperature of the surrounding environment. The higher the temperature, the more air will expand and increase in volume. If the temperature decreases, air contracts and reduces its volume.

Trap some air in a balloon. Make sure the air does not escape. Pour a little warm water on the surface of the balloon. What happens? The balloon will increase in size Why? Now pour some cold water on the surface of the balloon. What happens? Why? Air expands when heated and it contracts when cooled.



UNIT 8 Light

Reflection of Light

Following are experiments to show how light reflects. To do these experiments you need a mirror and a piece of shiny metal

a. Take the mirror and hold it in the sun so that the sun's rays are directed from it to a wall in the shade. What do you see? Is the light that is on the wall produced by the mirror?

b. Repeat the activity while in the shade with the mirror pointing away from the sun.

Do you see any light like the light in the first experiment? Why is there no light from the mirror falling on the wall? Where did the mirror get its light in the first experiment?

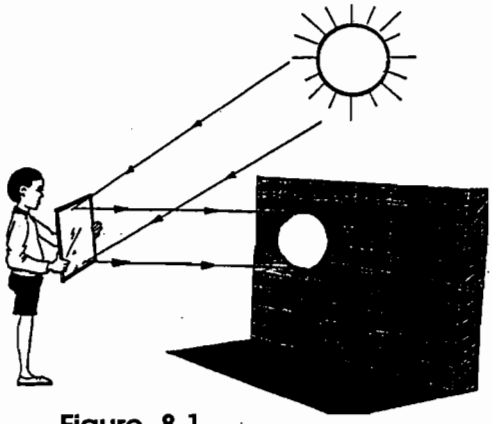


Figure 8.1

c. Use the shiny piece of metal to repeat the experiment you did with the mirror. Does it reflect light? Does it reflect as much as the mirror did? Why not?

Conclusions:

The mirror and the metal don't produce their own light. What you saw on the wall was the reflection of sunlight. When the ray of sunlight strikes a shiny surface it bounces back from the surface just like a ball bounces back when it hits a wall. We say it is reflected by the surface. If there is no light falling on the mirror or the metal, it will not reflect any light.

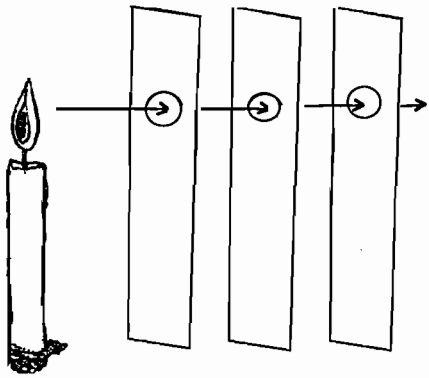
How does light travel?

Light travels in a straight line. You can see this by doing a simple experiment. You need a candle, a box of matches and three cards of equal size with a hole in the same position in each one.

a) Fold the cards so that they stand up and place them so that the holes lie in a straight line.
b) Light the candle and place it behind the hole in the first card.
c) Look through the hole in the card furthest from the light. What do you see?
d) Move the centre card a little to one side. What do you see? Why?

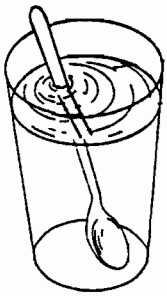
The bending of light (Refraction)

In our experiments on light you have seen that light is reflected by a mirror and other shiny and smooth surfaces. Look again at the picture above and note the path of the light rays.



Sometimes light bends when it passes through transparent things. You can do an experiment to see what happens to light rays when they pass through water. The materials you need for this experiment are a drinking glass, water and a spoon or a straight stick.

a) Fill the glass with water.
b) Put the spoon or stick into the glass of water.
c) Look through the side of the glass just at the level of the top of the water. What do you see?



Conclusions:

The spoon seems to bend as it enters the water. What really happens is that the light from the spoon bends as it passes through the water. Light also bends when it passes through the glass. This bending of light is called refraction.

The bending of light by lenses

Lenses are transparent pieces of glass with two polished surfaces. They are used in spectacles (eyeglasses), microscopes, telescopes, and cameras. There are two different kinds of lenses. One is called a concave lens and the other is a convex lens. Look at the drawings. The concave lens has its surface curved inward. The convex lens has its surface curved outward and is thicker in the middle.

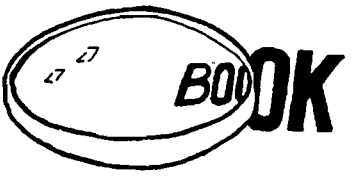
Concave lens

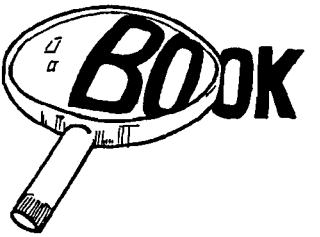
Convex lens

Looking through Magnifying Glasses

Let's look through concave and convex lenses. A magnifying glass is a convex lens. It makes the image look bigger. Eyeglasses for someone who is far-sighted are convex. (They can see things well that are far, but need magnification for things that are near.)

Concave lenses make images smaller. Spectacles for someone who is short-sighted are concave. (They can see things well that are near, but they need things that are far made smaller to see them clearly.)
Look at the diagrams below.





First look at things through a concave glass. What happens?
Next Look at things through a convex lens (a magnifying glass). What happens?

Conclusions:

Lenses make light rays bend. The convex lens makes the rays bend toward each other and this makes things seen through the lens look bigger. That is why convex lenses are used as magnifying glasses.

A concave lens makes light rays bend away from each other and this makes things look smaller.

Questions:

1. What does the word reflected mean?
2. Why couldn't you see the candle light through the holes in the cards when they weren't in a straight line?
3. Why can't you tell how deep a pond is by looking at it on a sunny day?
4) Why is a convex lens used in a microscope?

The colours of light (The Spectrum)

What colour is light? Is it white? You can see the colours of light by carrying out an experiment. The materials you need are: a mirror, a white piece of paper fixed on a piece of cardboard and a large deep plastic basin almost full of water.

Follow these steps to perform the experiment:

1. Place the plastic basin that is almost full of water outside in bright sunlight.
2. Put the mirror inside the water in a slanting position.
3. Hold the piece of white paper fixed on cardboard in front of the mirror. Position the paper so that the sun reflects light from the mirror onto the piece of paper.

Answer these questions:

a. What do you see?
b. What colours do you see?
c. How many different colours do you see?
d. What does the white light consist of?

Conclusions:

You see a band of colours on the white paper that looks like a rainbow. The band of colours is called a spectrum. Light from the sun is made up of the seven different colours you see: red, orange, yellow, green, blue, indigo and violet. The water separated them for us to be able to see them.

You have probably seen a spectrum before, can you recall when and where? Perhaps this was when there was a small amount of rain while there was bright sunlight. The spectrum you saw was a rainbow.

Making a rainbow

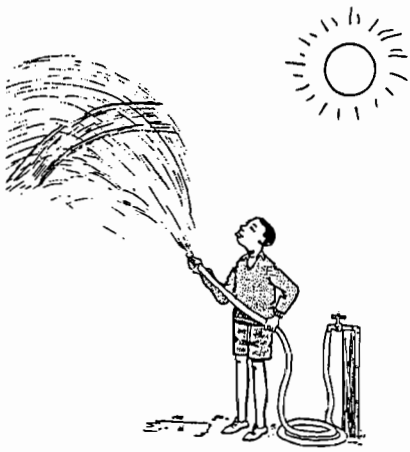
Following is a way to make a rainbow to see a spectrum. The materials you need for this experiment are a long plastic hose (2-5 metres long) and a source of running water (a tap).

a) On a bright sunny day, attach the hose to the water tap.
b) With your back towards the sun spray a stream of water high into the air.
c) Look through the drops of water. Do you see a spectrum?

A Colour Wheel

This is another experiment where you can see how the colours of the spectrum make up white light. Do the following steps:

a) Draw a circle on a piece of white cardboard and cut it out.
b) Divide the circle into seven equal sections.
c) Colour each section one of the colours of the spectrum.
d) Make a hole in the centre big enough for a thin pencil or small stick to pass through.
e) Spin the card like a top.
f) Can you see the colours? Why not?



When the colours of the spectrum are mixed together, they make white light. The primary colours are red, green and blue. Mixing two primary colours together can make other colours, called secondary colours.

Forms of Energy

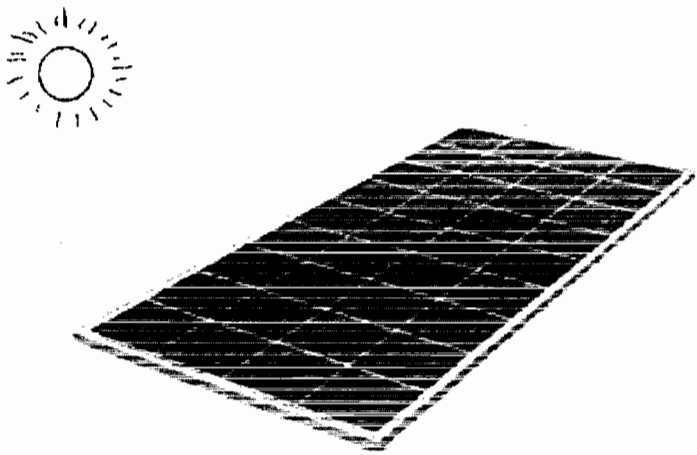
Heat

Heat is the most common form of energy in our daily life. One of the sources of heat is the sun, which gives both light and heat. The experiments below show that we get heat from the sun. You will need a variety of common objects, two thermometers and a large plastic sheet.

1. On a sunny day, around noon, take different objects outside into the sun. You can take a tin or a bucket of water, a piece of dry wood, a panga, an empty tin, a glass and pieces of paper. Leave the object in the sun for an hour and then compare their warmth with similar objects kept in the classroom.
2. Take two thermometers. Put one outside in the sun for several hours and keep theother one in the classroom. Read their temperature regularly, every 15 or 30 minutes. Plot a graph for the temperatures and compare the graphs.

Electricity from Light

Electricity can be obtained from a source of light like sunlight through a solar panel. Solar panels are made of a special kind of cell that changes sunlight to electricity that is stored in batteries. This stored energy is used to light electric lights or to heat water.



Sound Energy

Sound is considered a form of energy. It travels away from the sound source through the surrounding medium (air, water, solid).

Electric Energy

Electricity is a kind of energy. We cannot see it but we know what it does. It makes things red-hot and gives is light. We can cook, light our houses and run machines with it.

Chemical Energy (Stored Energy)

Food and fossil fuels (coal, oil, gas) are forms of chemical energy which are released during chemical reactions. Food energy is released during digestion and fossil fuel energy are released when they are burned.

The Speed of Light

Light energy takes time to move from one place to another, but light travels extremely fast, so fast that we don't realise it's travelling. When you turn on a lamp, light suddenly fills the room. What actually happens is that the light energy travels from the lamp into your eyes. Scientists have been able to measure this speed of light using special instruments. The speed of light is 300,000 km per second.

Exercise

(a) What are the components of the air we breath?

(b) Which gas has the largest proportion in the atmosphere?

(c) Give two uses of oxygen.

(d) Nitrogen is an important gas. Give reasons.

(e) Why is carbon dioxide useful to plants?

(f) What is the speed of sound in air?

UNIT 9 Sound

The Role of Sound

We use sound for many things. It's role in society includes sending messages and making music for enjoyment. Following are some of the special sounds that society uses.

1. Traditional Horns

In Africa, horns are traditionally used to tell the community that there is danger or war. Horns may be blown during dances to accompany songs or dancing steps and rhythms. Some horns are long and curved while others are twisted. Each type of horn produces a distinctive sound.

When you blow a horn, a flute or a whistle, the shape of the instrument causes the air to vibrate. The vibrations are the sound waves that we hear as sound.

2. Traditional Drums

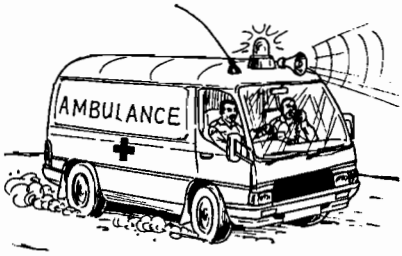
Drums are made of a cylinder of wood with skin or hide stretched over the top. When the top is struck with a stick or your hand, the skin vibrates, producing a sound wave which we hear. Some people are experts at beating drums. In some societies they send messages about deaths and funerals and war through their drumbeats in addition to making rhythms for dancing.

3. Bells

Do you have a bell at your school? If a school has a bell the head teacher uses it to send messages to the students. Bells are rung to call you to come when it is time to begin class, for assemblies or at the end of lunch break. Hearing the bell ringing makes you understand that it is time for an activity. When a bell is rung once or twice, what does it tell you? When it is rung continuously for half a minute what does it tell you?

4. Ambulance Siren

A siren is a device that gives a continuous wailing sound. They're used in several ways. For medical uses, they are fitted to an ambulance. When you see an ambulance with a red spinning light and hear the siren, it means that there is somebody with a medical problem who needs to be rushed to the hospital. The siren is a warning to other vehicles and people to keep away because the vehicle is coming at a high speed. What do you do when you see an ambulance or hear the siren?



5. Police Vehicle Siren

Police vehicles also have sirens. Police vehicles may be cars, landrovers or vans. When you hear a police vehicle siren, what comes to your mind? Usually it means that the police have been called to a crime. Examples of crimes are break-ins and fights. Police vehicles are also called to accidents.

6. Security Alarm

A security alarm is a device that makes a continuous sound that's very loud . It is fitted to a building or a vehicle. Some security alarms are automatic. The doors and window of the building or the doors of the vehicle are fitted with sensors that sense when someone is trying to break in. They turn on the alarm automatically. Other alarms are turned on by watchmen when there is danger. The loud sound attracts the police and local people to come to the crime scene.

7. Fire brigade

A fire brigade is a group of trained fire fighters. They have a special red vehicle that carries ladders, water with flexible water hoses, fire extinguishers, and other equipment to put out fires. Fire brigades also have sirens that warn people to leave the road because a fast-moving vehicle is approaching.

The Speed of Sound

We have already learned that sound travels in solids, liquids and gases. Scientists have measured the speed of sound in the same way that they have measured the speed of light. Sound travels at different speeds in solids, liquids, and gases.
The speed of sound in air is 330 - 350 meters per second.
The speed of sound in water is 1200-1500 meters per second.
The speed of sound in solids such as wood, copper, iron and steel is 6000 meters per second.

Activity:

a) Have one learner stand at one end of the football ground with a drum.
b) One group of students stands at the other end of the football ground. They should have a stop watch.
c) Another group stands much further away with another stop watch. The pupil brings down the drumstick to hit the drum, while the rest of the class observes from the distances.
d) They measure the time with the stop watches from the time the stick hits the drum until the time they hear the noise of the drum.

Exercise:

Match the following sounds with the relevant messages

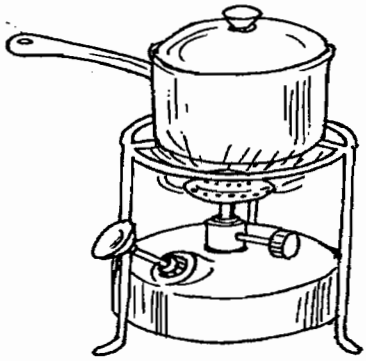
Sounds	**Messages**
Ambulance Siren	Dancing
Bell Ringing	Accidents
Drum	Thief
Alarm	Lesson Time

UNIT 10 Heat and Energy

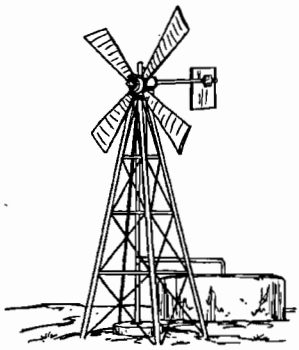
Heat is a form of energy, and there are other forms of energy such as energy from chemicals (chemical energy) and energy from electricity (electrical energy). Electrical energy may be stored in batteries. Look around your house and see what you have that uses energy, for example, your cooking fire or the batteries in your torch.

Following are important points about energy:

1) All types of food contain stored chemical energy.
2) Fuels like coal, charcoal, paraffin and gas contain stored chemical energy.

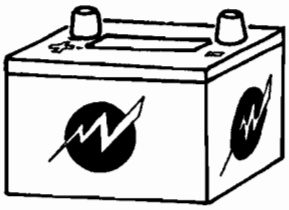


3) Any object that is moving has energy. This energy is called kinetic energy. For example, a moving ball, a moving toy car, wind, moving heat, and moving sound all possess kinetic energy.



4) Moving things like machinery have mechanical energy.

4) Electricity can be generated from waterfalls, wind and sun.
5) Electricity can be produced by chemical reactions.



Car battery

As you can see, one of form of energy can be changed into another. For example, light from the sun can be trapped by the leaves of plants and changed to a food chemical (glucose). In humans and animals glucose is also used for energy. It is broken down into heat to keep the body warm for energy to do work. Therefore heat, like other forms of energy, can be changed or transformed into other forms of energy.

Activity:

Identify forms of energy in the following substances. Choose the correct one from the brackets.

1) Fuel/ chemicals (heat, chemical, light).
2) Moving air/steam/water/water falls (kinetic, mechanical, chemical).
3) Electricity/dry cells/car battery (kinetic, electric, chemical).
4) Sun (chemical, light, heat).
5) Moving parts of a machine (mechanical, kinetic, electrical).
6) Name forms of energy that can be obtained from substances containing stored chemical energy such as charcoal and paraffin.
7) Name forms of energy that can be obtained from a torch cell (heat, light, electricity, chemical).

Exercise:

Give an example where:

1) Heat from steam moves an engine.
2) A chemical is burnt to produce heat and move an engine.
3) A chemical reaction is used to produce electricity heat and light.
4) Sun energy is used to warm water and produce electricity.

UNIT 11 Environment

Our Environment

Our environment is our surroundings. It includes both living and non-living things.

What makes up our environment?

Our environment is made of the following things:

a) The **soil** on which we live and build our huts or houses. There is **water** in the form of ponds and streams.
b) The soil itself contains **water** that supports the growth of vegetation and other living things.
c) Living things including ourselves are surrounded by **air** which we breathe. Without air we cannot live.
d) Living things, including ourselves, need **warmth** and **light** which come from the sun. We also make fires for lighting and warming ourselves.
e) We are surrounded by **living things.** Some are big while others are too small to see. Some of them are useful while some of them are harmful to us.

Changes in the environment caused by human activities.

If we make of list of the activities that families in New Sudan do, the activities will differ depending on the community and region. Typical activities in settled communities will include:

a) Clearing bushes
b) Cutting trees
c) Digging and tilling the soil
d) Making roads
e) Building huts or houses or farm structures
f) Breaking and moving stones and rocks
g) Burning fires
h) Hunting

In pastoral communities, common activities include:

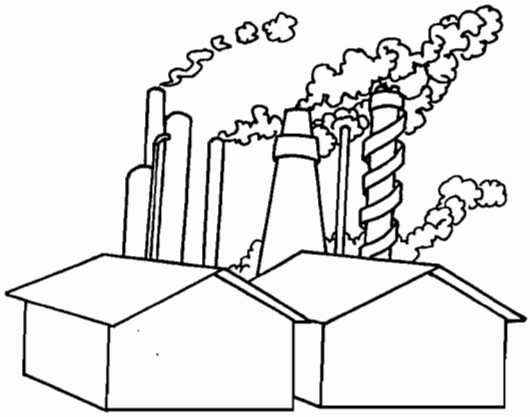
a) Grazing livestock
b) Making structures and houses for people and livestock
c) Feeding livestock
d) Cultural activities
e) Hunting
f) Burning fires

How do these activities change the environment? Look at each point and say what effect it has.

Pollution of the Environment

Air Pollution

Any kind of burning causes smoke to go into the air. Smoke affects the atmosphere, making it hazy. We cannot see clearly if there is smoke in the air. Smoke also makes it difficult for us to breathe. In towns vehicle exhaust and factories cause air pollution.



Water Pollution

Humans, animals and plants all need clean water to live. One bad effect of development is that water may become polluted. Water is polluted by:

a) Sewage from villages and towns. Sewage has to be treated. It shouldn't be released into water sources in a raw form.
b) Herbicides and pesticides used on farms may be washed into streams and ponds by rain and can poison fish, animals, and humans.

c) Industries located on the banks of rivers may dump poisonous chemicals into the water. This is cheaper than treating them or disposing of them in a safe way. Governments need to control such industries.
d) Oil spills from tankers kill many living things in the sea water including sea birds.
e) Fertilizers washed by rain enter rivers and cause water plants to grow in such large amounts that they use all the oxygen in the water, so fish and other animals cannot live.

Soil Pollution

When farmers use large amounts of chemicals like fertilizers, herbicides and insecticides, they can pollute soil. In the soil, these chemicals can poison worms and other living things. Some fertilizers can make soils too acidic or too alkaline so that crops do not grow properly.

Conservation of Trees and Plants

We should be careful not to destroy the trees and plants in our area. Trees and plants are important to us. We use them for the following things:
a) Building houses
b) Making furniture
c) Building bridges
d) Electric poles
e) Medicines from leaves, barks and roots
f) Fuel
g) Sources of gum and latex.

Trees and plants are also important to us for:
a) Cooling and shading
b) Reducing soil erosion
c) Reducing water evaporation from soil

Conservation of Wild Animals

East Africa is world famous for the wild animals it has. Tourists from all over the world come to East Africa to see the wild animals. Governments in all East African countries have created game reserves and game parks are to protect the animals from poachers. Poachers are people who capture or kill the animals.

Activity:

Discuss with members of your class why:

a) zoos keep wild animals

b) children should see wild animals

c) animals are valuable

d) some animals are disappearing from the earth

e) we study animals such as apes, elephants and lions

f) tourists like to see wild animals

g) we should protect the habitats of wild animals

Water Conservation

Water must be conserved. Think of life without water. All living things need water. Water conservation refers to both keeping normal amounts of water available in an area, and keeping the water in a clean and natural state.

When we conserve water, we try to control the amount that people use so that there is always a normal supply, and control water pollution so that the water we have is clean.

Activities:

1. Think of how you can reduce the amount of water you use from:

a) The tap when washing hands

b) The water tank when cooking

c) The pot when drinking

d) Showers when bathing

2. Explain how the following things help conserve water

a) Building dams

b) Planting trees and crops

c) Planting lawn grass

d) Putting grass around young plants

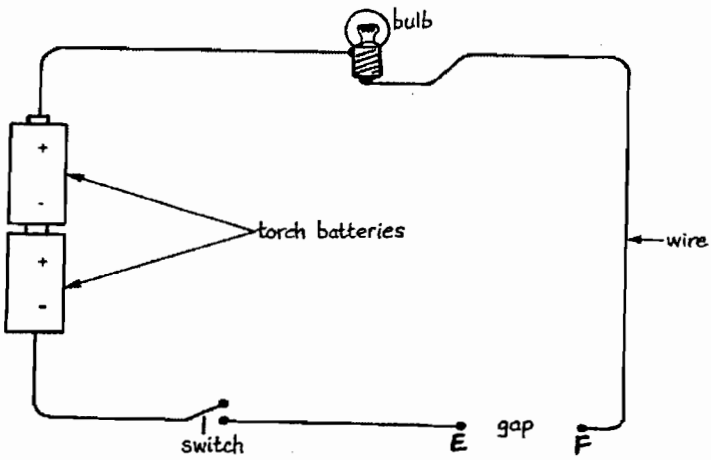
UNIT 12 Electricity and Magnetism

Electricity and magnetism are related. Electricity can be used to produce magnets, and magnets can produce electricity. In this unit we will study simple electric circuits and basic magnetism.

A Simple Electric Circuit

To make a simple electric circuit you need the following materials. Look at the diagram and make one.

a) One or two dry cell batteries
b) Thin copper wires
c) A switch
d) A torch bulb



Conductors and Insulators

Conductors are materials that electricity can pass through, while insulators are materials that block electricity and don't allow it to pass. Insulators are also called non-conductors.

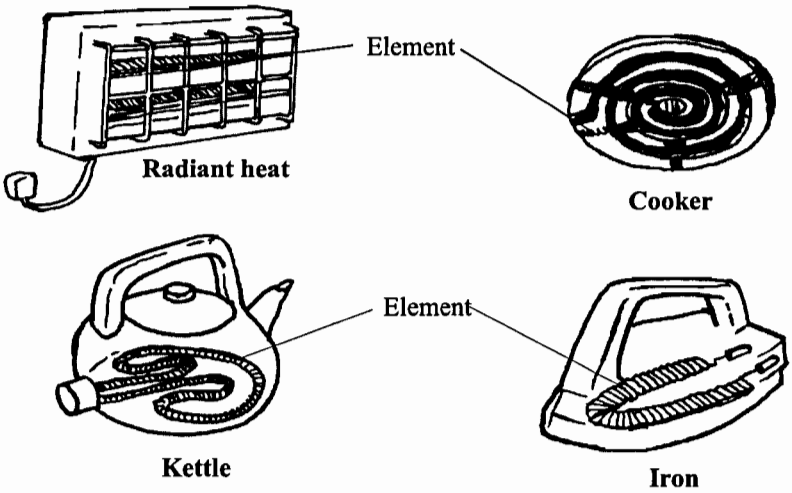
In your electric circuit put the following materials in the gap. Close the switch and see which materials cause electricity to pass through them. (If electricity can pass through the bulb will light.)

1. Iron wire
2. A piece of cotton thread
3. Nylon thread
4. A piece of rubber band
5. Cello tape
6. A piece of glass

Draw two columns, one each for conductors and insulators (non-conductors). Tick each object whether it is a conductor or insulator.

Use of Electricity to Produce Heat

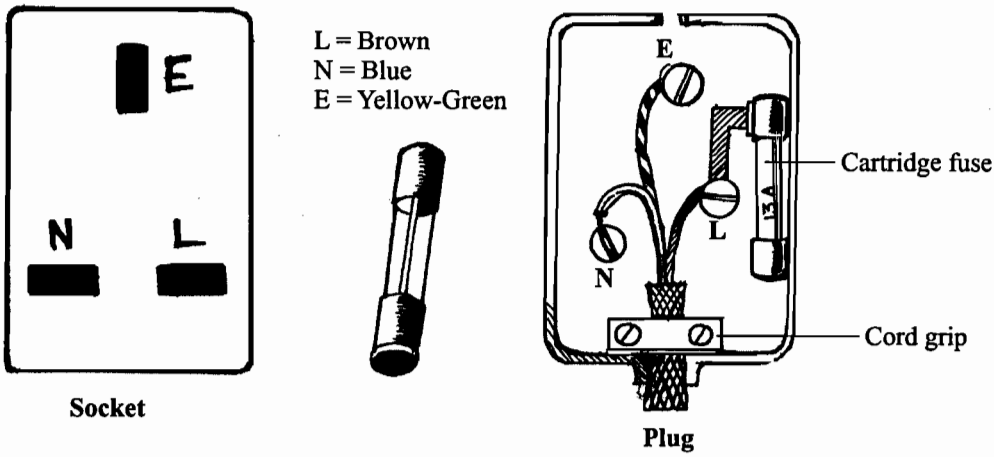
You need any of the appliances: electric cooker, kettle, bread toaster, and an iron. Connect the appliance to a source of electric current. The wire inside the device is called the element. It heats red hot. In this way electricity produces heat.



How Does a Fuse Work?

A fuse is short piece of wire made of tin and copper. Fuses are placed in electric circuits to stop the electrical current from flowing if the level becomes too high. The wire in the fuse melts and breaks when the current going through your machine is too high, stopping the current. If there is no fuse, the wires will keep on heating until they become red hot and catch fire.

Look at the diagram of a fuse on the next page and explain how it works.



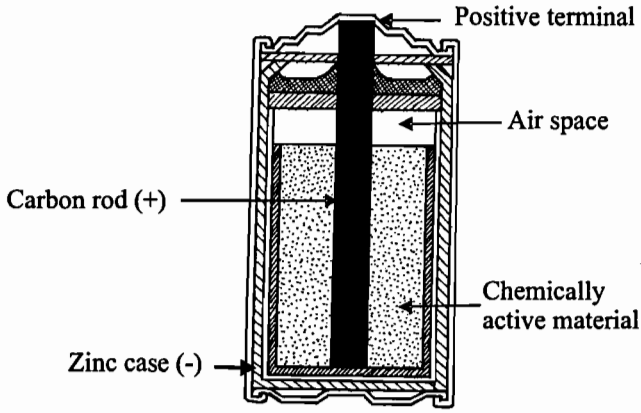
The Structure of a Dry Cell

Find a used dry cell and cut it open to find out how it works.

a) Cut along the length with a strong knife

b) Examine what is inside.

c) Describe what you see.



The zinc case reacts with the chemical paste to produce an electric charge. Can you think why the battery may leak? What is the black rod for? Does it conduct electricity?

Magnetism

Magnetic and non-magnetic material

Take a magnet and try different materials to see what it attracts. Use some materials made of metal and some not made of metal. They may include pencils, rulers, stones, papers, razor-blades, erasers, grass, bottle-tops, maize, buttons, hair, copper wire, glass, an aluminium pot, clay pot and pins. Which materials did the magnet attract? Which materials did the magnet not attract?

Sort out the materials and arrange them in two groups, then write down what you found in a table as shown below.

	Materials attracted by magnet	Materials not attracted
1.		
2.		
3.		
4.		
5.		

The materials that a magnet attracts are called magnetic materials. A magnet attracts only materials made of iron, steel, cobalt and nickel. These materials may be made into magnets (magnetised) themselves.

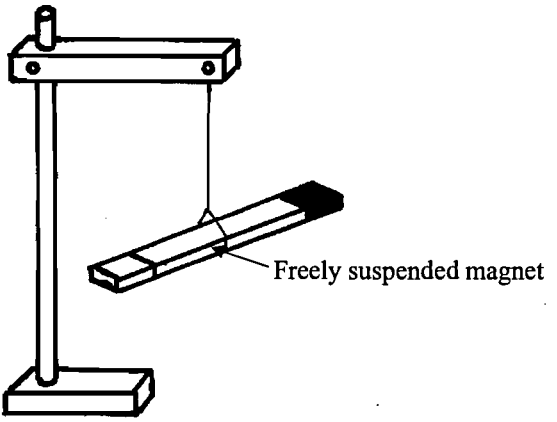
Non-magnetic materials are materials that aren't attracted by a magnet. They cannot be made into magnets. Examples of non-magnetic materials are: paper, copper, aluminium, plastic, bones, charcoal, rubber, chalk, glass and many others.

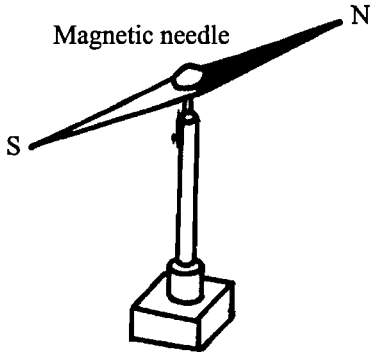
Making a magnet and a Magnetic Compass

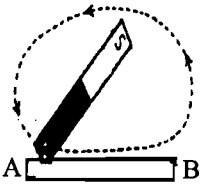
Magnetic materials can be turned into magnets. Using a bar magnet, magnetise an iron nail AB by rubbing it with a bar magnet. AB becomes a magnet with poles at A and B. Can you say which pole is north and which is south? Test this magnet so that A and B poles are identified.

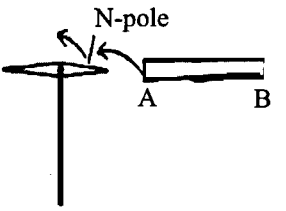
To make a compass, magnetise a needle that has a small hole in the centre. Stroke the needle several times until it becomes a magnet. Suspend the needle. Which pole points north?

If a magnet is stored, it tends to lose its magnetic power. It becomes weaker and weaker. To prevent this from happening bar magnets are stored in pairs with their poles N and S facing S and N.





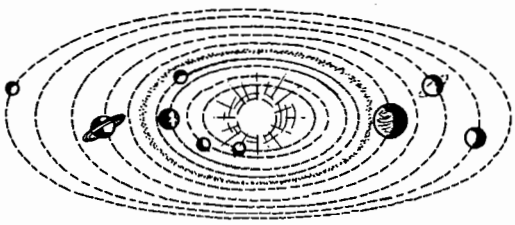




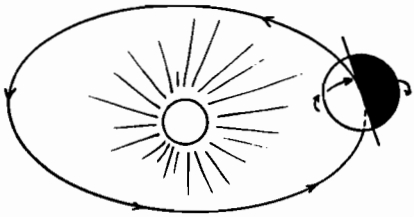
UNIT 13 Earth and Space

The Solar System

Our earth is one of the nine planets that revolve round the sun. The word planet is derived from a Greek word meaning "wanderer". The planets don't really wander, though. They revolve around the sun in fixed orbits maintained by the attraction of the sun's gravity. The nine plants, their moons, and also asteroids, meteors and comets are part of the solar system. "Solar" refers to the sun, and the solar system includes all the bodies associated with out sun.



The Solar System



The Earth's Orbit

Look at the diagram and find the nine planets. The order of the planets starting from the sun is:

1. Mercury	2. Venus	3. Earth
4. Mars	5. Jupiter	6. Saturn
7. Uranus	8. Neptune	9. Pluto

The Earth is 149,600,000 km away from the sun, and Pluto is 5,900,000,000 km away. Pluto is the planet that's the furthest from the sun. The sun is a star and attracts the planets by its enormous gravity. The sun is extremely hot.

The earth is the only planet where living things are found. That is because there is no oxygen or water on the rest of the planets. Also, the temperatures on these planets are either too cold or too hot.

Planets are not stars. Planets are solid bodies while stars are made of gas. Following are other facts about planets and stars:

a) Planets do not have their own light but reflect light from the sun. Stars have light of their own. The gases that make up the stars are white-hot and burn to give light and heat.

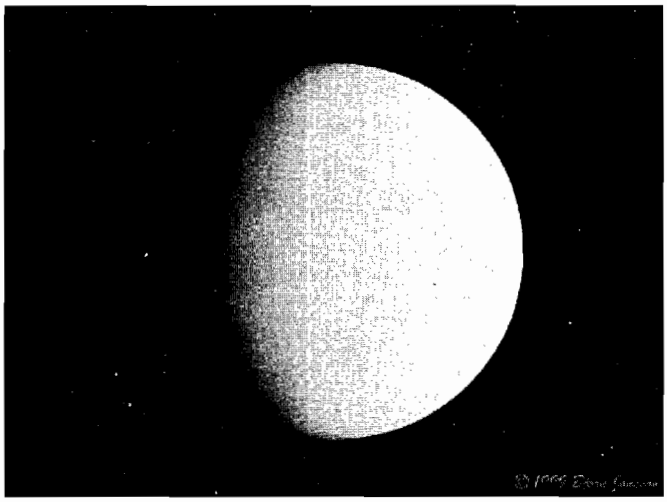
b) Planets rotate on their axis and revolve in their orbits around the sun.
c) Planets have moons (satellites) near them. The earth has only one satellite (the moon). Some of the other planets have more than one moon.

Mercury

This is the smallest planet in the solar system. It is also the nearest to the sun. You can see it in the east before sunrise and in the west after sunset. It is quite a bright planet but may not be easily seen because it is so small.

Venus

This is the brightest planet and you can see it in the east before sunrise and in the west after sunset.



Venus

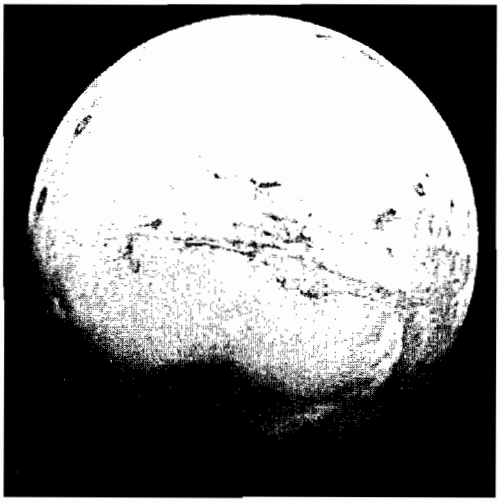
Earth

We have already learnt that the earth is one of the planets. It takes one earth-year to revolve around the sun. The planets whose positions are further than the earth from the sun in the solar system are called the outer planets. They include Mars, Jupiter, Saturn, Uranus, Neptune and Pluto.

The outer planets take a longer time to travel around the sun. As you can see from the diagram, the path of their orbits is very large. Pluto, which is the farthest planet from the sun, takes 248 years to travel around the sun.

Mars

Mars is smaller than the earth. The temperatures on this planet are neither too cold nor too hot. This means that living things could live there. However, there is no oxygen on Mars, therefore, no life exists on it that would require oxygen.



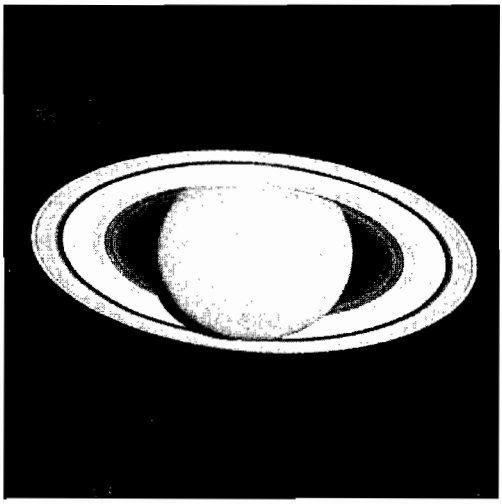
Mars

Jupiter

This is the largest planet in the solar system.

Saturn

This is the only planet that is different from the rest. It has beautiful rings surrounding it.



Saturn

Apart from Mars, all the outer planets are extremely cold. This is because they are far away from the rays of the sun. Because the rays of the sun falling on them are very weak they reflect very little light. This is why we cannot see them without a telescope.

Stars and Galaxies

There are millions of stars in the sky. Each of these stars is a sun. The nearest star to our sun is Alpha Centauri. A collection of stars is called a galaxy. Our galaxy is called the Milky Way. There millions of galaxies in the universe (we don't know the number). Try to observe the sky in the evening and identify some stars.

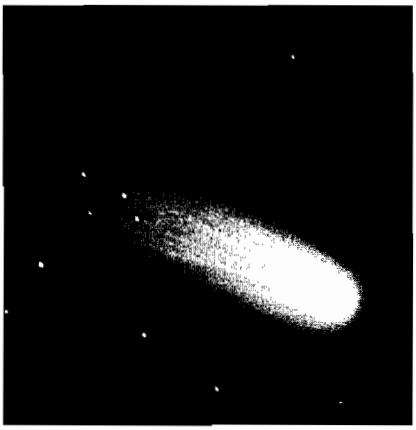
Andromeda Galaxy

Comets and Meteors

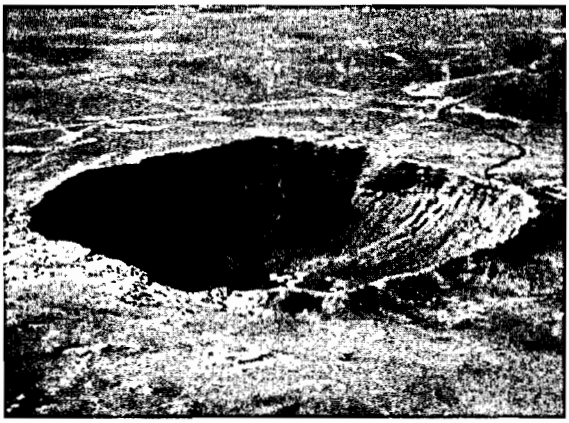
Comets and meteors are minor bodies of the solar system. Comets are icy bodies that revolve around the Sun. They are affected by the gravity of the planets. Comets may come close to the earth. Some are visible with the naked eyes e.g. Halley's Comet seen every 76 years. It was seen in 1910 and 1986. When a comet nears the Sun, some of the ice in the comet turns to gas. The gas and loose dust freed from the ice create a long luminous tail that streams behind the comet.

A meteor is a large piece of rock that also moves round the sun. Meteors are invisible because they do not produce light, unlike comets which are surrounded by hot gases.

When a meteor enters the earth's atmosphere, it burns up, producing a streak of light. These are called shooting stars. Sometimes large meteors don't burn up completely so that some mass still reaches the earth, hits the surface of the earth and creates a crater.



A comet



A meteor crater

Questions:

1. On which planet of the solar system are living things found?
2. Does the sun move round the planets or do the planets move round the sun?
3. The sun is not a planet. True or False?
4. The path on which the earth travels round the sun is called its.....
5. The earth makes a complete revolution round the sun in ..... years(s).
6. The bright objects moving at high speed across the sky may be.....
7. There is oxygen and water in the moon; therefore there are living things on the moon. True or False

8 ..... is seen in the sky when the whole surface of the moon faces the sun.

A. full moon B. Crescent moon C. gibbous D. quarter moon

9. The sun is a .....
10. The largest planet is.....

. A. Jupiter B. Pluto C. Mercury D. Neptune

11. It takes ..... years for Pluto to travel round the sun

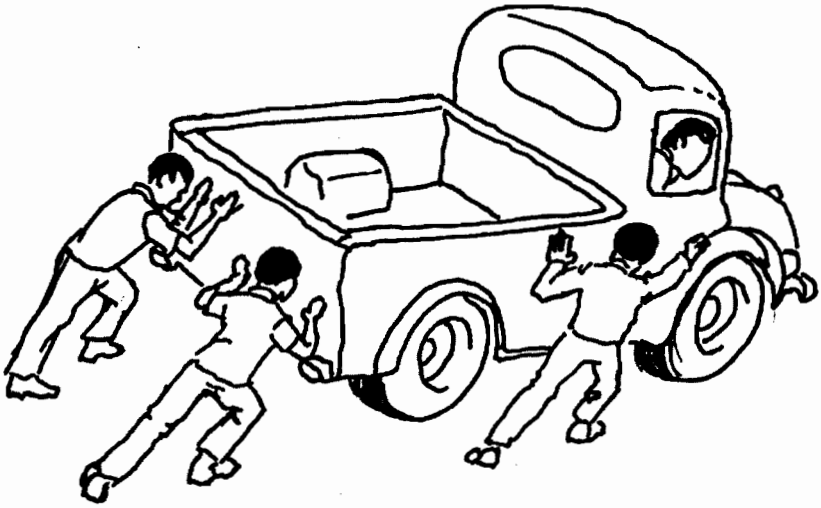
A. 248 B. 10 C. 100 D. 360

UNIT 14 Making Work Easier

Force

In science, force and energy mean almost the same thing. Force means "strength, energy or power," and energy refers to the "power to do work". Force also refers to the pushes and pulls that make things move.

A push or pull from the wind can make leaves or paper move. A force can stop an object from moving, change the direction of its movement, and increase or decrease the speed at which it is moving.



The car is stuck in mud. It will not move.
The men must use force to make it move.

A force can change the shape of an object e.g. Clay can be moulded into a shape by pressing on it.

Types of Force

A. Gravity

When a ripe fruit falls from a tree, it falls toward the earth. When we throw a ball into the air, it comes back down. ***The force that makes every moving object move towards the surface of the earth is called gravity.*** Gravity from the sun keeps the Earth and the other planets in their orbits as they revolve around it.

You can conduct an experiment to see the effects of gravity. You will need a tennis ball, a football, a feather and a piece of paper.

a) Climb a tree or ladder.
b) Drop the four items at the same time and observe what happens.
c) Where you surprised by what happened?

You should have seen that the large and small balls fell at the same rate. That is because the force of gravity is the same, regardless of the mass of the object. All objects should fall towards earth at the same rate if no other factors are involved.

Air pressure is one factor that can affect the rate. The feather and the piece of paper fell more slowly than the balls. That is because their surface area is large compared with their mass. Air pressure pushed up against the feather and the paper, and so their fall was slowed down.

B. Friction

Friction is the force produced when two surfaces are rubbed together. Friction causes heat. That is why we rub our hands together to warm them. It is also why machines get hot.

The force applied to an object either reduces friction (resistance) or increases it. For example, when riding a bicycle you apply some force to the pedals. The force then moves the bicycle wheels forward, reducing friction

between the rubber tyres and the road surface. Applying the brakes increases the friction and stops the bicycle.

Friction helps this bicycle to move

Activity:

Which surfaces produce the greatest friction when you are pulling or pushing something: sand, clay, small stones (gravel), smooth wood, rough wood or plastic sheeting? Conduct some experiments to find out.

C. Motion

Non-living things don't move on their own. An external force must be applied to them. In order for motion (movement) to occur, the force applied must be greater than the weight of the object and the frictional force.

Carry out these experiments to find out how much force is needed for movement to occur. You will need a feather, a tennis ball, a football, a thick book, a grass stalk, and sticks of different sizes.

a) Put the feather on a table or desk and blow it.
b) Do the same with the tennis ball and then the football.
c) Push the book with the grass stalk.
d) Push it with the different sized sticks.
e) Use the sticks to push the balls along sandy soil, and through grass.

How much force was needed to move each object? Was there the same friction (resistance) on the surface of the table as there was on the ground, or through the grass?

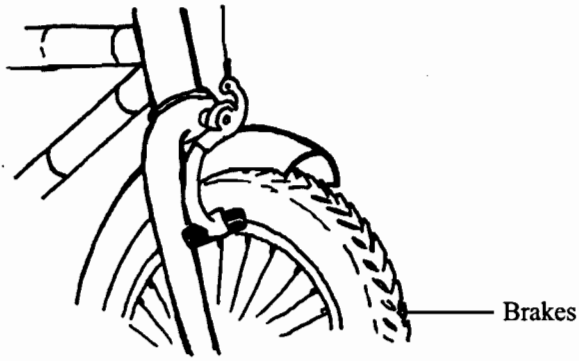
Questions:

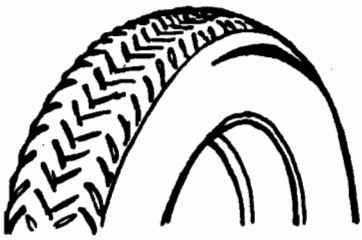
1. What would happen to the earth if the sun had no gravity?
2. Does a rough surface or a smooth surface produce the greater amount of friction?
3. Which would fall to the ground more quickly - an empty 5 litre jerry can, or a full one? Why?

Advantages of Friction

Without friction we wouldn't be able to walk. Friction develops between our feet and ground. When driving, the tyres of a car or bicycle could not grip the road if there were no friction between them. The tread on a tyre increases friction. Other ways that friction is helpful:

Walking on mud is more difficult than walking on dry ground.





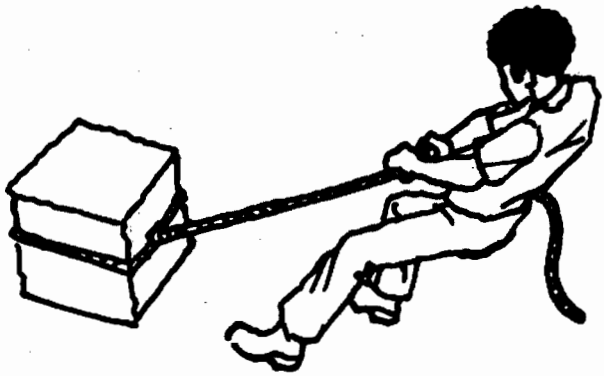
Friction makes these brakes work.

a) Brakes: all brakes develop a force of friction on the wheels causing them to stop.

b) Friction makes matches light.

Disadvantages of Friction

We have seen that friction can be very useful. It can also make problems for us. For example, if there is too much friction between the moving parts of machines, this friction will produce heat. Too much heat can damage the parts.



If you pull a heavy load over rough ground, friction between the load and the ground makes the work much more difficult, or even impossible.

Ways of Reducing Friction

Man has invented a number of ways to reduce unwanted friction.

1. Lubricants: Lubricants are liquids or semi-liquids and they are slippery. Water is a lubricant as are paraffin, cooking oil, grease and engine oil. They reduce friction because they make the surface smoother.
2. Rollers: These are another way of reducing friction.
3. Wheels: These also reduce friction, although they need friction to work. An example is a wheelbarrow. Can you think of other types?

Making Work Easier with machines

With the word "machines", one immediately thinks of huge structures used in factories or industries or on farms, but the word actually refers to things we use to make work easier (simple machines).

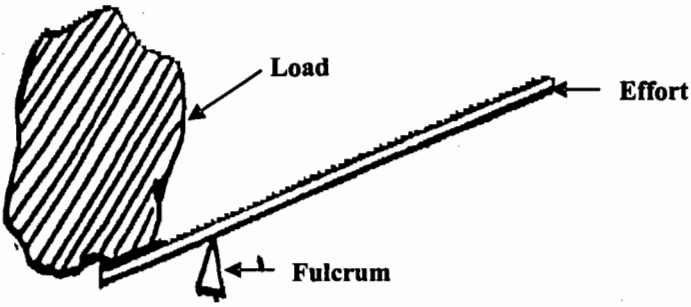
Sailing through water

Levers

A lever is a simple machine which can move freely about a fixed point called a fulcrum. When we talk about levers, the following terms are used: effort, fulcrum and load.

Effort is the force applied to the lever.
Fulcrum is the point about which the lever moves.
Load is the work being done.

The illustration shows how this works:



Questions:

a) What is force?

b) What does friction tend to do to moving objects?

c) Why is it more difficult to work on wet mud than on a dry surface?

UNIT 15 Properties of Matter

Matter is anything that occupies space and has mass.

States of Matter

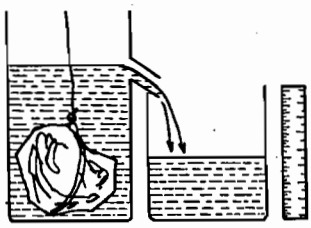
Matter can exist in the following states:
(a) solid: These are hard at room temperature. They can be handled. For example a lump of iron, a piece of wood, a piece of rubber, fat, etc.
(b) liquid: These need a container to hold them. For example, water, milk, oil, alcohol, honey.
(c) gas: These move and disperse in the atmosphere. Some gases are coloured and can be seen while some are invisible. Gases occupy any space and any container. For example a bottle which appears empty is in fact full of air. Examples gases are carbon dioxide, oxygen and nitrogen.

Characteristics of Matter

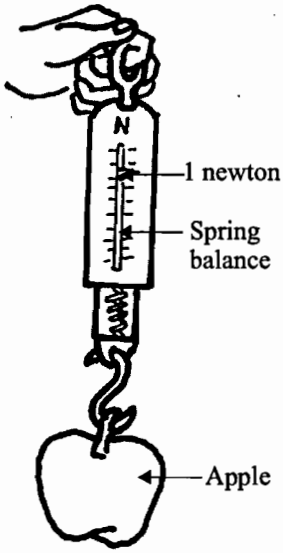
Matter has volume and size; shape and weight.
(a) Volume of Objects: The length, width and height of regular objects can be measured. For example a block of wood. The volume can be calculated by multiplying length x width x height.

The volume of an irregular object can be obtained by measuring the volume of water it displaces. The volume of a gas can be measured by measuring the volume of the container having the gas.

Volume is measured in cubic centimetres (cm^3) or cubic decimetres (dm^3).



(b) weight: The weight of an object is the pull of the earth on the object in a particular place. When using a spring, the pull of the earth on a mango can be measured as shown here.



The nearer to the earth's centre, the more the same mango will weigh. Do you think that the same mango will weigh more or less on a mountain? The weight of anything can be measured by hanging it on a spring balance which is marked in Newtons.

In science we prefer to use mass instead of weight. Mass is the measure of the amount of matter an object has in itself. Look at the balance used by the butcher. The mass of meat is measured against the known masses of weights in other pans. The mass of a kilo of meat is balanced with the kilogram weight.

(c) density: Density refers to how heavy or light a substance is by comparing its mass to its volume. Density is mass per unit volume of a substance. Calculate density, volume and mass of an object with this formula:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Changes of matter from one form to another

The state in which matter exists depends mainly on two things: *temperature* and *pressure*. The state of matter can therefore be changed by increasing or decreasing the temperature of the material, or by increasing or decreasing the pressure acting on the material.

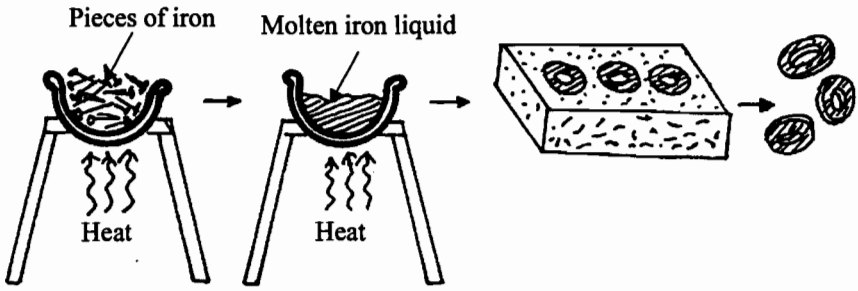
Take, for example, candle wax. At ordinary temperatures, it exists as a solid. If you heat the wax in a metal container, it melts and becomes a liquid, which can be poured out. If you continue to heat the liquid wax, it will turn into gas.

Solid	$\xrightarrow{\text{Heat}}$	Liquid	$\xrightarrow{\text{Heat}}$	Gas
(Candle wax)		(Liquid wax)		(candle wax vapuor)

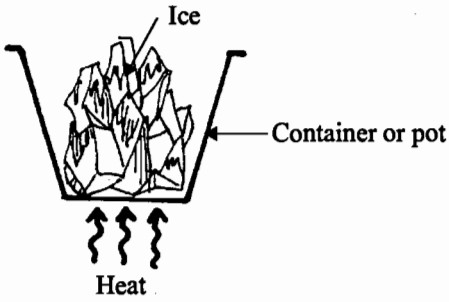
If you go to a tinsmith's or blacksmith's shop, you may see the smith heating iron in a fireplace. When the iron turns red-hot it becomes soft. The smith then hits and beats it into the shape he wants.

If he continues to heat pieces of iron, the pieces will melt and turn into liquid iron. If this liquid is poured into moulds it will harden into an object in the shape of the mould.

Therefore when matter is heated or cooled it changes its state. Take water as an example. Ice is a solid form of water. When ice is heated it starts to melt and becomes a liquid, which is water. If you continue heating the water, it turns into steam or water vapour (a gas) which escapes into the air.



If you now reduce the temperature, the water vapour (gas) will condense into a liquid (water) and if you lower the temperature even further, the water will freeze and solidify to form ice.



Questions:

1. How do you turn water into a solid?
2. How do you turn water into a gas?
3. How can you measure the weight of a rock?
4. How can you measure the volume of a rock?
5. Compare weight and volume.

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