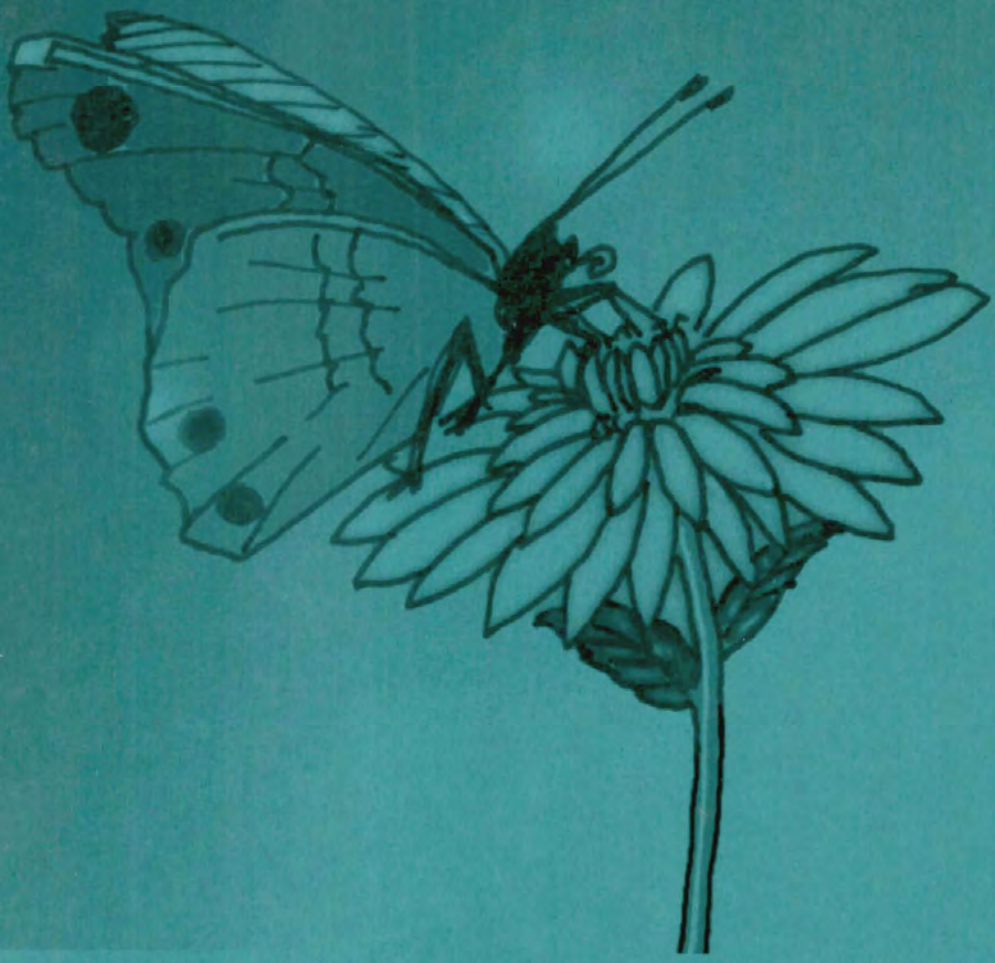
ACCELERATED LEARNING PROGRAM

SCIENCE

LEVEL 4



SECRETARIAT OF EDUCATION
NEW SUDAN

ACCELERATED LEARNING PROGRAM

SCIENCE

LEVEL 4

Secretariat of Education
New Sudan

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SUDAN BASIC EDUCATION PROGRAM

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Introduction

This book is intended for ALP level four learners. In this book, learners are expected to understand many new concepts about science. The book covers fourteen units which have been developed to meet the needs of ALP level four learners in observing, performing and learning scientific facts. Learners and teachers should understand that, to make the best use of this book, they should read it carefully and do all exercises and practical experiments.

This book contains illustrations and diagrams in each unit to aid in understanding the concepts presented. There are also practical experiments in science, and learners should use local materials when they are performing these experiments.

The aim of this book is to provide ALP learners with practical knowledge that will improve the physical environment of New Sudan for the benefit of individual families and communities. It provides practical exercises to sharpen learners' practical skills. It also provides questions for self evaluation at the end of each unit.

The editors would like to thank all those who participated in the development of these materials.

UNIT 1 Health Education

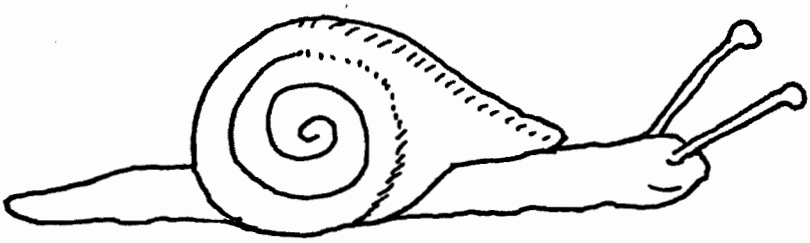
Water-borne diseases

Water-borne diseases are diseases that spread from person to person through contarninated water. Some of the common water-borne diseases in New Sudan are:

i. Bilharzia (shistomiasis)
ii. Typhoid
iii. Amoebic dysentery
iv. Cholera

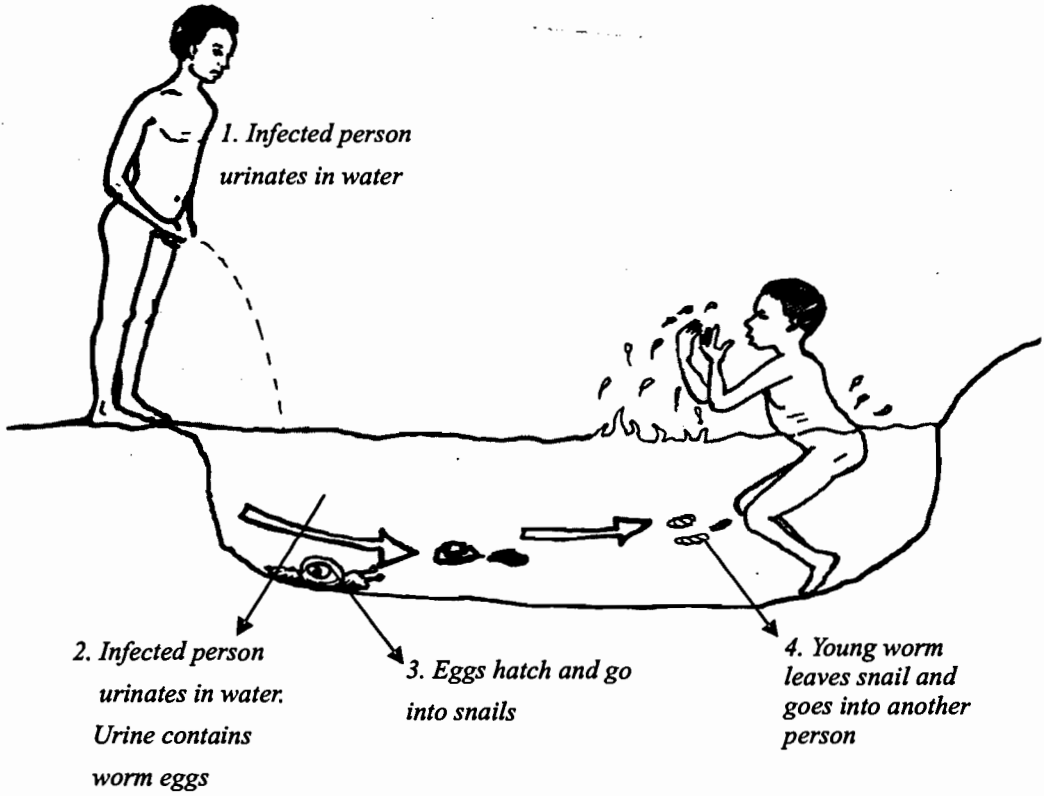
A. Bilharzia (Shistomiasis)

Bilharzia is a water-borne disease caused by tiny worms which enter the body through the skin when a person is bathing or washing. The disease is spread from person to person by infected people urinating or passing faeces into a water



The snail that helps bilharzia worms breed in water

source. The bilharzia worms breed in water using snails as hosts. The urine and faeces of the infected person contain eggs that hatch in the water. After the worms hatch they go into snails where they grow. After a certain amount of time the young worms leave the snails and enter the bodies of people who are washing or bathing. They enter the person's body by boring through the skin and the person becomes infected. The worms are parasites that live in the person's blood, so bilharzia is called a parasitic disease of the blood.



Bilharzia (Shistomiasis) cycle

Cause of bilharzia

Bilharzia is an infection of tiny worms that enter the body of a healthy person. It is caused by bathing or washing in contaminated water.

Signs and symptoms of bilharzia

- Itching
- Pain in the lower abdomen
- Bloody diarrhoea (rectal bilharzia)
- Bloody urine (urinary bilharzia)
- High fever
- Loss of blood causing anemia.
- Rashes on the skin

Prevention of bilharzia

- Dispose of faeces and urine in a sanitary way.
- Always use deep pit latrines or flush toilets.
- Don't enter water where bilharzia snails and worms may be present.
- Faeces and urine should not contaminate water sources (rivers, dams, lakes, and wells)
- Drinking water should be chemically treated or boiled to kill the bilharzia worms.
- Don't walk barefoot in swampy areas.
- Use protective shoes and clothing.
- Kill snails by spraying the water where they live.

Treatment of bilharzia

- Use Niridazole (Ambilhar)
- Use Metrofinate.

b. Typhoid

Typhoid is a water-borne disease caused by a bacterium called salmonella typhi. The bacteria are passed in either urine or faeces. Improper disposal of infected urine and faeces may cause contamination of the water supply in rivers, dams, lakes and wells, thus infecting people who drink the contaminated water.

Causes of typhoid

- A bacterium called salmonella typhi.
- The bacteria are passed either in the urine or faeces of infected people.
- Poor disposal of contaminated urine and faeces.

Signs and symptoms of typhoid

- Headache
- Severe fever
- Severe diarrhoea
- Vomiting
- Dehydration

Prevention of typhoid

- Proper disposal of faeces and urine
- Domestic water should be boiled or chemically treated before drinking.
- Hands should be washed before eating.
- Fruit should be washed with clean water before it's eaten.
- There is a vaccination for typhoid which should be given to people living in or visiting areas where typhoid is present.

Treatment of typhoid

Use of antibiotic drugs such as Chloramphenical (chloromycetin) capsules.

c. Amoebic Dysentery

Amoebic dysentery is a water-borne disease caused by a protozoan called Entamoeba histolytica. When the amoeba cyst is ingested, the cyst's membrane is digested and the protozoa are released. When they reach the large intestines (colon), the Entamoebic histolytica multiply, which may lead to diarrhoea and bloody faeces.

Causes of amoebic dysentery

- It's caused by protozoan called Entamoeba histolytica.

Signs and symptoms of amoebic dysentery

- Headache
- High fever
- Bloody diarrhoea
- Loss of body weight
- Loss of appetite
- Dehydration
- Abdominal pain

Prevention of amoebic dysentery

- Avoid contaminated food and water.
- Always drink boiled water.
- Store food properly so that it doesn't become contaminated.
- Don't eat unwashed fruit and vegetables that may be contaminated.
- Dispose of faeces in deep pit latrines.

Treatment of amoebic dysentery

- Tetracycline capsules.
- Metronidazole tablets.
- Cotrimazole tablets
- Oral rehydration solution to regain lost water and salts

d. Cholera

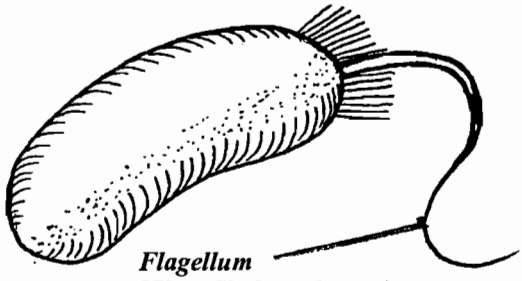
Cholera is a water-borne disease caused by bacterium called Vibro cholerae. It is a dangerous disease in the tropics. These bacteria are found in contaminated water

and are spread by eating food or drinking water contaminated by the faeces of infected people. It's also spread by flies moving from faeces to food. People living where sanitation is poor and the domestic water supply is contaminated can easily contract the disease. If there is an outbreak of the disease in a specific area, it spreads rapidly and can cause an epidemic where many people die.

Cholera is a serious disease because it causes the body of the infected person to lose fluids quickly, causing dehydration which may result in death if not treated immediately. Death by cholera can be rapid, within twenty-four hours of infection in extreme cases.

Causes of cholera

- Caused by a bacterium called Vibro cholerae.
- Spread by faeces of infected people contaminating food and water.
- Spread by flies that carry bacteria to food, thus contaminating food.
- Poor sanitation results in contamination of food and water.



Vibro Cholerae bacterium

Signs and symptoms of cholera

- Severe fever
- Vomiting
- Severe diarrhoea
- Dehydration
- Loss of body weight
- May lead to death

Prevention of cholera

- Dispose of faeces and refuse in a sanitary way to prevent contamination of water and food.
- Use deep pit latrines which are not located near a water source.
- Maintain good personal hygeine.
- Drinking water should be boiled and filtered.
- Infected persons should be isolated (kept away) from other people.

Treatment of cholera

- Give patients extra drinking water
- Give patients rehydration solution
- Tetracycline capsules
- Cotrimazole tablets
- Metronidazole tablets

Questions:

1. What are water-borne diseases?
2. List four common water-borne diseases.
3. State five symptoms of bilharzia.
4. Name two water sources you know.
5. Typhoid is caused by a _____called_____.
6. Name three steps you would take to prevent and control cholera.
7. Suppose a person contracts cholera, what measures would you take to save the patient?
8. Explain the life cycle of bilharzia.

Airborne diseases

Airborne diseases are contracted through air droplets. Common airborne diseases are:

i. influenza
ii. mumps
iii. meningitis
iv. Tuberculosis

a. Influenza

Influenza is an airborne disease caused by a virus. It is sometimes referred to as "flu" or sweating sickness. It is spread through air droplets and has an incubation period of one to three days.

Causes of influenza

Influenza is caused by a virus. It's spread from person to person through inhaling and exhaling air. The influenza virus can mutate (change) from year to year, and there are influenza outbreaks yearly around the world. Some years the outbreaks are serious and many people die, but other years they aren't so serious.

Symptoms of influenza

The symptoms of influenza are:

i. sneezing and running nose
ii. headache and high fever
iii. sores in the throat and coughing.

Prevention and treatment of influenza.

The main way to prevent influenza is to create awareness so that affected patients are kept away from other people and the virus isn't spread. Early treatment is necessary with the use of antibiotics to avoid a secondary attack. New vaccines for influenza are created yearly.

Questions:

1. What is influenza?
2. Describe the symptoms of influenza.
3. How is influenza contracted?
4. Why are antibiotics used to treat influenza?
5. What's the best way to stop the spread of influenza?

b. Tuberculosis (TB)

Tuberculosis is an infection of the lungs. It's caused by a bacterium that enters the lungs and sometimes other parts of the body, including the bones. TB is a common disease that weakens and kills infected people. However there are drugs available to treat TB, and tests that show whether or not a person is infected.

Causes of Tuberculosis (TB)

The disease is highly contagious and spreads from person to person by coughing or spitting. The droplets of water contain the TB bacteria. TB can also infect cattle, and people can become infected by drinking milk from infected cows.

Symptoms of tuberculosis (TB)

i. chronic coughs
ii. upper back pain
iii. weight loss
iv. weakness

Prevention and treatment of tuberculosis (TB)

Medication is usually taken for one to two years. While treatment is going on, and

even afterwards, the person should eat a nutritious diet. To avoid contracting TV, don't sleep in unventilated rooms with an infected person and avoid sharing eating dishes with someone who is infected. It's important to have a TB test or chest x-ray to check if the TB bacteria is present in the body.

Questions:

1. What measures would you take to prevent the spread of Tuberculosis?
2. What's the treatment for TB?
3. Have you ever known anyone who had TB? Describe their experience with the disease.

c. Mumps

Mumps is an airborne disease caused by a virus. The disease causes painful swelling in the neck. Mumps is more common in children than in adults.

Causes of mumps

Mumps is caused by bacteria which are spread from person to person.

Symptoms of mumps

The first symptom begins two or three weeks after being exposed to someone with mumps. Signs are fever, painful mouth sores, a soft swelling below the ears at the lower jaw, swelling in the neck, and secretion of saliva in the mouth.

Prevention and treatment of mumps

The swelling goes away by itself in about ten days without the need of medication. Aspirin can be taken to lessen pain and fever. Feed the patient with soft, nourishing food and keep the patient's mouth clean. If complications develop in the form of meningitis seek medical advice and give appropriate antibiotics.

Questions:

1. What is mumps?
2. What causes mumps?
3. State the symptoms of mumps.
4. Have you had mumps? Can you describe the disease?

d. Meningitis

This is an airborne disease caused when the meninges of three membranes which enclose the brain and spinal chord become inflamed as a result of a bacterial attack. The bacterium is called *meningococus*. This is a serious infection of the brain which may affect children and lead to death.

Cause of meningitis

Meningitis is usually caused by complications that develop from other diseases such as measles, mumps, whooping cough, or ear infections. It is a serious infection of the brain which is more common in children of mothers who have tuberculosis. Sometimes infants develop tubercular meningitis in the first few months of life.

Symptoms of meningitis

The symptoms of meningitis are:

- Stiff neck and pain in the spinal cord
- Loss of weight and body weakness
- Dehydration in the body and loss of appetite
- Vomiting

Prevention and treatment of meningitis

For prevention of tubercular meningitis, newborn babies of mothers with tuberculosis should be vaccinated with B.C.G. at birth. If you suspect someone has meningitis get treatment quickly. Every minute counts. Take the person to a hospital to be treated with injections of ampicillin.

Revision Exercise:

1. What are the symptoms of tuberculosis?
2. Which disease bacteria can be controlled in New Sudan? Which are more difficult to control?
3. What are possible ways of controlling airborne diseases?
4. What is the cause of meningitis?
5. What is the cause of mumps?
6. What is the cause of influenza?
7. What is the cause of tuberculosis?
8. State the symptoms of tuberculosis.
9. How can airborne diseases be prevented in new Sudan?
10. How can we fight these contagious diseases in the new Sudan in particular and in Africa in general?

Drug abuse

Drug abuse refers to people taking drugs without a doctor's prescription or taking drugs when they are not sick. Some people take drugs for pleasure. Some drugs are extremely harmful to human health. Examples of such drugs are

i) tobacco
ii) alcohol
iii) bhang
iv) miraa

Commonly abused drugs

Tobacco

Tobacco is a plant with leaves and flowers that can be smoked. Smoking is a bad habit. It causes many lung diseases such as bronchitis and tuberculosis. It also causes lung cancer which usually leads to death. Smoking delays the production of gastric juice and may cause stomach ulcers. Smoking causes discoloration of the teeth and is a major cause of heart disease. Heavy smokers run out of breath easily and have little energy to work. Pregnant mothers who smoke give birth to smaller babies which develop more slowly. Smoking often causes fires in houses and places of work. You can see that there are many negative points to smoking.

Alcohol

Alcoholic beverages such as beer contain ethanol as the active ingredient. Alcohol affects the brain and has a tranquilizing effect. Alcohol damages the liver and may cause heart problems. Anaemia and certain diseases of the eyes and skin are caused by drinking alcohol. Other alcoholic diseases include diabetes, gout, and nutritional deficiencies because people who drink a lot may not eat properly.

When people use alcohol in excess, they become "drunkards". People who are addicted to alcohol (who must drink it every day) are called "alcoholics". When men become dependent on alcohol their earnings may be used mostly on drink, leaving their families without food. Excess drinking causes a hangover the following day and the person can't do his work properly. Drivers who are drunk often cause accidents and deaths. Drunkenness leads to unnecessary fights and difficulties in walking and speaking. People who are drunk may have sexual intercourse more freely, leading to infection by HIV/AIDS. Alcohol causes many problems for families and society.

Bhang (Cannabis)

Bhang comes from the leaves or flowers of *cannabis sativa*. The plant is widely used throughout the world, and is commonly smoked in hand-rolled cigarettes. Its effect is variable but it commonly induces pleasure and happy feelings. The effects can vary from anxiety to excitement. It also leads to an increased pulse rate, red

eyes, loss of motivation and poor memory or concentration. The use of Bhang is illegal in New Sudan.

The Bhang user's heart rate increases and he/she may feel stronger and more confident than usual. Users may become aggressive and daring and get involved in quarrels, fights and other crimes, although in other people it causes sleepiness and idleness. The drug is somewhat addictive. Initial withdrawal symptoms may include loss of appetite, anxiety, sleeplessness, sweating and headache.

Miraa (khart)

Miraa is a stimulant drug. When leaves and the bark of the miraa plant are chewed, it keeps a person awake over a long period of time. Excess chewing of miraa can lead to addiction, dryness of the mouth, and depression. In some countries men spend all their money chewing miraa daily.

Revision Exercise:

1. Which drug causes lung cancer?
2. What do we call a person who is addicted to alcohol?
3. Describe the effects of bhang and miraa (khart).
4. Why do you think some of these drugs are illegal?

Classification of Drugs

Curative drugs

Curative drugs are those used to treat illness. They're also drugs but they're good drugs that help people and society. They're called "curative" because they cure diseases. Examples of curative drugs are streptomycin, penicillin and quinine.

Preventive drugs

Preventive drugs are those which prevent us from being attacked by diseases. These are mainly vaccines. When we are given vaccinations against diseases like polio and measles our bodies develop resistance to the disease. There are certain vaccinations that all young children should have.

Implications of drug abuse

Drug abuse refers to using drugs that our bodies don't require to fight disease. Drug abuse has serious effects on users including

- health
- social life
- economic life

Health effects

As you have seen, narcotic drugs interfere with normal body functions, for example, alcohol affects your brain, liver, and stomach. The continuous use of drugs can lead to a breakdown in health. People who abuse drugs may become mentally unbalanced, very ill and may even die.

In addition, when people use a drug often they may become addicted to it and need it daily. For drug addicts, their priority is getting their drugs, and they may steal to get money to buy them. Drug addicts don't eat properly which may lead to malnutrition.

Social effects

Drug abusers usually cause a lot of problems for their families and society at large. Following are some of the social problems they can cause:

- When intoxicated or drugged they act irresponsibly. They quarrel and fight with people without provocation. People who drive while drinking or using drugs have accidents more often than people who don't.
- They may steal from other people to get money for buying drugs.
- They may not take care of their hygiene and physical health.

Economic effects

- Drug abusers use large sums of money to buy their drugs, money that could have been used for development within the family and nation at large.
- Drug abusers do not work efficiently and therefore are not productive economically.

Prevention of drug abuse

- People need to become aware of the dangers of drugs.
- Security should be tightened concerning drugs.
- Appropriate laws should be followed.
- Drug users should be educated to understand the consequences of their use.
- The best way to avoid becoming a drug addict is by abstaining from using drugs. Remember that it is against the law to possess illegal drugs.

Sexual transmitted diseases (STD)

Sexually transmitted diseases are diseases that are spread through sexual intercourse. The most common STDs found in New Sudan are gonorrhoea, syphilis and HIV/AIDS.

Gonorrhoea

This is a disease of the genital organs caused by a bacteria. The bacteria is a gonococcus called *Niesseria gonorrhoea.* In men the bacteria infects the urethra while in women it infects the vaginal track.

Men may experience the following symptoms:

- Painful urination.
- Drops of pus from the penis
- Difficulty in urination; sometimes a man cannot urinate at all.
- Fever
- After some weeks or months he may get a hard tender swelling in the knees or other joints. He may develop other associated problems in the body. In men the first symptoms start from 2-5 days to 3 weeks or more after sexual contact with the infected person.

In women, at first there are often no symptoms.

- A woman may feel a little pain when passing urine or have a slight vaginal discharge.
- If a pregnant woman has gonorrhoea and is not treated before giving birth, the infection may get in the baby's eyes causing blindness.
- After some weeks or months there will be pain in the lower belly.
- There will be menstrual problems.
- A woman may become sterile.
- Other complications may occur.
- In women months may pass before symptoms develop.
- An infected woman may pass the disease to another to person starting a few days after becoming infected.

Mode of transmission

Gonorrhoea can be transmitted in several ways. The most common way is through sexual intercourse. In infants infection occurs at birth if the mother has the disease.

Prevention

Because gonorrhoea is a social disease involving two or more people, if one partner is infected all of that person's other sexual contacts must be treated at once so that they do not infect more people. Using condoms during sexual intercourse will prevent the passing of the disease from one person to another. A person being treated for gonorrhoea should not have sex with anyone until three days after treatment is finished.

Treatment

Gonorrhoea can be treated in health clinics. The drugs used are antibiotics, which must be administered by a qualified doctor. Some of the commonly used drugs are procaine penicillin injection, and tetracycline eye ointment, which can be used in the eyes of the babies to avoid blindness. A woman who is pregnant should not take tetracycline as it may harm the baby.

Syphilis

This is an acute STD which affects the genital organs of both men and women. The infected areas have lesions which are painless.

Syphilis is caused by spiral-shaped bacteria called *Traponema pallacium.* It is a sexually transmitted disease spread by sexual intercourse. It can also be transmitted through blood transfusions. Infants may acquire the disease at birth, or through the placenta if the mother has contracted the disease and has not been treated before the seventh month of pregnancy.

Prevention

- If you suspect you're infected get prompt treatment.
- Be careful with whom you have sex.
- Encourage mothers to be checked for the disease.
- Educate others.

Treatment

It's easier to treat syphilis if the infection is detected in the early stages, before six months. Treatment involves using broad spectrum antibiotics such as penicillin, tetracycline and erythromycin. Patients should be re-examined after six months to a year to confirm a total cure. Patients in advanced stages of the disease need to receive specialized medical care.

HIV / AIDS

AIDS stands for Acquired Immune Deficiency Syndrome. It is caused by the virus (HIV). HIV is not transmitted by insect bites or casual personal contact.

Modes of transmission of HIV

HIV is transmitted in human beings as follows:

1. By sexual contact with infected people.
2. Through transfusion of blood and blood products.
3. By using unsterilized needles and syringes.
4. By sharing sex tools e.g. vibrators.

5. An infected pregnant woman may also transmit this deadly disease to her baby at the time of birth.

Signs and symptoms of HIV / AIDS

a) Swollen lymph nodes
b) Loss of weight
c) Persistent diarrhoea
d) Thrush and skin diseases
e) Unusual prolonged cough
f) Fever and sweating
g) General weakness

Prevention of HIV / AIDS

a) Avoid sexual intercourse outside marriage.
b) Ensure that the instruments used for medical purposes such as needles and syringes are well sterilized.
c) Avoid sharing tooth brushes, razor blades, and towels.
d) Hospitals should check donated blood properly before transfusion.
e) Avoid mouth/anal or genital or open mouth kissing.
f) Use condoms during sexual intercourse.

Answer the following questions:

1. What virus causes AIDS?
2. List the symptoms of AIDS.
3. What measures should you take to avoid AIDS?
4. What safety measures should you take in handling needles and syringes?
5. What drugs are used to treat AIDS?

UNIT 2 Water

Water is a basic necessity of our lives. Human beings and other animals require water for their body cells, blood, digestion of food, and other bodily processes. The transport of digested food to the different parts of the human body and the process of excretion are facilitated by the presence of water. Water is also a necessity for plants. Most plants need water regularly or they will die.

Sources of water

Every community, family, and person needs a continual source of water. Some of these sources of water are:

- rainfall
- lakes
- rivers
- ponds
- dams
- underground water

Importance of water conservation

Fresh water is a valuable resource because without water life isn't possible. As populations grow the conservation of water is becoming something of great importance. The need for increasing food production has led to the cutting down of forests which had been rainfall catchment areas. This causes water to flow away rather than go into the ground where it feeds wells and boreholes. Large scale deforestation reduces rainfall, which affects the amount of water in rivers. Some rivers stop flowing continually and have water only in the rainy season.

Therefore, it's essential to devise ways and means to conserve water for use by humans, animals and plants. Water conservation in natural areas refers to protecting rainfall catchment areas, planting trees where they have been cut down, and using crop rotation and other measures to reduce soil erosion.

Uses of recycled water

Recycled water refers to waste water that is cleaned and used again. Following are some uses of recycled water:

a) Waste water for irrigation

In towns where people use toilets that are flushed with water, pipes carry the waste to

places where it is treated with chemicals. The treated waste water is recycled for irrigation, while the treated solid waste is used as manure to enrich the soil.

b) Spraying with chemicals

Farms are sprayed with chemicals to kill and protect against crop pests. Most chemicals are diluted with recycled water before using them.

c) Dipping animals

To protect domestic animals from parasites such as ticks and tsetse flies, animals are dipped in water mixed with chemicals.

There are many other things for which recycled water can be used.

Methods of water conservation in the community

Some of the methods of collecting water in the community are:

- damming
- water troughs
- water pots, drums, and tanks

i. **Dams:** These are water reservoirs constructed to contain rainwater for domestic and irrigation purposes such as for rice, and coffee and tea plantations.

ii. **Water troughs:** Water troughs are water reservoirs dug below the land to provide water for domestic animals and plants.

iii. **Pots, drums, and tanks:** These are some of the domestic containers used to reserve water for human beings and domestic animals.

Water conservation as practised on farms

It's important to educate farmers so that they know about ways to conserve water on their farms. Conservation activities that can be used on farms include:

a) mulching
b) cover cropping
c) forestation

a) **Mulching:** Mulch is a protective cover put on the soil surface around plants to reduce evaporation. When you put mulch on plants less water is required for the plants to grow. Leaves, straw and sawdust are often used for mulch. There are several ways that mulch works to reduce the loss of water:

i. Reduction in the amount of sunlight hitting the soil. This keeps the soil temperature low and reduces water loss.

ii. Reduction of the effects of wind and air movement on the soil.

iii. Reduction in water loss by run off. The mulch holds the water in place around the plant.

b) Cover cropping: This refers to the practice of planting low crops such as beans and groundnuts to cover the soil. The purposes of cover cropping are:

i. to improve to soil structure
Ii. to increase organic manure in the soil
iii. to retain moisture in the soil
iv. to raise food crops for animals (fodder crops)
v. to increase the amount of nitrogen in the soil (by planting beans and groundnuts)

Grass planted as cover crop

c) Forestation: This is the practise of planting trees in rainfall catchment areas. It is a water conservation practice because the planted trees control water loss in the area. Forestation is essential for water conservation because the roots of the plant help hold water in the soil, and because shade from the trees and leaves that fall from the trees protect the ground from sunlight which would dry out the soil.

Revision exercise:

1. Explain briefly the importance of water to human beings.
2. Name two sources of water in your area.
3. Water collected from lakes, rivers, pools, ponds and dams is not suitable for drinking. What would you do to make it suitable for drinking?
4. What does mulching refer to?
5. Name three reasons why we practise mulching.
6. Why is important to have trees growing in water catchment areas?

UNIT 3 Animals

Reproductive system in mammals

Reproduction refers to adults creating children so that the species can continue to exist. Of course, reproduction doesn't occur only in humans but in all animals and plants. For reproduction to occur it's necessary to have fertilization of a female egg by a male sperm.

In mammals fertilization occurs internally, that is, inside the body. After fertilization the egg develops within the female's body in the uterus (or "womb").

In some mammals called marsupials, an example of which is the kangaroo, the zygote (developing egg) doesn't develop completely within the uterus, but completes its development in a pouch. Marsupials can give milk to their very young babies in their pouches (referred to as *viviparity*).

In most mammals the zygote or embryo develops fully into a young mammal which resembles the adult. After the babies are born they take milk from their mothers. The milk is produced in mammary glands. In mammals parental care is highly developed. In some species, including humans, the parents care for their young for a number of years.

In some animals which reproduce by laying eggs the embryo develops while the egg is inside the mother until it is at near or full maturation. The eggs may hatch before they are laid e.g. as in snails, insects and some fish. This is called ***ovoviviparous.***

Reproduction in human beings

Human beings like other mammals use reproduction to maintain their specie's existence. The type of reproduction is called sexual reproduction.

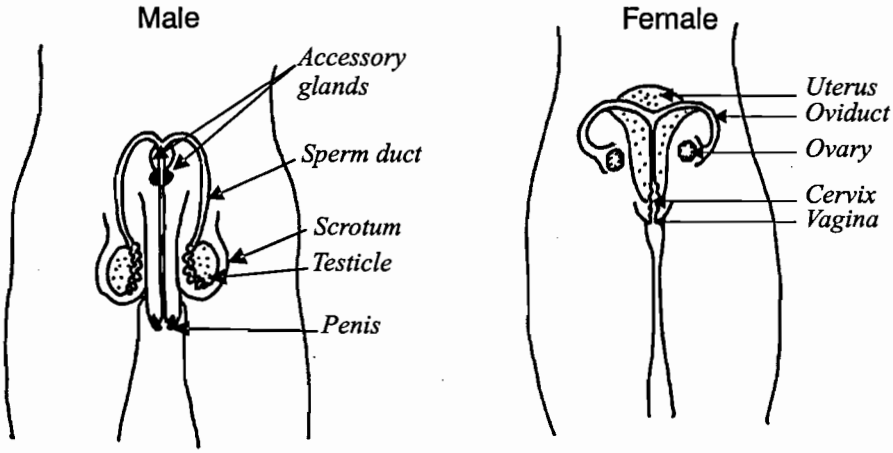
The male reproductive organs include

- The penis with a tube called the urethra running through it.
- Two testes which are enclosed in a sac called the scrotum. The testes produce sperm which are stored in the seminal vesicles.
- A long duct passes from each testis to the urethra. This tube is called the sperm duct.

The female reproductive organs include:

- The vagina which is a muscular tube, also called the birth canal.
- The uterus (womb) in which the embryo develops.

- The lower part of the uterus which opens into the vagina, called the cervix.
- Two ovaries that release eggs (ova). One of the ovaries releases one egg (an ovum) about every 28 days. The two ovaries alternate in releasing eggs.
- From each ovary is a tube called the oviduct (or fallopian tube) that leads to the uterus. Fertilization takes place in the oviduct.



Human reproductive organs

Sex cells

The male produces sperm cells. These are produced by the testes. The sperm (cell) is the male reproductive cell. Each sperm has a long tail and a head that has a nucleus. There are also glands surrounding the upper part of the urethra which secrete fluids. These fluids mix with the sperm cells to make semen.

The female produces eggs (ova) from the ovarian cells.

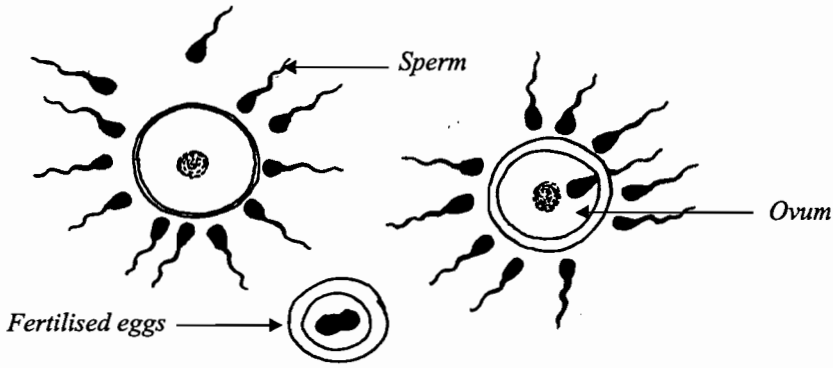
A sperm

Fertilization

During sexual intercourse, sperm are introduced into the vagina by the male's penis. The sperm swim up to the uterus in the liquid produced by the male (semen). The sperm reach the fallopian tubes where they meet a mature egg. Many sperm may surround an ovum (egg), but only one sperm enters into it. After the two have fused (united) together, fertilization takes place. This fertilization is called internal fertilization because it takes place inside the body of the female. Then the new cell called a zygote is formed. The other sperm die after fertilization has taken place. The fertilized egg divides itself repeatedly to form a mass of many cells.

Development during pregnancy

The fertilized egg travels down the oviduct and into the uterus. Meanwhile, the walls of the uterus have developed a thick lining. The fertilized egg uses a finger-like projection to attach itself to the thick lining of the uterus. The lining later becomes the placenta and the finger-like projection becomes the umbilical cord.



fertilization and formation of zygote

The fertilized egg is now called an embryo and it develops into a foetus. Surrounding the foetus is a sac known as the amnion. This sac contains a fluid called amniotic fluid. This fluid protects the foetus from shock and movement.

The developing foetus gets its nutrients and oxygen from the mother's blood through the umbilical cord. Waste products, which include carbon dioxide passed from the developing foetus, go into the mother's blood through blood vessels in the umbilical cord.

Twins

Have you ever seen two children who were born together at the same time from the same mother? These children are called twins. There are two types of twins: fraternal twins and identical twins.

- **Fraternal twins**

Sometimes two eggs or ova from the ovaries of a woman may be released at about the same time. If the two eggs are fertilized by two sperm cells from the man at the same time, the babies that are born are called fraternal twins. Fraternal twins do not usually resemble each other exactly. Both of them may be boys or girls or one may be a girl and the other may be a boy. They're different because they came from two different eggs so their DNA isn't exactly the same.

- **Identical twins**

Sometimes a single fertilized egg may divide into two equal parts. If that happens, the two babies are called identical twins. Identical twins are always either both boys or both girls. They usually resemble each other and are very difficult to distinguish from one another by an outsider. Identical twins think and behave in the same manner in many ways. They're the same because they came from a single egg so they both have the same DNA. Do you have identical twins in your village or school? Discuss characteristics of identical twins that you have observed.

Gestation period

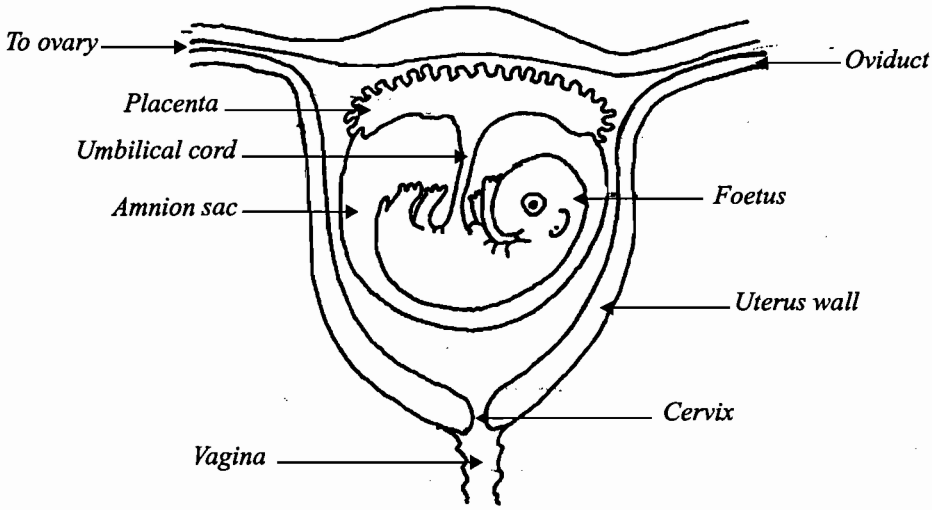
The period between conception (fertilization of the egg) and birth is called the gestation period. The gestation period varies in different mammals. In mice the period is about 22 days, in rabbits it is about 30 days, and in man it is 9 months. In a large mammal like an elephant it is about 18 months.

During implantation three membranes develop. The allantois and chorion form part of the placenta and the amnion forms the amniotic cavity. At this time the embryo is two weeks old and appears as a bump in the uterine wall. As the embryo grows the cells differentiate into tissues and organs, and by the end of 3 months, the heart and the blood vessels forming the foetal circulatory system are fully developed. The head region, which includes the nose and eyes, are also well developed as is the spinal cord.

By the end of the 9 month period the foetus's head is directly above the cervix and all the organs and systems are fully developed to be functional at birth. If the baby is born before six months it will not survive and this is called a *miscarriage*. If foetal development is interfered with chemically or physically so that the foetus leaves the mother's body and dies, the action is called an *abortion*. If birth occurs after the seventh month before full time, it is called a *premature birth*. A

premature baby can survive if it has attained a certain weight or if it has specialized medical care. In hospitals premature babies are cared for in incubators.

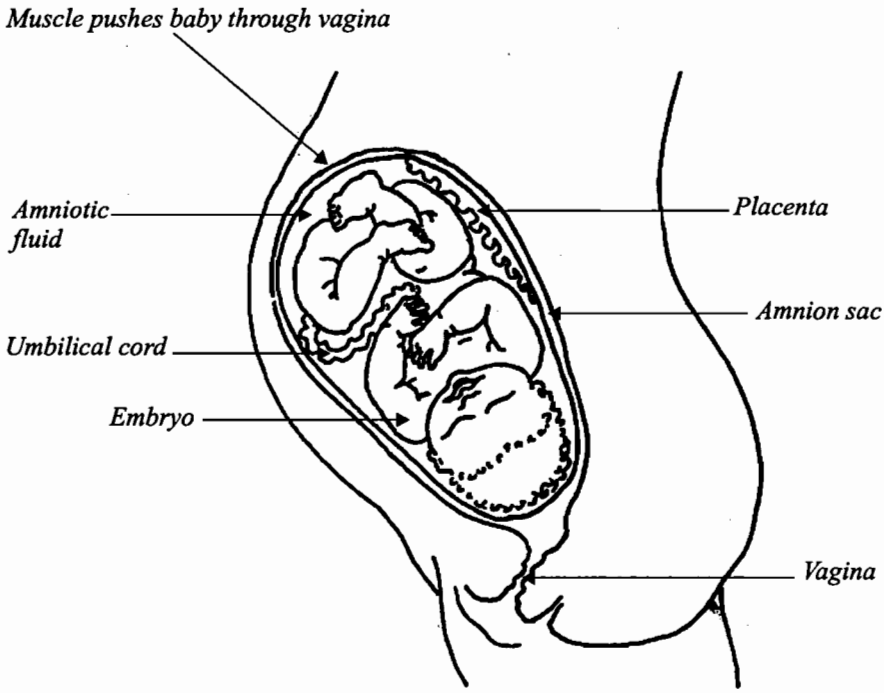
A pregnant mother must have a balanced diet to keep her healthy. In the food she eats there should be plenty of protein, calcium and iron, and other nutrients. A pregnant woman's diet should include fish, eggs, meat, milk, vegetables, and fruit. These nutrients are required by the developing embryo. The embryo requires protein for the development of muscles and connective tissues and for general growth and development. Calcium and phosphorus are required for the formation of bones, and iron is needed for the formation of haemoglobin (in blood). Therefore, pregnant mothers should eat a well-balanced diet that is sufficient for both her and the foetus.



Development of foetus

Delivery

After the zygote has developed into a fully grown foetus at 9 months, the baby is ready to be born. Its head is positioned directly above the cervix. The uterus walls contract, the amnion is broken and the amniotic fluid is released. The contractions of the uteruine wall push the baby downwards through the cervix. The baby comes out of the uterus through the birth canal (vagina). The head comes out first. Once the baby is born, the umbilical cord is tied and cut to separate the baby from the placenta. Tying prevents the loss of blood. The part of the umbilical cord that remains in the mother's body and the placenta are known as afterbirth. They are released from the body after the birth of the baby.



Position of foetus before birth

Now begin the many years of care by the mother and father. In humans and other animals this includes feeding, educating and the special bond that develops between parents and children.

Reproduction in Birds

Fertilization

During mating the male bird climbs onto the back of the fernale. The male then passes his sperm into the cloacae of the hen by pressing his cloacae against the hen's. Male birds have no penis arıd female birds have no vagina. Instead, both have cloacae.

The sperm that are deposited into the cloacae of the hen swim up the oviduct. There they meet the eggs and fertilize them, so the eggs are fertilized internally. After fertilization, the eggs travel down through the oviduct where the eggwhite and eggshell are produced. It takes abut 24 hours for an egg to travel through the oviduct to be laid.

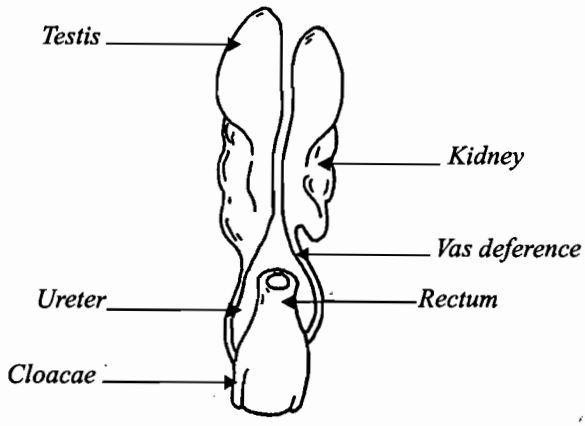


Diagram of female bird organ

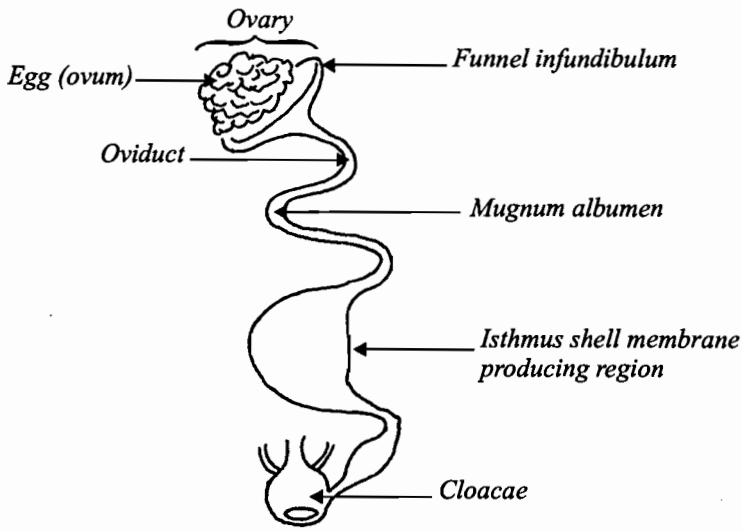


Diagram of male bird organ

Incubation, development and hatching

The female bird lays the fertilized eggs and sits on the eggs to the provide heat that keeps them warm. This is called incubation. It is usually the female bird that incubates the eggs, but in some species such as pigeons the male also helps do it. The female bird keeps the eggs at a temperature approximately the same as her own body. Unfertilized eggs can be laid by female birds, but they cannot hatch into chicks. Both fertilized and unfertilized eggs can be eaten.

The period of incubation in birds varies from one species of bird to another. For example, for a chicken it is 21 days while for a duck it's 28 days. There are two main methods of incubating eggs: (i) natural incubation (ii) artificial incubation.

a) Artificial incubation

In this method eggs are put in special machines called incubators. These incubators provide the warmth that enables the eggs to hatch into chicks.

b) Natural incubation

In this method, a broody hen sits on the eggs until they hatch into chicks. A broody hen is one that shows a natural behaviour or interest in sitting on eggs and rearing chicks.

Unlike amphibians and reptiles, birds provide a lot of parental care for their chicks; this is called brooding. It takes place from day one to when they are about eight weeks old. This can be done naturally by the hen or artificially by the use of an incubator. You may have observed this behaviour in your chickens and ducks at home.

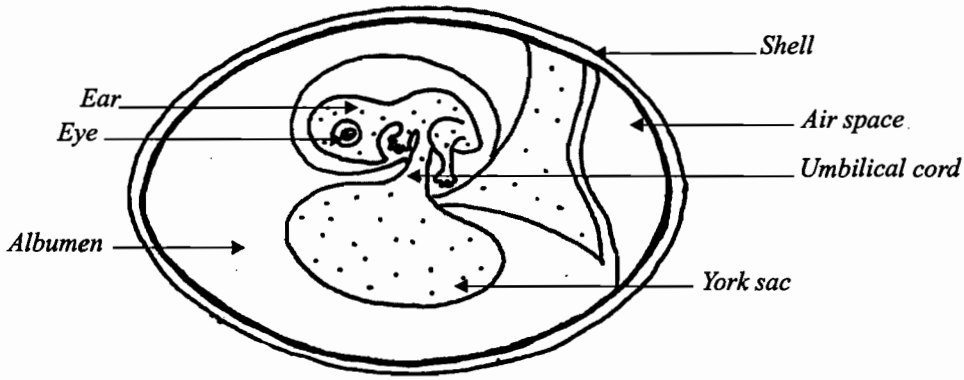


Diagram of developing chick embryo stages

Revision exercise :

1. Apart from human beings, name at least 5 other mammals found in your environment.
2. Name the sex cells produced by a male mammal.
3. Where is the ovum produced?
4. Where is the ovum fertilized?
5. Where does the ovum develop after fertilization?

UNIT 4 Plants

Photosynthesis

The process that plants use to make food in their leaves or other green parts of the plant is called *photosynthesis,* meaning "put together by light". The leaves of plants are green because they contain a substance called chlorophyll. Chlorophyll absorbs sunlight and by a chemical process involving carbon dioxide produces energy products that the plant uses to live and grow. Photosynthesis is the basis of all food production in plants.

For photosynthesis to take place the following things are necessary:

a) chlorophyll
b) water
c) carbon dioxide: this is a gas in the atmosphere that is also a necessary raw material for photosynthesis.
d) heat: this comes from the sun and provides the correct temperature for the process to take place.
e) light: light supplies the energy needed in the process of photosynthesis. When the factors above combine in green plants, starch and oxygen is formed.

$$\text{Carbon dioxide} + \text{water} \xrightarrow{\text{Sunlight}} \text{starch} + \text{oxygen}$$

Differences between plants and animals.

Look at any animal around your home such as a cow, a goat or a human and compare it with a plant. What similarities and differences can you see?

Following is a summary of differences between animals and plants:

	Animals	Plants
1.	Animals eat plants or other animals and drink water.	Plants make their own food by the process of photosynthesis. They also absorb nutrients from the soil.
2.	The cells of animals have no cell wall.	The cells of plants have a cell wall.
3.	Animals are able to move about by walking, flying, crawling or swimming.	Plants do not move about; branches, leaves and flowers move upwards in response to heat and light. The roots grow down in response to water and gravity.
4.	Animals respire (breathe) by means of lungs, gills or spiracles.	Plants respire (breathe) by means of tiny holes in their leaves called stomata.
5.	Animals have sense organs that help them respond to external stimuli; such organs are eyes, ears, skin and nose.	Plants have no sense organs but they respond to sunlight and gravity.

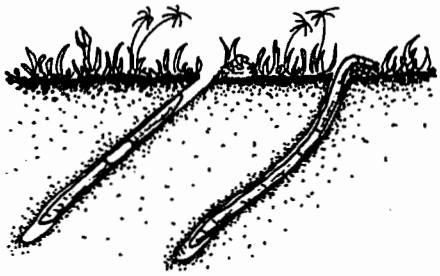
Interdependence

If you go around your area you can see different kinds of living organisms such as worms, insects, birds, fish mammals, snakes, and plants. If you take time to observe the things they feed on, you will find that all living things depend upon each other to live. Animals eat plants and other animals. Every animal has a certain number or type of plants of other animals that it eats. There are even some plants that eat animals. We say that animals and plants depend on each other.

Let's look at the various ways of interdependence.

How plants depend on animals

- Green plants need carbon dioxide to make food. Animals provide plants with carbon dioxide which they breathe out during respiration.
- Animals add nutrients to the soil from their faeces and urine. Plants absorb these nutrients by their roots. When animals die they decay, and this decayed animal matter, along with the faeces, urine and decaying plants and leaves, increases the amount of humus in the soil. Humus is the organic matter found in loamy soil.



Earthworms dig the soil

- Some animals such as earthworms dig

into the soil and make the soil loose and fertile so that plant roots can grow well.

- Some insectivorous plants feed on animals.
- Some plants use animals for pollination. Most commonly, bees spread pollen while feeding on plant nectar.
- Plants grown for crops need the care of human beings.

How animals depend on plants

- Animals cannot live without oxygen. They take oxygen from the air and give out carbon dioxide during respiration.
- Animals depend on plants for their food directly or indirectly.
- Some animals depend on plants for shelter against the rain and hot sun.
- Some animals such as birds, monkeys, insects and others make their homes in trees.
- Animals feed on plants.

How animals depend on each other

- Many carnivorous animals feed on other smaller animals.
- Insects such as bees, ants, and termites are social animals and live in colonies; they help each other by sharing work.
- Many parasitic animals such as tapeworms, liver flukes, ticks, fleas and mites live in or on other animals for food. Such animals feed on the blood or digested food of their host.
- There are many other ways that animals depend on each other.

How plants depend on other plants

- All green plants need light to make food. Some plants have weak stems. They climb on other plants to get light.
- Some small plants grow under big trees for protection from wind and direct sunlight.
- Some parasitic plants, such as lichens, grow on trees. Parasitic plants absorb nutrients from their host.
- Dead, decaying plants increase the humus content in the soil providing nutrients for other plants to grow.

How human beings depend on plants

Human beings cannot live without plants. They are useful for us in many ways. Some uses of plants are as follows:

- **Food and drink:** We get grains (wheat, rice, maize) fruits, vegetables, and oils for food from plant. Tea, coffee, cocoa, wine, beer, juices and many others are obtained from plants.

- **Purification of air:** Green plants purify air. Plants give out the oxygen that we breath in, and use up the carbon dioxide that we breath out.
- **Fuel and timber:** People make charcoal from trees. We use charcoal and firewood in our homes for heat, cooking, and boiling water. From trees, we get timber which we use for building houses and boats.
- **Medicine**: We use some trees and plants, benefitting from healing roots, leaves, and bark. Medicine such as quinine is made from the bark of a cinchona tree; iodine, obtained from sea weed, is used for making tincture of iodine.
- **Shade and shelter:** We like to sit under the shade of a tree on a hot sunny day. We stand under trees when it rains.

How human beings depend on other animals

We get ivory from the tusks of elephants. The claws and canine teeth of lions are used for making necklaces and earrings. The hooves of cattle are used for making glue. The skins of elephants, lions, leopards and other animals are used for making purses, belts and clothing. Animal fat is used for making soap.

Food: Human beings kill many animals such as sheep, goats, pigs, cattle, and chickens for food. People also eat fish. We get eggs from birds like chickens and ducks. We get milk from animals like cows; and get honey from honeybees. We get wool, fur and leather from animals to make clothes and shoes. We also get silk from silkworms.

Transport: We use horses, camels, donkeys and mules for carrying loads and pulling carts. Horses and camels are ridden for transportation. In some countries like India elephants are used to carry heavy goods and for transportation.

Farming: Farmers use oxen, horses and camels for ploughing fields.

Tourist industry: Wild animals are very important for the economy of East African countries. Tourists from foreign countries come to countries like Sudan to see wild animals in their natural habitat.

Pets: Many people keep dogs, cats, and birds as pets. The dog is a faithful animal that guards our houses and homes.

The Food chain

Plants and animals don't live in isolation, separate from each other. They live in groups with other plants and animals. Plant and animal lives are affected by the other plants and animals around them. In every community you will find

herbivorous animals feeding on green plants, carnivorous animals feeding on herbivorous animals, and bacteria and fungi living on organic matter. The green plants are called producers, while animals are called consumers. Bacteria and fungi are called decomposers.

A food chain shows how all animals get their food directly or indirectly from plants. Carnivorous animals feed on other smaller animals. Following are few examples of food chains, illustrating how different members of communities depend on each other.

1. Grass $\xrightarrow{\text{Eaten by}}$ Grasshoppers $\xrightarrow{\text{Eaten by}}$ lizard $\xrightarrow{\text{Eaten by}}$ snakes $\xrightarrow{\text{Eaten by}}$ hawks
2. Grass $\xrightarrow{\text{Eaten by}}$ rabbits $\xrightarrow{\text{Eaten by}}$ wild dogs $\xrightarrow{\text{Eaten by}}$ leopards
3. Plants $\xrightarrow{\text{Eaten by}}$ insects $\xrightarrow{\text{Eaten by}}$ frogs $\xrightarrow{\text{Eaten by}}$ snakes $\xrightarrow{\text{Eaten by}}$ hedgehogs
4. Microscopic plants $\xrightarrow{\text{Eaten by}}$ small crustacean $\xrightarrow{\text{Eaten by}}$ herring $\xrightarrow{\text{Eaten by}}$ man

- In a food chain, if any group is missing the whole community is affected and the chain is broken. Then all organisms either migrate to other places or die of starvation.
- If there are no frogs, the snakes will die of starvation. Similarly the hawks will die if there if there are no snakes. The number of insects will then increase. Soon they will eat all the plants. After no plants are left, the insects will also die of starvation. Similarly, if the number of any group increases, the whole community is affected in the same way.

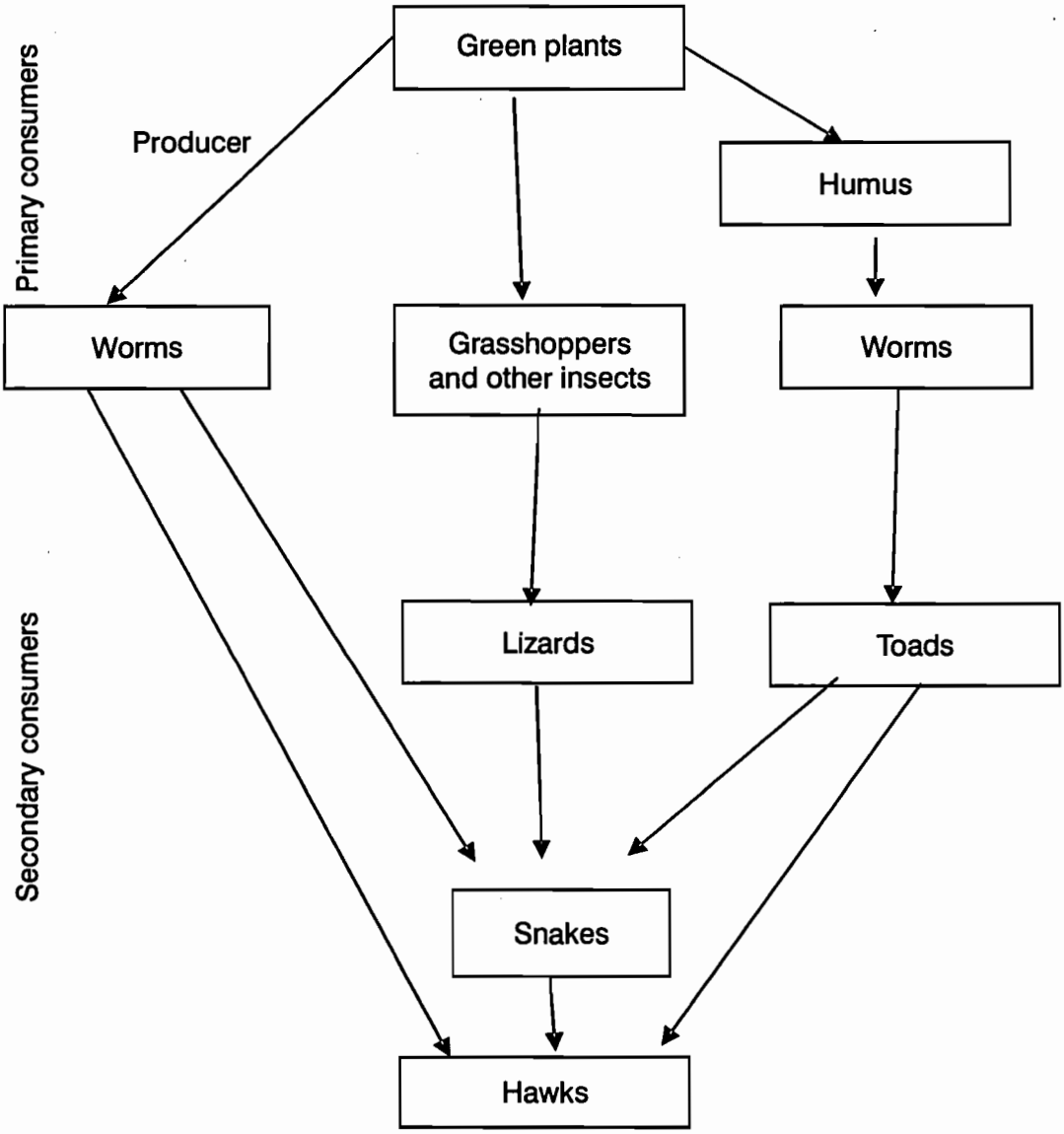
Nature keeps a balance in any ecosystem. An ecosystem is an area where there is a balance of animals and plants depending on each other. For example, if hunters kill all the lions in an area, the number of antelope will increase. There will be too many antelope for a few years until they eat too much of the grass, then many of them will die of starvation and the number will decrease.

Questions:

1. How do animals depend on plants.
2. How do plants depend on animals.
3. In food chain green plants are called _____ while bacteria and fungi are known as_____.

The Food web

An animal seldom depends on only one type of food. Similarly a particular food is eaten by more than one consumer. For example, snakes feed not only on lizards but on toads and mice. Similarly toads are not only eaten by snakes but by hawks. This more complicated relationship of the food chain is called a food web.



Seed and fruit dispersal

If seeds fall close to the parent plant, they will not have enough space and food to grow. To avoid overcrowding they are scattered far away from the parent plant. This scattering away is called dispersal.

Agents of dispersal

Self dispersal: Many kinds of plants, after they are ripe, split open with a strong force and throw out the seeds at some distance. Examples are peas and beans.

Wind: Many plants have their seeds carried away by the wind. Such seeds have special adaptations so they can be carried by the wind such as the following:.

- Some seeds are so small and light that they can be carried away by wind.
- Some seeds have hair, e.g. cotton seeds.
- Some seeds have wing-like floating mechanisms such as Jacaranda.
- Some seeds have a sensor mechanism: when the wind blows, seeds are thrown out of the capsule, e.g. poppy.

Animals: Birds and other animals eat fruit and scatter the seeds. e.g. mangoes and oranges. Some seeds have husks or spines which stick on hair, fur or clothing of passing animals, e.g. black jack.

Water: Seeds dispersed by water have thick outer coverings. They can float and be carried by the water for long periods. The seeds of some water lilies have air spaces in them that allow them to float on water. Coconuts float and can move many hundred of kilometres in the sea.

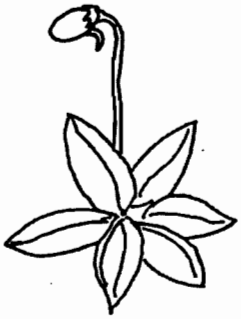
Reproduction in Plants: Pollination

Most plants also have male and female cells which must join together to reproduce (to create seeds). In some plants the male cell is in pollen. The pollen grains are produced on the anther of the flower. The female cell is on the stigma. The transfer of pollen grains from anthers to stigma is called pollination. Without pollination, fertilization cannot take place and no fruit or seeds will be formed.

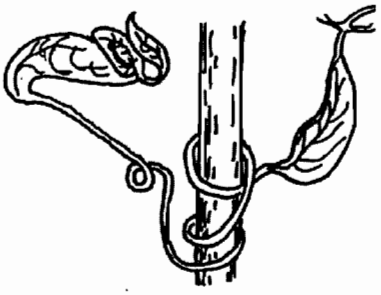
Types of pollination

a) **self pollination:** This takes place when pollen grains fall on the stigma of the same flower.

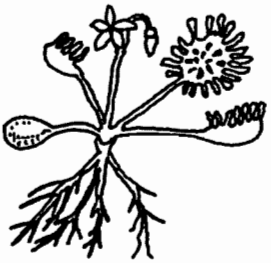
b) **cross pollination:** This takes place when pollen grains of one flower fall on the stigma of another flower.



Butterwort



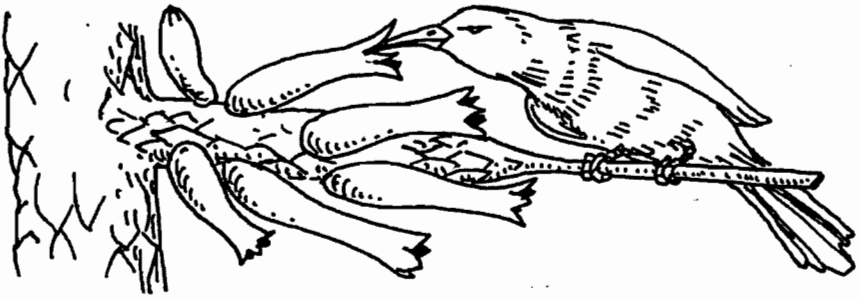
Pitcher plant



Sundew

Insectivorous plants
(plants that eat insects)

Insects pollinating flowers



A bird pollinating a flower

Agents of pollination

The main agents of pollination are insects and wind, but water and birds can be involved with some species.

Insects

Insects like bees, butterflies, and beetles are very active in the pollination of flowers. Insect-pollinated flowers are usually brightly coloured and scented to attract the insects. They also contain nectar that bees collect to make honey. The plants produce heavy sticky pollen so that it sticks to insects and they have broad sticky stigma. All flowering plants grown to beautify homes have insect-pollinated flowers.

Wind

In plants like maize, wheat and grasses the flowers are pollinated by the wind. In such plants the flowers are not brightly coloured and some don't even have petals. They don't need scent or nectar to attract insects and their pollen grains are very light so that they can be blown by the wind easily.

Birds

A common bird that assists in pollination is the sunbird. These are small birds with long beaks. They visit flowers to collect nectar. Flowers such as hibiscus that are large and brightly coloured are attractive to the sunbird.

Water

Some water plants are pollinated by water currents. The pollen grains float in the water.

Questions:

1. The process by which green plants manufacture their own food is called _____

   a) osmosis b) chlorophyll c) photosynthesis d) pollination

2. Flowers pollinated by insects have the following characteristics. Which one of the choices below is correct?

   a) They are sticky and fleshy.

   b) They have brightly coloured petals and sweet nectar.

   c) They have hooks and barbs to hold to the insect

   d) None of the above.

3. Which of the following is not necessary for the photosynthesis process.
   a) carbon dioxide b) sunlight c) oxygen

4. What two things are by-products of photosynthesis?

5. Plant and animal organisms that depend on a host for food are called _____.

6. _____ and _____ are the examples of animals responsible for cross pollination.

7. The process by which pollen grains are transferred from one flower to another of the same kind is called _____

UNIT 5 Soil

Have you ever seen rain water running from higher land to lower land? Or wind blowing from one direction to another? What happens to the top layer of the soil? To protect the soil from water and wind, we need to practice what is known as *soil conservation*.

Soil erosion

Soil erosion is the removal of topsoil, usually by the action of the wind or water. When the wind blows it carries away the particles of the fertile topsoil. The topsoil is the most fertile part of the soil, but it's usually only a thin layer, so the fertility of the soil decreases if it is lost. In areas near the desert the wind may carry sand from the desert and deposit it on farm fields, thus causing the soil to lose its fertility.

Rainwater also causes erosion. When it rains, rainwater washes off particles of the soil and carries them down into streams. Have you ever seen how muddy a big river like the Nile is? This mud is soil from the area surrounding the river. Water flowing down hills into river and carrying soil can cause pits that become bigger and bigger, making the area useless for agriculture.

When a sheet (or layer) of topsoil is washed away by rain, it's called *sheet erosion.* Gullies develop along footpaths and cattle and vehicle tracks. When rainwater flows along these tracks it scoops out V shaped gullies. This type of erosion is called *gulley erosion*. Sometimes any temporary stream can start up gulley erosion. When rainwater carries soil particles and forms shallow channels, it's called *rill erosion*. When raindrops hit bare soil, particles of soil fly up and fall somewhere else. The loss of soil in this way is called *splash erosion*.

Methods of soil conservation

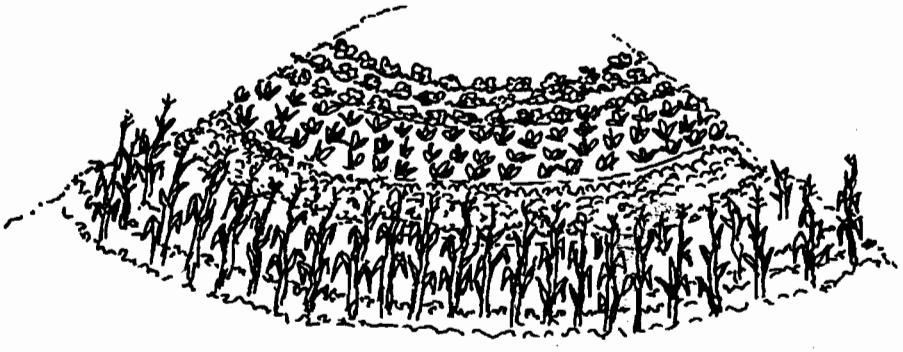
Three ways of controlling erosion are:

a) Growing vegetation or spreading crop residue or plants debris on the soil surface.
b) Preventing water from concentrating and moving in narrow channels.
c) Reducing the velocity of moving water or run-off by contouring or terracing farmland.

1. **Planting grass strips:** Groundcover plants like grass hold soil firmly with their roots. This prevents the soil from being washed or blown away. These cover crops also trap moving soil as water flows through the garden.

2. Contour farming

This is the practice of ploughing around a hillside and planting crops on the contours that follow the shape of the hill. These contours prevent water from flowing down the hill fast enough to carry soil with it. Some trees and bush must be left at the top of the slope. The ridges across the slope and along the contours of the land keep the water from flowing downhill.

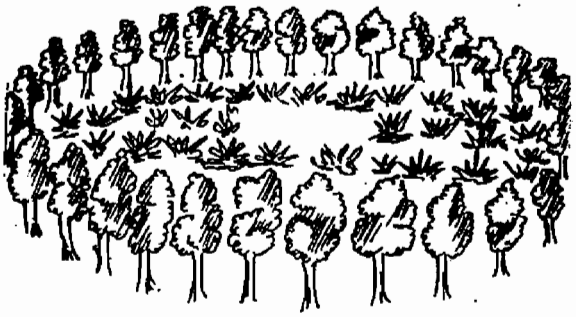


3. Terracing

Terraced farming consists of creating "steps" on the hillside using rocks, soil and trees. From a steep slope, the farmer creates many level plains on which he grows crops. Instead of flowing freely down the hillside, water stops on the level steps or terraces. In this way the lower terraces aren't eroded and the higher terraces get enough water.

4. Planting trees

Planting trees around a farm helps to reduce the speed of wind and water. This reduces wind and water soil erosion. The roots of the treees hold the soil particles. The fallen leaves and branches also prevent rain from hitting the soil directly and check the speed of running water, thus helping to reduce soil erosion.



5. Mulching

Mulches are crop residues or artificial materials used to cover the soil in a crop field. Crop residue may be elephant grass, sunflower heads and stalks, banana leaves or stalks of cereals such as maize, wheat and sorghum. Following are some of the advantages of mulching.

a) Mulching reduces soil erosion by checking the speed of water and reducing the battering effect of rain on soil.
b) Mulching increases water filtration downwards into the soil.
c) Mulching increases fertility of the soil when as it decomposes.
d) Mulching improves soil moisture by reducing evaporation.
e) Mulching keeps the soil temperature even (not too hot, not too cold).
f) Mulching keeps pests away from the stems and roots of plants.

6. Cover cropping

Cover crops are either crop residue (vegetable leaves) or artificial materials used to cover the soil in a crop field. Crop coverings may be elephant grass, sunflower heads and stalks, banana leaves or stalks of cereals such as maize, wheat and sorghum. Artificial crop covers are potatoes, spreading beans, grass and many other types of plants which grow over the surface of the soil and slow down the speed of the flowing water. Cover crops prevent the movement of the soil and impact of rain drops.

7. Making cut-off drains

Making cut-off drains or ditches is a process for draining excess water from farm land. Ditches drain water, keeping it at a correct level so that crops don't drown in too much water. It also improves soil ventilation and decreases soil erosion.

8. Ridging

Ridging refers to making long narrow raised bands on the surface of the land to conserve moisture for use by crops, especially root crops. Ridges act as barriers on the soil surface and this may reduce the rain water from washing away the soil.

9. Strip cropping

This is a system whereby different crops are planted in strips parallel to the general slope of the field, with strips of grass or gravel in between to slow down the runoff of water. Examples are planting cassava or sweet potatoes in rows with strips of grass grown between them.

Construction of ridges and terraces

Ridges are constructed to reserve moisture for crops, to allow better root penetration, especially in root crops and eventually to make harvesting root crops easier. They also act as barriers on the soil surface and in this way reduce the flow of rainwater. Rainwater normally carries away soil as it flows down a ploughed piece of land. The ridges control the flow of the water and act as barriers to the movement of soil. In this way, ridges control soil erosion.

Revision exercise:

1. What do we mean by soil erosion?
2. List the main causes of soil erosion.
3. List the different types of soil erosion.
4. List the methods of controlling soil erosion.
5. Mr. Wani is on a steep hillside. He wants to grow crops. What precautions would you suggest for him to take to prevent soil erosion?
6. Choose the correct answer from the following statements.

A farmer wants to plant a crop in rows on a sloping hillside. The rows should run

a) parallel to the direction of slope.
b) at an angle of 40 degrees to the direction of slope
c) at a right angle to the direction of slope
d) in any direction as the particular direction is least important.

7. *Contour farming on a sloping hillside*

a) reduces soil erosion
b) increases soil erosion.
c) improves soil texture
d) none of the above

8. *Nyijur has a farm on the slopes of a steep hill. What would you advise her to do to reduce soil erosion.*

a) Plant tall trees to act as wind breaks.
b) Add fertilizers.
c) Make terraces
d) Grow different types of crops each year.

UNIT 6 Weather

Weather and climate

In level 2 you learnt about weather charts and recording daily weather conditions. You observed that weather conditions can change often, even during the same day. For example, a day can start off sunny, but clouds can build up and bring rain in the evening. Therefore, when we talk about weather we mean the conditions of the atmosphere in a particular place at a specific time. We use words like hot, cold, dry, rainy, sunny, and cloudy to describe weather conditions.

The study of weather is known as meteorology. Scientists who study the weather are called meteorologists. They forecast the weather over a period of 24 hours, 48 hours, a week, etc. Forecasting is the predicting of the future state of the atmosphere. Meteorologists use satellites to give them information about the weather. The inforrnation is analyzed and the weather forecast is broadcast on local radios and T.V.s. Meteorology involves the study of

- Atmospheric pressure
- Rainfall
- Humidity
- Cloud formations
- Wind
- Ternperature

The study of weather is very important because it has a great effect on our lives. It determines the kind of clothes to wear, the kind of houses to build and the kind of crops to grow. Air and sea navigation is also influenced by weather. Forecasts help us to protect ourselves and our property against the disastrous effects of unfavourable weather such as storms, cyclones, hurricanes, etc.

Climate

Climate is the term used to describe the average weather conditions in a particular region over a long period of time. For example, in Western Equatoria the climate is wet with moderate temperatures while in Bahr El Ghazal it's hot and dry with little rainfall. The difference between weather and climate is that weather concerns a short span of time, while climate relates to a longer period. In New Sudan there are two seasons in a year, the wet and dry seasons.

Climate and land use

Land is used for farming, to grow food and cash crops and it can also be used by pastoralists for grazing livestock. In some areas, forests are planted for timber and paper production. The natural habitat of animals is destroyed by human occupation and use of land, so most governments have set aside areas to be reserved for wildlife. This is to ensure that certain species of animals aren't hunted to extinction. It also attracts tourists who want to see animals that are not found in their own countries; and tourists bring hard currency which benefits the country. These activities cannot be carried out in the same place at the same time because land use and climatic conditions vary.

Farming land

Do you know what type of crops people in your region grow? Why do they grow these crops and not others? Certain crops grow best in certain climates. For example, regions with high temperatures and a lot of rainfall are good for growing some types of cereals, legumes, and fruit including mango, pawpaw and pineapple. This type of climate is referred to as an equatorial climate and is found in Western Equatoria.

Areas with less rainfall than the equatorial climate, but that are still hot and wet are known as tropical areas with a tropical climate. This type of climate has two distinctive seasons: the wet and hot seasons. Crops that do not need much rainfall can be grown there such as sorghum.

Exercise:

Find out what crops are grown in your region. Compare them with those grown in other regions such as Equatoria, Nuba, and Bahr El Ghazal.

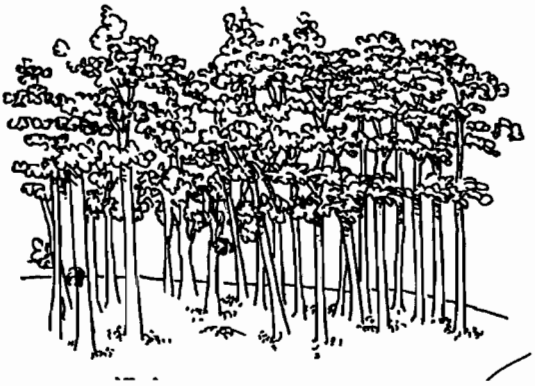
Pastoralism

This is a way of life for some communities. It involves keeping livestock such as cows, goats and sheep. Pastoralism is usually practised in semi-arid regions. These regions have little rainfall and very high temperatures. The average rainfall for these areas is around 600-800ml. Because of inadequate rainfall there is inadequate pasture for the animals in one place. As a result pastoralists are semi-nomadic. They move from place to place according to the seasons in search of pasture and water for their animals.

Forests

Where in New Sudan can you find tall trees that make a forest? How much rainfall is there? What about the temperature? Forest are found in areas with heavy, reliable rainfall where there are also high temperatures, such as along the equator

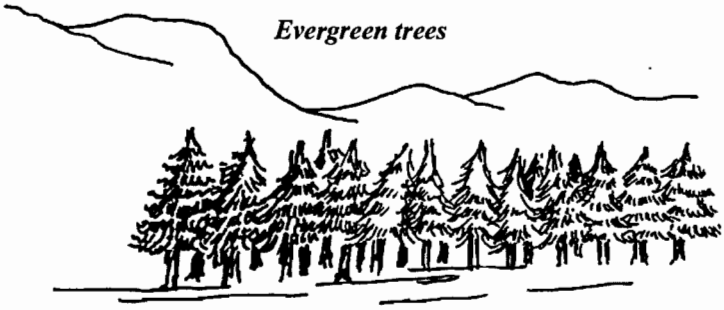
Equatoria forest



where there is an equatorial climate. In this climate, trees grow very tall and have broad leaves that form canopies (shelters). As a result, there is rainfall all year round and the trees are always green.

Forests are also found in areas with a Mediterranean climate, and in high mountains with heavy rainfall. In high mountains there are pine and fir trees.

Evergreen trees



Mangrove trees

Forests of mangrove trees are found along the coastal regions where the ground is swampy and temperatures are high. The roots of mangrove are exposed in order to absorb carbon dioxide from the air. The leaves are waxy to protect them from the salt in the sea water. Cooler areas with high rainfall have forests of deciduous trees, that is, trees that lose their leaves in the cold season.

Game reserves

Wild animals play an important part in preserving the balance of nature. They also contribute to the beauty and wonder of life. Scientists use wild animals in their research. To continue having wild animals we must preserve those that already exist. Many animals are in danger of extinction because they are being killed randomly, and because of expanding human populations and activities such as agriculture, construction, and the development of industries.

To protect wild animals most countries have set aside areas known as wildlife reserves or game parks. Hunting is forbidden in these areas. Wildlife rangers patrol the parks to prevent poaching and to ensure that tourists remain in their vehicles so that their lives are not at risk. The animals that can be seen in game parks are those that live naturally in that climatic region and find their food there.

To enable people to view or see animals that are not usually found in the region, governments set up zoos. In zoos animals are kept in cages or small natural areas and fed by the keepers. In a good zoo conditions are made as much like the animals' natural habitats as possible. For polar bears, there may be a deep cold pool so they can keep cool, and for monkeys there are trees to climb.

Revision exercise:

1. Explain why forecasting the weather is important to people.
2. Find out the climate of the area in which pastoralists in New Sudan live.
3. What types of crops are grown in semi-arid regions?
4. Describe the climate where you have thick forest in New Sudan.
5. Name a game reserve in your region.
6. Why do you think wildlife is important to the economy of a country?

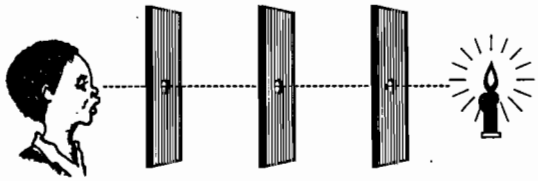
UNIT 7 Light

Light enables us to see. When it's completely dark we are unable to see, and this is why we light our homes at night.

Sources of light

1. Natural sources, the sun, the moon and the stars
2. Artificial sources
3. Flames from fires and candles
4. Oil lamps and kerosene lamps
5. Electric torches and electric lights

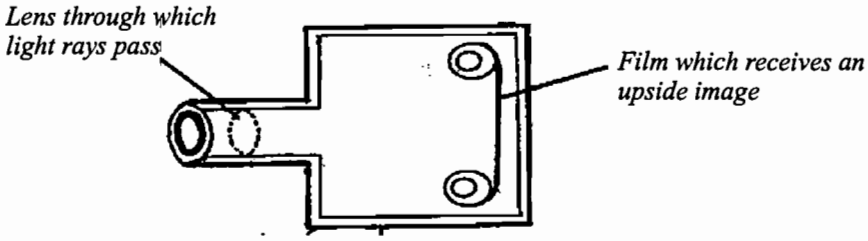
Light travels in a straight line. Its speed is 3×10^8 meters per second.

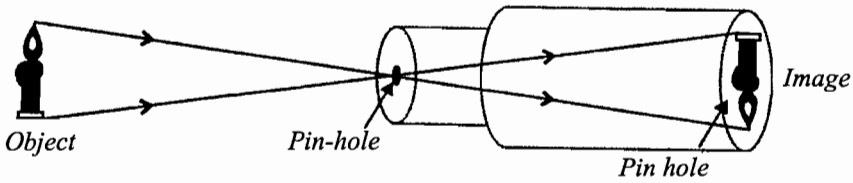


Light travelling in a straight line

A Pinhole Camera:
Structure

A pinhole camera consists of a closed box made of wood, plastic, or cardboard with a pinhole (a very small hole) in the front. At the back is some photographic film. How are pictures taken by a pinhole camera? Light from an object travels in a straight line through the pinhole and an image of the object is formed on the film. The image is sharp if the hole is small but it is not sharp if the hole is big.

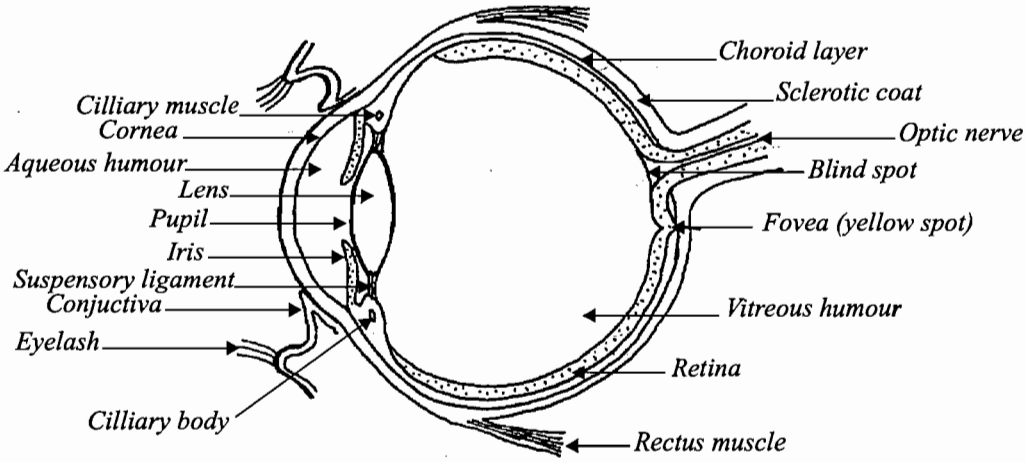




How images are formed in a pin hole camera

7.2 The human eye

The eye is the organ of sight, and is attached to the wall of the eye socket in the skull by six muscles. These muscles move the eyeball.



Structure of the human eye

Structure

The eye consists of the following parts: pupil, lens, suspensory ligaments, optic (eye) nerve, ciliary muscles, iris, cornea, conjunctiva, the aqueous and vitreous humours, sclerotic coat, blind spot, tear gland, eye lashes, eyelids and choroids. Look at the diagram of the eye to find these parts.

Pupil: This is the hole that allows light to pass into the eye. The size of the pupil depends on the amount of the light entering the eye. In dim light the pupils widen to allow more light to enter the eyes. In bright light the pupils become smaller to allow less light to enter the eyes.

Lens: this refracts light rays coming from an object so they meet on the retina and form the image. There are also lenses in eyeglasses, microscopes, and telescopes.

Suspensory ligaments: These hold the lens in position.

Retina: This is the innermost layer and is sensitive to light. The light from the object produces points of light on the retina. The image formed on the retina is inverted and smaller in size than the real object.

Optic nerve: This carries nerve impulses from eye to the brain where the information is processed.

Iris: The iris increases and decreases the size of the pupil to control the amount of light entering the eye.

Cornea: This is the front transparent part and refracts the light rays passing through it into the eye.

Conjunctiva: This helps the eyeball move easily by secreting mucus.

The aqueous and vitreous humours: These are liquids inside the eyeball that refract light rays so that an image is formed on the retina. Their outward pressure keeps the eyeball round.

Sclerotic coat: This protects the innermost delicate parts of the eye. It has attachment points for the muscles of the eye and gives shape to the eye.

Forea: This is also called the yellow spot. It contains sensory cells in greater number, allowing for the most distinct vision of the image. All our fine seeing is done by it.

Blind spot: This is the place on the retina where the nerve fibres leave the eye and enter the optic nerve. There are no sensory cells at this spot, so it is not a light-sensitive area.

Tear glands: These secrete a liquid that washes the eye and keeps it moist.

Eye lashes: These prevent dust particles and other things from entering the eye.

Eyelid: This protect the eye and removes any foreign body that enters.

Choroid: This is below the sclerotic coat. It contains black pigments which stop reflection of the light rays. Blood vessels in it supply food and oxygen to the eye.

Following is a comparison of parts of the camera and equivalent parts of the human eye:

A camera	**the human eye**
1. Shutter	eye lid
2. Aperture (pinhole)	pupil
3. Diaphragm	iris
4. Lens	lens
5. Film (screen)	retina
6. Case of the camera	sclerotic coat
7. Black paint	choroids

Differences between images formed in the pinhole camera and the human eye.

In the camera, light from any point of the object is brought to focus on the film and a clear image is obtained when the film is developed. The light entering the aperture is controlled by the diaphragm.

In the eye, the iris adjusts the size of the pupil to allow the correct amount of light to enter the eye. Outdoors on a bright day the pupil is very small but in low light it opens wide to permit maximum light to enter.

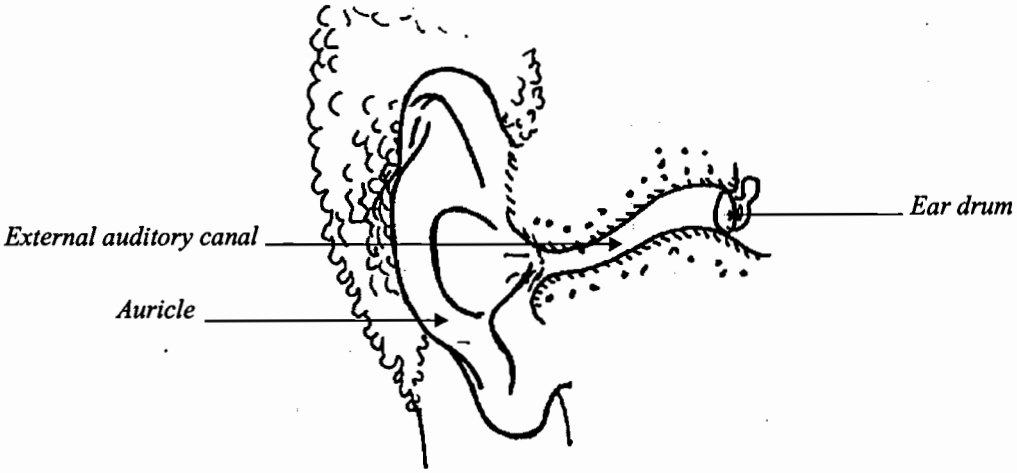
Rays of light from an object enter the eye through the pupil, and then pass through the lens to form an image on the light sensitive screen known as the retina in the back of the eye. The inverted (up-side-down) image is conveyed to the brain by the optic nerve. The brain corrects the inverted image and we see the objects the right way.

Revision exercise:

1. Describe the structure of the pinhole camera.
2. Explain how an image is formed in the pinhole camera.
3. Draw both a pinhole camera and the human eye and give a comparison between the parts of a camera and the equivalent parts of the human eye.
4. Describe how an image is formed by the retina.
5. True or false: Images formed by the pinhole camera and the human eye are upright and enlarged.

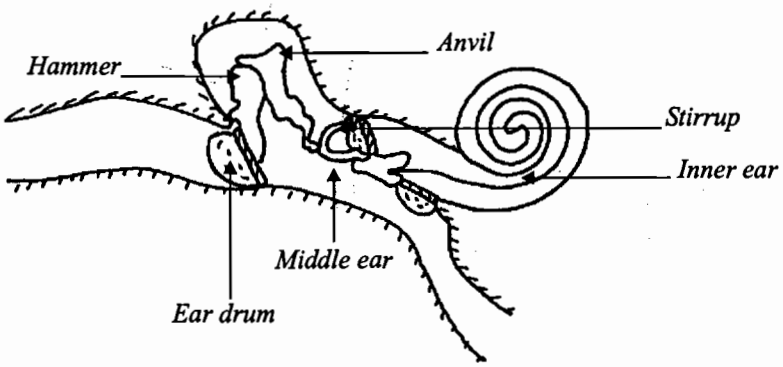
UNIT 8 Sound

Sound is the movement of vibrations in air, liquids, and solids. The reflection of sound waves on the smooth surface is known as an echo. It's almost impossible to learn to speak without being able to hear. Without speech and hearing we cannot communicate meaningfully so hearing is one of our most important senses.



The structure of the human ear

The outer ear consists of flaps of skin and cartilage called **auricles** which catch sound waves and direct them into a tube called the **auditory canal**. The auditory canal guides the air waves to the **eardrum**, which is about 2.5 cm long and lined with skin. The first part of the canal also has sweat glands, hairs, and glands that produce ear wax. The hairs and wax protect the eardrum from dirt,



The Auditory Canal

small insects and other objects that may enter the ear. Sometimes a lot of wax is formed and hearing becomes difficult. You should never try to remove the wax yourself as you may damage the eardrum and lose hearing in the ear.

The **middle ear** contains the three smallest bones in the human body. These are the **hammer, anvil** and **stirrup**. The stirrup is smaller than a grain of rice. These bones are shaped like the objects they're named after. Sound waves are caused by vibrations, and when sound waves hit the eardrum it vibrates. The vibrations pass across the hammer, anvil and stirrup which act as an amplifier. In other words, the vibrations become stronger before they are passed onto the inner ear.

A tube called the **Eustachian tube** goes from the middle ear to the back of the throat. Most of the time the Eustachian tube is collapsed but it opens when you yawn, swallow or blow your nose. This allows air to pass from the inner ear to the throat to equalize the pressure on both sides of the eardrum. When you climb a high hill or take off in an airplane you might feel your ears pop. That tells you that air is passing through the Eustachian tube because the air pressure becomes less as you go higher into the atmosphere.

The inner ear looks like a snail shell. It consists of bony passageways with membranes which are separated from the bones by a special fluid. This part of the ear is called the **cochlea**. In the membranes are hairs and nerves that pick out different sounds. Together these nerves form the auditory nerve which passes electric impulses to the hearing centre in the brain. In the inner ear we also find the organs of balance. Sensitive hair-like cells are pulled in one direction when you stand up, and in another direction when you are lying down. Messages are sent to the brain to inform it of the position of the head and body and of all the turning movements of the head. Infections or malfunctions of the middle ear may result in a loss of balance, causing the person to stagger as if drunk.

Activities:

1. Test your own hearing by holding a watch at different distances from one ear. Cover the other with your hand.

2. Take turns with your partner to hold stiff paper or cardboard behind your ear to increase the size of your ears. Stand some distance apart and test whether you can hear what is said better with "elephant ears".

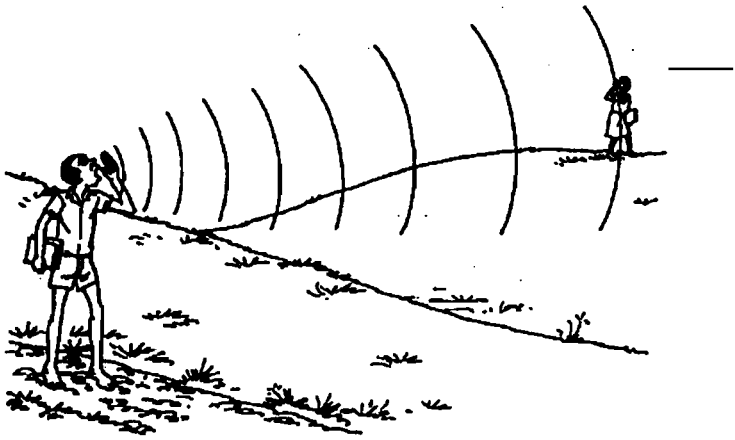
3. Bring a variety of instruments or sound producing objects to the lesson. Make sounds with them. In your exercise book, make a table such as the one below and record your findings. Discuss whether everyone enjoys the sounds and finds the same sounds or voice tones easy to hear.

Object	Sound high/low Loud/soft	Sound pleasing/ unpleasing	Easy to hear/ difficult to hear

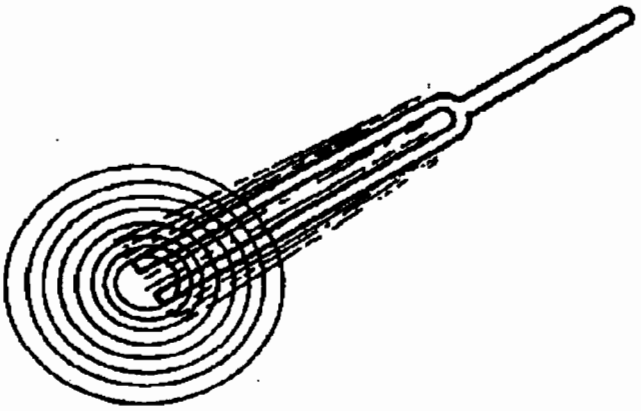
How sound travels

Go to a large body of water such as a pond or river that has a smooth surface. Lie down and make ripples on the surface of the water by hitting it with your hand, and then by blowing on it. In what direction do the ripples travel? You will notice that the waves weaken as the circles move outwards.

Sound waves travel through the air and the liquid of the inner ear in the same way that you see the waves moving through the water. For this reason, you hear sound best when you are close and in a direct line with the source of the sound. If you are far away or to one side, the sound waves will have weakened by the time they reach you.



A tuning fork is a two-pronged steel fork that makes a particular sound when struck. Tuning forks are used by musicians such as guitarists to give the correct notes for tuning their instruments. The guitar string is tightened or loosened until its pitch is the same as the sound given by the tuning fork.



A tuning fork and sound waves

Pitch: This is the degree of highness or lowness of a sound as heard by a listener.

Loudness: This depends on the frequency of the sound waves. Frequency refers to how many waves are produced per second. The frequency is increased by the amount of force that is applied to making the sound, for example, how hard you hit the tuning fork.

Questions:

1. Give another name for auricles.
2. In which part of the ear is the auditory canal?
3. What is the purpose of the Eustachian tube?
4. What is the function of the auditory nerve?
5. The organs of balance are found in the a) outer, b) middle , c) inner ear (choose the correct answer)
6. Why can you hear sounds better inside a room than you can hear outside?
7. How are loud sounds produced?
8. How are sounds produced by a trumpet or horn?
9. What is the function of the bones called the hammer, anvil and stirrup?

UNIT 9 Heat

Heat conservation

Heat may be defined generally as energy in transfer from one body to another due to temperature differences between them. When two bodies are brought into contact, heat flows from the one that has a higher temperature to the one that has a lower temperature.

Heat conservation refers to saving or conserving heat, so that not much is wasted. The best way to conserve heat is to improve the devices that are used to transform heat energy.

Improved energy-saving cooker/heater

The traditional charcoal cooker (kanuun) is made of metal. Metal is a good conductor of heat which means that not only does the metal feel hot to touch, but some of the heat energy passes into the metal and into the air around it, instead of passing upwards to the cooking container.

Cooking container on a charcoal stove ("Kanun")

The kanun has been improved by lining it with clay which is a poor conductor of heat. It is also cone shaped so that the maximum amount of heat goes upwards to the cooking container and not through the sides. If you have an old-fashioned cooker, you can improve it by plastering the inside with a mixture of clay and dry grass (hay). You will find that less fuel is needed for cooking because the heat is directed up to the cooking pot and is not lost.

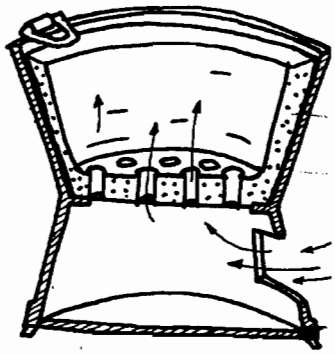


Diagram of a charcoal stove ("Kanun")

Making a charcoal cooler

In our homes we like to keep water cool or keep foods like meat and fish cool to preserve them. Traditionally people used water to cool things, putting the food or beverage in a container in the shallow water of a stream or wrapping it in a wet cloth. Refrigerators that use electricity or kerosene keep food much cooler.

We can make a simple charcoal cooler that uses only hot air as its source of energy. It works on the principle that rapid evaporation causes cooling. A clay pot of water stays cool because the water seeps through the clay and evaporates (we say the clay is porous). When wet charcoal comes in contact with hot moving air (heat energy), the water on its surface evaporates very fast. This causes the charcoal to cool. So, if we line a large container with charcoal and pour water on it we can place a smaller container of food in it to keep it cold.

Activity:

Make your own charcoal cooler. If you don't have a source of charcoal, put sand on the bottom of two large containers, put one container inside the other, and put sand in the space between them. Keep your charcoal or sand wet. You might want to keep the charcoal in place by putting some wire mesh between the charcoal and the space for the food container. Test your cooler with some drinking water in tins or cups.

UNIT 10 Electricity and Magnetism

Making a magnet from electricity

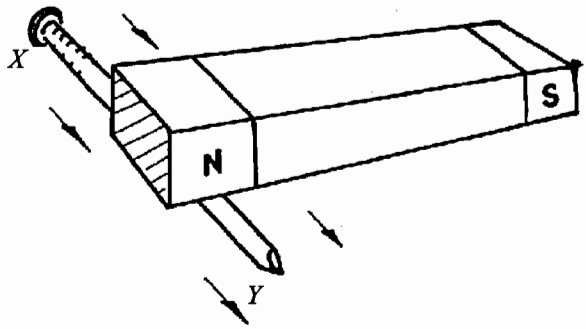
We know that the North Pole has magnetic properties that cause magnets to point north. Have you ever seen or played with a magnet? Did you know that it's possible to make magnets?

There are two ways to make magnets. First, you can make one by rubbing a piece of metallic material, like a nail, against a magnet. Secondly, a magnet can be made by passing electric current through the same kind of material. In the experiment below you will be able to make a magnet.

1. Making magnets by rubbing a magnet against metal

In the diagram below N is the North Pole of the magnet and S is the South Pole. X and Y are the two ends of the nail. Place the N pole of the magnet at the end of a nail marked X. Rub the magnet along X of the nail as shown in the diagram. Lift up the magnet at point Y and repeat the exercise several times. Note that the magnet is rubbed along the nail only in one direction and not back and forth.

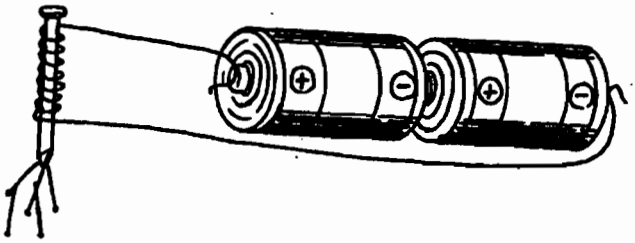
Now place the nail near some pins. What do you see happening? (The nail should attract the pins so they stick to it.)



2. Making magnets using electric current

A magnet made with electricity is called an electromagnet. In this experiment we'll make an electromagnet. The following equipment is needed for the experiment:

- A 10 cm nail
- An insulated copper wire
- One or two batteries



Wind the insulated wire around the nail in many coils as shown in the diagram below. Place one end of the wire at the positive (+) terminal of the battery and the other end at the negative (-) terminal. Put some pins or razor blades near the tip of the nail. Observe carefully what happens to the pins or razor blades. Now answer the following questions:

i. What happens to the pins or razor blades when the two ends of the copper wire are attached to the batteries?
ii. What happens when one end of the wire is removed from the batteries?
iii. What do you think will happen if the number of the batteries is increased to three?

This is a magnet made by electric current. Electromagnets are temporary. The magnetic force is lost when current is switched off.

How to store magnets

Magnetism can be destroyed or lost if magnets are not taken care of properly. Following are ways by which magnetism can be lost:

a) Heating destroys magnetism
b) Hitting a magnet with a hammer several times while keeping it at an East - West direction destroys magnetism.
c) Keeping two magnets with their like poles close to one another destroys magnetism.

Uses of magnetism

Some uses of magnets are listed below. What other uses can you think of? Add them to the list.

- Doctors use magnets in hospitals for removing iron bits from eyes.
- People use magnets to find directions.
- Watch repairers and watchmakers use magnets for picking up iron screws.
- Magnets are used in electromagnetic bells in houses and offices.
- They can be used for picking up pins, razor blades, nails etc.
- Magnets are used in factories for separating magnetic materials from nonmagnetic materials.
- Large electromagnets are used for picking up heavy iron loads.

Revision questions:

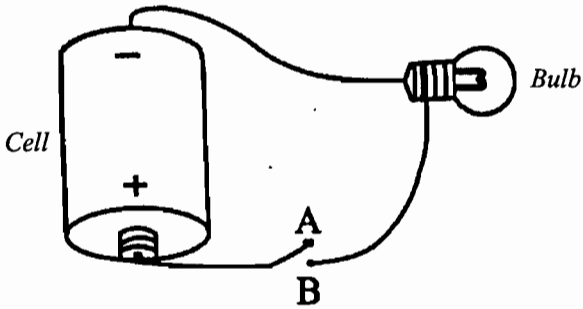
1. Which of the following materials are attracted to magnets and which are not? Paper, razor blade, pin, grass, sand, wood, iron, copper, silver, wax, steel wool, aluminium, paper clips, needles and rubber.
2. Write down the properties of a magnet.
3. What do we mean by the "like poles" of two magnets?
4. In which direction will a free suspended magnet come to rest?
5. How does a compass help travellers?
6. Name two ways by which magnets can be made.
7. The magnetic force of a magnet is greatest in the centre of a magnet. True or false?
8. Magnetic force can pass through all materials to attract other materials. True or false?
9. Which pole of the earth does the needle of a compass face: the North Pole or the South Pole?
10. Magnets that are made by electric current are called_____

Electricity

Electricity is a kind of energy. We know what electricity does but we cannot see it. It makes the burners of an electric cooker red hot and lights up light bulbs. We can use electricity for cooking, lighting our homes and washing our clothes. Electricity is also used to run factories and produce magnets.

The electric circuit (Activity)

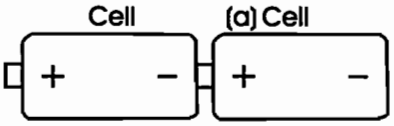
Connect a dry cell battery and a flashlight bulb as shown in the diagram below. Use copper wires to make the connections. When the switch AB is closed, the bulb lights up. Try to find out what happens when:



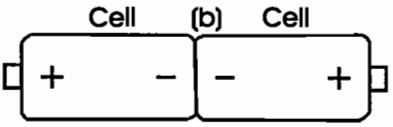
i. the switch is off
ii. one of the connecting wires is cut off with a pliers
iii. the wire is separated from the cell.

When we do these things the bulb does not light. This is because the path of the electric current is disconnected.

For an electric current to flow, there must be a complete path called an electric circuit. Electricity flows if the cells are connected as in diagram. An electric circuit is a flow of an electric current in a complete path. Electricity flows if the cells are connected but does not flow if disconnected.



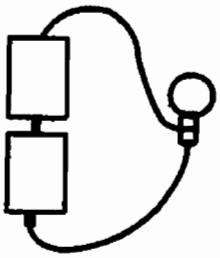
(a)



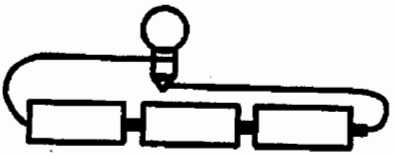
(b)

Electric circuit in series

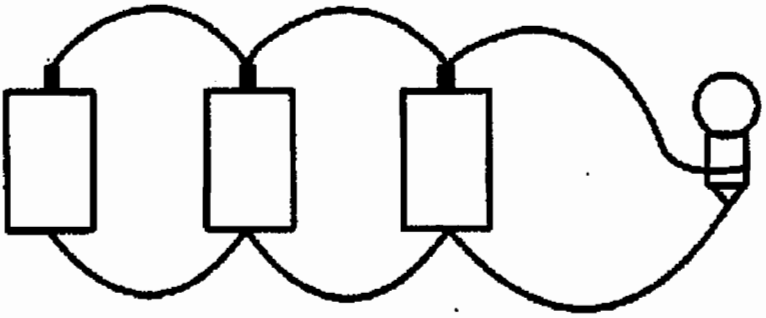
In diagram (i) for two dry cells and in diagram (ii) for three dry cells, each 1.5 volt cell is arranged so that the positive (+) end of one is joined to the negative end of the other. Cells arranged in this way are said to be in a series. When a bulb is connected with a wire as in the diagram above, it lights up. The total voltage in the circuit in (i) is 3.0 volts and that in (ii) is 4.5 volts. The bulb in (ii) is brighter than that in (i).



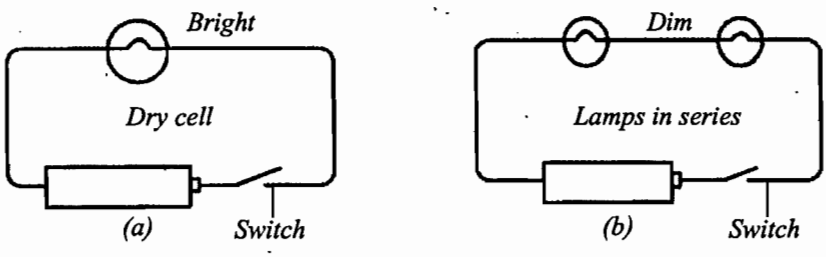
(i)



(ii)



Cells in parallel

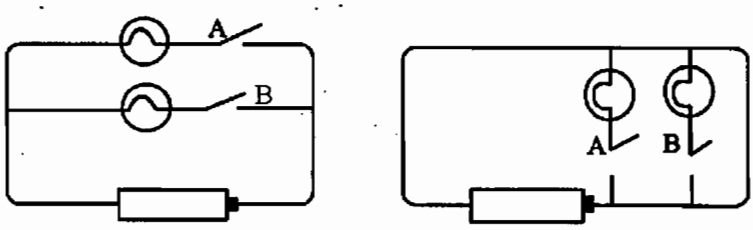


Lamps in series

In the diagram above all the positive (+) ends of the three cells are joined together. Cells arranged in this way are said to be parallel. In the parallel circuit, the total voltage is the same as that of a single cell, but a cell in this circuit lasts longer than that of a single cell.

Arrange the circuit as in the diagram above (a) and (b). Diagram (a) shows one cell lighting the lamp to brightness. In diagram (b) two lamps are connected in a series. The lamps give a very dim light. This means the current has dropped because there is more resistance in the circuit (two lamps sharing the power of one cell).

- Now switch off (b) and note that both lamps go off.
- Let the switch in (b) be on. Now remove one of the two lamps. What happens? The other lamp goes out. We can therefore conclude that when the lamps are connected in series,
- One switch controls both lamps.
- The lamps do not burn to normal brightness.



Lamps in parallel

Now the two lamps are connected in parallel and to a single cell. When the switches A and B are on, both the lamps burn to full brightness. When the lamps are in parallel, the total resistance is less and more current is supplied.

i. Put the switch "A" off. The lamp "A" goes out but the lamp "B" still lights to full brightness.

ii. Put the switch "B" off. The lamp "B" goes out and the lamp "A" still burns.

We can conclude that when the lamps are connected in parallel,

i. They burn to normal brightness.
ii. Each of the lamps is controlled by a separate switch.

Warning!

Before we study the electric bell let's revise some of the facts about electricity. Although electricity is very important for our lives, it can also be very dangerous if not used carefully. A strong electric current can kill you, so you should never play with electric wires, cables or sockets.

The Solenoid

About 170 years ago a scientist named Micheal Farady discovered that a magnet pushed into a coil of insulated wire produced a current in a wire. The apparatus which is known as a solenoid is the basis for electric motors and electric generators.

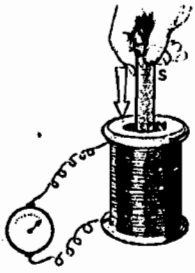
How to make an electric bell

To make an electric bell you need the following materials:

i. insulated copper wire
ii. a cone or reel of wire
iii. a magnet
iv. a bicycle bell

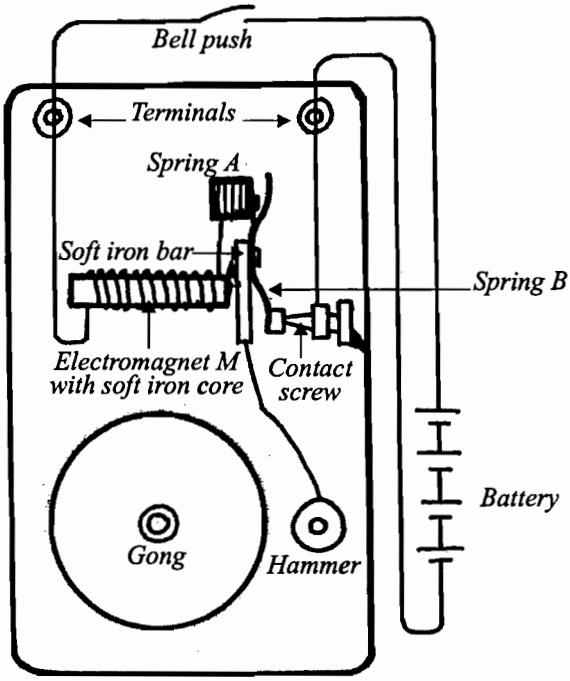
- Take a cone or reel made of a nonconductor of electricity: a piece of wood or a plastic section of a large nylon or rubber hose pipe.
- Make a large hole in the centre
- Insert a magnet into the hole at the centre.
- Attach one end of the wire to the bell
- Try to see if it can ring. What happens?

Note: if it does not work the first time, make some adjustments and try again. Remember that some inventors make many attempts before they invent new things.



How an electric bell works

1. When the bell push is pressed, current flows through the circuit.
2. The current in the coils of electromagnet M causes the soft iron core to become a magnet i.e. M now acts as a magnet.
3. M, being magnetised, attracts the soft iron bar. The bar therefore moves to the left towards the core and causes the hammer to strike the bell.
4. When the soft iron bar moves to the left, it carries with it the spring B. Hence, there will be a gap between the spring B and the contact screw,; the circuit is broken and the current no longer flows.
5. M loses its rnagnetism. The soft iron bar and with it the spring B return to their original positions.
6. There is now contact between the spring B and the contact screw. The circuit is complete and current flows once more and the whole process is repeated.
7. This causes a continuous to and fro movement of the hammer that rings the bell.



An Electrical bell and its parts

Electric motor

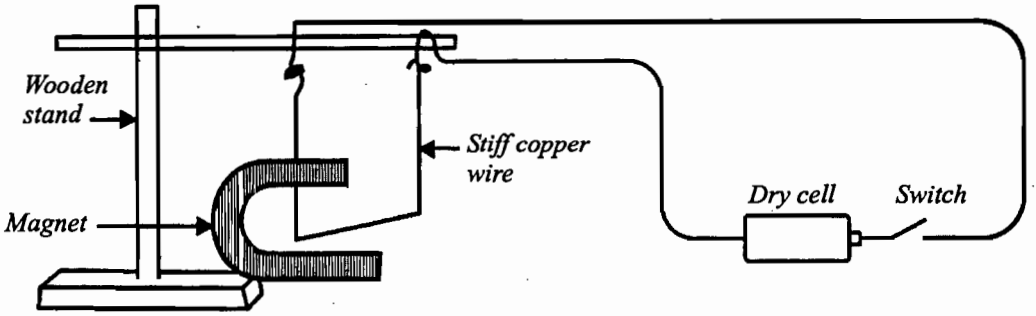
Suspend a swing of stiff copper wire by hooks, as shown, between the poles of magnet. The swing must have good electric contact with the hooks and hence with connecting wires to the dry cell.

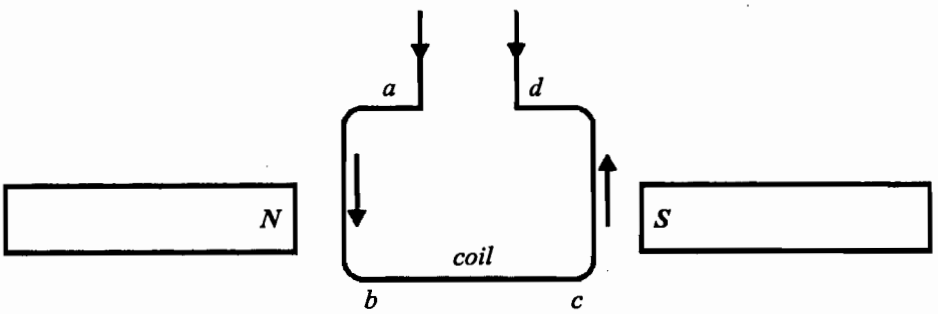
Switch on the current. What do you observe? The copper wire swings one way or the other. Reverse the connections at the cell. You will see that the wire swings in the opposite direction i.e. there is a force which acts on the wire carrying current when it is in a magnetic field.

Now repeat this using a coil. When a current is passed through the coil, it rotates. The rotation is caused by forces acting on sides ab and cd. The upward force on one side of the coil and the downward force on the other side result in the rotation of the coil.

If we want this coil to keep turning, the turning force should always be in the same direction i.e. the current in the coil nearest to N-pole (or S-pole) should always be in the same direction whether the side ab or dc is towards it. In short, the current in the coil should be reversed exactly after half-turn.

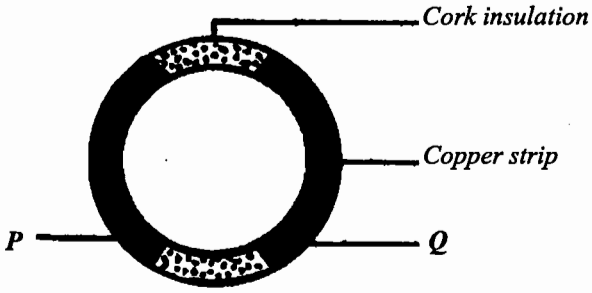
The best way to understand how this is done is to examine toy motors and to construct one yourself.





Construction of a simple electric motor

1. Wind 10 turns of insulated copper wire on a match box to make a rectangular coil.
2. Put a thin iron rod through the coil and let its end pass through two wooden supports fixed on a wooden base.
3. Make a simple commutator (exchanger) using a core, covering it with copper strips as shown.



P and Q are commutator halves, separated by cork insulation. It helps to reverse the current in the coil. It's mounted on the iron rod and the bare ends of the coil are connected to it.

4. Two metal strips or brushes are fixed to the wooden base. They're arranged to make contact with the commutator halves and are connected to the terminals of a battery.
5. Arrange a horseshoe magnet around the coil. Switch on the current, give an initial push with your fingers to start your motor running.
6. You can make the motor more powerful by
   a. Adding more dry cells i.e. increasing the current
   b. Having more turns of wire in the coil
   c. Using a more powerful magnet

Electric motors drive fans and refrigerators for cooling, grinding and mixing food, starting cars and turning parts of machines in industry. They drive trains, sewing machines; weave cotton, wool and artificial fibres for making cloth.

A Simple telegraph

Since people first realised that electricity could travel through metal wires, they have tried to discover how they could use it carry messages over long distances.

When the electric battery was invented, it could be used to send a current along an insulated wire using the earth to complete the electric circuit. The current was started and stopped by a simple switch which opened or closed a gap in the copper wire. The pattern of the current flow could be detected several kilometres away.

Samuel Morse is remembered for inventing the telegraph and Morse Code. The telegraph uses a spring-loaded switch or tapping key at the sending end and an electro-magnet at the receiving end. The magnet stimulates movement in an iron core and the movements are traced out by a pencil onto a strip of paper that passes through the receiver. The signals sent are in the form of short and long electric pulses and are written as dots and dashes.

Activity:

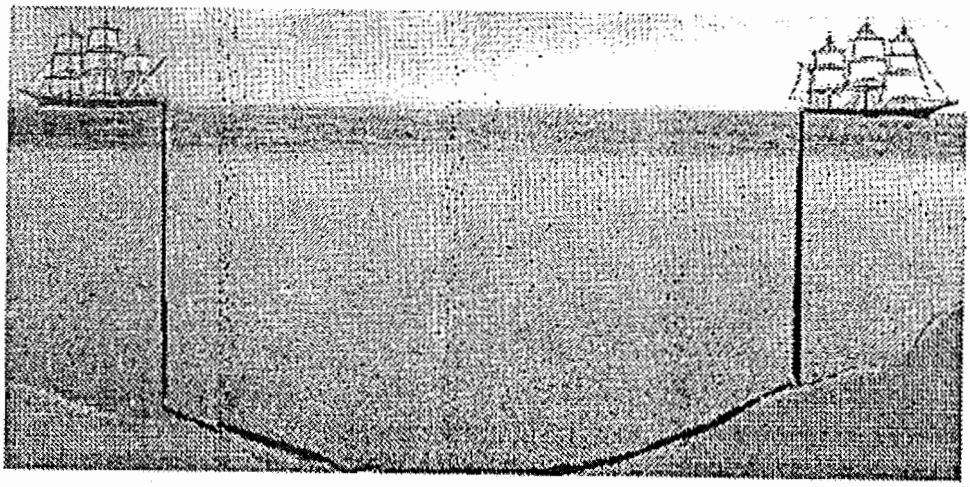
1. In groups, make a simple electric circuit with copper wire, a torch battery and bulb. Use a small piece of metal to make a switch which you can open and close.
2. Send short and long signals by opening and closing the switch. You can count 1 - 2 with the switch closed for the dashes and 1 for the dots.
3. Send a simple message. Your group members will record the flashes of the light bulb as dots or dashes and then use the table to write them as letters.

a	.–	j	.–––	s	...
b	–...	k	–.–	t	–
c	–.–.	l	.–..	u	..–
d	–..	m	––	v	...–
e	.	n	–.	w	.––
f	..–.	0	–––	x	–..–
g	––.	p	.––.	y	–.––
h	....	q	––.–	z	––..
i	..	r	.–.		

The telegraph made a great difference in the time needed to get messages from one place to another. It was used for many years to transmit messages, and shrank the time needed to send information from weeks or months to minutes. Some years after the adoption of the Morse Code, a way was found to transmit printed letters, and even images, in place of dots and dashes. Today, written messages are sent quickly by e-mail and fax.

The invention of the telephone made it possible to transmit the human voice by electric current through wires. The telephone does this by changing the pattern of sound waves of a voice into a pattern of electric impulses. At the receiving end, the pattern of sound waves is re-created and the voice is heard.

After the telegraph was invented, submarine (underwater) cables were built to carry messages from one continent to another. Cables could carry more than 2,000 letters a minute between places on opposite sides of the world. More modern than cables are communication satellites. Many satellites now circle the earth transmitting messages from computers and telephones.



Laying the first transatlantic cable in 1875

Questions:

1. What do you think are the advantages and disadvantages of a submarine cable?
2. Do you think sending messages by satellite is more or less effective than cables? Why?

UNIT 11 The Environment

Utilizing waste materials in the environment

Many materials found in the environment have a variety of uses e.g. plant materials can be used as food, for building, fuel etc. The rate at which natural resources are being used is so high that in the future there may be few or no resources remaining. For this reason, we need to explore ways of using waste materials more efficiently.

It's possible to recycle many waste materials that we produce. Here are six examples of waste products we can re-use.

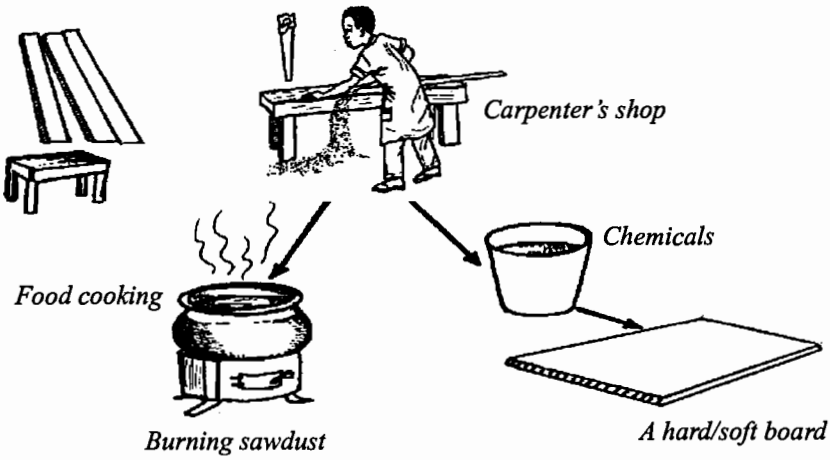
Using sawdust to make hard boards, soft boards and other things

Sawdust is the fine wood particles that are produced when a piece of wood (timber) is being sawn (cut by a saw). Visit a carpenter's shop with your teacher and class. You will see how such sawdust is thrown away as waste.

One use of sawdust is to mix it with chemicals to make hard and soft boards which are used to make things like table tops and ceiling boards (covering over a room underneath the roof). See the diagram.

Sawdust as a fuel

Try to get some sawdust from a nearby carpenter's workshop and burn it in a "kanuun." Which fire burns longer, a charcoal fire or a sawdust fire? Sawdust can also be used as bedding for farm animals. Remember that recycling waste like sawdust helps to conserve our forests.



Coffee husks as fuel

Is coffee grown in your area? Can you tell the class some ways that people use parts of the coffee bean that remain after harvest?

The outer coat of the coffee bean can be put in the soil as compost. The seed inside has a hard outer covering. This is called a husk. In some factories, coffee husks are made into a type of charcoal which burns slowly in the cooker.

Animal dung

Do you have an animal like a goat or a cow? If you have one, what do you do with its dung? Dung (or manure) from cattle, goats, sheep, donkeys and chickens makes good compost and fertilizer which increases soil fertility. It is also used as plastering material for houses.

Before dung can be used for growing vegetables, it needs to be broken down by adding sawdust, grass or ash. It should be worked into the soil and the ground should be watered well before crops are planted in the soil.

Cow Dung as fuel

Dung can also be processed and used as fuel. For example, in cattle camps, cow dung is dried and burnt to protect both animals and people from mosquitoes, flies and other biting insects. The smoke acts as an insect repellent. In addition to this, cow dung can be dried and used as fuel for cooking.

Dung to produce Bio-gas

Dung can be used to produce bio-gas. To make bio-gas, three air-tight drums are placed side by side and joined to each other by pipes. Animal dung is stored in the largest tank and allowed to rot. The gas produced passes through the pipe into the next container where it is purified and then into the third tank where it is stored. It then passes through pipes to be used either for cooking or to generate electricity.

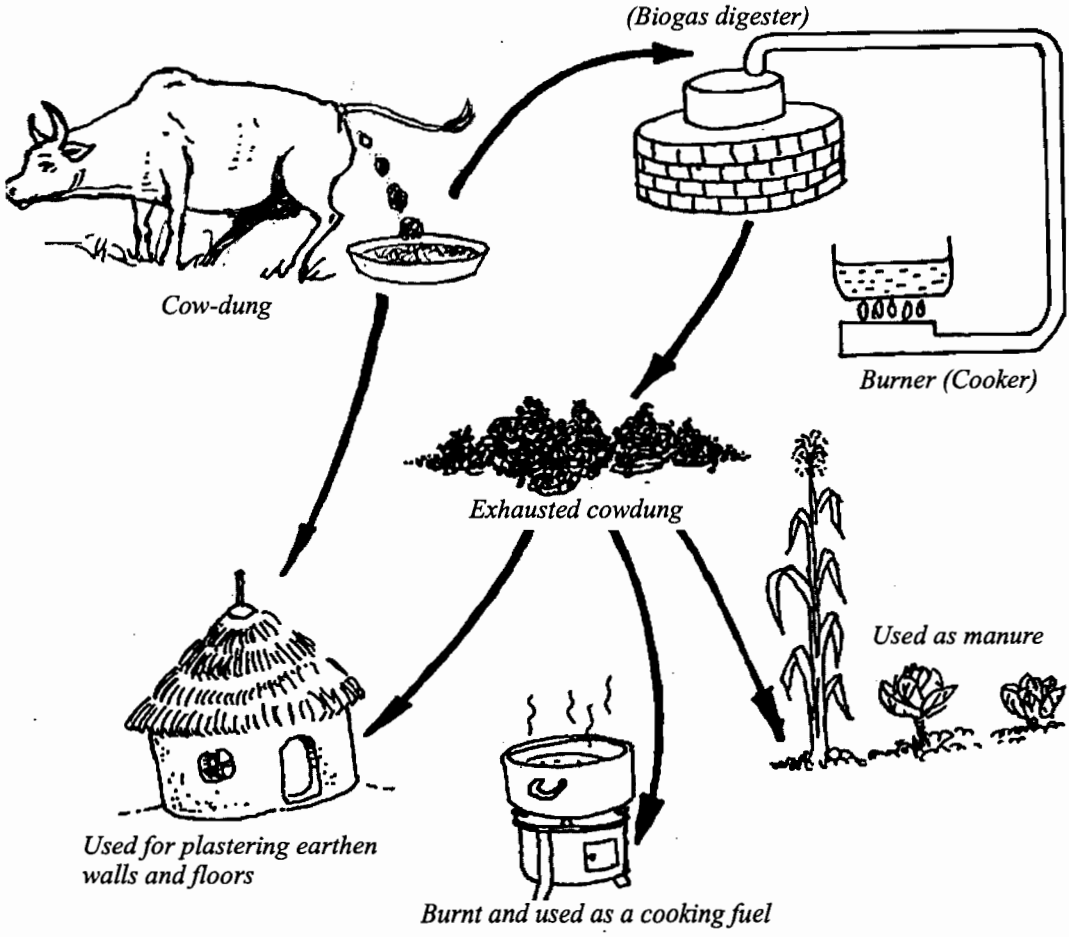
This technology is used largely in India and China and has been introduced in Kenya.

Recycling Used Fuel

Used motor oil can be used very effectively as wood preservative. It is applied on wood items such as fence poles to prevent ants from destroying the wood.

Ashes as whitewash

In some areas where there is no whitewash from factories, ashes can be used as whitewash. Sometimes cow dung is mixed with the ashes to make paste. This



How Cow Manure is Recycled

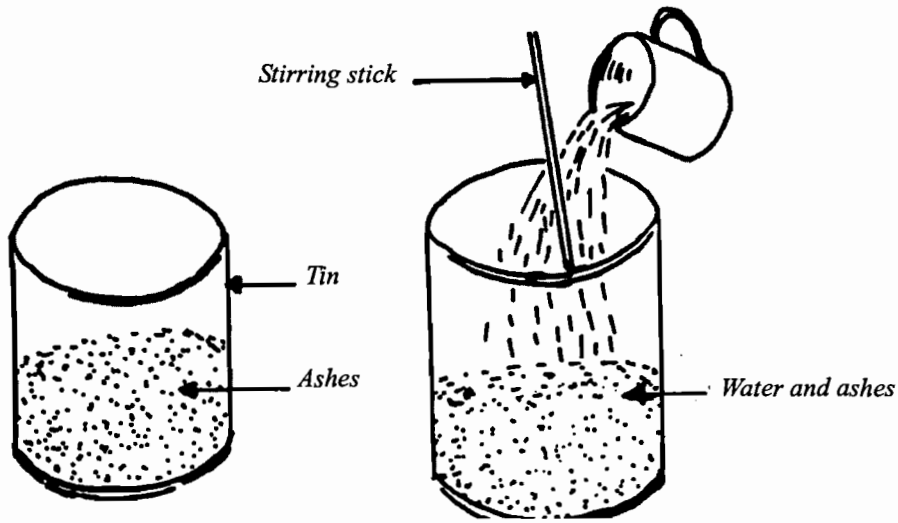
paste is smeared on earth walls as whitewash. It is also used on floors to make them smoother.

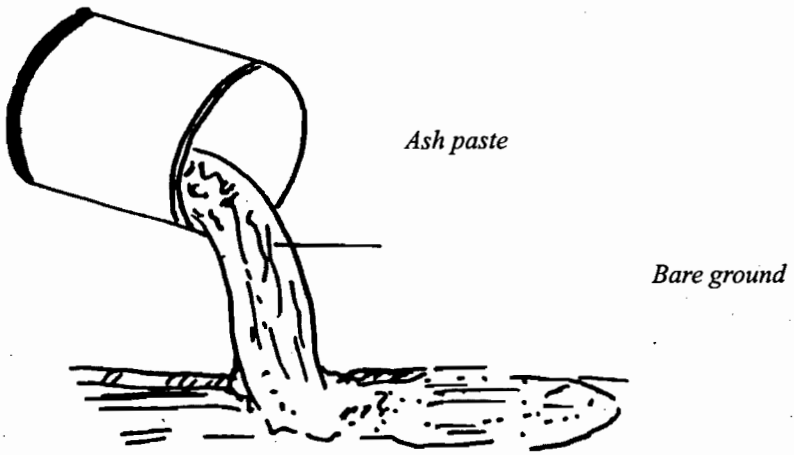
Add some water and stir the mixture to make a paste.

- Apply some to the ground using your palm.
- Wait until it is dry and observe the spot smeared with ash. What does it look like?

Activity:

- Collect some ashes.
- Get some tins, water and a strong stick.
- Put some ashes in an empty tin.





Other uses of ashes

Ash is also used in vegetable growing, e.g. "malukia", okra, pumpkin, tomatoes etc., to keep off pests which could destroy them. It is also added to stored grain to preserve it. In both cases ash acts as a pesticide. Ashes do not have any harmful effects on grain, while chemicals used for grain preservation can.

Some types of ashes can be filtered to produce salt (sodium carbonate) for cooking. Ashes are rich in potassium salts so they can be used to fertilise soil. Ashes are good cleaning agents, so they can be used to scrape dirty aluminium pots instead of buying cleaning powder. Ash is also used for the decoration of walls.

Recycling

In recycling we reuse materials, sometimes treating them first. Two commonly recycled materials are water and paper.

Recycling Waste water

Water gets dirty when we use it. It's possible to filter waste water and use it again for washing floors, clothing and even ourselves. It can also be used to water plants.

In factories that use a lot of water, the water is filtered through machinery and circulated to be re-used for cooking, and cleaning. When water passes through a radiator, it condenses into steam and is cooled to form water to be used again. Sewage water, which contains human waste, can be used to produce biogas. What remains in the first tank of the processor makes excellent manure to help increase the fertility of the soil on the farm.

Waste paper

Most toilet paper is made from recycled waste paper. Clean waste paper is collected and sent to factories where it is mixed with chemicals and water in big tanks. This turns the paper into a liquid. When the liquid paper is dried, it is rolled and cut by machinery and made into toilet tissue, cartons, brown paper and packaging materials.

Questions:

Choose the correct answer from the following statements

1. Dry fine ash can be used as:
   a) food b) cooler c) pesticide d) recycle
2. What is sawdust?
3. Discuss two activities practised in your community which do not help in conservation of water.
4. List materials in your area that could be recycled and be re-used.
5. List down the two commonly re-used materials in your community.

UNIT 12 Earth and Space

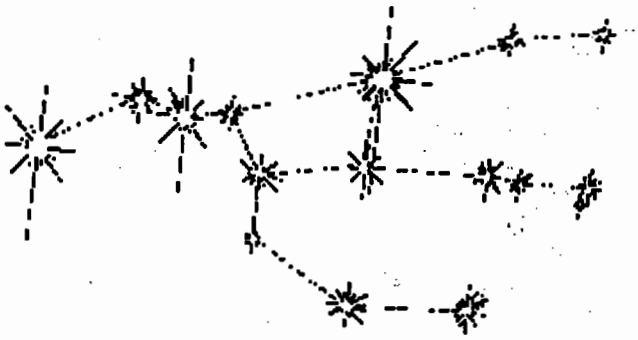
Constellations

Do you ever look at the stars on a clear night? Ancient people named groups of stars that they thought made pictures in the sky. These groups of stars are called constellations.

Constellations are seen in a specific areas of the sky at night, but as the earth revolves and orbits the sun the constellations are seen at different places in the sky, or sometimes they cannot be seen at all.

The ancient Greeks and Romans observed groups of stars and named them after people and animals from their mythology (traditional stories). For example, the constellation Leo was named after a lion and Ersa Major is the Great Bear. Travellers, especially sailors, used to rely on the position of certain stars to find their way. The position of some constellations also guided ancient people to know when to cultivate their fields.

See if you can recognise these constellations. The lines drawn between the stars will help you to see the shape of the object that the constellation is named after.



The Great Bear

Sirius

The brightest star that can be seen from the earth is called Sirius or the Dog Star. It is about the same size as the sun but gives out nearly 30 times as much light as the sun. The ancient Egyptians watched Sirius carefully. When it was seen rising in the east, it was time for the Nile to flood.

Orion

Orion is a group of seven bright stars. Look for Orion about an hour after the sun has set. In December and January look for Orion in the part of the sky furthest away from where the sun sets. In February you can see Orion overhead. In March and April, look for Orion in the direction the sun sets.

The Plough

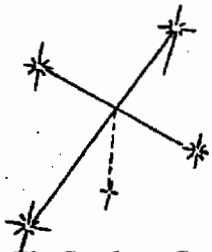
The Plough is also a group of seven stars. Face the direction that the sun sets. Your right shoulder will point to the northern part of the sky. The plough will be in this part of the sky from April to July.

Leo, the lion

The Plough

The Southern Cross

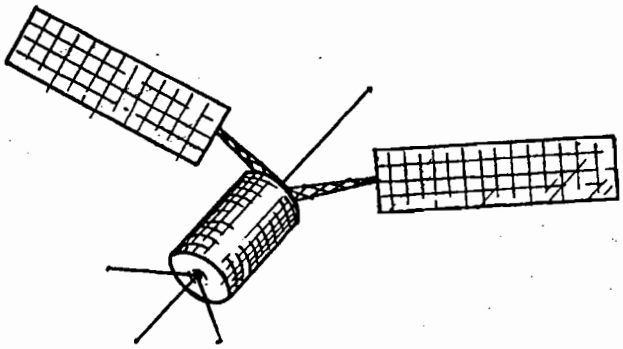
This is one of the closest constellations to the earth, being about 9 light years away. The Southern Cross is a constellation of the southern hemisphere (the half of the earth south of the equator), but it can be seen low in the southern sky in the northern hemisphere at certain times of the year. A line drawn downwards through the cross points south.



The Southern Cross

Activities:

1. On a clear night when there is no moon, take paper and a pencil and draw as many constellations as you can.
2. Ask some elders to tell you the names of the constellations in your mother tongue.
3. Find out how travellers and farmers rely on the position of the constellations.



Satellites/Moons

There are two types of satellite: natural and artificial.

The word satellite means "an attendant." In astronomy a satellite or moon is a body that revolves around a planet. The moon, which circles the earth, is a satellite. Seven planets in the solar system have moons, these are:

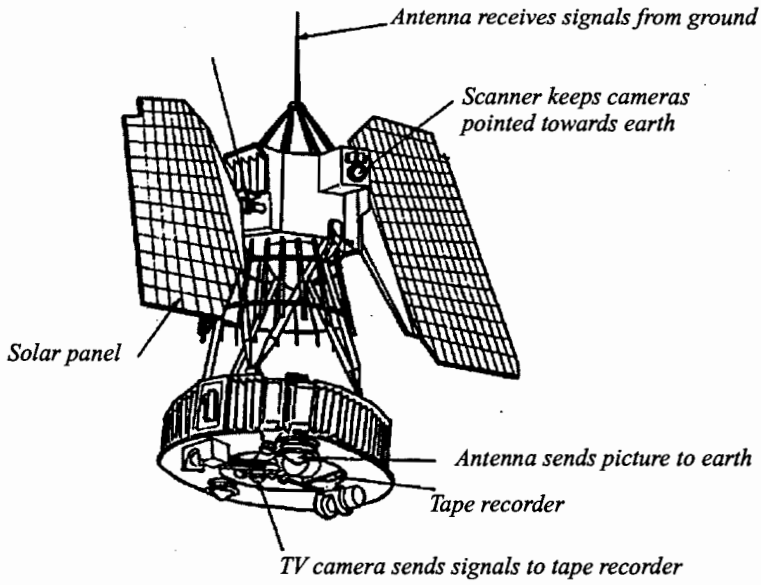
Earth:	1 moon
Mars:	2 moons
Jupiter:	62 moons
Saturn:	37 moons
Uranus:	27 moons
Neptune:	13 moons
Pluto:	1 moon

Have you ever seen something moving in the clear night sky that resembles a star? This could be an artificial satellite. Man-made (or artificial) satellites are made to travel through space in an orbit around the earth. To stay in space they must travel at a certain speed far enough from the earth's surface where air and gravity cannot affect them and pull them back to the earth.

At about 160 km above the earth, satellites are able to stay in orbit for a few months but eventually they will fall down into the earth's atmosphere because at this height there is enough air to slow a satellite down and cause it to fall, burning up from the heat-producing friction from the air. Therefore, most satellites orbit the earth at a height of more than 300 km.

Artificial satellites are equipped with communication and electronic recording equipment to send information back to earth. They also send out signals so that scientists on earth can track them.

Satellites have different functions. Some transmit information about the



A manmade satellite

weather by sending photos of cloud movement. Communication satellites make it possible to send radio messages, phone calls and television programmes between distant parts of the earth. They receive signals from sending stations, amplify (strengthen) them and send them back to earth.

Navigation satellites help pilots, sailors, and people in vehicles find their exact positions. All modern aeroplanes and ships are equipped with instruments to receive these signals. Scientific satellites measure things such as radiation and the strength of the earth's magnetic field. Military satellites gather information about troops and equipment but this information is kept secret.

Questions:

1. What is a constellation?
2. What did the position of Sirius tell the ancient Egyptians?
3. How can you find your way at night in the southern hemisphere?
4. Name the earth's satellites.
5. Give the scientific definition of a satellite.
6. Why do artificial satellites orbit so high above the earth?
7. What is the purpose of the large "wings" on the artificial satellite?
8. How can satellites help meteorologists predict the weather?
9. How do pilots and sailors find their position today?
10. How can a television programme broadcast in Japan be shown at the same time in New Sudan?

UNIT 13 Making Work Easier

Definition of Work

What is work? Can someone doing an mathematic problem be said to be doing work? Your answer may be yes but scientists will disagree with you. The scientific definition of work says that work done depends on only two things:

- The force applied on an object.
- The distance through which the force moves the object.

This means work is done only when:

- The force applied moves an object over a distance or
- A moving object is brought to a stop or
- The direction of an object is changed.

Therefore the force applied to an object either reduces friction (resistance) or increases friction.

Now let's look at some examples of work being done:

1. To ride a bicycle you apply force to the pedals. The force moves the bicycle forward. This means you're doing some work. When you want to stop, you apply force to the brake and this brings the bicycle to a stop. This is also called "work" by scientists.

2. In a basketball game, a player steps to one side and applies some force to the moving ball to catch it. She then turns her body and applies force to throw the ball through the basket a few metres from her to score points. She has also done some work.

Making Work Easier

Now let's look at ways to make work easier.

An inclined plane

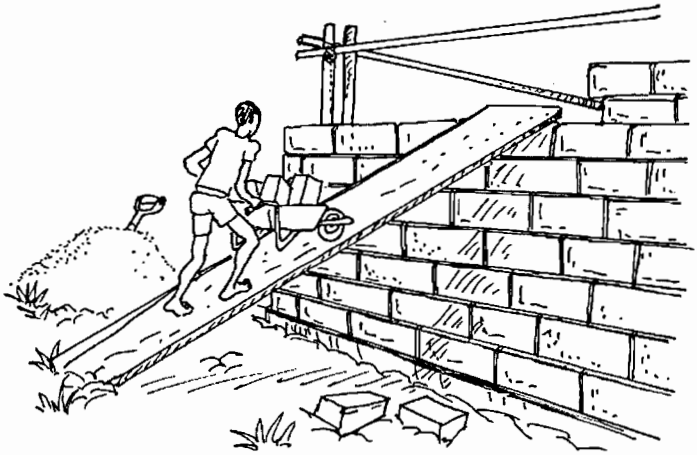
Suppose you're making a cement roof for a house and you need to get cement to the top of the building. What ways could you do this?

You will remember that one simple machine you have already learnt about is the inclined plane.

Look at the picture. Why does the man have to work quite hard? It's because the slope on the inclined is quite steep, and the steeper the slope the more effort (force) is required. How could he reduce the steepness of the slope? He needs to use a longer plank of wood.

A ladder is another example of an inclined plane, but because it has rungs for climbing, the slope can be quite steep. Ladders are very useful if you're painting or making repairs to a building.

One way to carry building materials to the top of a tall building would be to build a ramp of earth starting from a distance back so that the slope is gradual.

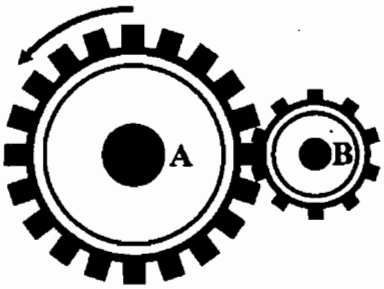


Then wheel barrows or even pickup trucks could carry building materials to the top. However, it's not practical to build long incline planes to the top of high buildings, so other machines are used to lift materials.

Gears

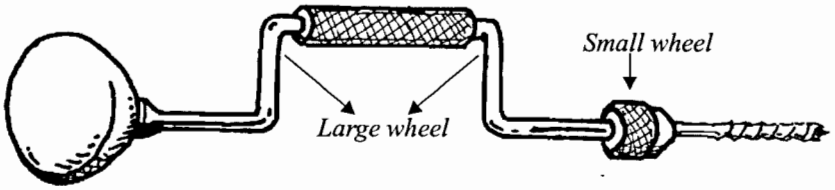
Gears are simple machines consisting of a series of cog wheels (wheels with teeth). These wheels work together to transmit and control motion.

As the first wheel moves in one direction, it forces the next wheel to move in the opposite direction. Watches have a larger and a smaller wheel which work in this way. When the larger wheel turns once, the smaller one turns more than once. This makes work easier.



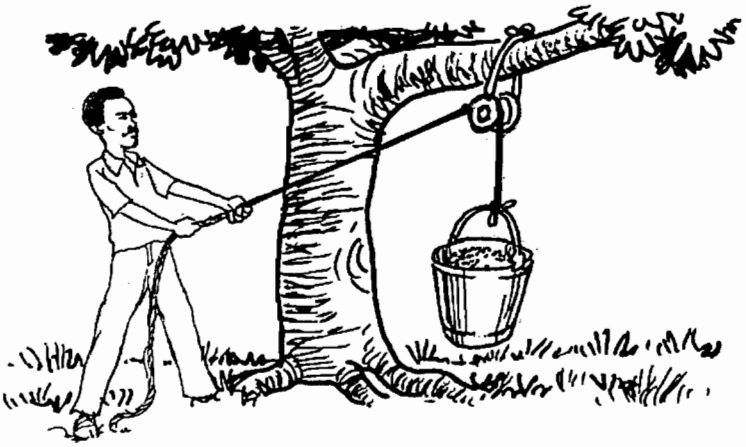
A bicycle is geared by means of two toothed wheels and a chain. The larger wheel in front is connected to the wheel behind with the chain. When it turns once, the smaller wheel behind turns more than once. This makes riding the bicycle easier.

Another example of a geared wheel that makes work easier is the hand drill. When you turn the larger wheel once, the smaller wheel holding the screw turns much faster and more than once. Have you ever seen or used a hand drill?



The Pulley

Pulleys are levers that can turn all the way around. They can be used to lift objects and could lift the cement in the first example. They are used to lift things from pits and from boats. The winch that lifts water from a well uses the same principle.

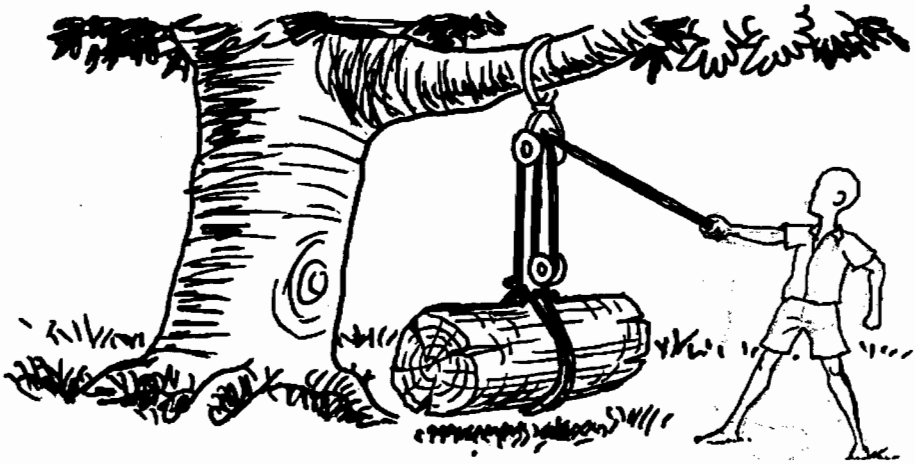


Pulleys can be made from local materials. The wheel that carries the rope has a groove in it and the axle inside the wheel is fixed so that just the wheel turns.

The above diagram shows a single pulley. When you pull the rope at one end, the other end goes up. If you pull one side of the rope 50 cm downwards, the other side moves up 50 cm.

You can make the work of lifting a load from the ground easier by

increasing the number of pulleys. You will then need more rope at one end of the pulley to lift the load at the other end. If the pulleys are the same size, the only advantage is that you can pull from different directions. If one pulley is bigger than the other, it will increase either the speed or the force of the operation.



Activities:

1. In small groups, make a ladder. Find branches or poles that are strong enough to hold the weight of the heaviest person in your group. Use nails or strong binding materials to fix the rungs in place.

2. Make a pulley. You can use an empty carton and string, or an empty tin can with its bottom removed and rope made from sisal or reeds. In both cases you will need to fix the string to the pulley. Use it to lift objects of appropriate size and weight for the size of the pulley you have made.

Questions:

1. What's the difference between a pulley wheel and an ordinary wheel?
2. Why does a bicycle have two different sized cog wheels?
3. Suggest three different ways you could use to lift bricks to the top of a building that is under construction.

UNIT 14 Properties of Matter

Definition of Matter

What is matter? We are surrounded by things of all kinds: rocks, soil, tables, chairs, water, oil, air, cooking gas, animals, food, cars, machines and many other things. We recognize these things by our senses, directly or indirectly. Some we feel (air), some we smell (perfume, gases), some we see (most of the things around us), and some we taste (food). All these things are called material things or forms of matter.

All living things or non-living things are matter. In science we define matter as any substance which has weight and occupies space.

Mass and weight

In science we distinguish between mass and weight. They don't mean the same thing. The mass of an object is the amount of matter or substance it contains. For example, when we take a pair of scissors, a stone or a bunch of keys, each has an amount of matter in it that will not change if you carry it from one planet to another where the gravitational force changes. The mass will be constant.

Weight is the downward pull by gravitational force on an object. This can change because gravity is not constant on other planets. A person on the moon weighs only one third of his/her weight on earth but his mass is the same. Mass is measured with a beam balance while weight is a force and can be measured with a spring balance. When we use a beam balance to compare objects, we are comparing the masses because the force of gravity for each of the object is the same and does not affect the comparisons.

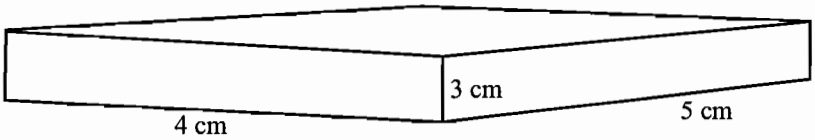
Determining the Volume of Objects

We have studied in Math how to determine the volume of regular objects but it becomes complicated if you want to determine the volume of an irregular object because it's difficult to determine their height, breath and length.

Regular objects

We get the volume of regular objects (such as a cube) by multiplying length by the width by height. The result is given in cubic centimetres (cm^3). For example, if a block of wood measures 3cm by 4cm by 5cm:

The volume of the block is L x W x H
Where L = length, W = width, and H = height
= 3 cm x 4 cm x 5cm = 60 cm^3



How do we find the volume of a stone (an irregular object)? We cannot measure the height, width or length of objects that have no regular shape (irregular objects). To find the volume of irregular objects we have to use different methods.

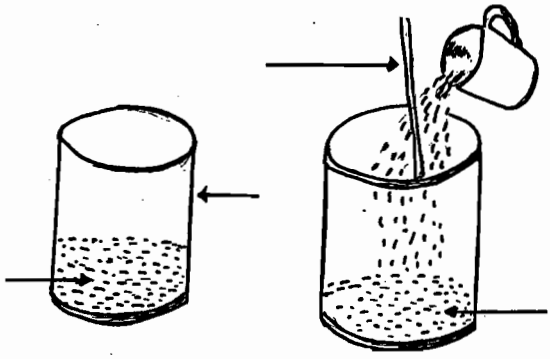
Activity with irregular objects

Materials needed: tins, water, graduated tin or bottle with a wide mouth, small stone and a string.

1. Take a stone and tie it with the string. Fill the bottle or the graduated tube half full with water and note its volume.
2. Lower the stone into the water. What happens to the level of water in the jar?
3. Read the level of the water if your measuring jar is graduated. What's the difference between the reading before and after lowering the stone into the water?
4. Now fill the bottle or the jar completely with water. Lower the stone into the water jar again. What happens to the level of water as the stone goes in? Remove the stone from the jar. What happens to the level of water?

The changes you've seen are caused by the volume of the stone you lowered into the water. In this way we are able to find the volume of an irregular object. This method is called the displacement method.

Example: if the level of water in the measuring jar is 20ml and a stone is lowered into it, the level of water may rise to 30ml. The volume of the stone is found by subtracting the reading of the level of water before the stone was lowered into water from the reading after lowering the stone.



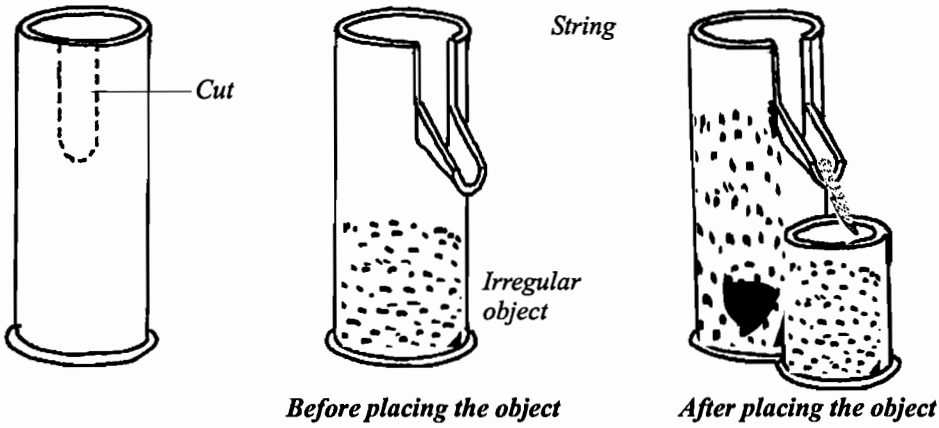
Therefore: 30ml 20ml = 10ml

The unit of measure commonly used in measuring liquid is a litre.

(1 litre = 1000 millilitres = 1000cm^3)
1cm^3 = 1ml

In the above example, because the difference is 10 cubic millilitres, the volume of the stone is 10 cubic centimetres.

Another way of finding the volume of an irregular object is measuring the overflow. In this activity you will need an overflow can and a small tin or bottle. The overflow can is made by cutting a small tin as shown below.



1. Take your overflow can and fill it with water to the level where you had cut. Place the collecting can or baby feeding bottle as shown below.
2. Put the irregular body in the overflow can and collect the water that's displaced in the collecting can.
3. Measure the volume of the water that overflowed into the collecting can. The

volume of the water you get is equivalent to the volume of the irregular object that was dipped into the overflow can.

4. Remove the irregular object (stone) slowly from the water. What do you notice about the level of the water?
5. You can now use the methods you have learnt to find density of irregular objects.

Density

If you compare the masses of tins containing wheat, flour and sand you will find that the tin containing soil is heavier than the others although the tins are equal in volume. To understand why sand is heavier than the other two things, we shall introduce a new unit of measurement. Volume is measured in cubic centimetres or cubic metres written as cm^3 or m^3 respectively. Is it correct to say that one cubic centimetre of sand ($1cm^3$) is heavier than one cubic centimetre of maize flour? The mass of $1cm^3$ of a substance is called the density of the substance. When we say that the density of sand is greater than that of water, what do we mean? Density is calculated by dividing the mass of the object by its volume.

Exercises:

1. A piece of wood has a mass of 36 grammes and volume of $60cm^3$ What is its density?
2. A stone has a mass of 24.0g and its volume is 10 cubic centimetres. What is its density?

Acids

Have you ever tasted something sour? The substance that is sour is called an acid. The word acid means "sour". Things that taste sour include lemons, sour milk, grape juice, vinegar, and tamarind. Lemons contain citric acid which makes them sour, while soured milk has lactic acid.

These are called organic acids because they come from natural sources. There are also inorganic acids which are manufactured and don't come from plants or animals. Examples are nitric acid and sulfuric acid. These acids are very strong and are used in manufacturing, as in the production of chemicals.

Testing for acids

Scientists use a special kind of paper called litmus paper to test for the presence of acids or alkalis. Litmus is a dye obtained from lichens (small fungus plants that grow on rocks).

Paper that has been stained with litmus turns red when it touches acid. Acids in food can be tested by tasting them, but sulphuric acid and other strong

acids should be tested with litmus paper because they can burn.

Base/Alkali

A base or alkali is a chemical compound which reacts with an acid to form a salt and water. We can say that it neutralises the acid; that is, it removes the acidic qualities from it. The saliva in your mouth is an alkali and it neutralises acidic foods, as well as helping with the digestion of starches. Alkalis are used in medicine to help with digestive problems.

The word alkali comes from the Arabic word al-kali meaning ashes. Kombo (ash used when cooking green leaves) is an alkali which takes the acid out of the leaves. Common salt (sodium chloride) is also an alkali.

Potassium is another salt which is essential to the body because it plays a part in the process by which food is changed into energy and new tissue. Potassium compounds are also used in medicines. Potassium salts are also needed by plants and are used in fertilizers. Alkali are used for making soap when oil is added to caustic soda.

Identification of substances containing bases

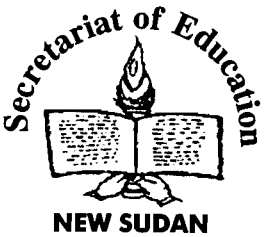
The following substances contain bases: lime water, caustic soda, calcium hydroxide, ammonia and magnesium hydroxide or milk of magnesia. Bases turn litmus paper blue as an indicator.

Adding acids to bases

When an acid is mixed with a base in the proper amount, the acid loses its sour taste and its ability to turn litmus paper red. Likewise the base loses its ability to turn litmus paper blue. In other words they neutralise each other. Salt and water are formed. The salt is in solution (mixed with the water) but if you heat it, the water evaporates and leaves the salt behind.

Questions:

1. Without using litmus paper, how can you test whether food is an acid or a base?
2. Why should you never do this with substances other than food?
3. Name the acid that is found in milk.
4. Is potassium chloride an acid or a base?
5. Name the special paper used to test the presence of acids or alkalis.
6. What colour does it turn with acids? What colour does it turn with bases?



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