GENERAL SCIENCE

For Grade VIII

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Khyber Pakhtunkhwa Textbook Board Peshawar

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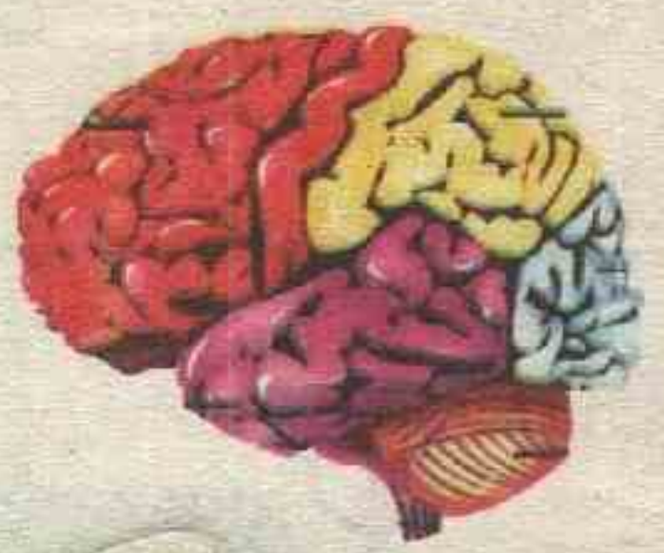
UNIT 1

HUMAN ORGAN SYSTEMS



After studying this unit, students will be able to

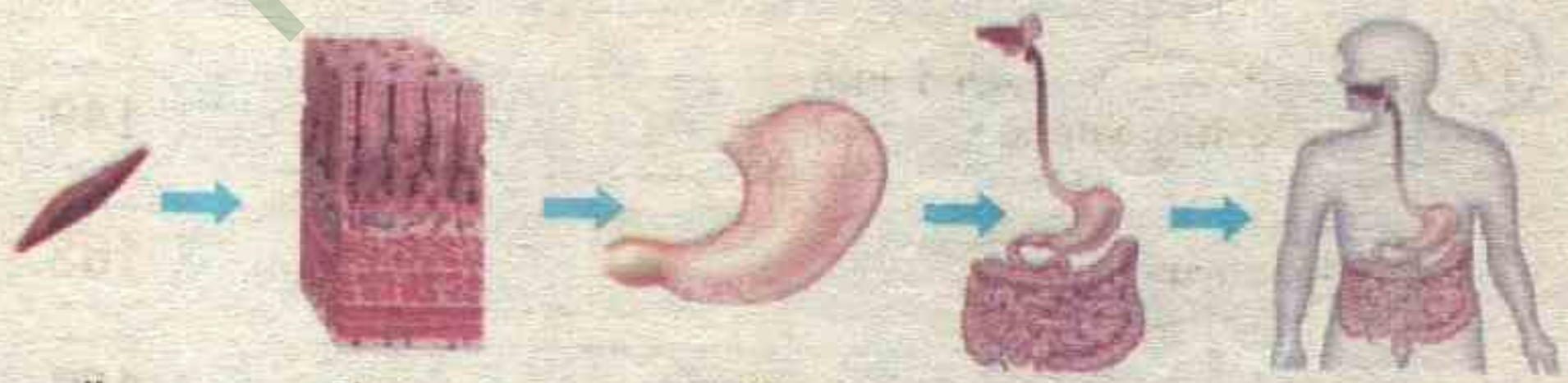
- Describe the structure and functions of the nervous system.
- Describe the working of the nervous system through a model.
- Explain reflex action with an example.
- Differentiate between voluntary and involuntary actions they have experienced.
- Define excretion.
- Draw and label human excretory system.
- Describe the role of kidney in excretion of waste.
- Investigate the possible causes of the malfunctioning of kidneys.
- Suggest techniques to cure problems of kidneys.

Introduction

In the previous grades, you have learnt about how different cells combine to form tissues, many tissues make up an organ and in turn organs are linked together to form organ systems which perform specific body functions. For example, the following organ systems work within the human body:

- Nervous system
- Respiratory System
- Excretory system
- Reproductive System
- Circulatory System
- Digestive system

You learned about the human digestive and circulatory systems in the previous grade. In this unit, you will learn about the human nervous system and the excretory system.



Nervous System

If you touch a hot stove, instantly the message is conveyed to your brain and the brain orders you to jerk your hand away. This happens within a second. Similarly, when an insect sits on your arm, your brain receives the information and sends back a stimulus for you, to jerk your hand or to flick the insect away before it stings you. How do these actions happen?

An organ system in the human body which carries messages from one part of the body to another and make us feel and react to things and situations is called nervous system.

The human nervous system consists of neurons and tissues that regulate stimuli and responses. The nervous system is a complex information processing system that consists mainly of the brain, spinal cord and nerves.

Our nervous system is divided into two parts.

(i). The central nervous system (CNS).

(ii). The peripheral nervous system (PNS).

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The brain of an adult human weighs between 1300 -1400 grams.

The brain of a cat weighs about 30 grams and dog about 70 grams.

The brain of an elephant is about 6000 grams.

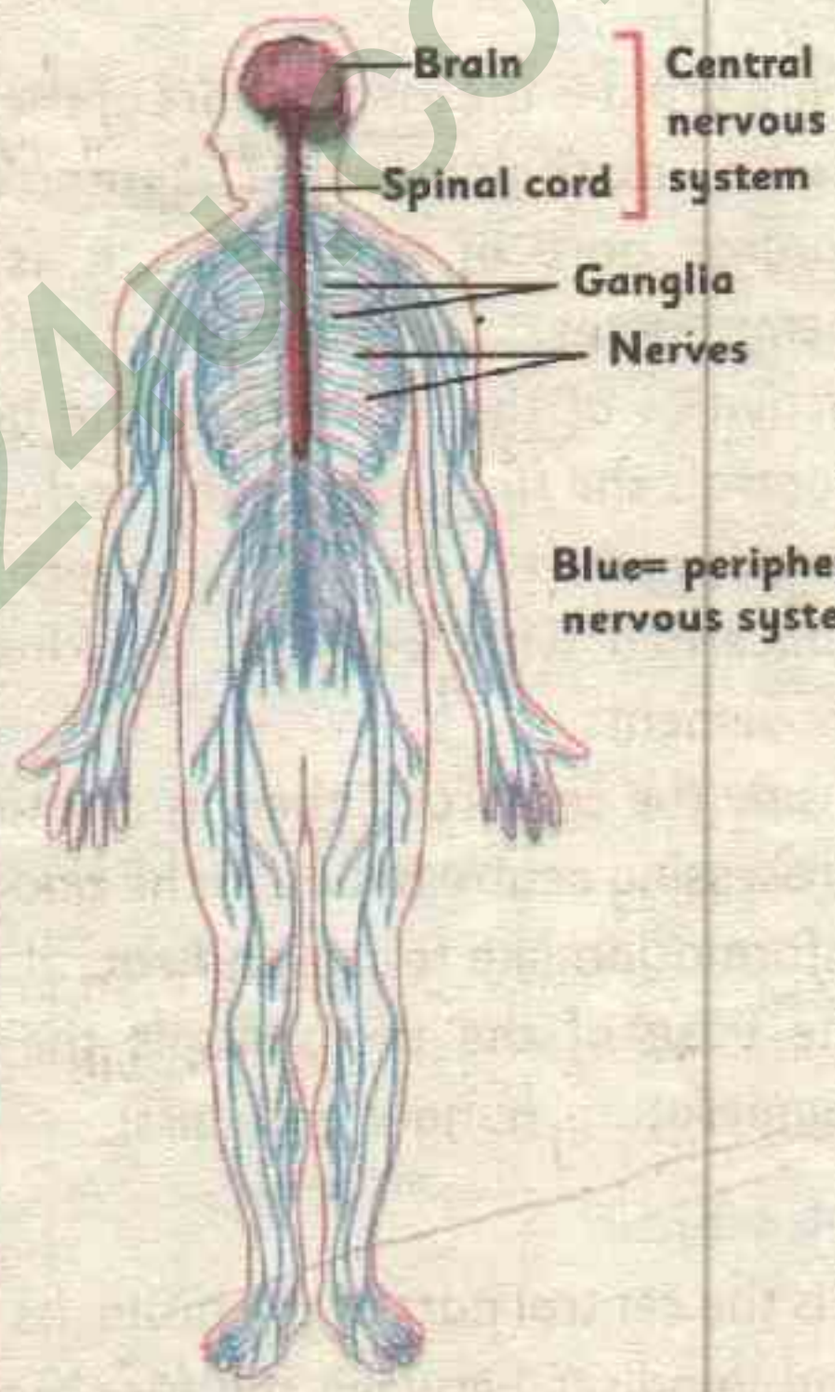


Fig 1.1 Humen nervous system

The Central Nervous System (CNS)

The central nervous system acts as a control center of the whole nervous system. It comprises brain and spinal cord.

1. The Brain

The human brain is enclosed in a bony case called the cranium. An adult human brain weighs about three pounds and consists of billions of neurons. Three layers of connective tissues called meninges and the fluid present in these layers protect the brain. The brain can be divided into three main parts, called fore brain, mid brain and hind brain.

(a) Fore brain

Fore brain is the largest part of the brain. It consists of three main parts, i.e. cerebrum, thalamus and hypothalamus. Cerebrum is the top most and the largest part of the brain. It is divided into right and left cerebral hemispheres. The right cerebral hemisphere controls movement and activities of the left side of the body, while the left cerebral hemisphere controls the right side of the body. Cerebrum is the control centre of many sensory areas like sight, speech, smell, taste and hearing. It is also concerned with learning, thinking, intelligence, memory and voluntary movements.

Inside the cerebrum, there is a small structure called thalamus. It acts as a processing centre between the body and the cerebrum by receiving sensory information like touch and sound and carrying them to the cerebrum. At the base of the thalamus is the Hypothalamus, which regulates body temperature, hunger and thirst.

(b) Mid brain

It is the central part of the brain. Its basic function is to transfer information and impulses between the fore-brain and the hind brain. This part of the brain is associated with vision, hearing, sleep/wake and temperature regulation. The mid brain also serves to control some reflexes such as changing size of the pupil to control the amount of light entering the eye.

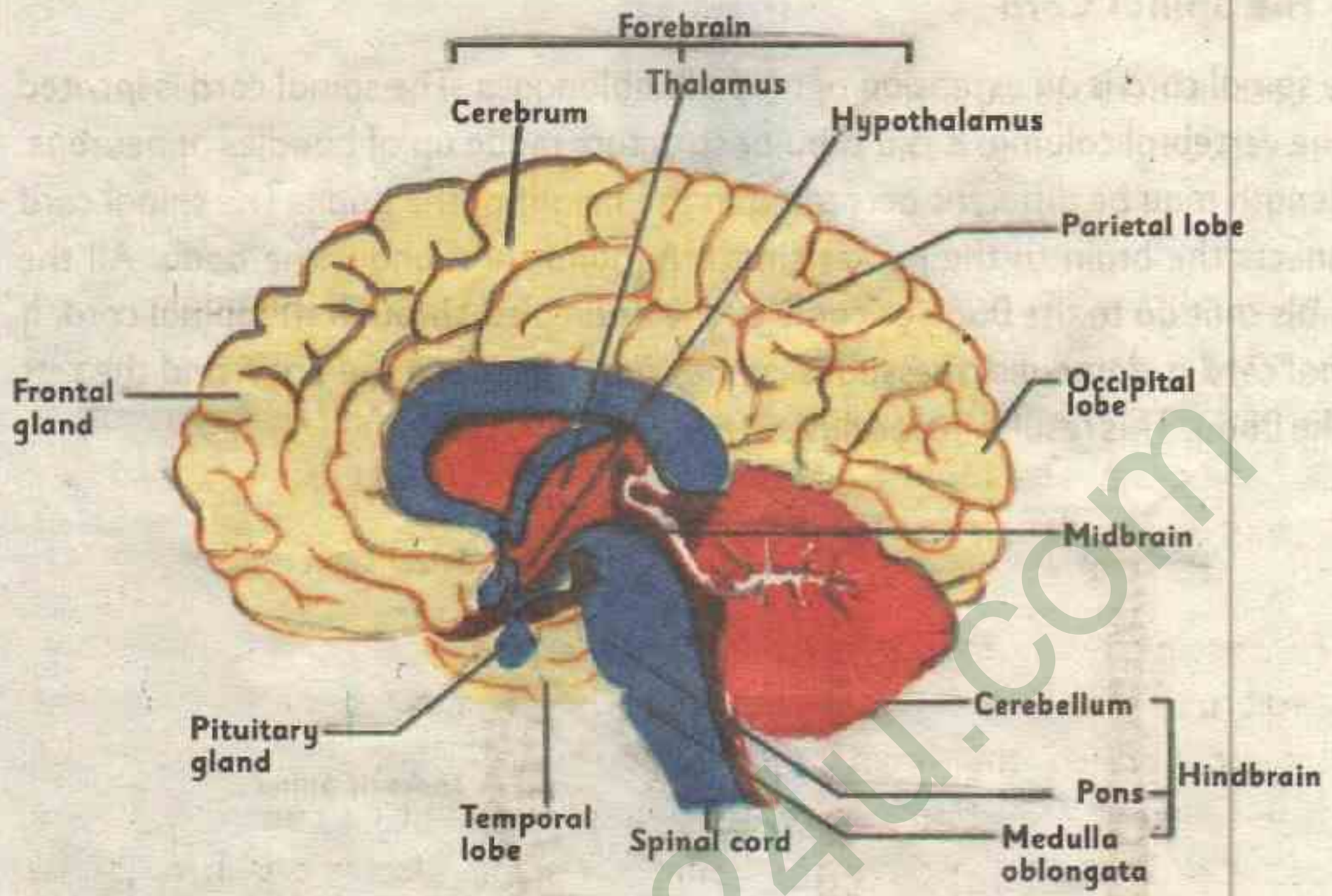


Fig 1. 2 Section of skull showing different parts of human brain

(c) Hind brain

The hind brain consists of three parts, i.e. Cerebellum, Pons and Medulla oblongata.

Cerebellum is the second largest part of the brain. It is mainly concerned with posture, balance and locomotion of the body.

Pons is a small oval structure present above the medulla oblongata. It serves as a bridge for the conduction of impulses between the cerebrum, medulla oblongata and the cerebellum. It is concerned with the rate of breathing, sleeping and also regulate eye movement and facial expressions.

Medulla oblongata connects the brain to the spinal cord. It controls heart beat, swallowing, vomiting, coughing, sneezing, digestion and breathing etc. Medulla oblongata keeps on working when the rest of the brain does not work.

2. The Spinal Cord

The spinal cord is an extension of medulla oblongata. The spinal cord is located in the vertebral column. It is a tubular structure made up of bundles of neurons. Its length may be different according to the height of the body. The spinal cord connects the brain to the nerves that are found throughout the body. All the signals that go to the body or come to the brain pass through the spinal cord. If spinal cord is damaged, messages cannot move between the brain and the rest of the body. This results in paralysis.

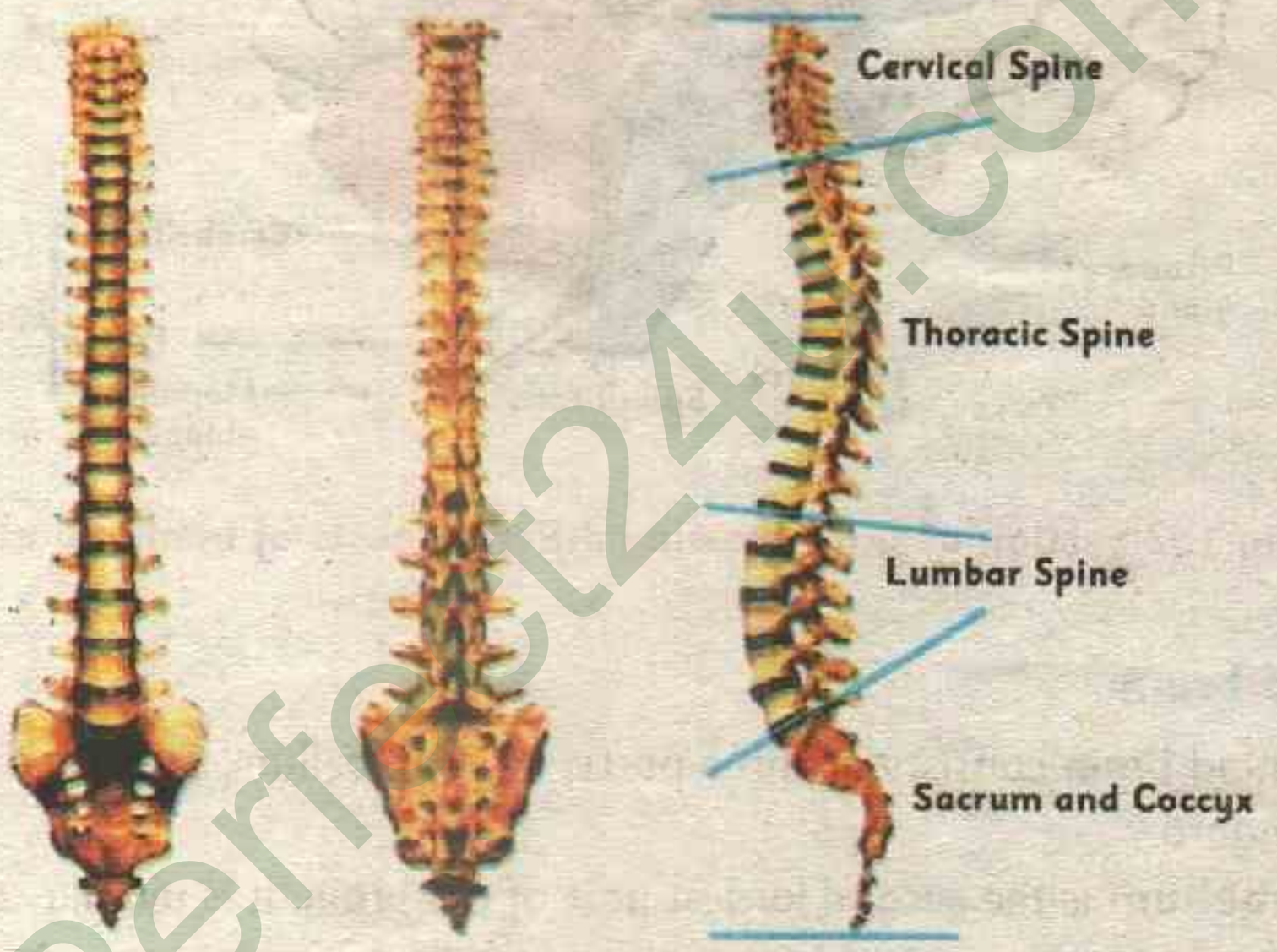


Fig 1.3 Human spinal cord

The Peripheral Nervous System (PNS)

The peripheral nervous system consists of sensory and motor neurons, which are distributed throughout the body. **Sensory neurons** carry the impulses from the receptors to the central nervous system while the **motor neurons** carry the messages from the central nervous system to the effectors (muscles or glands). The peripheral nervous system consists of 12 pairs of cranial nerves, which emerge from the brain and mainly serve the head and neck. It also

contains 31 pairs of spinal nerves, which branch off from the spinal cord and reach the rest of the human body.

Points to Ponder

When you feel cold, you start shivering. Can you identify which kind of a response shivering is?
Can you think of an example of a voluntary response to shivering?
Think of more examples of voluntary and involuntary responses and discuss with your fellow students and teacher.

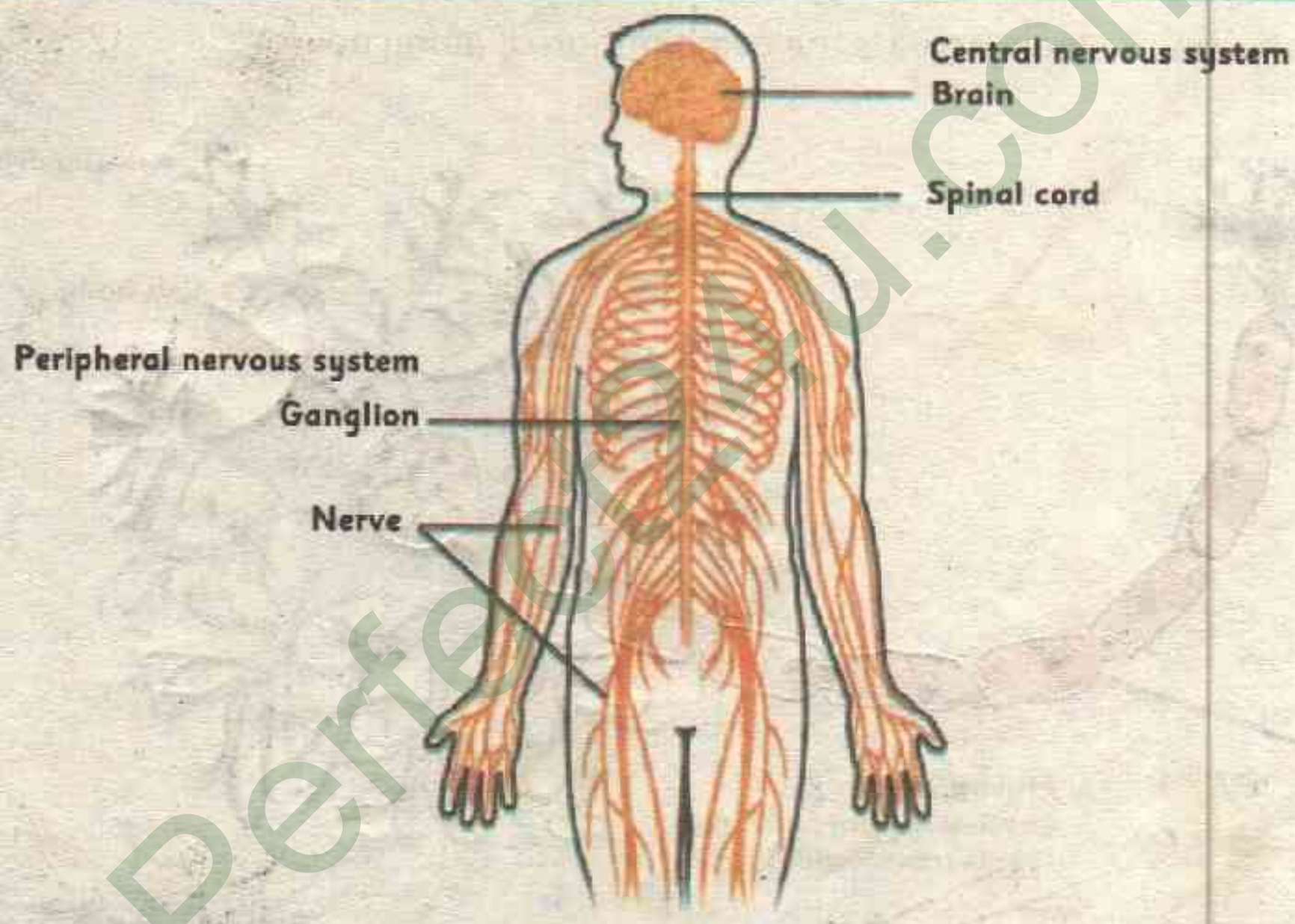


Fig 1.4 Peripheral nervous system

Neurons and their types

Brain has more than 100 billion nerve cells, which are called neurons.

Neuron

A neuron is the basic structural and functional unit of the nervous system. All parts of the nervous system, i.e. brain, spinal cord and nerves are made up of neurons.

Neuron Structure

Science TidBit

Brian of an adult man consists of about 100,000,000,000 neurons.

A neuron consists of two parts, cell body and axon. The cell body is thicker region of the neuron containing the nucleus and most of the cytoplasm. There are threads like projections on the cell body called dendrites. The axon is a long projection that carries impulses away from the cell body. Usually a neuron has a single axon. Fatty substances covering the axon, form a myelin sheath. Neuron transmits messages in the form of electrochemical waves called nerve impulses. A single nerve is the combination of many neurons.

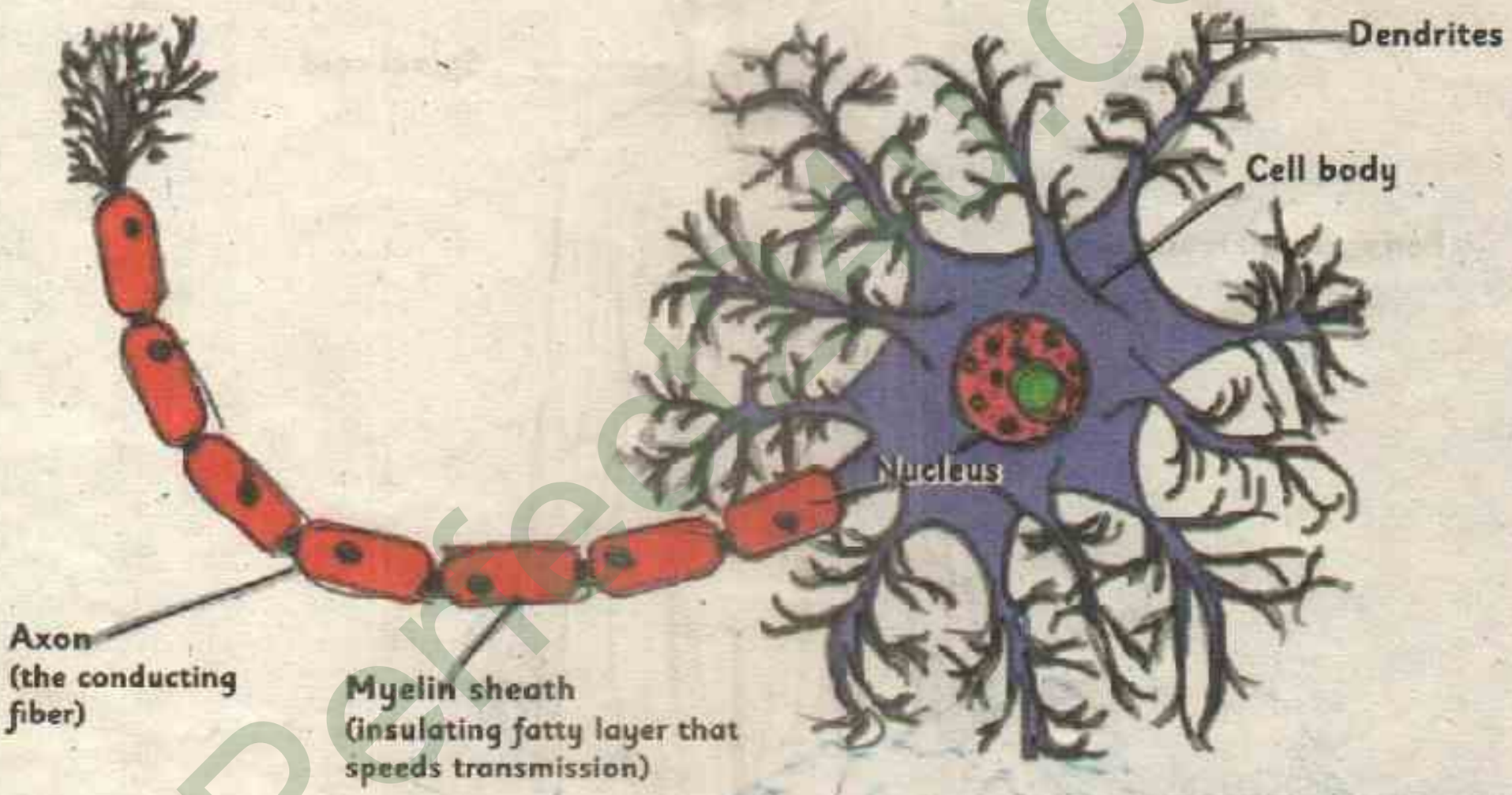


Fig 1.5 Nerve cell or neuron

Important Fact

Impulses may travel as fast as 150 meter per second or as slow as 0.2 meter per second.

Types of Neurons

On the basis of their functions, neurons are of three types.

(a) Sensory neurons

Sensory neurons carry nerve impulses from sense organs (ears, eyes, skin, tongue, nose etc.) to the central nervous system.

(b) Motor neurons

Motor neurons take impulses away from central nervous system to effectors (Muscles and glands).

(c) Associative / Inter neurons

Associative neurons present in the central nervous system, link the sensory and motor neurons. They analyze the messages for proper responses.

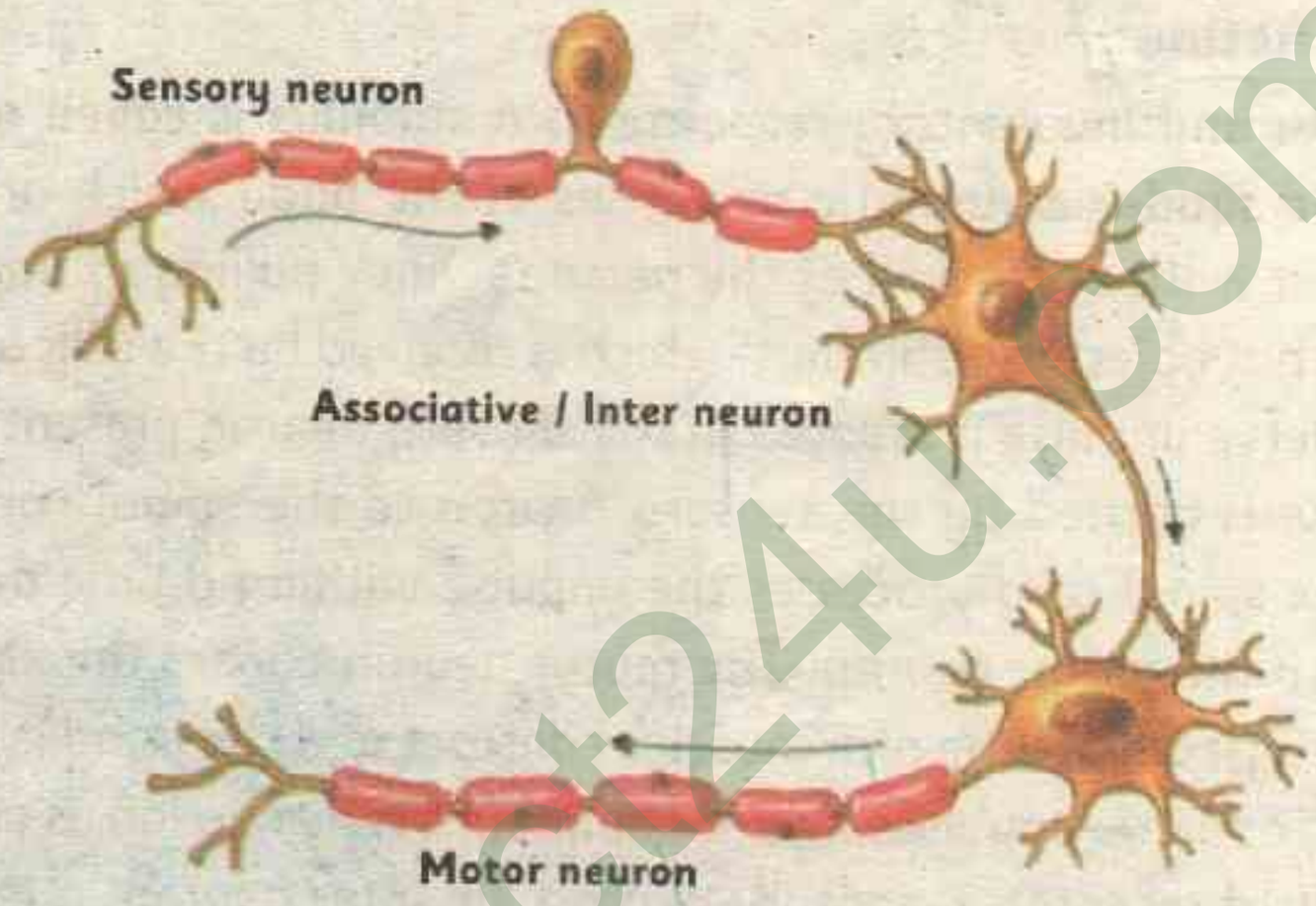


Fig 1.6 Sensory neuron, inter-neuron, motor neuron

Working of Nervous System

Nervous system coordinates all body functions. It also detects the changes in the environment and produces response to the changes.

Any change in the environment (external or internal) that can be detected by a receptor to initiate a nerve impulse is called stimulus (heat, cold, sound,

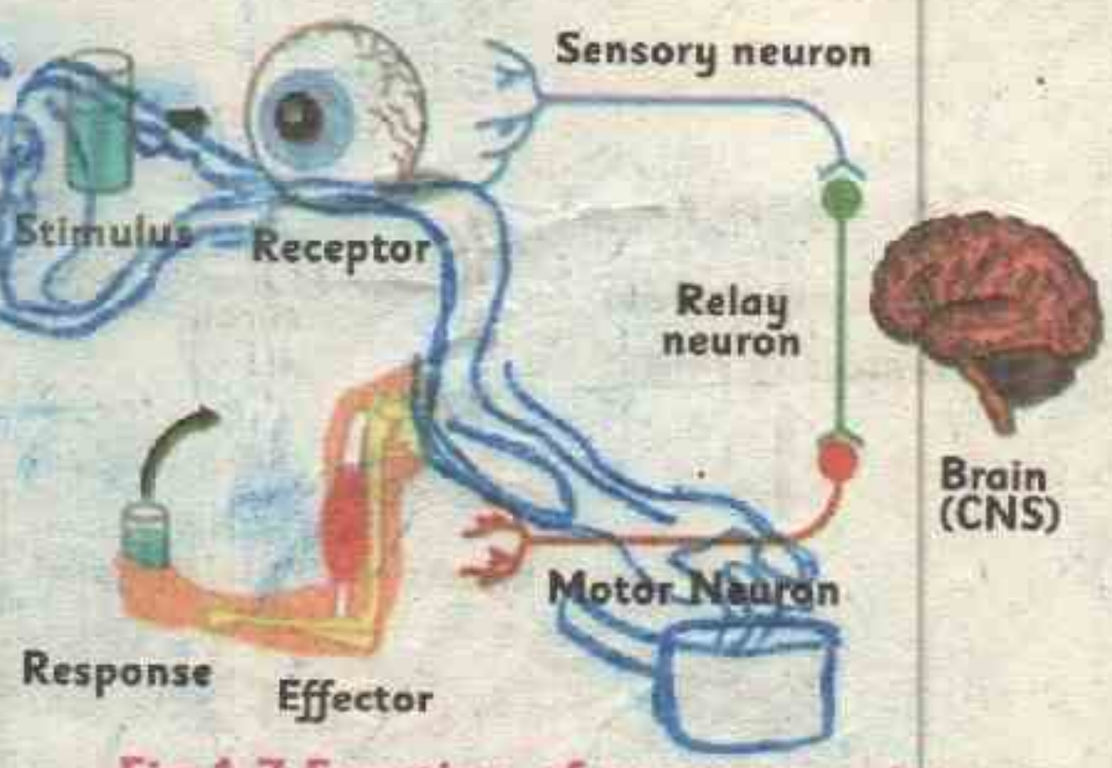


Fig 1.7 Function of nervous system

pressure, waves etc) are the examples of stimuli. The special organs, tissues or cells, which detect stimuli, are called receptors.

The sensory neurons carry the messages (stimuli) in the form of nerve impulses from receptors to central nervous system.

The central nervous system processes the messages and transmits the nerve impulses to motor neurons. The motor neurons carry the nerve impulses to the parts of the body which produce responses. Such parts are called effectors.

The Reflex Action

An immediate and involuntary response to a stimulus is called reflex action. These are the sudden automatic responses of the body which are shown for certain stimuli without the will of the person. Quick pulling of hand just after touching the hot object is a stimulus, which is received by the cells (receptors) of the skin. A nerve impulse is created in the sensory neuron present in skin. The nerve impulse is carried by the sensory neuron to the spinal cord. The inter neuron of the spinal cord processes the impulse within no time and transmits the impulse to the motor neuron. The motor neuron carries the impulse to the arm muscles (effectors). The arm muscles contract and the hand is pulled back. The pathway of nerve impulses, which complete a reflex action, is called a reflex arc. It consist of receptor, a sensory neuron, an inter neuron, a motor neuron and effectors.

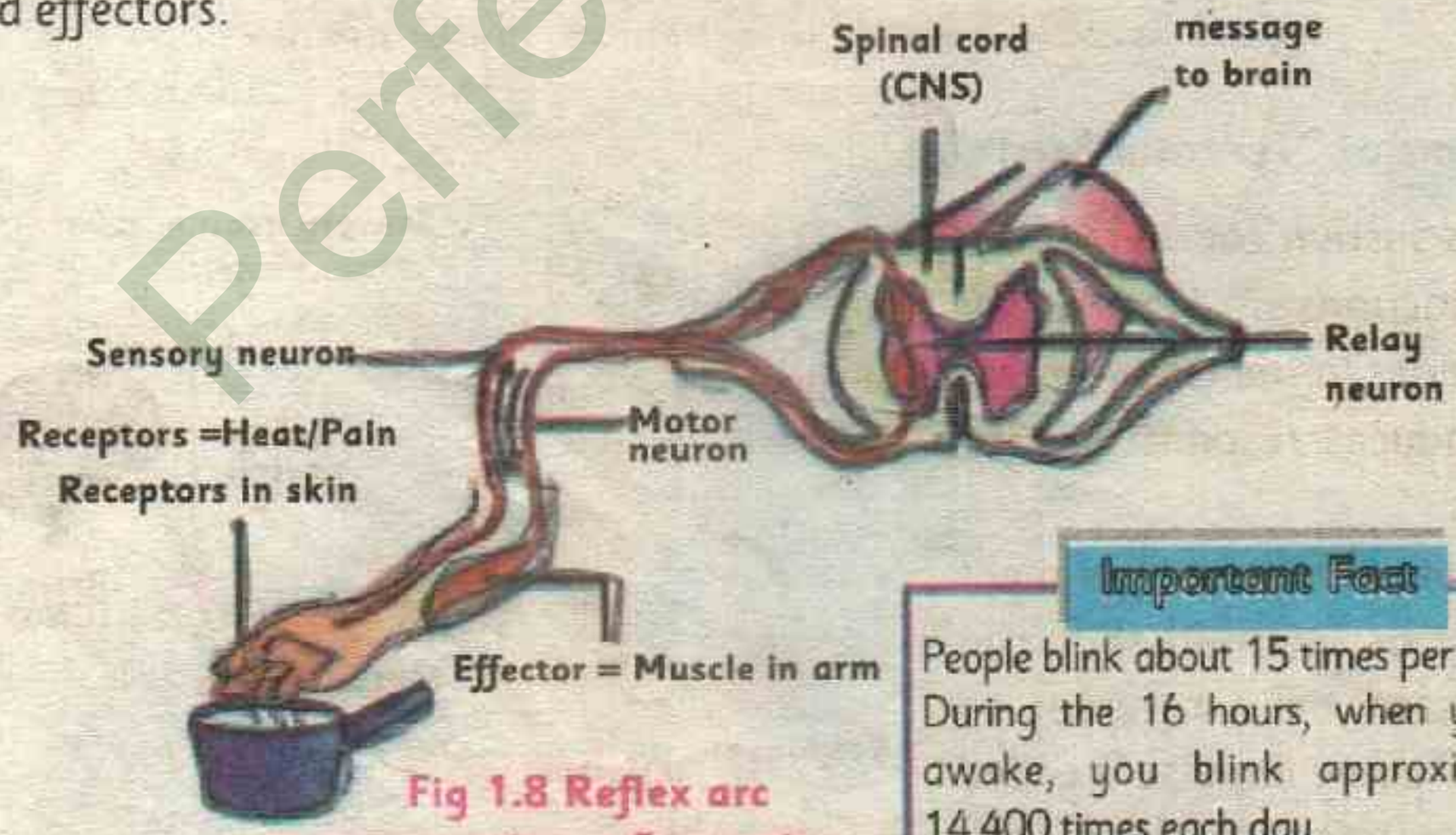


Fig 1.8 Reflex arc representing reflex action.

Important Fact

People blink about 15 times per minute. During the 16 hours, when you are awake, you blink approximately 14,400 times each day.

Primary Actions are categorized into voluntary and involuntary actions.

Voluntary Actions	Involuntary or autonomic actions
The actions performed under conscious control. You are conscious of what you are doing. Your brain receives nerve impulses from the environment and analyses them for action.	The actions performed unconsciously. You have no consciousness of what your organs are doing. These involuntary actions are regulated by your autonomic nervous system.
Examples: • You pick up a glass of juice. • You clap hands while watching cricket match.	**Examples:** • Your heart beats. • Your intestines digest food. • You blink your eyes.

Excretory System

Cells produce nitrogenous materials, salts and carbon dioxide as by-products of metabolic breakdown of sugars, fats and proteins. If these toxic wastes accumulate in the body, they may cause damages. The process of removing the waste products from the body is called excretion. The organ system responsible for this excretion is known as excretory system. The excretory system removes non-solid wastes through sweat, urine and exhalation.

The human excretory system consists of one pair of kidneys and associated structures, i.e. two ureters, a urinary bladder and urethra.

Human Kidney

The human body has two dark brown bean shaped kidneys in the abdominal region, one on either side of the vertebral column. The outer surface of kidney is convex while the inner surface is concave.

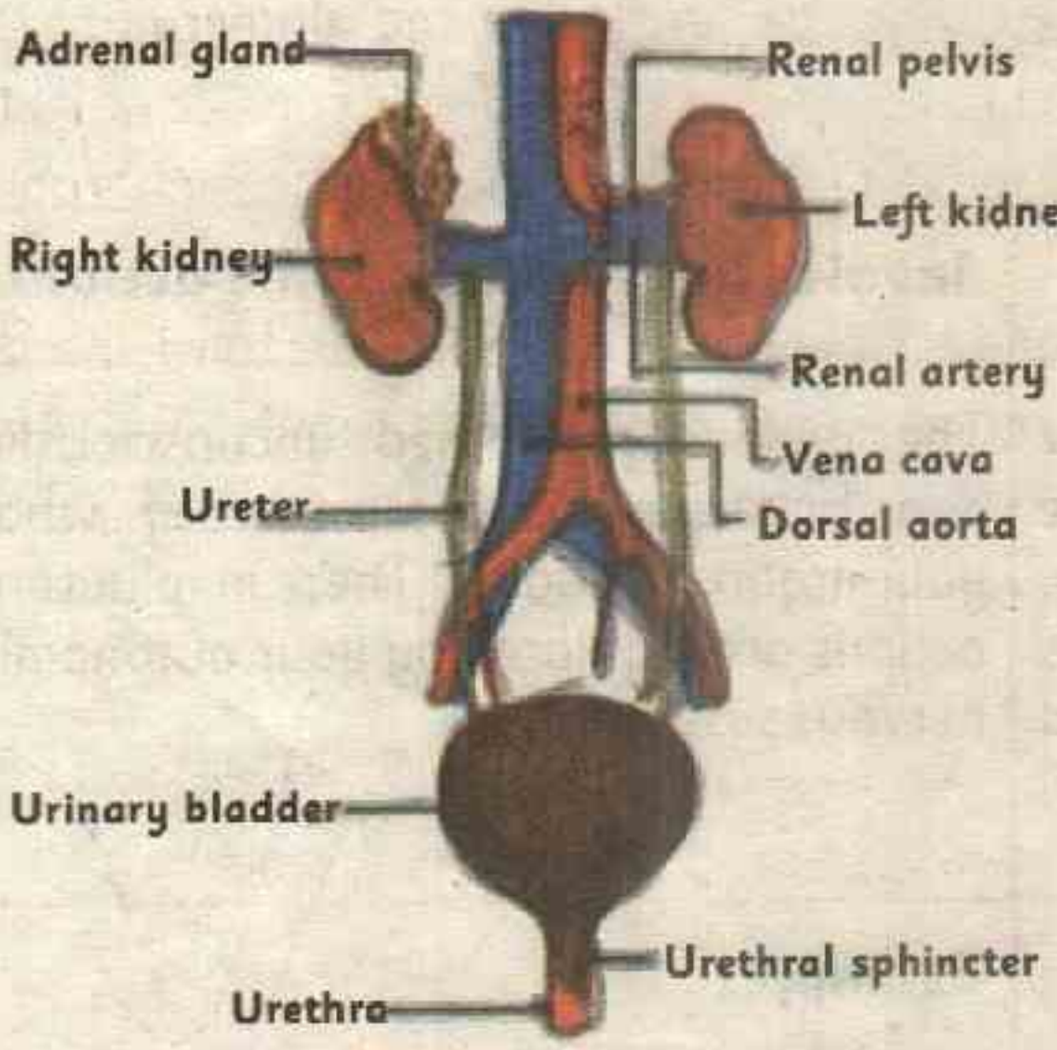


Fig 1.9 Human excretory system

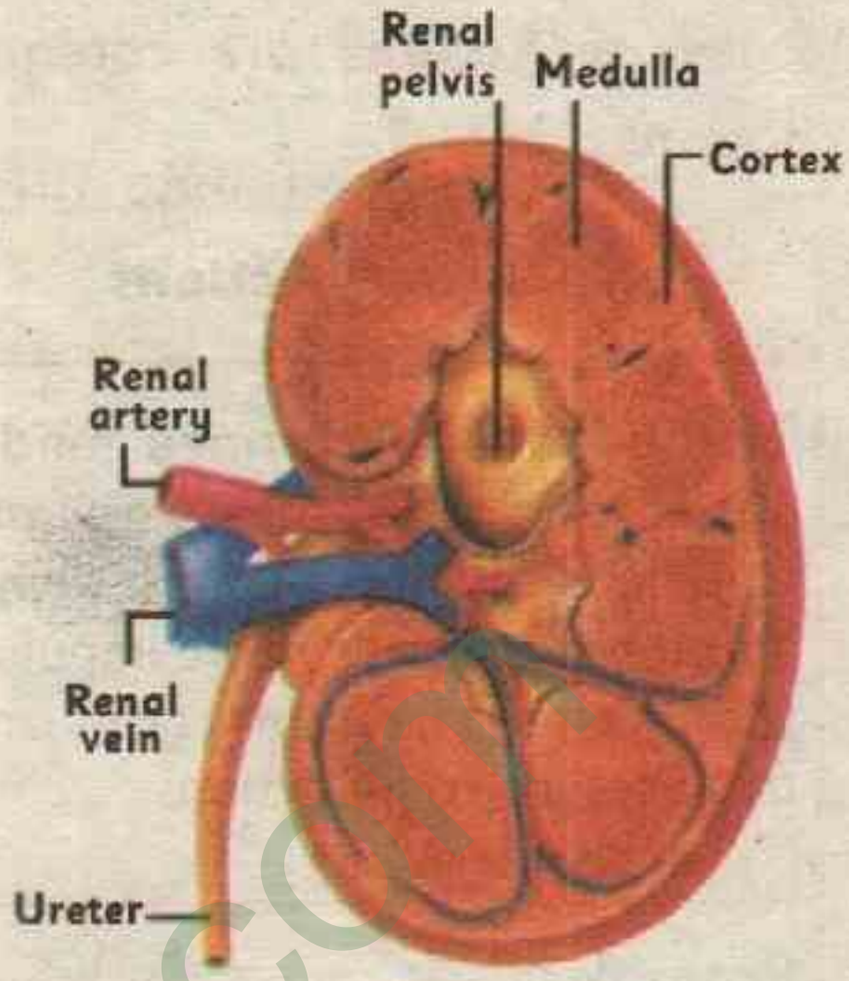


Fig 1.10 Internal structure of kidney

The tube, which arises from each kidney and enters the urinary bladder, is called a ureter.It transports urine from kidneys to urinary bladder. Urinary bladder is a muscular sac, which collects urine from both kidneys through ureters. From the urinary bladder the urine is released outside the body through a fine tube called urethra.

Internal Structure of Kidney

Internally, each kidney is divided into three region i.e. renal cortex, renal medulla and renal pelvis. **Renal cortex** is the outermost region. **Renal medulla** is the middle region and **Renal pelvis** is the inner area where urine is drained. The urine from renal pelvis moves into ureter.

Nephrons

Nephrons are the structural and functional units of the kidney. Each kidney has over one million nephrons. Each nephron has two parts. i.e. renal corpuscle and renal tubules.

The first part of the nephron is called the **Renal Corpuscle.** It consists of two structures, i.e. Glomerulus and Bowman's capsule. Glomerulus is a cluster of blood capillaries formed by the division and sub division of small arteries.

Bowman's capsule is a cup shaped structure, enclosing the glomerulus. The tube like structure of the nephron connected to the Bowman's capsule at its tip is called the **Renal Tubule**. Urine is formed in these tubules. The renal tubule consists of three parts. The first coiled part of renal tubule is called proximal tubule. The next part is U-shaped and is called Loop of Henle. The third and last part of the renal tubule is again coiled and is called distal tubule. The distal tubules of many nephrons open in a collecting duct. Many collecting ducts join and drain the urine out of the nephrons into the Renal pelvis.

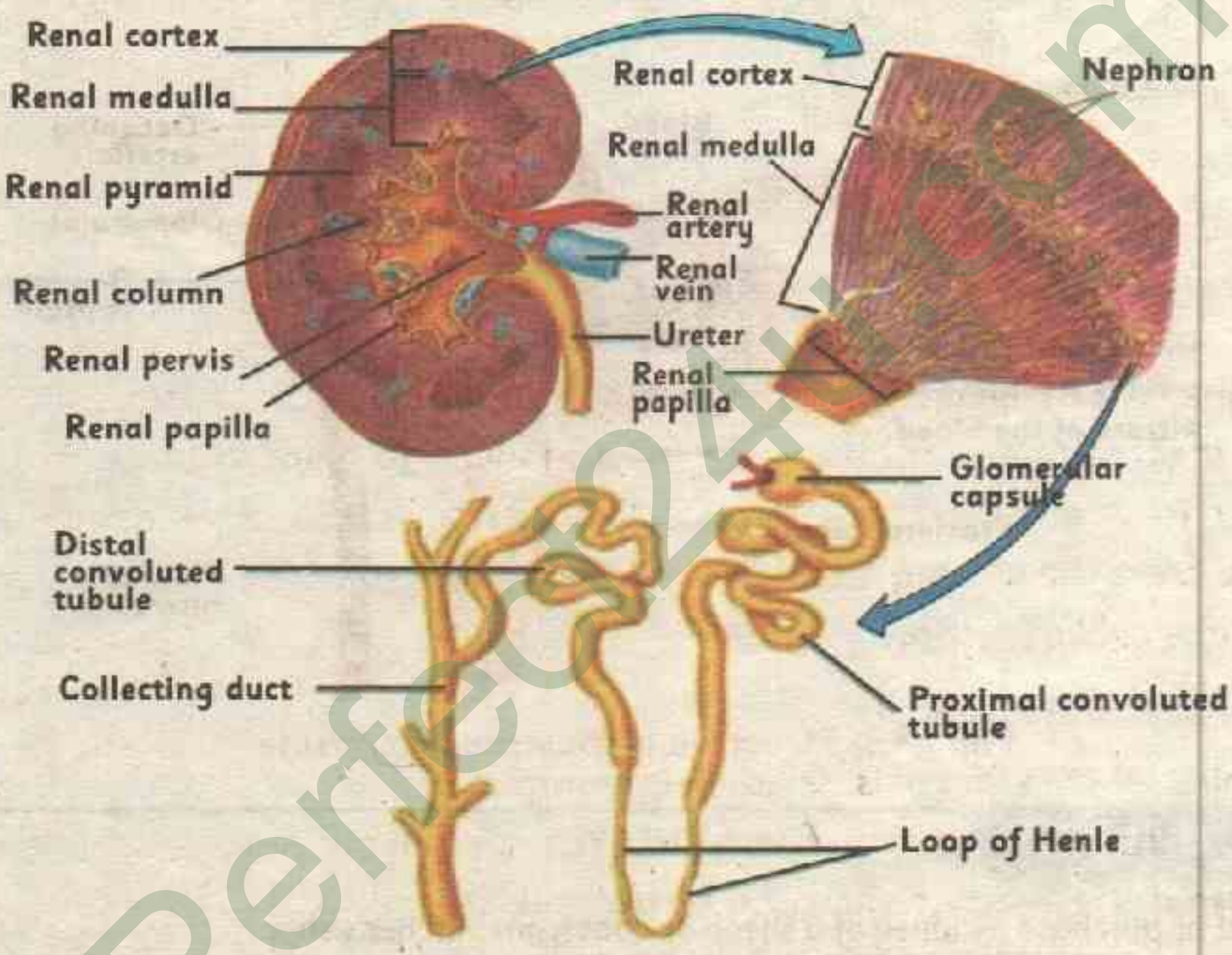


Fig 1.11 Internal structure of kidney and nephron

Role of Kidney

Blood carrying nitrogenous waste materials from the body is brought to the kidneys by incoming blood vessels called arterioles. Inside the kidneys, blood containing nitrogenous waste reaches the Glomerules. Here most of the excess water and waste materials filtered from the blood into the Bowman's capsule. The blood after losing waste material goes into the outgoing arteriole, which

ultimately with many other arterioles forms the renal artery. The clean blood is brought back to the main circulatory system.

The waste material and excess water pass into the renal tubule from the Bowman's capsule. From here, the waste material and excess water passes through the proximal tubule, the loop of Henle and finally through the distal tubule into the collecting duct in the form of urine. The urine then drains from the collecting tubules into the renal pelvis, which opens into the ureter from each kidney. From the ureter, the urine is passed to the urinary bladder. From here the urine is passed out of the body through the urethra.

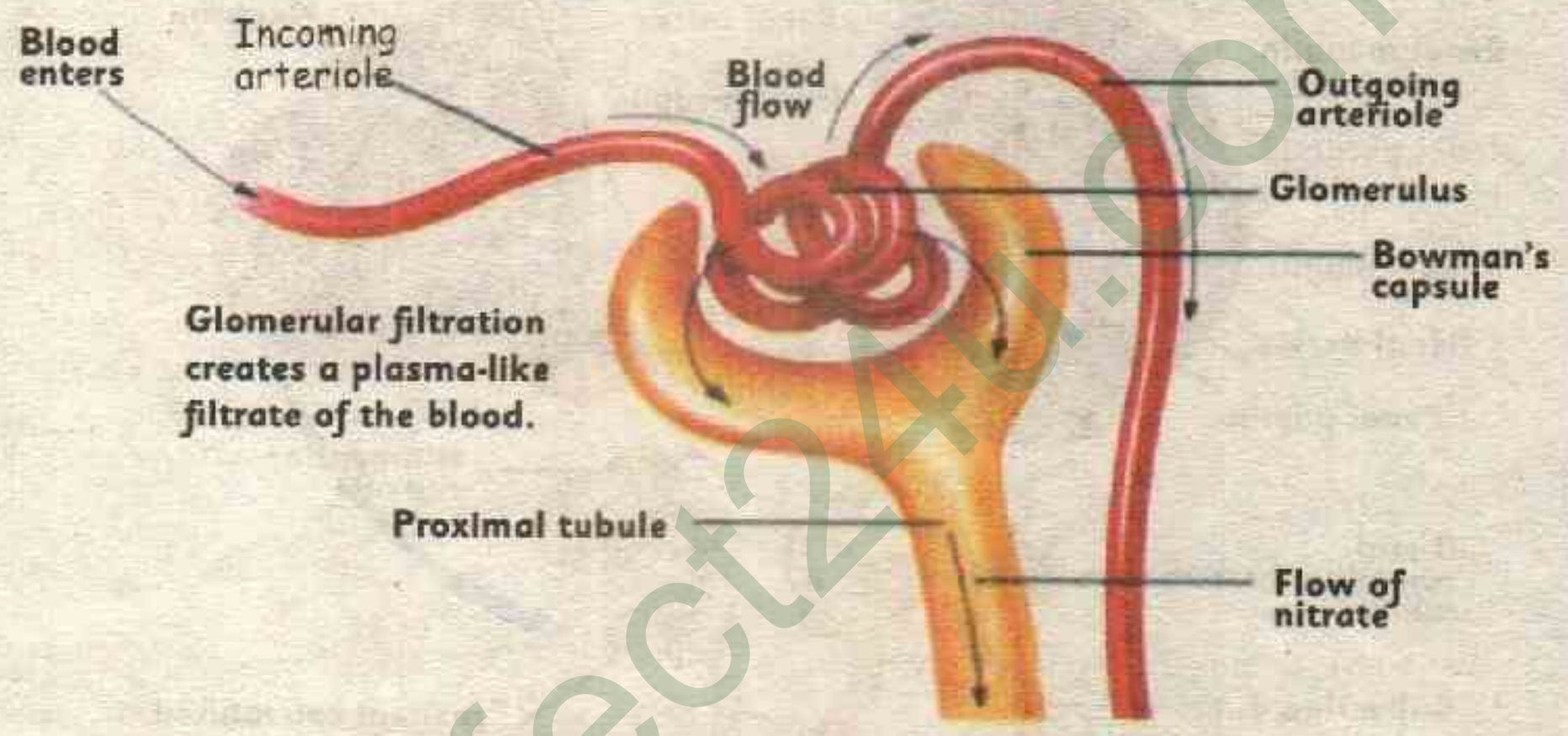


Fig 1.12 Structure of Bowman's capsule

Activity 1.1

- Get or purchase a kidney of a sheep or goat from butcher's shop.
- Observe its outer structure and make its diagram on your notebook.
- Cut the kidney into two halves.
- Observe the cut surfaces of two halves of the kidney with the help of magnifying glass and draw the internal structure of the kidney in your notebook.

Malfunctioning of kidney

The most important thing to remember about kidney disorders is that kidney is not a solitary organ. When your kidneys are damaged or not working properly, other organs are also affected.

Formation of stones in kidney

Sometimes kidneys do not work efficiently i.e. they cannot remove nitrogenous waste or salts from the blood properly. In such situations, the salts accumulate in kidneys and form stones. Formation of stones disturbs the normal functioning of the kidneys and cause severe pain. Kidney stones may travel to ureter or urinary bladder. The common causes of stones in kidneys are excessive calcium salts in the food and uric acid, etc.

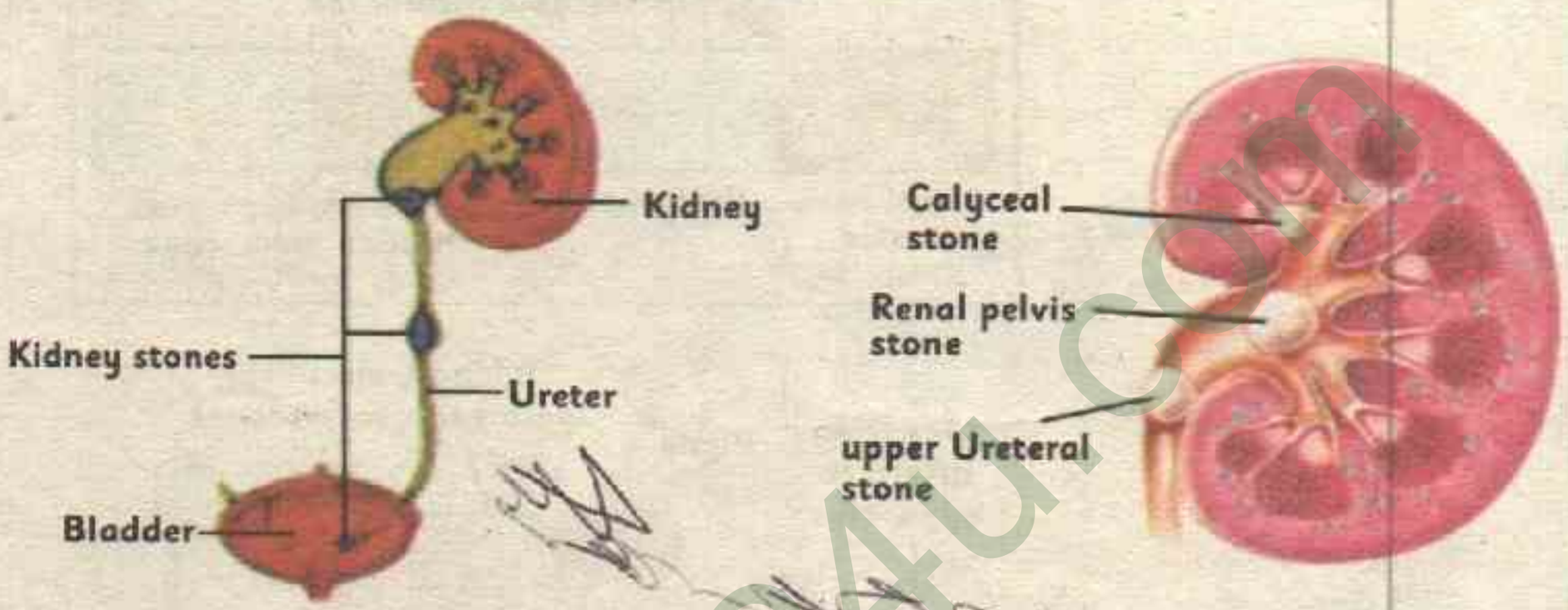


Fig 1.13 Stones in kidney and urinary bladder

Renal Failure

Renal failure is the complete or partial failure of kidneys to work. The main causes of renal failure are long term infections, diabetes mellitus and hypertension. Diabetes mellitus is a disease in which sugar level of the blood remains high. Hypertension is a state of high blood pressure of the body. Sudden blockage of blood supply to the kidneys may also result in renal failure. Dialysis and kidney transplant are the treatments for renal failure.

Treatment of Malfunctioned Kidneys

Removal of kidney stones

Small sized stones can be removed through urinary system by drinking more water. Medium sized stones are removed by lithotripsy, which involves bombardment of shock waves on the stones from the outside. Shock waves break the stones into small pieces, which are passed out of the body through urine. Still larger stones need surgery for their removal.

Dialysis

Cleaning of blood by artificial methods is called dialysis, which is done by a machine called dialyzer. The blood of the patient is passed through the dialyzer, which contains dialysis fluid. Blood flows through the tubes of the dialyzer and the dialysis fluid flowing around these tubes remove the waste materials from the blood. The cleaned blood is returned to the body.

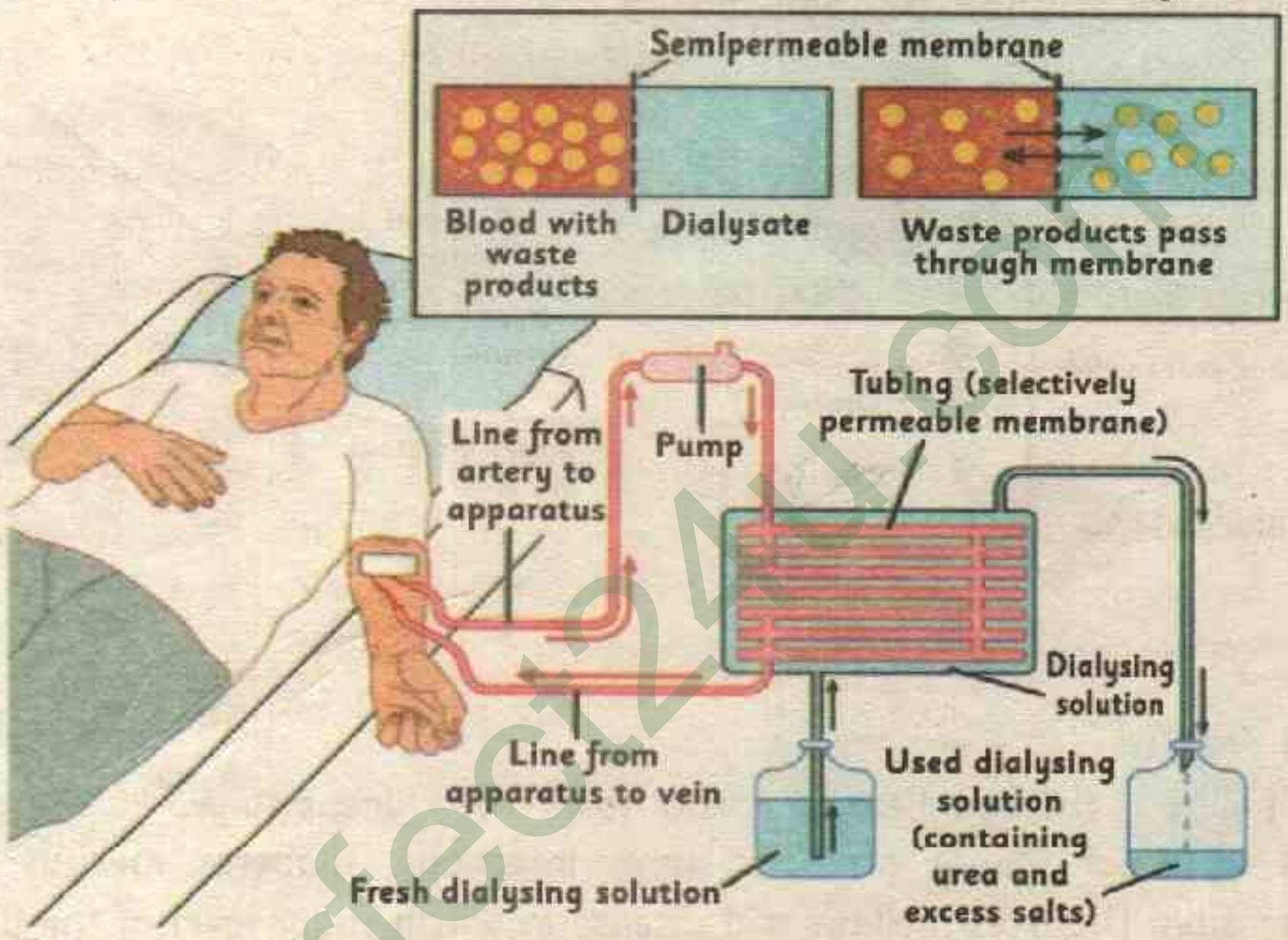


Fig 1.14 Dialysis process

Kidney Transplant

In this method, a kidney donated by some healthy person is grafted in the body of the patient to replace the damaged kidney. The donor of kidney may be a blood relative or any other close relative having the same blood group.

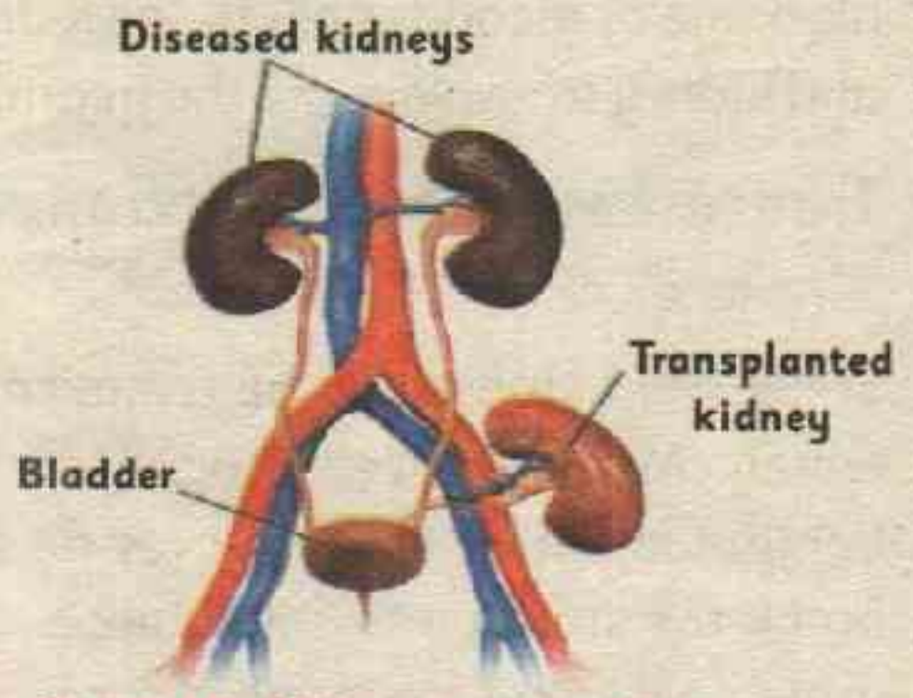


Fig 1.15 Kidney transplant

KEY POINTS

- The nervous system carries messages from one part of the body to another and coordinates body functions.
- The brain and spinal cord are collectively called Central Nervous System (CNS).
- Peripheral nervous system consists of a network of nerves, which connect the central nervous system to all the body parts.
- Neurons are functional and structural units of the nervous system.
- Sensory neurons carry messages from sense organs to the central nervous system.
- Motor neurons carry messages from central nervous system to muscles and glands.
- Inter-neurons are present in brain and spinal cord. They form a link between sensory neuron and motor neuron.
- The actions performed under conscious control are called voluntary actions.
- The actions performed without involvement of thinking process are called involuntary actions.
- The system that eliminates waste materials from body is called the excretory system.
- Nephrons are the structural and functional units of kidneys. These have tubules where urine is formed.
- Each kidney is divided into three region i.e. renal cortex, renal medulla and renal pelvis.
- Accumulation of salts in kidneys results in kidney stones.
- Dialysis and kidney transplant are the treatments of renal malfunction and failure respectively.

Exercise

A. Fill in the blanks.

i. Human brain is divided into three parts.
ii. Reflex actions are automatic responses.
iii. The actions which are performed under conscious control are called voluntary.
iv. Filtering of blood takes place in the kidney.
v. Cleaning of blood by artificial methods is called dialysis.

B. Choose the correct answer for each of the following statements.

i. Sensory neurons carry messages towards:
(a) muscles (b) muscles and glands
(c) sense organs (d) brain and spinal cord

ii. The part of neuron which receives messages are:
(a) cell bodies (b) dendrites (c) axons (d) nuclei

iii. Accumulation of salts in kidneys results in:
(a) diabetes (b) hypertension (c) kidney stone (d) cancer

iv. Medium sized stones are removed by:
(a) dialysis (b) lithotripsy (c) excretion (d) laser

v. Renal failure can be caused by:
(a) infections (b) hypertension (c) diabetes mellitus (d) all of these

C. Give short answers of the following.

i. Define: (a). excretion (b). reflex action (c). neuron
ii. Skin is also considered as excretory organ, why?
iii. Draw and label the structure of a neuron.
iv. Differentiate between:
(a). Receptors and effectors.
(b). Voluntary and involuntary actions with examples.
(c). Lithotripsy and dialysis.
v. Explain the central neurons systems.

D. Give detailed answers to the following questions.

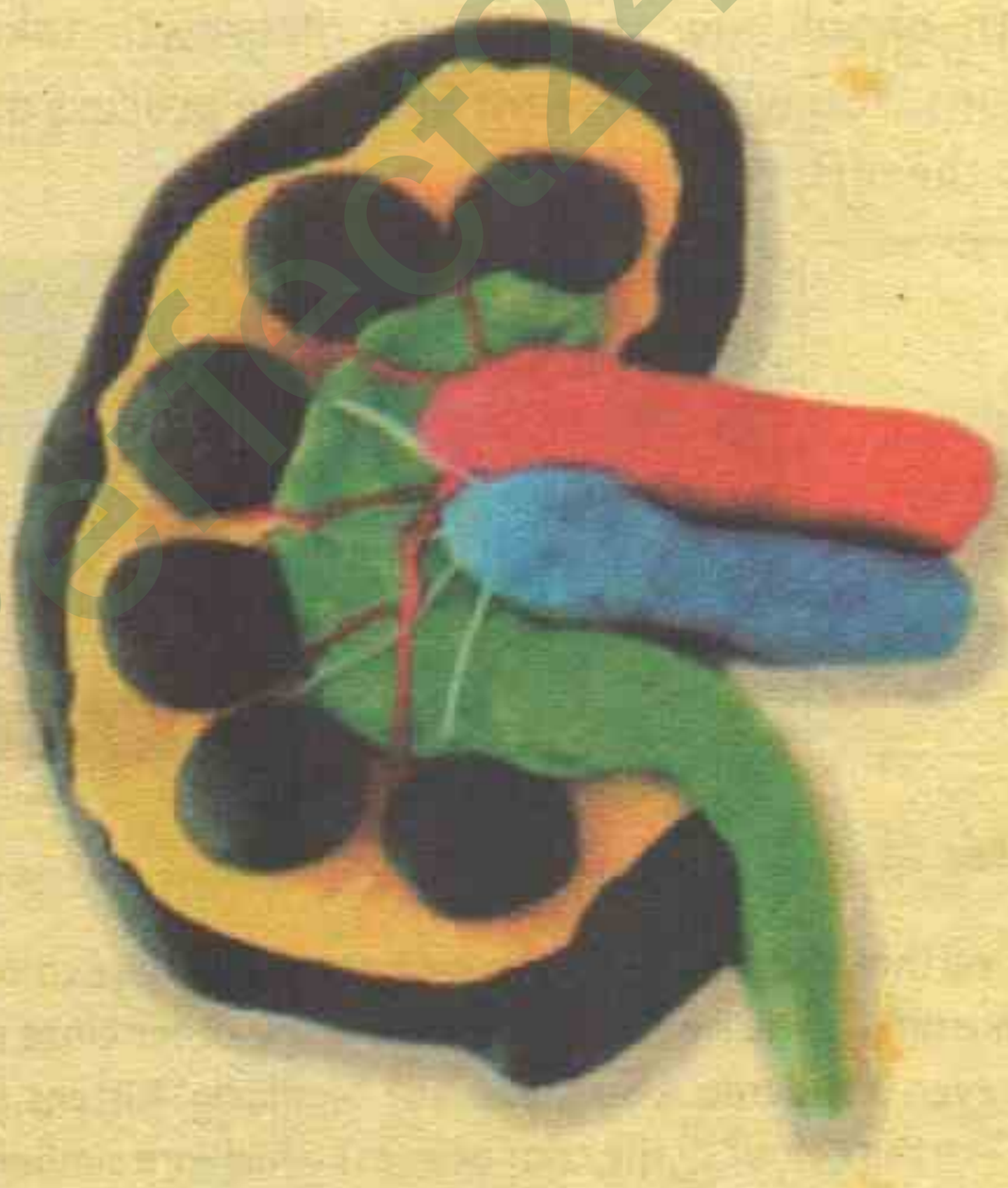
i. Explain reflex action with the help of an example and diagram.

ii. Describe the role of kidneys in excretion of waste.

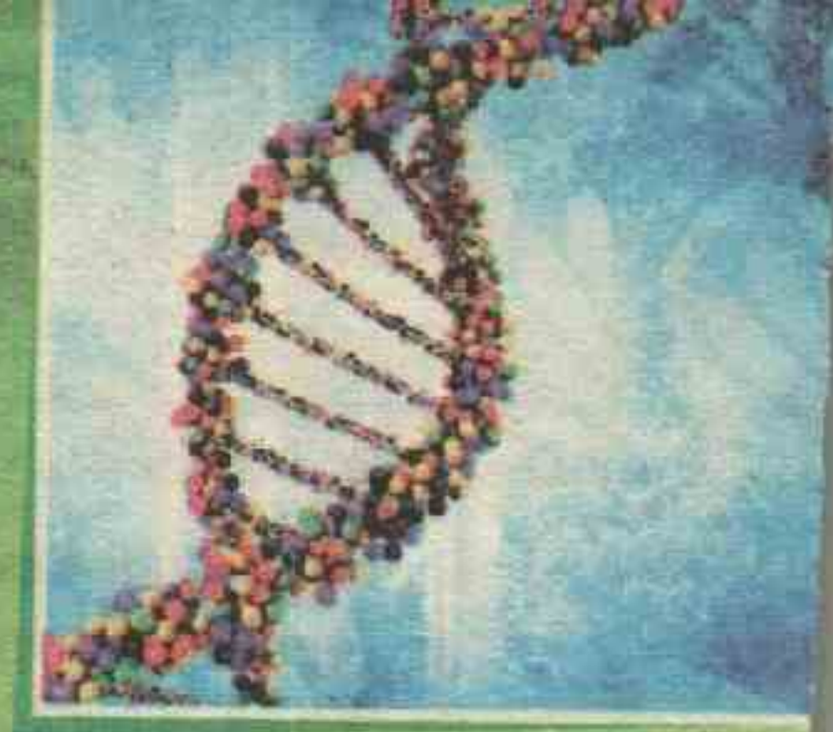
iii. A person with kidney disease could be treated either by using a dialysis machine or by a kidney transplant operation. Compare the advantages and disadvantages of these two methods of treatment and how long does a transplanted kidney last.

Project

Using recycled materials, make a model showing the structure of kidney and outline the structure and functioning of a kidney tubule.



Human Kidney Structure



UNIT 2

HEREDITY IN ORGANISMS

After studying this unit, students will be able to:

- Differentiate between mitosis and meiosis.
- Identify DNA and chromosomes in the cell diagram.
- Define heredity and recognize its importance in transferring of characteristics from parents to offsprings.
- Identify the characteristics that can be transferred from parents to offsprings.
- Compare characteristics related to ear and eye colour.

Introduction

All living things reproduce to form new offsprings. In the previous grades, you have learnt the types of reproduction (sexual and asexual reproduction). In this unit, you will learn about how the process of growth takes place through repeated cell divisions. You will also learn about the process of transfer of traits from the parents to the offsprings.

Point to Ponder

You may have observed that children usually have hair, skin or eye colour like one of their parents or perhaps like one of their grand parents or some other close relatives like aunts or uncles. Have you ever wondered why this is so? Similarly, kittens born to a cat may have many features (like the colour of the coat or eyes), which are similar to the parents.

Cell Division

Living organisms consist of cells and these cells have the ability to reproduce and multiply through cell division. A cell has to grow to its full size before it divides. Cell division is a process by which a parent cell divides into daughter cells. There are two methods of cell division; mitosis and meiosis.

Mitosis

Mitosis is a process of cell division in which a parent cell divides into two daughter cells in such a way that the number of chromosomes in the daughter cells remain the same as in the parent cell. The daughter cells so produced are genetically similar to one another as well as to the parent cell. This type of cell division results in the increase of the number of body cells during growth and development.

Meiosis

Meiosis is the process of cell division in which a parent cell divides into four daughter cells (gametes) in such a way that the number of chromosomes in the daughter cells is half to that of the parent cell. The gametes so produced are genetically different from one another and also from the parent cell.

Differences between mitosis & meiosis

Mitosis	Meiosis
Occurs in all somatic/body cells of an organism.	Meiosis occurs in the germ cells of an organism.
Two daughter cells are formed.	Four daughter cells are formed.
Daughter cells have a complete set of chromosomes, identical to the parent cell.	Daughter cells have half the number of chromosomes as compared to the parent cell.
The daughter cells are genetically identical.	The daughter cells are genetically different.
Involves a single division.	Involves double cell divisions.

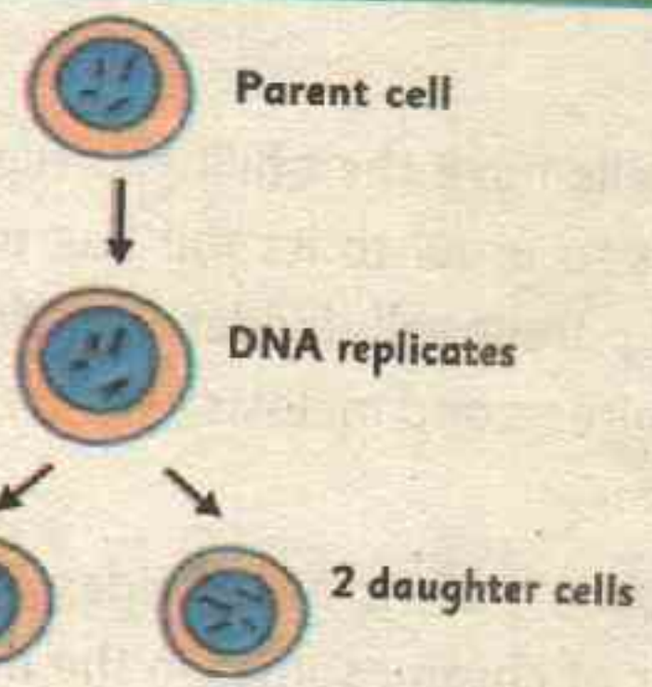


Fig 2.1 Mitosis

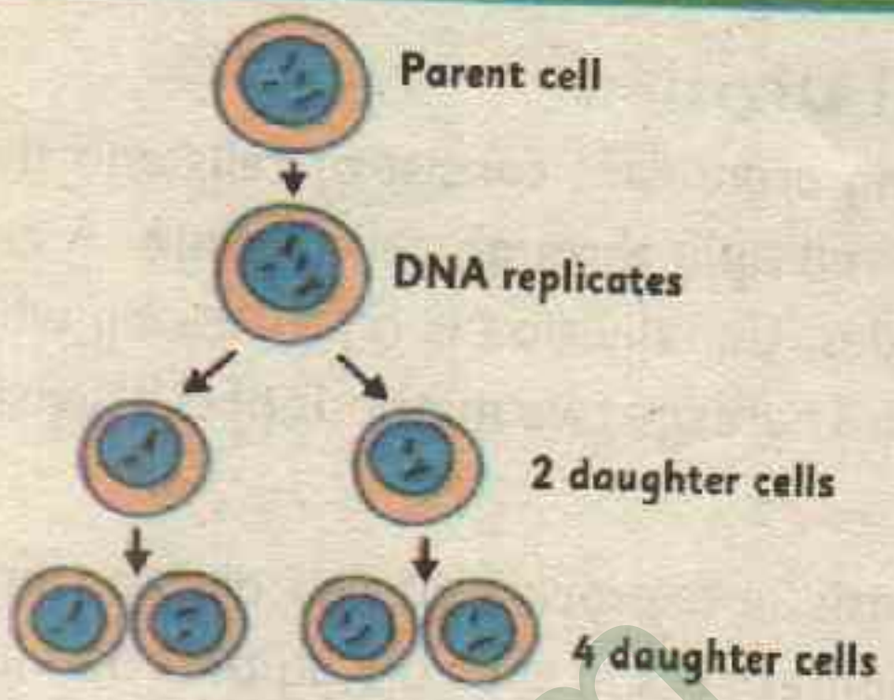


Fig 2.2 Metosis

Chromosomes, Genes and DNA

Chromosomes are thread-like structures present in the nucleus of each cell. The chromosomes are made up of **Deoxyribonucleic Acid (DNA)** and a protein called Histone. DNA is coiled many times around proteins, which provides structural support to the chromosome. DNA is made up of units called nucleotides. The four types of nucleotides are adenine (A), guanine (G), cytosine (C) and thymine (T). DNA being heredity material, carries all the information from parents to offsprings.

DNA has short segments called **genes**. These genes are transferred from parents to children and carry the traits of the parents to the offsprings. A Gene is the basic physical and functional unit of heredity. Genes occur in pairs. A pair of genes control each heredity characteristic (e.g. eye colour, height, etc). One member of a gene pair comes from male while other comes from female.

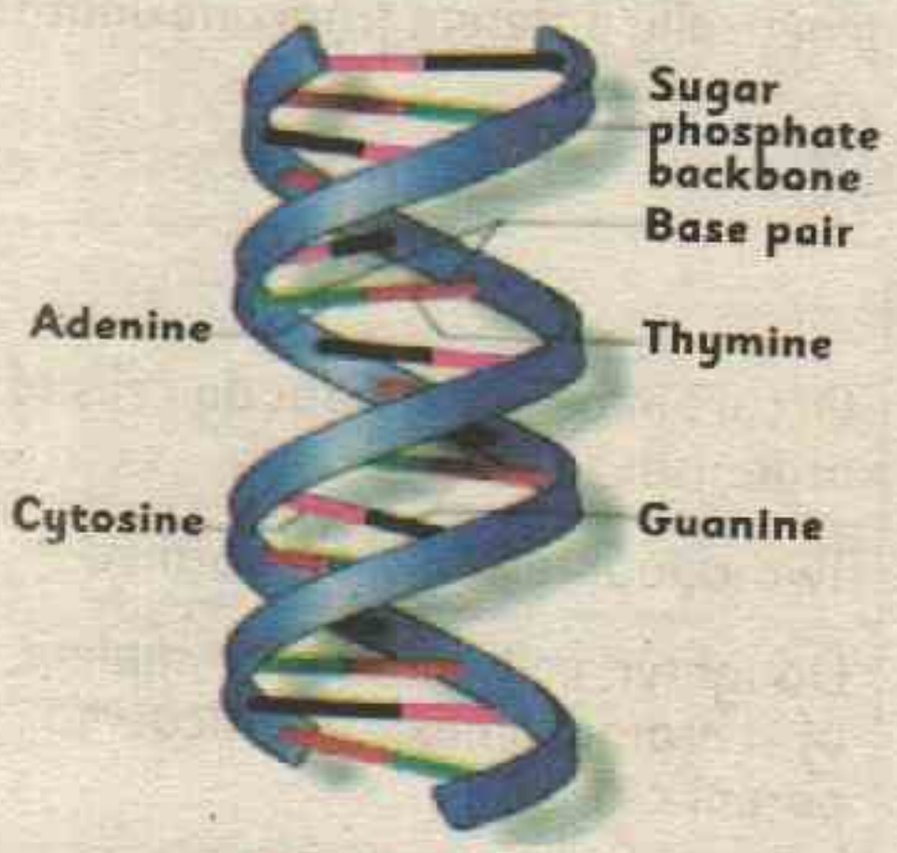


Fig 2.3 DNA

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Humans have 23 pairs of chromosomes, hermit crabs have 127 pairs of chromosomes elephants have 28 pairs, cats have 19 pairs and a carrot plant has 9 pairs of chromosomes and one species of roundworm has only one pair.

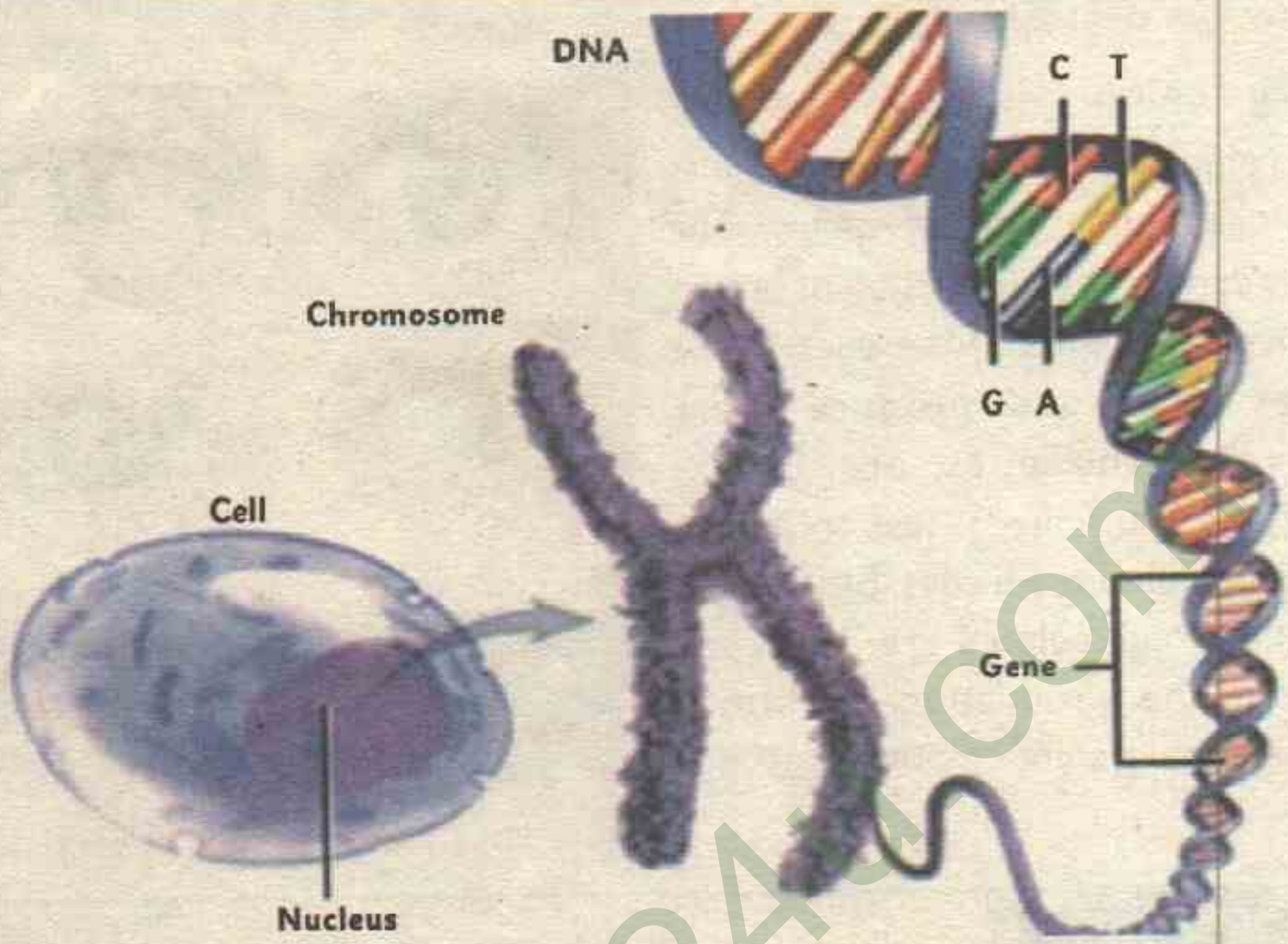


Fig 2.4 Chromosomes, Gene and DNA in a Cell

Heredity

The transfer of characteristics from parents to offsprings is called heredity. Chromosomes, DNA and Genes form the basis of heredity. Genes carry the traits or characteristics of the parents to the offsprings. This is the reason that siblings resemble one another and their parents. Plants grown from seeds, resemble their parent plant. Eye colour, hair colour, detached or attached ear lobes, intelligence and height are examples of heredity characteristics.

Inheritable and Non Inheritable Characters

The characters which can pass from one generation to the next generation are Inheritable characters (e.g. eye colour, height, attached and detached earlobes, Intelligence) while those characters which are not transferred to next generation are non-inheritable characters (e.g. if a body organ of a person is lost or weakened due to disease, this character is not transferred to offsprings.

Examples of inheretible characters in human

(a) Eye colour

The colour of eyes in an organism is controlled by a pair of genes. The genes control the production of brown pigment in the iris of the eyes. If the genes work and produce more pigment, the eyes are black. Production of very less pigment results in light brown eyes. Blue, green and hazel eye colours are developed due to the production of brown pigment in different amounts.

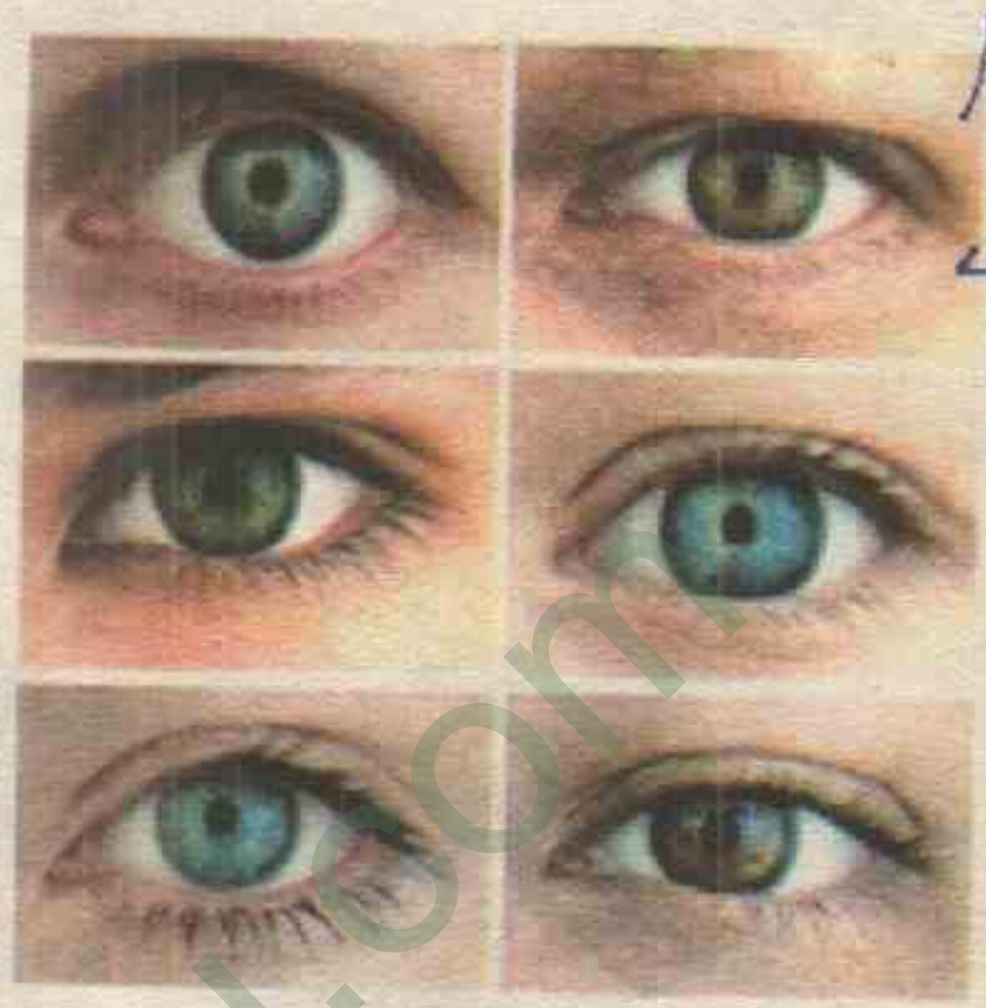


Fig 2.5 Different Eye colours

Activity 2.1

- What features are common to you and your brothers and sisters? Make a list.
- Which of these features are also present in your parents and grandparents?

(b) Detached and Attached Earlobes

Some people have earlobes attached with the sides of face while others have free earlobes. This happens due to genes. When the genes carry the characteristic of detached earlobes, the person will not have earlobes attached to the sides of the face. Some people who have suppressive gene for this trait, their earlobes are attached with the sides of face.

Detached Earlobes Attached Earlobes

Fig 2.6 Ear lobes

KEY POINTS

- Reproduction is the basic characteristic of all living things. It is the process in which new individuals are produced which resemble their parents.
- In asexual reproduction, single parent is involved.
- In sexual reproduction, both male and female parents are involved.
- Mitosis is the method of cell division in which a parent cell is divided into two daughter cells with the same number of chromosomes as that of the parent cell. It takes place in the body cells.
- Meiosis is the method of cell division in which a parent cell is divided into four daughter cells (gametes) with half the number of chromosomes as compared to the parent cell. It takes place in germ cells.
- Chromosomes are thread like structures made up of DNA and histone protein and are present in the nucleus of the cell.
- DNA is a heredity material carrying information from parent to offspring.
- Transfer of characteristics from parents to offspring is called heredity.
- A gene is a physical and functional unit of heredity responsible for various traits in living organisms.
- Chromosomes, genes and DNA are the basis of heredity.
- Humans have 23 pairs of chromosomes.
- The characters which can pass from one generation to the next generation are Inheritable characters (e.g. eye colour, height, attached and detached earlobes, Intelligence).
- The characters which are not transferred to next generation are non-inheritable characters.

Exercise

A. Choose the correct answer for each of the following statements.

i. Living organisms have a set of characteristics that are transferred from:

(a) environment (b) school

(c) parents (d) all of the these

ii. Division of a cell into two daughter cells is called:

(a) growth (b) cell division (c) cell inheritance (d) cell death

iii. Chromosomes are made up of:

(a) DNA (b) proteins (c) DNA and Protein (d) fats

iv. Transfer of traits from parents to offsprings is called:

(a) heredity (b) reproduction (c) transformation (d) division

v. Eye colour in human beings is controlled by:

(a) genes (b) nucleus (c) cytoplasm (d) meiosis

B. Mach the words of column A with suitable words of column B.

Column A	Column B
DNA	Two identical daughter cells
Free earlobe	23 pairs
Mitosis	Gene
Chromosome in humans	Thymine
Adenine	Heritable character

C. Give short answers of the following.

i. Define the following terms.

(a). Gene (b). DNA (c). Chromosome

ii. Where does meiosis takes place in the human body? How many cells are produced from parent cell, when it divides by meiosis?

iii. Write any four inheritable characters and three non-inheritable characters.

iv. How does the amount of pigment affect the eye colour in human beings?

v. Explain heredity.

D. Give detailed answers to the following questions.

i. Explain the need for the production of genetically identical cells.

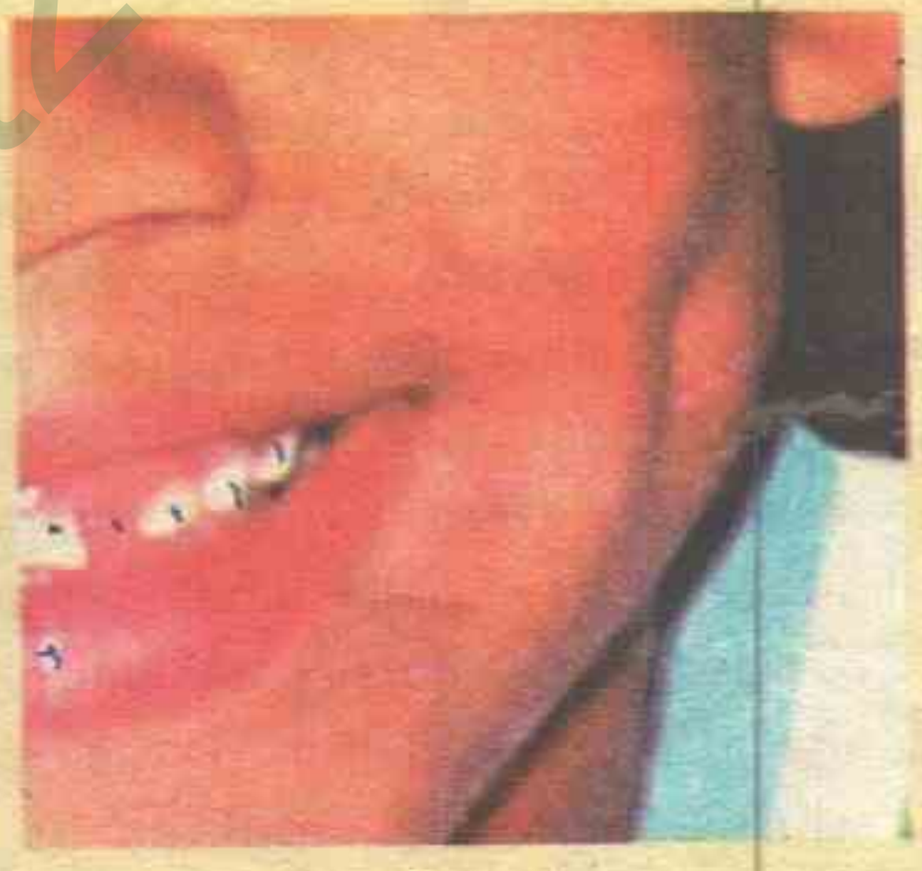
ii. Write down the differences between mitosis and meiosis with the help of diagrams.

iii. Give any four characteristics of humans which are affected by the heredity. Explain any one of them is detail.

Project

Search for some interesting and informative facts about heritable characteristics in humans. Share the information with your teacher and class fellows.

Toe size



Dimple in face

UNIT 3

BIOTECHNOLOGY

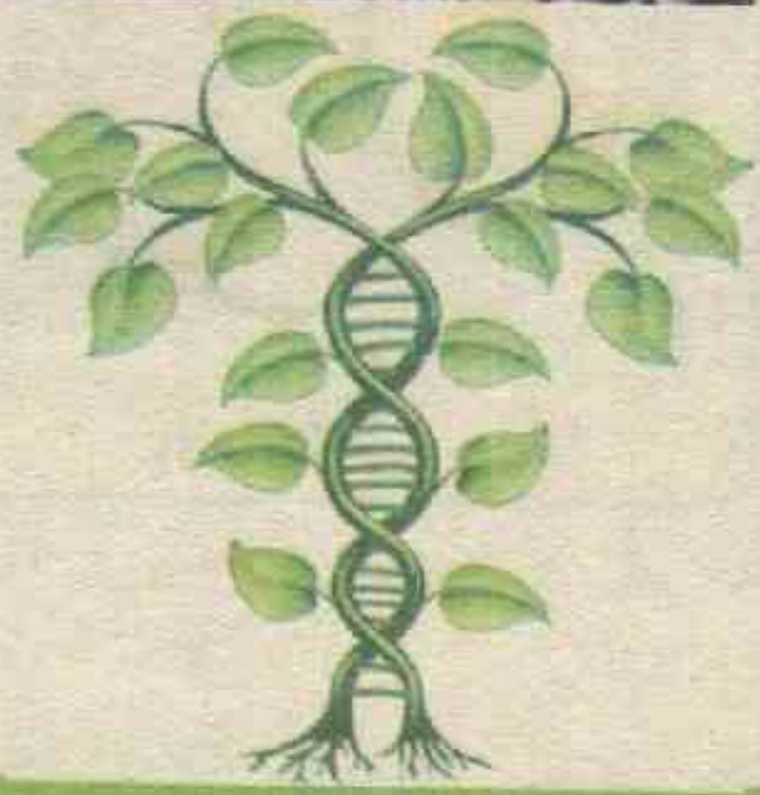
After studying this unit, students will be able to:

- Define Biotechnology.
- Explain how DNA is copied and made.
- Describe the relationship between DNA, genes and chromosomes.
- Define bacterium.
- Explain how genes are introduced into a bacterium.
- List some biotechnological products used in daily life.
- Explain that genetic modification in different foods can increase the amount of essential nutrients.
- List general applications of biotechnology in various fields.
- Explain how biotechnology allows meeting the nutritional needs of growing populations.

Introduction

In the previous unit, you have learnt about heredity and how basic traits are transferred from the parent(s) to the offsprings through genes. In this unit, you will explore how DNA is copied and made as well as the relationship between DNA, genes and chromosomes. You will also learn how understanding of structure of DNA led to the welfare of mankind.

The use of living organisms or their products for the welfare of mankind is called **Biotechnology**. The ultimate goal of this field is to improve the yield of products from living organisms by making modifications in their DNA.



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Major break through in biotechnology

Pre-20th century	▪ Identification of living cell and bacteria. Discovery of: ▪ small pox and rabies vaccines. ▪ artificial sweeteners. ▪ DNA and chromosome.
20th century	▪ penicillin ▪ 3D structure of DNA. ▪ fabrication of artificial limbs. ▪ cloning of first mammal (a sheep called Dolly).
21st century	▪ vertebrate, invertebrate and bacterial genome sequence. ▪ completion of human genome sequence. ▪ sequencing of rice genome, invention of bionic leg.

DNA Replication

As you studied in the previous unit, that DNA is the basic heredity material in living organisms and is responsible for the transfer of characters from one generation to the next generation.

DNA has a unique property to replicate itself. During the replication process, the DNA makes similar copies of itself. DNA replication takes place in the nucleus during cell division.

Steps involved in DNA replication

The first step in DNA replication is the unwinding of the double helical structure of the DNA molecule. The two strands separate from each other.

In the second step, each of these strands produces a new strand using all the four types of nucleotides present in the nucleus. In this way, one DNA molecule produces two daughter DNA molecules. Each DNA molecule has one new strand and one strand of parent DNA. The two daughter DNA molecules are the exact replicas of each other.

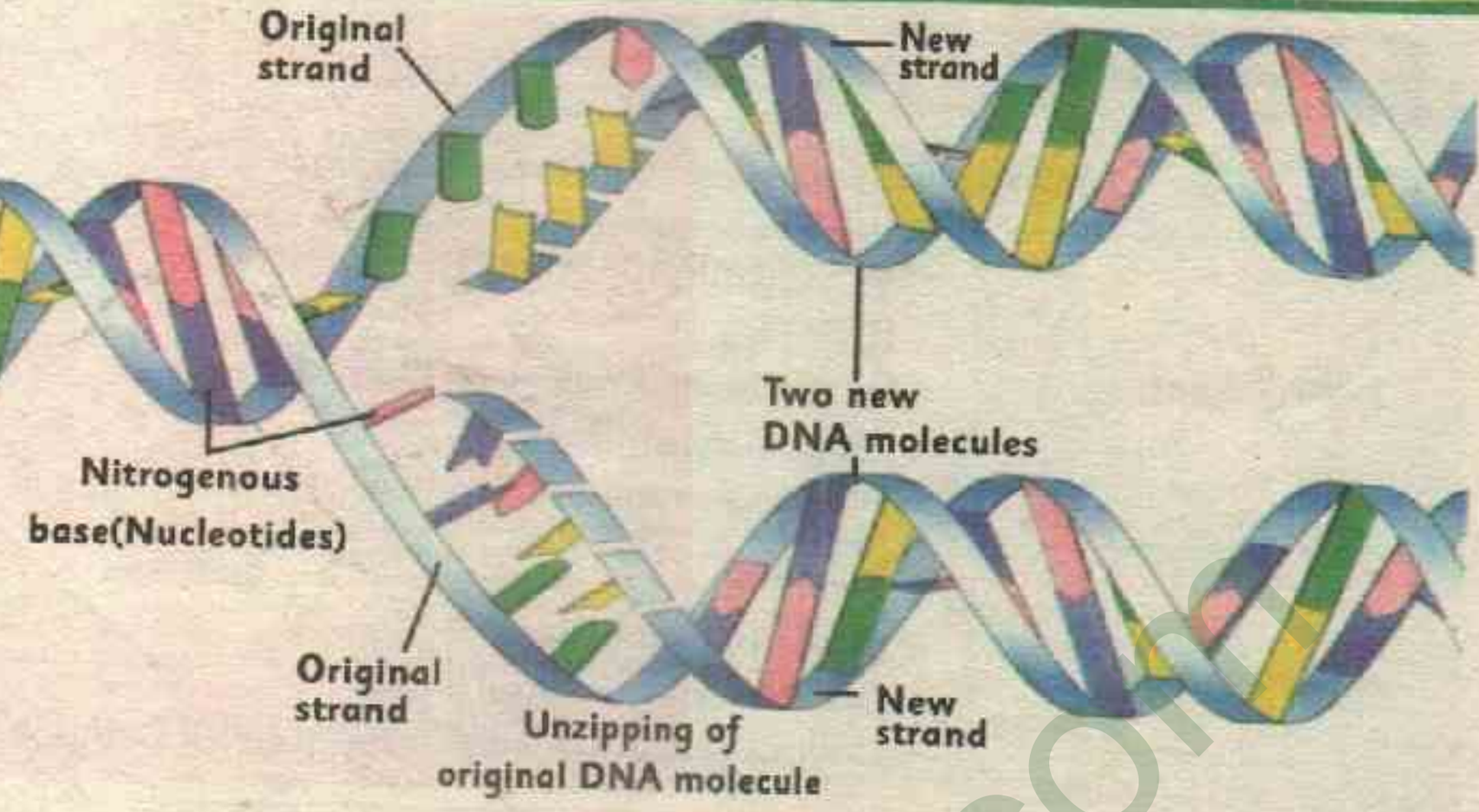

Fig 3.1 DNA Replication

Relationship between DNA, genes and chromosome

As you know from the previous unit that DNA, genes and chromosomes are related to each other.

- DNA is a hereditary material, which carries all the information from parents to the offsprings.
- Gene is the basic structural and functional unit of heredity. Genes occur in pairs and are located on chromosomes. Each heredity character in an organism is controlled by a pair of genes.
- Chromosomes are coloured bodies present in the nucleus. They are visible as thread like structures. Each chromosome is made up of DNA, coiled many times around a protein called histone.

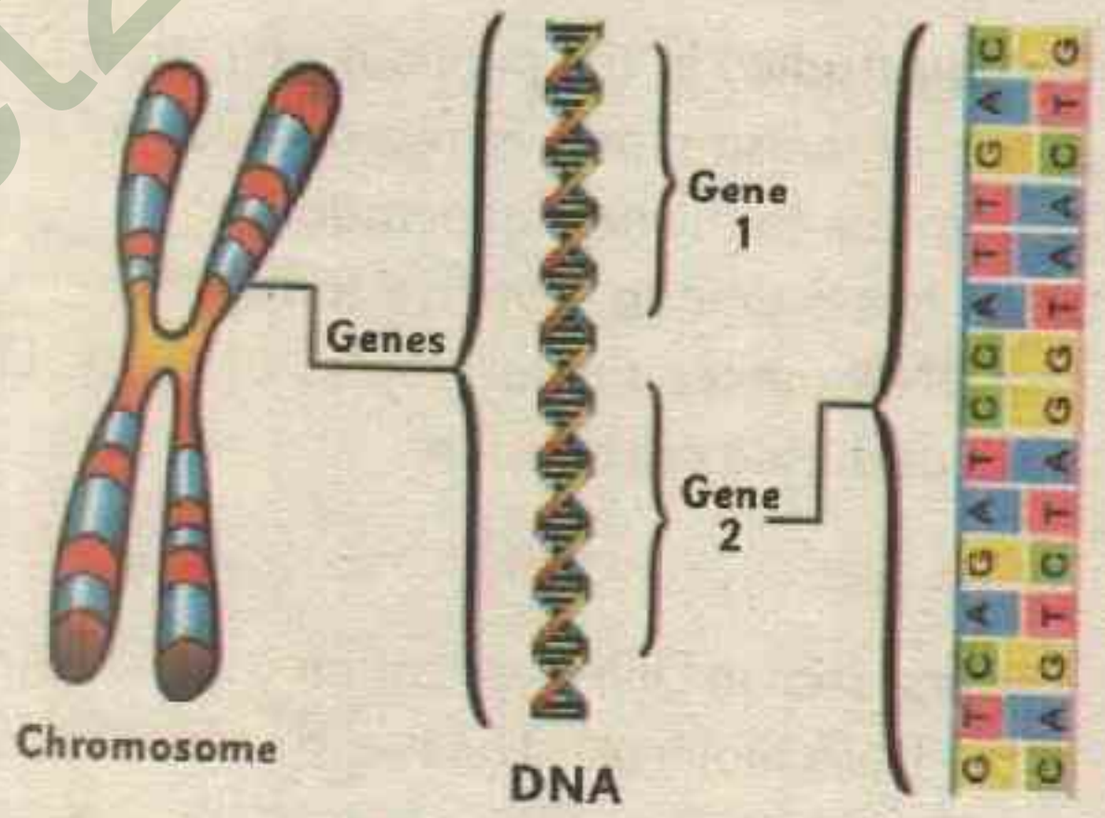

Fig 3.2 Genes

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In human cells, there are more than one thousand genes on a single chromosome.

Bacteria (Singular Bacterium)

Bacteria are unicellular organisms that do not contain a membrane bound nucleus. Each Bacterium has a single chromosome present in the cytoplasm along with an extra chromosomal DNA molecule called plasmid which is also known as vector. The plasmid can be easily isolated from a bacterial cell and a gene can be attached with it. Thus the plasmid can carry a foreign gene into the bacterium.In this way, plasmid acts as a carrier of a foreign gene.

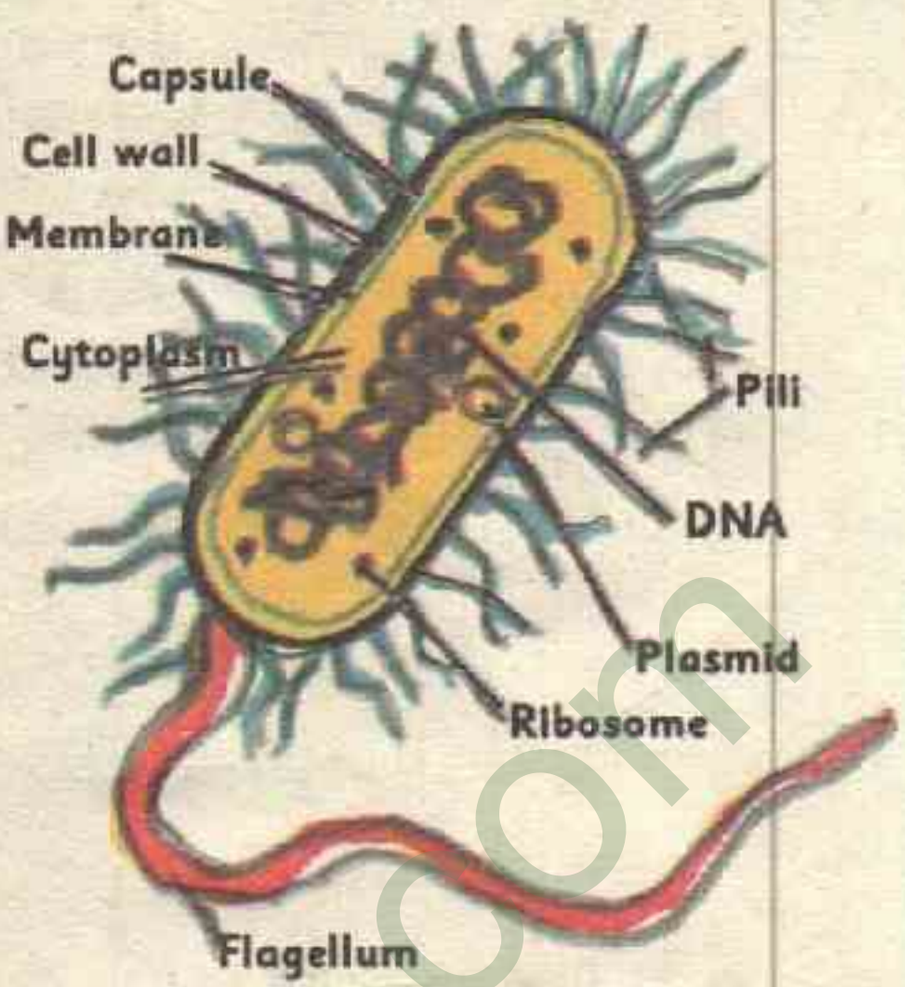


Fig 3.3 Bacterium

Introduction of genes into a bacterium

Genetic engineering is an advanced technique in biotechnology. The scientists select and isolate the useful gene from one organism and insert it into another organism, usually into a bacterium. The organism that contains a foreign gene in its cell is called transgenic organism. The inserted gene produces the desired products in transgenic organism.

Science TidBit

Why do scientists use bacteria in genetic engineering?

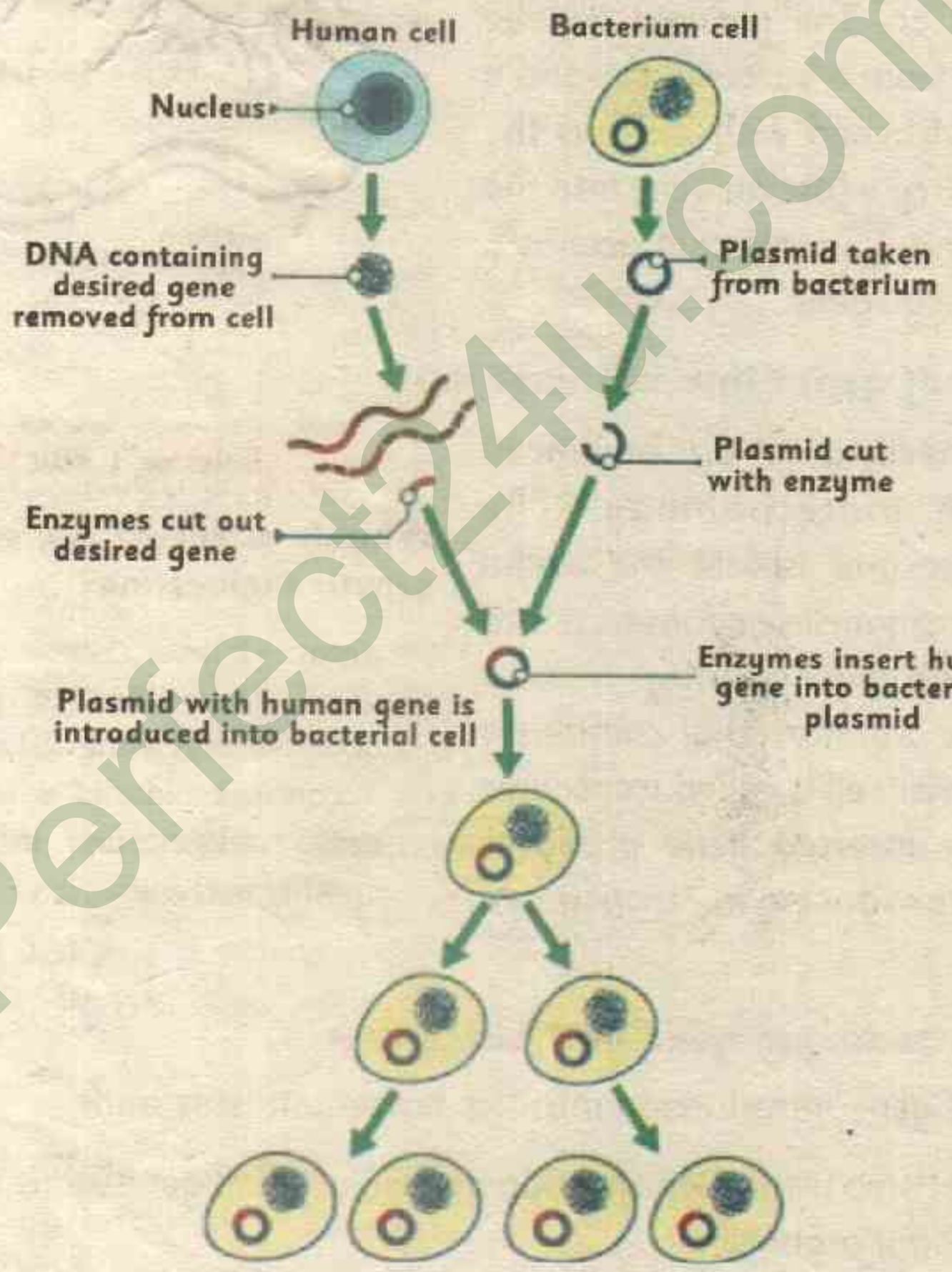
- Because it is very simple and easy to grow. It divides to form two daughter cells within 20 minutes.
- It contains plasmid which can be easily isolated and inserted into another bacterium.

Process of introducing gene into bacterium

The process of gene introduction into the bacterium is as under:

1. The first step is the identification and isolation of gene (gene of interest) from donor organism.
2. An enzyme called restriction enzyme is used to cut the gene from the DNA of donor organism.

3. The isolated gene is then attached with plasmid DNA taken from a bacterium. The attached gene and plasmid DNA are collectively called recombinant DNA.
4. The recombinant DNA is then introduced into a bacterium, the bacterium starts dividing and produces a bacterial colony.
Thus every bacterium of the colony contains the desired gene and hence they produce the desired product (Protein).



Bacteria reproduce rapidly. This creates bacteria with the new characteristic.

Fig 3.4 Introduction of gene into bacterium

Biotechnology in daily life

Biotechnology has important role in our daily life. We are using different products of biotechnology. Some of the daily life products are:

- Bakery products, yogurt, cheese, bread and vinegar.
- Food crops modified by biotechnology.
- Different medicines e.g. Insulin for diabetes, Vaccines and antibiotics.
- Biodiesel, washing detergents, sugars, plastics etc.

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The bacterium which takes in the recombinant DNA is called genetically modified bacterium (GM bacterium) or transgenic bacterium.

Genetic modifications

Genetic modification is the change in the genetic organization of an organism using biotechnological techniques. This change can be produced by removal, addition or modification of gene. This process is used in crops to develop many characteristics in plants, for example, increased productivity, improved nutritional quality, novel products and disease resistant. The organisms whose genes are modified are called genetically modified organism (GMOs) or transgenic organisms.

Usefulness of genetically modified organisms

(a) Micro organism resistance

By genetic modifications, microorganism resistant varieties of plants can be produced such as Ring spot virus resistant GM papaya, grown in Hawaii. Similarly, researchers are trying to produce transgenic chicken that will be resistant to the bacterial infections that cause food poisoning.

(b) Improved nutrition and quality of food

- Genetically modified sweet potatoes have been enhanced with proteins and other nutrients.
- Production of better quality fruits and vegetables and increasing their shelf lives are also due to genetic modification.

- Genetically modified fish have genes that promote the production of growth hormones. This results in growth enhancement in several species including Salmonids, Carps and Tilapias.
- Microorganism resistant varieties can be produced through genetic modification such as ring spot virus resistant GM papaya.
- Transgenic chickens are resistant to bacterial infections.
- Transgenic cows produce more milk or milk with less lactose or cholesterol.

Application of Biotechnology

Four major areas in which biotechnology techniques are applied include agriculture, food production and preservation, health and environment.

1. Biotechnology and agriculture

Biotechnology has played an important role in improving our agricultural yield. Herbicides (weed killing chemicals) and pesticides (insect killing chemicals) are used to eliminate weeds and insects and thus protect crops. Using biotechnology, scientists insert weed resistant and pest resistant gene into plants. Cultivation of such genetically modified crops improves the quality of crops and makes them safe for human use. Proteins in foods may be modified to increase their nutritional qualities. Proteins in legumes and cereals maybe transformed to provide the amino acids needed by human beings for a balance diet. Biotechnology improves the taste, texture and appearance of the food. The major crops that have been modified are maize, wheat, rice, potato, corn and soybean.

Fig 3.5(a)
Modified Corn

Fig 3.5(b)
Diseased Corn

2. Food production and preservation

In animals, high yield of milk and meat can be produced through biotechnology.

Similarly, the quality of fruits and vegetables can be improved by introduction of better quality genes.

Fig 3.6 High yield producing cow

Fig 3.7 Genetically modified fruits and vegetables

3. Health

Biotechnology techniques are also used for curing diseases and improving health. Identification of causes of diseases, production of medicines and correction of genetic defects etc. are the major contributions of biotechnology. One example is the preparation of insulin by joining its gene with a plasmid (vector) inserted into the bacterium. Various biotechnology products that are used to save lives include:

Insulin	Useful for diabetics
Vaccines	Used against many infectious diseases
Growth hormones	Useful for stimulating growth

Fig 3.8 Biotechnology products used to save lives

4. Environment

Environmental problems like pollution, degradation of land and sewage water are also resolved by using biotechnology. Microorganisms e.g. genetically modified bacteria are used to treat sewage and garbage. They may also be used to clear spilled oil. Microbes, which are used as bio-pesticides and bio-fertilizers, are being developed by using biotechnology techniques.

Role of biotechnology in meeting the nutritional needs

Biotechnology plays a vital role in meeting the nutritional needs of human population. We can enhance food production and nutrition by improvements in livestock and plants using different techniques of biotechnology such as tissue culture and genetic engineering etc. Tissue culture is an important technique of biotechnology. We can get the types of crops and other plants, which give more production using this technique. Similarly, genetic engineering is used in animals for better production of milk and meat. For example, Neeli Ravi buffalo is produced for better production of milk and Nancy sheep for production of more meat. Such animals are very helpful in meeting the nutritional needs.

In short, biotechnology has a great importance in human life. We can succeed in meeting our food problems through biotechnology.

Fig 3.9 Genetically improved products

KEY POINTS

- The use of living organisms or their products for the welfare of humanity is called biotechnology.
- DNA is the heredity material and is responsible for the transfer of characteristics from generation to generation.
- DNA replication is the process by which a double-stranded DNA molecule is copied to produce two identical DNA molecules.
- Circular DNA of a bacterium is called plasmid.
- Genetic modification is the change in the genetic organization of an organism using biotechnological techniques.
- An organism having a foreign gene (gene of interest) in its DNA is called transgenic or genetically modified organism (GMO).
- Biotechnology has played an important role in improving agricultural products, helps in food production and preservation, solving health problems and reducing environmental problems.
- Genetic engineering is the application of biotechnology in which different technologies are used to modify the DNA of an organism.
- Tissue culture is an important technique of biotechnology. We can get the types of crops and other plants, which give more production using this technique.
- Herbicides and pesticides are used to eliminate weeds and insects and thus protect crops.

Exercise

A. Choose the correct answer for each of the following statements.

i. The additional circular pieces of DNA present in bacterial cell are called:
(a) RNA (b) chromatid (c) plasmid (d) nucleotide

ii. The branch of science in which living organisms are used for the welfare of humans is called:
(a) biochemistry (b) biotechnology (c) microbiology (d) genetics

iii. Plasmid and attached foreign gene with it are collectively called:
(a) recombinant cell (b) recombinant DNA
(c) recombinant plasmid (d) recombinant chromosome

iv. The organism whose genes are modified is called:
(a) GM organism (b) transgenic organism
(c) recombination organism (d) all of these

v. A gene is inserted into a bacteria by:
(a) digestion (b) genetic engineering
(c) fermentation (d) biodegradation

B. Match the words of column A with suitable words of column B.

Column A	Column B
Plasmid	DNA
Diabetes	Stimulating growth
Growth hormone	Insulin
Double helix	Bacterium
GMOs	modified genes

C. Give short answers of the following.

i. Define biotechnology.
ii. Write some important products of biotechnology.
iii. What are genetically modified organisms?

iv. What is DNA replication? Explain.
v. Draw a labeled diagram of bacterium.

D. Give detailed answers to the following questions.

i. Explain the process of introducing gene into bacteria.
ii. Describe the role of biotechnology in agriculture and health.
iii. Describe the role of biotechnology in meeting the nutritional needs of human beings.

Project

1. Find out the method of making yogurt.
   (a) What is curd?
   (b) Why is curd used to make yogurt?
   (c) Why is milk boiled before it is used to make yogurt?
   (d) How does the yogurt taste?
   (e) Why does it taste that way?
2. A farmer plans to grow corn in his field and then feed the corn to his cows, which he raises to sell meat. How could the farmer use the biotechnology to produce more modified corns to feed his cows?

Corn field

Making yogurt

UNIT 4

POLLUTANTS AND THEIR EFFECTS ON THE ENVIRONMENT

After studying this unit, students will be able to:

- Explain the sources, properties and harmful effects of air pollutants.
- List problems in human organ systems caused by air pollutants.
- Plan and conduct a campaign that can help to reduce air pollution in their local environment.
- Explain the Greenhouse effect.
- Describe the causes and effects of ozone depletion.
- Carry out a research to explain global warming and its likely effects on life on earth.
- Design a model to explain the Greenhouse effect. Explain the formation of acid rain and identify its consequences on living and nonliving things.
- Define deforestation.
- State the effects of deforestation on the environment.
- Identify human activities that have long-term adverse consequences on the environment.
- Explain the importance of local and global conservation of natural resources.
- Suggest ways in which individuals, organizations and government can help to make earth a better place to live.

Introduction

Can you recall what you have learnt about environmental pollution? In grade V you have learnt about the definition of pollution, kinds of pollution (water, air, and land), main sources of pollution (smoke, sewage water, solid wastes, industrial wastes) and measures to reduce the pollution.

In this unit, you will learn about air pollutants, their sources and harmful effects on human organ systems and effects of human activity on environment. You will also learn about the role you can play for the protection of the earth from the hazards of environmental pollution.

Point to Ponder

Our atmosphere consists of 78% nitrogen, 21% oxygen, 1% argon and other gases such as carbon dioxide. What do you think, what will happen to the proportion of these gases and elements if deforestation continues and more factories / vehicles keep emitting heavy smoke?

You will also study about the green house effect, acid rain, deforestation, global warming and the importance of conservation of energy.

Pollution

Any unwanted and undesirable change in the environment that affects the atmosphere and disturbs the ecosystem is called pollution. The addition of certain contaminants or pollutants to the environment is also called pollution. Animals, plants, humans and all other organisms suffer due to pollution. The major types of pollution can be categorized as follows:

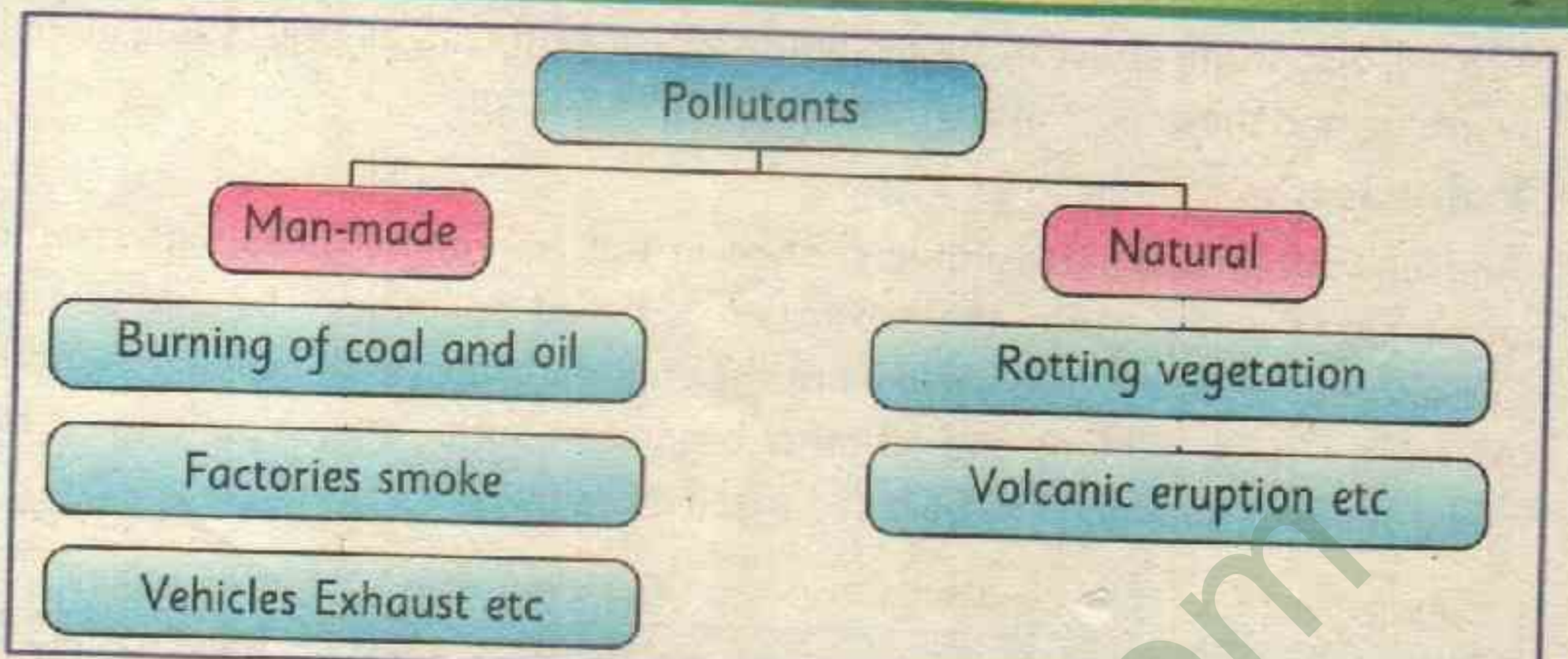
Fig 4.1 Types of pollution

Air Pollutants and their sources

Pollution began to be recognized as a serious threat during the industrial revolution of the 19th century. During this period, burning of fossil fuels in the factories and industries led to a high level of waste gases in the air. Like other forms of pollution, air pollution has dangerous effects on the environment.

During air pollution, harmful pollutants are released into the air. These harm all living organisms. It may be man made or natural. Carbon monoxide (CO), sulphur dioxide (SO_2), oxides of nitrogen (NO and NO_2), chlorofluorocarbons (CFCs), etc, are the main air pollutants, produced by human activities and natural sources.

Fig 4.2 Smoke emitted from thermal power station



Sulphur dioxides (SO_2)

Sulphur dioxide (SO_2) is one of the main oxides of sulphur and is produced as a result of various industrial processes. The key sources of SO_2 include coal and petroleum, when they undergo combustion. Smoke released from thermal power plants contains SO_2. Further oxidation of SO_2 forms Sulphuric Acid (H_2SO_4), which is a highly dangerous liquid that damages many substances.

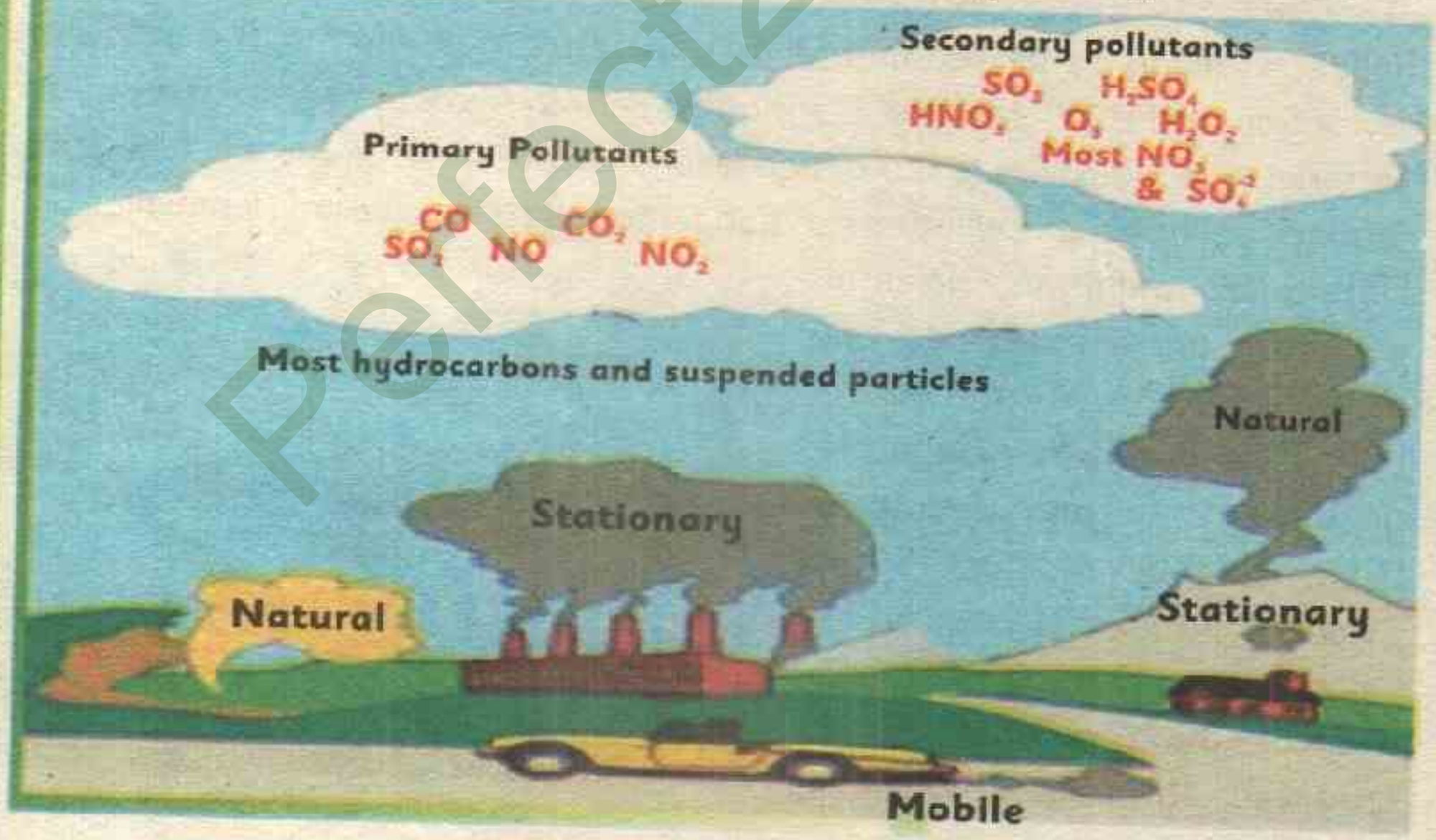


Fig 4.3 Air pollutants

Nitrogen Oxides (NO_x)

Nitrogen dioxide (NO_2) can be observed as a brown haze above the cities. It is one of the several nitrogen oxides which is the most easily observable and the most prominent air pollutants. Nitrogen oxides are produced when coal and oil are burnt at high temperature in industries and engines of vehicles.

Important Fact

Sources of air pollutants

- Natural: decaying vegetation
- Stationary: factories
- Mobile: vehicles

Sulphur dioxide destroys chloroplast in plants. As a result, photosynthesis and the growth of plants are affected.

Carbon Monoxide (CO)

Carbon monoxide is a colorless, odourless, non- irritating but very poisonous gas. CO is produced by the incomplete combustion of coal and other fossil fuels. Smoke released from motor vehicles and industries is the main source of carbon monoxide.

Chlorofluorocarbons (CFCs)

Chlorofluorocarbons (CFCs) are the compounds which contain chlorine, fluorine and carbon atoms. These are the major cause of breakdown of ozone layer. As a result, more ultra violet rays reach the earth. CFCs are used in aerosol spray, as cooling agent in refrigerators, air conditioners and foam packing. On leakages from these appliances CFCs enter the atmosphere and reach the ozone layer.

Harmful effects of air pollutants

1. Acid rain

Chemical reactions involving air pollutants can create acidic rain compounds which can cause damage to vegetation and buildings. Acid rain can destroy leaves of plants.

2. Eutrophication

Rain can carry oxides of nitrogen to rivers and soil. This can cause abnormal growth of algae in water bodies making conditions for other aquatic organisms very difficult to live.

3. Ground level ozone

Chemical reactions involving air pollutants create poisonous ozone (O_3) gas, which affect people's health and can damage plants and animals' life.

Problems Caused by Pollutants in Human Organ System

(a) Effects of Sulphur dioxide

Sulphur dioxide can cause

- Irritation of eyes, nose and throat.
- Breathing difficulties, pneumonia, asthma and chronic bronchitis.
- Lungs cancer.
- Respiratory failure.
- Cardiovascular diseases.

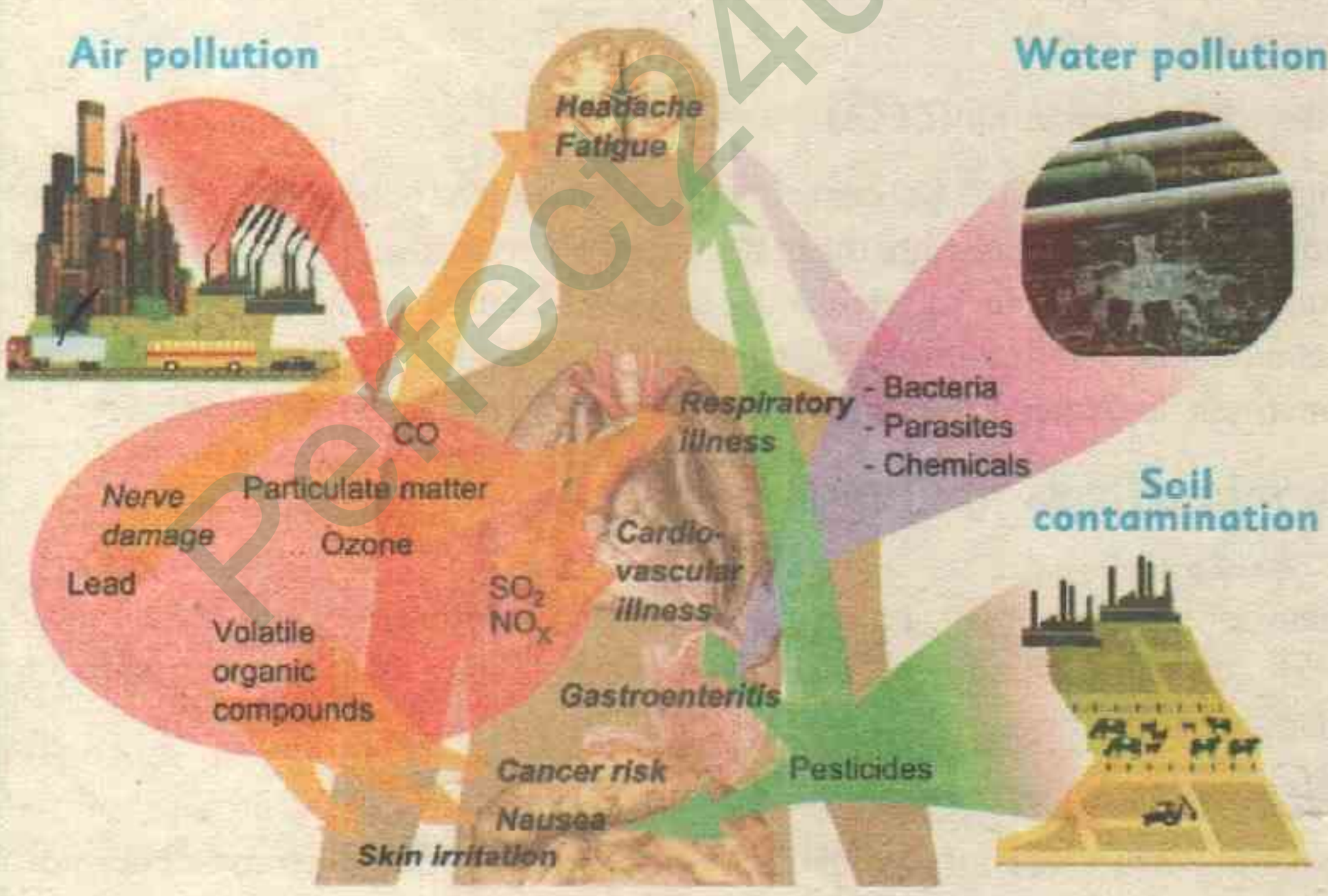


Fig 4.4 Harmful Effects of Air Pollutants on Human Organ System

(b) Effects of Oxides of Nitrogen

Oxides of Nitrogen can cause

- Severe effects on lung tissues and damage them badly.
- Difficulty in breathing and respiratory illness.
- Failure of heart.

(c) Effects of Carbon monoxide

Carbon monoxide can cause

- Damage to central nervous system and heart.
- Severe headaches, nausea, dizziness.
- Respiratory problems.
- Reduction in the oxygen carrying capacity of hemoglobin.

(d) Effect of Chlorofluorocarbons (CFCs)

- Chlorofluorocarbons are the main cause of skin cancer.

Activity 4.1

Plan and conduct a campaign that can help to reduce air pollution in your local environment.

Effect of Human Activities on Human environment

Generally human activities such as use of vehicles, burning of fuels, aerosol sprays, fertilizers, waste products, insecticides and deforestation are affecting environment. These actions can cause degradation of habitats and also result in the depletion of natural resources.

Green House Effect

When the UV (ultraviolet) radiations enter the earth, a part of it is absorbed by the earth and the rest are reflected back to the atmosphere. Some gases present in the atmosphere e.g; carbon dioxide, methane, oxides of nitrogen, water vapors, etc. trap a part of the heat reflected by the earth, causing an increase in the atmospheric temperature. This atmospheric effects is known as greenhouse effect. The gases involved in the green house effect are called green house gases.

e.g; carbon dioxide, carbon monoxide etc. An increase in greenhouse effect can lead to global warming and climate change. Coal burned in power stations contains carbon, which combines with oxygen to form carbon dioxide. Which is also a cause of increase of carbon dioxide concentration in air.

Fig 4.5 Green house effect

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Green house is a big room made of glass panels. It provides a suitable warm environment for the rapid growth of plants and vegetation. The glass of the greenhouse allows the sun's heat to enter and get trapped inside. The heat in the green house is reflected back by the Earth. The glass does not allow heat to go back, thus the green house keeps the inside environment warm.

Global Warming

Global warming refers to the rise in average temperature on earth. Due to human activities like burning of fuels, industries vehicles etc, the green house gases are continually increasing in the atmosphere and speeding up the green house effect. As a result, the earth is getting warmer and warmer this phenomenon is known as global warming.

Global warming is causing the glaciers to melt at an alarming rate. The snow on Polar Regions and the mountains melts faster, causing floods and raise in the level of seawater. The climate of many regions of the world is also changing due to global warming. Global warming is a serious threat to the life on earth, especially to future generations.

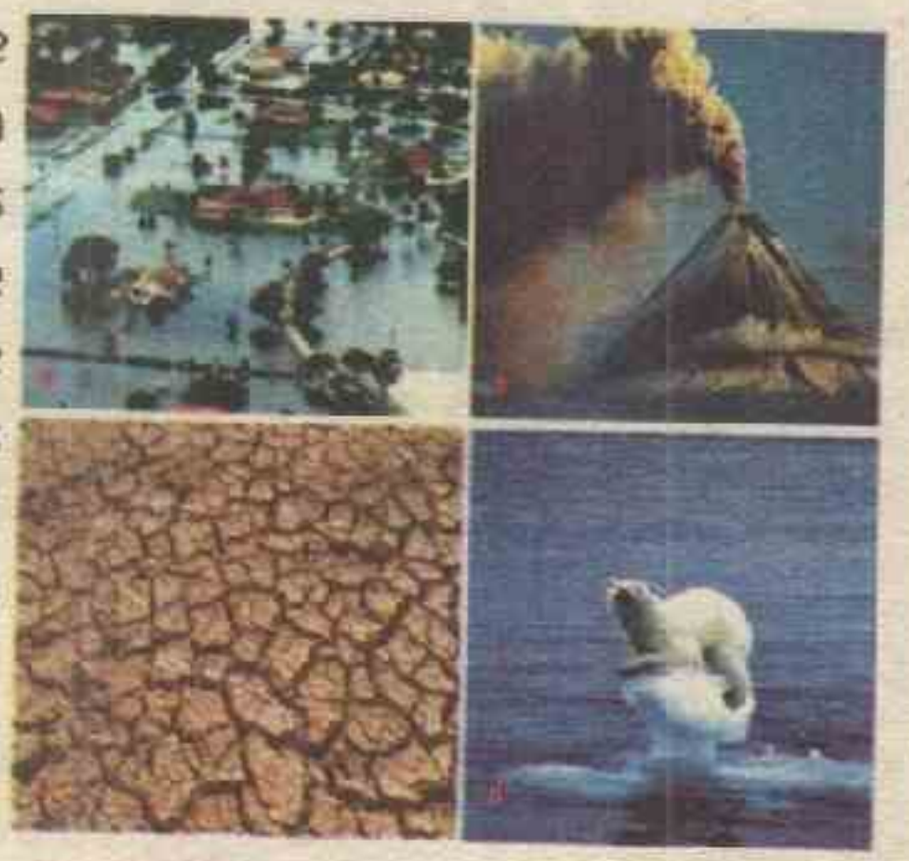


Fig 4.6 Effects of global warming

Activity 4.2

Prepare a poster to explain global warming and its effects on living organisms.

Acid Rain

When the quantity of acids increase in the atmosphere, it leads to acid rain during rainfall. Acid rains are the result of excessive carbon dioxide, sulphur dioxide, smoke and nitrogen dioxide in the atmosphere. When these gases come in contact with water vapours, acids such as sulphuric acid, nitric acid etc. are formed. These acids make the rain water acidic.

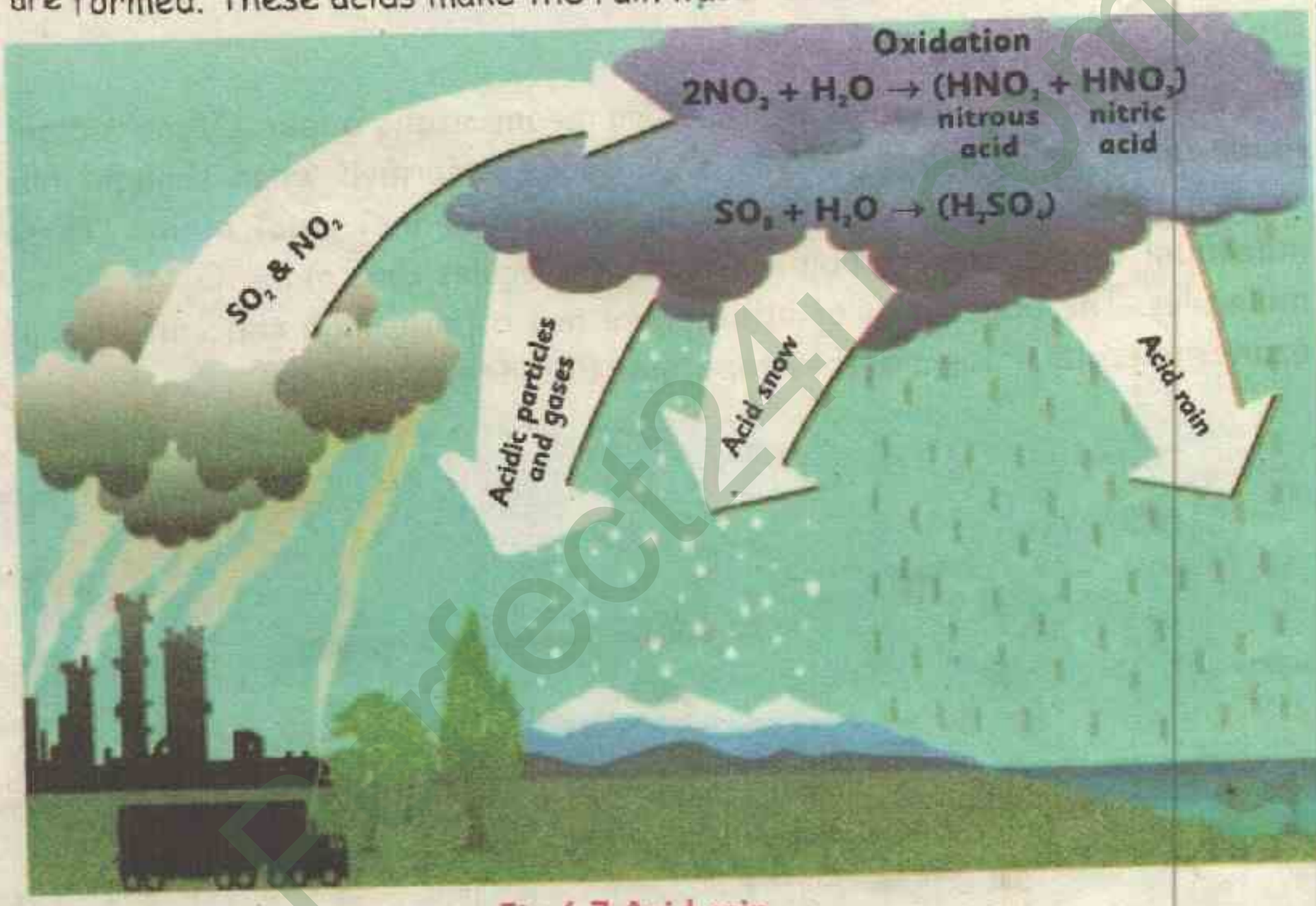


Fig 4.7 Acid rain

Acid rain harms a lot of living and non-living things. For example:

- Kills the aquatic life in rivers, ponds and lakes.
- Destroys the leaves and bark of trees.
- Corrodes the metals and stones used in buildings.
- Damages the crops.

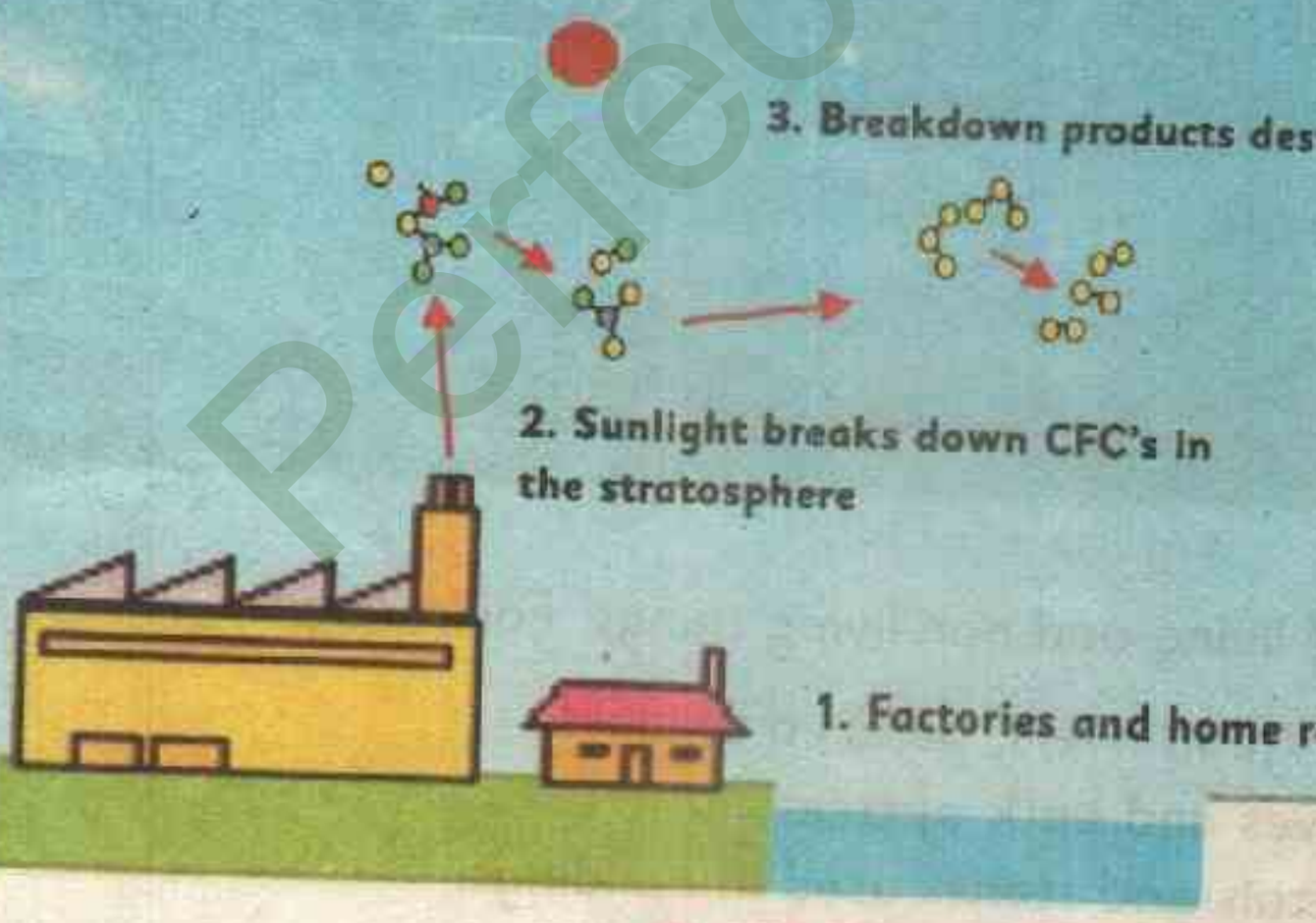
Fig 4.8 Effects of Acid rain

Science TidBit

Due to the effect of acid rain, stone buildings are corroded. This type of damage to the stone structures and buildings is called stone cancer.

Depletion of Ozone Layer

The word "Ozone" is a Greek word, which means strong odour. Ozone is a gas made up of three oxygen atoms (O_3). Ozone is formed when sunlight hits oxygen molecules (O_2) and breaks up them into individual atoms. These individual atoms then combine with O_2 molecules and make O_3 or Ozone molecules. The upper part of atmosphere has a fairly high concentration of ozone molecules, known as the ozone layer (Ozone sphere).



$$CFCl_3 \rightarrow CFCl_2 + Cl$$
$$CFCl_2 \xrightarrow{UV} CFCl + Cl$$
$$Cl + O_3 \rightarrow CLO + O_2$$
$$ClO + O_3 \rightarrow Cl + 2O_2$$

Fig 4.9 Ozone layer depletion

The ozone layer protects us from harmful ultraviolet (UV) rays of the sun. Chlorofluorocarbons (CFCs) which are used in air conditioners, refrigerators, spray, etc enter the air due to leakage from these appliances. On reaching the ozone layer they break down the ozone molecules and thus cause depletion of the ozone layer. This phenomenon of the ozone layer depletion is not only harmful to human beings but also damages other organisms.

Science TidBit

One chlorine molecule from CFCs can destroy up to 100,000 ozone molecules.

Deforestation

Deforestation refers to the cutting and removal of forests for human use. Forests bring favourable characteristics to an area. They stop storms, soil erosion and bring rain. Forests are the main source of timber, firewood, resins, gums, medicines and habitat for large number of plants and animals. However, increasing human population has resulted in the need for increased demand for firewood, construction and more area for harvesting. Human beings are therefore engaged in deforestation.

Increase in trade and possibilities of exporting wood items like furniture etc. have speed up the process of deforestation. However, the effects of deforestation are more severe than just the loss of trees. Deforestation is affecting human life to a great extent by bringing about negative changes in the environment and atmosphere.

Fig 4.10 Deforestation

Science TidBit

At least 25% of the total area of a country must be covered by forests but in Pakistan only 5% of the total area is covered.

Deforestation causes many problems some of which are:

- Air pollution.
- Green house effect.
- Destroy habitat for wildlife.
- Global warming and increasing sea level.
- Soil erosion.
- Less rain.
- Sea animals dying.

Fig 4.11 Effects of deforestation on wildlife

Effects of human activities on wild life

Humans are responsible for causing changes in the environment that affect animals and plants species. We take up more space on earth for our homes and cities. We pollute habitats of wild life. We hunt and kill wild animals for our pleasure. All of these activities take resources and habitats away from plants and animals.

Activity 4.3

Identify human activities that have adverse effects on the environment.

Conservation of Resources

Natural resources are derived from the environment. Many of them are essential for survival while others are used for satisfying our needs. The protection and preservation of natural resources in the environment is called conservation.

Natural resources can be categorized as follows:

Renewable resources

A renewable resource is one, which can be used repeatedly because it is recycled naturally. Examples are oxygen, fresh water, solar energy, timber

and biomass. Many renewable resources can be depleted by human use but their quantity is not affected by human consumption thus maintaining a flow.

Non-renewable resources

The resources like minerals and fossil fuels, which are not regenerated quickly are known as non renewable resources. The rate of formation of nonrenewable resources is extremely slow, they cannot be made available once depleted. These resources need to be used up carefully. Examples are metal ores, fossil fuels (coal, petroleum, natural gas) and ground water in certain aquifers.

Conservation Measures

Resources can be conserved:

- Indirectly through human population control and reducing pollution.
- Directly through conserving natural resources.

Saving the Earth

We all know that earth is the only known planet with life on it in this universe. We should respect and conserve all the natural resources we get from our earth, not only for ourselves but also for our future generations. We can save earth by saving trees, natural vegetation, water, natural resources, etc.

We should strictly follow all the possible measures to control environmental pollution and global warming. Everyone should plant more trees in the surrounding areas to reduce pollution and the effects of global warming. Afforestation, reforestation, recycling of used paper and other natural products, saving of natural resources (minerals and fossil fuels etc.), electricity, water and environment, should be supported and promoted.

Fig 4.12 Saving the Earth

The following specific measures can be taken to make the Earth a better place to live.

- Domestic and other solid wastes should not be dumped at open places.
- Use of bicycles for short travelling, not only reduce pollution but also good for our health.
- Sulphur and lead free fuels should be used in vehicles.
- Dispose off the garbage in time and in a proper way.
- Sewerage water should be drained properly.
- Special filters should be installed in the chimneys of industries to filter the dangerous gases and these should be shifted away from the residential areas.
- Trees should be grown along road sides.
- Deforestation should be avoided.
- Recycling of waste material should be encouraged.

Fig 4.13 Disposing off garbage

Activity 4.4

Prepare charts showing harmful effects of air pollution.

KEY POINTS

- Any unwanted and undesired change in environment is called pollution.
- The major types of pollution are air pollution, land pollution, water pollution and noise pollution.
- Sulphur dioxides (SO_2), Nitrogen Oxides (NOx), Carbon Oxides $(CO)_x$ and Chlorofluorocarbons (CFCs) are main pollutants of environment.
- Due to green house effect, increase in average temperature of Earth is called Global warming.
- Chlorofluorocarbons cause the depletion of ozone layer in our atmosphere.
- The air pollutants like sulphur dioxide and oxides of nitrogen, get dissolved in rain water and cause acid rain.
- Deforestation produces changes in the weather, climate and disturbs the ecosystem.
- Eutrophication causes abnormal growth of algae in water bodies making conditions for other aquatic organisms very difficult to live.
- Human activities such as use of vehicles, burning of fuels, aerosol sprays, fertilizers, waste products, insecticides and deforestation are affecting environment.
- Renewable resource is one, which can be used repeatedly because it is recycled naturally. Examples are oxygen, fresh water, solar energy etc.
- Nonrenewable resources formation rate is extremely slow, they cannot be made available once depleted. These resources need to be used up carefully. Examples are metal ores, fossil fuels etc.

Exercise

A. Fill in the blanks.

i. Dry air contains almost 78% percent of nitrogen.
ii. Ozone layer filters ultraviolet from sunlight.
iii. Rain can carry oxides of nitrogen to rivers and soil, which can lead to abnormal growth of algae, this is called Eutrophication
iv. carbon is a poisonous gas, produced by the incomplete combustion of coal and other fossil fuels.
v. The word 'Ozone' is a Greek word meaning strong odour

B. Choose the correct answer for each of the following statements.

i. Which of the following is not a greenhouse gas:
(a) methane ✓ (b) carbon dioxide
(c) sulphur dioxide (d) nitrogen

ii. The main reason for increase in the amount of carbon dioxide in air is:
(a) plantation (b) deforestation (c) recycling (d) using CFC's

iii. The phenomenon which does not lead to global warming:
(a) green house effects (b) Ozone depletion
(c) CFC's (d) photosynthesis

iv. Ultraviolet radiations from sun that reach the earth cause:
(a) Respiratory disorder (b) Typhoid fever
(c) Skin cancer (d) Bronchitis

v. The source of all of the following pollutants is vehicle exhaust EXCEPT:
(a) Carbon mono-oxide (b) Carbon dioxide
(c) CFC's (d) Nitrogen oxides

C. Give short answers of the following.

i. What are the main air pollutants?
ii. Name two greenhouse gases. Why are they called 'greenhouse' gases? Briefly explain.
iii. How can we conserve our resources?

iv. What are the sources of chlorofluorocarbons?

v. Define deforestation and its effects.

D. Give detailed answers to the following questions.

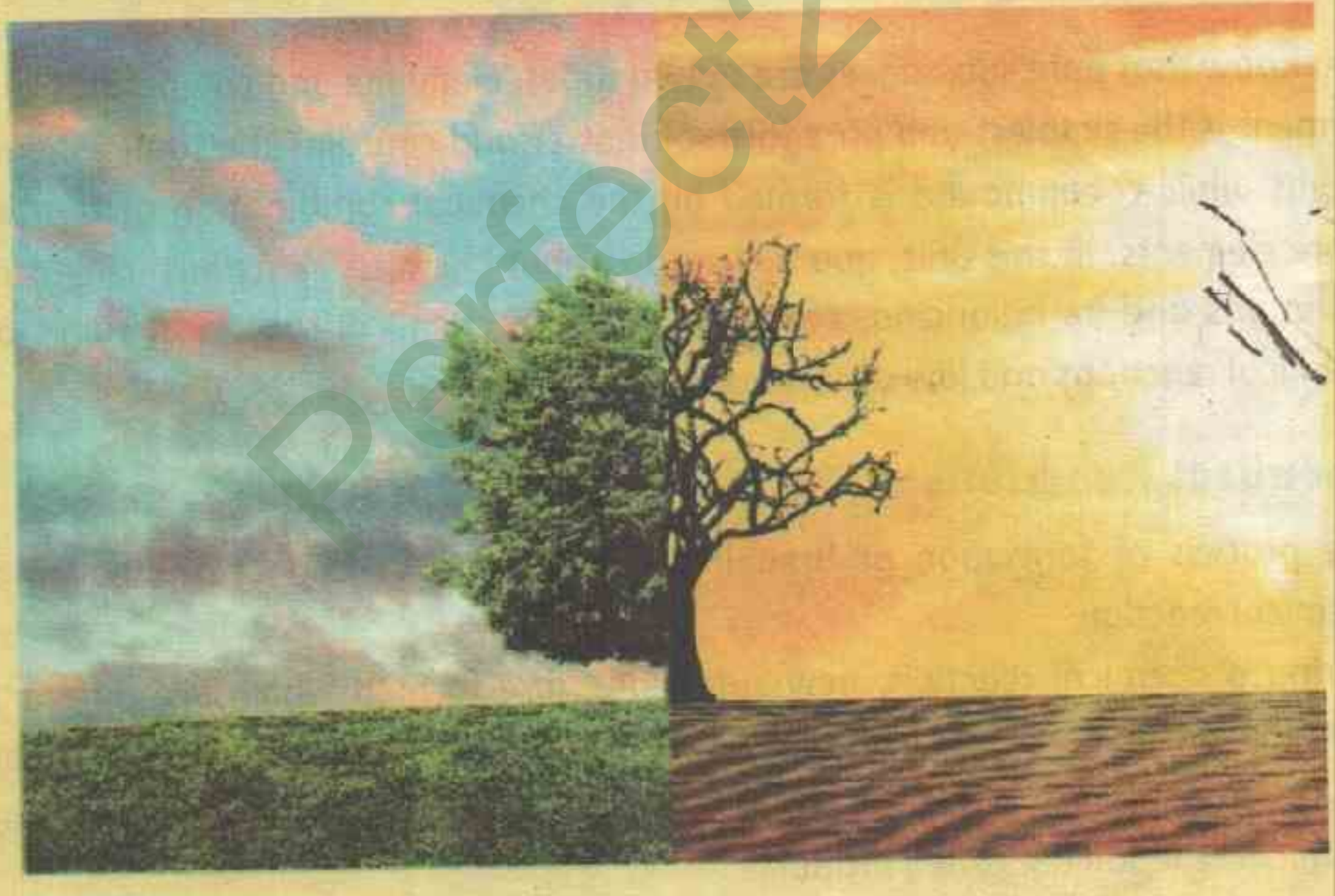
i. Which human activities can cause air pollution? What are the negative effects of air pollution?

ii. Why it is important to conserve the environment? Give two reasons.

iii. Define Global warming. What are the causes and effects of global warming?

Project

1. With the help of your teacher, draw posters as a part of a campaign highlighting environmental concerns (deforestation, global warming, etc).
2. Identify the role and suggest few ways of different organizations, the government and your own community in which technology can be used to keep the environment conserve, clean and green with specific example for each way.



Global warming

UNIT 5

CHEMICAL REACTIONS

After studying this unit, students will be able to:

- Define chemical reactions and give examples
- Explain the rearrangement of atoms in chemical reactions.
- Explain the balancing of a chemical equations.
- Define the law of conservation of mass.
- Identify the nature of a chemical change in various reactions.
- Describe changes in the states of matter in chemical reaction.
- Explain the types of chemical reactions with examples.
- Explain the energy changes in chemical reactions.
- Describe the importance of exothermic reactions in daily life.

Introduction

You know that pure substances are of two types; elements and compounds. An element is the simplest and pure form of matter and contains the same kind of atoms while a compound is formed by the chemical combination of two or more elements. In this unit, you will study about chemical reactions, chemical equations and its balancing, energy changes in chemical reactions, types of chemical reactions and law of conservation of mass.

Chemical Reactions and their examples

The process of formation or breaking of a chemical compound is called a chemical reaction.

During a chemical reaction, new substances are formed which are different from the starting substances. Those substances which combine with each other are called reactants, while those substances which are produced as a result of chemical reaction are called products.

Chemical reactions are not only involved in various biological processes like

Changes in states of matter

You know that matter is neither created nor destroyed during a chemical reaction. However, a chemical change may accompanied by a change in physical state of the reactants due to the rearrangement of atoms. For example, water (liquid) is formed by the combination of oxygen (gas) and Hydrogen (gas). Mentioning physical state with reactants and products is one of the basic characteristics of chemical an equation.

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(l)}$$

Chemical equations

You know that elements are represented by symbols and chemical compounds are represented by chemical formulae. Similarly, a chemical equation is the representation of chemical reaction in terms of symbols and formulae.
In a chemical equation, reactants are written on left hand side and products on the right side of arrow. Arrow head shows the direction of equation.

For example:

$$\underbrace{AgNO_3 + NaCl}_{\text{Reactants}} \longrightarrow \underbrace{AgCl + NaNO_3}_{\text{Products}}$$

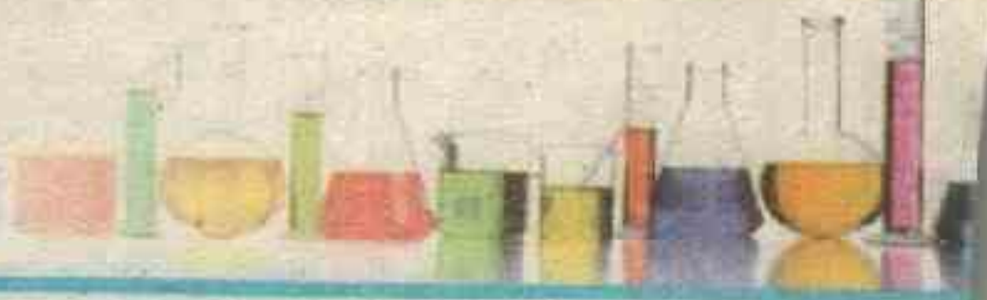
Characteristics of a chemical equation

- A chemical equation must be a representative of a chemical reaction.
- Symbols and formulae of the reactants and products must be correct.
- It should be balanced in terms of atoms of reactants and products.
- It must show physical state of substances involved in chemical reactions.

Activity 5.3

Count the number of atoms of each element in the following chemical formulae.

i. Sucrose. $C_{12}H_{22}O_{11}$
ii. Calcium Nitrate. $Ca(NO_3)_2$
iii. Ammonium Sulphate. $(NH_4)_2SO_4$
iv. Potassium Chlorate. $KClO_3$
v. Sodium hydroxide. NaOH



Balancing of chemical equation

According to law of conservation of mass, matter is neither created nor destroyed during a chemical reaction, therefore the number of atoms of each element must be equal on both sides of a chemical equation. Various methods are used for balancing of chemical equations but the simplest method for balancing is inspection or trial and error method. The following steps are involved in balancing of chemical equations.

Step I: Write unbalanced chemical equation. The symbol and formulae of the reactants and products must be correct.

Step II: Count the number of atoms of each element on both sides.

Step III: If the number of atoms are different on both sides, write the required number as a coefficients of the symbols or formulae.

Step IV: Work with one element at a time.

Step V: Always start with a relatively small number.

Step VI: Start with atoms that appear only once in the reactants and products. Usually leave the di-atomic elements like nitrogen, hydrogen and oxygen etc, until last.

Examples of Balancing Chemical Equations

Example-1 Balance the following equation

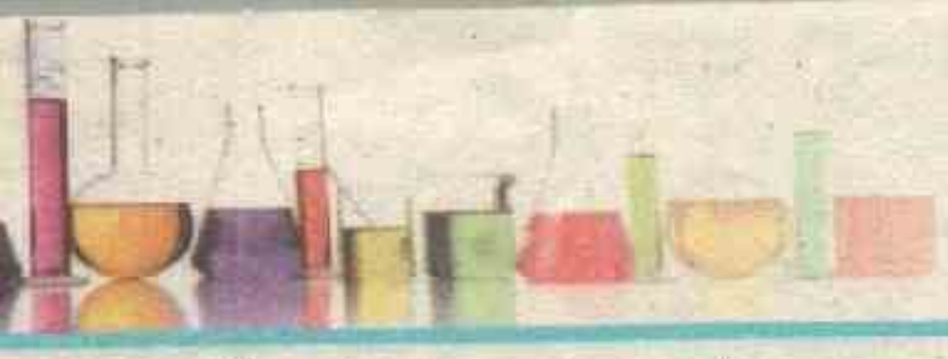
$$CH_4 + O_2 \longrightarrow CO_2 + H_2O$$

Identify the elements in the equation: C, H, O

Reactants	Products
C=1	C=1 Balanced
H=4	H=2 Unbalanced
O=2	O=3 Unbalanced

You have 4 H in CH_4 at left side and only 2H in water on right side, so you need to double the co-efficient of H_2O to balance Hydrogen atoms on both sides.

$$CH_4 + O_2 \longrightarrow CO_2 + 2H_2O$$



Now look at the carbon atoms. You can see the number of carbon atoms is same on both sides.

Finally, check the number of oxygen atoms on both sides. You can see that the number of oxygen atoms on left side of equation is 2 and 4 on right side, so you need to add 2 as co-efficient of O_2 at left side to balance the oxygen atoms on both sides.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

Check your work, the final balanced equation is written as below:

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

Example-2 Balance the chemical equation:

$$Fe + H_2O \longrightarrow Fe_3O_4 + H_2$$

You can start by balancing Fe atoms on both sides of equation. There is only one Fe atom on the left side while 3 Fe atoms on the right side. So, you have to add coefficient '3' with Fe at left side to balance the Fe atoms on both sides of the equation.

$$3Fe + H_2O \longrightarrow Fe_3O_4 + H_2$$

Now look at the oxygen atoms on both sides of the equation. As there is one oxygen atom on left side and 4 oxygen atoms on right side of the equation. So, you have to add coefficient '4' with H_2O on left side to balance oxygen atoms on both sides of equation.

$$3Fe + 4H_2O \longrightarrow Fe_3O_4 + H_2$$

Finally, you have to balance the hydrogen atoms on both sides. As there are 8 hydrogen atoms on left side and 2 hydrogen atoms on right side. So, you have to add coefficient '4' with H_2 at right side to balance hydrogen atoms on both the sides.

$$3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$$

Activity 5.4

Balance the following chemical equations

i. $KOH + H_3PO_4 \rightarrow K_3PO_4 + H_2O$

ii. $Na_3PO_4 + HCl \rightarrow NaCl + H_3PO_4$

iii. $Ba_3N_2 + H_2O \rightarrow Ba(OH)_2 + NH_3$

iv. $CaCl_2 + Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + NaCl$

v. $NH_3 + O_2 \rightarrow NO + H_2O$

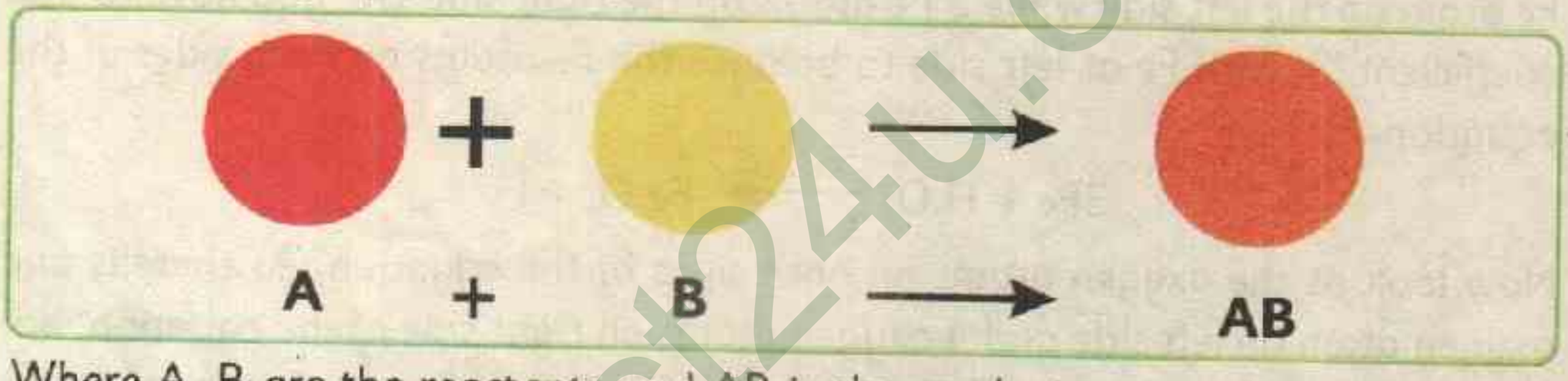
Types of chemical reactions

Chemical reactions can be categorized into four basic types. However, these do not cover all the types of reactions.

i. Addition or synthesis reactions.
ii. Decomposition reactions.
iii. Single displacement reactions or Substitution reactions.
iv. Double displacement reactions.

i. Addition or Synthesis Reactions.

These chemical reactions occur where two or more substances react together to form one product. They are relatively large in number. Addition reactions can be symbolically represented as,



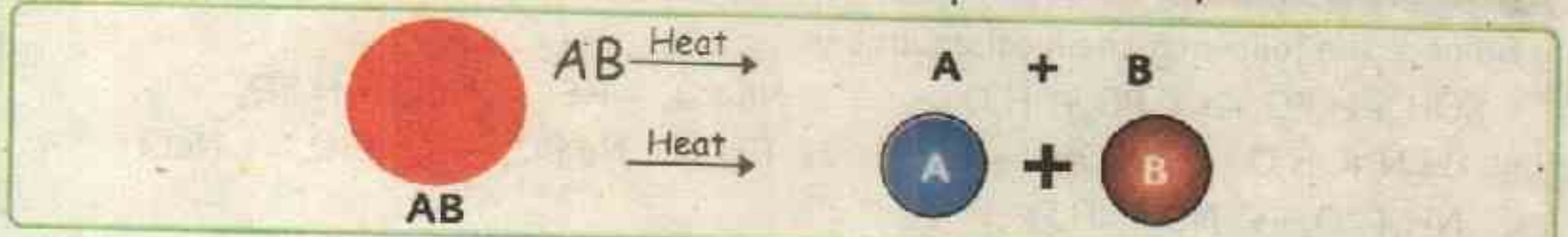
Where A, B are the reactants and AB is the product.

Examples: $S + O_2 \longrightarrow SO_2$
sulphur oxygen sulphur dioxide

$2Fe + O_2 \longrightarrow 2FeO$
iron oxygen iron oxide

ii. Decomposition Reactions.

Decomposition reactions have one reactant which breaks up to from two or more products. Usually, decomposition reactions are endothermic as they required heat. Decomposition reaction can be represented as,



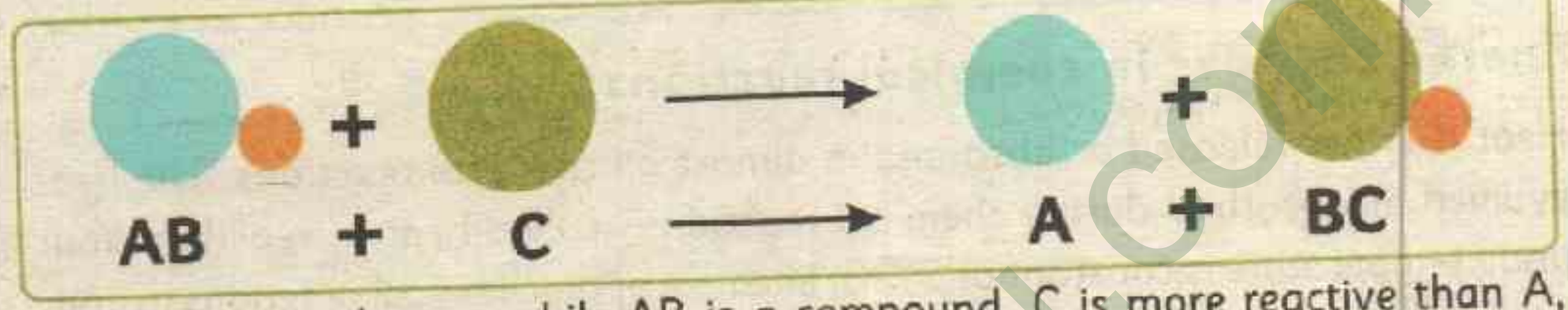
Where AB is the reactant while A and B are products.

Examples: $CaCO_3$ (calcium carbonate) $\longrightarrow$ CaO (calcium oxide) + CO_2 (carbon dioxide)

$2KClO_3$ (potassium chlorate) $\longrightarrow$ $2KCl$ (potassium chloride) + $3O_2$ (oxygen)

iii. Single Displacement Reactions.

Such types of chemical reactions occur when a more reactive element displaces a less reactive one from its compound.



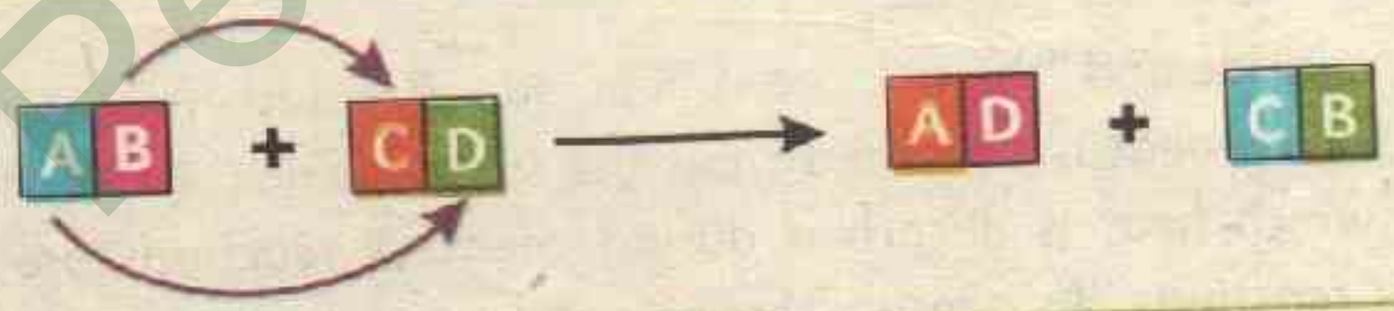
Where C is an element while AB is a compound, C is more reactive than A, therefore it displaces A from its compound.

Examples: Zn (zinc) + $2HCl$ (hydrochloric acid) $\longrightarrow$ H_2 (hydrogen) + $ZnCl_2$ (zinc chloride)

$2Na$ (sodium) + $2H_2O$ (water) $\longrightarrow$ $2NaOH$ (sodium hydroxide) + H_2 (hydrogen)

iv. Double Displacement Reactions.

Double displacement reactions involve the exchange of ions between two compounds. Double displacement reaction can be represented as,



Where AB and CD are reactants, they split into ions when dissolved in water and produce AD and CB products by exchanging their ions.

Examples: HCl (hydrochloric acid) + $NaOH$ (sodium hydroxide) $\longrightarrow$ $NaCl$ (sodium chloride) + H_2O (water)

$$\underset{\text{copper sulphate}}{CuSO_4} + \underset{\text{zinc oxide}}{ZnO} \longrightarrow \underset{\text{zinc sulphate}}{ZnSO_4} + \underset{\text{copper oxide}}{CuO}$$

Activity 5.5

Complete the following chemical equations

- $Na + H_2 \longrightarrow$ _____
- $Mg + 2HCl \longrightarrow$ _____
- $N_2 + H_2 \longrightarrow$ _____
- $KOH + HCl \longrightarrow$ _____

Energy changes in chemical reactions

Heat is either released or absorbed in almost all chemical reactions. The heat evolved or absorbed during chemical reaction is called heat of reaction. Your body temperature is constant at 37°C, because of biochemical reactions in your body which absorb or release heat. There are two types of reactions with respect to energy changes.

Fig 5.2 (a) Exothermic reaction

Fig 5.2 (b) Endothermic reaction,

Endothermic reaction

"Endo" means inside and "therm" means heat, so the endothermic refers to those reactions in which heat is absorbed from the surroundings. All those chemical reactions in which heat is absorbed during chemical reactions are known as "Endothermic reactions."As a result, the temperature of the surroundings drops. These reactions cannot proceed without addition of heat. For example, the decomposition of potassium chlorate and calcium carbonate require heat.

$$2KClO_3 + \text{Heat} \longrightarrow 2KCl + 3O_2$$
$$CaCO_3 + \text{Heat} \longrightarrow CaO + Co_2$$

Fig 5.3 Endothermic reaction

Exothermic reaction

"Exo" means outside and "therm" means heat, so exothermic reactions are those reactions in which heat is released into the surrounding. As a result, the temperature of the surroundings increases. All those chemical reactions in which heat is released during a chemical reaction are known as exothermic reactions. The best example of exothermic reactions involve burning.

Fig 5.4 Exothermic reaction

For example

i. Burning of natural gas (methane).

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + Heat$$

ii. Formation of ammonia.

$$3H_3 + N_2 \rightleftharpoons 2NH_3 + Heat$$

Importance of exothermic reactions in daily life

Exothermic reactions are extremely important in our daily life.

- The life on earth is possible due to the exothermic reactions taking place in the sun.
- The heat released during respiration, not only keeps us warm but also provides energy for our normal functions.
- We enjoy the warmth from the heat released by the combustion of wood, charcoal and natural gas.
- The heat released by the burning of fuels is also used for cooking food, running vehicles and operating factories.

KEY POINTS

- A chemical reaction is the process by which new substances are formed.
- Mass can neither be created nor destroyed during a chemical reaction.
- During a chemical reaction, total mass of products is equal to the total mass of reactants.
- Chemical equation is the representation of chemical reaction in terms of symbols and formulae.
- Chemical reactions can be categorized into four basic types.
- Addition reactions occur when two or more substances react together to form one product.
- In decomposition reaction, there is only one reactant which must be a compound. Which breaks down into two elements or compound.
- Single displacement reactions occur when a more reactive element displaces a less reactive one from its compound.
- Double displacement reactions involve the exchange of ions between two compounds.
- Heat is either released or absorbed in almost all chemical reactions.
- The heat evolved or absorbed during chemical reaction is called heat of reaction.
- All those chemical reactions in which heat is released are known as exothermic reactions.
- All those chemical reaction in which heat is absorbed are known as endothermic reactions.
- The simplest method for balancing is inspection or trial and error method.

Exercise

A. Fill in the blanks to complete the following equations.

i. $2KClO_3 \longrightarrow$ 2KCl + $3O_2$

ii. $3H_2$ + N2 $\longrightarrow 2NH_3$

iii. $2Na + 2H_2O \longrightarrow$ 2NaoH + H_2

iv. $NaOH + HCl \longrightarrow$ NaCl + H_2O

v. Mg + 2HCl $\longrightarrow MgCl_2$

B. Choose the correct answer for each of the following statements.

i. Substances on the left hand side of a chemical equation are called:
(a) electrons (b) groups (c) products (d) reactants ✓

ii. The reaction in which there is only one reactants, which must be a compound is:
(a) ✓ decomposition (b) displacement
(c) synthesis (d) double displacement

iii. Number of atoms of reactants is equal to number of products in a balanced chemical equation:
(a) sometimes (b) often (c) ✓ always (d) never

iv. The reaction between sodium and chlorine to from sodium chloride is:
(a) displacement (b) decomposition reaction
(c) ✓ addition reaction (d) double decomposition reaction

v. The heat evolved or absorbed during a chemical reaction is called:
(a) heat of reaction (b) exothermic
(c) ✓ heat energy (d) endothermic

C. Give short answers of the following.

i. What are the characteristics of chemical reactions?

ii. Define chemical reaction and its types.

iii. Explain each type of chemical reaction with one example each.

iv. Exothermic reactions are very important in our daily life. Give two reasons.

v. What is a balanced chemical equation? Why chemical equations need to be balanced?

D. Give detailed answers to the following questions.

i. Explain the steps for balancing of chemical equations with two examples.

ii. (a) Define Law of conservation of mass. Explain with the help of two examples.

(b) When a pile of wood is burnt, the ash left behind is less as compared to wood. How Law of conservation of mass is applicable in this situation?

iii. Define heat of reaction. Differentiate between exothermic and endothermic chemical reactions, with examples.

Project

(a) Make a list of ten endothermic and exothermic reactions from daily life.

(b) Write any twenty balanced chemical equations is your copies.

Exothermic reaction

Endothermic reaction

UNIT 6

ACIDS, ALKALIS AND SALTS

After studying this unit, students will be able to:

- Define the terms acid, alkali and salt.
- Describe the properties of acids, alkalis and salts.
- Explain the uses of acid, alkali and salt in daily life.
- Define indicators.
- Use indicators to identify acids, alkalis and neutral substances.
- Investigate the colour changes in the extracts of various flowers and vegetables by adding acids and alkalis.

Introduction

Acids, alkalis and salts are three main categories of chemical compounds. These have certain definite properties, which distinguish one category from the other. The sour taste of many fruits and vegetables is due to various types of acids present in them. The digestive fluids of most animals and humans also contain acids. Alkalis on the other hand are the chemical compounds that have bitter taste and soapy to touch. Soap, drain opener and detergents are some examples of alkalis. Salt is the third category of chemical compounds. Salt is formed by the reaction of acid and alkali. Table salt, potash alum and baking soda are some of the examples of salts. In this unit, you will learn about the properties and usage of acids, alkalies and salts. You will also learn about their identification.

Acid

The word acid is derived from a Latin word "acidus" which means sour. It is defined as a substance, which provides hydrogen ions H^+ in aqueous solution.

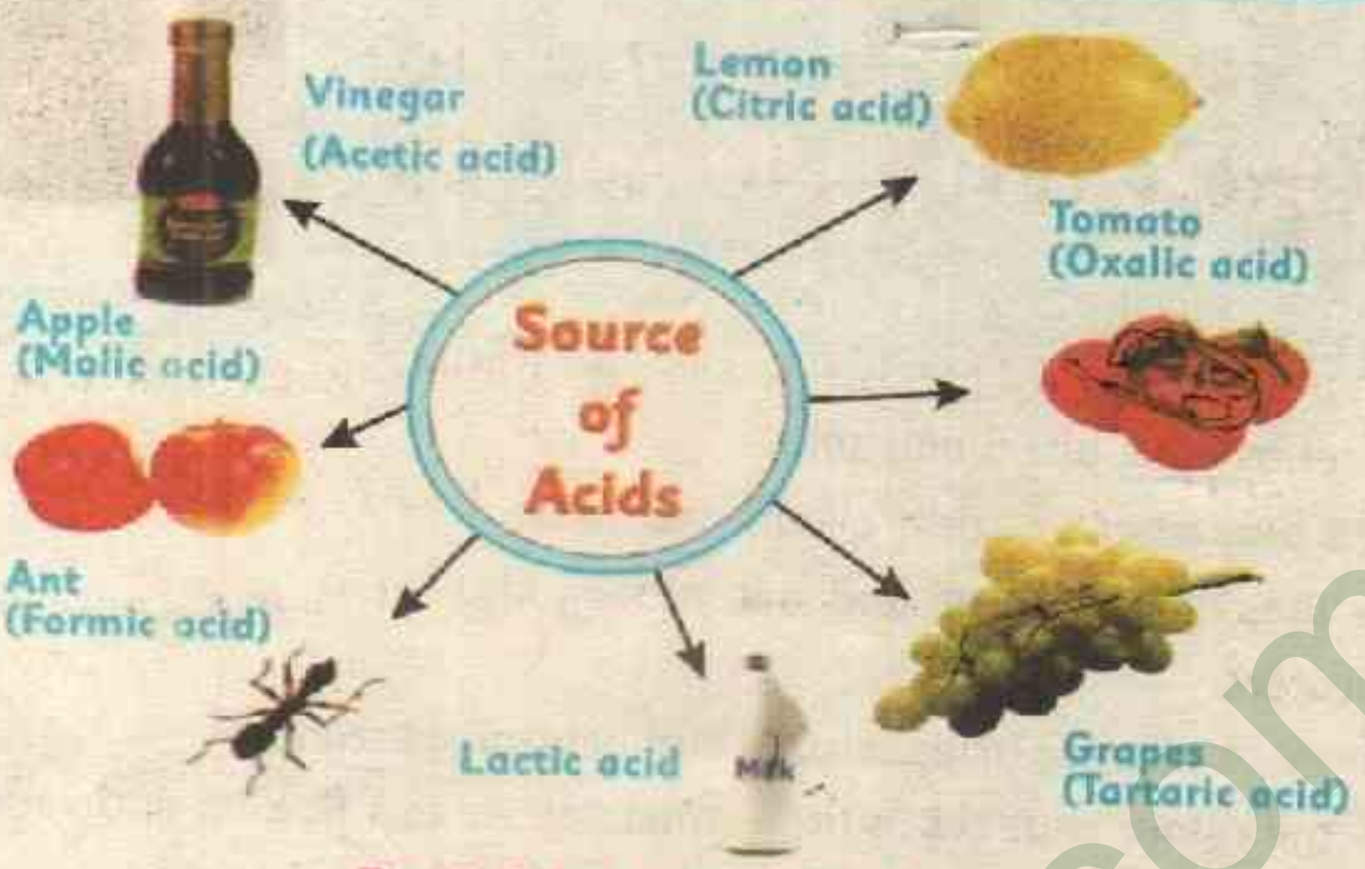


Fig 6.1 Acids and their sources

Physical properties of acids

Acids have following physical properties.

- sour taste.
- turn blue litmus paper to red.
- turn methyl orange to red.
- aqueous solution of acids conduct electric current.
- strong acids destroy fabric and cause burns on the skin.

Chemical properties of acids

i. Ionization

Acids give hydrogen ion H^+ when dissolved in water.

$$HCl \longrightarrow H^+ + Cl^-$$

$$H_2SO_4 \longrightarrow 2H^+ + SO_4^{-2}$$

ii. Reaction with metal

Acids produce salt and hydrogen gas when treated with metals.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

iii. Reaction with alkalis

They give salt and water when treated with an alkali. This reaction is called neutralization reaction.

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

$$HNO_3 + NaOH \longrightarrow NaNO_3 + H_2O$$

iv Reaction with carbonates

Acids and carbonates react to produce salt, water and carbon dioxide gas.

$$MgCO_3 + 2HCl \longrightarrow MgCl_2 + CO_2 + H_2O$$

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$$

Alkali

Alkali is defined as a substance which provides OH^- ions in aqueous solution. Examples of alkalies are, Sodium hydroxide NaOH, Potassium hydroxide KOH and Ammonium hydroxide NH_4OH etc.

Important Fact

Water soluble bases are called alkalies. All alkalies are bases but all the bases are not alkalies.

Fig 6.2 Alkalies around us

Physical properties of alkalies

- They have a bitter taste.
- They are slippery to touch.

- They conduct electricity when dissolved in water.
- Strong alkalies damage skin and fabrics.
- They turn red litmus to blue.
- They turns colorless phenolphthalein to pink.

Chemical properties of alkalies

i. Ionization:

Alkalies give hydroxyl ions OH^-, when dissolved in water.

$$NaOH \longrightarrow Na^+ + OH^-$$

$$KOH \longrightarrow K^+ + OH^-$$

ii. Reaction with acids:

They give salt and water, when treated with acids.

$$KOH + HCl \longrightarrow KCl + H_2O$$

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

iii. Reaction with fats:

Alkalies reacts with fats to produce soap and glycerin.

$$\text{Alkali} + \text{Fats} \longrightarrow \text{Soap} + \text{Glycerin}$$

Salt

A chemical compound formed by the reaction of an acid and base is called salt. The reaction is called neutralization reaction. Examples of salts are, Table salt (NaCl), calcium sulphate ($CaSO_4$), potassium chloride (KCl), Baking soda ($NaHCO_3$) etc.

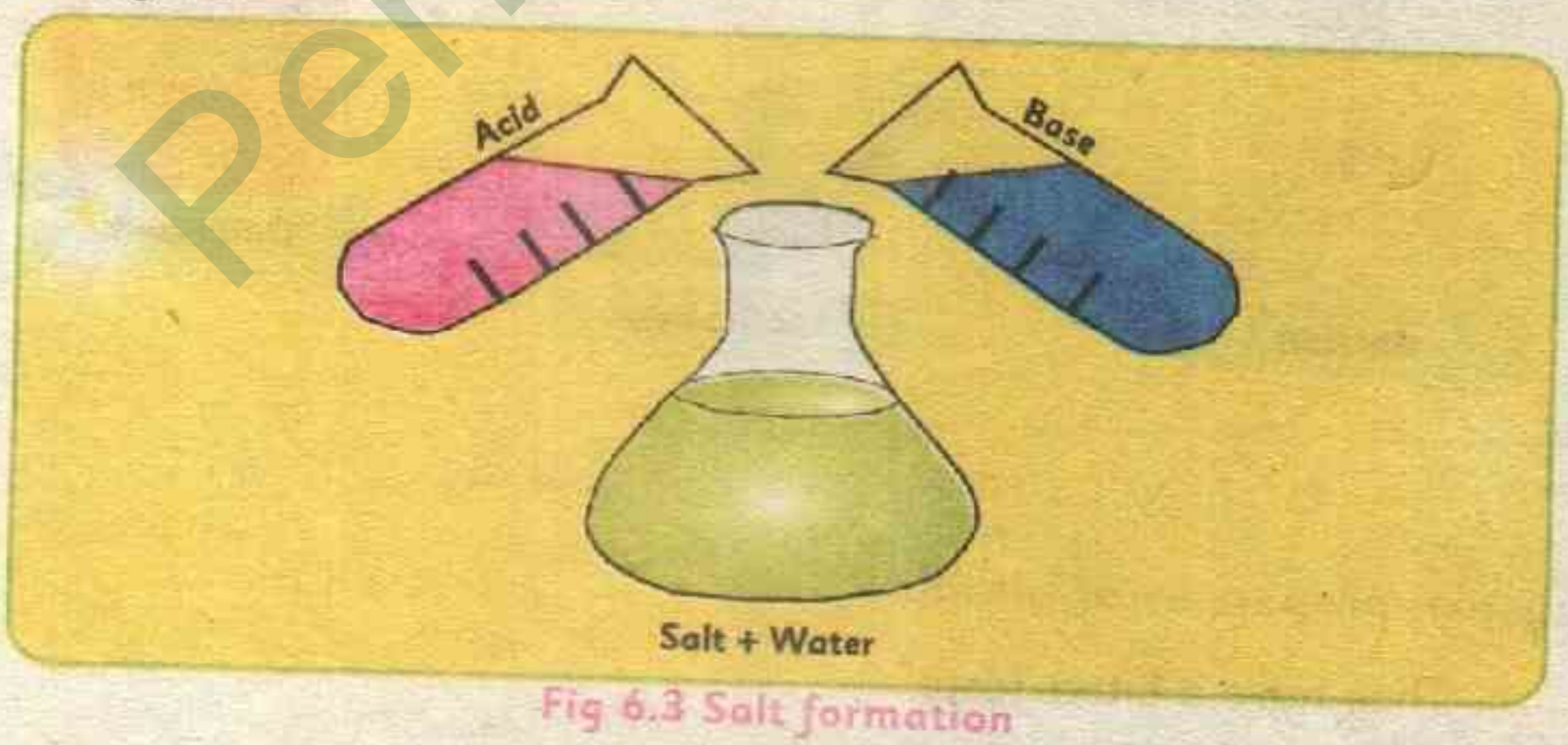


Fig 6.3 Salt formation

Properties of salt

- The aqueous solution of salt conduct electric current.
- Salt may be acidic, basic or neutral.
- The general formula of a salt is written as, B_nA_m. Where B is basic ion, A is an acid ion, n and m are the valences of acidic and basic ions.

Uses of acids, alkalies and salts

Uses of Acids

Acids have a number of applications in our homes and industries. Some of the uses of acids are as under:

i. Vinegar contains acetic acid. It is used in pickles and in many food preparations.

ii. Lemon and orange juice contains citric acid. Citric acid is used in the preparation of fruit salts and as a food preservative.

iii. Acids have many uses in industry. Nitric acid and sulphuric acid are used in the manufacture of fertilizers, dyes, paints, drugs and explosives.

iv. Sulphuric acid is used in car batteries. It is also used in manufacturing a number of synthetic products.

v. Acids are used to make aqua regia in which noble metals such as gold and platinum can be dissolved.

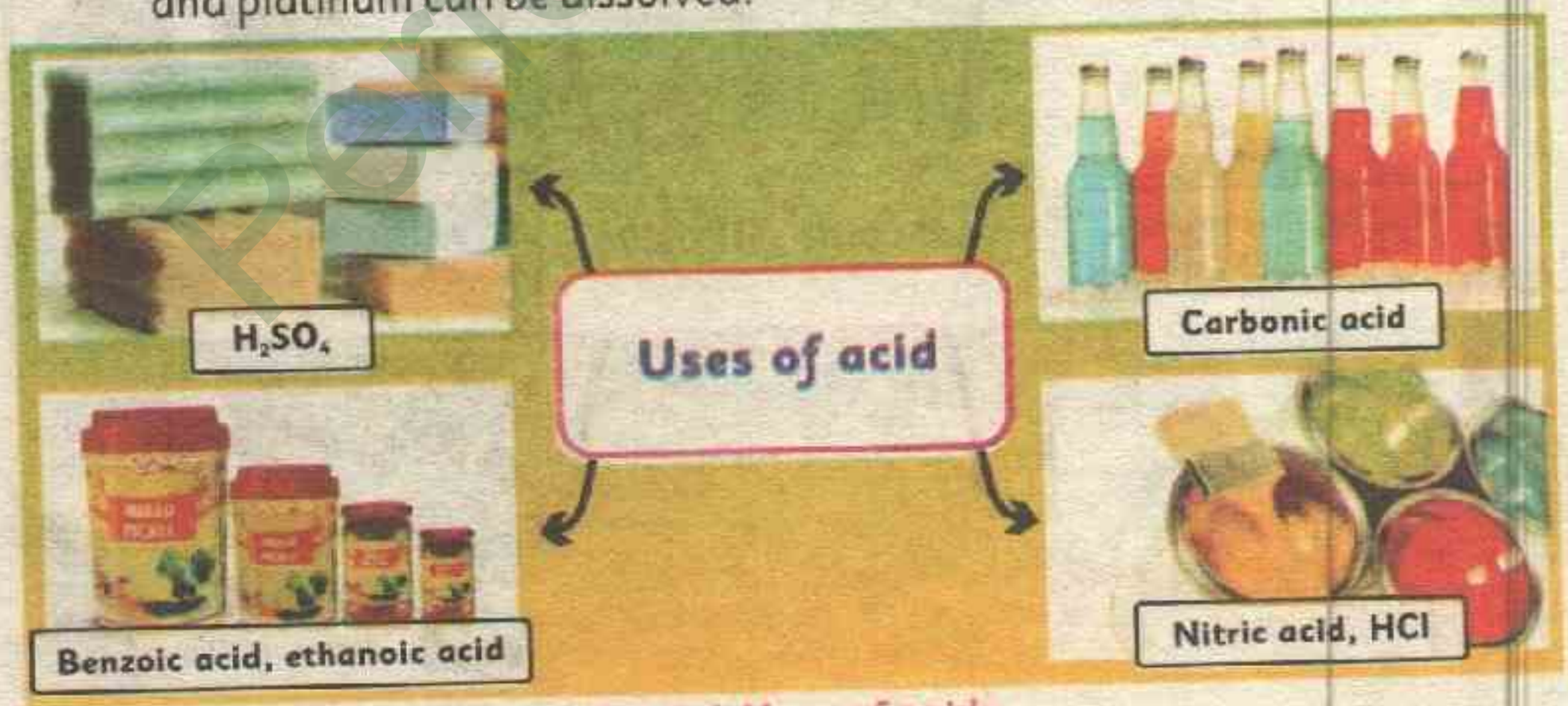


Fig 6.4 Uses of acids

Uses of alkalies

Some of the important uses of alkalies are;

i. Ammonia (NH_3) is used in the production of fertilizers (ammonium nitrate), in the manufacture of nitric acid and neutralize acids in the petroleum refining.

ii. Aluminum hydroxide ($Al(OH_3)$) is used as antacid to reduce the acidity of stomach.

iii. Calcium hydroxide ($Ca(OH_2)$) is commonly known as slaked lime or lime water. It is used for white wash, neutralize the acidity of soil and sewage treatment.

iv. Sodium hydroxide (NaOH) is commonly known as caustic soda. It is used in the manufacturing of soaps, detergents and cleaners.

v. Magnesium hydroxide ($Mg(OH)_2$ suspension is used as an antacid and as a non-hazardous alkali to neutralize acidic waste water. It is also used in toothpaste.

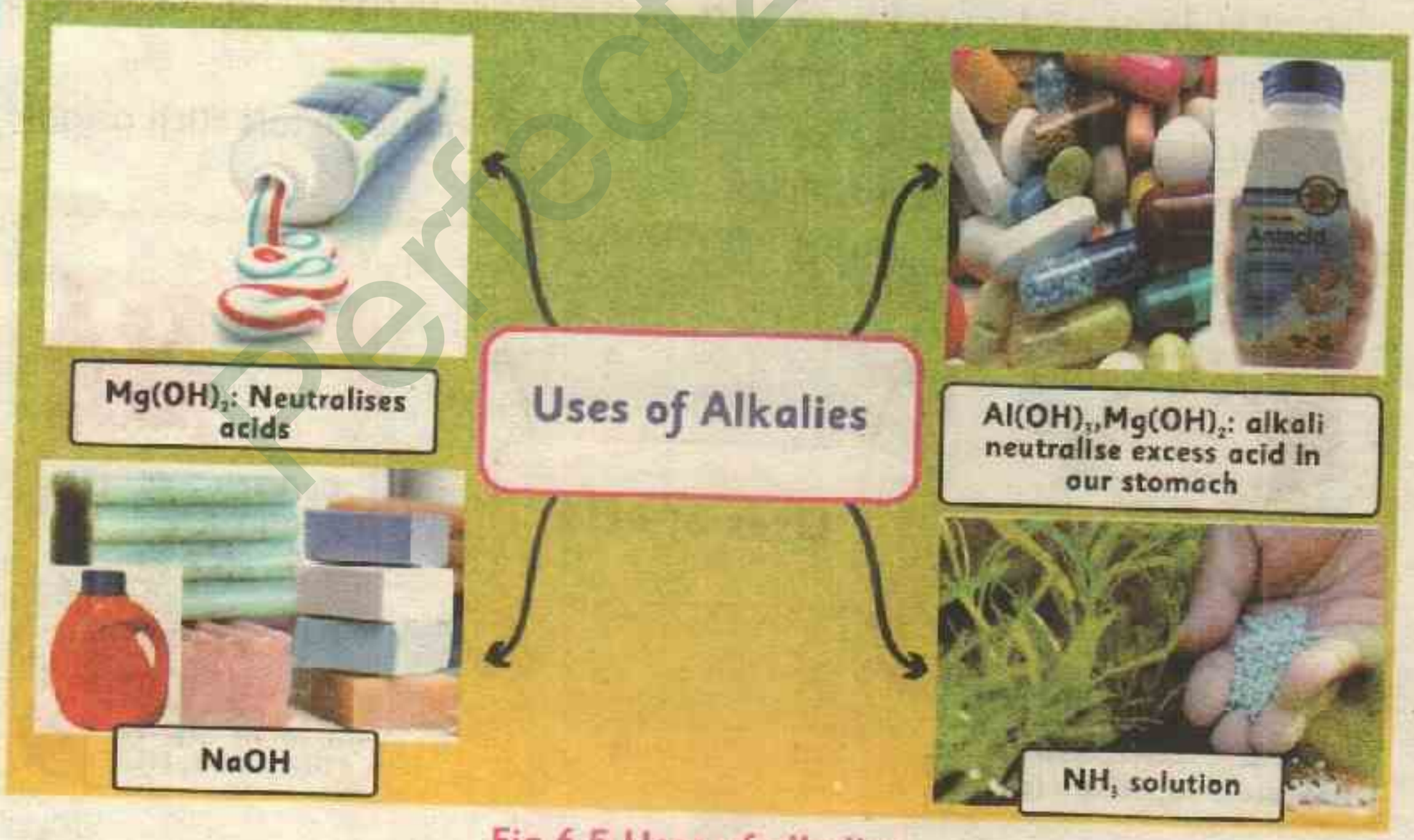
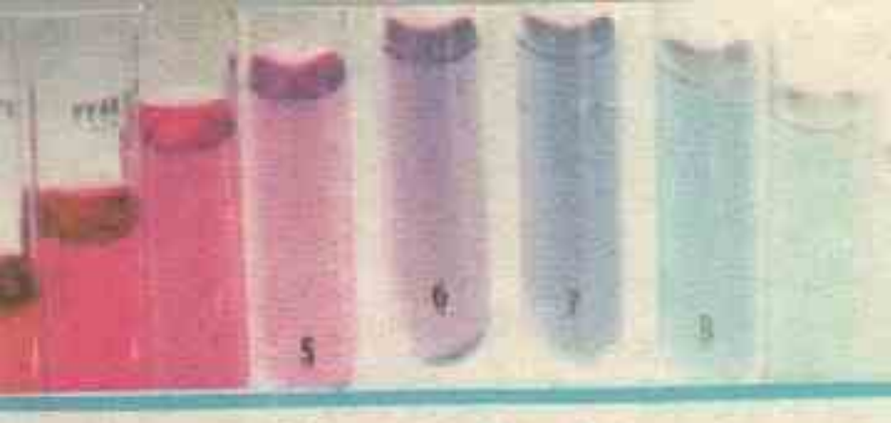


Fig 6.5 Uses of alkalies



Uses of salts

i. Sodium chloride (NaCl) is used as a table salt, preservative and in industries for the manufacture of many sodium compounds.

ii. Potash alum ($KAl(SO_4)_2.24H_2O$) is commonly used in water purification, and as antiseptic for minor bleeding due to shaving.

iii. Copper sulphate ($CuSO_4.5H_2O$) is a very versatile chemical and is extensively used in industry. In agriculture it is used as a pesticide.

iv. Sodium carbonate (Na_2CO_3) is used in the making of glass, soap, washing soda etc., and as a house hold cleaning agent and as water softener.

v. Sodium hydrogen carbonate or baking soda ($NaHCO_3$) is commonly used as an anti acid, in fire extinguishers and in bakeries.

vi. Magnesium sulphate ($MgSO_4.7H_2O$) is commonly known as Epsom salt. It is used as laxative in medicine to treat constipation.

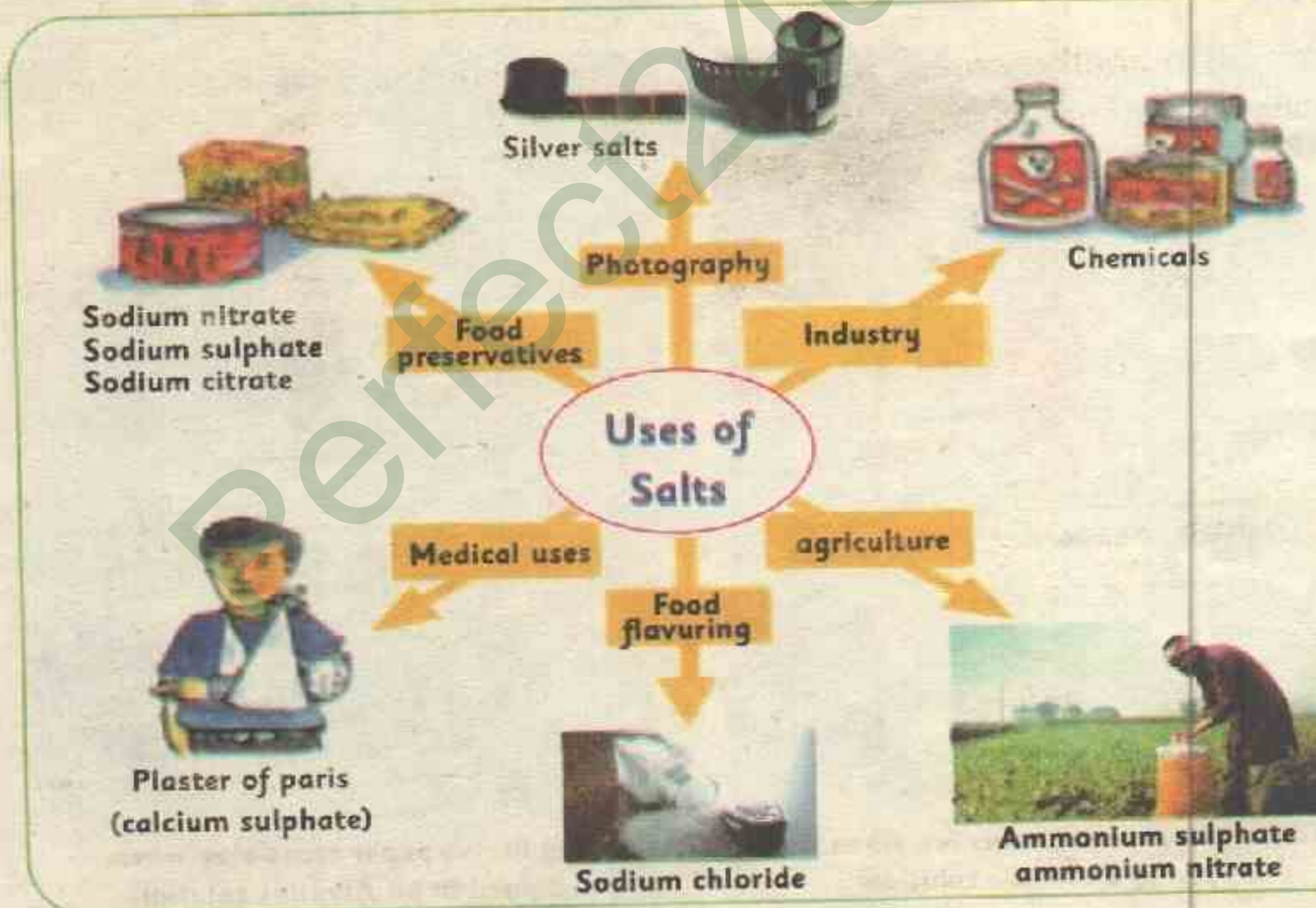
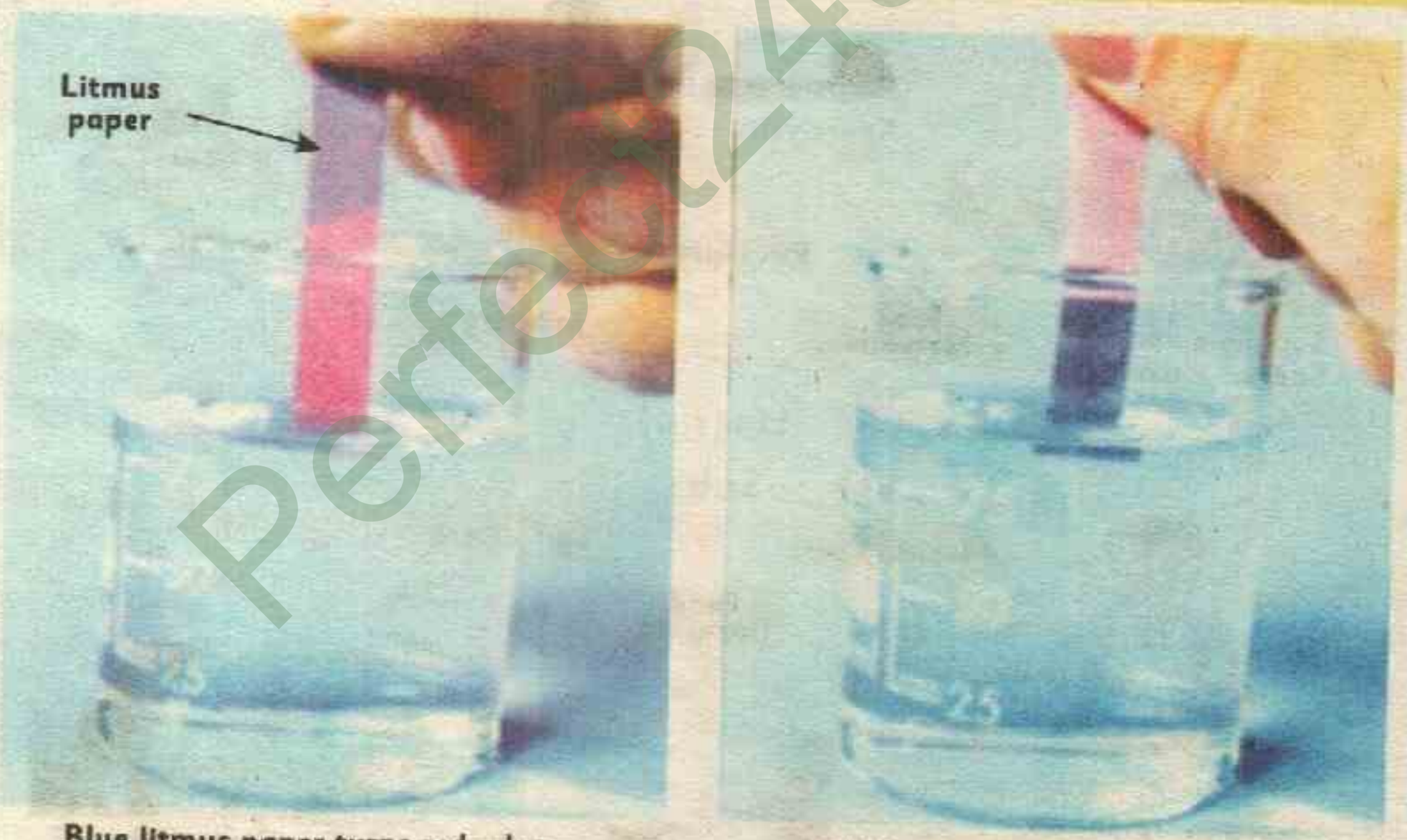


Fig 6.6 Uses of salts

Acid - Alkali Indicators

The most common method to get an idea about the nature of solution is to use an indicator. Those substances which indicate the nature of a solution whether acidic or basic by changing their colour are called indicators. A classic example of indicators is litmus paper. Blue litmus paper turns red when it is dipped in acidic solutions while red litmus paper turns blue when dipped in alkaline solutions. However, both (red and blue) litmus papers remain unchanged in neutral solution. The most common indicator is found on "litmus" paper.

Colour of litmus paper	Acid	Alkaline
Blue	turns red	stays same
Red	stays same	turns blue



Blue litmus paper turns red when dipped in an **Acidic** solution

Red litmus paper turns blue when dipped in an **Alkaline** solution

Fig 6.7 Use of litmus paper as indicator

Activity 6.1

Find out the nature of the following substances with the help of litmus paper

Substance Tested	Red Litmus color	Blue Litmus color	Acid, Alkali, or Neutral?
Table Salt Solution			
Milk			
Tap Water			
Baking Soda solution			
Soap solution			
Hydrogen Peroxide			
Shampoo			
Orange Juice			
Apple Juice			
Sugar solution			

Fruit and flower extracts as indicators

- **Beets:** An alkaline solution will change the color of beet juice from red to purple.
- **Black Berries:** Blackberries juice change from red in an acidic solution to dark blue or violet in an alkaline solution.
- **Cherries:** Cherries and their juice are red in an acidic solution but turn blue to purple in an alkaline solution.
- **Grapes:** Blue grapes change from deep red in an acidic solution to violet in an alkaline solution.

- **Onion:** Red onion change from pale red in an acidic solution to green in an alkaline solution.
- **Petunia Petals:** Change from reddish-purple in an acidic solution to violet in an alkaline solution.
- **Rose Petals:** Rose petals turr from red to blue in an alkaline solution.

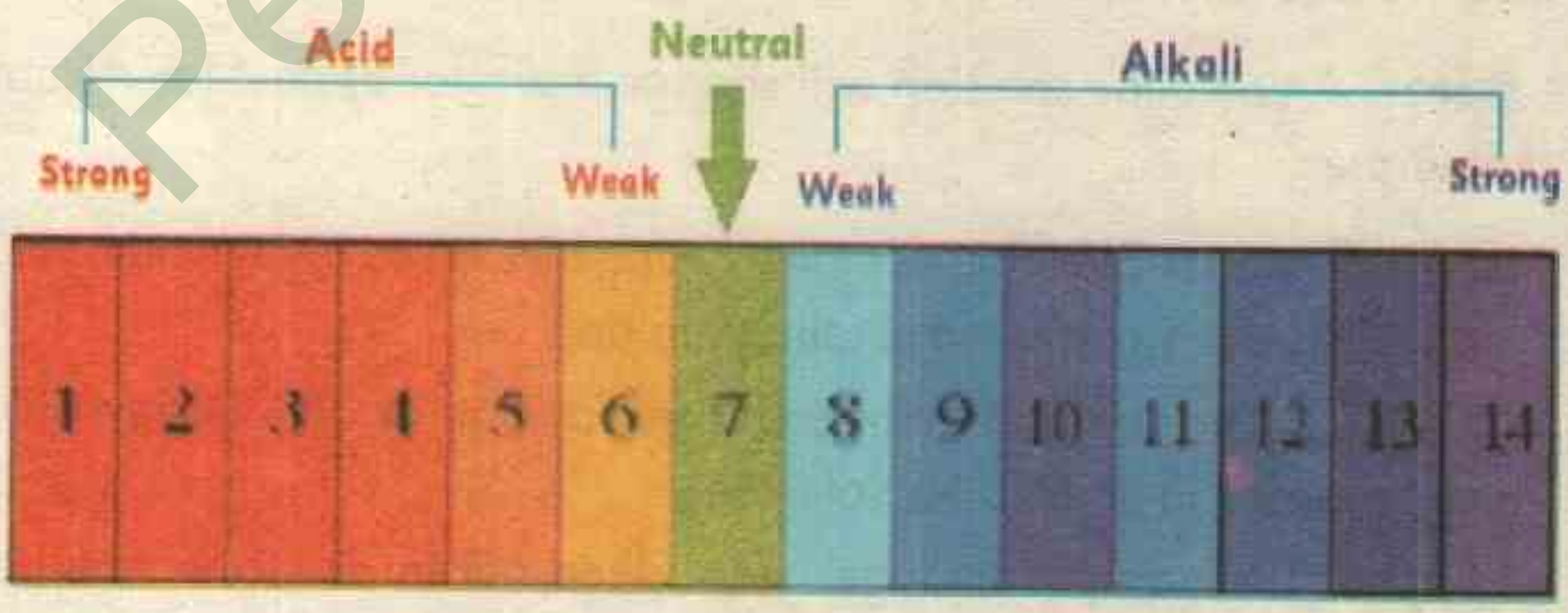
Activity 6.2

Preparation of Indicator from Hibiscus petals

1. Cut approximately 10 mature hibiscus flowers.
2. Remove the red petals.
3. Put them in a mortar and pour 6ml of ethanol or surgical spirit.
4. Crush the petals with pestle in a mortar until all of the liquid has been extracted from the petals.
5. Filter the solution and you have the reddish indicator ready.
   i. It turns red in acidic solution.
   ii. It turns dark green (almost black) in alkaline solution.

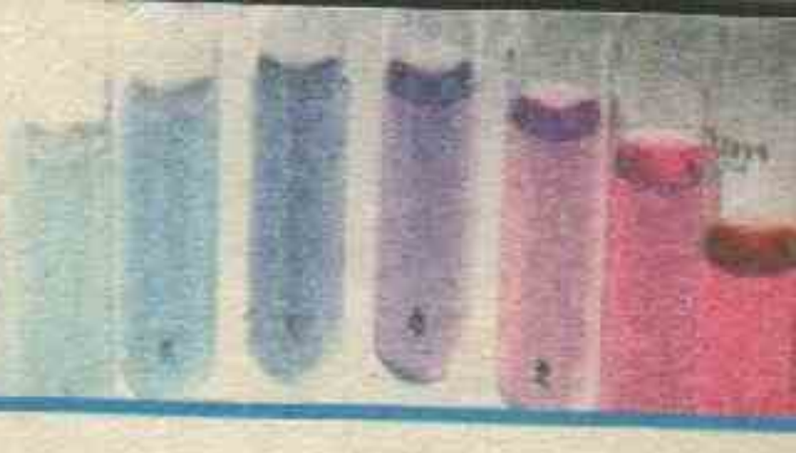
Important Fact

The strength of an acid and base is measured by pH scale. pH is determined with the help of pH paper or pH meter and then the value is compared with pH scale. The range of pH scale is from 0 to 14. The pH range of acids is below 7 while the pH range of alkalis is above 7. Seven is the pH of neutral solution i.e. pure water.



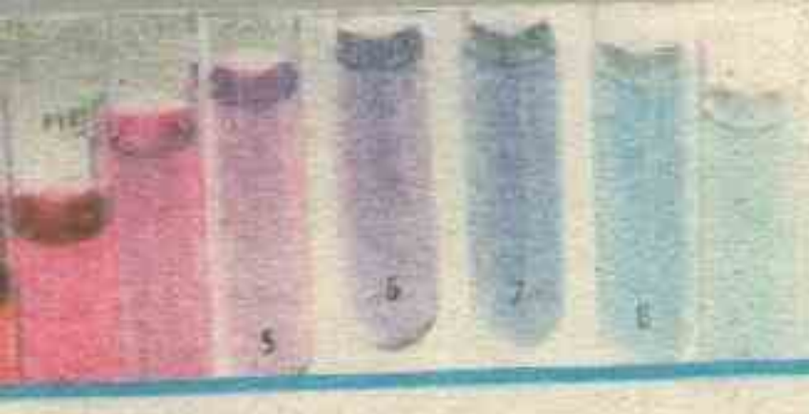
pH values of various items

Fig 6.8 pH values of various daily use items



KEY POINTS

- An acid is a substance, which provides hydrogen ions H^+ in aqueous solution.
- An alkali is a base that dissolves in water.
- An alkali is a substance, which provides hydroxyl ions OH^{-1} in aqueous solution.
- An acid is sour while an alkali is bitter in taste.
- An indicator is a substance which determines the nature of a solution i.e. acidic, basic or neutral.
- Acid turns blue litmus paper red.
- An alkali turns red litmus paper blue.
- Salt is formed by neutralization reaction.
- Strong acids and alkalies destroy skin and fabrics.
- The strength of an acid and base is measured by pH scale.
- pH is determined with the help of pH paper or pH meter and then the value is compared with pH scale.
- The range of pH scale is from 0 to 14.
- The pH range of acids is below 7 while the pH range of alkalis is above 7.
- Seven is the pH of neutral solution i.e. pure water.
- Fruit and flower extracts are also used as indicators.



Exercise

A. Complete the following statement.

i. All alkalies are bases but all the bases are not alkalis.

ii. An acid and base react to form salt and water and this reaction is called neutralization reaction

iii. Acid give salt and hydrogen gas when treated with metal.

iv. NaOH reacts with HCl producing NaCl and H_2O.

v. Vinegar contains acetic acid.

B. Choose the correct answer for each of the following statements.

i. Which one of the following acids is used in car batteries?

(a) HCl (b) HNO_3 (c) H_2SO_4 (d) none of these

ii. The colour of red and blue litmus stays same in aqueous solutions of:

(a) HCl (b) HNO_3 (c) H_2SO_4 (d) NaCl

iii. The alkali used as an antacid is:

(a) KOH (b) $Ca(OH)_2$ (c) NaOH (d) $Al(OH)_3$.

iv. Which one of the following salts is used in the treatment of constipation:

(a) NaCl (b) $MgSO_4$ (c) $CuSO_4$ (d) $NaHCO_3$

v. Rose petals turn blue in:

(a) alkaline solution (b) acidic solution

(c) salty solution (d) neutral solution

C. Give short answers of the following.

i. Define neutralization reaction and give examples.

ii. Why CH_3COOH is an acid?

iii. How will you differentiate between acid, alkali and salt?

iv. Define acid, alkali and salt. Give two examples of each.

v. Plaque is formed on your teeth. Plaque feeds on the sugar left on your teeth if you do not brush your teeth and produces acid. Why is it good to use bicarbonate toothpaste and brush the teeth twice a day?

D. Give detailed answers to the following questions.

i. Describe the physical and chemical properties of acids and alkalies, Give their uses as well.

ii. What is a salt? What are the uses of salt? Give three examples of salts.

iii. Solution (1), Which has a pH of 4 is added to solution (2), Until the mixture has pH of 7.

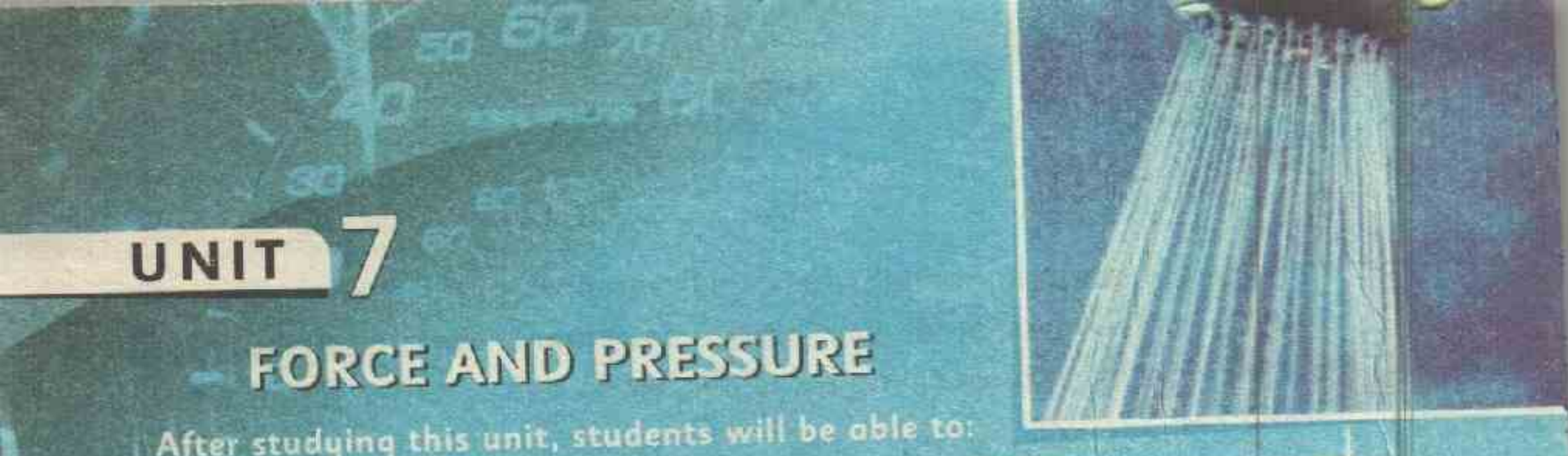
(a) What can you say about solution (1)?
(b) What can you say about solution (2)?
(c) What can you say about the mixture of 1 and 2?

Project

1. Apple science! (Group work)
Use acids, alkalies and salts from your kitchen for an apple experiment for example vinegar, lemon juice, milk of magnesia, baking soda, etc. Cut the apple in cubes and place in each of these chemicals and find out the colour change of an apple cubes in each of these chemicals and show your working to your teacher and class fellows.

2. Is it true to say that blackboard chalk is calcium carbonate? State a proof for your claim.

Chalk in acid



UNIT 7

FORCE AND PRESSURE

After studying this unit, students will be able to:

- Define the term pressure.
- Identify the units of pressure.
- Explain hydraulics and hydraulic system by giving examples.
- Explain how gases behave under pressure.
- Describe the causes of gas pressure in a container.
- Explain the working of aerosols.
- Identify the application of gas pressure.
- Describe the term atmospheric pressure.

Introduction

In previous grades you have already learnt about the concept and definition of force as "push" or "pull". You have learnt about the effects of force with respect to changes in position and shape of the object i.e. when a force is applied on object it brings about change either in its position or in its shape. You know that when you pull something you apply a force. Similarly, when push or press something you apply a force. Can you give examples of the situations in which you produce or tends to produce motion, stops or tends to stop a moving body by applying "push" or "pull"? In daily life you would have heard about the use of term "pressure" like gas pressure, blood pressure, water pressure etc. In this unit, you will learn about pressure, its relation with force and area. You will also learn about water pressure, gas pressure and their applications.

Pressure, Force and Area

The concept of pressure is related to the force and the area on which the force is exerted. Have you observed when you stand on a heap of sand, your feet sink into the sand due to your weight (force). But if you stand on wooden plank lying on the sand, the plank does not sink into the sand, why? In the first case,

the force of your body weight spreads over small area of feet while in second case, the same force spreads over larger area of plank. We can say that in first case the amount of force acting perpendicular on unit area is greater than the second case. In other words, in first case pressure due to force is greater than the second case. Thus, pressure is defined as "the amount of force acting perpendicularly on unit area of a body". Mathematically it can be written as:

$$\text{Pressure} = \frac{\text{Force}}{\text{Surface area}}$$

Point to Ponder

Why do sharp blades of scissors cut well?

If pressure is denoted by P, force by F and area by A, then the above equation can be written as:

$$P = \frac{F}{A}$$

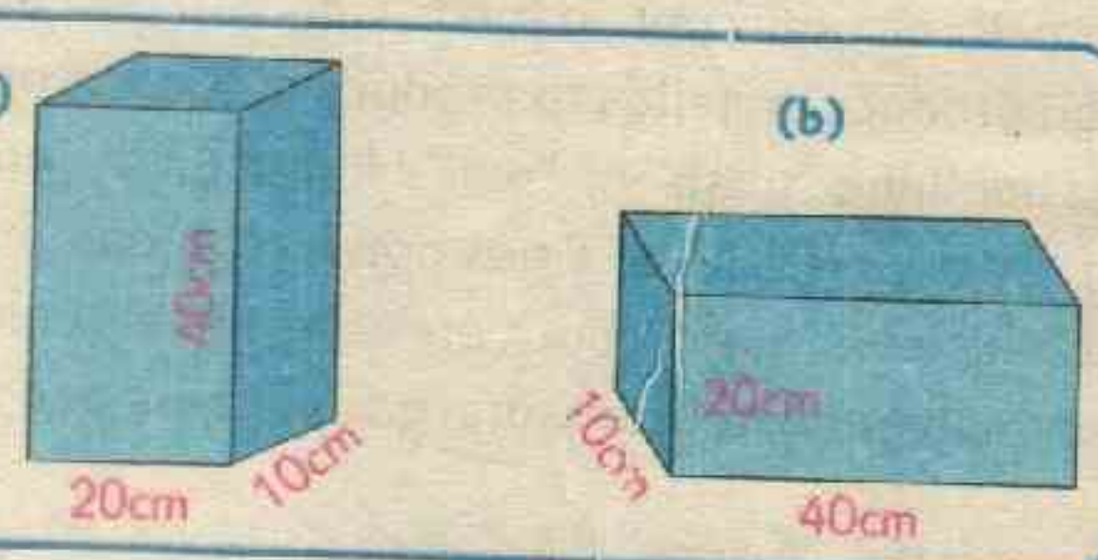
Units of preissure

In System International Units the unit of pressure is called pascal, denoted by Pa, The unit of force is newton (N) and that of area is square meter (m^2), so by putting these values in above equation we get:

$$Pa = \frac{N}{m^2} = Nm^{-2}$$

Activity 7.1

In which position a or b the block exerts more pressure?



Thus when one newton force acts perpendicularly on an area of one square meter, the pressure exerted will be one Pascal (Pa).

Science TidBit

Hydraulic system is often used to produce a large force by applying a small force.

Hydraulics

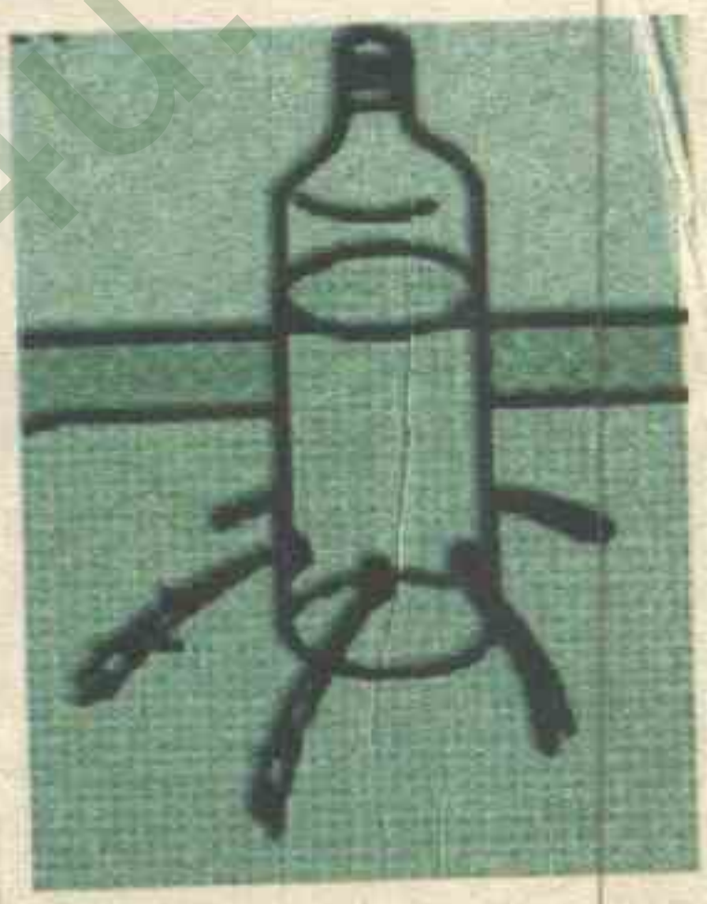
The branch of science (physics) which deals with the transmission of fluid pressure through vessel as a source of mechanical force is called hydraulics.
As pressure is defined as "the force acting on unit area, applied in a direction perpendicular to the surface of the object". So, hydraulic pressure can be stated as the force exerted by a fluid on unit area, anywhere on the surface within the container.

Pressure of fluid can be better understood with the help of Pascal's principal. Pascal's principle of fluid-pressure states that "pressure applied on a liquid in closed container is transferred equally in all directions throughout the liquid."

Activity 7.2

Illustrate Pascal Principal

Apparatus: Plastic bottle, a thin iron nail, scotch tape and water



Procedure:

1. Take a plastic bottle
2. Make a few holes with a nail in the bottle at different places at same height.
3. Close the holes with the help of scotch tape.
4. Fill the bottle with water and place it on a table.
5. Remove quickly the tape from the holes and observe the ejecting out streams of water from the holes.

Observation: Does the water eject out from all the holes with the same speed and pressure?

Hydraulic system

A mechanism (a machine or mechanical appliance) which works on the Pascal's principle of fluid pressure and transmit force from one place to another, is called a Hydraulic system.
Examples: hydraulic press, hydraulic brakes, hydraulic jack, hydraulic lift etc.

Hydraulic Press

Hydraulic press is a machine which works on the Pascal's principle. It consists of two cylinders, one of large cross-sectional area and the other small cross-sectional area. Both the cylinders are connected with a tube. Pistons are fitted at the openings of both the cylinders, which are filled with fluid (water, oil etc.). When the small piston is moved down with a force, it exerts pressure which is transmitted through the fluid to the larger piston. The large piston moves up and compresses the thing place over it, as shown in the figure. 7.1. Hydraulic press is used to compress raw cotton, cloths etc. into bales. Hydraulic jack and hydraulic lift are shown in the figure 7.2.

Fig 7.1 Hydraulic Press

Fig 7.2 Hydraulic Jack and hydraulic lift

Hydraulic Brakes

The brakes of vehicles work on the Pascal's principle. In such type of brakes when the driver pushes down the pedal, the pressure is exerted on the oil due to force applied. In turn the oil transfers this pressure to the brake of the wheels. The brake shoes or discs stop the wheels by friction effect.

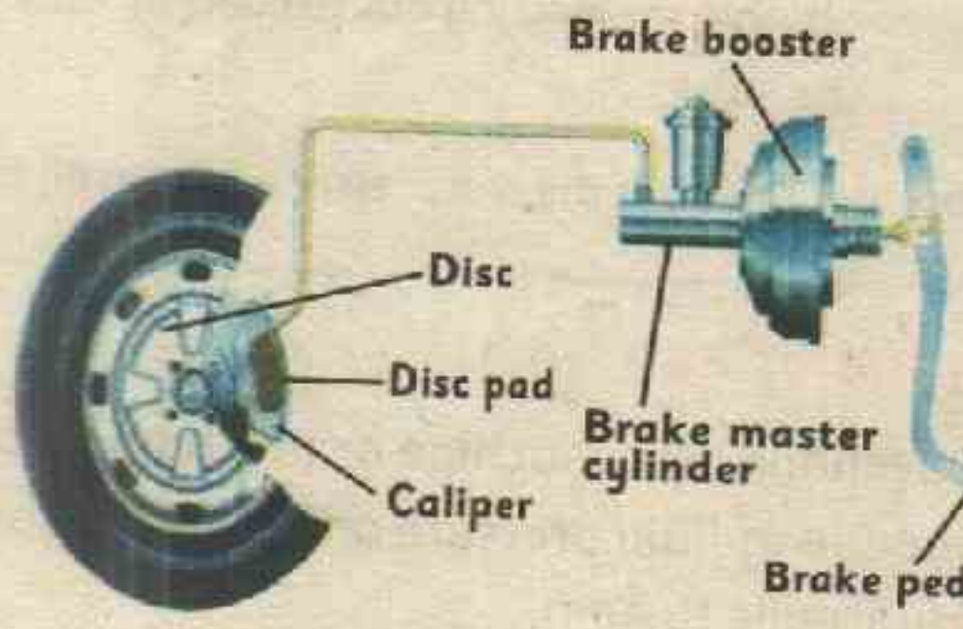


Fig 7.3 Hydraulic break system

When pressure is released from the pedal, the springs pull back the brake shoes and wheels again turn freely.

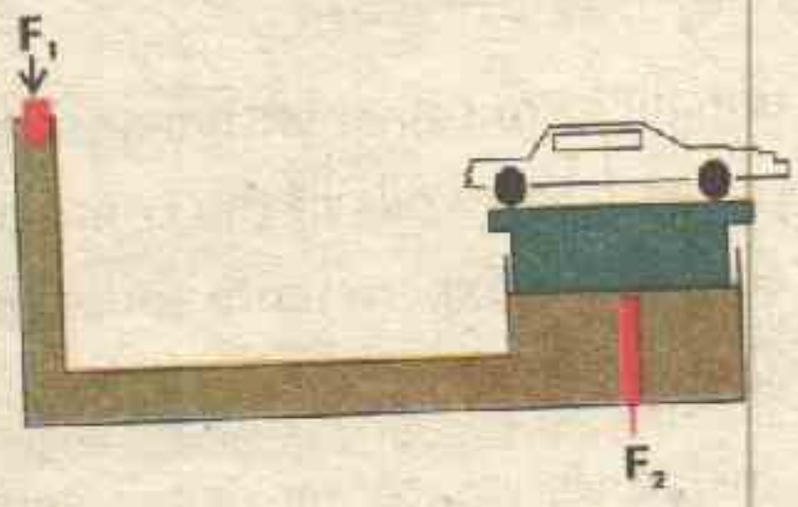


Fig 7.4 Application of Pascal's Law

Water Pressure

Like other liquids water exerts pressure due to distribution of its own weight, which acts in all directions. However, this pressure increases with its depth. Water pressure can be further explained with the following activity.

Activity 7.3

Apparatus: Plastic bottle, a thin nail, scotch tape and water

Procedure:

1. Take a large plastic bottle and make three holes with a thin nail on the side of the bottle at different heights.
2. Close the holes by using scotch tape.
3. Fill the bottle with water and place it on a table.
4. Remove the tape quickly from the holes.

Observations:

1. Note the distances of the streams coming out from the holes. The distance of the lowest stream will be the greatest.
2. Note the angle of each stream with the surface of bottle. You will see that each stream comes out from the holes with angle of 90°.

Conclusion:

1. Pressure of water (liquid) increases with depth
2. Pressure of water is exerted normally at the surface of the container.

Pneumatics: (Pressure of gases)

The study of behaviour of gases under pressure is called pneumatics. The molecules of a gas are free to move because the force of attraction between them are very weak.

Causes of gas pressure

When you fill a container with a gas, the gas molecules collide with one another as well as with the walls of the container. Thus they exert pressure on the walls of the container. Experiments show that the pressure of a gas depends on its quantity and also on its temperature.

1. Inside the container, if temperature rises, the motion of the molecules and pressure increases due to more collisions of molecules with the walls of the container.
2. On increasing the quantity of the gas in the container, the number of collisions of molecules will also increase thus increasing the pressure in the container. You might have observed that tube of bicycle tyre bursts if it is filled with more air or if it remains standing in hot summer daylight.

The molecules in a gas are not very close together so it is possible to squeeze them together so they take up less space or volume. This is called compressing a gas. It puts the gas under pressure.

Activity 7.4

Take two balloons. Inflate one of the balloons and place it near fire. Take another balloon and inflate it more than its capacity.

What will happen in both the cases and why?

Behaviour of Gas under pressure

Robert Boyle, a British scientist, studied the behaviour of a gas under pressure. He studied that the volume of a gas changes with the change in pressure under constant temperature. He concluded that "for a given mass of a gas, the volume of the gas changes inversely with the change in pressure at constant temperature. In other words, if the temperature is kept constant, the volume of a gas in a container decreases with increase in pressure and volume increases with decrease in pressure.

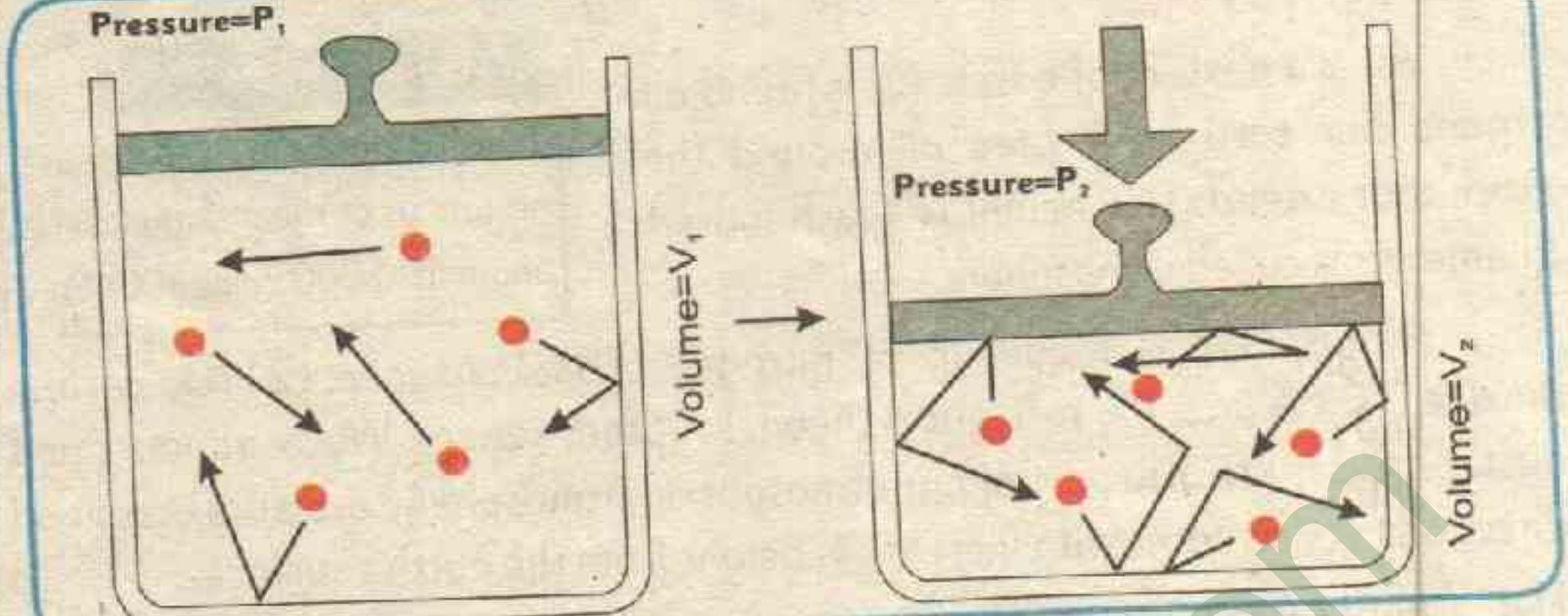


Fig 7.5 Boyle's Law

Aerosols

An aerosol is a suspension of tiny liquid particles in a gas enclosed under pressure and released as a fine spray by means of a propellant gas. An aerosol spray is a can bottle, containing a liquid inside sealed and fitted with a hollow tube that acts as a hydraulic press. When knob is pressed, it exerts pressure inside the bottle and liquid is sprayed out in the form of aerosol.

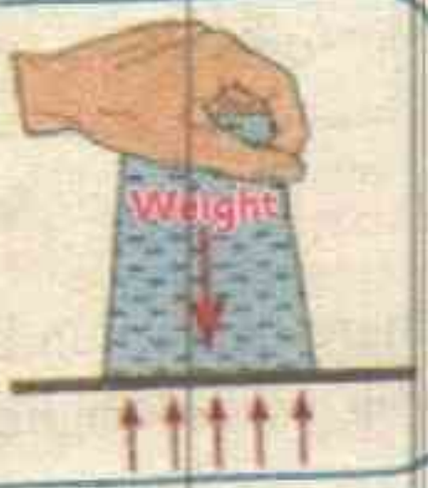
Fig 7.6 Aerosol Spray

Important Fact

In most aerosol's CFCs were used as propellants. Now CFCs are banned because they deplete the Ozone Layer

Activity 7.5

Fill a glass completely with water and place a thin card board over its mouth. Invert the glass pressing the card board firmly to the rim. When the hand is removed, the cardboard will remain in position, preventing the water from running out. Discuss why this happens.



Atmospheric pressure

Air is a mixture of gases. Air is found all around our earth. The area all around the earth that extends to a height of few hundred kilometers is called atmosphere.

Atmosphere is made up of nitrogen (78%), oxygen (21%), carbon dioxide 0.03% and 1% rare gases (neon, krypton, xenon). Water vapours and dust particles are also part of our atmosphere. Atmospheric pressure acts in all directions. It decreases with increase in height from the Earth's surface.

The atmosphere because of its weight exerts a pressure on the surface of the earth, which is called atmospheric pressure.

At sea level, the mean density of the air is maximum and the atmospheric pressure is maximum. As we go up from the sea level, the density of the air decreases. Air pressure at Peshawar will be greater than in Murree. Why?

Do you know?

The atmospheric pressure around us at the ground level is about 100,000 Pa or 100KPa.

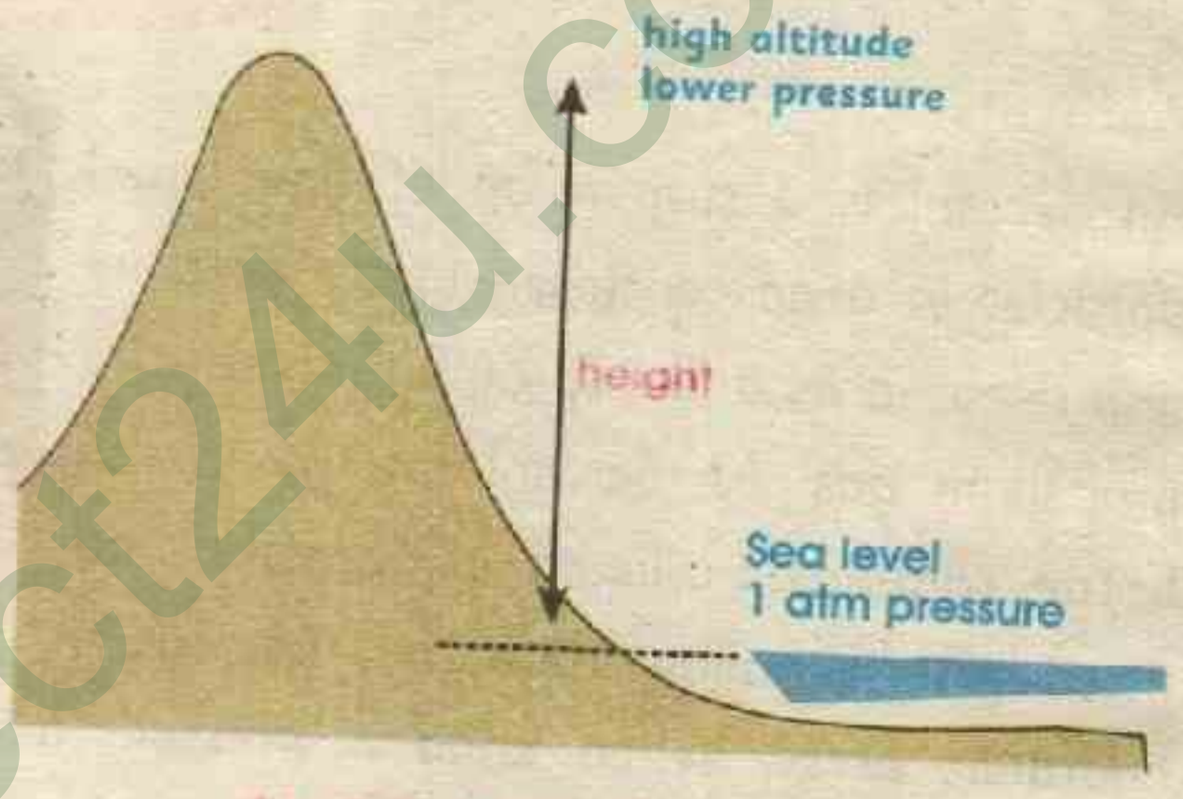


Fig 7.7 Atmosphere pressure and height relationship

Point to Ponder

How are air pressure, altitude and temperature related?

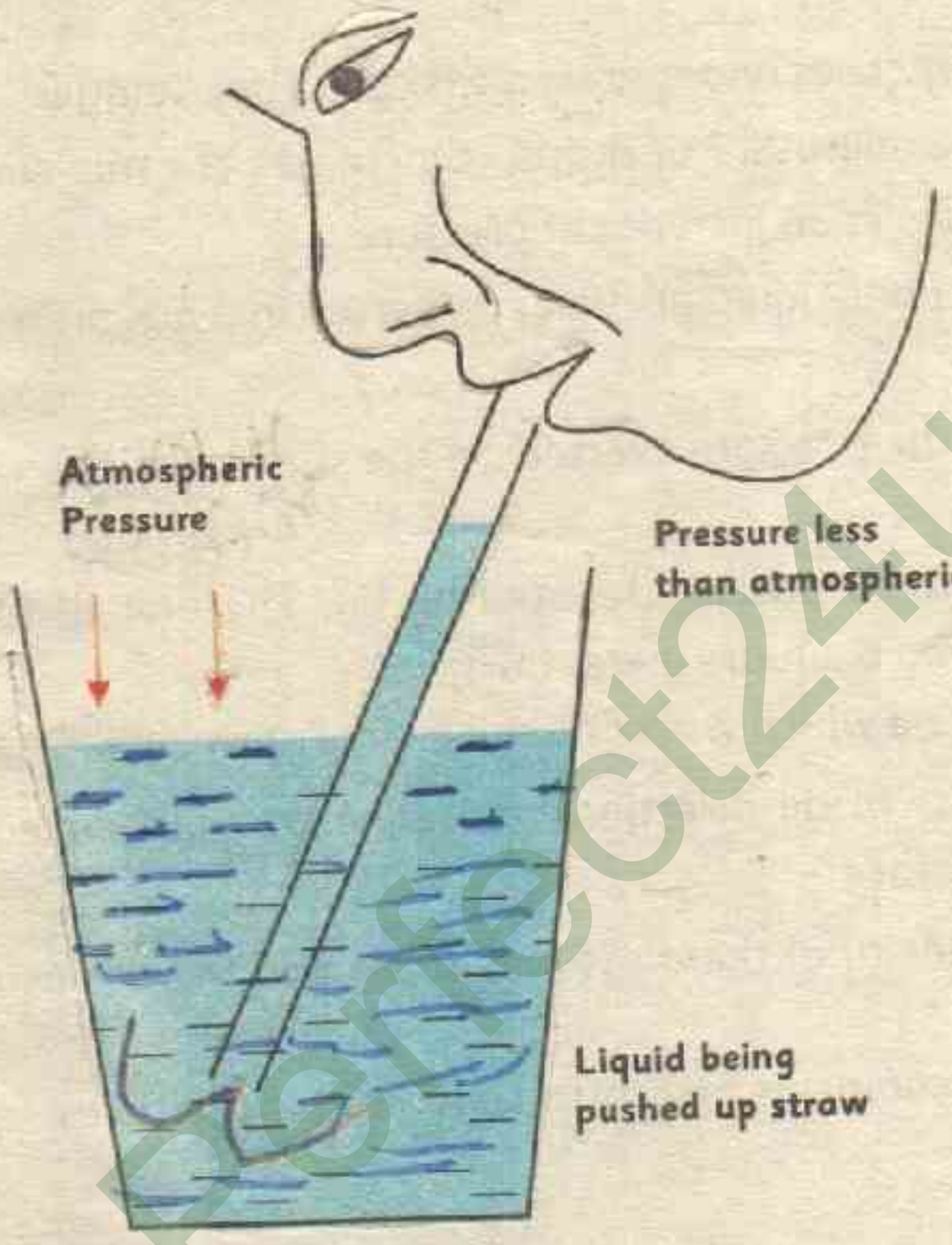
Science TidBit

Barometer is a device which is used for the measurement of atmospheric pressure.

Application of gas pressure

There are a number of applications of gas or atmospheric pressure, some of which are given below:

1. Air motion is caused due to difference in air pressure.
2. Wheels remain inflated because of gas pressure and traffic keeps flowing on the road.
3. Insecticides and pesticides are sprayed through spray machine because of gas pressure.
4. Syringe is filled due to gas pressure.



Science TidBit

When we drink through a straw, the sucking action enables the water to come through the straw into your mouth due to atmospheric pressure.

Points to Ponder

- What do you say, when the number of molecules in the atmosphere decreases with height?
- How can you increase the water pressure in the tap in your kitchen?
- When pressure is exerted on parallel hydraulic pistons, do they start extending at the same time?
- Why mercury is used in a barometer, instead of water?

KEY POINTS

- Pressure is the perpendicular force exerted on a unit area of a surface.
- In hydraulic system, the force is transferred from one place to another with the help of a liquid.
- The study of behaviour of gases under pressure is called pneumatics.
- When we increase the temperature of a gas, it increases the movement of the molecules which results in an increase of pressure.
- Aerosol is a suspension of tiny liquid particles dispersed in a gas present in a closed container.
- Atmospheric pressure is the pressure exerted on the surface of any objects by the air.
- The unit of pressure is called pascal, denoted by Pa, The unit of force is newton (N) and that of area is square meter (m^2),
- Hydraulic press is a machine which works on the Pascal's principle.
- Atmospheric pressure acts in all directions. It decreases with increase in height from the Earth's surface.
- At sea level, the mean density of the air is maximum and the atmospheric pressure is maximum.
- Hydraulic press is used to compress raw cotton, cloths etc. into bales.

Exercise

A. Complete the following statement.

i. The study of the behavior of gases under pressure is called pneumatics
ii. The transmission of pressure through a liquid takes place in the hydraulic press.
iii. The pressure at any point in a liquid depends upon depth.
iv. The SI unit of area is m2.
v. A thick layer of air around our earth is called atmosphere

B. Choose the correct answer for each of the following statements.

i. The formula of pressure, P =

(a) F × A (b) $\frac{A}{F}$ (c) $\frac{F}{A}$ ✓ (d) F × D

ii. Which of the following is not a rare gas?

(a) Krypton (b) Xenon (c) Ozone ✓ (d) Radon

iii. A syringe gets filled due to:

(a) air pressure ✓ (b) water pressure
(c) vapour pressure (d) none of these

iv. Atmospheric pressure at Peshawar is _____ than Murree:

(a) greater ✓ (b) sometimes equal (c) always equal (d) less

v. Experiments show that pressure of a gas depends upon:

(a) quantity and temperature ✓ (b) atmospheric pressure
(c) quantity (d) temperature

C. Give short answers of the following.

i. Explain the relationship between force, area and pressure.
ii. Write a note on Pascal's principle with examples.
iii. Define pneumatics. How it is related to the force of attraction between gas molecules?

iv. What are aerosols? Write down the applications of gas pressure.

v. Relate the height from the Earth's surface with the atmospheric pressure.

D. Give detailed answers to the following questions.

i. (a) What is pressure? State its SI unit.

(b) What are the causes of gas pressure?

ii. What is a hydraulic press? Write its application.

iii. Define atmospheric pressure and how it's value changes with the height from the sea level.

Project

(Balloon Rocket)

You will need:

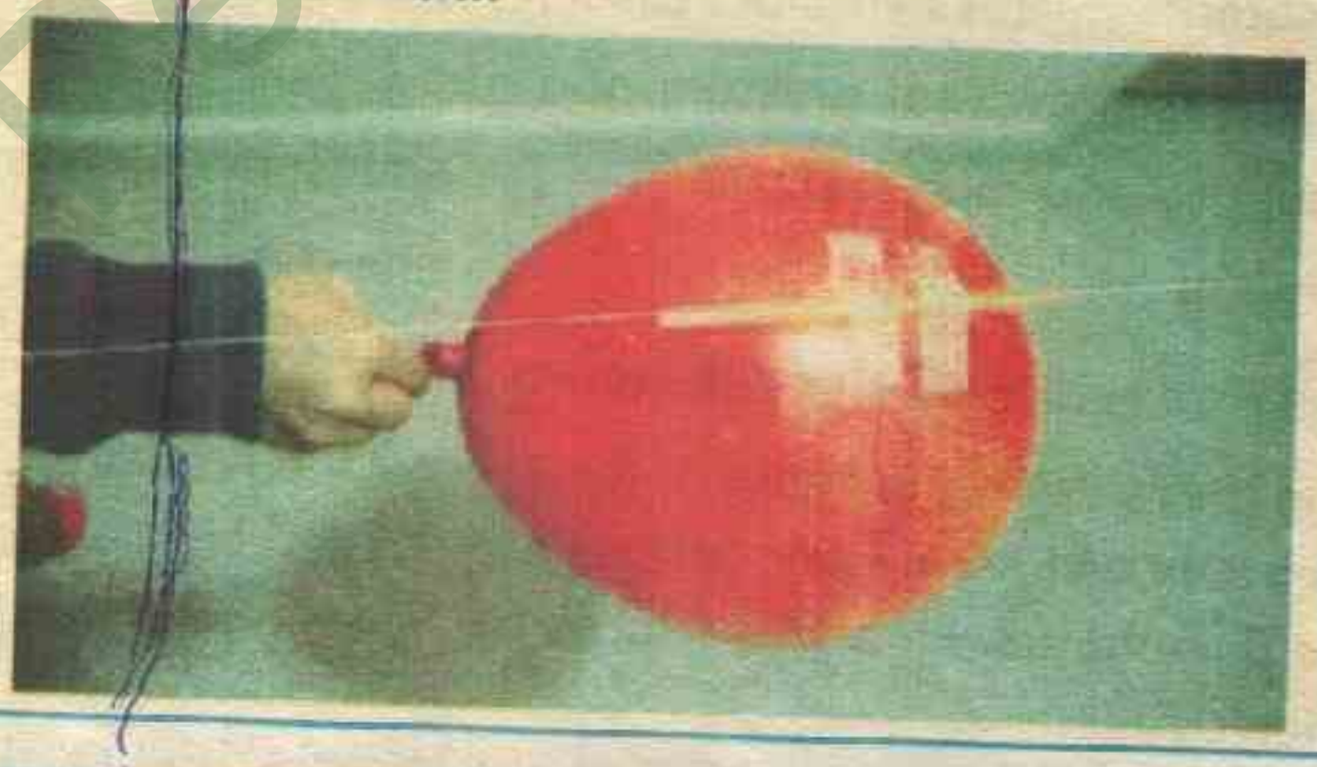
- One latex balloon (any colour)
- One plastic straw
- A long string
- Tape

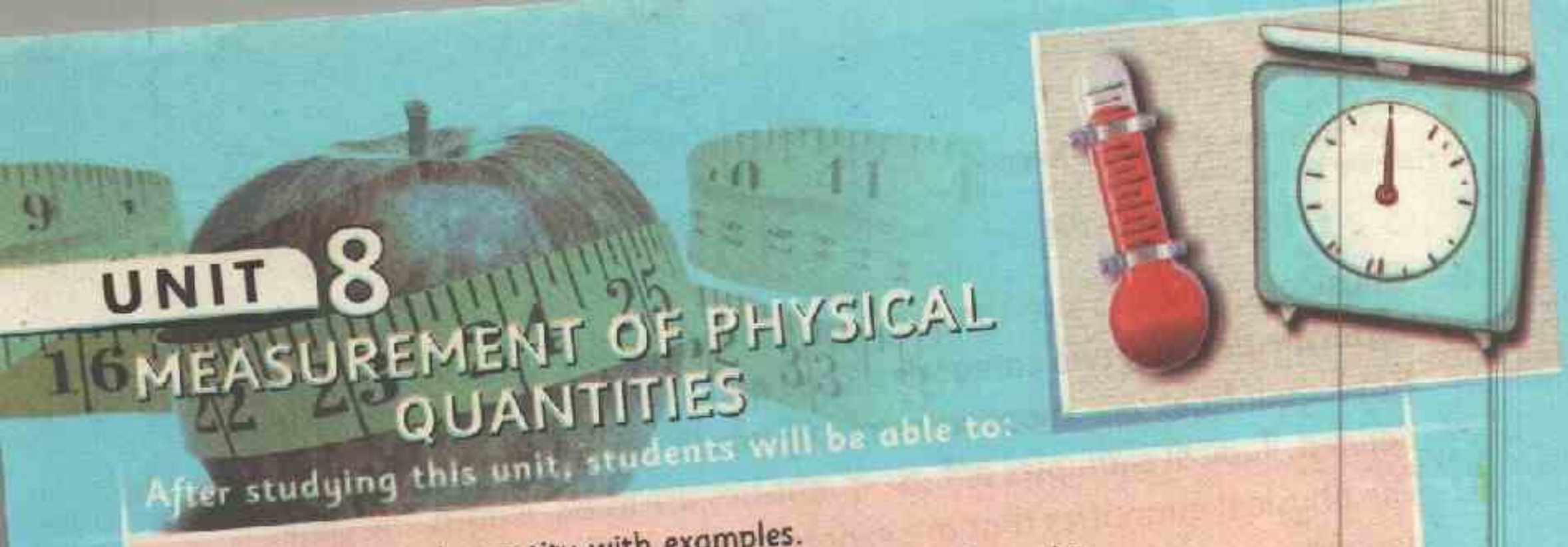
Step-1 Slide the string through the straw and secure both ends of it to the walls so that the straw is hanging about the floor.

Step-2 Blow up the balloon and hold the base closed with your fingers so the air does not escape.

Step3: While holding the base of the blow up balloon, tape it to the straw, then let go and watch your balloon rocket fly!

Find out How does it Work?





UNIT 8
MEASUREMENT OF PHYSICAL QUANTITIES

After studying this unit, students will be able to:

- Define a physical quantity with examples.
- Apply the prefixes milli, centi and kilo and interpret the units.
- Interconvert smaller units and bigger units.
- Select and use measuring instruments.
- Interpret SI units in daily life.
- Inverstigate why it is desirable for scientists to use the SI units in their work.
- Measure the volume of liquid by reading correct meniscus.

Introduction

Foundation of science rests upon physical quantities in terms of which physical phenomena are expressed. Therefore, their accurate measurement is necessary. Measurements are not confined to science only. They are also part of our daily life. They play an important role in describing and understanding the physical world. In this unit, you will study some of the physical quantities i.e length, volume, mass, time etc. and their measurements in system internati

Physical quantities

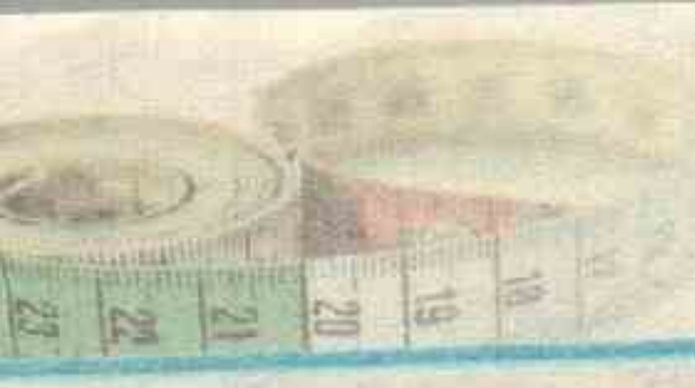
Physical quantities are those which can be measured. Physical quantities are often divided into two categories; base quantities and derived quantities. Base quantities are those in terms of which other physical quantities can be defined. Typical examples of base quantities are mass, length and time. The physical quantities that are expressed in terms of base quantities are called derived quantities e.g volume, speed, density, area etc.

Measurement of physical quantities

The comparison of something with some standard is known as measurement. The standard with which things are compared is known as unit. A physical quantity is expressed as the product of number and a unit. A number with proper unit is known as magnitude. For example "13 cm" represents magnitude, where '13' is purely a number while 'cm' is a unit of length. The unit of a base quantity is called a base unit. The unit of base and derived quantities are given in table. (8.1) and (8.2) respectively.

Table 8.1 Base Quantities and their Units

Quantity	Unit	Symbol
Length	Meter	m
s	Kilogram	kg
	Second	s
ture	Kelvin	K
rrent	Ampere	A
f light	Candela	cd
bstance	Mole	mol



System International Units

In past the system of units of one country was different form that of other country. However, in the middle of the last century, an international committee agreed on a set of units to measure physical quantities. This set of units is called system international units, denoted by SI.

This system is now used throughout the world. Its units are convenient for daily use. The scientists particularly prefer this system for the exchange of their scientific researches and informations with world's scientific community.

Table 8.2 Derived Quantities and their Units

Quantity	definition	SI unit in terms of base units
Area	Length × width	m^2
Volume (of solid)	(length × width × heigth)	m^3
Volume (of liquid)	Litre	L
Density	Mass / Volume	Kgm^{-3}

System International Units in Daily Life

In daily life we use the following units of System International for the measurement.

1. Metre

We use meter as a unit for the measurement of length. The standard meter is the length of a platinum-iridium alloy metal rod, kept at 0°C in International Bureau of Weight and Measurement at Sèvres near Paris (France).

Fig 8.1 Standard Meter

2. Kilogram

Kilogram is used as a unit for the measurement of mass of different things. The standard kilogram is the mass of platinum-iridium cylinder placed in International Bureau of Weight and Measurement.

Fig 8.2 Standard Kilogram

3. Cubic meter and Litre

In SI units cubic meter (m^3) is the unit for the measurement of volume. However, in daily life volume of liquids is measured in litres instead of (m^3) which is rather a smaller unit than (m^3). The Litre is related to cubic meter as under;

1 cubic meter = 1000 litre

Or 1 litre = $\frac{1}{1000}$ cubic meter

1 litre = 1000 milli-litre (ml)

1 ml = 1 cm^3 (1 cc)

Fig 8.3 Standard litre

4. Second

In SI units, the unit of time is second (s), which is $\frac{1}{86400}$ part of a mean solar day.

1 second = $\frac{1}{60}$ minute

1 minute = $\frac{1}{60}$ hour

1 hour = $\frac{1}{24}$ solar day

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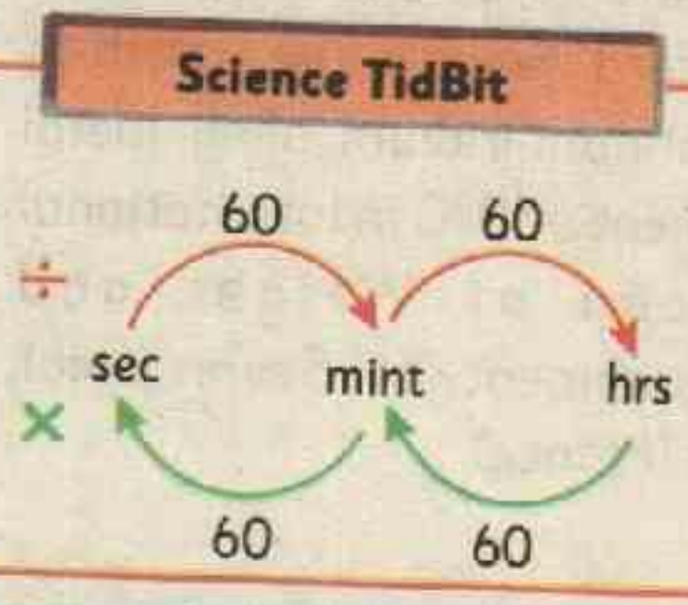

Prefixes and their use in Inter conversion of units

Prefixes are the words or letters added before SI units such as milli, centi, kilo etc. The value of these prefixes are multiples and sub-multiples of 10. Prefixes are useful to express very large or small quantities. Similarly, prefixes are used for the inter conversion of smaller units and bigger units.

(i) kilo (k) means 1000 (thousand).

(ii) centi (c) means $\frac{1}{100}$ (one hundredth part).

(iii) milli means $\frac{1}{1000}$ (one thousandth part).

When prefix kilo is added before a unit, its value is increased by 1000.

e.g. 1 kilometre (km) = 1000 metre (m)

1 kilogram (kg) = 1000 gram.

When prefix centi is added before a unit, its value is decreased by $\frac{1}{100}$ part.

e.g. 1 centimetre = $\frac{1}{100}$ metre

Similarly, when prefix milli is added before a unit, its value is decreased by $\frac{1}{1000}$ part.

e.g. 1 millimetre = $\frac{1}{1000}$ metre

1 milligram = $\frac{1}{1000}$ gram.

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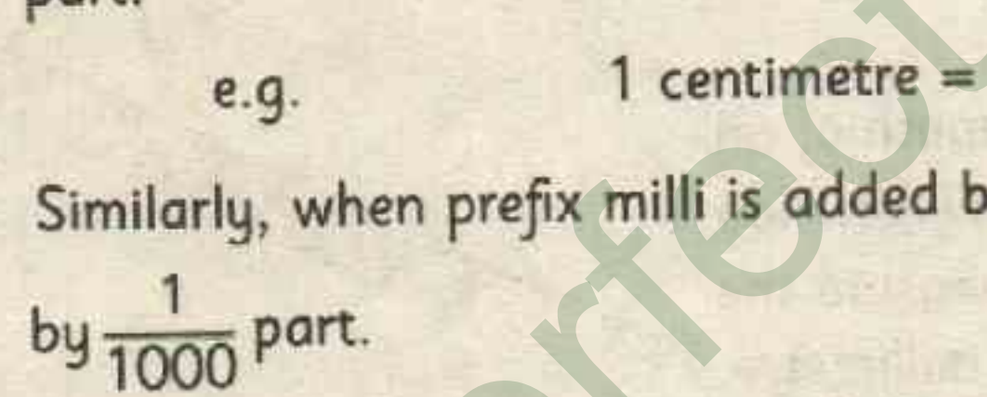

Activity 8.1

Convert 2kg to grams, 750 grams to kg, 1 milli second into second.

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Commonly used prefixes and their values are given in the table below.

Prefix	Factor	Symbol	Prefix	Factor	Symbol
exa	10^{18}	E	deci	10^{-1}	d
peta	10^{15}	P	centi	10^{-2}	c
tera	10^{12}	T	milli	10^{-3}	m
giga	10^{9}	G	micro	10^{-6}	m
mega	10^{6}	M	nano	10^{-9}	n
kilo	10^{3}	k	pico	10^{-12}	P
hecto	10^{2}	h	femto	10^{-15}	f
deka	10^{1}	da	atto	10^{-18}	a

Instruments for measurement

We use different instruments to measure different quantities.

Some of the measuring instruments are given below:

Metre ruler

Metre ruler is used to measure the length of an object. Metre ruler has 1000 small division called millimeters. Metre ruler can measure the length of a body correctly up to one millimetre. The metre ruler is shown in 8.4.

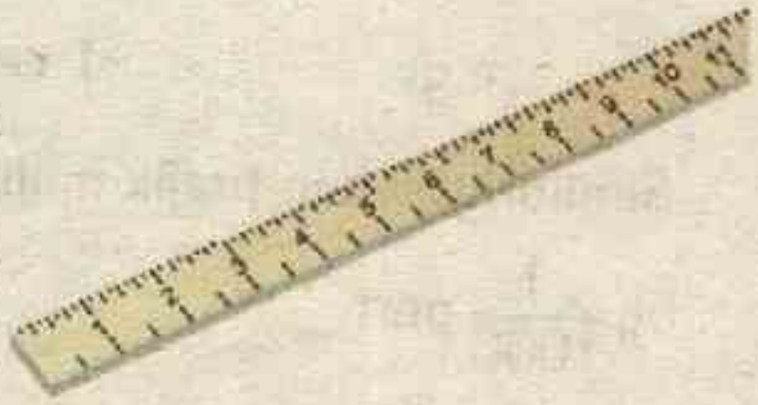

Fig 8.4 Meter Ruler

Measuring Cylinder

A measuring cylinder is used to measure the volume of a liquid. It is made up of transparent plastic or glass which has a vertical scale in millilitres (ml) or cubic centimetres (cm^3).

When a liquid is poured into the cylinder, the volume is read from the scale on the side. The surface of the liquid curves upwards at the point where it touches the inside of the cylinder. This

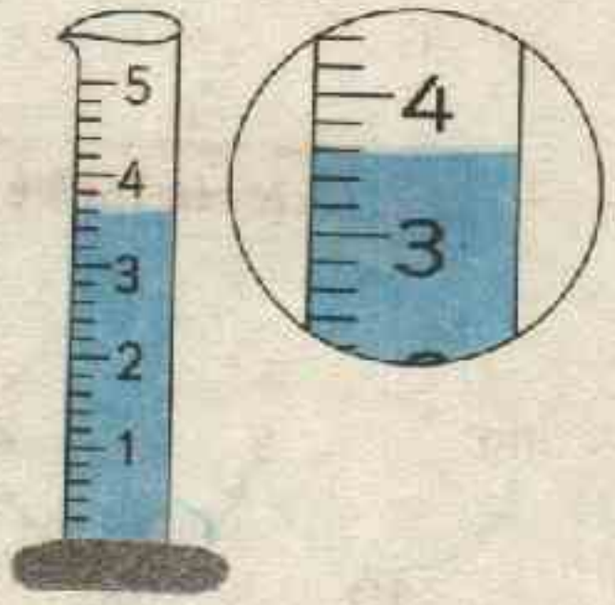

Fig 8.5 Measuring cylinder

curvature is called the meniscus. The volume is noted on the scale in front of the meniscus of liquid. For correct measurement of the volume, the cylinder must be placed on horizontal surface and the eye should be kept on a level with the bottom of the meniscus as shown in fig.8.6

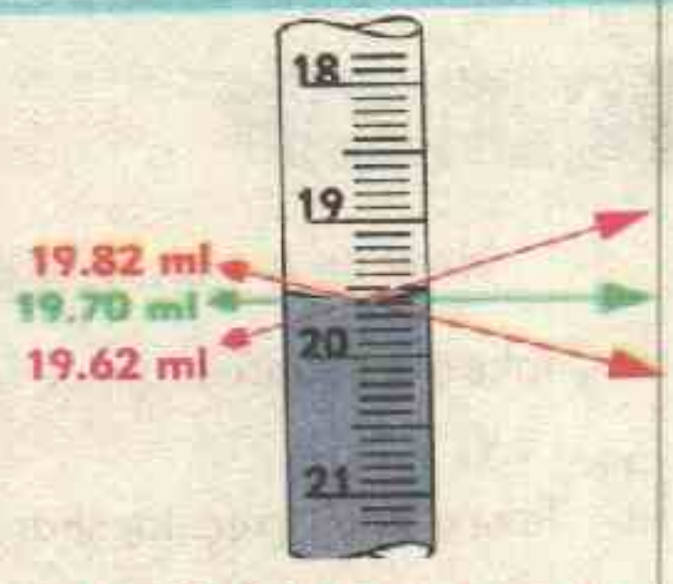

Fig 8.6 Volume reading

Measuring flasks

Measuring flasks are used to measure the volume of liquids the science laboratory. Measuring flasks are made up of fine plastic or glass and a mark at the neck tells the volume. You can take volume only in specific amounts which is written on the flask. e.g 25ml, 100 ml, 250 ml, 1000ml etc.

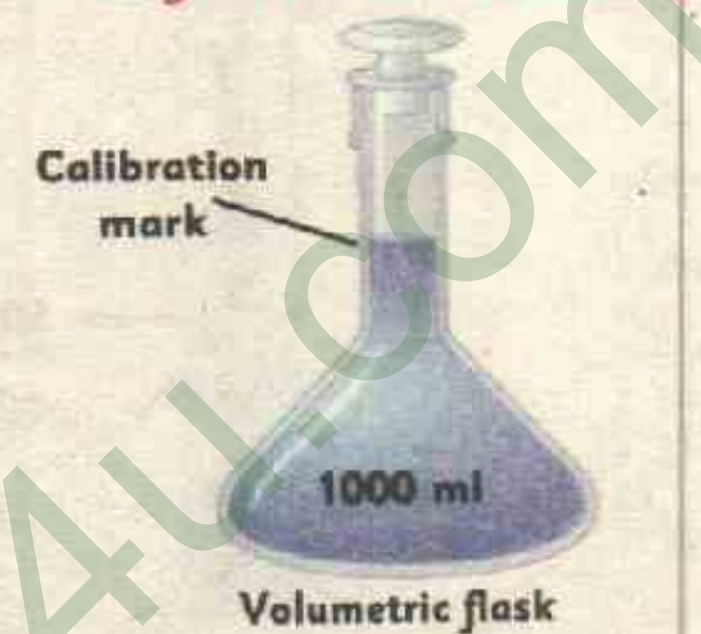

Fig 8.7 Measuring flasks

Pipette

While performing practical work with acid and alkali and you have to take a little volume of an acids or alkali up to 20ml, pipettes are used. They are made of fine transparent plastic or glass. The liquid is sucked up to the required level with the help of pipette filler.

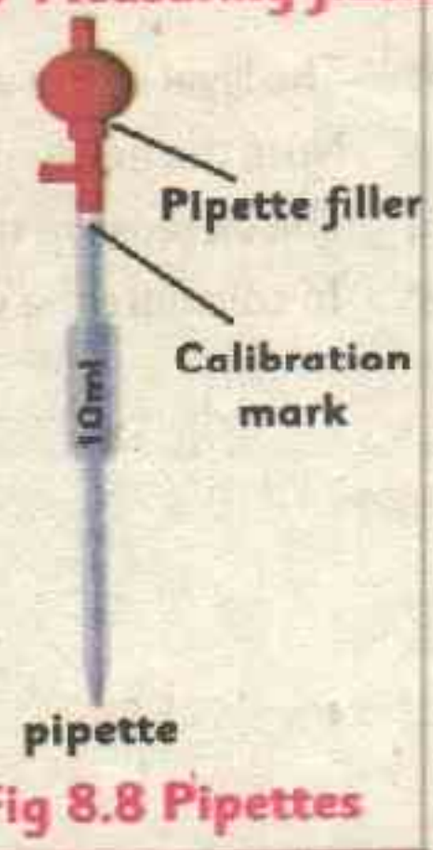

Fig 8.8 Pipettes

Remember: (To be careful)

While using the measuring instruments, some precautionary measures are necessary to avoid any accident. So, strictly obey the guidelines of teachers and use the instruments carefully.

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Meniscus of all liquids are curved downward except for mercury which has a meniscus curved upward, when put in a cylindrical container.

Activity 8.2

How to measure the volume of an irregular shaped object?

- Take a graduated cylinder and pour some water in it. Note the volume of water i.e V_1.
- Take a small irregular shaped object and drop it into the cylinder.

- The level of the water will rise.
- Note the new volume i.e V_2.
- The increase in the volume of water is the volume of the irregular object.
- To calculate the volume of the irregular object we use the following formula.

$$V = V_2 - V_1$$

KEY POINTS

- All measurable thing are called physical Quantities.
- The comparison of something with some standard is known as measurement.
- The standard with which things are compared is known as unit.
- A physical quantity is expressed as the product of number and a unit.
- Length, Mass, Time, Temperature, Electric current, Amount of substance and Intensity of light are seven base physical quantities in SI units.
- The quantities derived from base quantities are called derived quantities, e.g., Volume, Force, Power etc.
- Some prefixes are used along with units to represent very big or small quantities.
- The standard meter is the length of a platinum-iridium alloy metal rod, kept at 0°C.
- Kilogram is used as a unit for the measurement of mass of different things.
- In SI units cubic meter (m^3) is the unit for the measurement of volume.
- Every physical quantity is measured with a specific instrument, e.g., meter ruler for length, measuring cylinder, pipette and flasks for volume.

Exercise

A. Complete the following statement.

i. The comparison of something with some standard is known as measurement

ii. 25 milligrams is equal to 0.025 g.

iii. The SI unit for intensity of light is candela.

iv. In case of measuring water in cylinder, the eye should be kept on a level with the bottom of the meniscus.

v. Meter ruler is used to measure the length of an object.

B. Choose the correct answer for each of the following statements.

i. Which one is not a derived quantity:

(a) m^2 ✓ (b) m (c) s (d) kg

ii. Which alloy is used in standard metre and kilograms?

(a) gold and platinum (b) plgtinum and californium

(c) platinum and cobalt (d) iridium and platinum ✓

iii. 1kilo is equal to _____:

(a) 10^2 (b) 10^3 ✓ (c) 10^6 (d) 10^9

iv. 1kg is equal to _____:

(a) 100g (b) 1000g (c) $\frac{1}{1000}$ g (d) $\frac{1}{100}$ g

v. 1kg of water occupies volume of:

(a) $10dm^3$ (b) $1m^3$ (c) $1dm^3$ ✓ (d) $100cm^3$

C. Give short answers of the following.

i. Write seven base physical quantities along with their SI units.

ii. Write the uses of units in our daily life.

iii. Why scientists prefer SI units?

iv. Convert 1000 centimeters into meters and millimeters.

v. Physical quantities are divided in how many categories?

D. Give detailed answers to the following questions.

i. What are international system units? How they are used in daily life?

ii. (a) What is meniscus?

(b) Give in detail the procedure of measuring the volume of a liquid by reading correct meniscus in the measuring cylinder.

iii. What are prefixes? Explain their role in System international units.

Activity 8.3

Convert the following:

Units of length

- 1meter = _____ millimeters
- 1meter = _____centimeters
- 1kilometer = _____ meters
- 1centimeter = _____ millimeters

Example 3.5m = _____cm

7,500mm = _____m

56km = _____m

Units of mass

- 1gram = _____milligrams
- 1kilograms = _____ gram

Example 16g = _____ mg

16g = _____ kg

5kg = _____ g

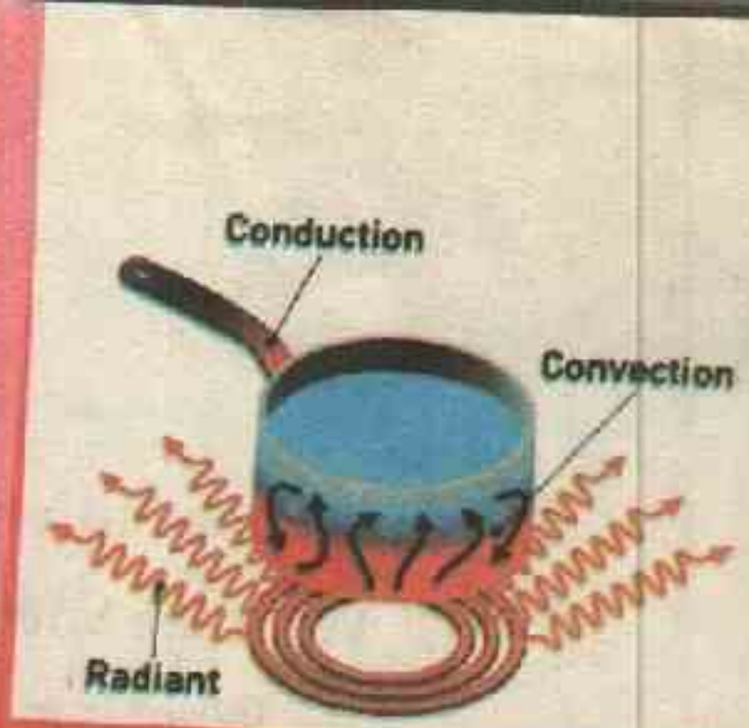
Units of volume

- 1kiloliter = _____liter
- 1liter = _____milliliter

Example 2l = _____ ml

6ml = _____ L

8,500l = _____ cm^3



UNIT 9
SOURCES AND EFFECTS OF HEAT ENERGY

After studying this unit, students will be able to:

- Describe the sources and effects of heat.
- Explain thermal expansion of solids, liquids and gases.
- Explore the effects and applications of expansion and contraction of solids.
- Describe the uses of expansion and contraction of liquids.
- Explain the peculiar behavior of water during contraction and expansion.
- Investigate the processes making use of thermal expansion of substances.
- Identify the damages caused by expansion and contraction in their surrounding and suggest ways to reduce these damages.
- Investigate the means used by scientists and engineers to overcome the problems of expansion and contraction in everyday life.
- Describe the working of thermometer.

Introduction

In previous grades, you have learnt about methods of transfer of heat that are conduction, convection and radiation. In this unit, you will study about sources and effects of heat energy. For example, thermal expansion and contraction of solids, liquids and gases. You will also study the applications of thermal expansion and contraction of heat in daily life.

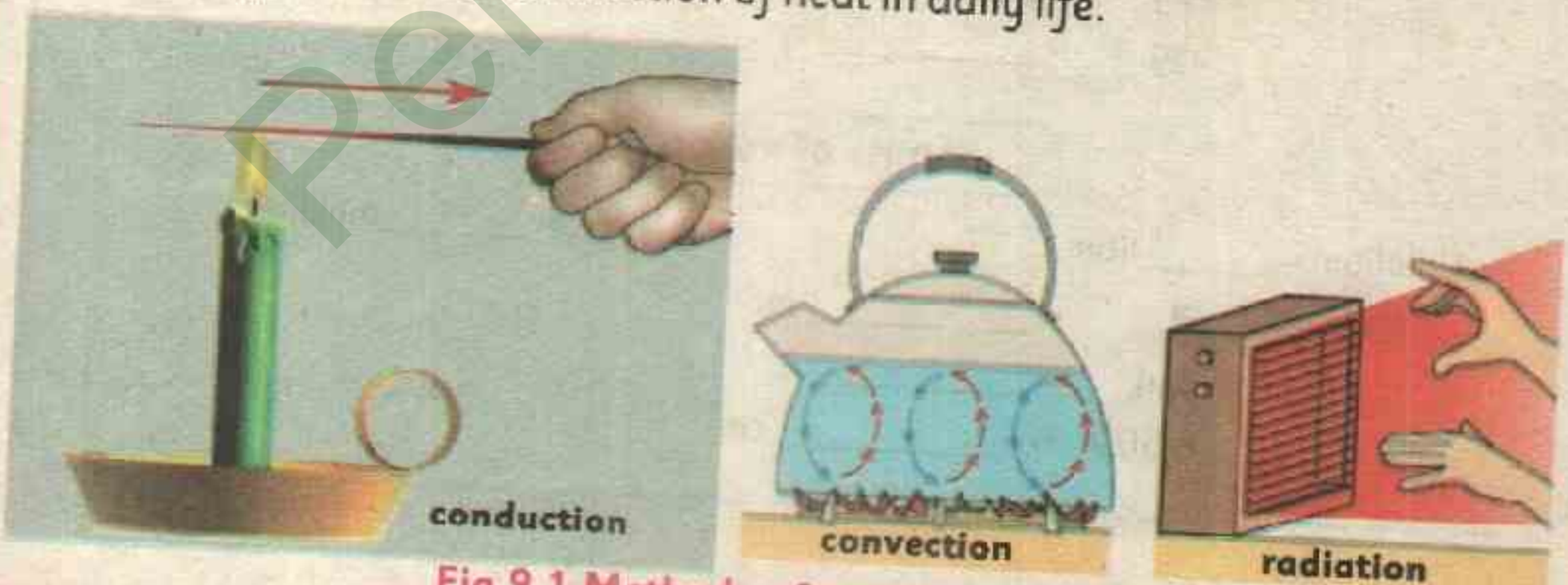


Fig 9.1 Methods of transfer of heat

Sources and effects of heat

Heat is a form of energy. It is transferred from one body to another due to difference in temperature.

Sources of Heat

1. Sun is the main source of heat.
2. In our daily life, we get heat from the burning of wood and fossil fuels i.e. oil, gas and coal.
3. Heat may be produced by friction. Whenever two bodies are rubbed against each other, heat is produced. In ancient times, this method was used for producing heat, by rubbing of flintstones. Similarly, when you rub your hands, you will feel them warm.
4. Electricity is also a source of heat. Whenever electricity is passed through the metal wire, it gets hot.
5. Heat is also produced by certain chemical reactions. e.g. the biochemical reactions in our body produce heat. Similarly, when CaO is added in water, heat is produced.

Effects of Heat

Heat can cause:

i. Changes in the state of matter.
ii. Chemical changes.
iii. Expansion in solid, liquid and gases.
iv. An increase in temperature.
v. Wind, rain and waves in seas are formed due to increase in temperature.

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Units for Measuring Heat

The Joule is the SI system unit for measuring heat:

$1 Joule = 1 newton.meter = \frac{1 kg.m^2}{s^2}$

The calorie is the heat required to raise the temperature of 1gram of water by 1 Celsius degree.

1calorie=4.81Joules

Thermal expansion and contraction

Solids, liquids and gases are expand on heating. This is called thermal expansion. Similarly, when they cool down, they contract. This is called thermal contraction.

We know that molecules are in constant motion in solids, liquids and gases. When they are heated, the movement of the molecules increases and the

distances between the molecules become larger which causes thermal expansion. Similarly, when they are cooled down, the movement of the molecules becomes slow. The distances between the molecules become small. As a result, they are contracted.

Do You Think!

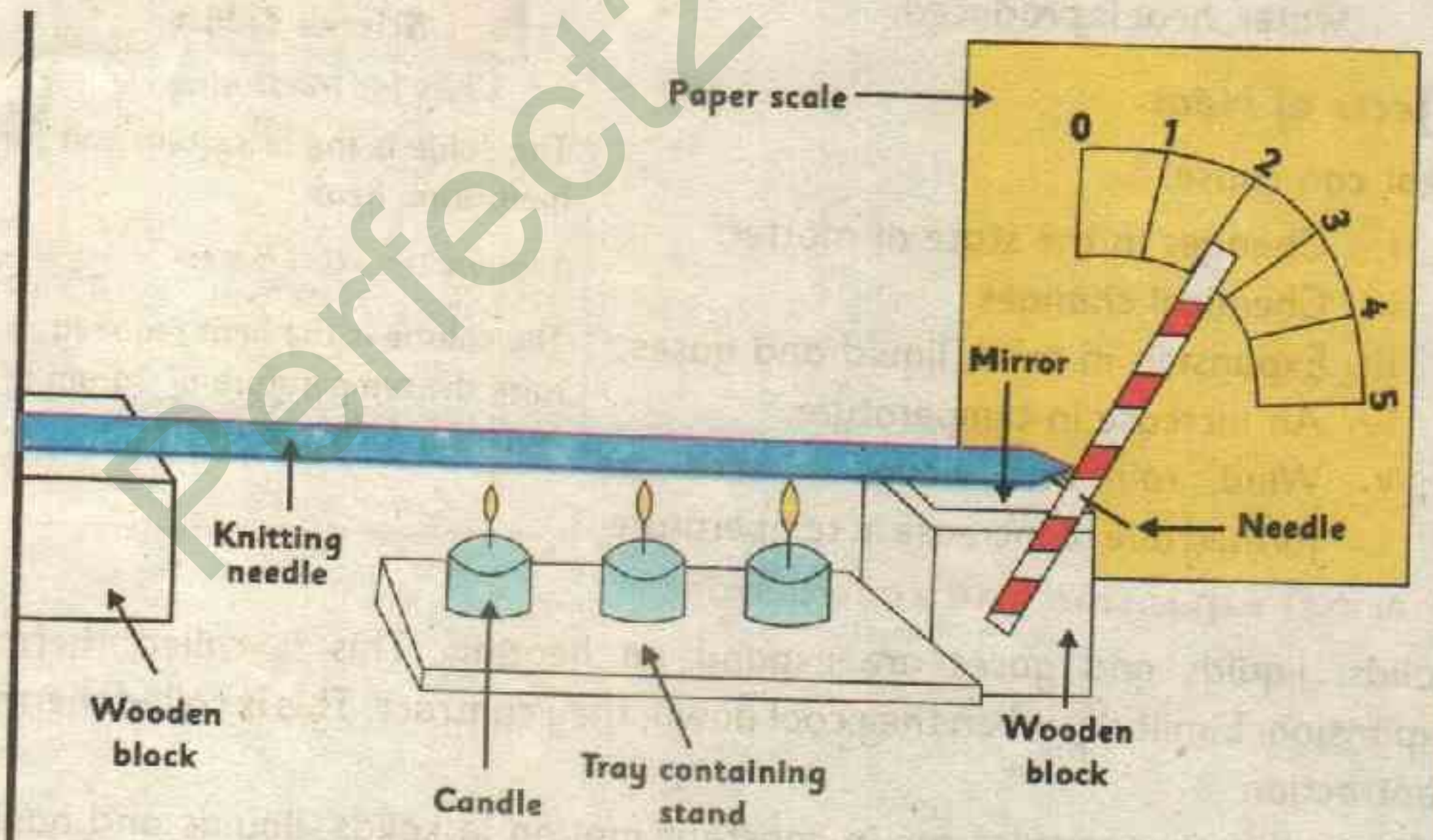
Why expansion occur due to heat?

Thermal Expansion of Solids

The length and volume of metallic objects expand on heating. The expansion in length due to heating is called linear expansion while that in volume is called volumetric expansion. This can be explained with the following activities.

Activity 9.1

Take a metallic rod about 1 meter in length. Clamp it's one end. Let it's other end rests on a needle. A long needle or a thick wire passes through the end of the straw which acts as a pointer. When the rod is heated by a candle, the pointer moves. This indicates that the length of the rod has increased due to which the needle rolls forward and movement of the pointer can be seen. This activity illustrates linear expansion in metallic rod.



Activity 9.2

Take a metallic sphere which can pass easily through the ring as shown in the figure (a). Heat the sphere and try to pass it through the ring again. In this case, the sphere does not pass through the ring, why? Because, due to heating the diameter of the sphere becomes greater than the diameter of the ring. Does the volume of the sphere also increase? Actually, due to increase in diameter, volume of the sphere also increases. Now, if the sphere is cooled down, it will contract, due to which it will be able to pass again through the ring. This activity shows the volumetric thermal expansion and contraction of metallic solids.

(a). Metallic sphere easily passes through a metal ring

(b). Thermal expansion - the sphere when heated undergoes volumetric expansion and does not pass through the metal ring

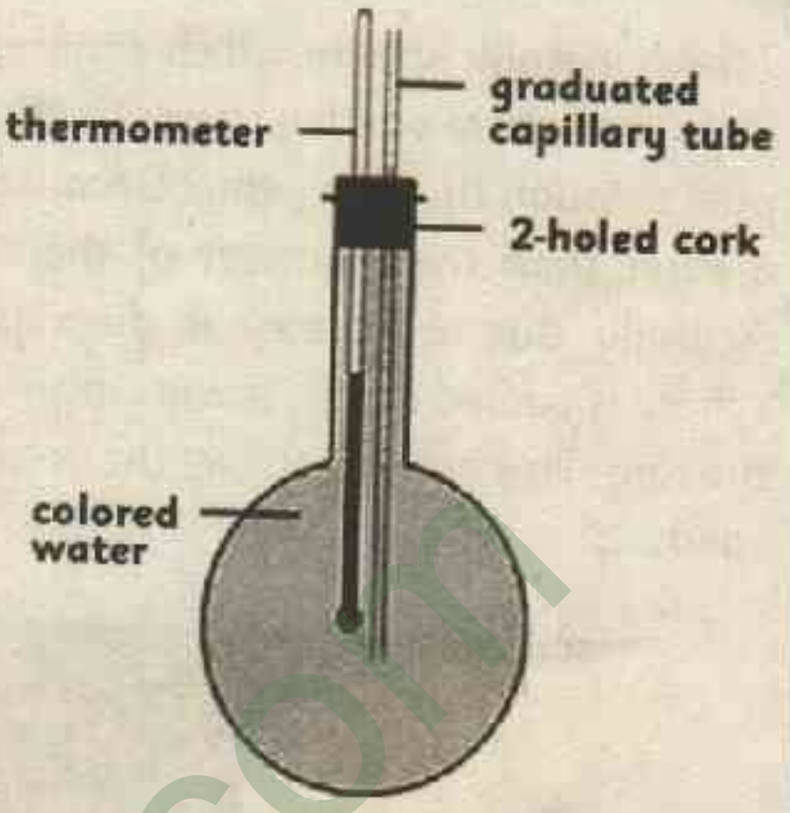
Thermal expansion of liquid

Liquids expand on heating and contract on cooling like solids. It can be explained with the help of activity 9.3.

Activity 9.3

Fill a flask with colored water. Insert a long glass or plastic tube through the cork and fit the cork tightly into the mouth of the flask as shown in the fig. You will observe that colored water in the tube will rise above the cork in tube. Mark the water level point, on the tube. Heat the flask. Water level further rises up in the tube. It is because water expands on heating.

Now allow the flask to cool. You will observe that liquids contract on cooling, the water level will come back. This activity shows that the liquids expand on heating and contract on cooling. The expansion is liquids in more than that in solids. Why?



Thermal Expansion of Water

Thermal expansion of gases

We know that like solid and liquids, gases also expand on heating and contract on cooling. In order to explain this phenomenon, let us perform the following activity.

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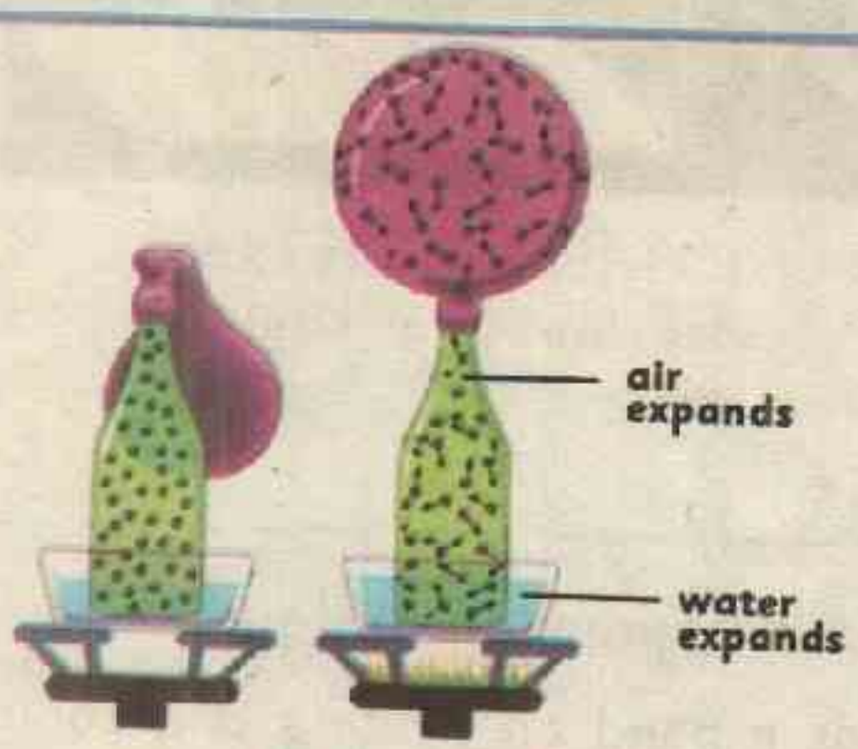
If we fill too much air in the tyres of vehicles they can burst in hot weather due to the expansion of the air in it. That is why there is a limit set, on how much air we can fill in the tyres.

Activity 9.4

Take a glass bottle and stretch a balloon on it's mouth. Heat the flask. What do you observe? The balloon inflates. The air inside the flask expands on heating and enters the balloon. Now let the flask cool again. What do you observe? The balloon deflates when cooled. This activity shows that gases expand on heating and contract on cooling.



Epansion of gas

Advantages

Applications of Expansion and contraction of solids

(a) Fixing a metal tyre into a wheel

Thermal expansion is useful in many ways. Metal tyres are fitted on large locomotive wheels with the help of thermal expansion. The rim is made slightly smaller in diameter. The rim is heated uniformly until it's diameter becomes larger than that of the wheel. The steel rim is slipped over the wheel and when it contracts on cooling, it becomes tight.

Fig 9.2 Fixing of metal tyre into wheel

(b) Riveting

Thermal expansion helps in riveting steel plates firmly together. The rivets are heated until they are red hot and forced through holes drilled in the plates. The end of the rivet is hammered flat, over the plates. On cooling the rivet contracts and pulls the plates very tightly together.

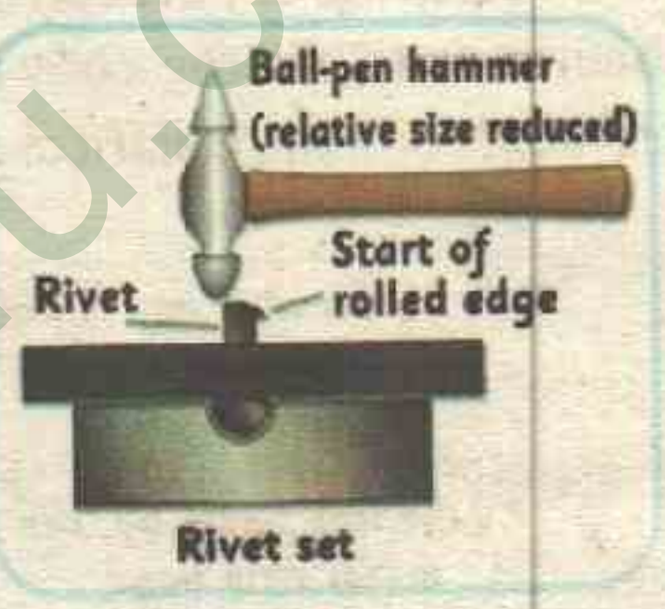


Fig 9.3 Rivet set

(c) Fixing an axle of a wheel

The fixing of an axle in a wheel is another useful example of thermal expansion and contraction. The axle is cooled in liquid nitrogen due to which it contracts. The wheel hole is uniformly heated and the axle is quickly inserted into the wheel hole. The wheel hole contracts and axle expands to fix tightly.

Fig 9.4 Fixing Axle of a wheel

(d) Fire alarms

The electric fire alarm works on the principal of expansion. In the circuit of the electric fire alarm, the bimetallic strip of brass and iron is used as shown in

figure 9.5. When a fire occurs, the heat of the fire causes the brass and iron strips to expand differently, causing the bimetallic strip to bend, which on bending touches the screw adjacent to it, thus completing the circuit. Once the circuit is completed, the bell begins to ring.

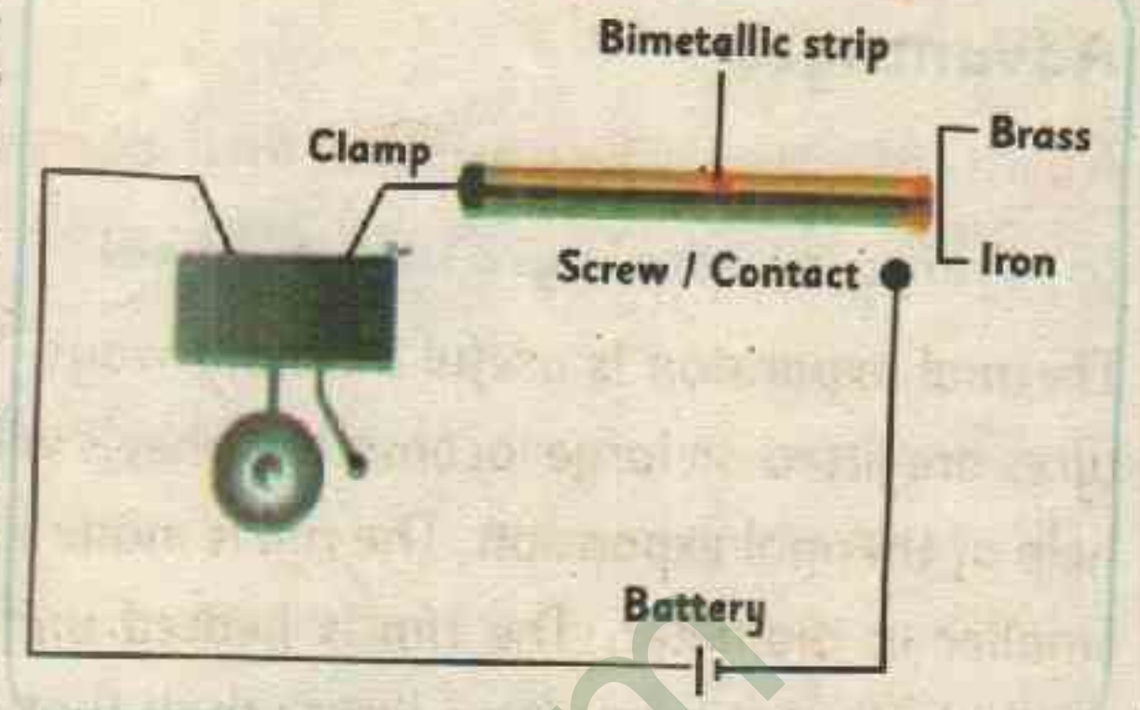


Fig 9.5 Fire Alarm

(e) Electric iron

In an electric iron, the current flows through the circuit and produces heat in the heater coils. As the coils heat up, the bimetallic strip bends away from the contacts and the electrical contact is completely broken.

Fig. 9.6 Electric iron

The break of contact stops the current from following and prevents the temperature rising above the required level. When the strip cools it straightens and contact is made again. In this way, temperature is maintained.

Effects of expansion and contractions of solids in every day life

The expansion of solids also has disadvantages especially in the construction of bridges, railways tracks and roads which are always subjected to change in temperature.

(i) Concrete road surface

While constructing concrete roads, factors of pressure expansion and contraction are considered. For instance, if road surfaces were laid on a continuous stretch, they would crack due to expansion and contraction with the changes in temperature. To avoid such damages, concrete road surfaces are laid down in sections with small gaps between them. These gaps are filled with such material which contracts with the expansion of concrete surface and expands with the contraction of concrete surface.

Fig 9.7 Cracks on road

(ii) Railway tracks

The railway tracks are laid in section with gaps between them that are joined by fish plates. If there are no gaps in rail tracks then thermal expansion will cause them to bend.

Fig 9.8 Railway tracks

(iii) Bridges

Bridges are made up of steel girders which expand when heated. A gap is kept between the girders to allow the expansion. If there was no gap, the girders would expand and bend. To allow for thermal expansion, one end is fixed while the other end rests on rollers in an expansion gap.

Fig 9.9 Bridge

(iv) Telephone wires / Overhead Power Cables

The telephones wires between two poles hang down in summer and become tight in winter. The wires are laid in such a way that they are allowed to expand or contract.

Over head telephones or electrical wires between two poles are given a certain amount of sag so that they can contract in winter without breaking. If there is no sag then wires can break on contraction.

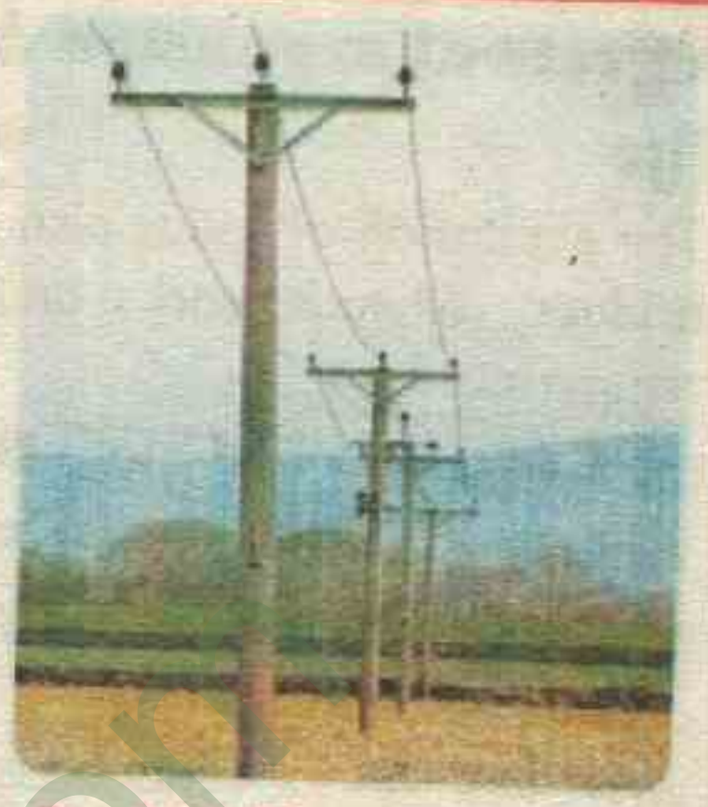


Fig 9.10 Electricity wires

(v) Pipelines

The metal pipelines can damaged due to expansion and contraction.

The expansion of water exerts pressure on the walls of the pipe, which must also be taken into account in order to avoid any loss or damage. Such damages can be avoided by coating the pipeline with an insulating material.

Fig 9.11 bending of metal pipes

Uses of expansion and contraction of liquids

The liquids expand more as compared to solids . Due to this property, mercury and alcohol are used in thermometers. However, as boiling point of mercury is very high and its expansion is also uniform, that is why it is preferred over alcohol.

Peculiar behavior of water expansion and contraction

Liquids in general, expand on heating and contract on cooling. But the expansion of water is little different from the expansion of other liquids. When water is heated from 0°C to 4°C it contracts instead of expanding. When it is further heated from 4°C up to its boiling point (100°C), It expands just like other liquids. In the same way, when water is cooled down from 100°C to 4°C,

it contracts. But when it is further cooled from 4°C to 0°C it expands and its volume increases.

The increase in the volume of water as its temperature is lowered from 4°C to 0°C is known as anomalous expansion or peculiar behavior of water. It mean that the density of water is maximum at 4°C. Under frozen water during winters, the aquatic life is able to survive in the water below the ice because ice acts as an insulator.

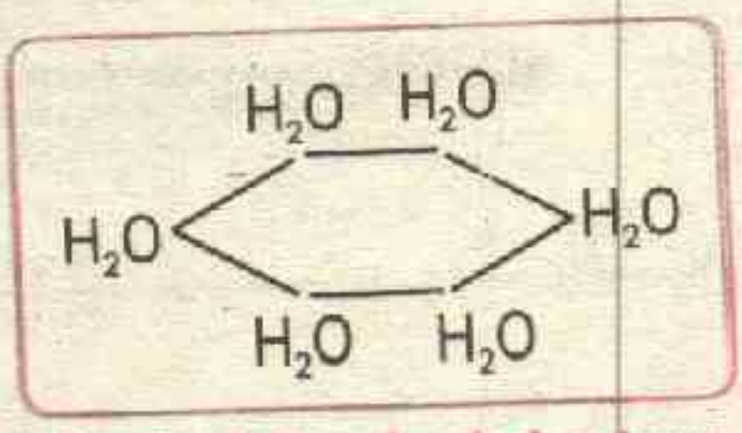


Fig 9.12 Pecular behaviour of water at 4°C

Fig 9.13 Pecular behaviour of water

Thermometer

An instrument used for measuring temperature, is called a thermometer. A common thermometer in everyday use consists of a glass bulb (B) connected to a thin glass tube called capillary tube (T). The glass bulb is usually filled with mercury that expands into the capillary tube when heated. The capillary tube is surrounded by thick graduated glass tube, called the stem (S), as shown in the figure 9.14. The capillary tube has a constriction just above the bulb which prevents the mercury from falling back during expansion.

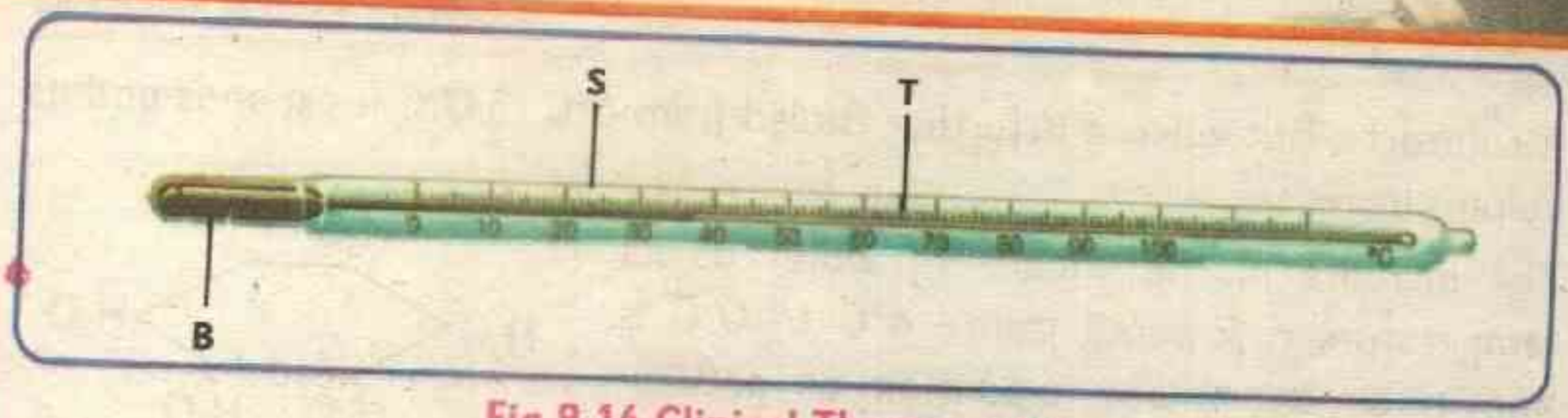


Fig 9.14 Clinical Thermometer

Scales of Temperature

In Clinical thermometers two scales for the measurement of temperature are used i.e. centigrade scale and Fahrenheit scale.

1. Centigrade or Celsius Scale

In this scale, the lower standard point or freezing point of ice is marked as 0°C and the upper standard point or boiling point of water is marked as 100°C at normal atmospheric pressure. The distance between these two fixed points is divided into 100 equal parts and each part or division is called degree centigrade, denoted by °C.

2. Fahrenheit Scale

In this scale, the lower standard point or freezing point of ice is marked as 32°F and the upper standard point or boiling point of water is marked as 212°F at normal atmospheric pressure. The distance between these two fixed points is divided into 180 equal parts and each part or division is called degree Fahrenheit, denoted by °F.

Science TidBit

Thermometers have mercury or alcohol inside them. It works on the principal of thermal expansion. When the mercury / alcohol get heated, they expand and rise up in the thermometer tube.

Working of Thermometer

When the thermometer is placed under the tongue in the mouth or in the arm pit, the mercury expands into the capillary tube due to heat of the human body. Usually, after two minutes when the thermometer is removed. The expanded mercury stays beyond the constriction in the capillary tube and shows the temperature of the body. After the use mercury is fallen down into the bulb by the jerks of hand. The normal human body temperature is 36.9°C or 98.4°F.

KEY POINTS

1. Material things expand when heated and contract when cooled down.
2. Expansion and contraction of solids and liquids can give rise to tremendous forces.
3. Expansion and contraction is applied in many daily life processes and instruments.
4. Expansion of water on cooling from 4°C to 0°C is called peculiar behavior of water.
5. Normal human body temperature is 36.9°C.
6. Bimetallic strip are used in electric iron, fire alarms and door bells.
7. The liquids expand more as compared to solids.
8. The expansion of solids also has disadvantages especially in the construction of bridges, railways tracks and roads which are always subjected to change in temperature.
9. An instrument used for measuring temperature, is called a thermometer.
10. In Clinical thermometers two scales for the measurement of temperature are used i.e. centigrade scale and Fahrenheit scale.
11. The expansion in length due to heating is called linear expansion while that in volume is called volumetric expansion.

Exercise

A. Complete the following statement.

i. Sun is the main source of heat.

ii. When two surfaces are rubbed against each other, heat is produced.

iii. Usually objects expand on heating and contract on cooling.

iv. In an electric iron, temperature is controlled by using bimetallic.

v. The bimetallic strip is straight when it is cooled but it bends when heated.

B. Choose the correct answer for each of the following statements.

i. Which material will expand on heating?

(a) solids (b) liquids (c) gases (d) all of these ✓

ii. At which temperature, volume of water is maximum?

(a) 0°C (b) 4°C ✓ (c) 110°C (d) –100°C

iii. Under frozen water, the aquatic life is able to survive in the water because ice acts as an:

(a) conductor (b) insulator ✓ (c) semiconductor (d) condenser

iv. In fahrenheit scale, the distance between two fixed points is divided into _____ equal parts or divisions.

(a) 100°F (b) 120°F (c) 180°F ✓ (d) 200°F

v. Heat is transferred through:

(a) conduction (b) convection ✓ (c) radiation (d) all of these

C. Give short answers of the following.

i. Define heat? What units are used for its measurement ?

ii. Explain the peculiar behavior of water?

iii. Which component expands on heating in fire alarms and how it works?

iv. Describe the sources and effects of heat.

v. How Fahrenheit scale is different from Centigrade or Celsius scale.

D. Give detailed answers to the following questions.

i. Explain thermal expansion of solids with the help of an activity.

ii. Describe the uses of expansion and contraction of liquids in our daily lives.

iii. Give the reasons for the following questions.

(a) Why a sag is given in the telephone or electrical wires?

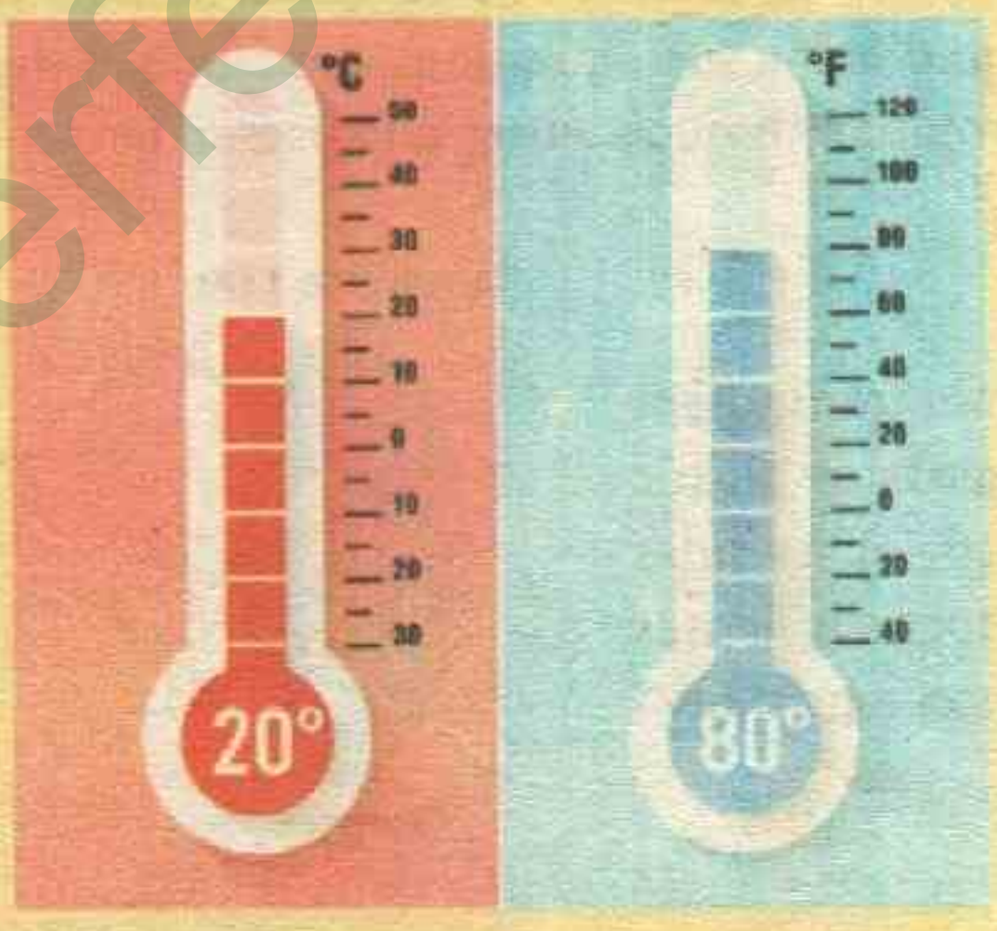
(b) Why mercury is preferred over alcohol in clinical thermometer?

(c) Why railway tracks are laid in sections with gaps between them?

Project

(a) Draw the diagrams of celsius / centigrade scale and fahrenheit scale thermometers on chart paper and explain their differences with the help of diagrams.

(b) Make a chart and describe the features of an ideal energy saving home. Explain why each feature like: use of solar panels on the roof, large double glazed windows, light colour wall paint etc, would be useful.



Celsius and Fahrenheit scale

UNIT 10

LENSES

After studying this unit, students will be able to:

- Define lens.
- Differentiate between the different types of lenses.
- Describe the image formation using a lens by ray diagram.
- Compare and contrast the working of a human eye with the lens camera.
- Explain how eye focuses by altering thickness of the eye lens.
- Investigate how eyes get used to darkness after sometime.
- Explain how lenses are used to correct short sightedness and long sightedness.
- Identify the types of lenses used for various purposes in daily life.

Introduction

In pervious grades, you have learnt about reflection and refraction of light. You have also studied about concave and convex mirrors. You being a student of science, come across questions like: What are lenses? Why people wear glasses? Which instrument is used to observe microorganisms? etc. To find the answers to these questions and many such questions, we study in this unit about types of lenses, image formation through lenses and uses of lenses in different optical instruments.

Lenses

A lens is made from a transparent material, such as glass or plastic and has one or both of its sides curved. Two main types of lenses are convex and concave as shown in figure 10.1.

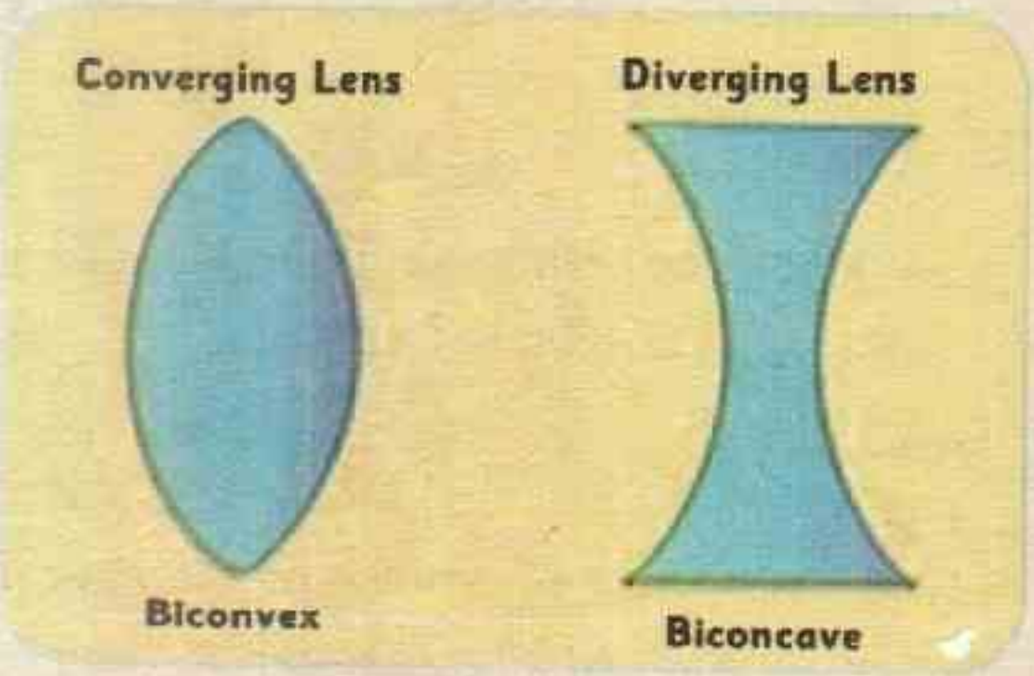


Fig. 10.1 Convex and Concave Lenses

Convex lense

A lens which is thick at the middle and thinner at the edges is called **convex lens.** When parallel light rays pass through the convex lens, they converge at a point called focal point denoted by 'F'. That is why a convex lens is also known as a converging lens as shown in figure 10.2.

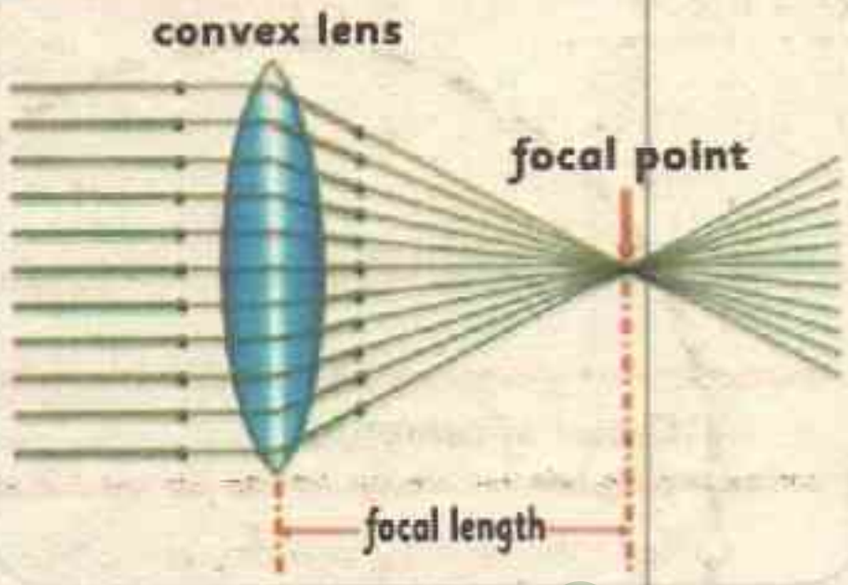


Fig. 10.2 Light rays converging from Convex Lens

Concave Lens

A lens which is thin at the middle and thicker at the edges is called concave lens. When parallel light rays pass through a concave lens, they diverge. If these refracted rays are traced back, these seem to meet at a point called the focal point of concave lens, denoted by 'F'. As this lens diverges the rays, it is also called diverging lens as shown in figure 10.3.

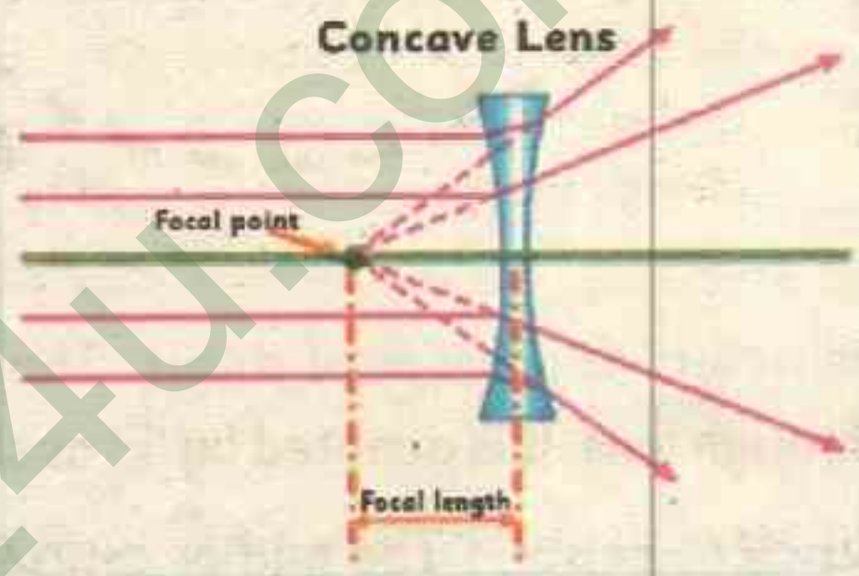


Fig. 10.3 Light rays diverging from Concave Lens

Important Fact

Some people use contact lenses instead of glasses. Contact lenses are made up of soft and flexible material. Due to which these are directly placed on the eyes.

Terms related to lenses

Followings are the terms related to lenses which one must know before studying the image formation by lenses.

Center of curvature

Center of the sphere of which the curved surface of the lens is a part, is called center of curvature of lens. It is denoted by 'C' as shown in figure 10.4.

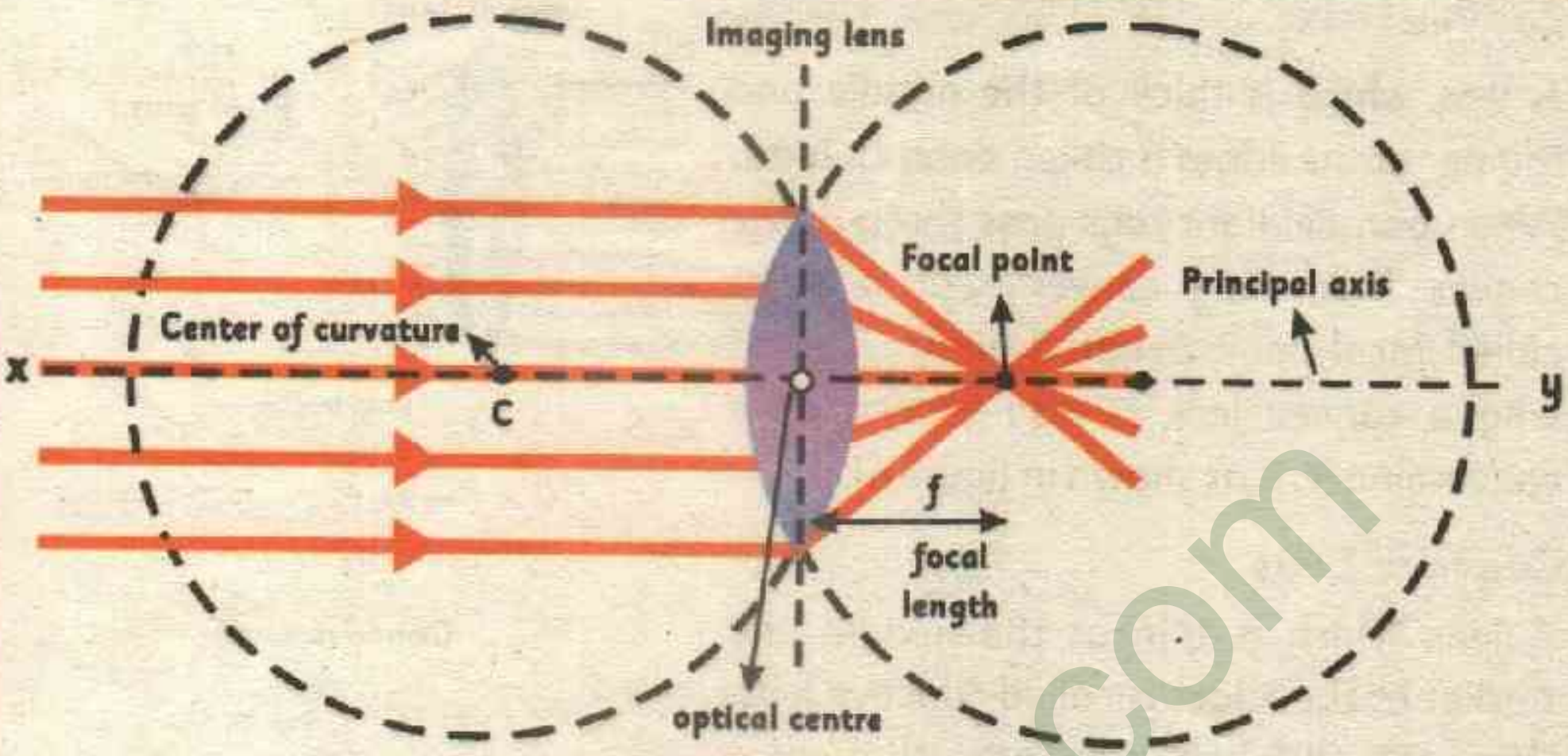


Fig 10.4 Convex lens

Principal focus/Focal point: The point where light rays meet after refraction through lens. It is denoted by 'F' as shown for convex lens in figure 10.4.

Optical center: The mid or central point of a lens is called its optical centre, denoted by 'O' as shown in figure 10.4.

Principal axis: A line passing through centre of curvature, optical centre and focal point is called principal axis or optical axis as shown in figure 10.4.

Focal length: The distance between optical centre 'O' and principal focus 'F' is called focal length. It is denoted by '*f*' and is shown in figure 10.4.

Ray diagrams

The location and nature of the image formed by a lens can be found easily through a ray diagram. In this method, diagram is drawn geometrically and then the image is traced from the diagram. In a ray diagram, rays of light are represented by straight lines. An arrow head is put over the line to indicate the direction. Although several rays of incident light, after refraction from the object spread out in all the directions but for the sake of convenience, three particular rays are used. Image is formed at the position where all the three rays or any two of them meet.

The three rays are the following:

1. A ray parallel to the principal axis, after refraction from convex lens passes through its principal focus. While in case of concave lens it appears to come from the principal focus.

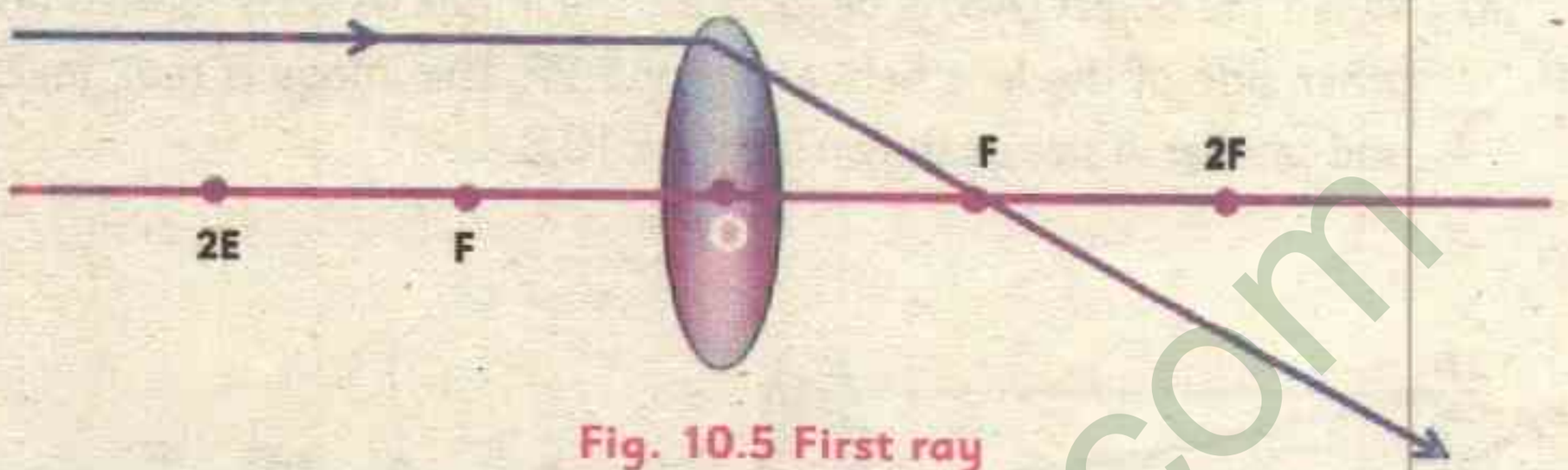


Fig. 10.5 First ray

2. A ray passing through the principal focus of a convex lens after refraction becomes parallel to principal axis as shown in figure 10.6.

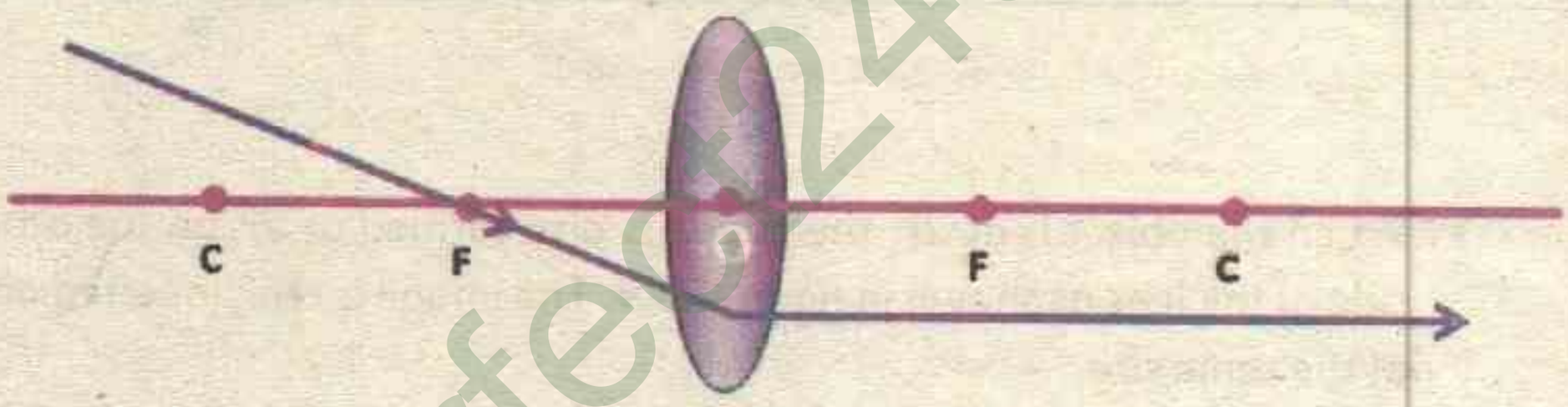


Fig. 10.6 Second ray

3. A ray passing through the optical centre of the lens will go unrefracted as shown in figure 10.7.

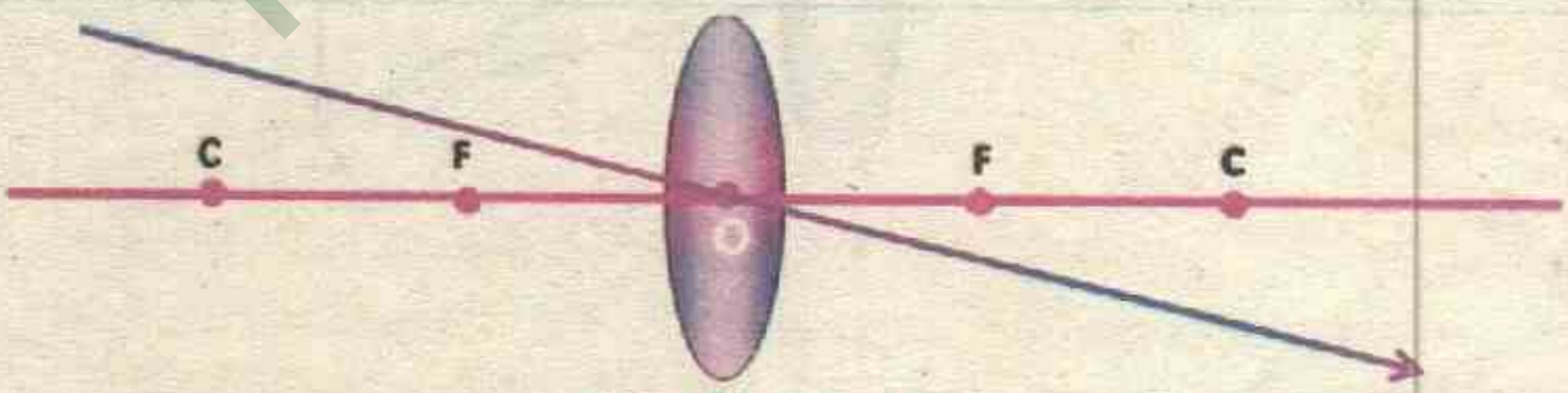


Fig. 10.7 Third ray

Image formation by convex lens

Following are the few ray diagrams showing different positions of the object and their image formation.

(a) When the object (AB) is beyond 2F, the image (A'B') is formed on the other side of the lens between F and 2F. The image is real, inverted and smaller in size as shown in figure 10.8.

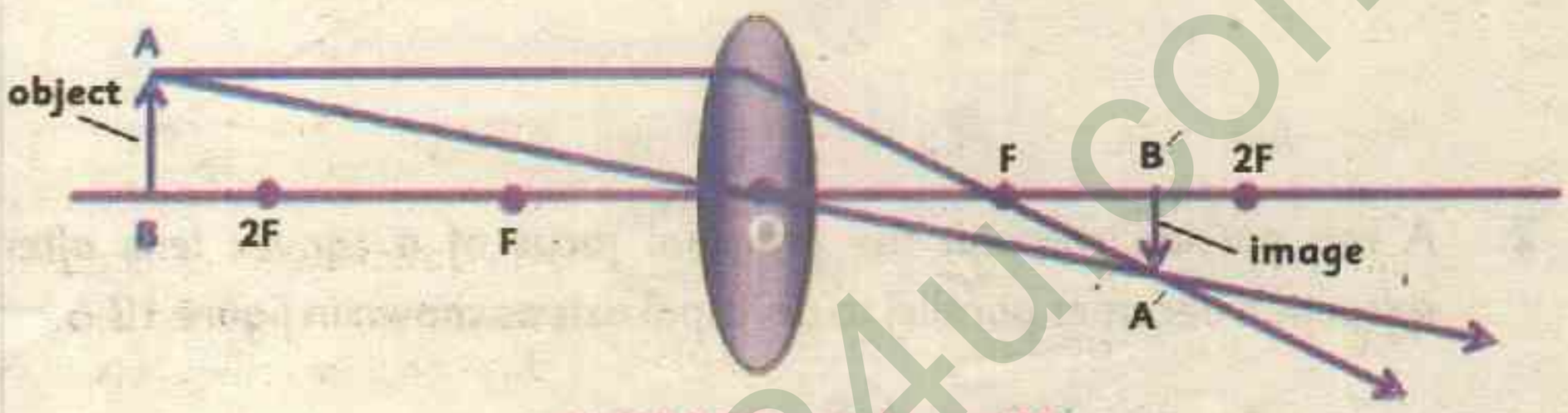


Fig 10.8 Object is beyond 2F

(b) When the object is at 2F, the image is also formed at 2F on the other side of the lens as shown in figure 10.9. The image is real, inverted and of the same size.

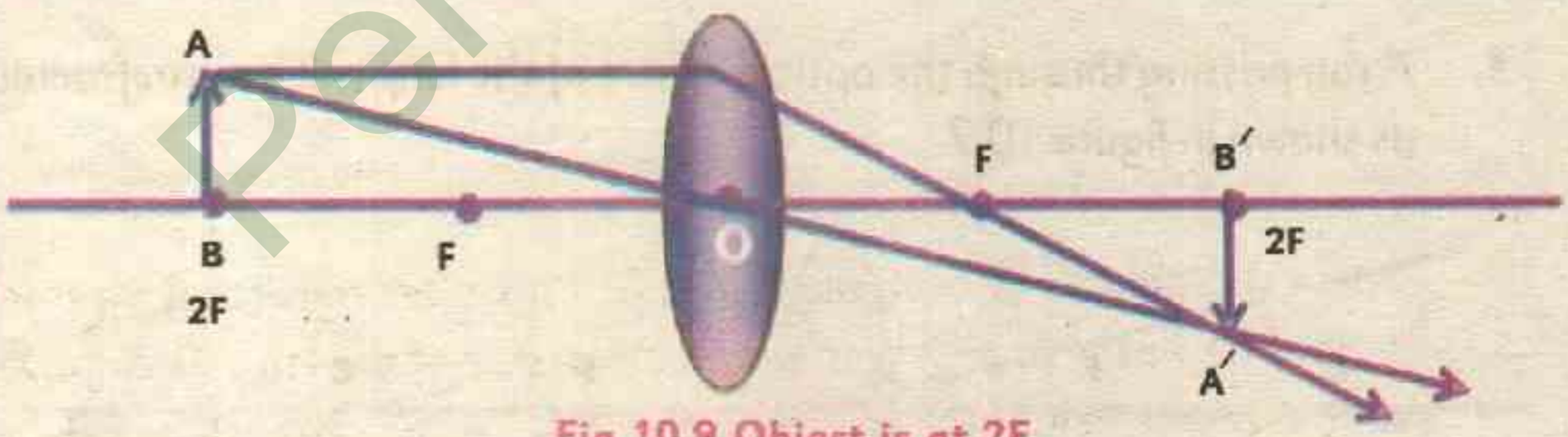


Fig 10.9 Object is at 2F

(c) When the object is placed between 2F and F, the image is formed beyond 2F on other side of lens. It is real, inverted and large in size as shown in figure 10.10.

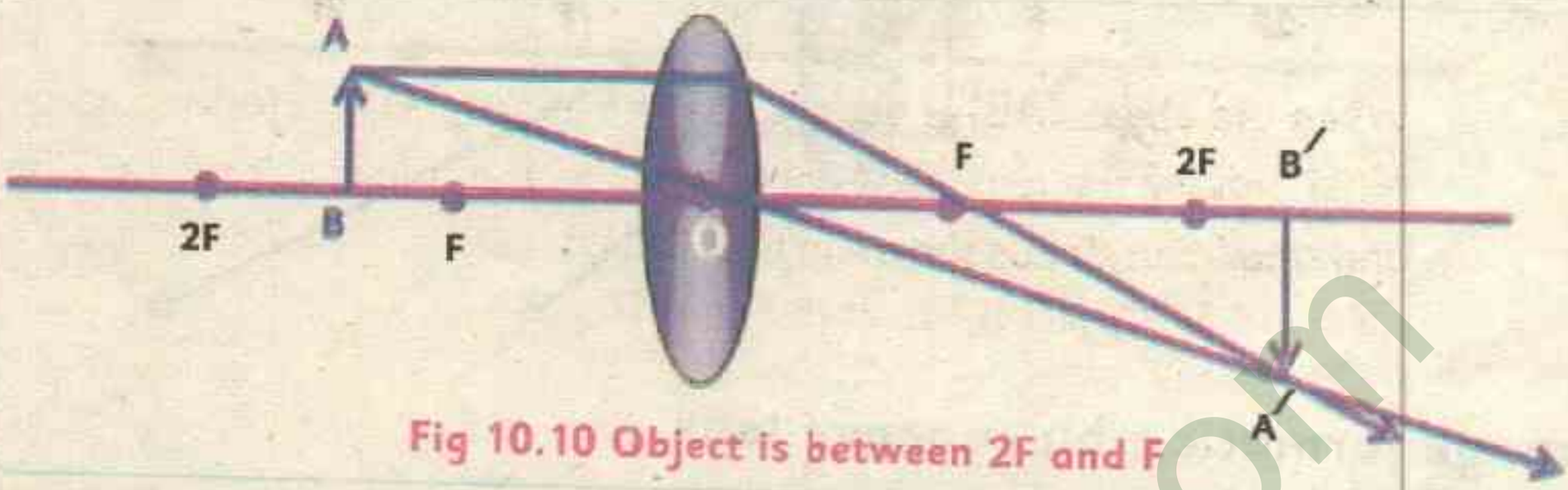


Fig 10.10 Object is between 2F and F

(d) When the object is placed at 'F', the image is formed at infinity on the other side. It cannot be shown in the diagram because rays become parallel after refraction. The image is real, inverted and very large in size as shown in figure 10.11.

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The focal length of a thin convex lens is greater than that of a thick convex lens,

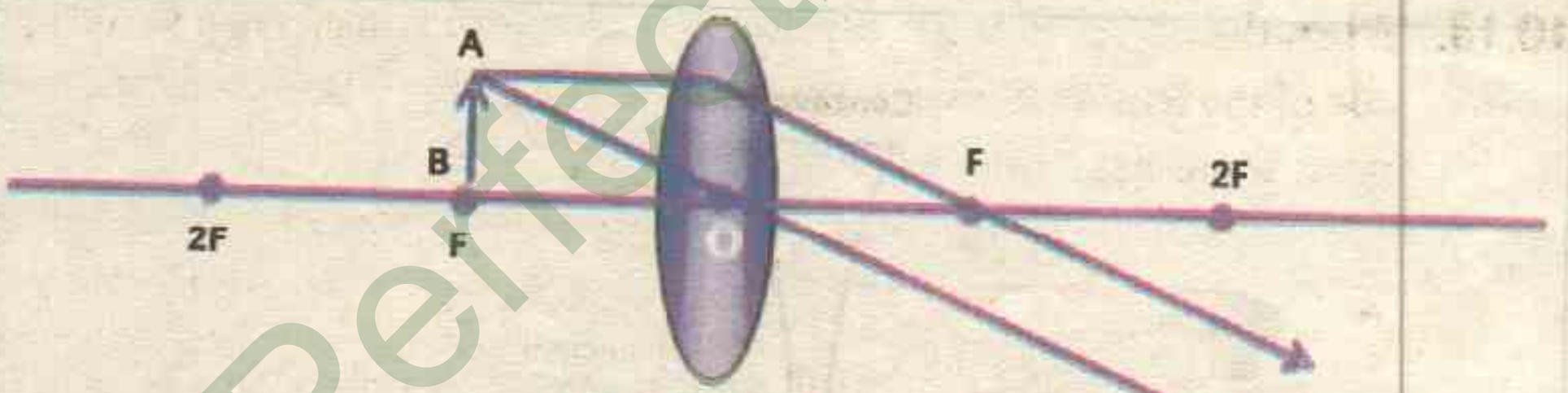

Fig 10.11 Object at F

(e) When the object lies between F and O, rays after refraction diverge out and do not actually meet on the other side of the lens. Therefore, no real image is formed on the other side of the lens. However, a virtual image will be formed at a point where the rays meet when extended back. These rays will appear to come from the image. The image will be magnified and erect as shown in figure 10.12.

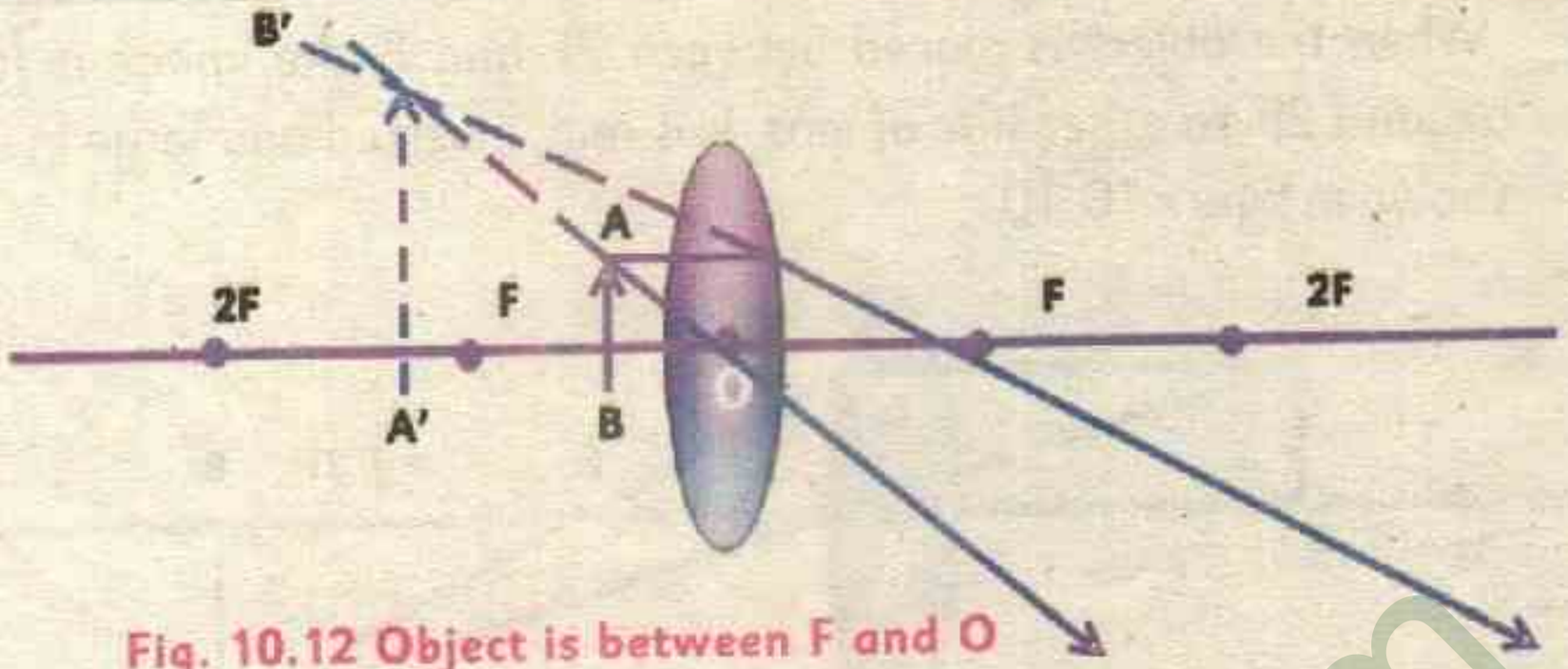

Fig. 10.12 Object is between F and O

Image formation by concave lens

Just like the ray diagrams for convex lenses, you can also draw ray diagrams for concave lenses by placing objects at different distances. You will learn that rays after refraction, diverge out and do not meet on the other side of the lens. Therefore, real image is not formed on the other side. However, a virtual image can be formed by extending the rays to the back. The image is always virtual, erect and smaller in size and is formed between principal focus and optical centre regardless of the position of the object from the lens as shown in figure 10.13.

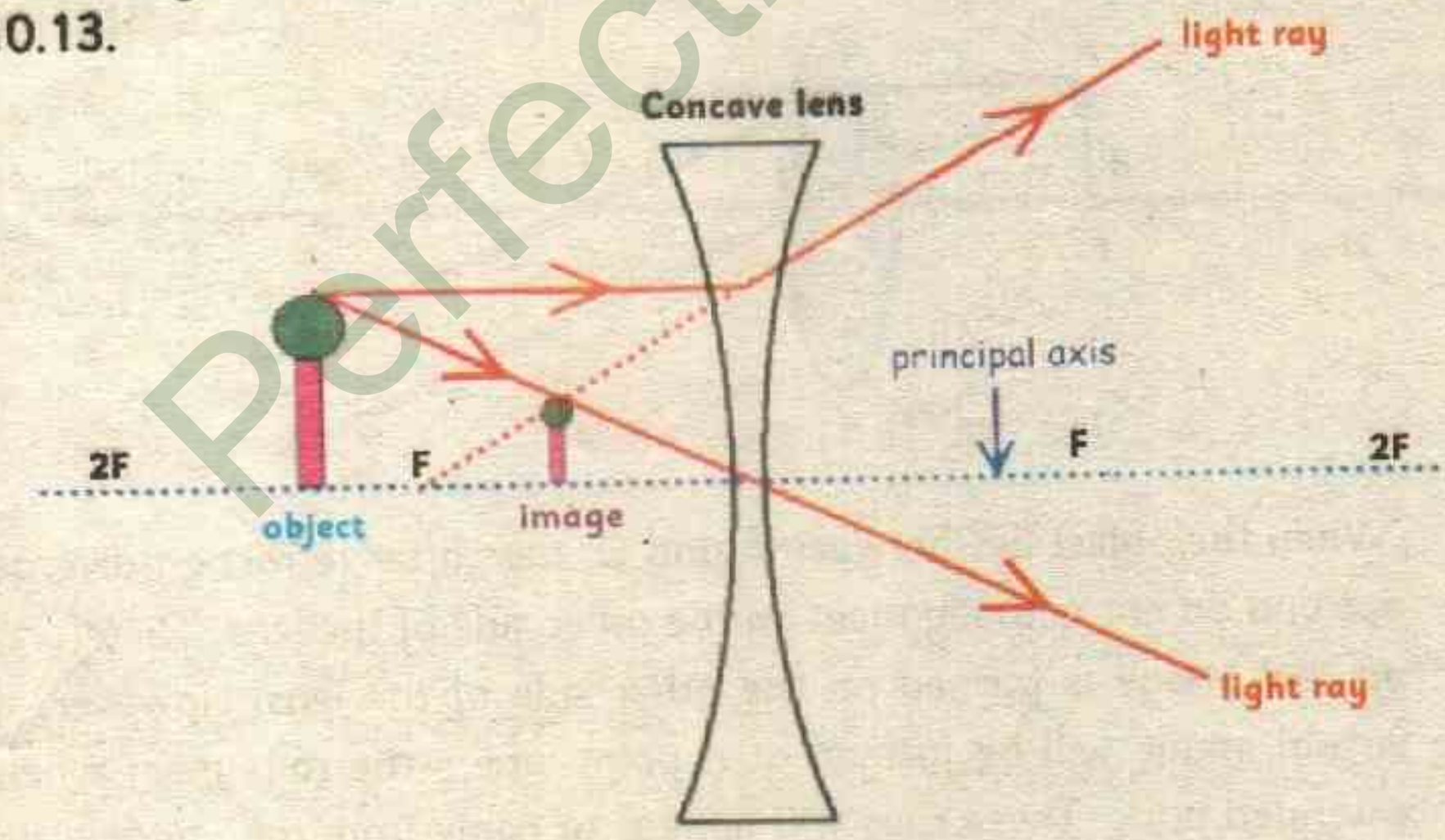

Fig 10.13 Ray diagram of concave lens

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Light ray passing through concave lens bend in such a way that they seem to meet behind lens or in other words appears to be coming from a point as shown in figure. That is why the focus point of concave lens is 'virtual' and its focal length is also taken negative.

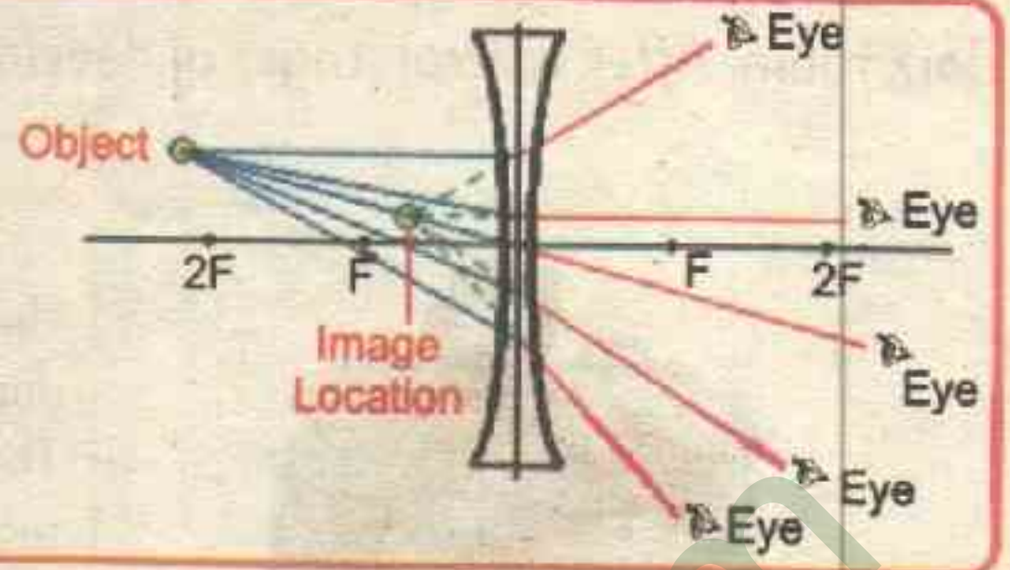


Image formation in cameras and human eyes

Camera

A camera is an optical instrument. Basically it is a box with a convex lens at one end and a light sensitive film placed at the opposite end, as shown in figure 10.14. The lens forms a real, small and inverted image of an object on the film. A distant image on the film is focused by moving the lens forward or backward in its holder.

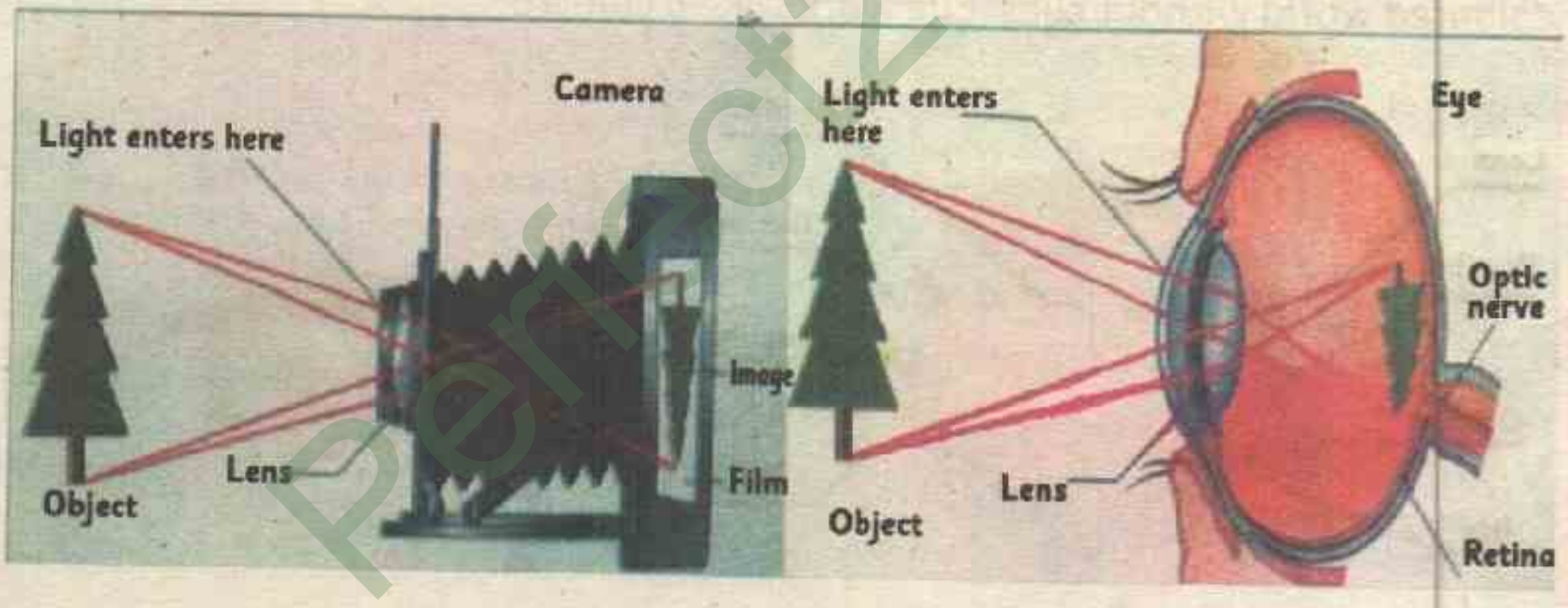


Fig 10.14 Comparison of camera and human eye.

The shutter opens and shuts quickly when its button is pressed. This lets light enter the camera for a very short interval of time. An adjustable diaphragm controls the aperture (hole) and the intensity of light entering the camera. The amount of light reaching the film depends upon the exposed time and the area of the aperture.

The film after being exposed is processed in different chemical solutions in a dark room. After several stages of development, the film is printed out.

Fig 10.15 Camera

Science TidBit

Unlike old-style cameras that used films, digital cameras are more popular these days. They capture and record images using digital technology. They also use lenses to focus and capture the pictures. They have many advantages as they give us instant photographs, allows us to edit a picture and makes it easier for us to share photographs.

Human Eye

Human eye is a precious gift of Almighty Allah. One cannot think of the coloured world without eyes. Eye works like a camera.

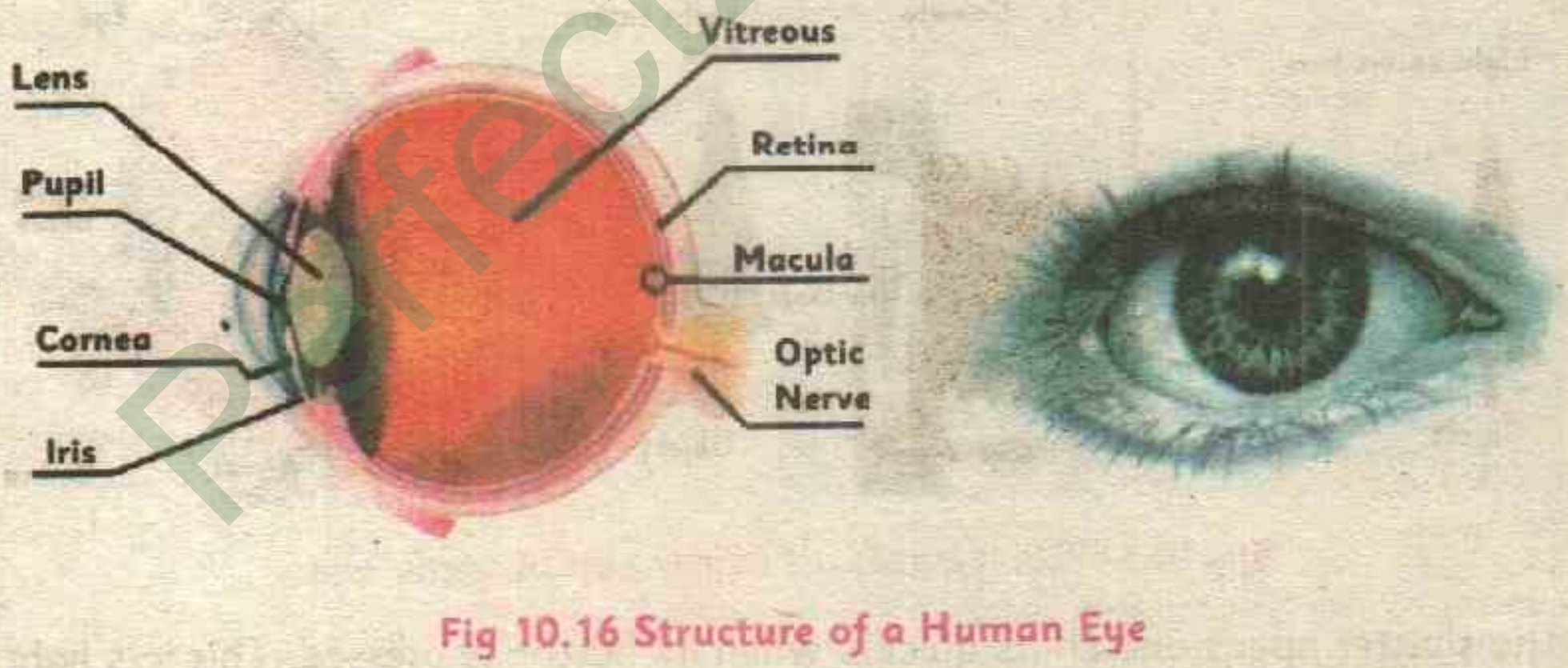


Fig 10.16 Structure of a Human Eye

Important Fact

Most animals focus by using the ciliary muscles to change the shape of the lens. Fish , however, focus the image by moving each lens backwards and forwards just like a camera.

It consists of an enclosure having a convex lens at one end and a light sensitive surface, the retina at the other end. The various parts of the eye are shown in figure 10.16. The convex lens system of the eye forms a small inverted image of anything in front of it. The iris diaphragm has a pupil in the middle of the eye which controls the amount of light going into the eye. Iris control the pupil size. The pupil grows larger to see things in dark whereas it contracts in bright light. The cornea and the watery fluid (vitreous) behind it do most of the focusing of the rays of light. The lens itself makes small focusing by becoming thinner or thicker. Unlike the camera the eye lens does not move back and forth.

The retina acts like a screen on which inverted image is formed. The optic nerve carries image from the retina to the brain, which interprets the image. The brain gives an erect view of the object.

Defects of eye and their correction

There are two types of defects in human eyes which are as under.

I. Short sightedness

A person suffering from short sightedness cannot see far off objects clearly but can see the nearby objects clearly. The lens of such an eye become thick and the focal length is reduced. Due to this reason parallel rays are focused infront of the retina.

Correction

Short sightedness can be corrected by wearing spectacles having concave lenses of suitable focal length. As a result, rays are focused on the retina.

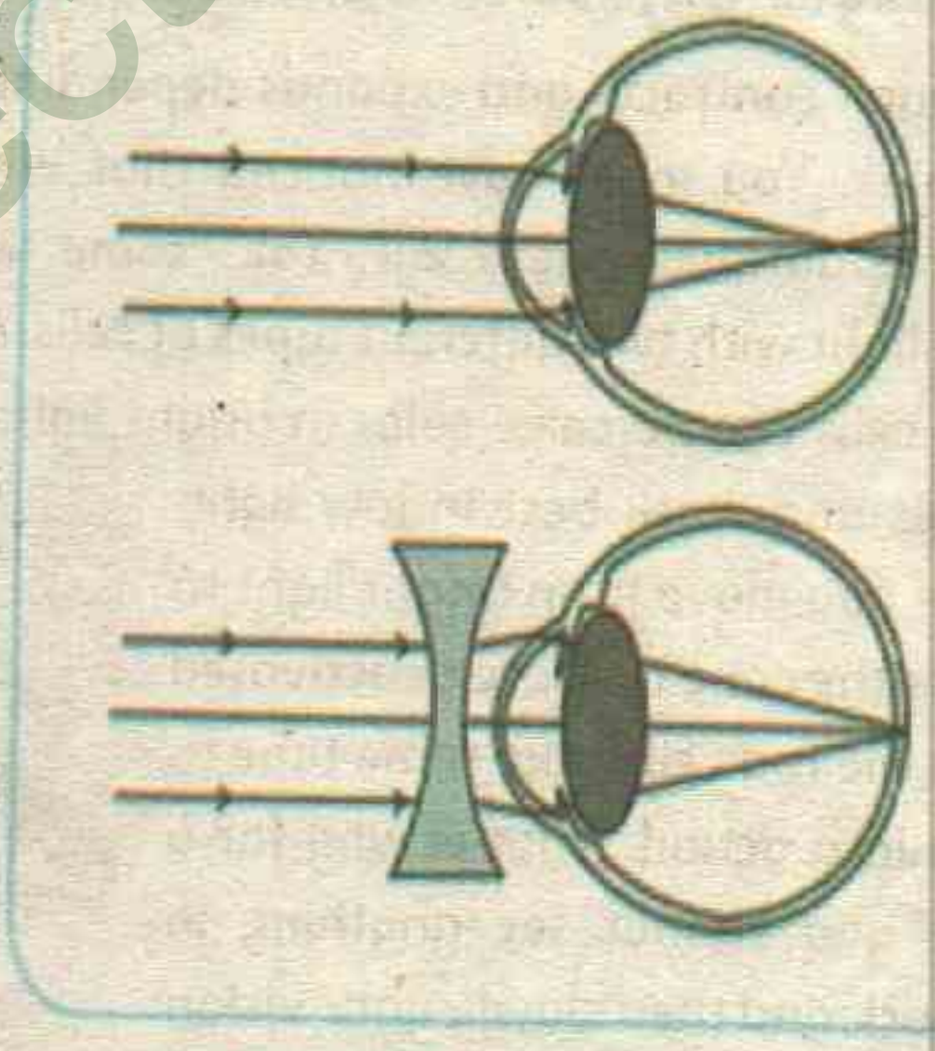


Fig 10.17 Short sightedness and its correction

ii. Long sightedness

A person suffering from long sightedness can not see the near objects clearly but far off objects can be seen clearly. The eye ball becomes thinner or less converging. Due to this reason parallel rays are focused behind the retina.

Correction

This defect can be removed by wearing spectacles having convex lens of suitable focal length which make the rays focused at retina.

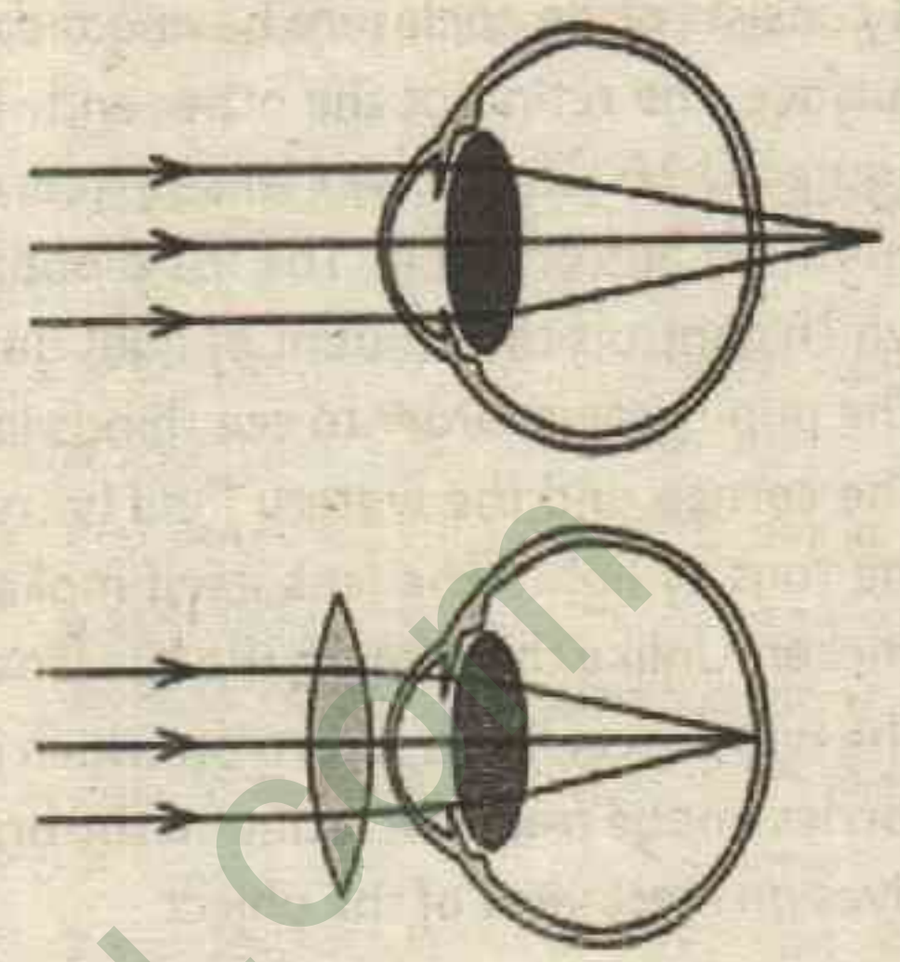
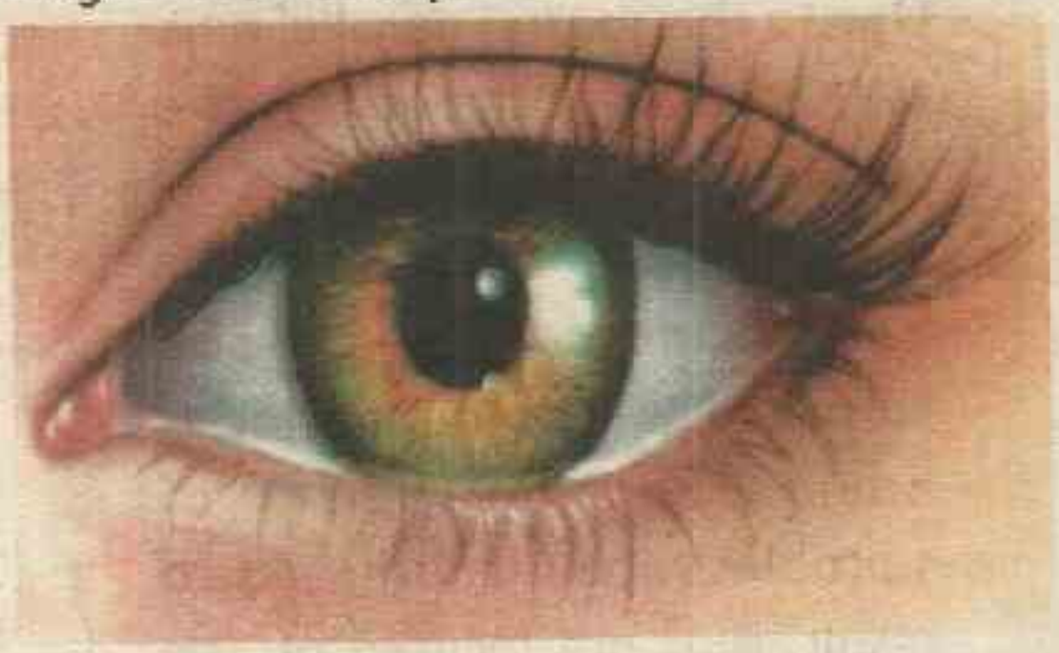


Fig 10.18 Long sightedness and its correction

How eyes adjust to darkness after sometime

The pupil contracts and expands depending upon the amount of light entering the eyes. You must have noticed that when you move from bright light to extreme darkness, your eyes take some time to adjust to the darkness. Eyes sense light with two different types of cells: rod and cone cells.

Cone cells can perceive color in bright light. Rod cells perceive black and white images and work best in low light. When you move from bright light to a dark the cone cells are deactivated while the rod cells take some time to come into action. That is why for a while you cannot see anything in the dark and then slowly your vision adjusts to the darkness and you are able to see.



Types and uses of lenses

There are various types of convex and concave lenses.

(i) Double convex lens: when both the surfaces of a convex lens are curved outward then it is called double convex lens or biconvex lens.

(ii) Plano-convex lens: If one of the surfaces of a lens is convex and other is plane, then it is called a plano-convex lens.

(iii) Plano concave lens: If one of the surfaces of a lens is concave and other is plane, then it is called a plano-concave lens.

(iv) Concavo-convex lens: If one of the surfaces of a lens is convex and the other is concave, such that the central region of the lens is thicker than edges, it is called a concavo-convex lens.

(v) Convexo-concave lenses: If one of the surfaces of a lens is concave and the other is convex such that the central region of the lens is thinner than its edges, it is called a convexo - concave lens.

(vi) Double concave lens: When both the surfaces of a lens are concave or curved inward then it is called double concave lens or bi-concave lens.

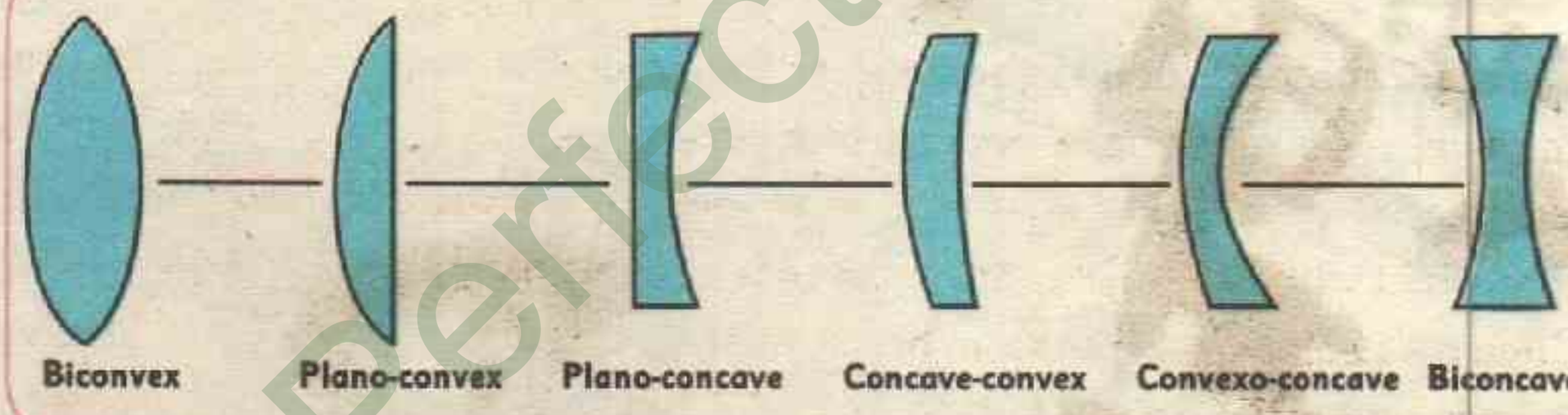


Fig 10.19 Type of Lenses

Uses

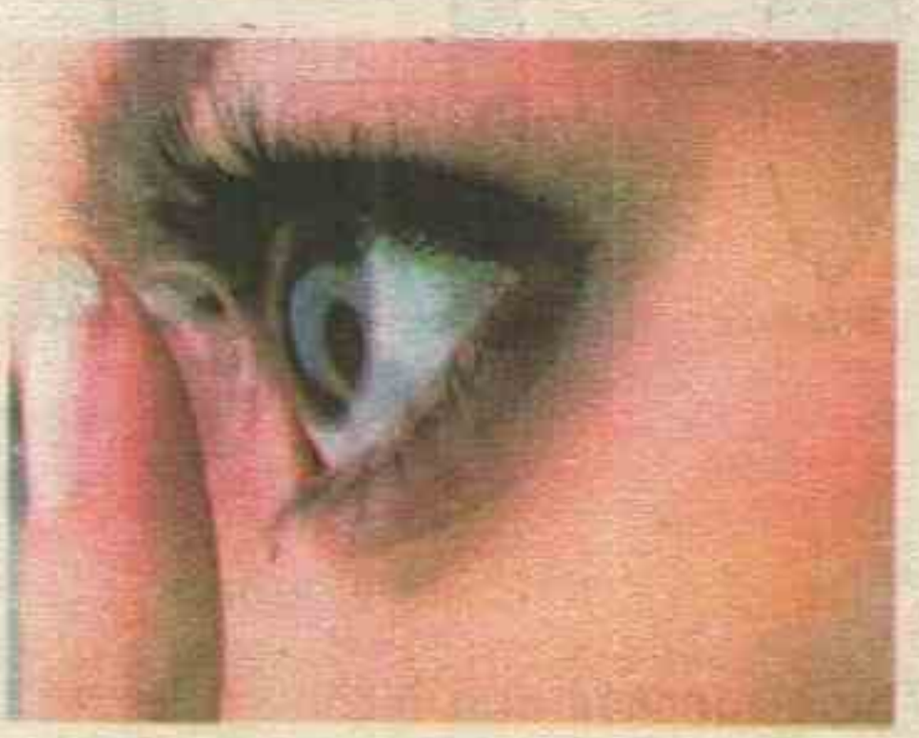
The biconcave and biconvex lenses are used in our science laboratories and experiments. They are also used in spectacles, binoculars, light microscopes, camera, astronomical telescopes and terrestrial telescopes. The plano-convex

and plano-concave lenses are commonly used in optical instruments like the optical projector. The concavo-convex and convexo-concave lenses are used in contact lenses to correct defective vision.

Camera

Optical projector

Optical telescope



Contact lens

KEY POINTS

1. A lens is a piece of transparent material like glass with one or both surfaces curved.
2. There are two main types of lenses, convex lens (converging lens) and concave lens (diverging lens).
3. A lens, which is thick at the middle and thinner at the edges is called convex lens and a lens, which is thin at the middle and thicker at the edges is called concave lens.
4. The centre of the lens is known as the Optical centre of the lens.
5. The centre of the sphere of which any surface of the lens is a part, is known as its Centre of Curvature.
6. A straight line passing through the centre of curvature, optical centre and focal point is called the principal axis.
7. Parallel rays after refraction through a convex lens converge at a point F which is called the principal focus / focal point of the lens.
8. The distance between the optical centre and the principal focus is known as focal length of the lens.
9. The image that can be obtained on the screen is known as real image.
10. The location and nature of image can be found through ray diagram drawing geometrically even without actually performing experiment.
11. The human eye is an organ to see things around us.
12. A camera is used to obtain image on the sensitive film. It works like a human eye.
13. Lenses are used in microscopes, telescopes, cameras and projectors.
14. There are two defects in eye vision: long sightedness and short sightedness.
15. The pupil contract and expands depending upon the amount of light centering the eyes.
16. There are six different types of lenses.

Exercise

A. Complete the following statement.

i. A lens which is thick on edges and thin from the centre is called concave lens

ii. The distance between principal focus and an optical centre of a lens is called focal length

iii. Concave lens is also known as diverging lenses

iv. The image formed by a convex lens is always virtual and real.

v. The problem of short sightedness is removed by wearing spectacles having concave lenses.

B. Choose the correct answer for each of the following statements.

i. A ray parallel to principal axis, after refraction from convex lens:

(a) does not bend (b) passes through centre of curvature

(c) passes through principal focus (d) passes through the centre of lens.

ii. The image formed by a concave lens is always:

(a) virtual (b) real (c) inverted (d) larger

iii. Pupil of an eye is made smaller or larger by:

(a) lens (b) cornea (c) iris (d) retina

iv. A line passing through centre of curvature, optical centre and principle focus is called:

(a) optical centre (b) focal length

(c) focal length (d) principal axis

v. The camera lens forms a _____ image of an object on the film.

(a) real, small and inverted (b) virtual, small and inverted

(c) real, large and straight (d) virtual, large and straight

C. Give short answers of the following.

i. Describe the paths of the three rays passing through convex lens with the help of ray diagrams.

ii. How the focal length is affected when the lens of an eye becomes thicker?

iii. Draw ray diagrams to show how a converging lens forms images. What are the characteristics of these images?

iv. Define the following terms related to a lens along with the diagram. (i) Principle axis (ii) Optical centre (iii) Principal focus (iv) Focal length.

v. Write only two uses of concave lens and convex lens.

D. Give detailed answers to the following questions.

i. Describe the features of a human eye that allows it to see.

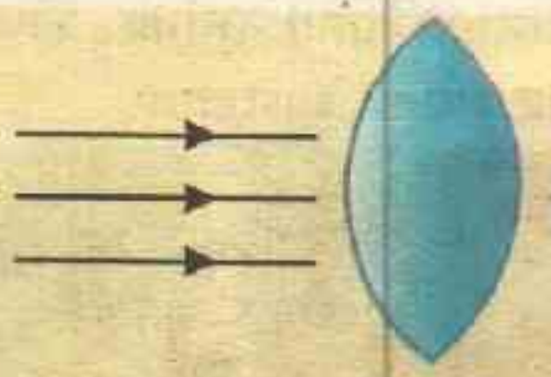
ii. Discuss how the eye and camera are very similar and point out some differences between them.

iii. Write a note on short sightedness and long sightedness and also explain how to remove these defects using lenses?

Test yourself activity

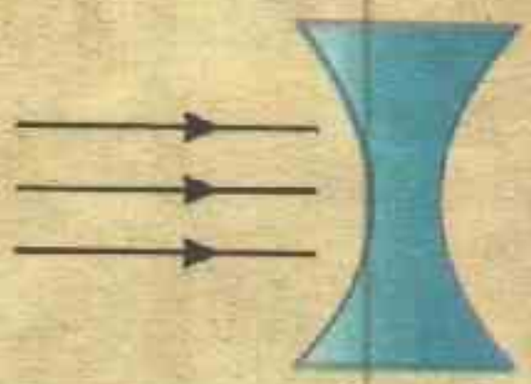
The diagram shows light rays entering two lenses.

i. What type of lens is
   (a) lens A?
   (b) lens B?



Lens A

ii. Copy and complete the diagrams showing the light rays entering and leaving each lens.
   (a) Use diagram A to explain what a focal point is?
   (b) Name one optical instrument that uses lens A and B



Lens B

UNIT 11

ELECTRICITY IN ACTION

After studying this unit, students will be able to:

- Design an experiment to generate electricity.
- Explain the working of model generator.
- Identify the simple devices that generate electricity in daily life.
- Design and demonstrate the working of a power station.
- List types of energy being used in power stations.
- Relate problems involved in generating electricity.
- Describe basic components of an electronic system.
- List components that are needed to turn A.C to D.C.
- State how output component in various devices could be used in their schools and surroundings.

Introduction

In previous grades, you have already studied in detail about electricity, static electric charges and their properties, electric current and its effects (heating, chemical and magnetic) and electric circuits. In this unit, you will learn about generating electricity, problems in generating electricity, working of power station and other sources of electricity. You will also learn about basic electronic systems.

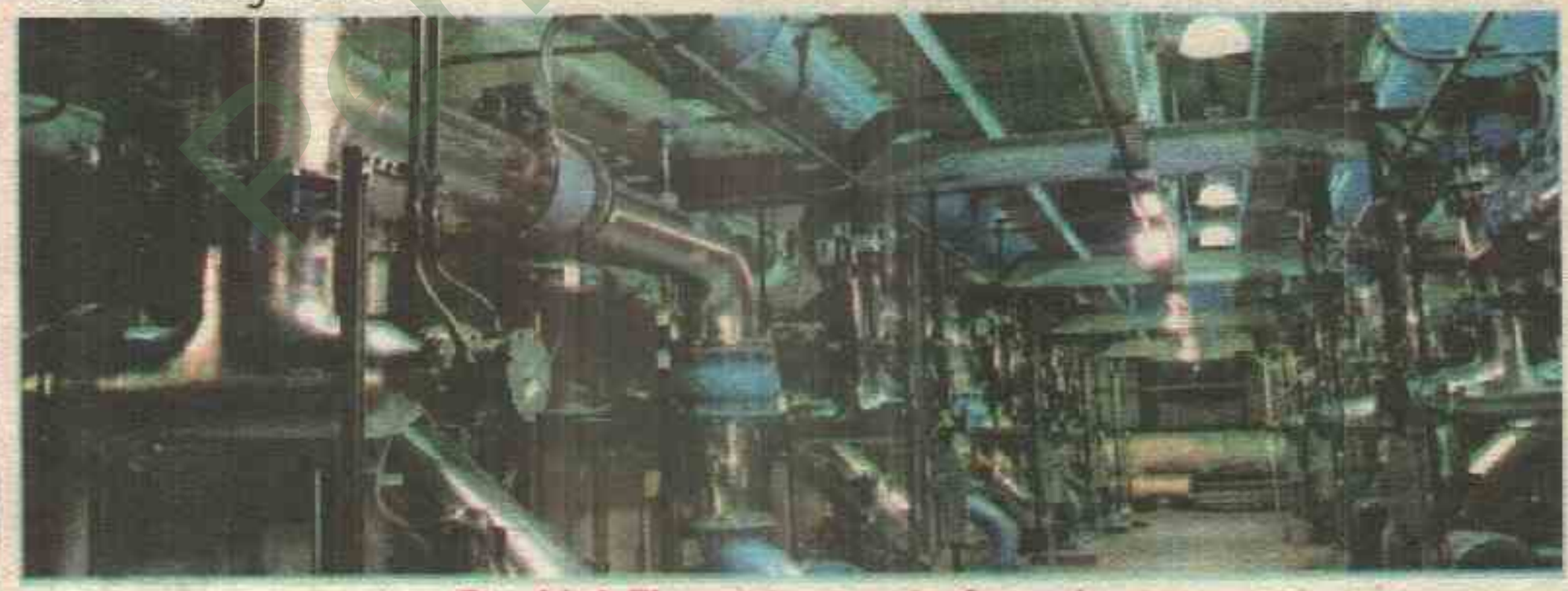


Fig 11.1 Electricity use in factories

Generating electricity

Electricity can be generated through generators. Generator is a device that converts mechanical energy into electricity energy. Two very common examples of generators are the mechanical generator as shown in figure 11.2 and the bicycle dynamo as shown in figure 11.3.

Fig 11.2 Generator

Fig 11.3 Bicycle Dynamo

A simple experiment to show how electricity can be generated.

Experiment

Connect a long coil of wire with a galvanometer. Take a bar magnet. Push it inside the coil quickly, pointing its north pole towards the coil. Keep observing the needle of galvanometer carefully while pushing the magnet inward. Does it show any deflection? Now pull the magnet backward quickly from the coil. Is the needle deflected again? Repeat the experiment pointing south pole of this magnet towards the coil. What is your observation? Now keeping the magnet stationary, move the coil back and forth over the magnet. Does the galvanometer show any deflection even now? You will observe the deflection of galvanometer in each case which means that the electricity is generated.

Science TidBit

"Hans Christian Oersted a Danish scientist in 1820 discovered a relation b/w electricity and magnetism"

Electricity in Action

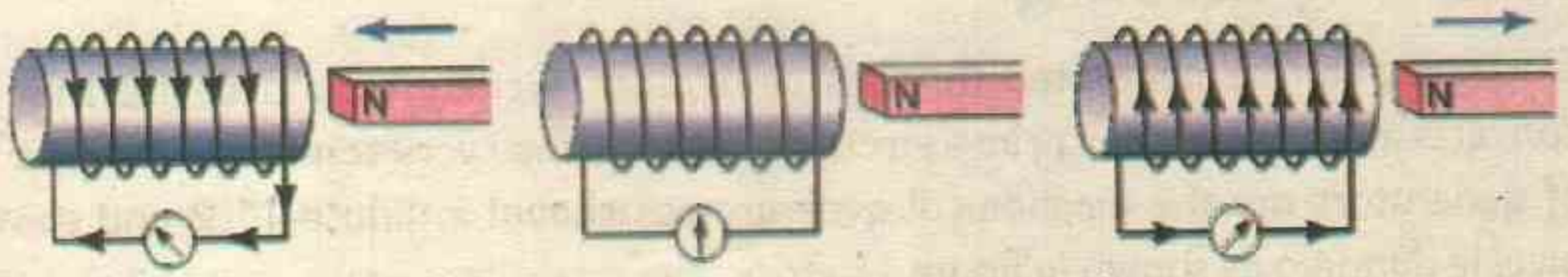


Fig 11.4 Generation of electricity using bar-magnet.

When there is a relative motion between a magnet and coil of wire, electric current starts flowing in the coil. This phenomenon is called electromagnetic induction. The direction of this current depends upon the direction of relative motion between the magnet and the coil.

Working of AC generator

The simple alternating current (A.C) generator is based on the principle of electromagnetic induction. It consists of a rectangular coil of wire ABCD, revolving at a steady speed in a magnetic field. In large generators, electromagnet is used as an armature, number of turns of wire wound on a soft-iron core. It is insulated and connected to a rotating main shaft which turns it about a horizontal axis, perpendicular to the magnetic line of force. The ends of the rectangular coil are connected to two copper slip ring. Current due to the rotation of the armature is conducted to the external circuit by mean of two carbon brushes which are made to press lightly against the slip rings.

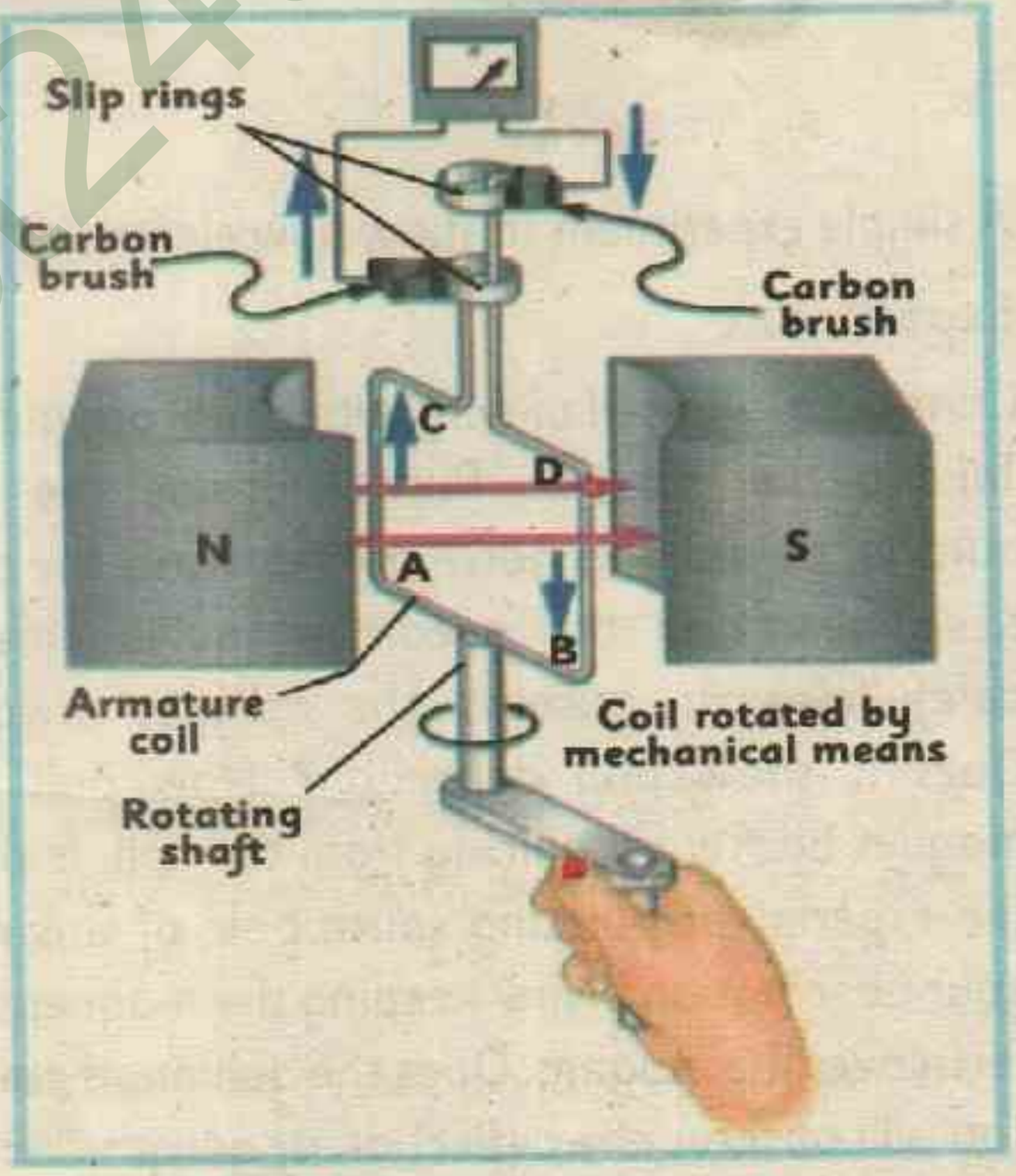


Fig. 11.5 Electric Generator

Lightly

Working of a bicycle dynamo (Portable generator)

As discussed earlier, a dynamo on a bicycle is used to generate electricity. A bicycle dynamo is a type of generator attached to a bicycle to produce electricity. The top of the dynamo touches the tyre's rim, which spins when the bicycle starts moving. Typically, a bicycle dynamo has one or more permanent magnets with coil of copper wire spinning inside its poles. The device consists of a stationary part called a stator and a rotating part called an armature. When the coil spins in the magnetic field, the magnetic flux begins to change through the coil, resulting in an electric field that produces an electric current. Bicycle dynamos attain a low efficiency in converting mechanical motion into electricity. However, there are large machines such as water wheels that attain high efficiency under ideal conditions.

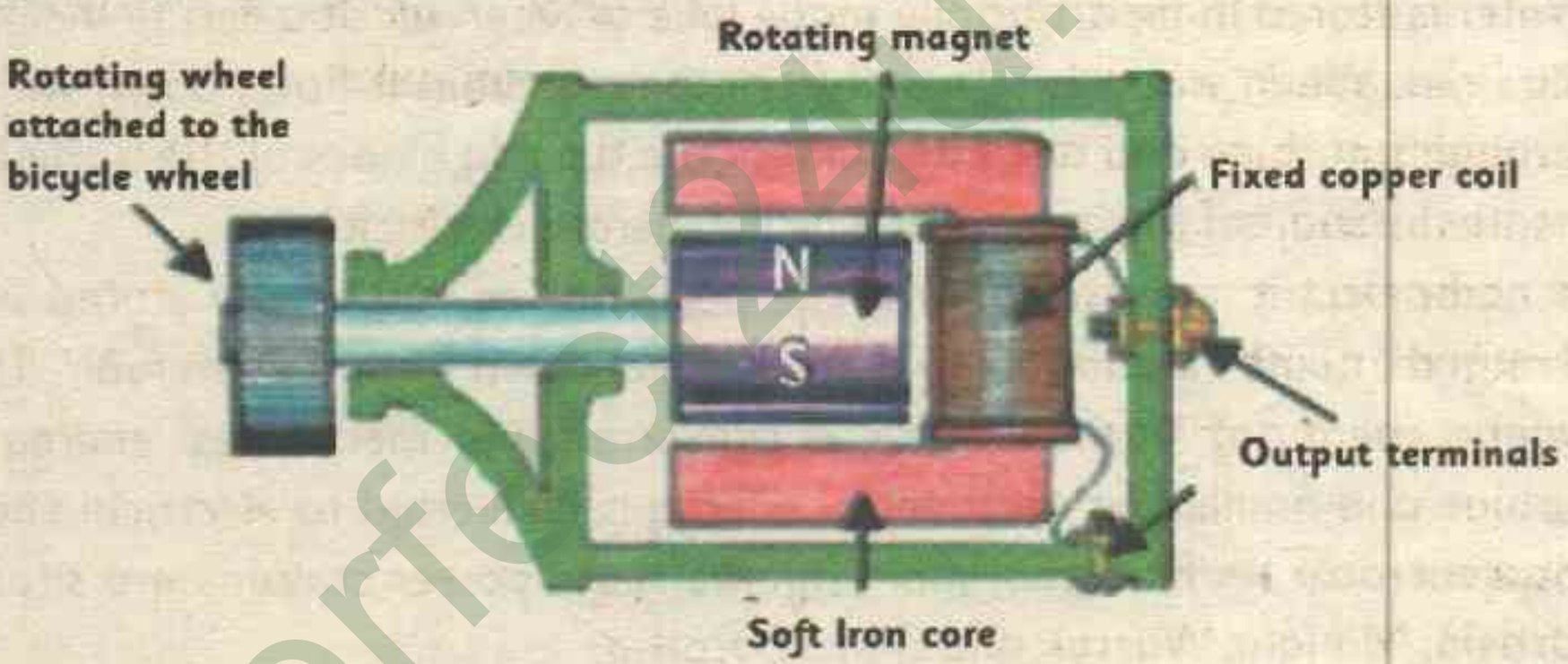


Fig 11.6 Bicycle Dynamo

Other sources of electricity

There are many different sources that can be used for the generation of electricity, some of which are given below.

1. The Battery

A battery is a chemical source for generating electrical energy. There are many kinds of batteries in use nowadays. One of the most common type is the ordinary flash light battery, often referred as a dry cell. Figure 11.7 is a diagram of the interior of such a battery. In this battery, the zinc case serves as

the negative terminal (cathode) while the carbon rod at the centre serves as the positive terminal (anode). The space between the two terminals contains a paste-like mixture of manganese dioxide, ammonium chloride and carbon. The chemical reactions that take place within the battery, cause the generation of electrical energy.

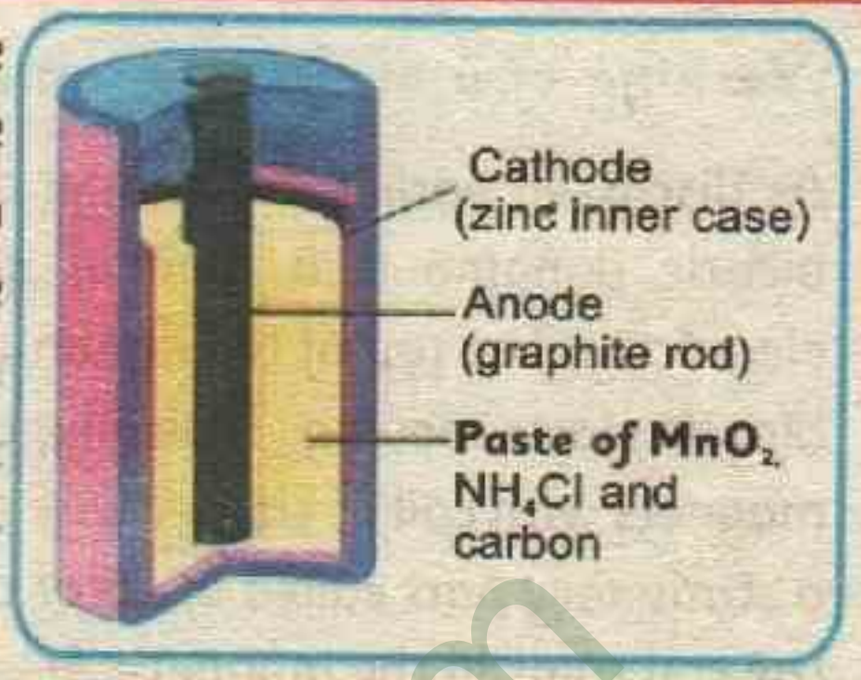


Fig 11.7 structure of dry cell

2. Hydroelectric Power

The electricity generated by conversion of kinetic energy of water, is called hydroelectric power. It is the cheapest and major source of electricity in Pakistan. The principle of hydroelectric power is shown in the figure 11.8. Water is stored in an artificially made lake or reservoir at a certain height from sea level. When water is released from the reservoir, it flows down with speed through a turbine and turns its blades. The turning blades of the turbine inturn rotate the shaft of the generator which generate electricity.

In hydroelectric power stations, the potential energy of the stored water is changed into its kinetic energy when it flows down from the reservoir. Then the kinetic energy of flowing water is converted into mechanical energy of the turbine and finally this mechanical energy is converted to electrical energy by the generator. In Pakistan, main hydroelectric power stations are situated at Tarbela, Mangla, Warsak and Ghazi Barotha.

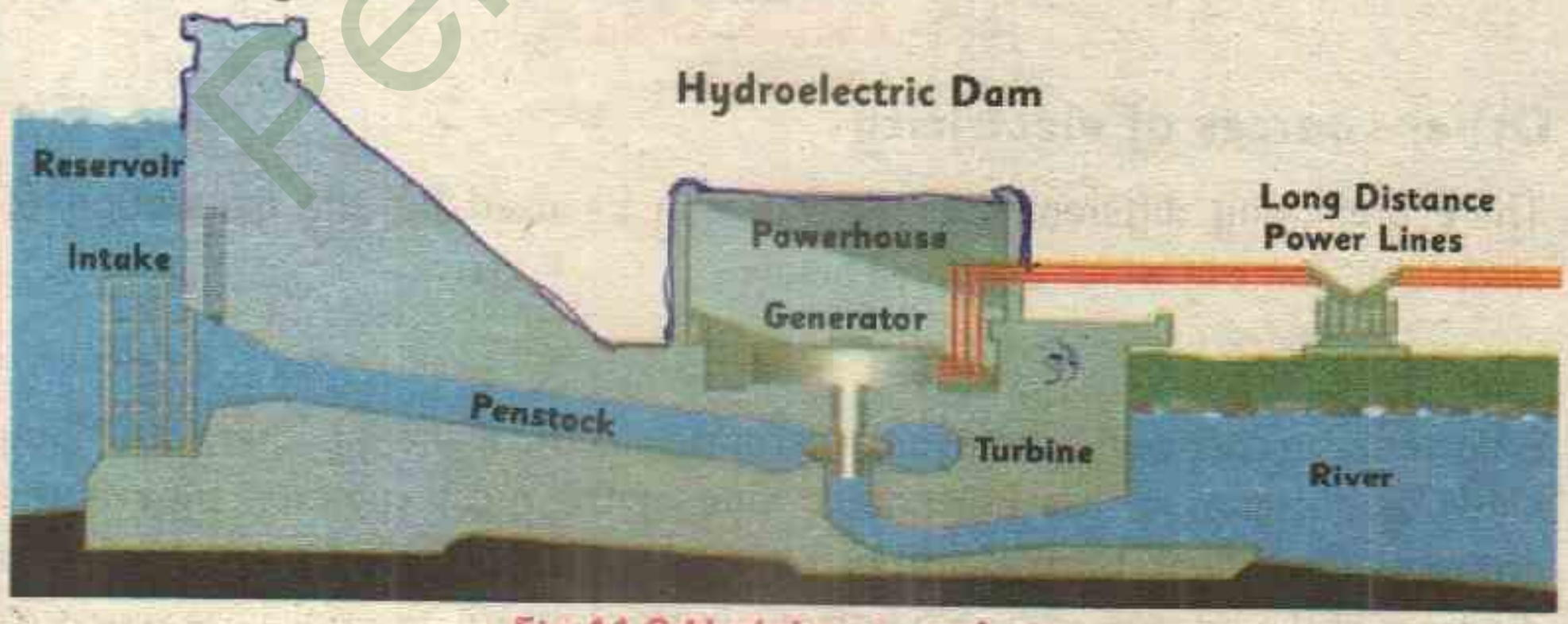


Fig 11.8 Hydal power plant

3. Wind Power

The use of wind energy as a source for generating electrical energy is called wind power. Kinetic energy of wind is converted into electrical energy by means of windmills. A windmill is a machine which converts kinetic energy of the wind into mechanical energy of the wind turbine. The turbine in turn rotates the shaft of the connected generator to generate electrical energy.

A typical windmill is shown in figure 11.9. A wind farm with a hundred or more windmills are needed for the generation of electricity on a large scale. A steady wind with a speed of about 20km/hr is needed for generation of electricity. Therefore, this method cannot be used everywhere for generating electricity. In Pakistan, this method is used in certain areas.

Fig 11.9 Wind Power

4. Nuclear Power

Generating electricity by means of heat produced by nuclear reactions in a nuclear power plant is called nuclear power. In a nuclear power plant, the heat generated by the fission reaction is used to convert water into steam. This steam is then used to rotate the steam turbine which in turn rotate the shaft of the connected generator to produce electricity.

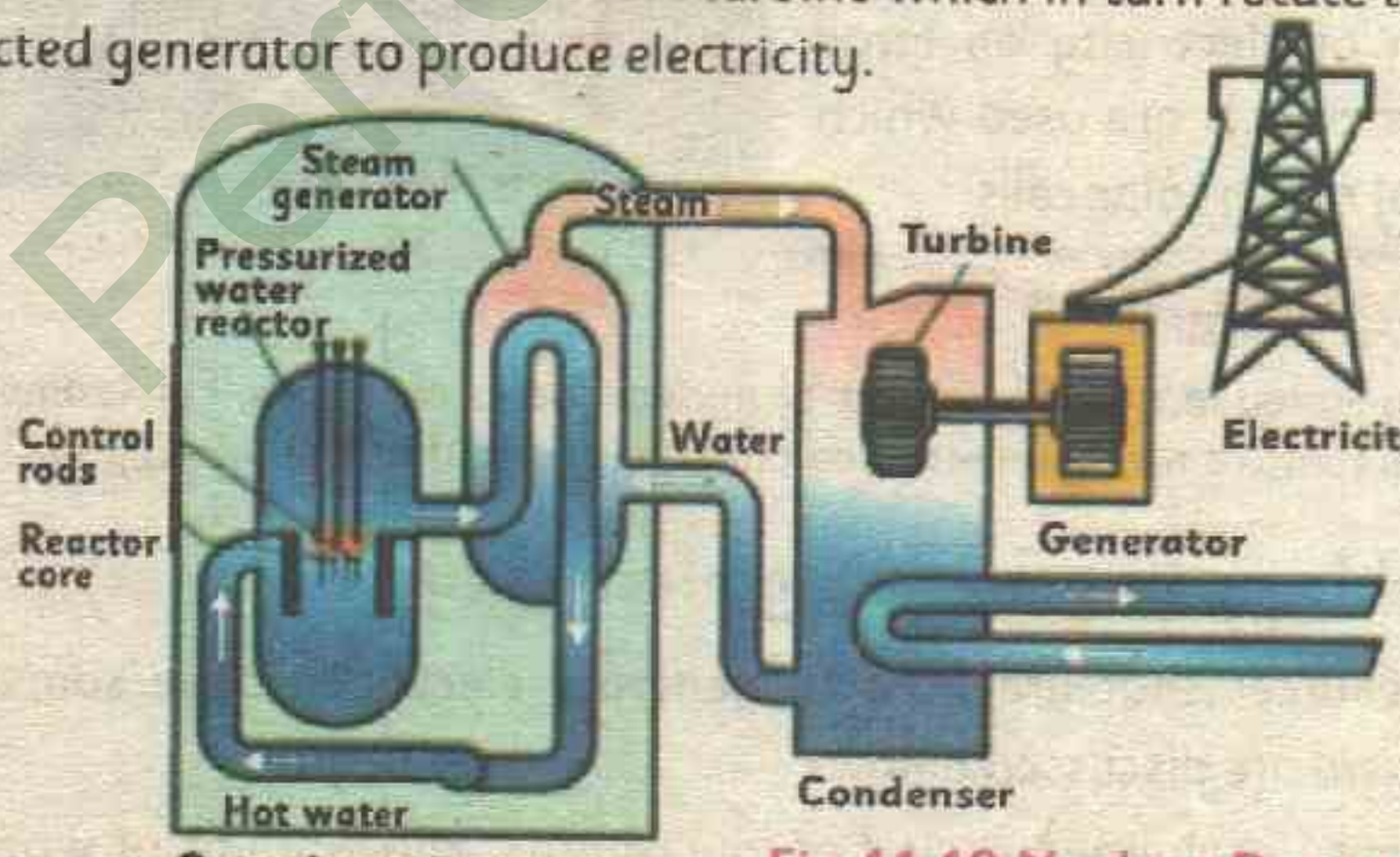


Fig 11.10 Nuclear Power Plant

5. Thermal power

Generating electricity by means of heat produced by burning of fossil fuels like coal, gas or oil in a thermal power station is called thermal power. In a thermal power station, the heat generated by the burning of fossil fuel is used to convert water into steam. This steam is then used to rotate the steam turbine which in turn rotate the shaft of the connected generator to produce electricity.

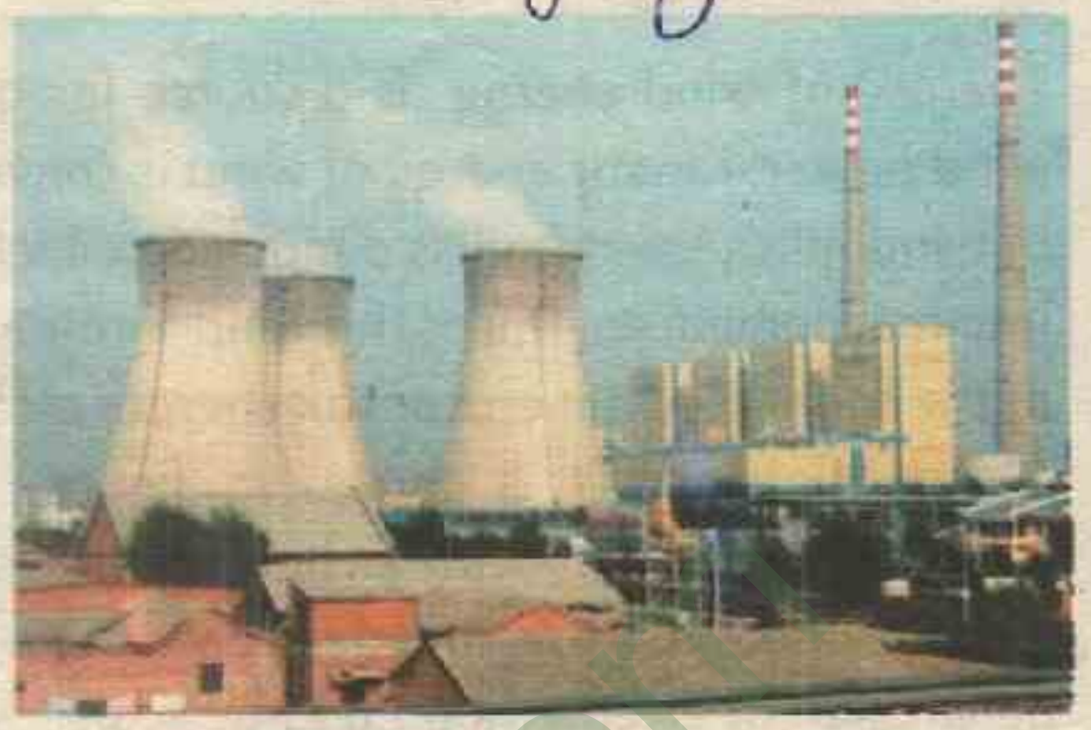


Fig 11.11 Thermal power plant

6. Solar power

Generating electricity by means of solar energy is called solar power. Usually Photovoltaic or solar cells are used for this purpose. When sunlight strikes a solar cell, it develops a voltage. For the generation of electricity on large scale, solar panels are used which comprise of many solar cells.

Fig 11.12 Solar power

Science TidBit

Tidal and geothermal energies can also be used to produce electricity.

Science TidBit

The energy stored in a small amount of nuclear fuel is enormous. For example, 1 kg of nuclear fuel contains nearly three million times the energy that is obtained from 1 kg of coal.

The problems in generating electricity

Different sources that are used to generate electricity have some problems. Some of them are discussed below:

- Due to prolonged period of low rainfall, the amount of water used for hydro power generation is of great concern.

- The high cost on construction of dams and non availability of suitable place for their construction is one of the problems.
- Nuclear power plants are the cheap source of generating electricity. However, these have harmful effects on nearby population and aquatic life due to nuclear radiations and wastes.
- High cost of solar panels and storage batteries is an issue for generating electricity from solar energy.
- Steam-cycle plants require a great deal of water for cooling.
- In generating electricity by wind mills, high cost and suitable place is required.
- Electrical energy cannot be stored; it has to be converted to a different form.
- The shortage of non renewable energy sources like fossil fules (coal, gas, oils).
- Generating electricity causes noise, air and soil pollution at point of generation.

Working of a power station

Electricity is generated in power stations. In power stations, steam is used to turn the turbine. In most power stations fossil fuels (coal, gas etc.) are burnt to produce steam. The design of a power station is shown in figure 11.13. Electrical energy generation using steam turbines involves following three energy conversions:

i. Extracting thermal energy from the fuel and using it to raise steam.
ii. Converting the thermal energy of the steam into kinetic energy in the turbine.
iii. Using a rotary generator to convert the turbine's mechanical energy into electrical energy.

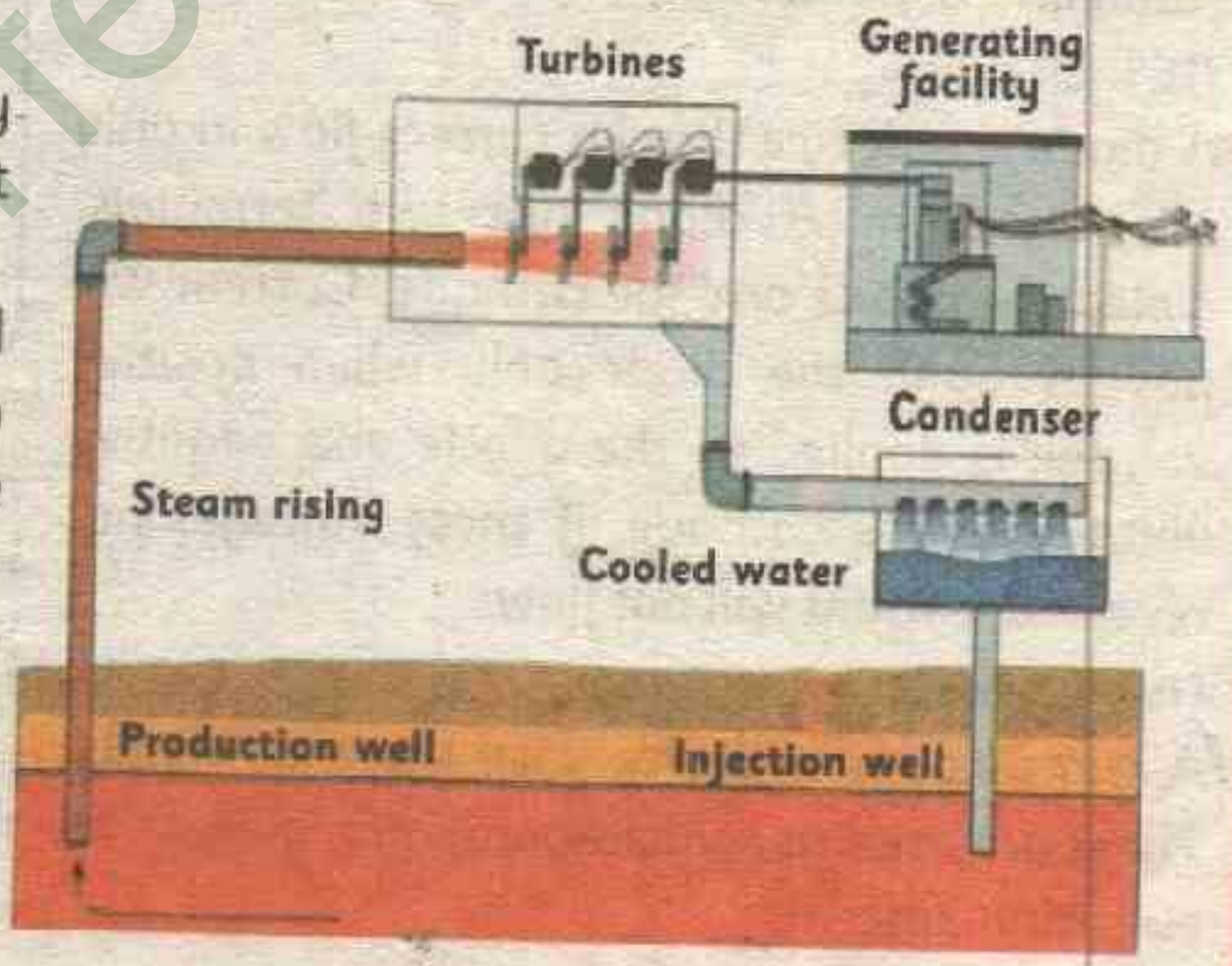


Fig 11.13 Electric power station

Electronic systems

Some of the basic electronic components are resistors, capacitors, diodes, transistors and integrated circuits. Here is a brief overview of the function of each of these basic electronic components.

(i) Resistors

A resistor is a component that resists the flow of current. It is one of the most basic components used in electronic circuits. Resistors come in a variety of resistance values which show how much they resist current. Resistance is measured in units called ohms and denoted by the symbol (Ω).

Fig 11.14 (a) Resistors

(ii) Capacitors

Capacitors are probably the second most commonly used component in electronic circuits. A capacitor is a device that can temporarily store an electric charge. Capacitance of a capacitor is measured in farad and is denoted by 'F'.

Fig 11.14 (b) Capacitors

(iii) Diode

A diode is a device that let current flow in only one direction. A diode has two terminals, called the anode and the cathode. Current will flow through the diode only when positive voltage is applied to the anode and negative voltage to the cathode. If these voltages are reversed, current will not flow.

Fig 11.14 (c) Diodes

(iv) Transistor

A transistor is a device with three terminals. These are used as switches and amplifiers in an electronic systems.

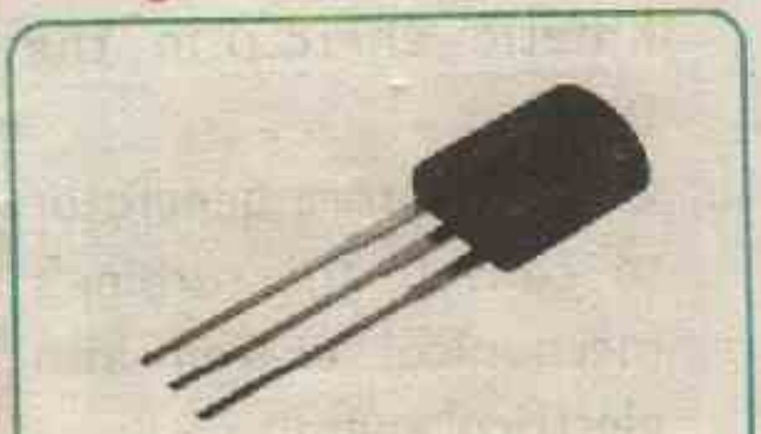


Fig. 11.14 (d) Transistors

(v) Integrated circuit (IC)

An integrated circuit is a special device that contains an entire electronic circuit, in which transistors, diodes and other elements are photographically engraved onto a tiny chip of silicon. Integrated circuits are the building blocks of modern electronic devices such as computers and cell phones.

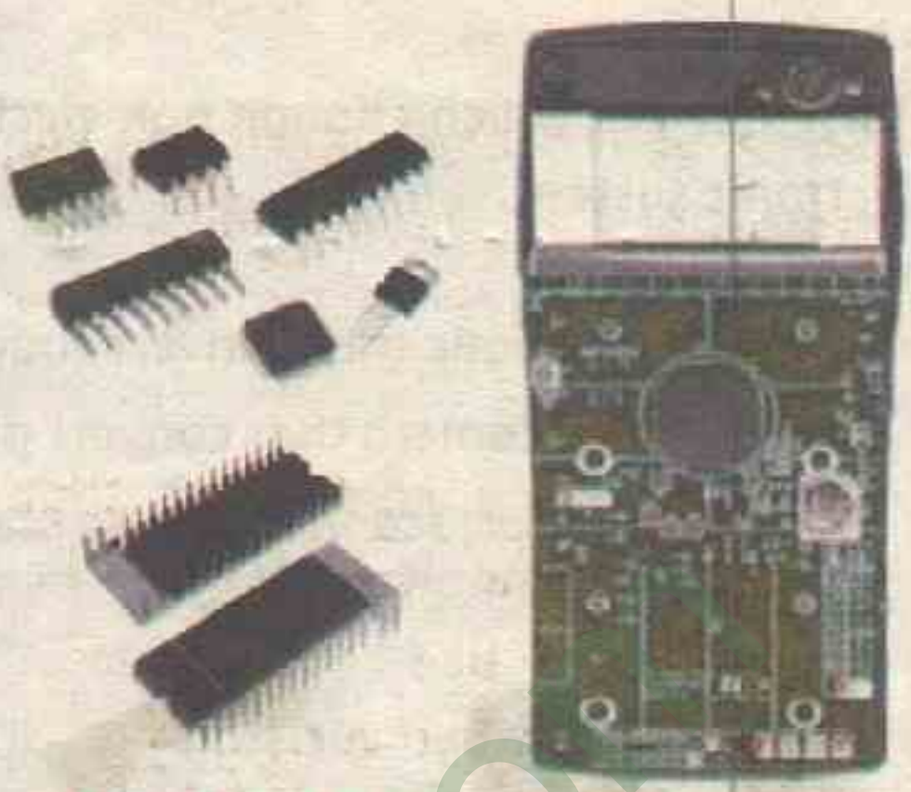


Fig. 11.14 (e) Integrated circuits

Conversion of A.C. to D.C

The current which flow only in one direction is called Direct current (D.C). The current which change its direction is called Alternating current (A.C).

Alternating current is the most efficient way to deliver electrical power. However, most electronic devices need direct current to function. The electrical devices that convert AC to DC are called a rectifier. Basically diode is a device, which converts AC to DC.

Fig. 11.15 AC to DC converter.

For this reason, AC to DC converter is either a part of devices themselves or as part of their power cords. If you have to built a DC operated device and wish to power it from an AC outlet, you must add an AC to DC converter.

Use of various electronic devices (input, processor, output)

Electronic system mainly comprise of three types of devices.

(a) Input devices

(b) Processors

(c) Output devices

Science

Input devices

Those devices which change non-electrical energy into electrical energy in an electronic system.

For examples

(a) A microphone that convert sound into electrical signal.

(b) A digital camera that convert picture into electrical signal.

(c) Photocopier, scanner, mouse and keyboard are some other input devices.

Digital camera | Microphone | Mouse and keyboard

Fig. 11.16 Input devices

Processors

Processors are the components that convert the input into required output through processing. Amplifier, tape recorder, Television and computer processors are the examples of processors.

Output devices

The devices that convert electrical energy into other forms of energy.

For example

(a) Loud speaker converts electrical signal into sound.

(b) Television converts electrical signal into a picture and sound.

(c) Monitors and printers etc are also output devices.

Printer | LCD creen | Speakers

Fig. 11.17 Output devices

KEY POINTS

1. A generator is a device that converts mechanical energy into electrical energy (electricity)
2. A coil of wire generates electricity when a permanent magnet is rotated in the middle of that coil.
3. In dry cell, a chemical energy is converted into electricity.
4. Nuclear power is generated by breaking nuclei of some heavy elements like uranium, plutonium etc.
5. Each method of generating electricity has its own limitations.
6. All power plants have turbine and generators to produce electricity.
7. An electrical system has many basic components which perform different functions.
8. Alternating current change its direction every moment.
9. Direct current does not change its direction.
10. A bicycle dynamo is a type of generator attached to a bicycle to produce electricity.
11. There are many different sources that can be used for the generation of electricity, some of which are the battery, water energy, wind energy, nuclear energy, heat energy, solar energy etc.
12. Electronic system mainly comprise of three types of devices. input devices, processors, output devices.

Exercise

A. Complete the following statement.

i. The device that produces electricity is called generator
ii. The part of an electric generator that generates current due to its rotation, is called dynamo
iii. Chemically the electricity is produced by using battery
iv. The devices that convert electrical energy into other forms of energy are called devices
v. Nuclear power is the production of electricity by breaking nuclei of some heavy elements like uranium

B. Choose the correct answer for each of the following statements.

i. Wind power is the type of electric generation in which _____ is used:
   (a) power of wind
   (b) power of water
   (c) power of nuclear
   (d) power of electricity

ii. In hydro power, _____ is used to run turbines:
   (a) moving water
   (b) electrical energy
   (c) wind energy
   (d) heat energy

iii. The general generator works on the principle of:
   (a) electrostatic
   (b) electromagnetic induction
   (c) magnetism
   (d) electromagnetic force

iv. Dynamo is a kind of:
   (a) mechanical device
   (b) chemical device
   (c) electric generator
   (d) none of these

v. In the dry cell, zinc acts as:
   (a) positive electrode
   (b) negative electrode
   (c) electrolyte
   (d) centre rod

C. Give short answers of the following.

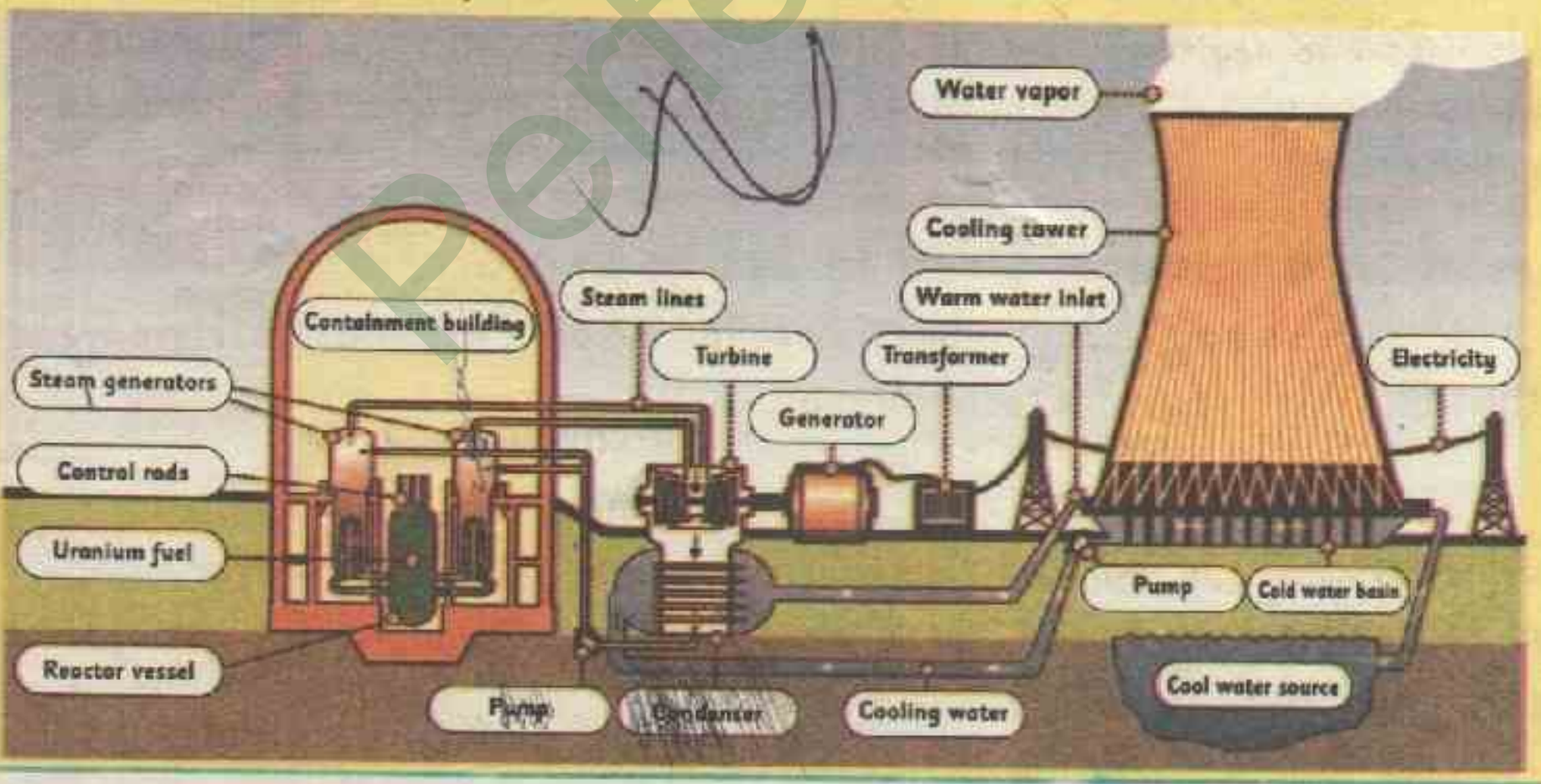
i. Define electromagnetic induction.
ii. Give few problems in generating electricity.
iii. How electricity is produced in hydro power stations?
iv. What should be the speed of wind for the production of electricity from a wind mill?
v. Define the following terms:
resistors, capacitors, diode, transistors and integrated circuit (IC).

D. Give detailed answers to the following questions.

i. How electricity can be generated in daily life?
ii. Make a list of sources of energy and explain any two in detail.
iii. (a) Explain the direct circuit and alternating current.
(b) Which device is used to convert AC to DC.
(c) What will happen if we do not use convertor while using DC operated device into AC outlet.

Project

Design and demonstrate the working of a power station and also list the types of energy being used in the power station.



UNIT 12

EXPLORING SPACE

After studying this unit, students will be able to:

- Describe development of tools and technologies used in space exploration.
- Analyze the benefits generated by the technology of the space exploration.
- Explain that how astronauts survive and research in space.
- Suggest the ways to solve the problems that have resulted from space exploration.
- Identify the technological tools used in space exploration.
- Identify new technologies used on earth that have developed as a result of the development of space technology.
- Design a space craft and explain the key features of design to show its suitability as a space craft.

Introduction

Space is the place outside our earth's atmosphere where there is no force of gravitation. It is the nature of human being to explore things. This curiosity has led human being to invent/discover many new things and to explore secrets of this universe and space. In previous grades, you have studied about origin of the universe, properties of stars, galaxies, black holes and telescope. In this unit, you will learn about different tools and technologies used in space exploration. You will also learn about different types of space crafts and spectroscope used in space crafts.

Tools And Technologies Used In Space Exploration

There are many tools and technologies that helps in space exploration. Here we discuss the following important technologies.

1. Telescope

The word "telescope" is derived from Greek word "tele" means "far" and "skopein" means "to look or see". A **telescope** is an instrument designed for the observation of distant objects.

The first known practically functioning telescope was invented in Netherland at the beginning of the 17th century. The invention of telescope was a milestone in scientific study of space and heavenly bodies.

Types of Telescopes

The name "telescope" covers a wide range of instruments. Different types of telescopes with respect to the radiations they detect, are following.

(a) optical telescope.
(b) radio telescope.
(c) broad-spectrum telescope.

a). Optical telescope

An optical telescope gathers and focuses radiations mainly from the visible part of the electromagnetic spectrum (called visible light). Optical telescopes increase the apparent angular size of distant objects as well as their apparent brightness. Optical telescopes help photographers, star gazers and astronomers to spot the details of a distant object. Optical telescopes are of three kinds:

(i). Refractor Telescope: It uses lenses.
(ii). Reflector Telescope : It uses mirrors.
(iii). Catadioptric Telescope: It uses mirrors with a lense designs.

Science TidBit

Hubble Space telescope is the reflecting telescope launched in 1990. It orbits around the Earth at a height of 600 Km. It sends clear pictures of galaxies and other celestial bodies.

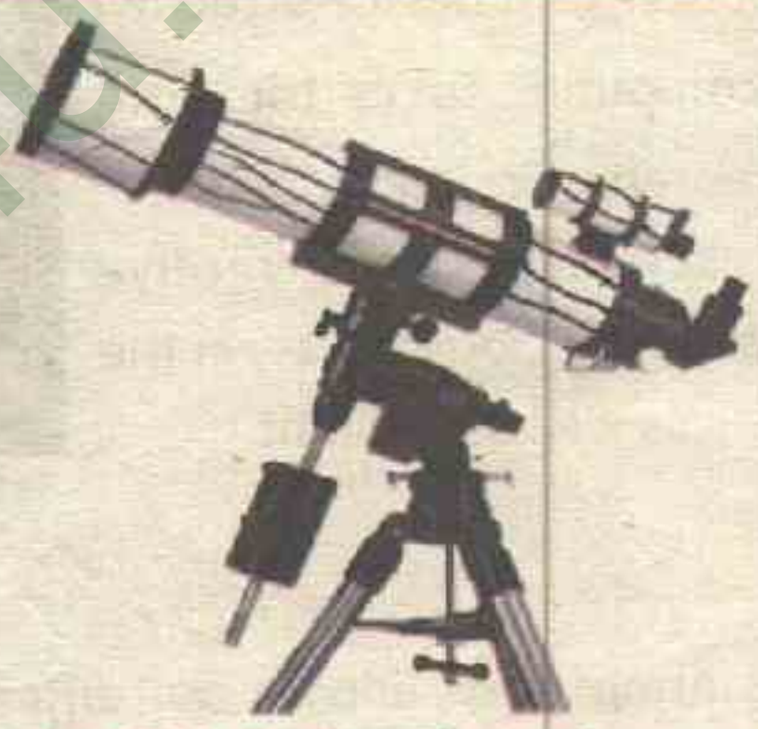


Fig 12.1 Reflecting telescope

b). Radio telescopes

A radio telescope is more sensitive, and able to create a visual picture of the signals it receives. Radio telescopes create a picture of the sky, not in visible light, but in radio waves. This is extremely useful device because there are objects that can not be seen through visible light. However, those can be seen by radio telescopes. A radio telescope has several main parts: a dish antenna, a receiver, a detector and an analyzer.

The **dish** collects the radio signals from space and focuses them on the antenna. The **receiver** takes the radio waves received by the antenna and converts them to electrical signals (voltages). The **detector** measures the power density of the electrical signal, which is necessary to turn the signals into a photo. The **analyzer**, usually a computer or a device attached to a computer, takes the data and creates an image from it. Radio telescopes can receive signals during cloud cover, in the daytime as well as at night.

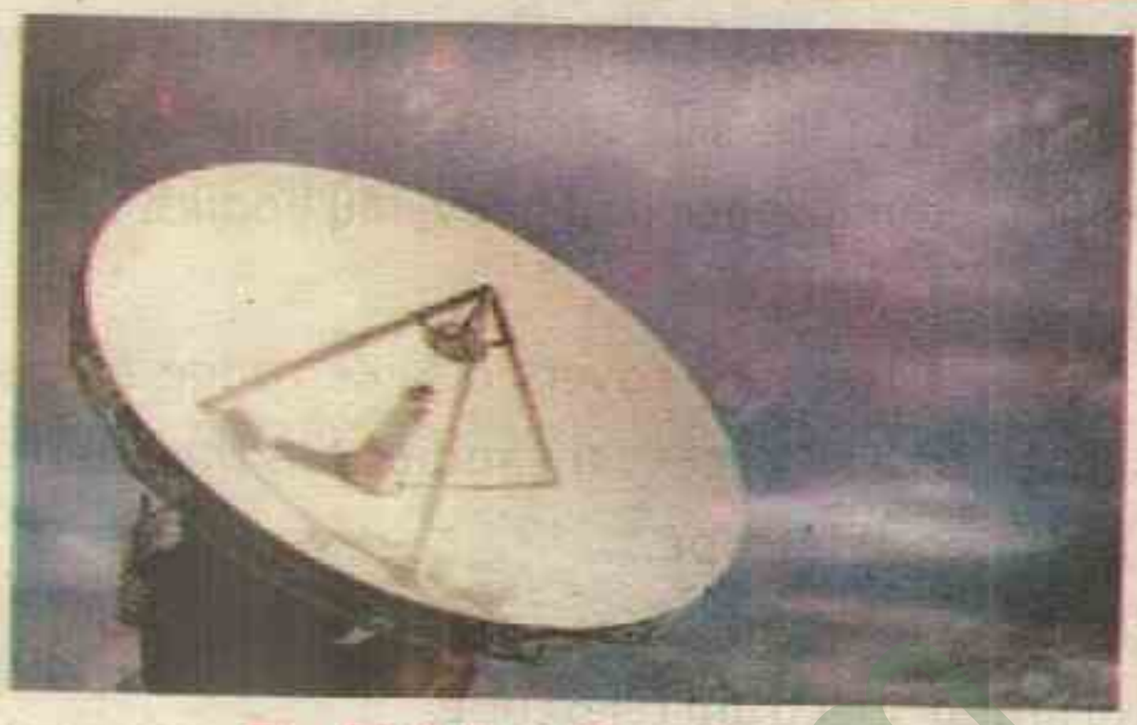


Fig 12.2 A radio telescope

Fig 12.3 X-ray telescope

c). Broad-spectrum telescopes

Earth's atmosphere blocks out different rays, coming from planets, stars and other heavenly bodies. So, astronomers use telescopes into the space to measure ultraviolet, infrared, gamma and X-rays as well as visible light and radio waves coming form outer space.

Space-crafts

A spacecraft is a vehicle designed for space flights. Spacecraft are used for a variety of purposes including communications, earth observation, meteorology, navigation, planetary exploration and space tourism. Spacecrafts are also known as "Space Ships".

Types of space crafts

Space Craft are broadly classified into two categories:

(a) Robotic Space Crafts (b) Manned Space Crafts

a) Robotic Space Crafts are sent into space for collection of data about space, planets and other celestial bodies. It is controlled from the centre on earth as it does not carry humans in it.

b) Manned space crafts carry equipments along with humans to space. They contain all the facilities necessary for human survival such as oxygen, food, water and specially built cabins.

a) Space probes

A space probe is a robotic spacecraft that travels through space to collect scientific information. It does not orbit the earth. Probes do not have astronauts. Probes send data back to Earth for scientists to study. Many space probes have been sent in space, which are sending information about heavenly objects and other artificial satellites. Voyager-1 and voyager-2 were probes used for collecting data about Mars and Jupiter.

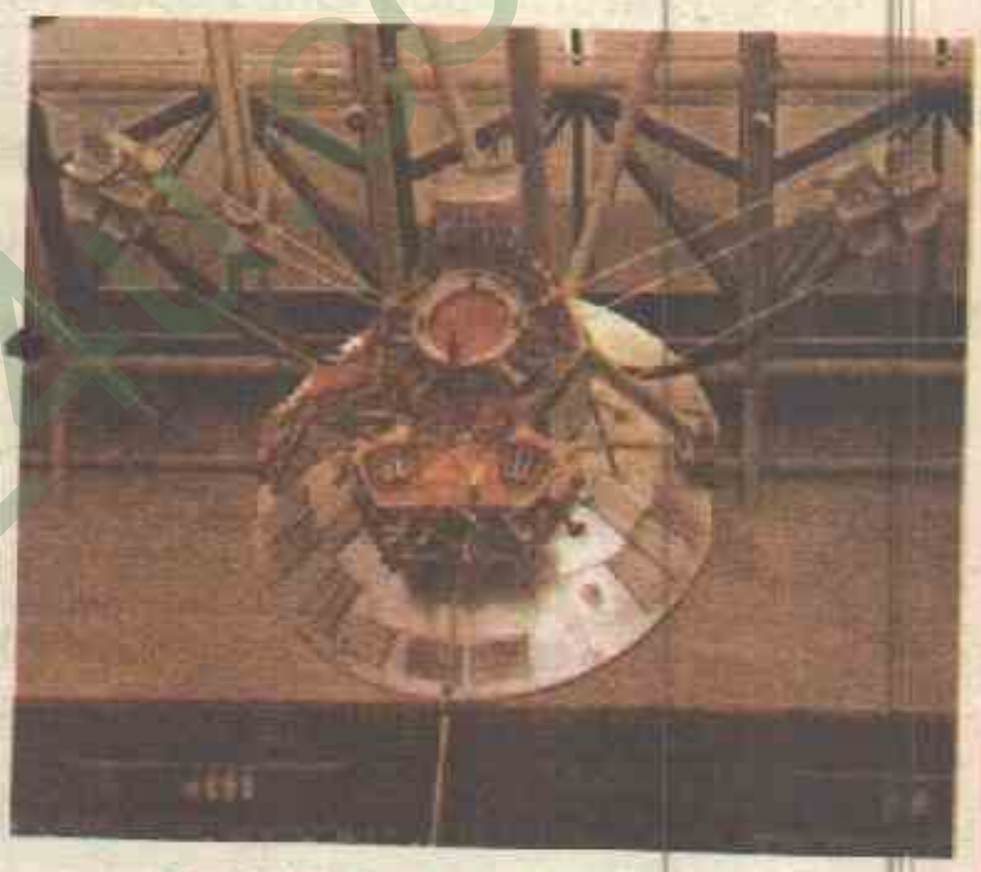


Fig. 12.4: A Space Probes

b) Space stations

A space station is a spacecraft, capable of supporting a crew. It is designed to remain in space for a long time. A space station is distinguished from other spacecrafts used for human space flight, by lack of major landing system. Therefore other space crafts are used to transport people and cargo to and from the space station.

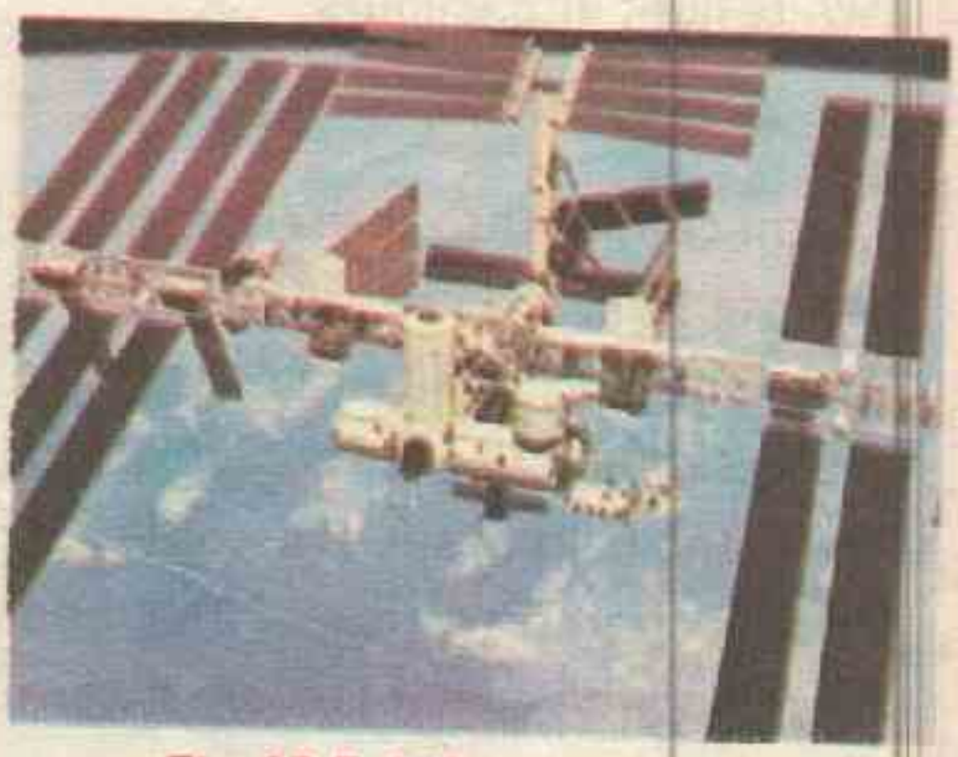


Fig 12.5 A Space Station

International space station is the largest space station in the space. It looks like a star in space. These Space stations are research platforms for greater number of scientific study.

c) Space shuttle

Space shuttle is manned space craft which is used to carry men in space. In this type of space craft, basic needs to maintain life are present. It is sent into space with the help of a rocket. After performing its tasks, it returns and lands back on Earth like an aeroplane. The first space shuttle was launched by NASA (National Aeronautics and Space Administration) in 1981. Many space shuttles have been launched by NASA till now.

Fig 12.6
A Space Shuttle with Rocket

d) Spectroscopes

Spectroscopes are used in telescopes to help scientists in analyzing the materials that make up stars and nabulae. It is an instrument used to examine different wavelengths (colours) of a light. It splits white light into colours.

Fig 12.7 A Spectroscope

Working

Light coming into the telescope is filtered through a tiny hole in a metal plate to isolate light from a single area or object. This light is bounced off a special grating which splits the light into its different wavelengths just like a prism makes rainbow. The split light is focused on to a detector forming a spectrum. With the help of spectroscopes, rays coming from distant objects are analyzed. Many characteristics of the body including structure, chemical formation, speed of movement etc. are determined from this analysis. Every space probe is fitted with spectroscopes.

Benefits Generated By Technologies Of Space Exploration

Space technology has provided many benefits in our everyday life. Scientists invent products and techniques to meet the requirements of space exploration. Often these inventions can also be used on Earth. Some of them are discussed here:

i. Fire Fighting Equipment

Apollo technology has been used to produce a lighter breathing system for Fire-fighters. The new system weighs about 9 kg and has a mask with greater peripheral vision.

Science TidBit

Space exploration is the scientific study of the space with the help of especially developed technologies.

ii. Firefighting Strategy

European Space Agency satellites provide information on fire locations. This is being used to help develop fire fighting strategy.

iii. Vision Research

Land stat and Skylab technology is used to check the human eye for refractive error and cornea or lens obstruction.

iv. Global Positioning Satellites

Satellites orbiting the Earth, Earth monitoring stations, and navigation receivers provide accurate positioning of ships, ground vehicles, airplanes and other portable device used. This technology has both military and non military uses.

v. Cordless tools

The cordless tool was developed for the study of moon's soil samples. This cordless technology is now used in the operating room, building construction, secret places and gardening.

vi. Active Pixel Sensor

This improved image technology requires less power, is less expensive and smaller than previous technology. It has provided better image for camcorders, digital cameras, night vision and x-rays.

vii. Tsunami Tracking

A satellite circling the Earth receives transmissions from under sea detectors. It provides accurate information on tsunami size and strength.

viii. Archaeology

Space shuttle radar image help to locate ancient cities, roads and ruins. This helps to pinpoint the archaeological areas faster. This technology helped to locate the lost city of Ubar which is located in Oman.

Survival In Space

In space, there are severe conditions which an astronaut has to face. For example, there is very high temperature, zero gravity and zero pressure. These factors badly affects human body and man does not remain in the state of consciousness. After entering the space unprotected, man can live normally for less than a few minutes, after this time, he will be paralysed. The water starts entering in his tissues due to zero pressure and body swells nearly double of its original size. The circulation of blood in body stops because it depends upon gravity and pressure. Many other degradations also occurs within 1-2 minutes of entering in space.

(a) Without a space suit, man cannot live in space more than 2-3 minutes. Most of the information about survival of an unprotected organism has been collected by experiments on animals including chimpanzees.

(b) Not every person can go in space even with all protective measures. It requires a long and tough training to enable a man to travel in space. That is why very few people have travelled in space.

(c) For breathing in space, astronauts carry air tanks with them containing pressurized oxygen and nitrogen.

(d) In space, astronauts are in weightless conditions. So, they do exercise to protect their bodies from organ damage.

(e) Pressurized air is managed to ensure living conditions in the cabins. To purify air, air conditioning system is used to remove moisture and carbon dioxide.

Problems Resulting From Space Exploration And Their Solution

Different problems arise during space exploration. some problems and their solutions are following:

a) Weightlessness

When space craft enter the Earth's atmosphere their weight increases by 10 grams for few minutes. It can damaged human body. To overcome this problem, astronauts lay down by keeping their face in the direction of space craft's movement.

b) High temperatures are managed by liquid-cooled garments

For the Apollo program, water-cooled garments were developed to protect astronauts from the Moon's high temperature. These garments can reduce body heat by 40 - 60%.

c) Corrosion of equipments is avoided by anti-corrosion coatings

NASA required coatings to cover and protect the launch structures from exhaust, temperature change , ocean spray and fog. Coatings which contain zinc dust and potassium silicate, resist the corrosion.

d) High cost management

Cost is a major problem in space programs. Involvement of private sector in missions could be a possible solution.

Science TidBit

Neil Armstrong was the first person who stepped on to the moon surface on July 1969. He was the commander of Apollo.

Technologies Used For Space Explorations

Space exploration has become easy and result oriented with the help of following technologies.

a) Space Rockets

Space rockets are used for the transportation of space shuttle, space stations and other space crafts into space.

b) Rocket Launching Pads

These rockets are launched into space through rocket launching pads. These are especially built platforms for firing rocket into the space. They can withstand extremely high temperature.

c) Telecommunication system

Special telecommunication system are provided to rockets and space crafts to help space crew communicate with each other and with the earth stations.

Fig 12.8 Rocket at its launching pad

Science TidBit

"The Benefits of space Exploration" Special technology developed for space are now used to improve the quality of life in the following few fields on earth.

i. Health and medicine
ii. Global Navigation
iii. Weather forcast and prediction of natural calamities.
iv. Electronics and computers.
v. Locating minerals, fossil fuels and water reserves.

Technologies Developed On The Earth As A Result Of Space Exploration

Space exploration has been a matter of interest for humans since a long time . So many technologies have been developed and improved with the passage of time to make space exploration easy. Some are as follow:

a) In order to withstand high temperatures and pressure, special types of metallic alloys have been developed which are now used in jet engines.

b) Solar cells are now-a-days a source of free and clean electricity. These were originally developed to provide electricity to space crafts.
c) Liquid cooled garments manufactured for astronauts are currently used by car racers and nuclear reactor workers.
d) Anti corrosion coatings made for space crafts are now used on statues, bridges, pipelines etc.

Activity 12.1

Space shuttle model

Step 1: Gathering the Materials

You will need the following material to make this model

1. Polystyrene cubes/packing material
2. A lot of tissue papers
3. Cardboard
4. Any cardboard hollow cylinder
5. White glue
6. Paints and brushes
7. Sand paper

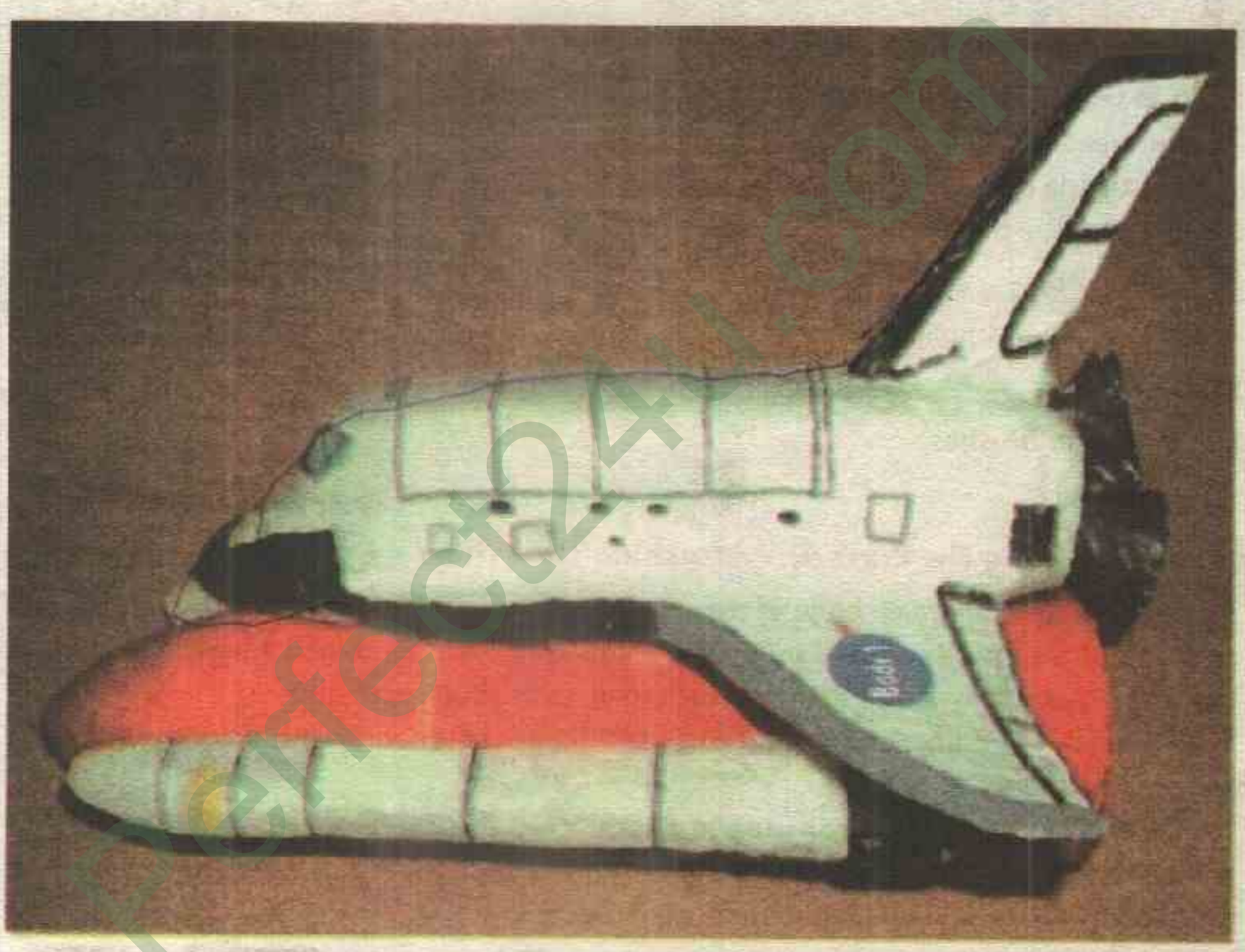
Step 2: Shaping The Parts And Attaching The Wings

To make the fuselage/main body of the shuttle, you will need to shape out the polystyrene in shape of the shuttle with a sandpaper. Now this could be a little tough. The second thing is to make the wings and then attach them to the body with glue.
Similarly, for the bigger rocket you can use cylinder cardboard and make the top with polystyrene shaped in a cone.
For the two thin rockets you can use pvc pipes.
You need to stick two straps at the bottom of the shuttle so that later the shuttle and rockets can be assembled together to the big rocket

Step 3: Assembling

Finally assemble all the parts together using white glue. Then put a coating of glue and tissue paper on every part of the shuttle and the rockets to make it firm and give a texture.

After it has dried, paint it and for detailing use Badr 1 stickers and you can make fine borders and windows according to your choice.



KEY POINTS

1. Telescope is a device which is used to see remote objects.
2. Radio telescopes receive radio signals from distant satellites.
3. An optical telescope gathers and focuses radiations mainly from the visible part of the electromagnetic spectrum.
4. A radio telescope is more sensitive and able to create a visual picture of the signals it receives.
5. Space craft are broadly classified into two categories, Robotic space crafts and Manned space crafts.
6. Space exploration has become easy and result oriented with the help of advanced technologies like space rockets, Rocket launching pads and Telecommunication system etc.
7. Spectroscope is a device used to measure the wavelengths of different radiations
8. Scientists invent products and techniques to meet the requirements of space exploration. Often these inventions can also be used on earth.
   Apollo technology has been used to produce a lighter breathing system for fire-fighters.
9. European space Agency satellites provide information on fire location.
10. Space shuttle radar images help to locate ancient cities, roads and ruins.
11. Due to severe conditions e.g. high temperature, zero gravity and zero pressure, survival in space is not possible for more than 2 minutes.
12. There are three types of telescopes with respect to the radiations they detect, that are following. (a) optical telescope. (b) radio telescope. (c) broad-spectrum telescope.

Exercise

A. Complete the following statement.

i. Astronomers use board spectrum to study extremely distant objects.
ii. spaceship is a craft or machine designed for space flight.
iii. A telescope is a vehicle designed for the space flights.
iv. twotimes was the first person who stepped on to the moon surface.
v. Zinc dust are used for the transportation of space shuttle and space crafts into space .

B. Choose the correct answer for each of the following statements

i. Telescope was first time invented in:
(a) England (b) America (c) Russia (d) Netherl

ii. Which technology is used to produce a lighter breathing system fo fighters:
(a) Apollo (b) Cordless
(c) Land state and sky lab (d) Global positioning system

iii. The first space shuttle was launched by NASA in:
(a) 1981 (b) 1982 (c) 1983 (d) 1984

iv. The telescope is used to see:
(a) small objects (b) distant objects (c) large objects (d) near objects

v. A space station is distinguished from other spacecrafts by:
(a) lack of major landing system (b) colour
(c) fuel (d) size

C. Give short answers of the following.

i. Write the names of different parts of the radio telescope and their functions?
ii. Write any three applications of space technology on earth.

iii. What are the uses of spectroscope?
iv. Enlist the problems faced by astronauts in space.
v. Name the technologies used for space exploration.

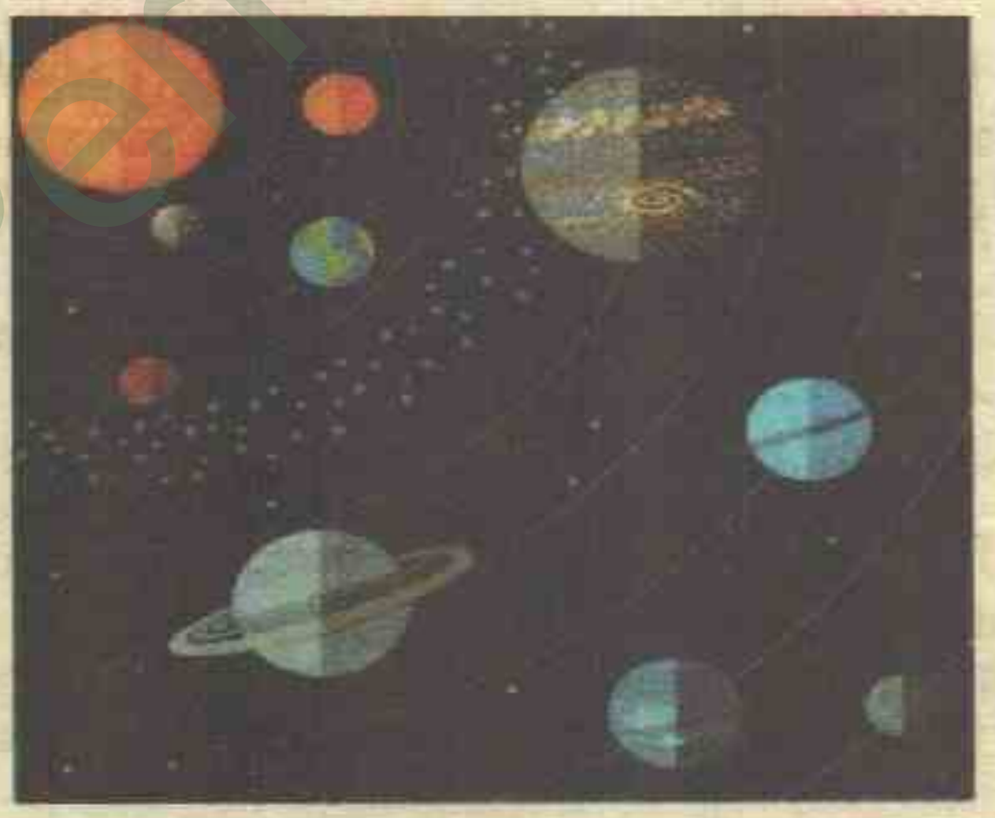
D. Give detailed answers to the following questions.

i. Write a detailed note on types of telescope.
ii. Explain the benefits of space exploration in detail.
   (a) Why spacecraft is used?
   (b) In how many categories, spacecrafts are broadly classified.
   (c) Differentiate between the categories of spacecrafts with examples.

Project

Inquiry based group Activity
Choose a planet in our solar system. Discuss and answer the following questions below.
Planet Name:.....
Number of moon (s): .....
Name of moon (s): .....
Planet temperature: .....
Distance from sun:.....
What is the planet made up of: .....

- Draw and colour your planet be sure to include its moons.
- Show your research to your teacher and class fellows.



GLOSSARY

Word	Meaning
Acid	The class of compounds that produce H^+ ion/protons when dissolved in water.
Acid Rain	SO_2, CO_2 and NO_2 are present in air. Rain water is mixed with them and acid drops are formed which fall down in the form of rain.
Addition Reaction	The reaction in which two substances combine to form a new compound.
Balancing a Chemical Equation	To equalize the number of atoms of each element in a chemical equation.
Base	The class of compounds that produce OH^-/hydroxyl ions when dissolved in water.
Base Quantities	Length, mass, time, temperature, electric current, light intensity and amount of substance.
Base Units	The units of base quantities like meter, kilogram, second, Kelvin, ampere, candela and mole.
Biotechnology	The use of living organisms for the benefits of man
Boyle's law	"Volume of a gas is inversely proportional to its pressure."
Brain	The most important organ of an animal body that control all the actions and processes occurring within body.
Camera	Device used to obtain image on sensitive film.
Cell division	The Process of division of cell into new daughter cells.
Centre of Curvature	Centre of the sphere of which lens surface is a part.
Chemical Equation	The method to express a chemical reaction using symbols of different elements and formulae of different compounds.
Concave lens	A lens thin at the middle and thicker at the edges.
Convex lens	A lens thick at the middle and thinner at the edges.

Decomposition	The reaction in which a compound break down to form two or more substances.
Deforestation	Cutting down of trees and using land for some other purpose
Derived Quantities	All those quantities which can be derived from base quantities e.g. speed, area, volume.
Derived units	The units of derived quantities like m^3, m^2, m/s, kg/m^3 etc.
DNA Replication	The copying of DNA during cell division.
DNA	The nucleic acid that contains genetic information. Chromosomes are made up of DNA and protein.
Dynamo	Device which convert kinetic energy into electrical energy.
Electronic System	Computer, amplifiers and microwave oven etc. are the examples.
Endothermic	The reaction in which heat energy is absorbed.
Excretory system	The organ system that excrete nitrogenous waste substances from the body.
Exothermic	The reactions in which heat energy is evolved.
Focal length	Distance of principal focus from optical center.
Force	An agent that produce or tends to produce motion or stops and tends to stop a moving body.
Gene	The unit of heredity in living organisms.
Generator	Device which convert mechanical energy to electrical energy.
Genetic engineering	Introduction of an organism's genes in a bacterium to get required products.
Greenhouse Effect	The process by which energy reflected back from earth's surface, is recaptured by some atmospheric gases like CO_2 and methane.
Heat	Total energy of all the moving molecules.
Heredity	Transfer of characteristics from parents to off springs.
Hydal power	Production of electricity through flowing water.

Hydraulic press	Press used to compress the cotton and thread into bales.
Incineration	Disposing off of waste materials by burning them
Indicator	The compounds that undergo a sharp change in their colour when they react with an acid or a base.
Kidney	Excretory organ in human body and other animals.
Landfill	Disposal of wastes by burying them in land.
Law of conservation of mass	Matter/Mass can neither be created nor be destroyed but can change its appearance and composition.
Lens	Piece of transparent material bounded by two spherical surfaces.
Mitosis	Cell division resulting two daughter cells
Nephron	The structural and functional unit of kidney.
Nervous system	The system that coordinates and controls the actions in the body of an animal.
Neuron	The structural and functional unit of nervous system. (also called nerve cell)
Optical center	Centre point of a lens.
Pascal's principle	The pressure exerted anywhere on a confined incompressible fluid is transmitted equally in all directions in the fluid".
Peculiar behavior of water	Water expands from 4°C to 0°C on cooling.
pH	Negative logarithm of H^+ ions concentration in a solution. It shows the acidity or basicity of that solution.
Physical Quantities	Quantities that can be measured.
Pneumatics	The branch of physics which deals with the study of behavior of gases under pressure is called pneumatics.

Pollutants	Undesired and unwanted agents present in the environment.
Pollution	Accumulation of undesirable materials in the environment.
Pressure	Pressure is force per unit area.
Principal axis	Straight line joining centers of curvatures of lens.
Principal focus	Point where parallel rays after refraction through lens meet or appear to come from.
Products	The new substances formed in a chemical reaction.
Ray diagram	Method to trace image geometrically.
Reactants	The substances that take part in a chemical reaction.
Real image	Image that can be obtained on screen.
Salt	The neutralization product formed by the reaction of an acid with a base is called salt.
Spacecraft	A craft or machine designed for spaceflight.
System international units	A system consisting of seven base units approved by International Bureau of Weights and measures.
Spectroscopes	An instrument used to study spectra.
Spinal cord	A rope-like bundle of neurons that is present within the vertebral column.
Space stations	Is an example of a spacecraft that does not have a propulsion landing sub-system
Telescope	An instrument designed for the observation of remote objects.
Thermal expansion	The expansion of material on heating.
Thermal power	Production of electricity by burning of fossil fuels.
Transistor	An electrical device used in digital systems.

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