GOVERNMENT OF TAMILNADU

# STANDARD NINE

## TERM I

## VOLUME 3


**NOT FOR SALE**

**Untouchability is Inhuman and a Crime**

A Publication Under
Free Textbook Programme of
Government of Tamilnadu

**Department of School Education**

First Edition - 2013
Revised Edition - 2014, 2015, 2016, 2017
(Published under Uniform System of School Education Scheme in Trimester Pattern)

Textbook Prepared and Compiled by
State Council of Educational Research and Training
College Road, Chennai - 600 006.

Textbook Printing
Tamil Nadu Textbook and Educational Services Corporation
College Road, Chennai - 600 006.

This book has been printed on 80 G.S.M Maplitho Paper

Price : Rs.

Printed by Web Offset at :

Textbook available at
**www.textbooksonline.tn.nic.in**

# CONTENTS


| UNIT | TOPIC | PAGE No. |
|---|---|---|
| | **SCIENCE** | (1 - 130) |
| | **BIOLOGY** | |
| 1. | Animal kingdom | 3 |
| 2. | Cells | 22 |
| | **CHEMISTRY** | |
| 3. | Is matter around us pure? | 40 |
| 4. | Atomic structure | 58 |
| | **PHYSICS** | |
| 5. | Measurement and Measuring instruments | 76 |
| 6. | Motion | 94 |
| 7. | Liquids | 110 |
| | ***PRACTICALS*** | 122 |

# CONTENTS


| UNIT | TOPIC | PAGE No. |
|---|---|---|
| | **SOCIAL SCIENCE** | (131 - 244) |
| | **HISTORY** | |
| 1. | Ancient Civilizations | 132 |
| 2. | Intellectual Awakening of 6th Century B.C. | 150 |
| 3. | Medieval Age | 159 |
| | **GEOGRAPHY** | |
| 1. | Tamil Nadu | 170 |
| 2. | Physiography of Tamil Nadu | 177 |
| 3. | Climate of Tamil Nadu | 185 |
| 4. | Resources of Tamil Nadu | 197 |
| 5. | Tamil Nadu - Agriculture | 213 |
| | **CIVICS** | |
| 1. | The Union Government | 226 |
| | **ECONOMICS** | |
| 1. | Demand and Supply | 241 |

# SCIENCE

## STANDARD NINE

### TERM I

## Note to the teacher…

As we present this revised edition of the Science Textbook, we would like to express our deepest gratitude to the learners and the teaching community for their enthusiastic responses.

In science some concepts could be subjected to change from time to time as new theories and principles are constantly being evolved.

We have tried to present facts and concepts of science (both concrete and abstract) in a visually appealing manner without detracting from the content.

Activity based learning is now accepted as the basis of science education. These activities should be regarded as a means for open-ended investigation rather than for verification of principles/content given in the textbook has been designed to facilitate low cost activities and experiments using locally available materials. With a view to streamlining the activities, we have now segregated them into three groups:

- I Do - activities to be done by an individual learner.
- We Do - activities to be done by a group of learners and
- We Observe - activities to be demonstrated by the teacher.

The third group of activities have a higher degree of difficulty or require careful handling as it may involve dealing with chemicals, electricity etc.,

The “More to know” snippets in the text represents some unusual and interesting facts or information in which the students need not be examined.

The evaluation section is nothing but another space for learning in a different manner. As the focus is on understanding, rote learning is to be discouraged thoroughly. Application of learnt ideas, problem solving skills and critical thinking is to be encouraged. There could be scope for more than one answer to a question, which should be acknowledged always.

To facilitate further reference, books and websites have been suggested at the end of each lesson. Suggestions and constructive criticism are most welcome. Valuable suggestions will be duly incorporated.

- Authors

*sciencetextbook@gmail.com*

Chapter 1

# ANIMAL KINGDOM

- Introduction
- Invertebrates
- Vertebrates
- Various modes of reproduction in animals
- Fertilization
- Viviparous Animals
- Oviparous Animals
- Young ones to adults

## ANIMAL KINGDOM

There are millions and millions of different organisms living along with us and around us. What if we could remember all of them by their names? Biologists have helped us achieve this by sorting all living things into meaningful groups.

You have already learnt that this system of sorting living organisms into various groups based on similarities and dissimilarities is called classification. If you knew Greek language, you would refer to this subject as Taxonomy because 'taxis' in Greek means arrangement and 'nomia' means method. Thus Taxonomy is the branch of biology dealing with identification, description, nomenclature and classification.

A Swedish Botanist, Carl Linnaeus (1707-1778) developed a hierarchy of groups for taxonomy. A hierarchy helps to arrange organisms in a sequence according to different levels of similarity. Linnaeus wrote a huge book, Systema Naturae, in which he arranged all the living organisms that he could find around him into different groups. This Linnaean system of classification is what we use today to name, classify and compare all living things.

The largest group of organisms is the kingdom. Many sub-groups are formed at various levels and they are arranged in different levels called taxa. The levels of taxa are Kingdom, Phylum, Class, Order, Family, Genus and Species, in descending order. Every animal on the planet right down to the smallest ones are classified according to these taxa.

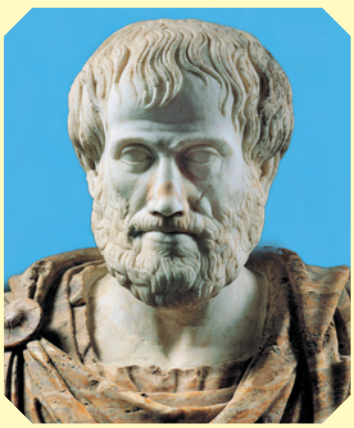
Organisms are separated into smaller and smaller groups on the basis of their common characteristics. Each group comes from the group before it. The smallest and the most specific group of classification is the species.

Some of the common characteristics or criteria that have been used for the purpose of classification are discussed below:

**ACTIVITY 1.1** **I DO**

Look at the given picture. List three reasons or criteria that you would use to classify this as a 'chair' and not a 'table'.

**MORE TO KNOW**

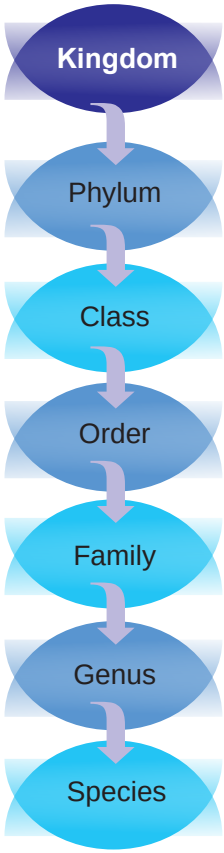


*Aristotle, the father of Zoology, was the first to classify animals based on their similarities and differences. (384-322 BC)*

**MORE TO KNOW**

*Carl Linnaeus, the Swedish Botanist is regarded as the father of modern taxonomy (1707-1778).*

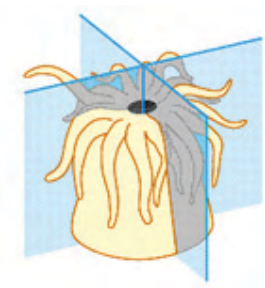
## Levels of classification




### Criteria for classification

1. Grade of organisation – Animals are grouped as Unicellular or Multicellular based on their number of cells.

2. Symmetry - When we look at the shape and structure of an organism and see that body parts are arranged around a central axis in such a way that a flat plane passing through this central axis can divide it into two identical halves, then we can consider it to be radially symmetrical. e.g. Hydra.



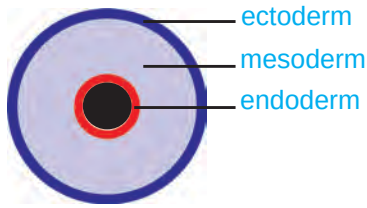
Radial Symmetry

Bilateral Symmetry

Creatures like earthworm, lobster have a bilaterally symmetrical body. An imaginary line drawn through the central axis can divide its body into identical left and right halves in only one longitudinal plane.

Amoeba has an irregular shape and exhibits asymmetry because any flat plane drawn through the centre of its body does not divide it into equal halves.

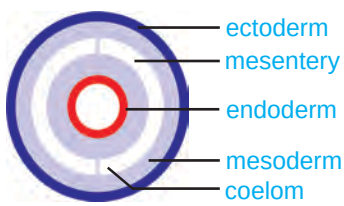
3. Germ layers – Germ layers are formed during the development of an embryo. These layers give rise to different organs, as the embryo becomes an adult. If an organism has two germ layers, the ectoderm and the endoderm, it is said to be diploblastic. If they have three germ layers, the ectoderm, the mesoderm and the endoderm, they are triploblastic animals.




The cross section of an embryo

4. Coelom - Coelom refers to a fluid-filled cavity inside the body. It separates the digestive tract and other organs from the body wall. A true body cavity or coelom is one that is located within the mesoderm.

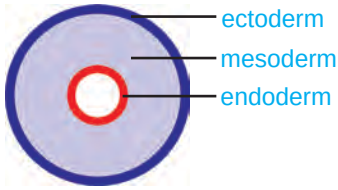
Based on the nature of the coelom, animals are divided into 3 groups. Organisms like the earthworm are called coelomates or eucoelomates because they have true coeloms.




Eucoelomate

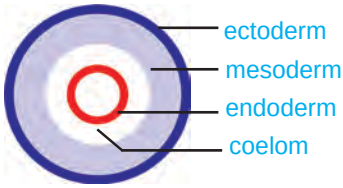
SCIENCE

Tapeworm is an example of an acoelomate because it does not have a body cavity.



Acoelomate

Animals like the roundworm have a body cavity but it is located between the endoderm and the mesoderm. This is considered to be a false coelom and these organisms are called pseudocoelomates.



Pseudocoelomate

5. Body temperature - Animals can be classified into two groups based on the ability to regulate their body temperature. Some animals like the fish and the frog, have body temperatures that vary with the temperature of their surroundings. They are called poikilotherms. Creatures like bird and man are called homeotherms because their body temperature remains a constant and is maintained slightly higher than that of the environment.

Based on criteria such as those listed so far, ecologist R.H.Whitaker created a Five Kingdom Classification, where he grouped all living organisms under five kingdoms:

Animals that are multicellular and do not have cell wall or chlorophyll are grouped under Kingdom Animalia which includes the following phyla:

1. Phylum Porifera (e.g. Sponges)
2. Phylum Coelenterata (e.g. Hydra)
3. Phylum Platyhelminthes (e.g. Tapeworm)
4. Phylum Aschelminthes (e.g. Ascaris)
5. Phylum Annelida (e.g. Earthworm)
6. Phylum Arthropoda (e.g. Cockroach)
7. Phylum Mollusca (e.g. Snail)
8. Phylum Echinodermata (e.g. Starfish)
9. Phylum Chordata

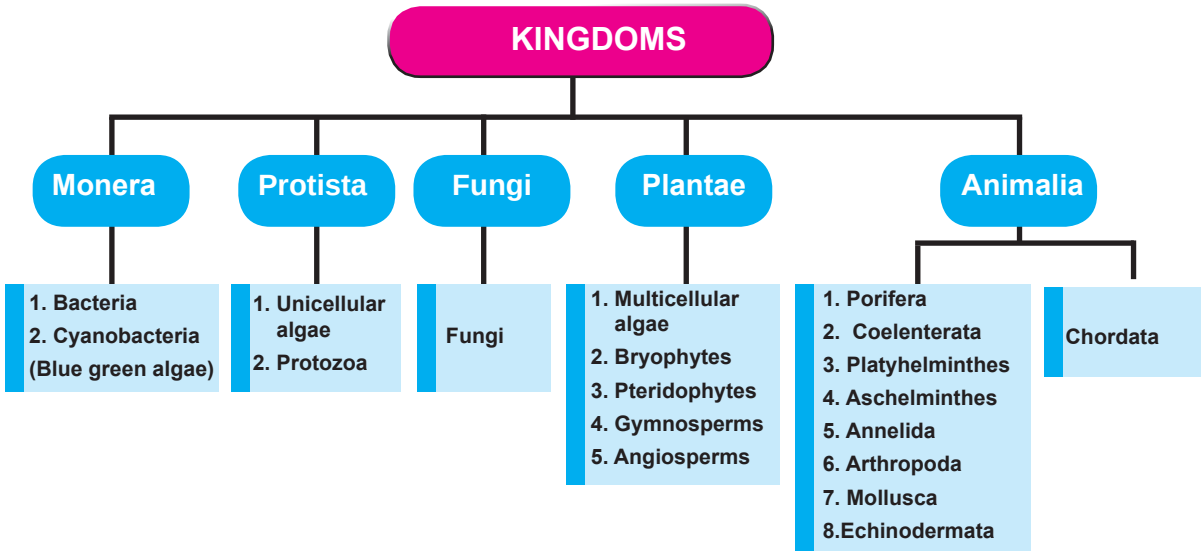
Phyla 1 – 8 are generally referred to as invertebrates because these animals do not have an internal backbone or vertebral column. Phylum Chordata includes animals that have a notochord during some stage of their development. A notochord is a flexible rod-shaped structure made of cartilage found in the body of a developing embryo. It forms the mid-line and main support for an organism. Vertebrates are chordates where the notochord has become a part of the animal's backbone, forming a bony vertebral column .

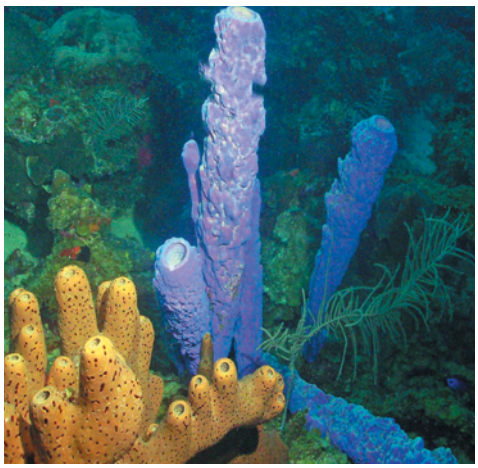
## 1.1. INVERTEBRATES

### 1. Phylum Porifera

These are the simplest and the most colourful of all multicellular animals. They are also known as pore-bearers. They do not have a mouth, instead their body has tiny pores through which water is drawn into the body. Their cells are not arranged into tissues but they capture bacteria and particles floating in water and consume them as food. Poriferans are marine and sessile, attached to rocks or shells at the bottom of the sea. The body is strengthened with the help of spicules that are made up of hard minerals like calcium or silica. e.g. Sycon

## R.H.Whitaker Classification



Sponges

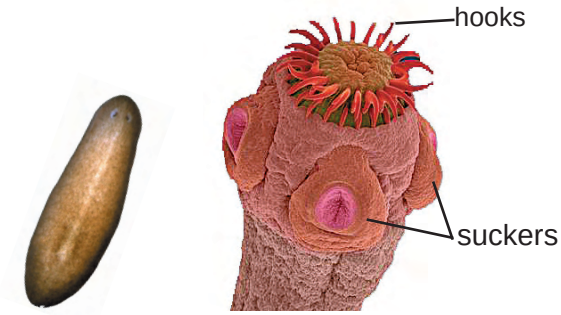
Sea anemone

### 2. Phylum Coelenterata

Coelenterates are colourful aquatic animals. Members of this group can be found attached and sessile, called polyps; or free-floating as a medusa. Coelenterates are diploblastic and shows radial symmetry. There is a distinct sac-like space inside the body called the coelenteron or gastro-vascular cavity which takes care of digestion. They do not have organs. Coelenterates have long finger-like structures around the mouth, called tentacles, that are used to catch prey and to protect themselves. The tentacles have special cells called nematocysts. These stinging cells have poisonous barbs inside and they are used to stun their prey. e.g. corals, sea anemone, hydra, jelly fish.

### 3. Phylum Platyhelminthes

These are flat, leaflike or ribbon-like organisms. They are more complex than Poriferans and Coelenterates. Their body is bilaterally symmetrical. The body wall is made up of three basic layers and hence the animals are triploblastic and acoelomate. Planaria is a free-living platyhelminth. Most flatworms, like the tapeworm, are parasites. These parasites have organs of attachments such as hooks or suckers that help them stay attached to the host.




Planaria Tapeworm

## 4. Phylum Aschelminthes

Organisms belonging to this phylum are also referred to as 'roundworms'. Their body is cylindrical and unsegmented and protected by a resistant cuticle. Their bodies are bilaterally symmetrical and triploblastic. They are pseudocoelomates with a fluid-filled space between the mesoderm and internal organs. Most roundworms are free-living and some are parasitic, and known to cause diseases. For example, filarial worm causes the dreaded disease elephantiasis and pinworms are found as parasites in human intestines.

Ascaris

## 5. Phylum Annelida

All annelids are worms .They have elongated, cylindrical and segmented bodies. Each segment carries identical sets of organs. This feature is called metamerism. These worms move with the help of small bristles called setae. Annelids are also bilaterally symmetrical and triploblastic. Their body contains a true coelom. Earthworm, leech and lug worm are examples of annelids.

Earthworm

**MORE TO KNOW**

*EARTHWORMS are referred to as "Farmer's Friend"? Why?*

*The earthworm plays a vital role in improving the fertility of the soil. It ploughs the land and assists in the recycling of organic matter for the efficient growth of the plants. The soil system is loosened, stirred up and aerated by the vertical migration of earthworms.*

## 6. Phylum Arthropoda

Arthropods are the largest group in the animal kingdom. It includes crustaceans (e.g.crabs and prawns), insects (e.g.butterflies and cockroaches), arachnids (spiders and scorpions) and myriapods (centipedes and millipedes). The word 'arthropod' means 'jointed foot' and all arthropods have limbs that are made up of jointed segments. The jointed limbs are used for locomotion, feeding and sensing. Their body is also segmented and grouped together to form head, thorax and abdomen. It is covered by a hard, firm external skeleton made up of a strong substance called chitin. All segments have flexible joints which enable movement. The arthropods exhibit bilateral symmetry. They have open type of circulation where blood vessels are absent and body-fluid circulates openly in the body cavity, bathing all the organs.

**ACTIVITY 1.2** **I DO**

*Observe a permanent slide of hydra under a dissection microscope. Draw what you see. Compare it with a picture of Hydra and label the parts. Locate the mouth. Note the number of tentacles.*

Insects are the only invertebrates that are winged.

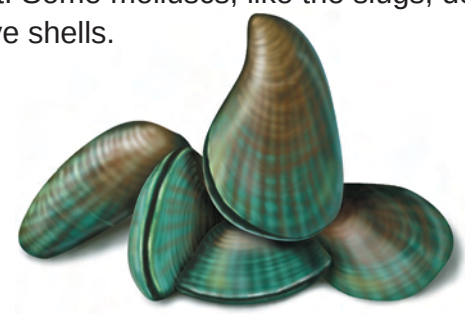
Butterfly

Scorpion

## 7. Phylum Mollusca

Molluscs and arthropods form a large part of the invertebrates that we come across in our lives.

When you look at the bodies of molluscs like snail, slug, clam, mussel, oyster, squid, and octopus you can see a large variety in shape. But they all share a common body plan: soft, unsegmented bodies without appendages, covered by a thin fleshy structure called mantle. The mantle protects the body by secreting a hard shell made of calcium carbonate. Most molluscs move around with the help of a muscular foot. Some molluscs, like the slugs, do not have shells.



Mussels

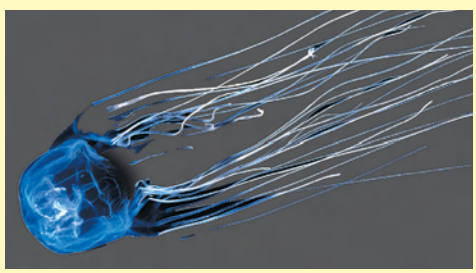
## 8. Phylum Echinodermata

Sea stars, brittle stars, sea urchins, sea-cucumbers and sea lilies are some examples of echinoderms.

'Echinos – derma' means 'spiny skinned'. These are marine animals. Their young ones show bilateral symmetry while the adult body show radial symmetry. They are triploblastic and coelomate. The body is covered by a thin outer skeleton, but they are not segmented. Echinoderms are unique because they have a system of water-filled canals inside the body. These canals project out in the form of hundreds of tubefeet on the underside of their body. A starfish moves with the help of tubefeet. Tubefeet have suction cups at their ends and is powered by muscles and hydraulic force from the water-vascular system. The water-vascular system also helps in the exchange of gases, internal transport of nourishment and excretion.

Starfish

**MORE TO KNOW**



*The Australian sea wasp or box jellyfish (Chironex fleckeri) is the most venomous coelenterate in the world. It has enough poison to kill about sixty people.*

SCIENCE

## 1.2. VERTEBRATES

The vertebrates are the most advanced group of organisms on the earth. These animals are larger in size than the invertebrates. They are coelomate, triploblastic and bilaterally symmetrical. They have a strong and flexible vertebral column made of a chain of cylindrical bones. Vertebrates also show characteristics that include body segmentation, closed blood circulation and presence of a well developed internal skeleton. They also have a well developed brain.

Vertebrates can be grouped into five classes.:

### 1.Class Pisces

Fishes are poikilothermic and exclusively aquatic vertebrates. Their body has a streamlined shape and is covered by overlapping scales. Fins are used for locomotion. Fishes breathe with the help of gills that are protected by a lid-like bony plate called the operculum. Some of them, like sharks and rays, have internal skeletons that are made of cartilage. The heart of the fish is the simplest among vertebrates. They are made up of two chambers: an auricle and a ventricle.

Lion fish

### 2.Class Amphibia

Amphibians are cold blooded vertebrates, but they do not have scales on their body. They are characterized by the ability to spend a part of their life in water and a part on land. They are the smallest group among vertebrates. Their skin do not have hair or scales. In its lifetime, an amphibian uses both gills and lungs for respiration. Their moist skin also helps in the exchange of gases for respiration. Frogs, salamanders and toads are examples of amphibians. An amphibian's heart has three chambers: two auricles and a single ventricle.

**MORE TO KNOW**

*Unforgiving fish: The stonefish is the most poisonous fish in the world. The poison is carried in its skin and in sacs attached to razor sharp spines along its back. When attacked or even accidentally stepped on, the stone fish pushes its spines into the predator and releases the poison into the wounds which usually results in paralysis or death.*

Salamander

**MORE TO KNOW**

*The drug derived from the extract of Poison arrow frog (Epipedobates tricolor) works as a powerful painkiller. It has the same benefits of morphine but without any side effects.*

**MORE TO KNOW**

*Amphibians are good indicators of environmental changes. They breathe partially through their skin which makes them sensitive to radiation, pollution and habitat destruction. Scientists believe that amphibians can show the first signs of environmental emergencies. In the last 20 years, the number of amphibian species has declined, with some species becoming extinct due to acid rain, ozone depletion and chemical pollution.*

How to distinguish frogs from toads?

| S. No. | TOAD | FROG |
|---|---|---|
| 1 | Short hind legs | Long hind legs |
| 2 | Rough, warty skin | Moist, smooth skin |
| 3 | Spends a little time in water | Spends more time in water |
| 4 | Walks and makes short hops | Jumps |
| 5 | Toothless | Teeth in upper jaw |
| 6 | Webless hind feet | Webbed hind feet |

### 3.Class Reptilia

Snakes, turtles, crocodiles and lizards are examples of reptiles. These are poikilothermic. When the temperature outside is warm, the animals warm up and become active. When the temperature outside is cold, they become less active. Their skin is dry and scaly, making it waterproof. The heart of a reptile has three chambers. They use their lungs to breathe.

### 4. Class Aves

Birds are homeothermic vertebrates and have streamlined bodies covered with feathers. They have four limbs. The front limbs are modified to form wings for flight. They use lungs to breathe and their bones are much lighter than that of other vertebrates. Their hearts are four-chambered. The pigeon, the crow and the sparrow are examples of birds that we commonly see flying around us. The ostrich, penguin, emu and cassowary are examples of birds that do not fly.

Owl

Peacock

SCIENCE

MORE TO KNOW

*Dinosaurs were reptiles, but they all died about 65 million years ago. Lizards and crocodiles that live on the earth today are relatives of the dinosaurs.*

## 5. Class Mammalia

Mammals are also homeothermic vertebrates. Their body is covered with hair unlike feathers that we see in birds.

Their skin has sweat glands and oil glands. The teeth of mammals are varied and this kind of teeth pattern is called heterodont dentition. Mammals have a four-chambered heart. The heart and lungs are separated from the rest of the organs in the abdomen with the help of a muscular sheet called diaphragm.

Mammals are characterized by the presence of mammary glands that produce milk to feed their young ones. Rat, cat, whale, dolphin, elephant, monkey and man are examples of mammals. The bat is an example of a flying mammal.

Dolphins

MORE TO KNOW

*Echolocation in Bats*

*Echolocation, also called bio sonar is used by several animals like bats. These animals emit ultrasound waves and listen to the echoes of those calls that return from various objects in the surroundings. They use these echoes to locate, range and identify the objects. It is used for navigation and for hunting in total darkness.*

**ACTIVITY 1.3** **I DO**

Name the animal:

- A marine invertebrate that has a porous body: _____
- A marine invertebrate that has a soft body and a shell: _____
- A homeothermic vertebrate with modified front limbs: _____
- A marine invertebrate that is covered with spines : _____
- An invertebrate that has a segmented body and jointed limbs: _____
- A vertebrate that has fur and feeds its young with milk : _____
- A vertebrate that has dry scaly skin : _____
- An invertebrate that has a long, segmented body without any limbs:_____

### *Vedanthangal Bird Sanctuary*

*It is one of the spectacular breeding grounds in India. It is located in Kancheepuram District of Tamilnadu (about 75 km from Chennai). The bird life (domestic and migratory) include Cormarants, Darters, Herons, Egrets, Open billed stork, Spoon bills, White ibis, Little grebe, Blackwinged suits, Grey pelican etc.*

*The ideal season to visit the sanctuary is from November to February.*

Vedanthangal Bird Sanctuary

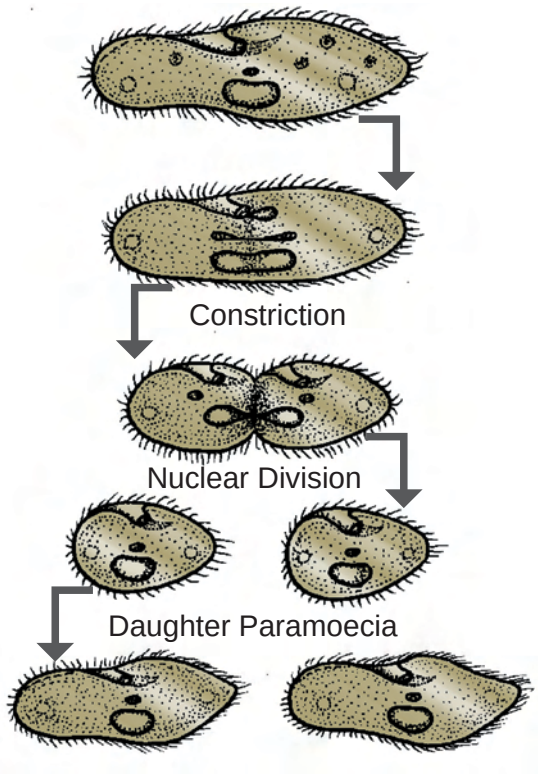
## 1.3. MODES OF REPRODUCTION IN ANIMALS

Reproduction is the capacity of an organism to produce young ones of their own kind. Living things reproduce to ensure the continuation of their species. All animals have the ability to reproduce. The process of reproduction can be asexual or sexual.

| Sl. No. | Asexual Reproduction | Sexual Reproduction |
|---|---|---|
| 1. | It involves a single parent. | It involves two parents (male and female) each capable of producing gametes. |
| 2. | It does not involve the fusion of gametes. | It involves the fusion of male and female gametes [sperm and ovum] resulting in the formation of zygote. |

### Asexual reproduction

During asexual reproduction, new individuals are formed from a single parent. A single celled organism may simply divide and give rise to independent daughter cells.




Binary fission in Paramoecium

Some of the ways in which organisms reproduce asexually are: multiple fission, binary fission, budding, gemmule formation and sporulation.

Paramoecium is an example of a unicellular organism that reproduces by binary fission. In this process, a constriction appears at the centre which divides the nucleus and cytoplasm into two parts. Thus a single Paramoecium gives rise to two daughter Paramoecia.

The Hydra reproduces asexually by budding. The body wall of the Hydra produces a bud-like outgrowth .This bud develops by repeated cell division, gradually grows in size and develops a mouth and tentacles at the free end. Soon a constriction appears at the point of contact; the daughter Hydra gets separated from the parent and leads an independent life.

Unfavourable conditions in the environment can also force some organisms to reproduce asexually.

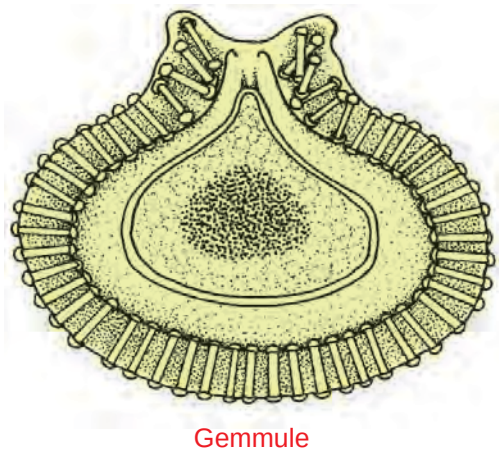
For example, sponges reproduce sexually during normal conditions. Being hermaphrodites, they can give rise to both male and female gametes for fertilization. When conditions are unfavourable, they either give rise to buds or produce packets of cells called gemmules. Each gemmule has extra protection in the form of an outer thick layer carrying numerous air spaces and two inner chitinous layers. These gemmules are released from the body. When conditions become favourable, the cell mass comes out of the gemmule through an opening called micropyle and develops into young sponges.

During unfavourable conditions, the protozoan Amoeba and the malarial parasite Plasmodium resort to an asexual method called cyst formation and sporulation. The protoplasm condenses and gets surrounded by a thick protective covering forming a cyst. When conditions become favourable again, the cyst dissolves. The protoplasm regains its original nature and undergoes multiple fission giving rise to numerous independent daughter cells. This process is called sporulation.

### Advantages of Asexual reproduction

1. It requires only one parent.
2. It is not complicated and does not involve gametes and fertilization.

Hydra with bud



Gemmule

### Disadvantages of Asexual reproduction

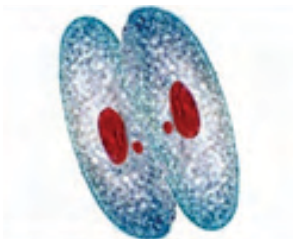
1. Offspring do not show much variation from parents. This reduces the possibility of having a variety that could lead to formation of new species after hundreds of years.
2. Undesirable characters are transferred from the parent to the offspring without any change.

### Sexual Reproduction

Sexual reproduction involves the production of sex cells or gametes. The male organism gives rise to male gametes or sperms and the female organism gives rise to the female gametes or the ova. In sexual reproduction, the male and female gametes fuse together to form a single cell called the zygote. The zygote grows to be a new adult.

Gametes are produced in organs that are generally referred to as the gonads. The male gonads are the testes and the female gonads are the ovaries. If an organism carries any one type of gonad, it is said to be a unisexual organism. In this case, the sexes are said to be separate as male and female. Bisexual organism, also referred to as hermaphrodites, are those that possess both testis and ovary in the same body. Hydra and tapeworm are examples of bisexual organisms.

Unicellular organisms like Paramoecium are also known to reproduce sexually. Two Paramecia come together, establish a bridge-like connection and exchange genetic material. Each of them separate and divide independently to give rise to daughter cells. This method of sexual reproduction is called conjugation.

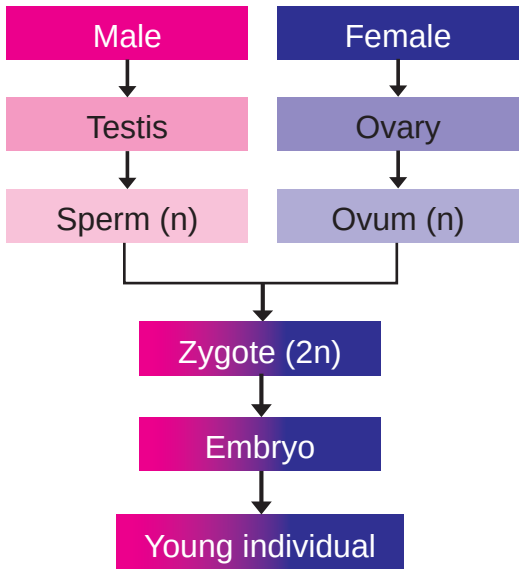


Conjugation in Paramoecium

Fertilization is the process of fusion of male and female gametes. It can be described as internal or external fertilization based on where it occurs. In most fishes and amphibians, the female lays unfertilized eggs in the water and the male releases sperms over them. This type of fertilization that takes place outside the animal's body is said to be external fertilization. In reptiles, birds and mammals internal fertilization takes place, where the male releases sperms inside the body of the female organism.

### Viviparous animals

In viviparous animals, example mammals, a zygote develops into an




Schematic representation of sexual reproduction

embryo that grows inside the mother, and receives nourishment directly from the mother. After a period of time, the mother gives birth to the young one that resembles the adult.

SCIENCE

### Oviparous animals

Insects, birds and most reptiles are oviparous. The zygote develops into a fertilized egg and is laid outside the body of the parent. These eggs are laden with yolk to nourish the embryo. Embryonic development takes place outside the body of the mother. These eggs have a hard calcareous shell that protects them from dehydration and are called cledoic eggs.

Cledoic eggs

### Young ones to adults

A zygote develops into an embryo and grows to become an adult. In insects, for example butterflies, young ones are in the form of larvae or caterpillars. They do not resemble their parents. These young ones undergo a complete transformation in their form and habit to become an adult. This process is called metamorphosis.

### Incomplete metamorphosis

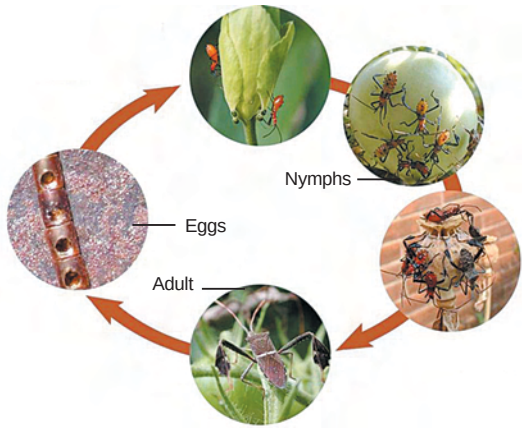
Among animals where the young ones resemble the adult, growth in size takes place.

In arthropods, the shell covering the body is shed periodically, to attain adult stage. In grasshoppers, the young ones called nymphs hatch out of eggs. Nymphs resemble their parents but are very tiny. These nymphs grow in size and shed their outer covering. This periodic shedding of the outer covering is called molting. Molting takes place several times before the nymphs become adults. This kind of lifecycle where the pupa stage is absent is called incomplete metamorphosis.

**MORE TO KNOW**

*Ovoviviparous animals*

*In these animals, the embryos develop inside the eggs that are retained within the mother's body until they are ready to hatch. The young ones are nourished by the egg yolk and there is no placental connection. e.g. Vipers*



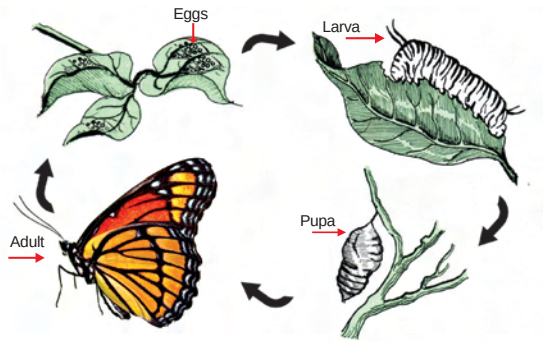

Incomplete metamorphosis

Egg ⟶ Nymph ⟶ Adult

### Complete metamorphosis

The lifecycle of the butterfly and the silk moth are examples of complete metamorphosis. Their young ones are worm-like and strikingly different from the adults. This caterpillar feeds voraciously on leaves for a few days, increases in size and then enters a resting stage called pupa. It remains in a cocoon for a period of time, after which the adult or imago emerges out of the cocoon.

## Lifecycle of the Butterfly




Complete metamorphosis

Egg ⟶ Larva ⟶ Pupa ⟶ Adult

MORE TO KNOW

*Molting hormone*

*Molting hormones or ecdysone or juvenile hormones are secreted by the neuro secretory cells of the brain and controls moulting in insects.*

## MODEL EVALUATION

### PART A

1.Match the following columns A, B and C to make meaningful sentences:

One is done for you: Birds lay eggs that are cledoic.

| A | B | C |
|---|---|---|
| Platyhelminthes | eggs | protection |
| Frogs | nematocyst | molting |
| Hydra | grasshopper | cledoic |
| Birds | amphibious | hooks and suckers |
| Nymphs | parasites | gills and lungs |

2. Classify the following organisms by giving reasons:

a. Cockroach b. Prawn c. Crow d. Monkey

An example is given below:

Monkey: Kingdom: Animalia Reason: They do not have chlorophyll.

Phylum : Chordata Reason: They have backbone.

Class : Mammalia Reason: They have hair.

3. "If two animals belong to the same family then they belong to the same order, class and phylum". Is this True or False? Why do you think so?

4. If you were a biologist, what would you say for:-

a) the branch of biology that deals with classification of organisms.

b) the units of classification.

c) an organism whose body parts are not arranged uniformly around the central axis.

d) the organisms which have true coelom.

e) the organisms that give birth to their offspring.

f) the organisms in which the body temperature remains constant.

g) the eggs without shells.

h) the changes (morphological, physiological, anatomical) during the lifecycle of an organism.

5. Explain the statements:

a) Mammals are heterodonts.

b) Budding is a type of asexual reproduction.

c) Hydra is a hermaphrodite.

d) The gametes are haploid, but the zygote is diploid.

6. Arrange the words in the correct sequence.

a) caterpillar, pupa, adult, egg

b) zygote, gonads, gametes, fertilization

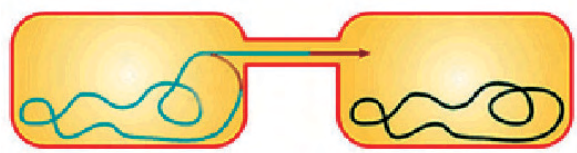
c) species, kingdom, family, genus

d) Aves, Amphibia, Pisces, Mammalia

## PART B

Answer the following in not more than two sentences:

1. Mammals are homeotherms. List the vertebrate classes that are poikilotherms.
2. Fertilization is internal in mammals. Name the group where external fertilization takes place.
3. Nymphs undergo a process to become an adult grasshopper. Describe it.
4. Frogs and toads are different but they are the same as amphibians. Are spiders and mosquitoes related? How?
5. The snail and the slug are related. Mention one difference between them.
6. The diagram shows a particular type of reproduction in bacteria where the cell contents are transferred through a canal.



a) Identify the type of reproduction.

b) Name another organism where you can notice similar type of reproduction.

c) Does this type of reproduction produce a new individual?

7. List out the functions of the tube feet of starfish.
8. Choose the odd one out and categorize the rest.

An example is given below:

owl, oyster, sponges, hydra

Category – invertebrates

Odd one – owl

a) Pupa, frog, larva, egg

b) Reptiles, Aves, Pisces, Amphibians

c) scales, pinna, three-chambered heart, lungs

9. Given below is a list of five animals with four features each. Underline the feature which does not match the animal.

a) Sea anemone – tentacles, aquatic, parasitic, cnidoblasts

b) Butterfly – backbone, insect, exoskeleton, bilateral symmetry

c) Dolphin – heterodont, poikilothermic, 4-chambered heart, mammary glands

d) Octopus – mantle, soft body, appendages, metameres.

e) Leech – suckers, bisexual, ectoparasite, acoelomate.

10. Match the phyla with their salient features :

| | |
|---|---|
| a) Coelenterata | – Parasitic |
| b) Platyhelminthes | – Pneumatic bones |
| c) Aschelminthes | – Nematocysts |
| d) Annelida | – False coelom |
| e) Aves | – Metamerism |

## PART C

Answer in a paragraph:

1. How do poikilotherms adapt themselves to changes in temperature. Give an example.
2. Taxonomy is the science of classification. Imagine you are a biologist and make a list of characteristics based on which you would classify a pearl oyster.
3. Young insects undergo certain changes to become adults. Define this change. Compare the life cycle of a grasshopper with that of a butterfly.
4. 

The organism in the picture above has wing like structures. Hence, a student grouped it under class Aves.

a) State whether the classification is right or wrong. If wrong, state to which class it belongs and give any two reasons.

b) Give 2 other examples of the above class.

c) The organism in the picture has a special feature to detect objects using ultrasound waves. Name that phenomenon.

*5. Identify the phyla based on their characteristic features and fill the box:*

| *INVERTEBRATA* | *PHYLUM* |
|---|---|
| *Organism with jointed legs, hard endoskeleton* | |
| *Soft body covered by a shell* | |
| *Flat ribbon like body with hooks and suckers* | |
| *Body with minute pores* | |
| *Spiny skinned marine animals* | |

## *SUGGESTED ACTIVITIES*

*Activity*

- *Cut a chart paper into seven pieces.*
- *Write the seven units of taxonomy in the chart pieces.*
- *Fix a double side tape at the back of the chart pieces.*
- *Arrange the units of Taxonomy in the correct order on a chart paper.*
- *Submit it for assessment.*

*Activity*

- *Collect pictures of different classes of animals of vertebrates.*
- *Prepare the branches of evolutionary tree with chart paper.*
- *Fix the pictures of animals according to their evolution.*
- *Let the students make an evolutionary tree for the invertebrates.*

*Activity Observation*

- *When you visit your native village, observe how hens hatch their eggs in a natural way.*
- *Write a paragraph on the process of natural hatching.*

*Activity Assignment*

- *Observe five animals in your locality.*
- *Write down the common names of these animals.*
- *Find out their zoological names. You may take assistance from your parents or senior students. You can also refer to the internet sources, if required.*

▶ *Prepare a table and make a classification.*

*Kingdom*
*Phylum*
*Class*
*Order*
*Family*
*Genus*
*species*

| Sl. No. | Animal | Invertebrates | Verterbrates |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |



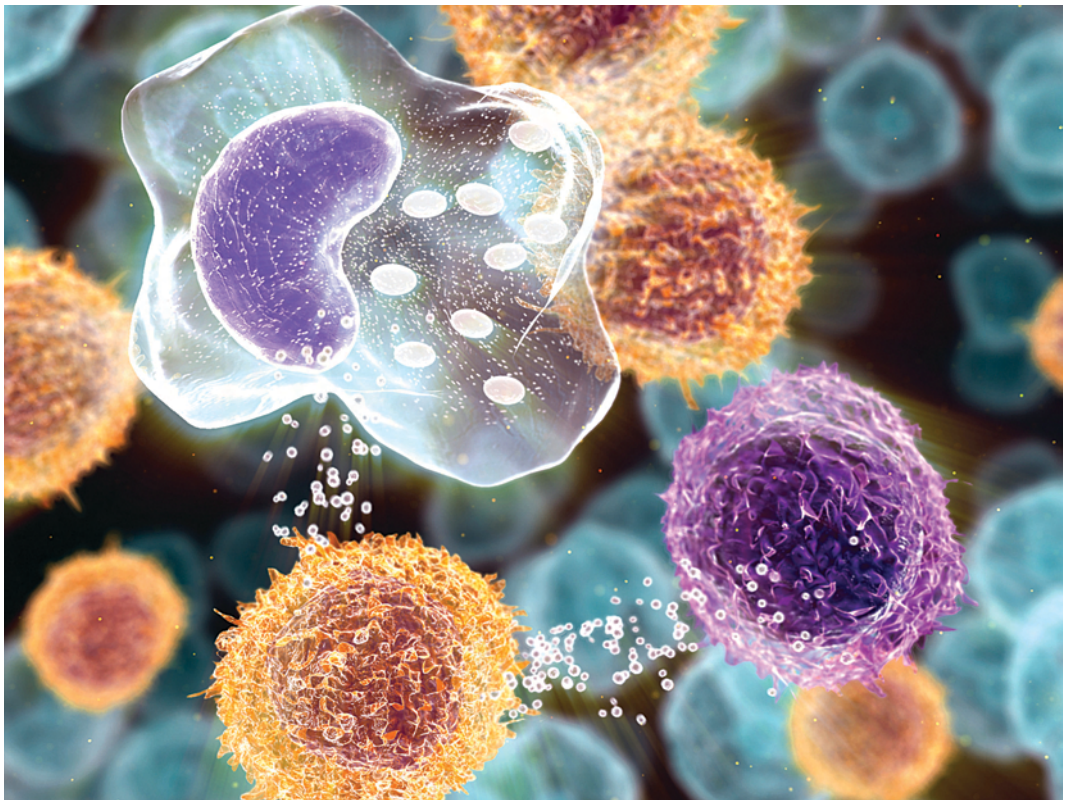
## FURTHER REFERENCE

*Books:* 1. Developmental Biology - Arumugam.N, Saras Publications.
2. A Manual of Zoology, Volume I& II - Ekambaranatha Iyar, E.K. and T.N.Ananthakrishnan, Viswanathan &Co.
3. Invertebrates - Barnes, R.D.,W.B.Saunders Publications.

*Webliography:* http://www.worldanimal.net

http://www.animaltrial.com

# Chapter 2



# CELLS

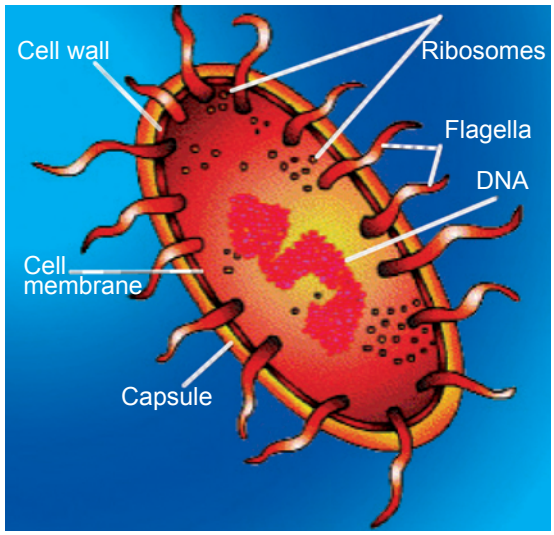
- Prokaryotic and eukaryotic cells
- Structural Organization of a cell
- Cell membrane and Cell wall
- Cytoplasm
- Cell organelles
- Nucleus
- Chromosomes - DNA structure
- Cell division and types, stages of mitosis
- Diffusion of substances

## CELLS AND TISSUES

Cells are the smallest functional units in a living organism. Many billions of years ago, life on the earth began in the form of a one-celled organism. These little organisms live even today and are probably the simplest of all living things found on this planet; And now more than 1000 different types of one-celled organisms have been discovered. This group of one-celled organisms is referred to as the 'prokaryotes'.

Prokaryota, in Greek means 'before nucleus'. Prokaryotes are organisms that do not have a well developed nucleus or any other structure in their cell that are bound by a membrane. Bacteria and blue-green algae are examples of prokaryotes. Their genetic material is in the form of a single thread-like structure that lies within the cell membrane.

For millions of years, prokaryotes were the only living thing on this planet till they evolved into more complicated "eukaryotic cells".



A Prokaryotic cell (Bacteria)

A eukaryotic cell has a well organized nucleus. It also has structures like endoplasmic reticulum, golgi body, mitochondria, plastids and vacuoles. Each of these structures is covered by a membrane. These specialized structures found in a cell are called organelles. Genetic material or chromosome is also found enclosed in a membrane-bound structure called nucleus. Protozoans, unicellular algae and fungi have eukaryotic cells. All plants and animals have eukaryotic cells.

| Sl. No. | Prokaryotic Cell | Eukaryotic Cell |
|---|---|---|
| 1. | It is generally smaller (1-10 microns) in size. | It is comparatively larger (5-100 microns) in size. |
| 2. | It lacks a well organized nucleus as its nuclear material is not surrounded by a nuclear membrane. | It contains a well organized nucleus as its nuclear material is surrounded by a nuclear membrane. |
| 3. | It has a single chromosome. | It has more than one chromosome. |
| 4. | Nucleolus is absent. | Nucleolus is present. |
| 5. | It lacks membrane bound cell organelles. | It possesses membrane bound cell organelles. |
| 6. | Cell division occurs by fission or budding. Mitotic and meiotic divisions are absent. | Cell division takes place by mitosis and meiosis. |
| 7. | Ribosomes are small. | Ribosomes are large. |

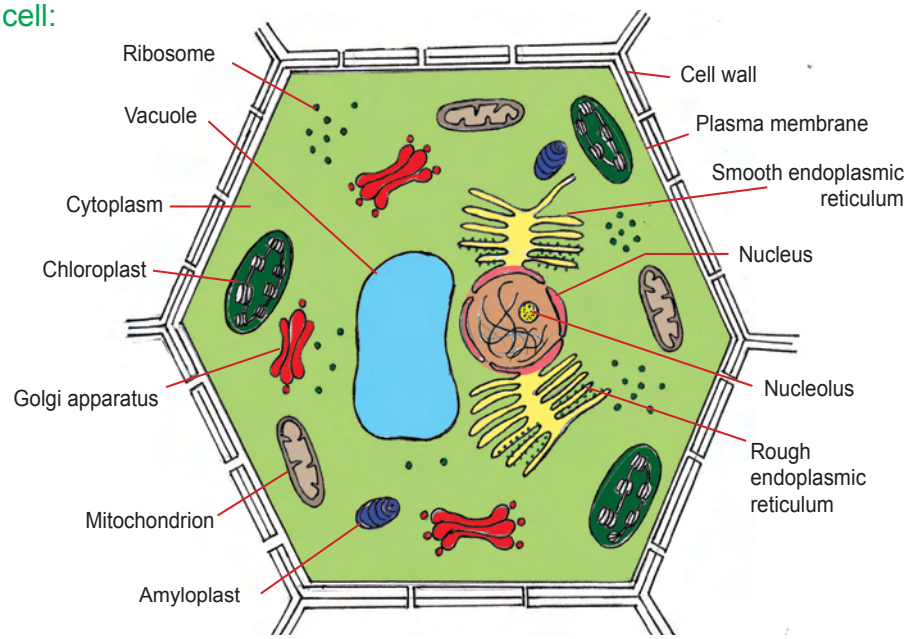
**ACTIVITY 2.1** **I DO**

*Imagine that a cell is like a large swimming pool….and you dive into it… How would you feel? What interesting things would you possibly find floating around you?*

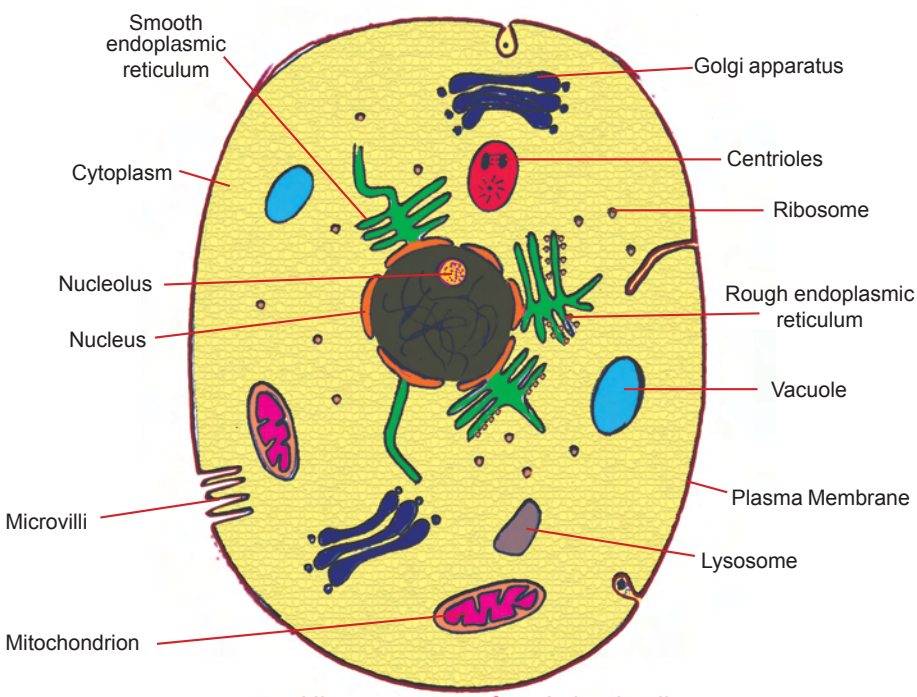
*Talk about it. Or draw what you imagine. Or write a story about it.*

You must have learnt about plant and animal cells. If we take a single cell of a plant and compare it with a single animal cell this is how it would look. You will find many things in common, in both plant and animal cells.

Study the diagrams and see if you can spot any difference between the plant cell and the animal cell:




Ultra structure of a Plant cell




Ultra structure of an Animal cell

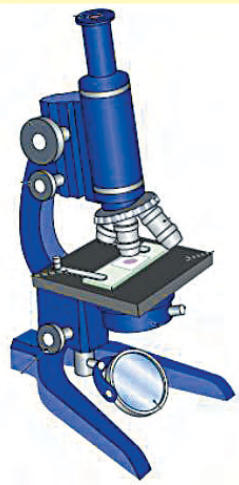
Let us compare the two cells:

Differences between Plant cell and Animal cell

| Sl. No. | Plant cell | Animal cell |
|---|---|---|
| 1. | Plant cell has an outer rigid cell wall which is made up of cellulose. | Animal cell lacks a cell wall. |
| 2. | Plant cell is larger than animal cell. | Animal cell is comparatively smaller in size. |
| 3. | Plant cell has large vacuoles which occupy more space in the cell. | Animal cell usually lacks vacuoles. Even if they are present, they are minute in size. |
| 4. | Centrosome is present only in the cells of some lower plants. | All animal cells contain centrosomes. |
| 5. | Lysosomes are found only in the eukaryotic plant cells. | Lysosomes are found in all animal cells. |
| 6. | Plant cell contains plastids. | Plastids are absent. |
| 7. | Mostly, starch is the storage material. | Glycogen is the storage material. |

**MORE TO KNOW**

- *The study of cell is not possible without a microscope. Robert Hooke in 1665 coined the term cell and discovered the cellular structure of cork.*
- *Anton Van Leeuwenhoek (1674), studied the structure of bacteria, protozoa, etc. under the simple microscope which he himself designed.*
- *Robert Brown, a Scottish Botanist, discovered that all cells contain nucleus.*
- *Purkinje coined the term 'protoplasm' for the living substance present inside the cell.*



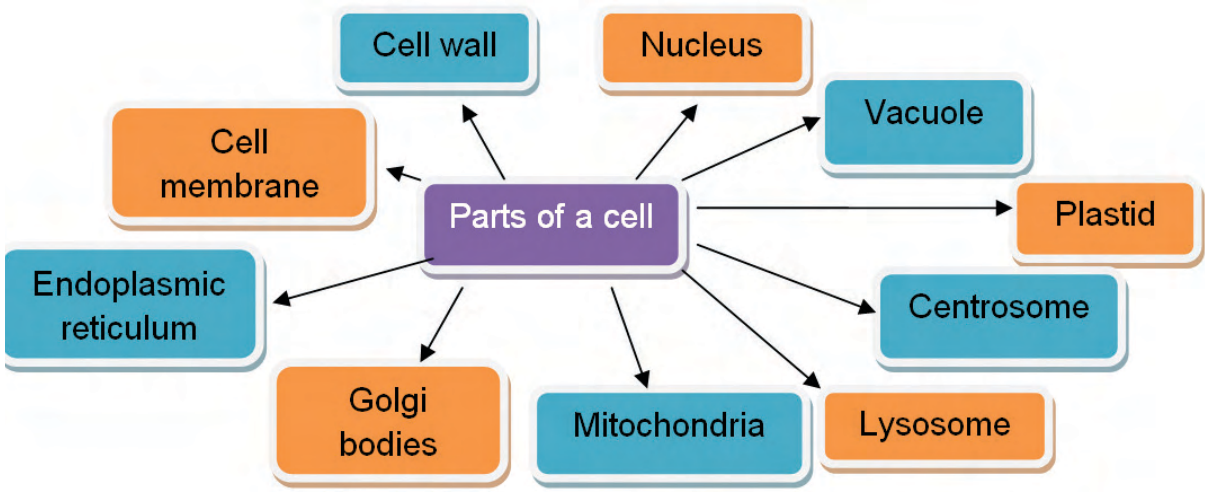
Compound Microscope

**ACTIVITY 2.2** **I DO**

- *I take a drop of curd, put it on a slide and stain it with saffranin.*
- *I heat the back of the slide for a few minutes.*
- *I observe the slide under a compound microscope.*
- *My observation : The bacteria seen in the microscope is a _____ (Prokaryotic cell/Eukaryotic cell)*

Would you agree, if we say that a cell is like a little bag filled with jelly-like semi-fluid substance with colourful tiny structures suspended in it?

The entire content of a cell is referred to as protoplasm. The structures embedded in it are organelles. Every aspect of protoplasm takes care of the life of the organism. Therefore, the protoplasm is described as the 'physical basis of life'.




## Parts of a cell

Cell Membrane (Plasma membrane or Plasmalemma)

The content of a cell is enclosed by a membrane called plasma membrane. It is found around all living cells. It is so important that it is also considered as an organelle that controls how substances move in and out of a cell. It acts as a barrier and helps the substances inside a cell to remain concentrated. It is made of a bilayer or a double layer of phospholipids in which proteins and carbohydrate molecules are arranged. All cell organelles are also bound by a similar membrane.

### Functions of plasma membrane:

- It provides an outer boundary to the cell and protects it from injury.
- It controls the substances that are allowed to enter and exit the cell. This regulation is called selective permeability. This is why a cell membrane is also described as a selectively permeable membrane.

**ACTIVITY 2.3** **I DO**

*Cut a small piece of onion and separate a peel. Place the peel on a glass slide in a drop of water. Put a drop of methylene blue on the peel. Wash it in water to remove the excess stain. Put a drop of glycerine and cover it with a coverslip. Observe it under the microscope.*

*The boundary of the onion peel is the cell membrane covered by another thick covering called cell wall. The central dense round body in the centre is called nucleus. The substance between the nucleus and the cell membrane is called cytoplasm.*

- It allows the flow of materials and information between different organelles of the same cell, as well as between the adjacent cells.

### Cell Wall

In addition to plasma membrane, a plant cell has a cell wall around it. Take a look at the picture of the plant cell and spot the cell wall. Where is it located?

Cell wall is found around the plasma membrane. It is made of cellulose and lignin. Lignin is water-resistant. The cell wall provides rigidity, protection and support to a plant cell and prevents it from collapsing. The cell wall is slightly elastic and its combined strength helps both small plants and tall trees maintain their shape, even when they sway in strong winds.

The cell wall in young cells is called primary cell wall. It is much thinner and more elastic than those found in older cells and allows the young cell to grow. When a cell stops growing, the primary cell wall becomes thicker and develops a new layer between it and the plasma membrane. This is called secondary cell wall and it has more lignin than the primary cell wall. The cell wall also plays an important role in the transfer of materials between cells.

## CYTOPLASM

Cytoplasm is the jelly-like, translucent, and homogeneous substance that fills up a cell. It is made up mostly of water and a few dissolved ions. It has a network of filaments that suspends the organelles and also maintains the shape of the cell. The cytoplasm also moves around slowly carrying the organelles around in a process called cytoplasmic streaming. It helps to keep the cell organelles dynamic and in motion.

The portion of cytoplasm immediately below the cell membrane is gel-like and is called ectoplasm. The cytoplasm between the ectoplasm and the nuclear membrane is liquefied and is called endoplasm.

The cytoplasm together with the nucleus is referred to as the protoplasm.

### Endoplasmic reticulum

Endoplasmic reticulum (ER) is an interconnecting system of channels and tubules that look like sacs and folds. It is spread throughout the cytoplasm and is continuous with the plasma membrane and nuclear membrane. There are two types of ER : rough and smooth.

The smooth ER are found in cells which synthesize steroids, hormones and lipids. The walls are smooth and form tubules.

Rough ER are found in cells which synthesize proteins. This type of endoplasmic reticulum has bumpy-looking walls because ribosomes are stuck all over it. Rough ER plays an important role in protein synthesis.

### Functions

1. Endoplasmic Reticulum (ER) provides large surface area for the metabolic activities of the cell.
2. Rough endoplasmic reticulum plays an important role in protein synthesis.
3. Smooth endoplasmic reticulum is involved in the synthesis of steroids, hormones and lipids.

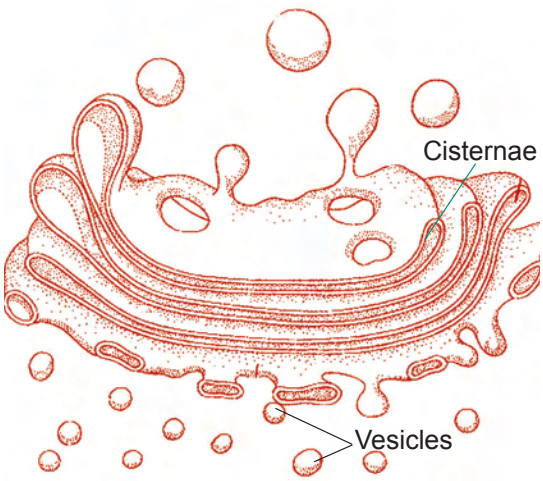
### Golgi Complex or Golgi Apparatus

Golgi complex refers to a collection of Golgi bodies that look like flattened, sac-like compartments arranged in stacks. This apparatus was first disovered by Camillo Golgi. They work closely with the ER and

package substances in the form of vesicles or cisternae and transport nutrients to various parts of a cell.

### Functions

1. Golgi apparatus is involved in the formation of lysosomes.
2. It is also responsible for the synthesis of cell wall and cell membrane.




Golgi Complex

## Lysosomes

Lysosomes are often referred to as 'suicide bags' or 'digestive bags'. They are membrane-bound vesicles produced by ER and Golgi complex, and often contain powerful digestive enzymes that are used to destroy worn-out organelles or digest foreign materials.

### Functions

1. Lysosomes are involved in the intracellular digestion of food particles ingested by the cell through endocytosis.
2. The lysosomes of WBCs (White Blood Cells) destroy pathogens and other foreign particles and thus take part in natural defence of the body.

**MORE TO KNOW**

*Lysosomes are involved in the destruction of aged and worn out cellular organelles. Therefore, they are also called demolition squads or scavengers or cellular housekeepers.*

## Vacuoles

Large fluid-filled sacs called vacuoles are found more in plant cells than in animal cells. Mature plant cells are found to have one large vacuole that almost fills up the entire cell. They may play the part of a contractile vacuole where excess water and waste is excreted from a cell. They also function as food vacuoles where they engulf material. For example, in Amoeba, the food vacuole engulfs food items and digests it using digestive juices.

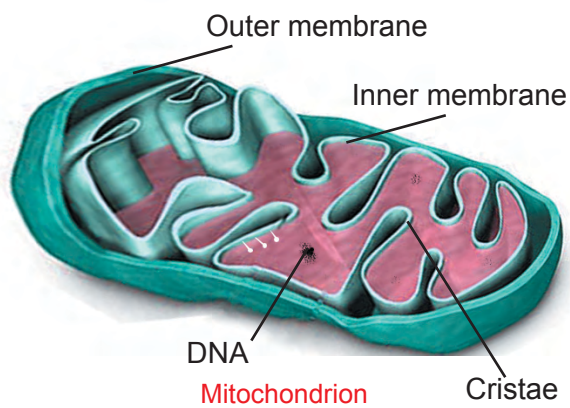
### Functions

i) Vacuoles store and concentrate mineral salts as well as nutrients.

ii) They maintain proper osmotic pressure in the cell to maintain its turgidity.

## Mitochondria

All living cells receive their supply of energy with the help of the mitochondria. They are very often referred to as 'powerhouses of the cell'. They are cylindrical in shape and bound by an inner and outer membrane. The inner membrane is drawn into folds called cristae that divide the chamber into incomplete compartments. These folds increase the surface area that can generate the energy-rich substance




Mitochondrion

called Adenosine Tri Phosphate (ATP). The cristae have pin headed bodies called $F_1$ particles or oxysomes, which play an important role in cell respiration. The area inside the inner membrane is called matrix. The matrix contains enzymes that produce molecules used in the ATP.

### Functions

1. Mitochondria synthesize energy rich compounds such as ATP.
2. The mitochondrial matrix also contains the mitochondrion's DNA and ribosomes.
3. This makes it a unique organelle.

### Plastids

Plastids, cell wall and large vacuoles are specific characteristics of plant cells.

Plastids occur as disc-shaped or ovoid organelles. They may be found as colourless plastids called leucoplasts or coloured ones called chromoplasts. Leucoplasts are colourless and help to store starch, oil and protein molecules. Chloroplasts are green and contain chlorophyll pigments that are responsible for photosynthesis.

### Structure of chloroplast

Each chloroplast consists of a double membraned envelope and a matrix. The inner membrane is arranged along the length of the plastids as lamellae. At certain regions, the lamellae are thickened and appear like a pile of coins. These are called the grana. Each granum consists of disc-shaped membranous sacs called thylakoids.

The photosynthetic pigment chlorophyll is located in the thylakoid membranes.

The non-thylakoid portion of the matrix is called stroma. It contains a number of enzymes involved in photosynthesis.

### Centrosome

Centrosome is present in animal cells and in certain lower plants. It is absent in prokaryotic cells and higher plant cells. It is located in the cytoplasm, just outside the nucleus and contains a pair of small, hollow granules called centrioles.

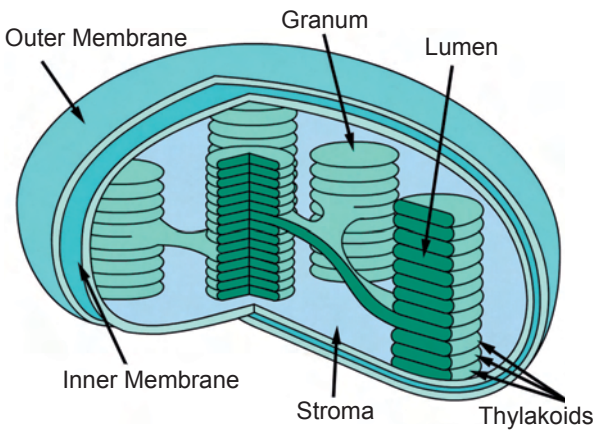
### Functions

Centrioles play an important role in the formation of spindle fibres during cell division.

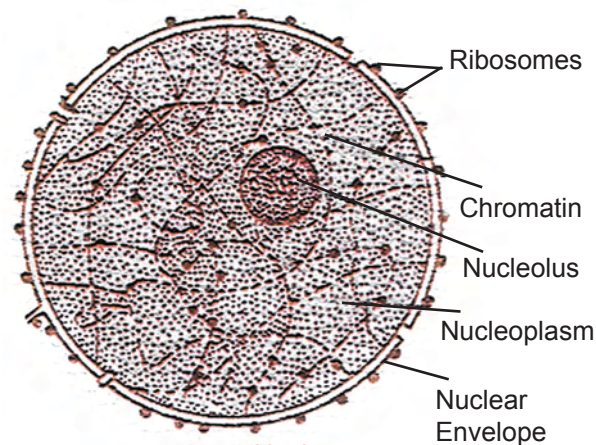
### Nucleus

A nucleus is commonly seen as a spherical structure surrounded by a double membrane called the nuclear envelope.

The nuclear envelope has a large number of holes or 'pores' that allow the



Chloroplast



Nucleus

cell to move molecules across the nuclear envelope and in and out of the nucleus. The nucleus performs two important functions. It controls the activity of the cell by determining what proteins are produced and when they are produced by the cell; and it also stores the genetic information of the cell, which is then passed on to daughter cells during cell division.

The nucleoplasm has two types of nuclear structures: i) the nucleolus ii) the chromatin.

The nucleolus is a spherical body rich in protein and RNA. It is the site of ribosome formation. There may be one or more nucleoli in the nucleoplasm.

The genetic information is in the form of a chromatin network of fine threads composed of genetic material DNA (Deoxy ribonucleic acid) and proteins. During cell division, chromatin is condensed into thick cord like structures called Chromosomes. The chromosomes contain genes and each gene is responsible for one hereditary character of the organism. Genes contain information for inheritance of features from parents to next generation in the form of DNA molecule.

## CHROMOSOMES

Chromosomes are the tightly coiled strands of genetic material that are visible as chromatin fibres only during cell division.

**ACTIVITY 2.4** **WE DO**

*Divide into 5 groups.*

*Group 1 will draw the structure of Endoplasmic Reticulum. Write a note on the structure and functions and display it for other students.*

*Group 2 will draw the structure of Golgi body. Write a note on the structure and functions and display it for other students.*

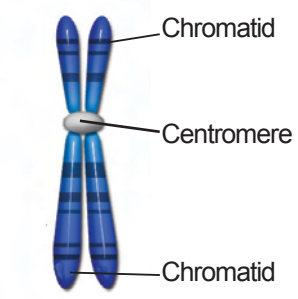
*Group 3, 4 and 5 can draw the structures of Ribosomes, Mitochondrion and Chloroplast respectively. Write a note on their structure and functions, and share it with other students.*

*Have a class discussion on the structure and functions of cell organelles.*

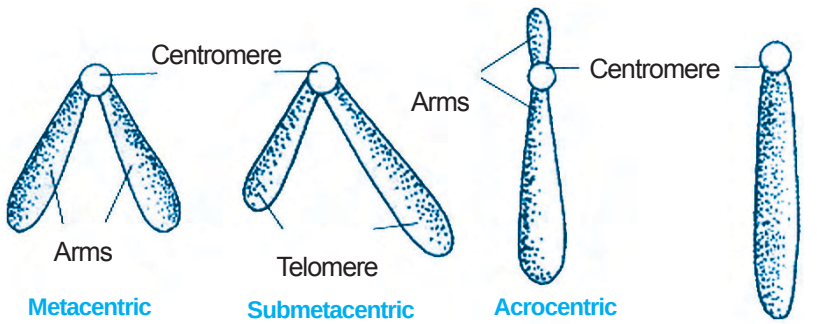
A chromosome can separate itself into two halves called chromatids. When separate, both sister chromatids remain attached to each other at the centromere, also known as the kinetochore.

Based on the location of the centromere, the chromosome can be grouped into four types:

1. Metacentric Chromosome: The centromere lies in the middle of the chromosome and the two arms are almost equal in length. It is a V-shaped chromosome.




Structure of Chromosome




Types of Chromosomes

2. Submetacentric Chromosome: The centromere lies slightly away from the middle of the chromosome and hence, its one arm is slightly shorter than the other. It is a 'J' shaped chromosome.

3. Acrocentric chromosome: The centromere lies near the end and hence, one arm is very short and the other arm is very long. It is a rod-shaped chromosome.

4. Telocentric Chromosome: The centromere lies at one end of the chromosome and hence, there is only one arm on one side. It is also a rod-shaped chromosome.

### DNA

Chromosomes are made of a long series of structures called genes.Genes are made of a chemical called Deoxyribo Nucleic Acid or DNA.

Each DNA strand is made up of millions of nucleotides. Each nucleotide is made up of a pentose sugar, a phosphate group and a nitrogenous base.

The nitrogenous bases are of two kinds- Purines and Pyrimidines. Adenine and Guanine are the purines and Thymine and Cytosine are the pyrimidines.

The structure of DNA was proposed by Watson and Crick. DNA is a double stranded structure in which the two strands are coiled around each other forming a double helix.

The backbone of the helix is formed of sugar and phosphate molecules. The nitrogenous bases are attached to sugar molecules.

The two poly-nucleotide strands are held together by hydrogen bonds between specific pairs of purines and pyrimidines.

**ACTIVITY 2.5** **I DO**

- *Prepare models of types of chromosomes, using Coloured paper / Coloured threads / China clay.*
- *Display them in the classroom and discuss.*
- *Display and explain them in the science club.*


DNA Structure

The phosphate and sugar molecules are same throughout the DNA strand but the nitrogenous bases change between any two of the purines and pyrimidines.

## CELL DIVISION AND TYPES

One of the most important characteristics of a living being is its ability

**ACTIVITY 2.6** **I DO**

- *Draw the diagram of the structure of DNA in a cardboard with the help of your textbook.*
- *Fill the two strands of DNA with coloured threads.*
- *Fix the coloured matchsticks between the two strands as seen in the diagram.*
- *Label the parts with the help of textbook.*
- *Display it in the classroom and discuss about the structure of DNA.*

to reproduce. The process of reproduction involves an increase in the number of cells by cell division. New cells can arise from pre-existing cells only through the process of cell division. Cell multiplication is needed for growth, development and repair of the body.

Cells divide by three different methods. They are Amitosis, Mitosis and Meiosis. In each case, division of nucleus occurs before the division of cytoplasm.

### Amitosis (Direct division)

Amitosis is a simple method of cell division. It is also called direct cell division. The nucleus elongates and develops a constriction around its middle. The constriction gradually deepens and finally divides the nucleus into two daughter nuclei. This is followed by the constriction of the cytoplasm to form two daughter cells. This type of cell division is common in prokaryotes. (e.g. Bacteria, Amoeba)

### Mitosis (or) Indirect cell division:

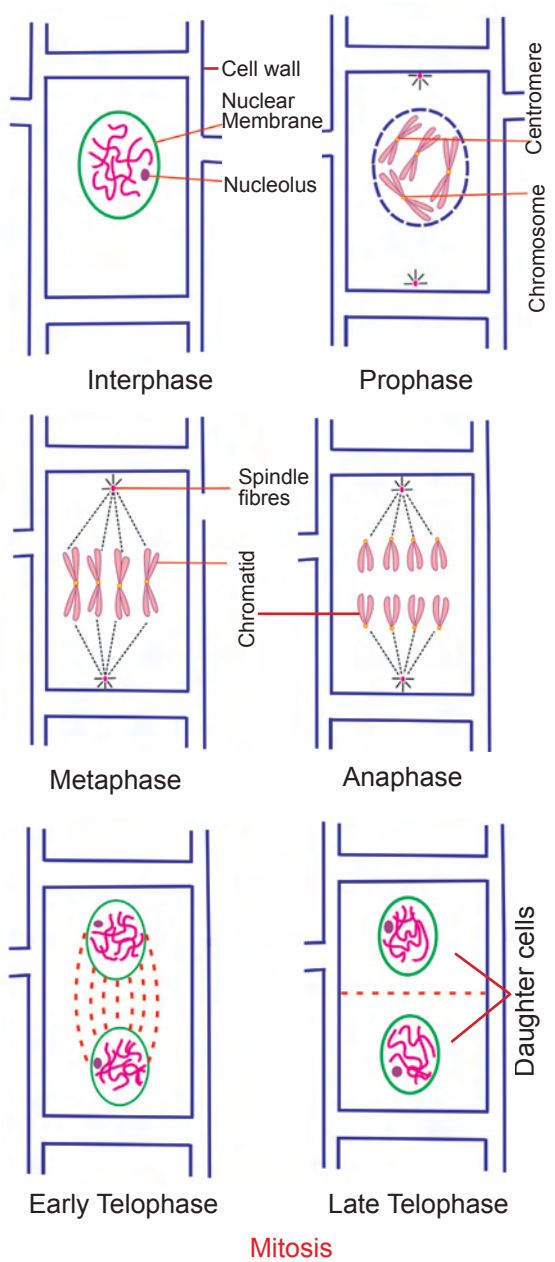
Mitosis takes place in somatic cells (body cells other than sperm and ovum). It is a continuous process and takes place in four phases. They are Prophase, Metaphase, Anaphase and Telophase.

### Interphase

Before a cell undergoes mitotic division, it prepares itself for the division. This phase is called interphase. The chromatin material duplicates due to duplication of nucleic acids.

### Prophase

- Chromatid fibres begin to coil and appear as long thread-like structures called chromosomes.




Mitosis

- Each chromosome consists of two chromatids that lie side by side and are joined along a point called centromere.
- Spindle fibres are developed from the poles towards the centre. Nuclear membrane and nucleolus start disappearing.

### Metaphase

- The nuclear membrane totally disappears.
- Chromosomes become shorter and thicker.
- The chromatids move to the centre of the cell with their centromeres.
- Centromeres are attached to the spindle fibres.

### Anaphase

- The centromere of each chromosome divides into two.
- When each chromatid gets a centromere, it becomes a chromosome.
- One of these chromosomes moves to one pole and the other towards the opposite pole by the contraction of spindle fibres.

### Telophase

- The daughter chromosomes reach the poles.
- The nucleolus and nuclear membrane reappear and thus two daughter nuclei are formed at the two poles of the cell.
- The spindle fibres disappear.
- This division of nucleus is called Karyokinesis.

### Cytokinesis

- The division of cytoplasm is called cytokinesis.
- In plant cells, the cytoplasmic division occurs by the formation of a cell plate at the centre of the cell between the two daughter nuclei. Thus at the end of mitosis, two identical daughter cells are formed.

### Meiosis

Meiosis is a type of cell division which takes place in the reproductive cells of organisms. This results in the formation of gametes.

## DIFFUSION OR EXCHANGE OF SUBSTANCES BETWEEN CELLS AND THEIR ENVIRONMENT

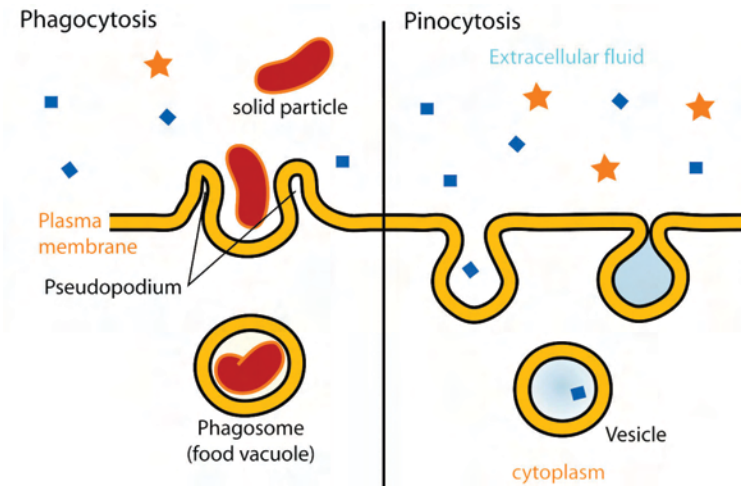
Materials are constantly exchanged between the cytoplasm and external environment across the plasma membrane by different processes. This transport across the membranes may be passive or active.

Passive transport happens when a substance moves across a membrane from a region of higher concentration to lower concentration. It does not require any metabolic energy.

Osmosis, simple diffusion and facilitated diffusion are examples of passive movement of molecules.

The process by which the water molecules pass through a membrane from a region of higher water concentration to the region of lower water concentration is known as osmosis. The process in which the water molecules enter into the cell is known as endosmosis. The process in which the water molecules move out of the cell is known as exosmosis. In plant cells, due to excessive exosmosis, the cytoplasm along with the plasma membrane shrinks away from the cell wall. This process is known as plasmolysis.

During simple diffusion, molecules of gases such as oxygen and carbon




dioxide enter the cell through the plasma membrane without the help of any other intermediary element.

When a substance takes the help of an intermediary element or a protein molecule to pass through a membrane, it is said to be a facilitated diffusion.

Substances are also transported across membranes from a region of lower concentration to higher concentration. This requires the use of energy molecules, like Adenosine Tri Phosphate or ATP. This type of movement across membranes is called active transport.

Materials can also enter or exit a cell without passing through the cell membrane. In endocytosis, the cell membrane takes a substance into the cell by folding inwards and forming a vesicle that encloses the substance. Lysosomes take substances or aging organelles in, by the process of endocytosis.

If a substance within a cell is enclosed in a vesicle and carried to the plasma membrane to be released outside the cell, it is said to be exocytosis. Enzymes and hormones are secreted by cells through the process of exocytosis.

During phagocytosis substances are taken up in solid form. Cells which involve in this process are called phagocytes and said to be phagocytic. (e.g. white blood cells). Cells take in liquids continuously through microscopic capillary structures on their cell membranes. This method of transport of substances is called pinocytosis.

## *MODEL EVALUATION*

### *PART A*

*Choose the correct answer :*

*1. The powerhouse of the cell is the _____ .*

*(chloroplast, nucleus, mitochondrion, lysosome).*

*2. The organelle that destroys worn-out cells is the _____ .*

*(centrosome, vacuole, lysosome, chromosome)*

*3. The cell division common in gametes*

*(mitosis, amitosis, meiosis, both mitosis and meiosis).*

4. Substances taken up in fluid form

(phagocytosis, exocytosis, receptor-mediated endocytosis, pinocytosis).

5. _____ are embedded on the Rough Endoplasmic Reticulum.

a) ribosomes b) lysosomes c) centrosomes d) mesosomes

6. The plant cell does not have a _____.

a) cell wall b) vacuole c) centriole d) chloroplast

7. _____ is a prokaryote.

a) Amoeba b) Bacteria c) Yeast d) Fungus

8. _____are the non-living components of the cell.

a) Lysosomes b) Vacuoles c) Nuclei d) Golgi bodies

9. Petals of flowers bear_____.

a) chloroplasts b) leucoplasts c) chromoplasts d) amyloplasts

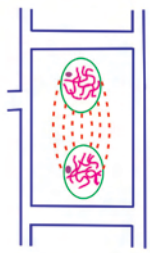
## PART B

Answer in brief:

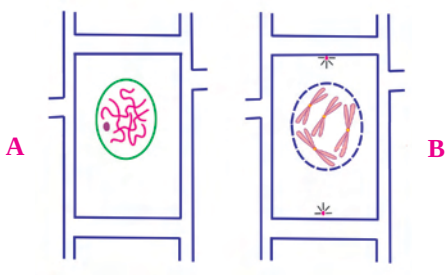
1. Look at the given picture:

Identify the phase of cell division.

What happens to the cell immediately after this stage?



2. Look at the given picture. Describe the changes in the nuclear material from stage A to stage B.

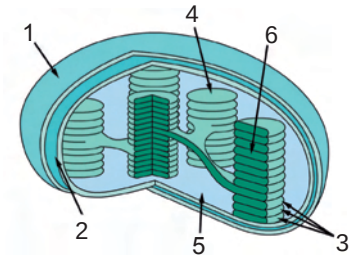



3. If the number of chromosomes in a nucleus is 24, how many finger-like structures will you be able to see during the metaphase. Why?

4. If plasmolysis is the shrinking of plasma membrane from the cell wall, what is exocytosis?

5. Genes are the physical basis of heredity. How are chromosomes, genes and DNA connected? Explain.

*6. Identify the organelle and answer the questions that follow:*

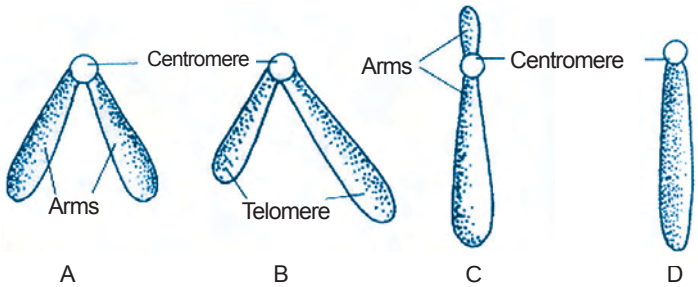



*a) Draw the diagram and label the parts 1 – 6.*

*b) What is the importance of the above organelle?*

*c) Name the pigment present in the organelle that is necessary for photosynthesis?*

*7. Observe the following diagram and answer the questions that follow:*




*a) Identify the type of chromosomes shown in A,B,C,D based on the position of centromere.*

*b) What are the shapes of chromosomes A,B,C,D.*

*c) Mention the role of centromere in cell division.*

*8. Pick the odd one out giving suitable reasons:*

*a) Nucleus , Nucleolus, Chromosome, Ribosome*

*b) Chloroplast, Cell wall, Dictyosome, Centriole.*

*c) Crista, inner membrane, outer membrane, granum*

*9. Study the diagram and answer the questions that follow:*


*a) Identify the structure shown.*

*b) Name the four nitrogenous bases found in the structure.*

*c) Who proposed the double helical structure of the DNA?*

*d) Name the components of DNA.*

*e) Expand the abbreviation DNA.*

*10. Identify the cell structures from their description:*

*a) contains cellulose and surrounds a plant cell*

*b) controls the entry and exit of substances*

*c) Jelly-like material which fills most of the cells*

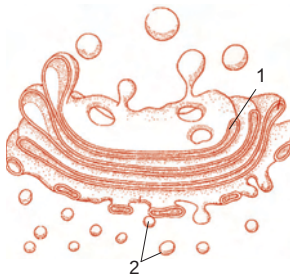
*d) involved in ribosome formation*

*e) involved in intracellular digestion*

*(cell structures – cytoplasm, Lysosome, cell wall, cell membrane, nucleolus)*

## *PART C*

*1. Study the diagram.*



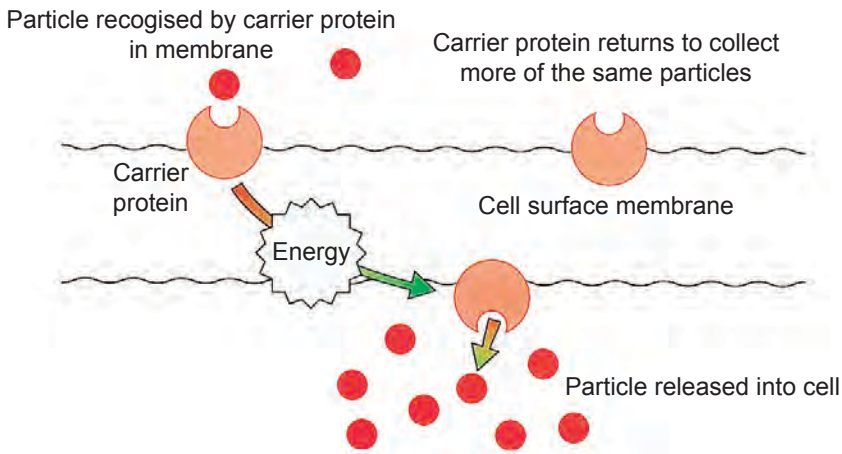

*a) Identify the organelle shown.*

*b) Copy and label the parts 1 and 2.*

*c) Who discovered the organelle?*

*d) List out its functions.*

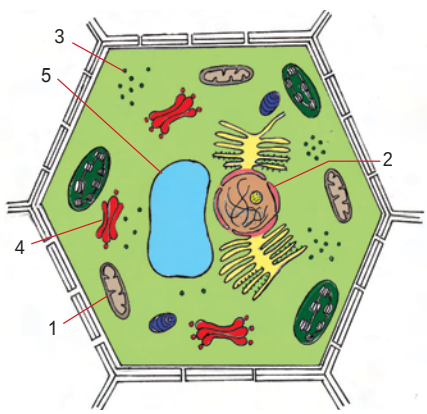
*2. Observe the diagram carefully and answer the following:*




*a) Name the type of transport.*

*b) Define the process.*

*3. Observe the diagram carefully and answer the following:*



a) Name the structure that carries out aerobic respiration.

b) Name the structure that controls the activities of the cell.

c) Name the structure that helps in the formation of lysosomes.

d) Name the structure that synthesises protein.

e) Name the structure that stores food.

## SUGGESTED ACTIVITIES (CCE)

### I. Discussion

- Draw the diagram of a Plant cell in one part of the chart and an Animal cell in the other part.
- Observe them and discuss.
- Differentiate between the Plant cell and the Animal cell.
- Fill up the following worksheet:

| Sl.No. | Plant Cell | Animal Cell |
|---|---|---|
| 1. | Cell wall is _____ | Cell wall is _____ |
| 2. | _____ are present. | _____ are absent. |
| 3. | Vacuoles are _____ in size. | Vacuoles are _____ in size. |

### II. Activity based learning

- Let the students divide themselves into two groups - A and B.
- Let group A draw the structure of a plant cell on a cardboard.
- Let group B draw the structure of an animal cell on a cardboard.
- From the cardboards, cut out the portions showing the cell organelles.
- Colour the cut out portions of the cell organelles with sketch pen.
- Let group A fix the relevant organelles in the empty spaces of the animal cell.
- Let group B fix the relevant cell organelles in the empty spaces of the plant cell.
- Discuss the structures of the plant cell and the animal cell, after the cell organelles are fixed correctly.

### III. Power point presentation

- Prepare a power point presentation showing pictures of cell organelles and explain about any one organelle.

### IV. Display

- Draw a diagram showing the stages of Mitotic cell division in a chart.
- Fix a bead as the Nucleus.
- Use different coloured threads for chromosomes and spindle fibres.

- *Observe the different stages and discuss.*
- *Write a note on every stage and display the chart.*

### *V. Dictionary Usage*

- *Collect the scientific terms from the lesson.*
- *With the help of a Science Dictionary or an Encyclopedia from your school library, find their meanings and write them down.*
- *Arrange them in alphabetical order and submit.*

### *VI. You can do it*

- *Take a suitable white PET bottle according to the diameter of the convex lens. Cut open the bottom portion open to a particular length.*
- *Fix the lens at the top of the bottle.*
- *Place the object (e.g. pollen grains) on a horizontal surface and keep the bottle over it.*
- *Observe the object through the lens.*
- *Can you see the structure of the pollen grain through the simple microscope you have made?*
- *If so, let your friends also use it to observe the plant parts.*



## FURTHER REFERENCE

*Books:*
1. Plant Physiology 2004 - Salisbury F.B and Ross C.W, Wadsworth Publishers.
2. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology - 2008 - Agarwal V.K and Verma P.S., S.Chand Publishers.
3. Life Science 1990 - Silver Burdett K Ginn Publications.

*Webliography:* http://www.sciencecentral.com
http://www.botany.org
http://www.khanacademy.org

Chapter 3

# IS MATTER AROUND US PURE?

- Mixtures
- Characteristics of mixtures
- Difference between mixtures and compounds
- Types of mixtures
- Homogeneous mixtures and their types
- Heterogeneous mixtures and their types
- Separation of different components of a mixture

## Matter

The entire world that we see, touch and feel around us is made up of matter. The fragrant fresh air that we breathe, the beautiful flowers and trees around us, the tasty fruits that we eat, the pets that we love, the roof and walls of our houses, the ground that we walk on and why, even our own bodies are all made up of matter.

Matter occupies space. In other words matter has volume. Some are large and some are small.

The quantity of matter contained in any object is referred to as mass. Hence, each and every matter is characterized by mass and volume.

All matter exists in any one of the three states - solid, liquid or gas. These are often referred to as the three physical states of matter.

Classification of Matter:

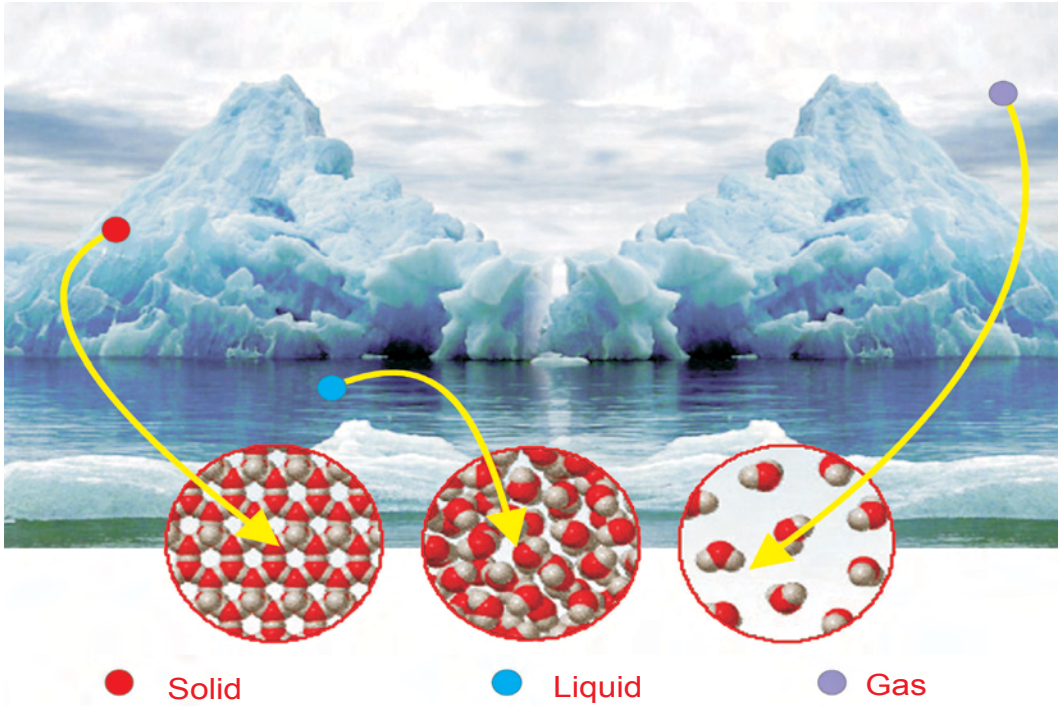
1. According to physical state as solid, liquid and gas.
2. According to its composition as element, compound and mixture.

## Physical States of Matter

**Solid:** Solids have a definite shape and a definite volume. They take a lot of energy to change the shape. They are rigid and not compressed appreciably even at high pressures. They usually have high densities and expand only very slightly, when heated. In a solid, the molecules are held tightly together in definite arrangements.

**Liquid:** Liquids have no definite shape and they take the shape of the container. They have a definite volume. They are not appreciably compressed by moderate pressures. They expand more than solids on heating and change into the gaseous state. They have lower densities than solids.

**Gas:** Gases have no definite shape. They take the shape of the containing vessel. Gases have no definite volume. They have the property to occupy the entire space available to them. They are easily compressed by even small pressures and also expand more than liquids on heating. They have low densities.



### Purity of Matter

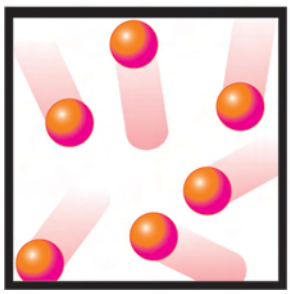
Substances rarely exist in a pure form in nature. They are often mixed with many other substances or materials. Their physical properties and chemical properties are either altered or not clearly visible because of the presence of other substances. A pure substance is a distinct type of matter that has the same properties (physical and chemical) throughout the sample.

### Elements, Compounds and Mixtures

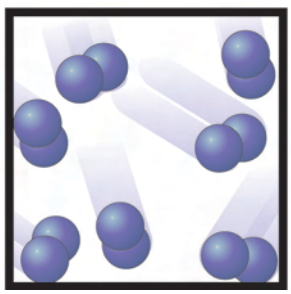
According to its composition, matter can be classified as an element, a compound and a mixture.

### Elements

An element is the simplest substance that cannot be broken down chemically. When it is pure, the smallest unit of an element that displays all the properties of that element is an atom. Atoms of the same element may be visualized as similar looking tiny little objects, (figure (a) below) each particle having the same physical and chemical properties as well. Many elements especially gases do not exist as single atoms. They exist in clusters (usually identical clusters of two or three atoms) as shown in figure (b) below. Examples of such elements are hydrogen and oxygen.



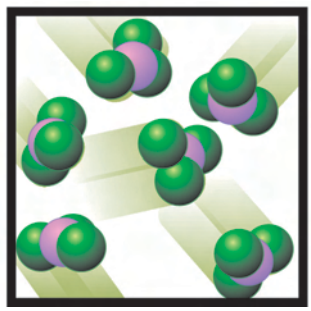
(a) Atoms



(b) Molecules

### Compounds

Compounds are substances resulting from the chemical combination of two or more elements in fixed proportions. The elements in compounds are chemically bonded to each other. The physical and chemical properties of such compounds do not resemble the properties of any of the constituent elements. For example, when hydrogen gas and oxygen gas are stored together in a container in the ratio 2:1 by volume, under certain conditions they would explosively combine to form water which is a liquid and has physical and chemical properties that are totally different from those of either hydrogen or oxygen. Water is a chemical compound. A molecule can be broken down chemically into atoms of the constituent elements. (figure (c)).



(c) Compounds

## 3.1. MIXTURES

When two or more substances are mixed together and the substances retain their individual original identities, the combination is called a mixture. For example, if you mix sand and water, sand retains its own properties and water retains its own properties. In a mixture, two or more substances are brought together but no chemical reaction takes place.

**MORE TO KNOW**

*The purity of a substance is often determined by measuring its physical properties. For example, a colourless, odourless, tasteless liquid which at atmospheric pressure, boils at 100$^{o}$ C, freezes at 0$^{o}$ C and has a density of 1.0 g cm$^{-3}$ is water. A pure substance can exist as an element or a compound.*

For example, if hydrogen and oxygen, in any ratio are mixed together in a container gently at low temperature in the absence of a spark, no chemical reaction would take place and the mixture would display the physical and chemical properties of hydrogen and oxygen.

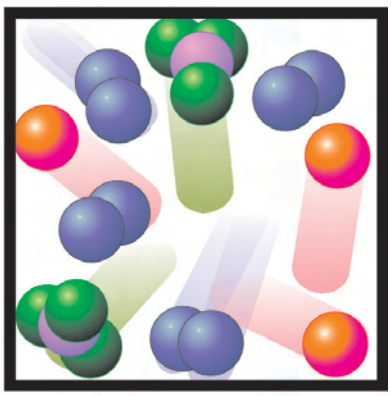
## 3.2. CHARACTERISTICS OF MIXTURES

Mixtures may consist of substances in the same or different physical states. For example, bronze is an alloy consisting of the two solid metals, copper and tin; both are in the solid state. Most common solutions are mixtures of a solid in a liquid. For example, salt dissolved in water.

Mixtures are not pure substances, since they are neither a single type of distinct matter nor do they display a single set of physical and chemical properties throughout the whole sample.

As shown in figure (d) below, we can imagine mixtures to be different types of atoms or molecules held together but essentially retaining their individual physical and chemical properties. In mixtures, elements are physically mixed in any ratio and no new compound is formed.

The substances that form a mixture are called constituents or components.



(d) Mixture

| Types of mixtures | Examples |
|---|---|
| Solid in solid | Coins, alloys |
| Solid in liquid | Seawater |
| Solid in gas | Smoke(carbon particles in air) |
| Liquid in solid | Amalgam (metal + mercury) |
| Liquid in liquid | Alcohol and water |
| Liquid in gas | Cloud, fog |
| Gas in solid | Gas absorbed by charcoal |
| Gas in liquid | Soda drinks |
| Gas in gas | Air |

**ACTIVITY 3.1** **WE DO**

Left - Sulphur and Iron
Right - Iron sulphide

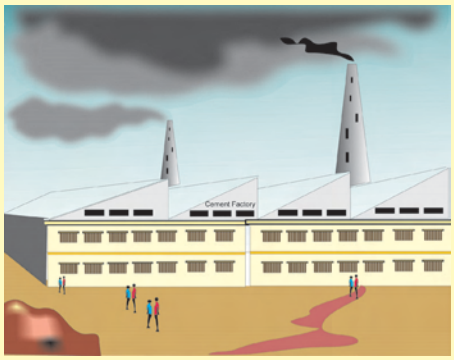
- *We mix iron powder and sulphur powder in a china dish.*
- *In another dish, we take the same substances and heat them strongly.*
- *We bring a magnet closely. Iron powder is attracted by the magnet and the compound iron sulphide is not.*
- *Now we distinguish a mixture from a compound.*

**MORE TO KNOW**

*The lead in your pencil is actually a form of carbon called graphite mixed with clay.*

SCIENCE

**ACTIVITY 3.2** **WE DO**



*Is air around us pure?*
*We shall discuss the reasons in groups.*

### The Law of Constant Composition

A pure compound always contains the same elements combined together in the same definite proportions by weight, irrespective of its method of preparation.

### Is water a mixture or a compound?

Water is a compound because of the following reasons.

- It is homogeneous.
- It has definite physical constants such as boiling point, freezing point, density, etc.
- The properties of water are entirely different from those of its constituents, i.e, hydrogen and oxygen.
- Water has a definite composition by mass. The ratio of H:O by mass is 1:8.

### Is air a mixture or a compound?

Air is a mixture because of the following reasons.

- Air does not have a fixed composition. The composition of air varies from place to place.
- Artificial air can be made by mixing the various components of air in the same proportions in which they occur at a place, and when this is done, no energy changes are noticed.
- The components of air can be separated by a physical method such as fractional distillation of liquid air.
- Liquid air does not have a definite boiling point. It boils over a range of temperature between -196ºC and -183ºC.
- If air is a compound, the composition of air expelled from humans should not be different from the composition of air around us. But it is known that during respiration, the exhaled air has lower percentage of oxygen than the ordinary air.

**ACTIVITY 3.3** **I DO**

*I classify the following into mixture or compound.*

*(i) Alloys (ii) Smoke (iii) Juice (iv) Milk (v) Common salt (vi) Coffee (vii) Carbon dioxide (viii) Ice cream.*

### Composition of inhaled air and exhaled air during respiration.

| Inhaled Air | Exhaled Air |
|---|---|
| Contains 78% nitrogen. | Contains 78% nitrogen. |
| Contains 20% oxygen. | Contains 16% oxygen. |
| Contains 0.03% Carbon dioxide. | Contains 4% Carbon dioxide. |
| Contains very little moisture. | Contains appreciable amount of moisture. |

### Composition of air

| Gas | in mass % |
|---|---|
| Nitrogen | 75.50% |
| Oxygen | 23.20% |
| Argon | 1.0% |
| Carbon dioxide | 0.046% |
| Neon | Negligible |
| Helium | Negligible |

### 3.2.1. Differences between mixture and compound

| Mixture | Compound |
|---|---|
| Elements are physically mixed in any ratio and no new compound is formed. | Elements are chemically combined in a fixed ratio to form a new compound. |
| They have no sharp or definite melting point, boiling point, density etc. | They have definite melting point, boiling point, density etc. |
| A mixture exhibits the properties of its constituent or component elements. | Property of a compound is different from its constituent or component elements. |
| They are either homogeneous or heterogeneous in nature. | They are always homogeneous in nature. |
| Constituents of a mixture can be separated by physical methods like filtration, magnetic separation etc. | Constituents of a compound cannot be separated by physical methods. |

## 3.3. TYPES OF MIXTURES

There are two types of mixtures. They are:

1. Homogeneous mixture
2. Heterogeneous mixture

### 3.3.1. Homogeneous mixtures and their types

Homogeneous mixtures consist of a uniform distribution of the substances throughout the mixture. Samples taken from any part of the mixture would have the same ratio of the ingredient substances and the same physical and chemical properties, although the properties of different samples may be different. Air is a homogeneous mixture of nitrogen, oxygen, argon and other traces of gases.

**ACTIVITY 3.4** **I DO**

*Aspirin is a medicine taken for headache. It is composed of 60% carbon, 4.5% hydrogen and 35.5% oxygen by mass, regardless of its source. I understood that aspirin is a _____(mixture/compound).*

There are three types of homogeneous mixtures.

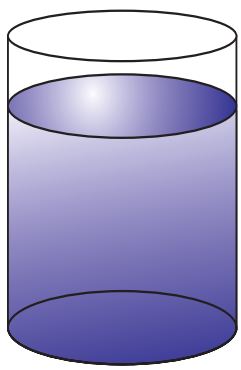
Solid homogeneous mixture - e.g. Alloys
Liquid homogeneous mixture - e.g. Alcohol in water
Gaseous homogeneous mixture - e.g. Air

Homogeneous Mixtures

Salt in water A cup of tea

**ACTIVITY 3.5** **I DO**

- *I mix a drop of ink in water.*
- *I observe whether the colour of the solution is uniform throughout.*
- *I conclude that it is a _____ . (homogeneous mixture/ heterogeneous mixture)*



SCIENCE

### 3.3.2. Heterogeneous mixtures and their types

Heterogeneous mixtures do not have a uniform composition. For example, if you take dilute buttermilk in a vessel and leave it undisturbed for some time, the particles will settle at the bottom and the water will remain on the top. The composition is not uniform. The ingredients of a heterogeneous mixture need not necessarily be in the same state – gas, liquid or solid.

Solid - solid heterogeneous mixture - mixture of sugar and salt

Solid - liquid heterogeneous mixture - chalk powder in water.

Gas - gas heterogeneous mixture - smoke in air.

Liquid - liquid heterogeneous mixture - kerosene in water.

**ACTIVITY 3.6** **I DO**

- *I mix a spoonful of sand in water.*
- *I try to see the particles of sand.*
- *I observe whether the particles are evenly distributed in the mixture.*
- *I write my conclusion about the nature of the mixture prepared.*

**ACTIVITY 3.7** **I DO**

*I classify each of the following as homogeneous or heterogeneous mixture.*

*(i) Tea (ii) Ink (iii) Fruit salad (iv) Sugar solution*

CLASSIFICATION OF MATTER

**Matter**

**Mixtures**

- Variable composition.
- Easily separated by physical methods.
- No definite physical constants.

**Pure Substances**

- Constant composition.
- Not easily separated by physical methods.
- Have definite physical constants.

**Homogeneous Mixtures**

- Have the same composition throughout.
- Components are indistinguishable.

**Heterogeneous Mixtures**

- Do not have the same composition throughout.
- Components are distinguishable.

**Elements**

- Contain atoms of the same kind like metals(Na, Ca), non-metals($O_2$,$Cl_2$), metalloids(Sb, As), noble gases(He,Ne)

**Compounds**

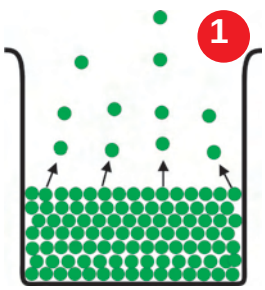
- Contain two or more elements in a definite ratio by mass.

## 3.4.SEPARATION OF DIFFERENT COMPONENTS OF A MIXTURE

Mixtures can be separated by simple physical procedures. To be able to separate the ingredients of a mixture, we would need to know the physical properties of the individual ingredients. Using the properties that are distinct and different, we can separate them. For example, if both the ingredients of a mixture are soluble in water then we cannot separate the ingredients. However, if we know that the melting point of two ingredients are different, then we can use that knowledge to separate the ingredients. A good knowledge of physical properties is therefore very important.

### Separation of heterogeneous mixture

1. Decantation: Used to separate a liquid from a solid (present as large particles) that does not dissolve in it.
2. Filtration: Used to separate a liquid from a solid (present as very small particles) which does not dissolve in the liquid.
3. Sublimation: Used to separate a volatile solid substance from a mixture containing a non-volatile solid substance.
4. Separating funnel: Used to separate two completely immiscible liquids.




1. Solid molecules evaporate


2. Iodine crystal vapourises


3. Sublimation of dry ice (carbon dioxide in ice form)

### 3.4.1. Separation of mixtures by sublimation

Sublimation is defined as a process, in which a substance in solid state is directly converted into vapour state.

At high temperature, the molecules of volatile solid move far away from each other changing the solid substance into vapour.

Consider a mixture containing common salt and camphor. Both common salt and camphor are solid substances. Common salt is a non-volatile substance. It does not undergo sublimation. Camphor undergoes sublimation. Hence camphor can be separated from common salt by sublimation.

**MORE TO KNOW**

*Solids that undergo sublimation are camphor, naphthalene, benzoic acid, iodine and ammonium chloride.*

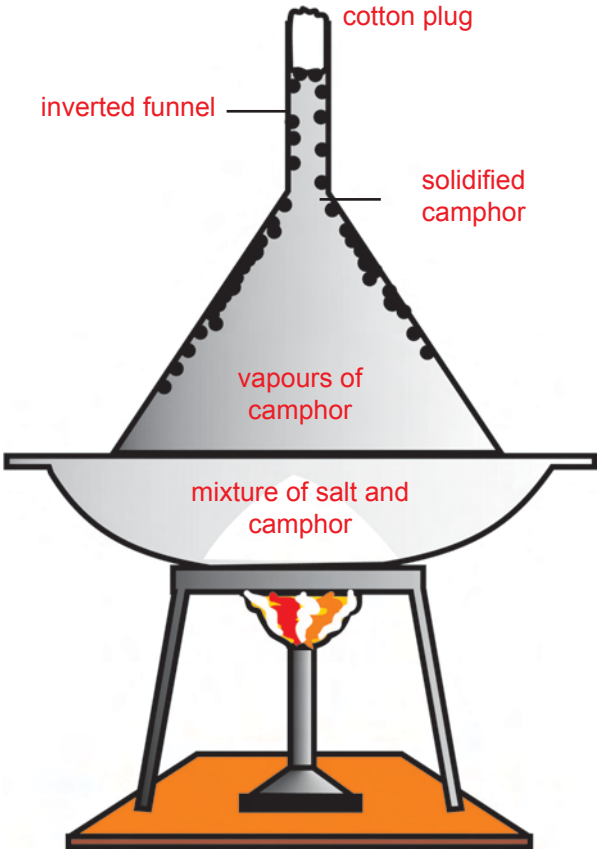
**ACTIVITY 3.8** **I DO**

*An equal quantity of fine salt and wheat flour are added into the beaker containing water and stirred well. The solubility of flour and salt in water are observed. The flour settles at the bottom of the beaker. I can now suggest a suitable method of separation of flour from the salt.*

**ACTIVITY 3.9** **I DO**

*We take a mixture containing common salt and camphor in a china dish placed over a stand and an inverted funnel is kept over it. The funnel stem is closed by means of cotton and the china dish is heated. The observations are recorded.*

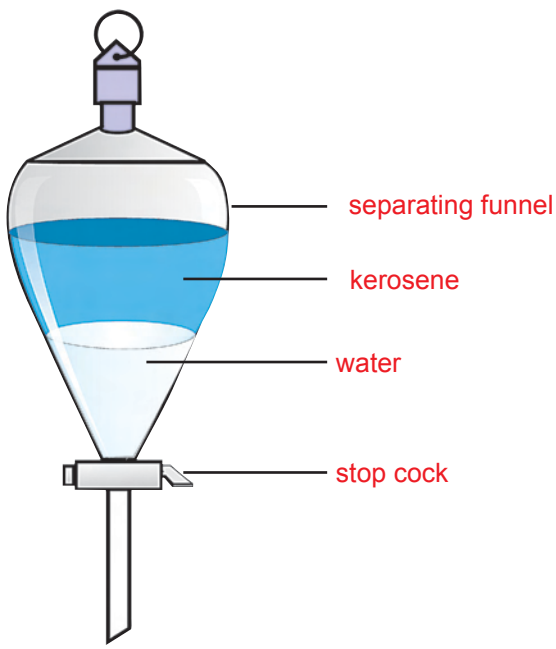
SCIENCE




sublimation of camphor

### 3.4.2. Separation of a mixture containing immiscible liquids

Immiscible liquids are usually separated by using a "separating funnel".




Consider a mixture containing kerosene and water. Both the liquids are immiscible with each other. By using a separating funnel, one liquid can be separated from the other. Less denser liquid remains in the upper layer while high denser liquid remains in the lower layer.

**ACTIVITY 3.10 WE OBSERVE**

- *Take a mixture containing kerosene and water.*
- *Pour the mixture into a separating funnel.*
- *Close the mouth of the separating funnel.*
- *Shake it for 10 minutes.*
- *Hold the funnel in a stand for 15 minutes.*
- *Observe the changes.*
- *Note the lower and upper layers.*
- *What is the principle behind it?*

SEPARATION OF HOMOGENEOUS MIXTURE

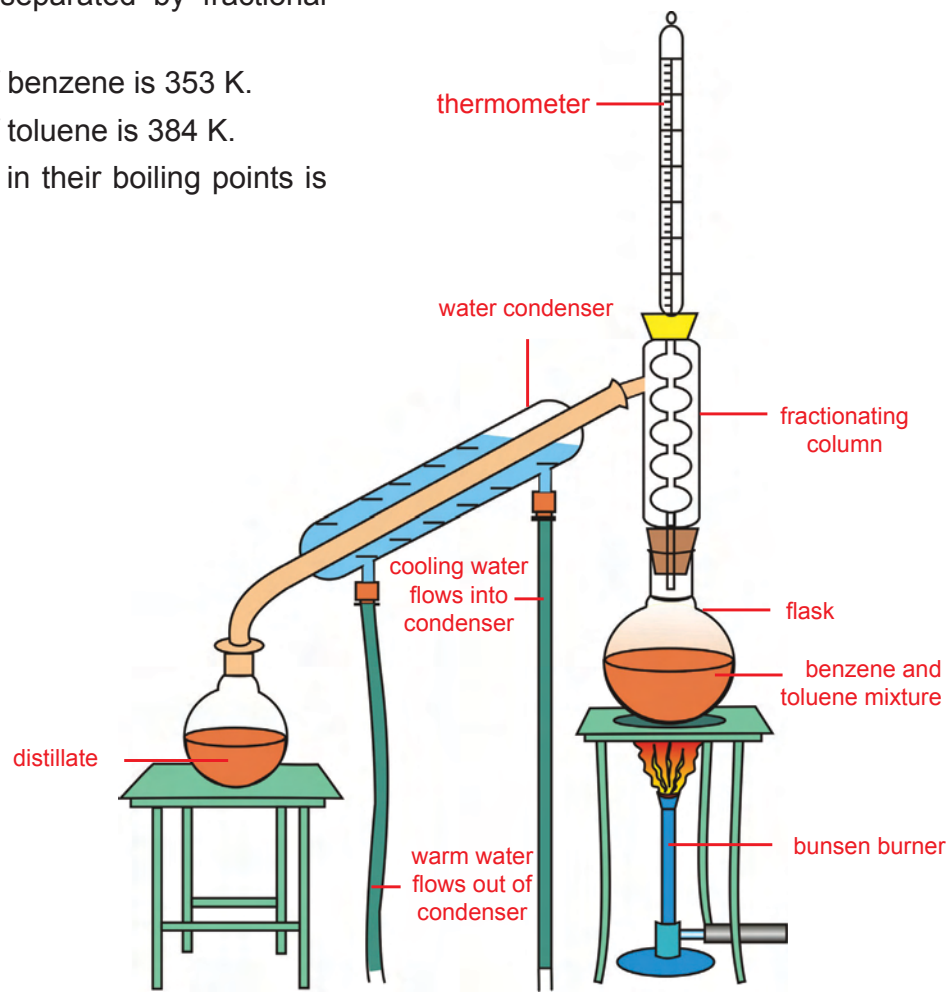
1. Distillation: Used to separate a non-volatile solid and a volatile liquid mixed together in a solution.
2. Fractional distillation: Used for separating a mixture containing two or more liquids with an appreciable difference in their boiling points.
3. Chromatography: Separation of two or more dissolved solids can be carried out by chromatography. It can be used to separate samples as small as a picogram ($10^{-12}$ g) and as large as several ions. It involves the distribution of solutes between a moving phase and a non-moving or stationary phase.

### 3.4.3. Separation of a mixture containing miscible liquids

Fractional distillation is a suitable method for separation of a mixture

containing miscible liquids. It works on the principle that the two liquids should vary in their boiling points by 25 K.

- Consider a mixture containing two liquids namely benzene and toluene.
- Both the liquids are miscible with one another.
- They can be separated by fractional distillation.
- Boiling point of benzene is 353 K.
- Boiling point of toluene is 384 K.
- The difference in their boiling points is 31 K.




MORE TO KNOW

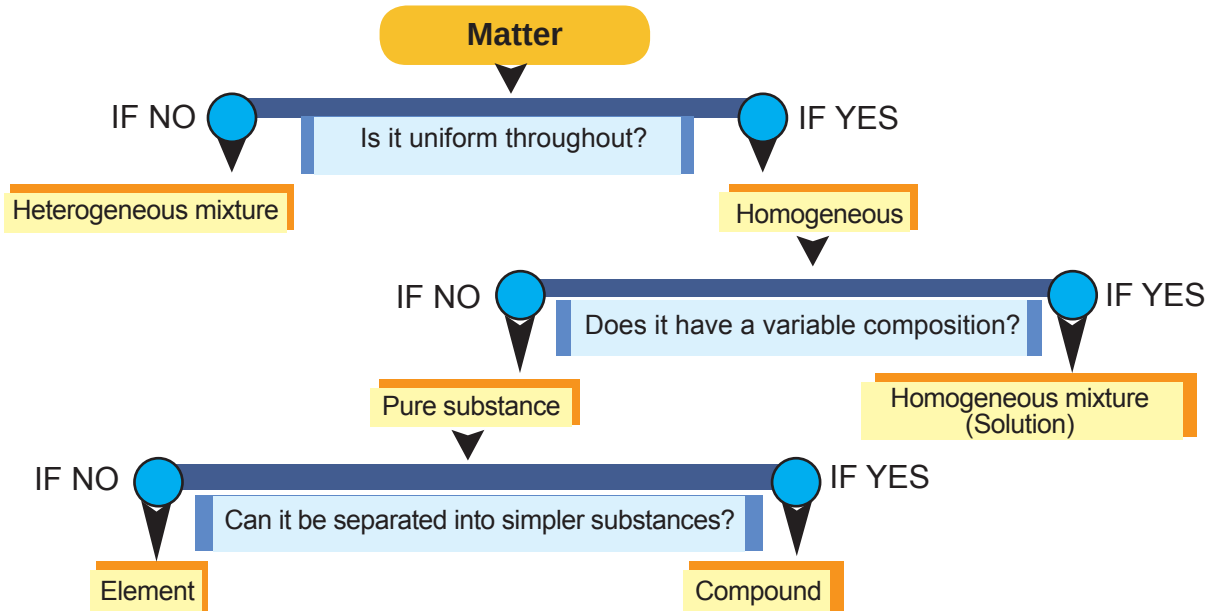
**FILTRATION PROCESSES ADOPTED IN VARIOUS FIELDS:**

1. Carbon filter: Powdered charcoal can be formed in such a way as to be full of tiny holes, which serves as a filter. As air is drawn through the holes, the charcoal traps gases and chemicals . Such carbon filters are put in the gas masks used by soldiers and firefighters.
2. Air-Conditioning filter: It circulates the air with fans and removes dust from air.
3. Automobile filter: Filters in the fuel line clean the fuel but they can block the flow of fuel, when they get clogged with dirt.
4. Water filter: Particles of matter suspended in water are removed by the use of chemicals like chlorine, potash alum and powdered carbon and filtered through beds of sand or porous separation.

**ACTIVITY 3.11** **WE OBSERVE**

- *Take a mixture of alcohol and water in a distillation flask.*
- *Close the distillation flask with a one-holed rubber cork and fit a thermometer.*
- *Fit a condenser. Then heat the mixture slowly.*
- *Alcohol vapourises first and gets condensed in the condenser and is collected.*
- *Water remains in the flask.*

Identification of element, compound and mixture.




## MODEL EVALUATION

### PART A

*Choose the correct answer:*

1. *The lead in the pencil we use is made of a material called graphite. Graphite is a mixture of _____ (carbon and clay, clay and nitrogen)*
2. *Pure water is a compound. It contains 11.19% by mass of hydrogen and oxygen by mass of _____. (88.81% , 31.81%)*
3. *Coins are mixtures of solid in solid. Smoke is a mixture of _____ (solid in gas, gas in solid)*
4. *Some pairs of items are given below. Can you identify the incorrect pair?*
   - *a) Air - gas in gas*
   - *b) Seawater - solid in liquid*
   - *c) Soft drinks - gas in liquid.*
   - *d) Amalgam - liquid in liquid*
5. *Components of a given matter can be separated by various purifying techniques. Components of liquid air can be separated by adopting _____ physical method. (fractional distillation, distillation, sublimation)*

6. Name the following:

a) Matter that has a definite volume but does not have a definite shape.

b) State of matter that does not have a definite volume for a given mass.

c) State of matter in which liquids change on heating.

d) State of matter with minimum space between molecules.

7. State whether the following statements are "True" or "False". Change the false statements by changing the underlined words.

a) Liquids expand more than gases on heating. (less than)

b) Gases cannot be compressed easily with a little pressure. (solids)

c) Solids have no definite shape.(Gases / Liquids)

d) Liquids have lower densities than Gases. (Solids)

e) Solids have very low densities.(high)

8. Name the following based on the composition:

a) A type of substance that cannot be broken into simple substances chemically.

b) The substances resulting from the chemical combination of two or more elements in fixed proportion.

c) Two or more substances are mixed together and the substances retain their individual original properties.

d) Mixture of two solids (metals).

9. Fill in the blanks:

a) The purity of a substance is often determined by measuring its _____ properties.

b) Water is a _____, _____ and _____ liquid which boils at _____ at atmospheric pressure and freezes at _____ and has a density of _____. So water is a _____ substance and is classified as a _____.

10. Match the following:

| | |
|---|---|
| i. Small units of an element | a. compound |
| ii. Clusters of 2 or 3 atoms | b. atoms |
| iii. Hydrogen | c. mixture |
| iv. Iron sulphite | d. molecules |
| v. The lead of the pencil | e. element |

11. Name the types of mixture for the following:

a) Zinc Amalgam (Zinc+Mercury) _____liquid in solid

b) Seawater _____

c) Soda drinks _____

d) Air _____

e) Carbon particles in air (smoke)_____

f) Brass (Cu+Zinc an alloy) _____

g) Alcohol + Water _____

12. Give the properties of water to illustrate that it is a compound, as the properties of water are different from that of its components ($H_2$ & $O_2$).

a) Properties of the elements present in water, state of _____

i. Hydrogen ⟶ gas – combustibility

ii. Oxygen ⟶ gas – state of oxygen and combustibility

b) Properties of water

i. State of water – (liquid)

ii. Combustibility – (neither combustible nor a supporter of combustion)

13. Iron and sulphur, when mixed form a mixture, but when heated, they form a compound. How are they identified as mixture and compound?

14. Give an example for:

a) Solid - Solid Homogeneous mixture _____

b) Liquid - Liquid Homogeneous mixture _____

c) Gaseous - Gaseous Homogeneous mixture _____

15. Write "True" or "False". Correct the wrong statements:

a) Mixtures have definite boiling points and melting points.

b) Compounds are always heterogeneous in nature.

c) In carbondioxide, carbon and hydrogen are combined in a fixed ratio.

d) Mixtures can be homogeneous or heterogeneous in nature.

e) Constituents of compounds can be separated by physical methods.

16. Choose the correct answer:

1. A mixture of two immiscible liquids can be separated by _____.

a. Filtration b. Separating funnel c. Distillation

2. A mixture of alcohol and benzene can be separated by the process of _____.

a. Distillation b. Evaporation c. Fractional distillation

3. A mixture of iodine and sand can be separated by _____.

a. filtration b. sublimation c. decantation

4. Percentage of nitrogen in the atmospheric air is _____.

a. 23.20% b. 75.50% c. negligible

5. Seawater is a mixture of _____.

a. solid in liquid b. liquid in liquid c. liquid in gas

17. Complete the following table:

| Sl. No. | Type of mixture | Example | Method of separation |
|---|---|---|---|
| 1. | mixture of two solids | | by using magnet |
| 2. | mixture of insoluble, heavy solid in water | | |
| 3. | | camphor and salt | |
| 4. | mixture of two miscible liquids | | |
| 5. | | dry leaves in water | |
| 6. | | | separating funnel |

18. Fill in the blanks:

a) Properties of compounds are different from those of its constituent _____.

b) Separation of Benzene – Toluene mixture can be done by _____.

c) Separation of two or more dissolved solids can be carried out by _____ , which involves the distribution between a _____ phase and _____ phase.

19. From the list given below, choose the suitable techniques to obtain the components in each mixture.

(distillation, fractional distillation, sublimation, chromatography, separating funnel, filtration)

a) Water from ink. _____

b) Iodine from the mixture of iodine and sand. _____

c) Water from mixture of kerosene and water. _____

d) Water from the mixture of alcohol and water. _____

e) Benzene from the mixture of Benzene and Toluene. _____

f) Sand from the suspension of sand and water. _____

g) Common salt from its solution with water. _____

## PART B

1. A pure substance contains a single type of particles. Is seawater pure or not? Justify.

2. In a compound, two or more elements are combined in a fixed ratio by mass. Mention any two properties of a compound.

3. Homogeneous mixture contains a single type of phase. Heterogeneous mixture contains different types of phases. Give one example for each type.

4. When solid camphor is exposed to air, it changes into gaseous state. It is a physical change. Name the process that takes place. Could you give another example for such a process?

5. (a) Separation of a mixture containing water and kerosene can be done by use of _____ (distillation , separating funnel)

   (b) _____ (sublimation, chromatography) process is used to separate common salt and ammonium chloride.

6. Liquid 'A' has a boiling point of 353 K and liquid 'B' has a boiling point of 384K. Both are miscible with each other. They are separated by "fractional distillation". Justify the reason for using fractional distillation method.

7. Give scientific reasons for the following statements:

**Solids:**

a) Why is air considered as mixture?

b) Why are sound, heat and magnetism not considered to be matter?

c) Why are solids rigid and not compressed appreciably even at high pressures?

d) Why do solids have high densities?

e) Why do solids expand only slightly on heating?

**Liquids:**

a) Why do liquids have no definite shape?

b) Do liquids have definite shape and volume?

c) Why do liquids expand more than solids on heating?

d) Why do liquids have lower densities than solids (Density is defined as mass per unit volume)

**Gases:**

a) Why do gases occupy the entire space of the container?

b) Why are they easily compressed even with a little pressure?

c) Why does the balloon expand as we blow air into it?

8. What is the fundamental feature which is responsible for the existence of solids, liquids and gases?

## PART C

1. In mixtures, components are combined in any ratio.

   a) How does a mixture differ from a compound?

   b) What are the various types of mixtures?

   c) Write an example for each type.

2. All matters in the universe exist in three states, namely solid, liquid and gas.

   a) Why do solid substances have a definite shape?

   b) Write any two properties of a solid substance.

   c) Will a solid substance expand on heating? Why?

3. *Heterogeneous mixture is separated by decantation. What is meant by decantation process?*

4. *How is an element different from a compound?*

5. *Write a short note on chromatography.*

6. *What are heterogeneous mixtures? Mention their types with examples.*

7. *Classify the following as solution, heterogeneous mixture, compound or element.*

   *i. Sodium ii.Glucose iii. Lemon juice iv. Coal dust in sand*

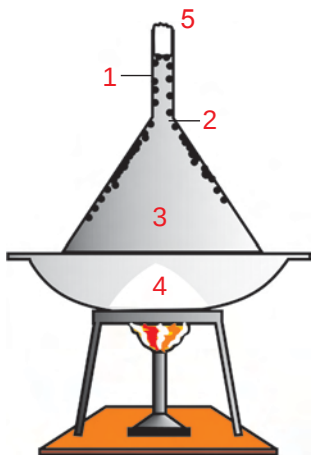
   *v. Common salt*

8. *Alchohol is mixed with water. Write briefly about the separation of the components.*

9. *How does the process of decantation differ from filtration?*

10. *How are immiscible liquids separated?*

11. *Look at the diagram given below. Name the process for which these tools are used and label the parts indicated.*




12. *Give reasons for the following:*

    *a) Water is a compound.*

    *b) Air is a mixture.*

13. *Write a note on sublimation.*

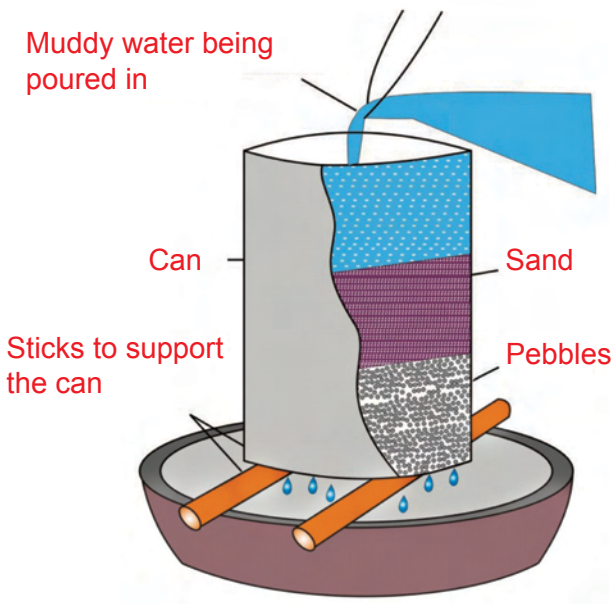
## ASSESSMENT ACTIVITY

*1.Water purification experiment*

*Know about the natural way of purifying dirty water.*

*You can make your own sand and gravel filter and use it to clean a sample of dirty water. Use a large, empty can. Punch eight holes around the bottom of the can with a big nail. Deposit about 8cm (3 inches) of pebbles in the bottom of the can, and cover the pebbles with the same amount of sand.*

*Collect some muddy water from a puddle or pond. Hold the can over the bowl and pour the muddy water into the can. Look at the water that comes through the can. It is much clearer than the water you had poured in.*




SCIENCE

## 2. Discussion

*Aim : To enable the students to know the components of the mixtures used in our daily life. Name the components of the mixtures listed below.*

| Mixtures | Components |
|---|---|
| 1. Air | |
| 2.Crude oil | |
| 3.Milk | |
| 4.Aerated drinks | |
| 5.Stainless steel | |

## 3. Classification

*Aim : To enable the students to classify the mixtures as homogeneous or heterogeneous.*

| Method of preparation of mixture | Type of mixture obtained |
|---|---|
| Sugar is added to water | |
| Both sugar and salt are added to water | |
| Smoke in air | |
| Mixture containing rice and wheat | |

## 4.Comparative Learning

*Aim : To enable the students to understand the method of purification involved in separating components of a mixture.*

| Type of mixture | Method of purification |
|---|---|
| Salt solution | |
| Mixture containing petrol and kerosene | |
| Mixture containing kerosene and water | |
| Common salt and powdered camphor | |
| Water containing fine sand | |

*5.Copy the following table and write an example of a mixture in each empty box. For example, coffee is a mixture of solid and liquid.*

| | Solid | Liquid | Gas |
|---|---|---|---|
| Solid | | Coffee | |
| Liquid | | | |
| Gas | | | |

6. Identify the physical states of the following:

| Matter | Physical state |
|---|---|
| Ice | |
| Air | |
| Water | |
| Rice | |
| Oxygen | |

7. A ship gets damaged and stranded in a remote Pacific island. The passengers manage to transport firewood, matchboxes and pots ashore. Descirbe how the marooned passengers will be able to obtain drinking water from the salty ocean water, with the help of diagrams.

8. A mixture of chalk powder and salt can be separated by combining more than one method. Salt is soluble in water, whereas chalk powder is not. The steps of the separation process are given below. Arrange them in correct order.

   i) Filtration removes the insoluble chalk powder.

   ii) Stir well. The salt dissolves in water.

   iii) Evaporation of the salt solution removes water.

   iv) Add some salt and chalk powder mixture to water.

   v) The chalk powder is then dried in sunlight.



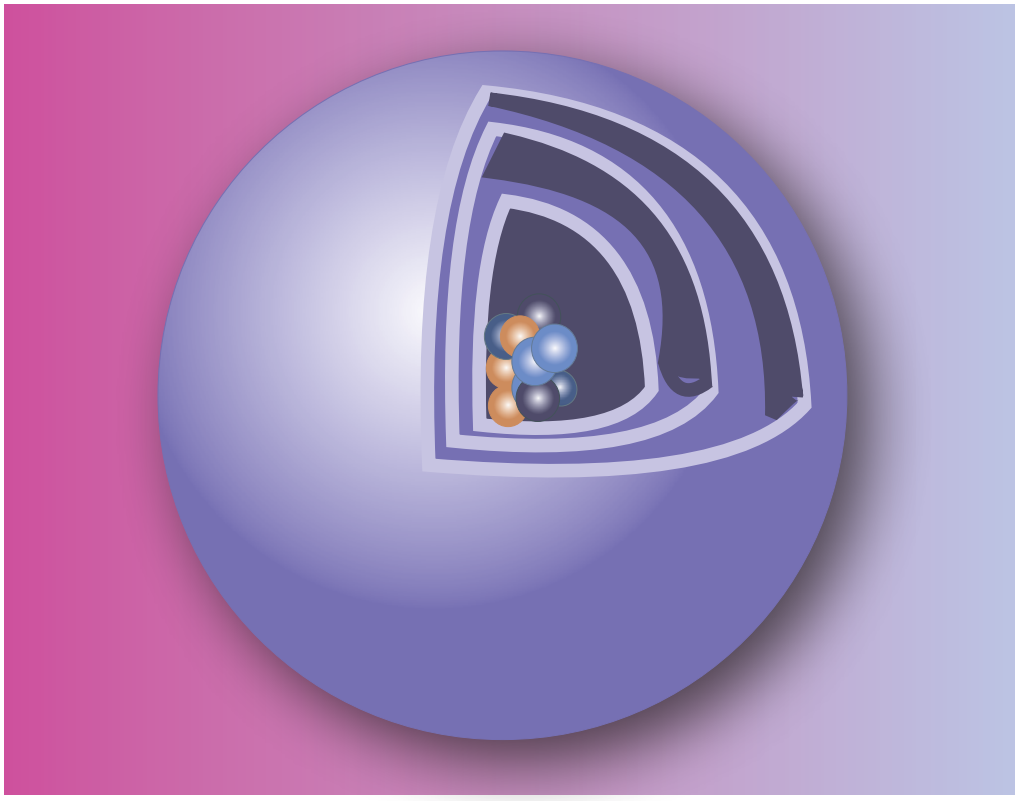
**FURTHER REFERENCE**

Book: General Chemistry (Second Edition) - Jean B.Umland & Jon M.Bellama
West publishing company

Webliography: http://www.tutorvista.com

http://www.khanacademy.org

Chapter 4



# ATOMIC STRUCTURE

- Discovery of the nucleus
- Rutherford's experiment
- Rutherford's model of atom
- Bohr's model of atom
- Discovery of neutrons
- Characteristics of fundamental particles
- Atomic number and mass number
- Isotopes
- Electronic configuration of atoms

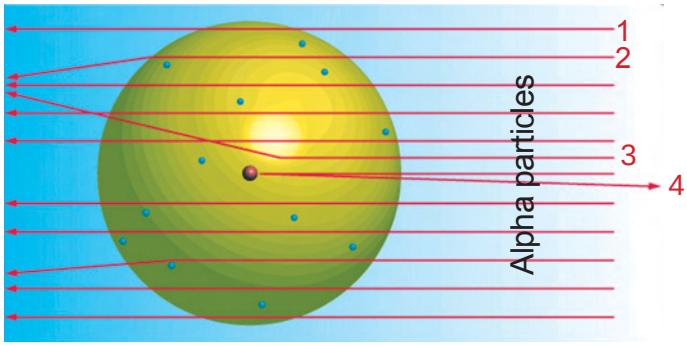
## ATOMIC STRUCTURE

### Need to study the structure of the atom

John Dalton proposed the idea of the atom as the smallest possible particle of any substance. He never worked with small particles of solids but actually he worked with gases. He analysed how they mixed with each other, how they formed compounds and how they dissolved in water etc. While working with all these, he discovered that whenever elements combine to form more than one compound, the ratio of the masses of elements in the compounds are small whole number ratios of each other. It led him to the idea that the smallest particle of one substance combined with the smallest part of another substance in fixed quantities.

The development of modern atomic theory is an excellent example of how science progresses. Many scientists contribute their knowledge for the development. New experiments lead to changes in the old theories and even new theories.Theories are useful in providing the basis for further research. Although J.J.Thomson's atomic theory explained the electrical neutrality of atoms, it could not reveal the presence of nucleus in an atom, which was later proposed by Ernest Rutherford in 1909.

Schematic diagram showing alpha particles bombarding one gold atom. The nucleus of the gold atom is found in the centre.




1. Not scattered at all 2. Slightly scattered
3. More scattered 4. Returned at 180°

## 4.1. DISCOVERY OF THE NUCLEUS

### Rutherford's contribution

Rutherford observed what happens to the alpha particles projected at a thin metal foil.

**Ernest Rutherford (1871-1937)**

Ernest Rutherford, a British physicist probed atoms with alpha particles. He was known as the "father of nuclear physics". He was awarded the Nobel prize for his contribution to the structure of atom in 1908.

## 4.2. RUTHERFORD'S EXPERIMENT

A stream of alpha particles was made to pass through a thin gold foil of about $4x10^{-5}$ cm thickness. Most of the alpha particles did go through the foil in a straight line. Some alpha particles were deflected through an average angle of 90° .Rarely the path of 1 in 20,000 alpha particles scored a direct hit on the nucleus and returned in an angle of 180°.

**MORE TO KNOW**

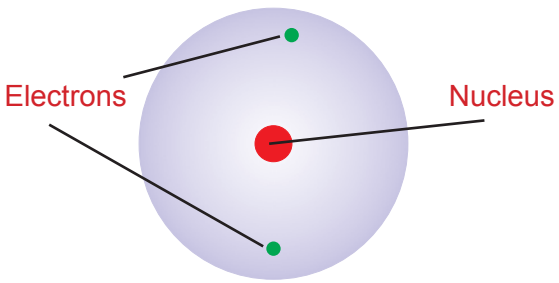
Alpha particles are helium ions $He^{2+}$ ( 2 protons, 2 neutrons and no electrons). The mass of an alpha particle is about 8000 times the mass of an electron. Velocity of alpha particles is about $2x10^7$ m/s.

SCIENCE

From this experiment, he concluded that there is a heavy positive charge occupying small volume, at the centre of an atom.

## 4.3. RUTHERFORD'S MODEL OF ATOM

- Atom has a very small nucleus at the centre.
- There is a large empty space around the nucleus.
- Entire mass of an atom is due to the mass of nucleus.
- Electrons are distributed in the vacant space around the nucleus.
- The electrons are moving in circular paths around the nucleus.

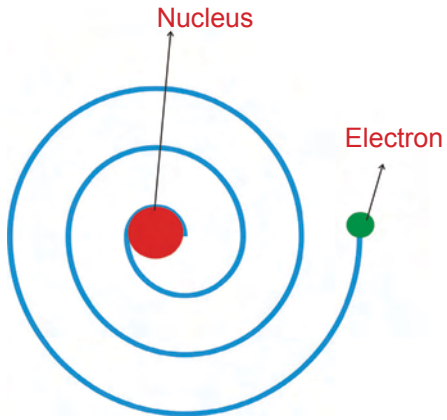



**MORE TO KNOW**

James Chadwick was one of Rutherford's students.

### 4.3.1. Limitations

According to the electromagnetic theory, a moving electron should accelerate and lose energy continuously. Due to the loss of energy, the path of electron may reduce and finally the electron might fall into nucleus. If it so happens, the atom becomes unstable, but atoms are stable. Hence, Rutherford's theory does not explain the stability of atom.




**MORE TO KNOW**

Imagine a small boy swinging a stone tied to the end of a string around him. The stone is able to occupy a larger volume because it is moving rapidly. Similarly, the electrons in an atom are able to occupy a larger volume because they are moving very fast.

**ACTIVITY 4.1** **WE DO**

We divide into groups and have a discussion about the following:

In Rutherford's experiment,

1. Why did the majority of alpha particles pass through the foil unaffected?
2. Why were a very few alpha particles deflected?
3. Is the size of the nucleus, small or big with respect to the size of the atom?

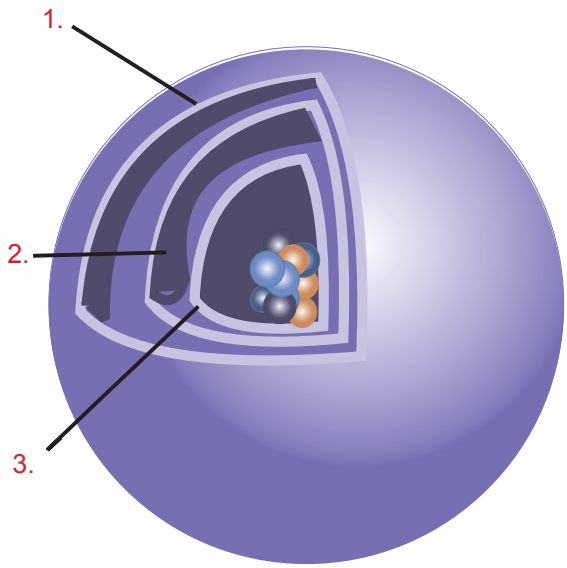
**Niels Bohr (1885 - 1962)**

Niels Bohr was born on October 7, 1885 in Copenhagen, Denmark. He was also an outstanding soccer player. He worked with Rutherford at the University of Manchester. Bohr's theory became the basis for modern physics known as Quantum Mechanics. Bohr received the Nobel Prize for physics in 1922.

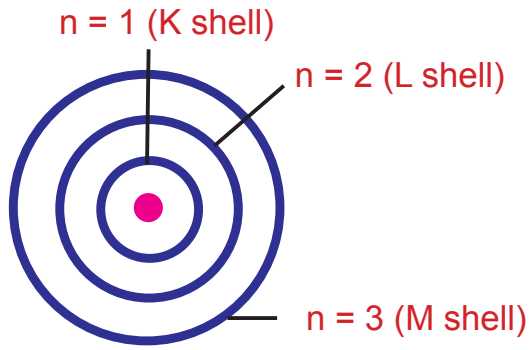
## 4.4. BOHR'S MODEL OF ATOM

Niels Bohr modified Rutherford's atom model and put forth the following postulates.

- In atoms, electrons revolve around the nucleus in stationary circular paths. These paths are called orbits or shells or energy levels.
- As long as electrons revolve in the same orbit, it does not lose or gain energy.
- The circular orbits are numbered as 1, 2, 3, 4 or designated as K, L, M, N shells. These numbers are referred to as principal quantum numbers (n).
- As we move away from the nucleus, the energy of the orbit constantly increases.
- Maximum number of electrons that can be accommodated in an energy level (n) is given by 2n2 .
- When an electron absorbs energy, it jumps from lower energy level to higher energy level.
- When an electron returns from higher energy level to lower energy level, it gives off energy.



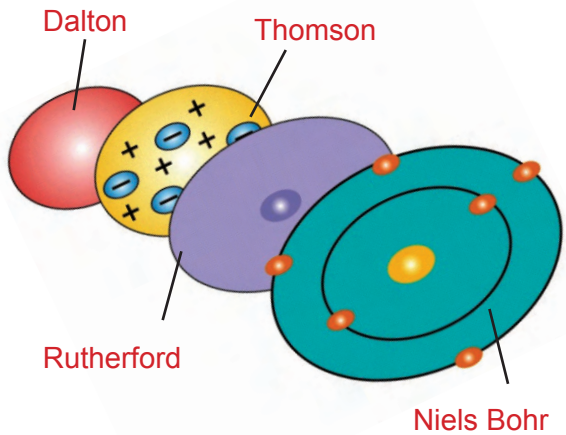

1. Third energy - level (M-shell)
2. Second energy - level (L-shell)
3. First energy - level (K-shell)




### Orbit

Orbit is defined as the path, by which electrons revolve around the nucleus.

## DALTON, THOMSON, RUTHERFORD AND NIELS BOHR - ATOM MODELS

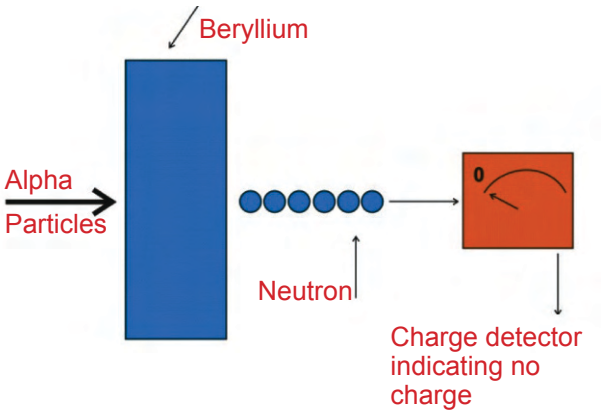



## 4.5. DISCOVERY OF NEUTRONS

In 1932, James Chadwick observed that when beryllium was exposed to alpha particles, particles with about the same mass as protons were emitted. These emitted particles carried no electrical charge. Hence, they were called as neutrons.

**Beryllium + alpha ray ⟶ carbon + neutron**

SCIENCE




**MORE TO KNOW**

Number of neutrons = Mass number - Atomic number (Number of protons or number of electrons)

Neutrons are particles with no charge i.e. neutral particles. Neutrons are present in the nuclei of all atoms except the hydrogen atom. The mass of a neutron is almost equal to the mass of a proton.

Atoms of the same element with different number of neutrons are called isotopes. Neutron is also regarded as a sub-atomic particle.

## 4.6. CHARACTERISTICS OF FUNDAMENTAL PARTICLES

The physical and chemical properties of elements and their compounds can be explained by the fundamental particles of an atom. The fundamental particles of an atom are:

Protons: They are positively charged particles. They are present inside the nucleus.

Electrons: They are negatively charged particles. They revolve around the nucleus in circular orbits.

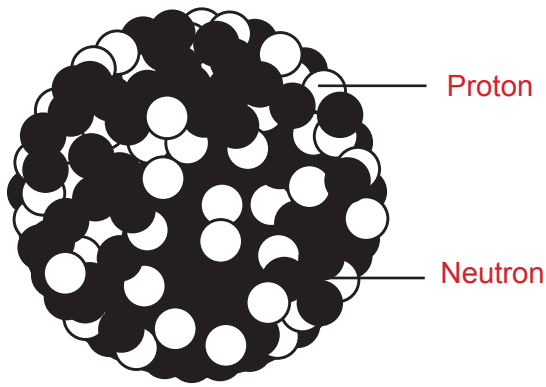
Neutrons: They are neutral particles. They are present inside the nucleus.

### 4.6.1. COMPOSITION OF NUCLEUS

Electrons have a negligible mass. Hence the mass of an atom mainly depends on the mass of the nucleus. Nucleus of an atom consists of two components. They are protons and neutrons.

Protons are positively charged. Protons repel each other because of their like-charges. Hence, more than one proton cannot be packed in a small volume to form a stable nucleus, unless neutrons are present.

Neutrons reduce the repulsive force between the positively charged protons and contribute to the force that holds the particles in the nucleus together.




Nucleus

**THE SUBATOMIC PARTICLES**

Besides Electrons, Protons and Neutrons, there are many sub-atomic particles such as:

- Mesons
- Positrons
- Neutrinos
- Quarks
- Pions
- Gluons

## Characteristics of sub-atomic particles

| | Electron | Proton | Neutron |
|---|---|---|---|
| Discovered by | J.J. Thomson and H.A.Lorentz | E. Goldstein | James Chadwick |
| Mass | $9.1 \times 10^{-28}$ g | $1.672 \times 10^{-24}$ g | $1.674 \times 10^{-24}$ g |
| Charge in Units | -1 | +1 | 0 |

### Nucleons

The elementary particles such as protons and neutrons are collectively referred to as nucleons.

## 4.7. ATOMIC NUMBER AND MASS NUMBER

### Atomic number (Z)

The Atomic number of an atom can be defined as the number of protons present in the nucleus of the atom or the number of electrons present outside the nucleus of the atom. Thus the atomic number of hydrogen would be one and that of helium would be two. The symbol of Atomic Number is Z. No two elements have the same atomic number; hence it is unique to each element. The atomic numbers of some elements are given in the table below:-

| Element | H | He | Li | Be | B | C | N | O | F | Ne | Na |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atomic number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

### Mass number (A)

The mass number (A) is defined as the sum of the number of protons and neutrons present in the nucleus of an atom of an element. For example, the mass number of Sodium is 23, which implies that the total number of protons and neutrons in the sodium atom is 23. The number of neutrons can be obtained by subtracting the atomic number from the mass number (12 for sodium). The mass numbers of some elements are given in the table below:-

| Element | H | He | Li | Be | B | C | N | O | F | Ne | Na | Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atomic number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Mass number | 1 | 4 | 7 | 9 | 11 | 12 | 14 | 16 | 19 | 20 | 23 | 24 |

**ACTIVITY 4.2** **WE DO**

A has 11 protons, 11 electrons and 12 neutrons.
B has 15 protons, 15 electrons and 16 neutrons.
C has 4 protons, 4 electrons and 5 neutrons.
Let's identify the elements A, B and C.

**MORE TO KNOW**

In lighter atoms, one neutron per proton is enough. Heavier atoms with more protons in the nucleus need more neutrons in the nucleus, for the nucleus to be stable. Thus the stability of the nucleus is determined by the Neutron-Proton (n/p) ratio.

**ACTIVITY 4.3** I DO

Let me complete the following table:

| Elements | Atomic number | number of protons | number of electrons |
|---|---|---|---|
| Boron | 5 | | |
| Sodium | 11 | | |
| Phosphorus | 15 | | |
| Neon | 10 | | |

### Representation of Atomic number and Mass number

$$^{\text{Mass number(A)}}_{\text{Atomic number (Z)}}X$$

For example,

Atomic number of nitrogen is 7.

Mass number of nitrogen is 14.

Representation: $^{14}_{7}N$

**ACTIVITY 4.4** I DO

I shall find out which of the following elements have the same number of neutrons.

1. Lithium - $^{7}_{3}Li$
2. Carbon - $^{12}_{6}C$
3. Nitrogen - $^{14}_{7}N$
4. Beryllium - $^{9}_{4}Be$
5. Oxygen - $^{16}_{8}O$

**MORE TO KNOW**

Chlorine has fractional atomic mass.

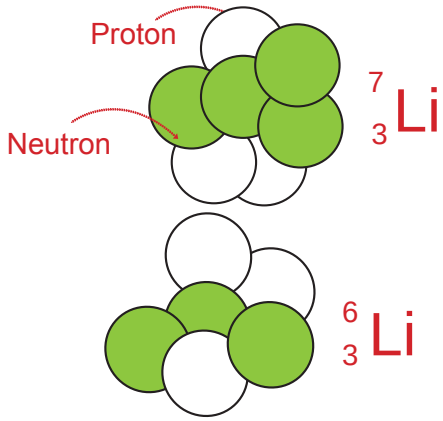
Chlorine-35 exists by 75%

Chlorine-37 exists by 25%

Average atomic mass of chlorine is,

$$\left\{\frac{75}{100}\times 35\right\}+\left\{\frac{25}{100}\times 37\right\}=35.5$$

## 4.8. ISOTOPES




Isotopes of Lithium

American scientist, T.W.Richards observed to his amazement that Lead samples collected from different places differed in atomic mass. This suggested that all atoms of an element are not exactly alike. It is clear that the atoms of an element have the same chemical properties, but they may differ in their masses.

**Isotopes are atoms of an element that differ in mass numbers, but have the same atomic number.**

### Characteristics of isotopes

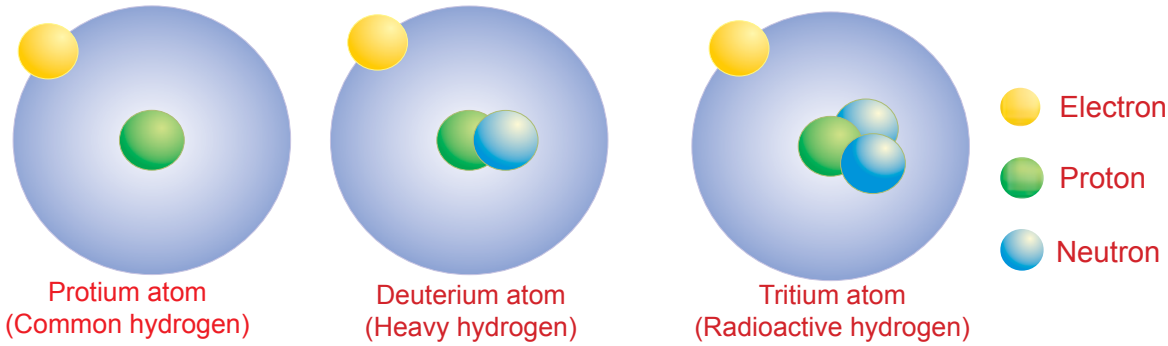
- Isotopes of an element differ in mass numbers only.
- Difference in mass number is due to the difference in number of neutrons.
- Isotopes of an element have the same chemical properties.
- However, variation in physical properties are noted in isotopes.
- Elements having isotopes exhibit fractional atomic mass.

**ACTIVITY 4.5** I DO

(i) I shall calculate the number of neutrons in the isotopes.

(a) $^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$ (b) $^{35}_{17}Cl$, $^{37}_{17}Cl$

(ii) My inference is _____




Protium atom (Common hydrogen) | Deuterium atom (Heavy hydrogen) | Tritium atom (Radioactive hydrogen)

***Isotopes of Hydrogen***

| Element | Isotope | Representation |
|---|---|---|
| Hydrogen | Protium | $^{1}_{1}H$ |
| | Deuterium | $^{2}_{1}H$ (or) $^{2}_{1}D$ |
| | Tritium | $^{3}_{1}H$ (or) $^{3}_{1}T$ |
| Chlorine | Chlorine-35 | $^{35}_{17}Cl$ |
| | Chlorine-37 | $^{37}_{17}Cl$ |
| Carbon | Carbon-12 | $^{12}_{6}C$ |
| | Carbon-14 | $^{14}_{6}C$ |
| Uranium | Uranium-235 | $^{235}_{92}U$ |
| | Uranium-238 | $^{238}_{92}U$ |

**ACTIVITY 4.6** **I DO**

The element bromine has the following isotopes: 49.7% of Bromine-79 and 50.3% of Bromine-81
Based on this, I shall calculate the average atomic mass of Bromine.

**ACTIVITY 4.7** **I DO**

- From the given average atomic mass, I can find out which element does exist with least number of isotopes.
- Chlorine-35.5
- Hydrogen-1.008
- Oxygen-16.0

### Uses of Isotopes

- Many isotopes find use in medical field.
- Iron-59 isotope is used in the treatment of anaemia.
- Iodine-131 isotope is used in the treatment of goitre.
- Cobalt-60 isotope is used in the treatment of cancer.
- Phosphorous-32 isotope is used in eye treatment.
- Carbon-11 isotope is used in brain scan.

## 4.9. ELECTRONIC CONFIGURATION OF ATOMS

It is known that atoms consist of a positively charged nucleus with protons and neutrons in it. Negatively charged electrons constantly revolve around the nucleus in a set of orbits. The electron orbits are numbered as 1, 2, 3, etc. Starting from the orbit closest to the nucleus. These orbits are also called **K, L, M, N** shells, as mentioned in the atom model proposed by Niels Bohr.

The maximum number of electrons in an orbit is given by $\mathbf{2n^2}$, where **n** is the orbit number.

| Shell number or energy level | Maximum number of electrons ($2n^2$) |
|---|---|
| First shell (K) | $2(1^2) = 2$ |
| Second shell (L) | $2(2^2) = 8$ |
| Third shell (M) | $2(3^2) = 18$ |
| Fourth shell (N) | $2(4^2) = 32$ |

SCIENCE

It must be understood that the second orbit begins to fill with electrons only after the first orbit is filled. The third orbit begins to fill only after the second orbit is filled. But the fourth orbit commences even before the third orbit is completely filled. The reason for this lies in the concept of quantum numbers.

Thus the term electronic configuration or electronic structure refers to the way, the electrons are arranged around the nucleus. Most of the properties of elements and their compounds depend on their electronic configurations.

To write electronic configuration, the principal quantum number of the shells must be known. This number describes the number of orbits present in the atom.

Let us consider sodium atom.

Atomic number of **sodium** = Total number of electrons in sodium = **11**

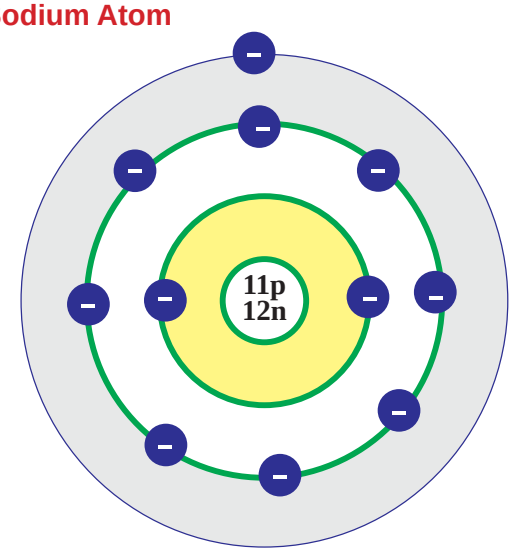
**Orbit wise distribution of electrons**

**Orbit** **Number of electrons**

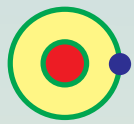
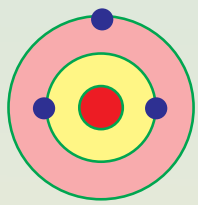
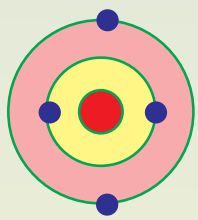
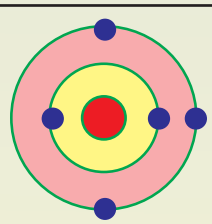
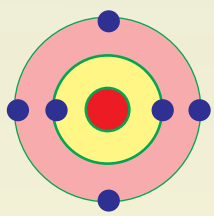
1. **(K-Shell)** $2n^2 = 2x1^2 = 2$ *electrons*
2. **(L-Shell)** $2n^2 = 2x2^2 = 8$ *electrons*
3. **(M-Shell)** *Remaining=1 electron*

The electronic distribution in sodium is **2, 8, 1.**

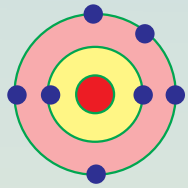
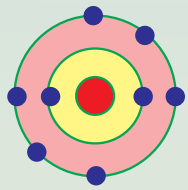
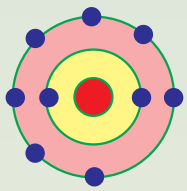
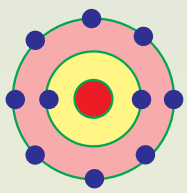
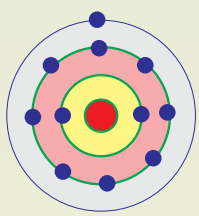
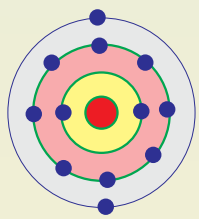
**Sodium Atom**

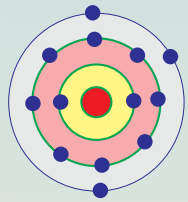
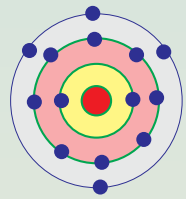
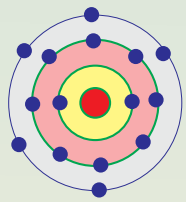
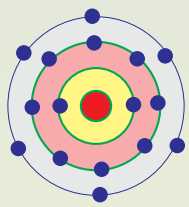
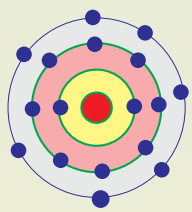
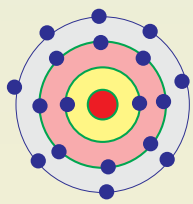



Some elements and their electronic configurations:

| Element | Atomic Number | Electron dot structure | Electron distribution |
|---|---|---|---|
| Hydrogen (H) | 1 |  | 1 |
| Helium (He) | 2 |  | 2 |
| Lithium (Li) | 3 |  | 2,1 |
| Beryllium (Be) | 4 |  | 2,2 |
| Boron (B) | 5 |  | 2,3 |
| Carbon (C) | 6 |  | 2,4 |

Some elements and their electronic configurations:

| Element | Atomic Number | Electron dot structure | Electron distribution |
|---|---|---|---|
| Nitrogen (N) | 7 |  | 2,5 |
| Oxygen (O) | 8 |  | 2,6 |
| Fluorine (F) | 9 |  | 2,7 |
| Neon (Ne) | 10 |  | 2,8 |
| Sodium (Na) | 11 |  | 2,8,1 |
| Magnesium (Mg) | 12 |  | 2,8,2 |

| Element | Atomic Number | Electron dot structure | Electron distribution |
|---|---|---|---|
| Aluminium (Al) | 13 |  | 2,8,3 |
| Silicon (Si) | 14 |  | 2,8,4 |
| Phosphorus (P) | 15 |  | 2,8,5 |
| Sulphur (S) | 16 |  | 2,8,6 |
| Chlorine (Cl) | 17 |  | 2,8,7 |
| Argon (Ar) | 18 |  | 2,8,8 |

SCIENCE

**ACTIVITY 4.8** I DO

I shall write the electron distribution

| Element | Atomic number | Electron distribution | | |
|---|---|---|---|---|
| | | K | L | M |
| Lithium | 3 | | | |
| Boron | 5 | | | |
| Fluorine | 9 | | | |
| Magnesium | 12 | | | |
| Phosphorous | 15 | | | |

### 4.9.1. Valence Electrons and valency

**The number of electrons in the outer energy level (orbit) of an atom are the ones that can take part in chemical bonding. These electrons are referred to as the valence electrons.**

The outermost shell or orbit of an atom is known as valence shell or valence orbit. The electrons present in the outer shell are called valence electrons.

The number representing the valence electrons is used to calculate the valency of the element. This valency is regarded as the combining capacity of elements.

Illustration

Lithium (Atomic number:3) has the electronic distribution,

(n=1) K Shell (2 electrons)

(n=2) L Shell (1electron)

Outermost shell is 'L'.

The valence electron = 1

The valency of Lithium = 1

When the number of electrons in the outermost shell is close to its full capacity, (such as 8 for L shell) valency is then determined by subtracting the valence electron number from the full capacity of 8.

Valency = 8-valence electrons

For example, fluorine (atomic number: 9) has the electron distribution,

| n | Shell | Electrons |
|---|---|---|
| 1 | K | 2 |
| 2 | L | 7 |

Outer shell (L) has 7 electrons which is close to the full capacity of 8.

Hence valency = (8 -7) = 1

**ACTIVITY 4.9** I DO

I can calculate the valence electrons and determine the valency.

| Element | Atomic number | Valence electrons | Valency |
|---|---|---|---|
| Hydrogen | 1 | | |
| Boron | 5 | | |
| Carbon | 6 | | |
| Magnesium | 12 | | |
| Aluminium | 13 | | |

## MODEL EVALUATION

### PART A

*Choose the correct answer:*

1. *Total number of electrons, that can be accommodated in an orbit is given by $2n^2$ (n = 1, 2, 3....). Maximum number of electrons, that present in the first orbit is _____. (8, 2, 18)*
2. *Goldstein discovered protons. It is present in the nucleus. The charge on the protons is _____ (negative, positive, neutral).*
3. *A subatomic particle is revolving around the nucleus in orbits. It is negatively charged. It was discovered by J.J.Thomson. The particle is _____. (proton, neutron, electron)*
4. *Number of neutrons present in $^{7}_{3}Li$ is 4. The number of neutrons present in $^{16}_{8}O$ element is _____. (8, 7, 6)*
5. *The Nucleus of an atom has two components. They are protons and _____ (positrons, neutrons, electrons)*
6. *The sum of the number of protons and neutrons present in the nucleus is called mass number. Find the number of protons in the following element. (11, 23, 12)*

| Element | Mass number | Number of protons | Number of neutrons |
|---|---|---|---|
| Sodium (Na) | 23 | ? | 12 |

7. *Atomic number and mass number of $^{35}_{17}Cl$ are 17 and 35 respectively. The number of protons present in it is _____ (17, 35, 18)*
8. *_____ isotope is used in the treatment of goitre. (Iodine – 131, Phosphorus – 32, Iron – 59)*
9. *The electron distribution of fluorine is 2, 7. The valency of fluorine is _____ (7, 2, 1)*
10. *Electron distribution of sodium is 2, 8, 1. The valency of sodium is _____ (2, 8, 1)*
11. *Every atom has an equal number of protons and electrons. Both are oppositely charged. Neutron is electrically neutral. The nature of atom is _____ (positive, negative, neutral)*
12. *Write True or False. Correct the false statements.*
    - *a) Most of the properties of elements and their components depend on their mass number.*
    - *b) The Valency of $^{35}_{17}Cl$ is 7.*
    - *c) Total number of electrons found in L shell will be 8.*

d) Isotopes of an element have same chemical properties.

e) Electrons reduce the repulsive force between positively charged protons.

f) The stability of the nucleus is determined by the Neutron – Proton ratio.

g) When an electron returns from higher energy level to lower energy level, it absorbs energy.

h) Smaller the size of the orbit, smaller is the energy of the orbit.

i) Neils Bohr's atomic model does not explain the stability of atom.

j) Bohr's theory became the basis of modern physics known as Quantum Mechanics.

## PART B

1. Electrons in an atom revolve around the nucleus in circular stationary paths.

   a) Who proposed such a statement?

   b) What is the name of the circular path?

2. K shell of $^{14}_{7}N$ has 2 electrons. How many electrons are present in the L shell?

3. $^{35}_{17}X$ is a gaseous element. Its atomic number is 17. Its mass number is 35. Find out the number of electrons, protons and neutrons.

4. Many isotopes are used in the medical field.

   a) Which isotope is used for the treatment of anaemia?

   b) Which one is used in eye treatment?

5. Write the electron distribution in the following elements.

| Element | Atomic number | Electron distribution | | |
|---|---|---|---|---|
| | | K | L | M |
| Boron | 5 | 2 | - | - |
| Magnesium | 12 | - | 8 | - |

6. Find the valence electrons and their valency.

| Element | Atomic number | Valence electron | valency |
|---|---|---|---|
| Carbon | 6(2,4) | | |
| Aluminium | 13(2,8,3) | | |

7. In the elements given below, identify: (a) Mass Number (b) Atomic Number (c) Number of Protons (d) Number of Electrons (e) Number of Neutrons

   $^{4}_{2}He$, $^{7}_{3}Li$, $^{11}_{5}B$, $^{12}_{6}C$, $^{27}_{13}Al$

8. Copy and complete the table by furnishing the missing information about the Uranium isotope.

| Isotope | Symbol | Number of Protons | Number of Neutrons | Number of Electrons |
|---|---|---|---|---|
| Uranium- 235 | $^{235}_{92}U$ | 92 | 143 | 92 |
| Uranium- 238 | | 92 | | |

9. Supply the missing details and complete the table:

| Characteristics | Protons | Electrons | Neutrons |
|---|---|---|---|
| Mass | | | |
| Charge | | | |
| Position in the atom | | | |
| Discovered by | | | |

10. Complete the Table:

| Sl.No. | Shell number | Maximum no. of electrons |
|---|---|---|
| 1. | First shell (K) | |
| 2. | Second shell (L) | |
| 3. | Third shell (M) | |
| 4 | Fourth shell (N) | |

11. Draw the diagrams of isotopes of Hydrogen with Electrons, Neutrons and Protons.

12. Calculate the number of neutrons in each of the Isotopes:

a) $^{7}_{3}Li$ b) $^{37}_{17}Cl$ c) $^{238}_{92}U$ d) $^{14}_{6}C$ e) $^{81}_{35}Br$

13 Draw the electronic configuration of the following:

a) $^{27}_{13}Ai$ b) $^{16}_{8}O$ c) $^{35}_{17}Cl$

14. Composition of the nuclei of two atomic species X and Y are given below. Give the atomic number and mass number of X and Y. What is the relation between the two species and which element or elements they represent?

| | X | Y |
|---|---|---|
| Protons | 6 | 6 |
| Neutrons | 6 | 8 |
| Atomic Number | ___ | ___ |
| Mass Number | ___ | ___ |

SCIENCE

15. From the symbol $^{23}_{11}Na$ state the :

a) mass number of sodium _____

b) Atomic number of sodium _____

c) Electronic configuration _____

d) Number of Protons _____

e) Number of Neutrons _____

## PART C

1. Name the elements with completely filled orbits.

| *Element* | *Atomic Number* | *Electron distribution* |
|---|---|---|
| *Nitrogen* | *7* | |
| *Neon* | *10* | |
| *Magnesium* | *12* | |
| *Sulphur* | *16* | |
| *Argon* | *18* | |

2. Correlate the facts with properties:

| | | |
|---|---|---|
| *(i)* | *The denser part of an atom* | *Valency* |
| *(ii)* | *Chargeless particle* | *Atomic number* |
| *(iii)* | *Outermost orbit* | *Nucleus* |
| *(iv)* | *Number of electrons in the outermost orbit* | *Valence shell* |
| *(v)* | *Number of protons* | *Neutron* |
| | | *Proton* |

3. How many electrons can be accommodated in K, L and M shells?

4. What are the fundamental particles of an atom? Name all the subatomic particles.

5. What are isotopes? Draw the isotopes of Hydrogen.

6. *What are alpha particles? How are they useful in the determination of nucleus of an atom?*

7. *Write briefly about the atomic model concept proposed by Rutherford.*

8. *List the limitations of Rutherford's atom model.*

9. *State the postulates of Bohr's atom model?*

*10. Give experimental evidence for the discovery of neutron.*

*11. Give orbit wise electronic configuration of:*

*i. Carbon (Atomic Number - 6)*

*ii. Fluorine (Atomic Number - 9)*

*iii. Magnesium (Atomic Number - 12)*

*iv. Phosphorus (Atomic Number - 15)*

*v. Argon (Atomic Number - 18)*

12. Name the scientist:

a) _____proposed the idea of atom as the smallest possible particle of any substance.

b) _____performed the gold foil experiment with alpha particles to conclude the *positive charge at the centre of an atom.*

*c) _____discovered the protons.*

*d) _____discovered the neutrons of an atom.*

*e) _____modified the atomic model with electrons revolving around the nucleus in stationary paths.*

*13. Name the following:*

*a) Total number of protons present in the nucleus.*

*b) The sum of the number of protons and neutrons present in the nucleus of an atom of an element.*

*c) The atoms of an element that differ in mass numbers have the same atomic number.*

*d) The shell which accommodates 18 electrons.*

*e) The electrons in the outermost energy level.*

*14. Complete the table:.*

| No. | Mass Number(A) | Atomic Number(Z) | Proton | Electron | Neutron | Electronic configuration |
|---|---|---|---|---|---|---|
| 1. | 7 | 3 | - | - | - | - |
| 2. | 14 | - | - | 7 | 7 | - |
| 3. | - | 8 | - | - | 8 | - |
| 4. | - | - | 11 | - | 12 | - |
| 5. | 19 | 9 | - | 9 | - | - |

15. Name the Isotope used in:

a) The treatment of Anaemia_____.

b) The treatment of Cancer _____.

c) The treatment of Eyes_____.

d) The Brain scan_____.

e) The treatment of Goitre _____.

16. Draw the electronic configuration of $^{7}_{3}Li$, $^{12}_{6}C$, $^{16}_{8}O$, $^{14}_{7}N$.

17. Which of the following is / are not true about Rutherford's experiment?

a) A very thin gold foil was bombarded by a stream of alpha particles.

b) Most of the particles passed straight through the foil.

c) Most of the space in the gold atoms is either vacant or occupied by some very light particles.

d) A few particles were deflected through an average angle of $90^0$.

e) Very few of them were returned by an angle of $180^0$ after hitting on the nucleus directly.

18. With reference to Rutherford's Atomic Model, complete the following statements:

a) Protons and neutrons of an atom are concentrated in its _____.

b) Atom has a very _____ nucleus at the _____.

c) Entire mass of an atom is due to the mass of _____.

d) The Nucleus is surrounded by _____ which are equal to the number of _____and revolve around it.

e) The nucleus is positively charged as it _____ the _____ charged particles.

## ASSESSMENT ACTIVITY

1. Assignment

Aim : To enable the students to understand the role of neutrons in the nucleus.

a. In lighter atoms, protons and neutrons are equal in number.

b. In heavier atoms, they are not equal in number. List out the reasons.

2. Project :

Aim : To construct the model of an atom.

Construct the model of an atom using available materials. Your model should have the correct number of shells, and the correct number of electrons in each shell. Use different colour codes to represent electrons, protons and neutrons. (Choose any atom of your choice)

### 3. Discussion

Aim : To enable the students to find out the major similarities and differences between Rutherford and Niels Bohr atom models

| Similarities | Differences |
|---|---|
| | |

### 4. Album

Aim: To enable the students to draw the atomic models.

Draw the atomic models of Dalton, Thomson, Rutherford and Niels Bohr.

### 5. What do you assume the shape of an atom to be? Tick your choice.

Square

Rectangular

Circular

Spherical

Elliptical



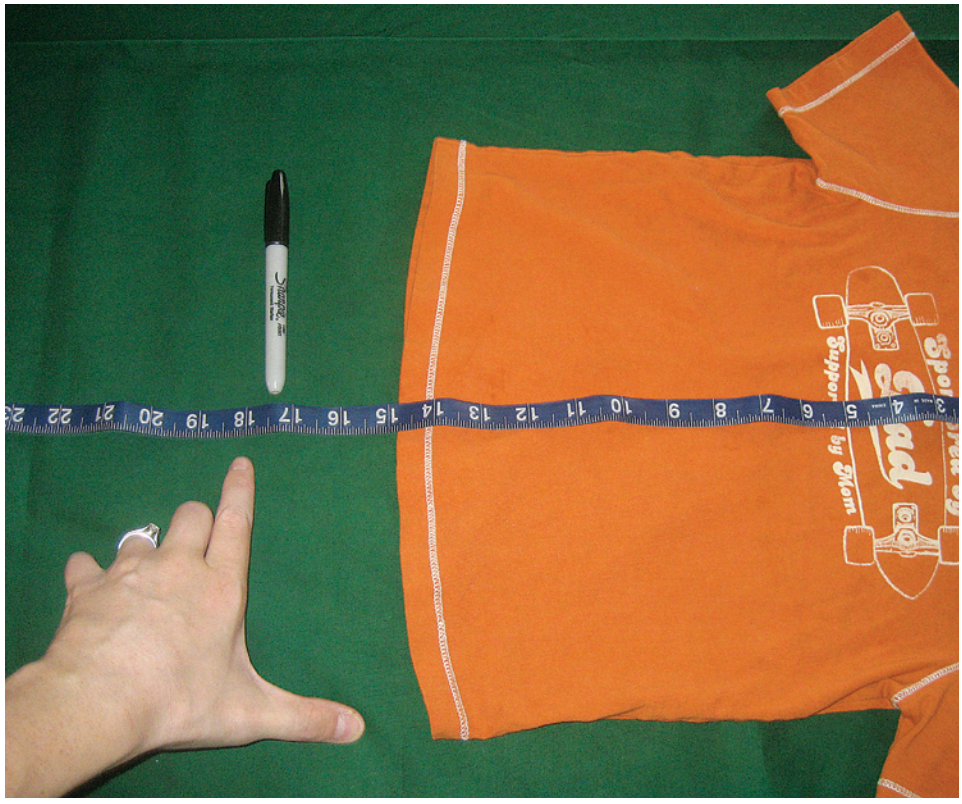
**FURTHER REFERENCE**

Book: Atomic Structure Advanced Inorganic Chemistry - Satya prakash, GD Tuli - S.Chand & Company Ltd.

Webliography: http://www.shodor.org

http://www.chemguide.co.uk.

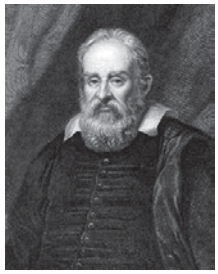
Chapter 5



# MEASUREMENT AND MEASURING INSTRUMENTS

- Concept of small measurements
- Measuring length
- Vernier Caliper
- Measuring mass and weight
- Measuring time


Nicolaus Copernicus


Galileo Galilei


Tycho Brahe


Johannes Kepler

Claudius Ptolemy (AD 90 – AD 168) was one of the most influential Greek writers of his times. He wrote that the moon, the sun and all the planets revolved around the Earth in an almost circular path. This remained the belief among people of Europe for almost thousand four hundred years. It was based on the observation that the sun, the stars and the moon rose in the east and set in the west.

Four sixteenth century astronomers Nicolaus Copernicus (1473-1543), Tycho Brahe (1546 – 1601), Galileo (1564 – 1642) and Johannes Kepler (1571-1630) changed that view completely. They dared to question the age-old belief. Based on keen observations and accurate measurements, they realized that it was the earth that was going around the sun; not the other way around.

Copernicus was the first to point out that Mercury, Venus, Saturn, Jupiter and Mars moved in a path that seemed to be centred around the sun and not the Earth.

Tycho Brahe, one of the greatest observing astronomers of any age, devised the most precise instrument available for observing the heavens. Observations of angular measurement in his times were correct to ¼ of a degree; but Tycho's were accurate to 1/30$^{th}$ of a degree. He produced the most detailed study of planets and stars of his time – an almanac of 777 stars.

Galileo built his own telescope, an instrument to observe the skies. The instrument gave a view of the heavens that was never before possible, affording close-up scrutiny of stars and planets. He discovered the three moons of the Jupiter, the rings of the Saturn and many other things in the skies. Based on his own observations, he supported Copernicus' view that the sun was at the centre of the orbits of the planets.

Kepler used the detailed record of observations made by Tycho particularly that of the planet Mars. Kepler proved beyond doubt using mathematical calculations that the planets followed an elliptical path around the sun rather than a circular one around the Earth. He was the first to introduce mathematically precise calculations.

Finally, the thousand four hundred year old belief was put to rest. It was made possible because of careful observations, accurate measurements using scientific instruments and detailed calculations.

## 5.1. IMPORTANCE OF ACCURATE MEASUREMENTS

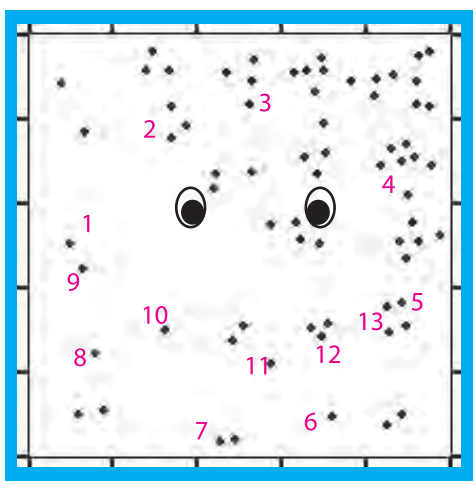
Have you read any detective stories or novels? The detective looks at the scene of crime, observes carefully, notices the position of things and is able to tell how the thief came into the room, what the thief looked for, what was stolen and finally, how the thief escaped from the scene of the crime with the booty.

Great scientists are a bit like the detectives, we come across in detective novels. They observe carefully, notice things, make the necessary measurements and are able to guess what must be actually happening in nature.

Look at the diagram given below. You can observe a set of dots in it.

Using a pencil, you can draw whatever pictures you want by joining the dots, in as many ways as possible. It is not necessary to use all the dots. Thereafter, erase all the lines and join the dots in the sequence as indicated by the numbers and see what the artist had in mind.

Imagine that each dot is a fact or a piece of data. The lines that join them are our interpretations of the data. We could give greater importance to some data by using that dot more than once. We could also avoid using some dots, if we think




**ACTIVITY 5.1 I DO**

*Read the passage given in the previous page and underline the words that you do not understand. Read the passage again and see if the meaning of some of those words is explained in the passage itself. Make a list of words that you still don't understand. Refer to a dictionary, if possible. Bring it up for a discussion in activity 5.2 or ask your teacher.*

*What are the questions that come to your mind? Write down those questions in your note-book.*

**ACTIVITY 5.2 WE DO**

*Try this simple activity. The whole class can divide themselves into small groups. Discuss the questions given below:*

- *According to the passage, what are the two important requirements for a better understanding of the world around us?*
- *Why should our observations be sharp and keen?*
- *Why should measurements be accurate?*
- *What are the three fundamental quantities we have learnt about in our earlier classes?*
- *What are the SI units of the three fundamental quantities?*
- *What are the smaller and larger units of Length, Mass and Time that we already know? Check each other out to make sure that every student is able to recall the fundamental smaller and larger units.*
- *When do you use the smaller units and when do you use the larger units?*
- *Present a summary of the discussions to the class and request your teacher to give her / his feedback.*

those pieces of data are less important or less reliable. Such a construction is called a Hypothesis in science. Thus many interpretations or hypotheses are possible with the given one set of data, but which one is the right one? It is possible to decide on that, only after we verify the hypotheses in a number of different ways or by obtaining additional data to see if they coincide with the lines that we have drawn.

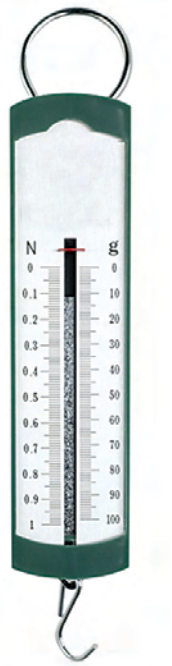
Quite often it happens that several years later, fresh data comes up and in the light of the fresh data our understanding of what is actually happening changes. Very often fresh data comes up with technological advancements and subsequently human beings are able to make more accurate measurements than what their forefathers did. A lot therefore depends on the instruments that are used to make the measurements. Are they accurate? Are they reliable? Let us learn more about measurements and measuring instruments!!

## 5.2. THREE CHARACTERISTICS OF MEASURING INSTRUMENTS

There are three important characteristics of measuring instruments that one must be familiar with. They are:

- Least Count
- Range
- Zero Error

The smallest value that any instrument can measure is called the least count of the instrument. For example, if you use a scale then the smallest division is one millimeter. It is the smallest value that the scale can measure and is called the least count of the scale. Some scales used for engineering drawing have half millimeter markings and therefore the least count of such scales is 0.5mm. When we say that the length can be measured correct to a millimeter, then we mean that the least count of the scale is one millimeter. Can you find the least count of the spring balance shown in the picture on the right?




The values between the minimum measurable value and the maximum value that can be measured is called the range of the instrument. For example, the range of the scale is zero centimeter to thirty centimeters. Usually, we state the maximum value as the range since the minimum value is generally zero. When we say, the range of the metre scale is 100cm, we mean that the range is from zero to 100cm. There are, however, special instruments that are designed to measure from a specific minimum value to a maximum value. In such cases we say the range of the instrument is from such and such value to such and such value. For example, if you had a Voltmeter that reads from 150V to 250V, then we say that the range of the Voltmeter is from 150V to 250V. Usually such instruments are built for a specific purpose and optimized to give accurate readings within the design range and the designer expects that the value will not go outside the design range.

Often instruments do not read zero at the minimum position. For example, the needle of an Ammeter may read 0.02 amperes when it is not connected to the circuit. Such an error is called zero error, since the needle at the minimum position is not reading zero. While using the instrument, one has to apply a correction to the reading to obtain the real value. The value that is read off the instrument is called the observed value to which we apply the zero error correction and obtain the measured value. We will learn more

about zero error and zero error correction later when we read about the Vernier Caliper.

## 5.3. SI PREFIXES

You already know the SI units for some selected fundamental quantities. Let us recall some of them:-

| Dimension | SI Unit |
|---|---|
| Length | Metre |
| Mass | Kilogram |
| Time | Second |
| Electric current | Ampere |

The metre, the gram, the second and the ampere are known as the base units, to which we can add some prefixes. The international committee on weights and measures also agreed on standard prefixes to base units to express smaller and larger quantities in terms of the base units. As far as possible, the SI unit was kept as the base unit. The SI unit of mass, the kilogram, however was an exception – can you guess why?

Thus one-tenth of a metre or 0.1 of a metre can be referred to as a decimeter.

**ACTIVITY 5.3 I DO**

*Find the least count and range of the different instruments used in your school physics laboratory.*

*I observe the divisions of my measuring scale. I check the number of divisions in 1cm. From my observation I find, if 10 divisions are seen, then 10 divisions = 1cm;*

*i.e. 1 division = 1/10 cm = 0.1cm = 1 mm*

*Hence, I conclude that the least count of the scale is 0.1cm or 1mm.*

*In the same way, I find the least count of different instruments used in my school laboratory.*

Similarly $10^{-6}$ seconds of time can be referred to as a microsecond. These prefixes can be used along with derived SI units as well. 1000000($10^6$) joules of energy can be referred to as a megajoule. You may be aware of some of these prefixes.

**Smaller Quantities**

| Factor | Prefix | Symbol |
|---|---|---|
| $10^{-1}$ | deci | d |
| $10^{-2}$ | centi | c |
| $10^{-3}$ | milli | m |
| $10^{-6}$ | micro | μ |
| $10^{-9}$ | nano | n |

**Larger Quantities**

| Factor | Prefix | Symbol |
|---|---|---|
| $10^{1}$ | deca | da |
| $10^{2}$ | hecto | h |
| $10^{3}$ | kilo | k |
| $10^{6}$ | mega | M |
| $10^{9}$ | giga | G |

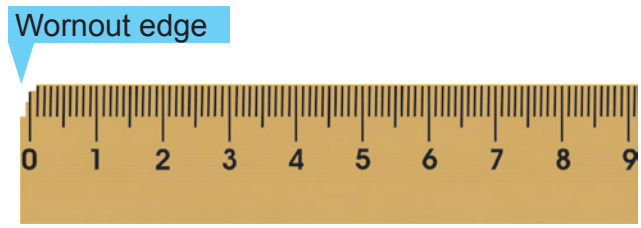
The kilogram is an exception. The base unit for mass is the gram, however the SI unit of mass is the kilogram and it already uses a prefix “kilo” which means 1000 grams. The prefixes are added to the base unit ‘gram’ e.g.– milligram, decagram etc. A thousand kilograms would make a megagram; it is also referred to as a tonne or a metric ton.

## 5.4. SOME HELPFUL TIPS

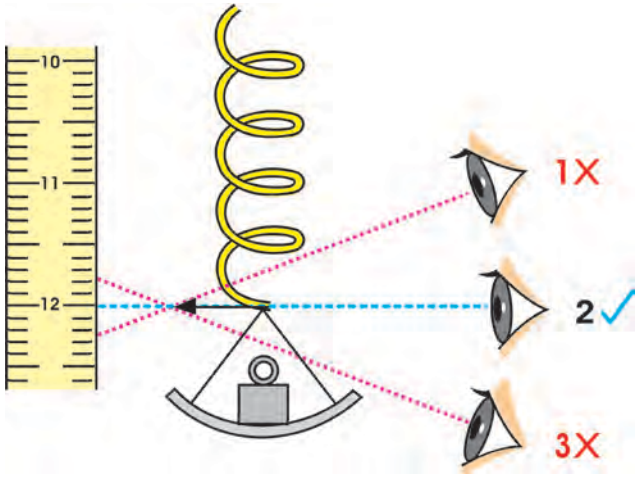
### 5.4.1. Tips for making accurate measurements

1. Never use the edge of the metre scale to measure the length of an object as it is invariably worn out and introduces an unspecified amount of zero error. Instead, align any centimeter mark to the left end of the object. Now take the reading of the left edge and that of the

right edge. The difference between the two readings will give the length of the object.




2. Readings must be taken with one eye closed. The line joining the eye, the edge of the object and the scale marking must be perpendicular to the scale to avoid what is called parallax error. Eye position 1 in the given figure is incorrect as pointer would appear to read 12.2. Eye position 3 is incorrect as the pointer would appear to read 11.8. Eye position 2 is the correct one, where the observed reading is the same as the actual reading.



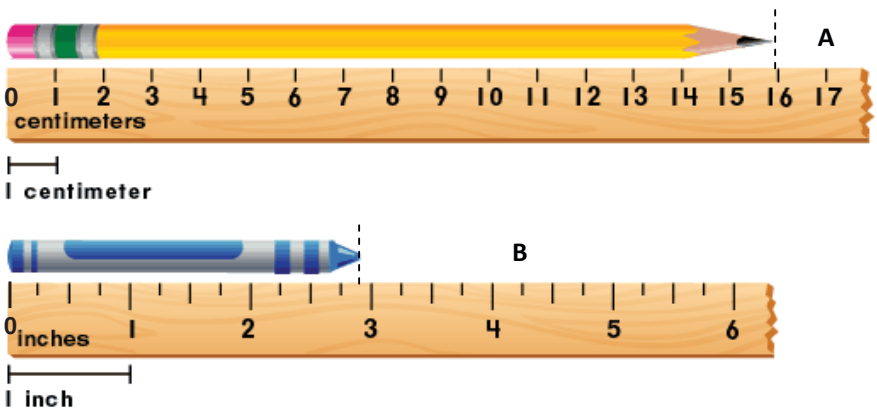

3. Readings must be exact multiples of the least count. For example, if the length of the object lies between two markings on the scale, the length must be read off to the nearest marking on the scale. Never estimate the value by interpolating. In the figure given, pencil A is exactly 16 cm since the tip of the pencil coincides with the 16cm mark. In case B, however, the crayon's length lies between 2.75 inches and 3 inches and is closer to 3 inches than to 2.75 inches. The length should therefore be recorded as 3 inches. This "error" is actually a limitation of the instrument being used for measurement and not the fault of the person making the measurement. It is called the uncertainty in measurement and you will learn more about it in higher classes.

### 5.4.2. Tips for recording measurements

1. Recorded values of measurements must always be accompanied by the appropriate units.

2. As far as possible, measurements must be tabulated.

3. Values must be recorded to the appropriate decimal place. For example, if the length is measured correct to a millimeter, say 40mm, but is recorded in centimeters then it




SCIENCE

must be recorded as 4.0cm and not as 4cm. The '0' after the decimal indicates that the measurement has been made correct to the millimeter. On the other hand, if it is recorded in meters then it must be recorded as 0.040m and not as .04m. Once again the '0' after the digit '4' indicates that the measurement has been made correct to the millimeter. The recording 0.04 indicates that the value has been measured correct to the centimeter. The last digit '0' therefore signifies the least count to which the measurement has been made.

## 5.5. MEASURING LENGTH

### 5.5.1. Vernier caliper

The vernier caliper is a device that is used a great deal in engineering work and in workshops which manufacture things. It is an ingenious device where two scales with fairly large least counts are used in conjunction with one another to measure very small values of length. The auxiliary scale, now called the Vernier scale after the inventor, is used nowadays in almost every instrument meant for accurate measurement such as the barometer, the microscope, the sextant (for measuring small angles), etc.

### 5.5.2. The principle of the vernier

The principle of the Vernier is delightfully simple. Let us say, you have two scales, one with a least count of 1.0mm(main scale) and the other with a least count of 0.9mm (auxiliary or Vernier scale) you can then measure an object whose length is 0.1mm quite easily. Refer to the diagram alongside; by aligning the left edge of the object with the zero of the main scale and butting the edge of the auxiliary scale to the edge of the object, you would find that the first marking of the auxiliary scale would exactly coincide with the first marking of the main scale (object length, 0.1mm + vernier division, 0.9mm = 1.0mm, the first main scale division).

Going the other way around, if we did not know the size of the object and we found that the first vernier division coincided with the first main scale division, we could state that the size of the object must be 0.1mm, since:-

object length, 0.1mm = 1.0mm, the first main scale division - vernier division, 0.9mm

You could now say that the least count of the combination of scales is 0.1 mm, which is the difference between the two least counts. Popularly it is written as follows:-

Pierre Vernier (1580 - 1637 ) was a French government official. Vernier was taught Mathematics and science by his father who was a lawyer and engineer. His father introduced Pierre to the works of Tycho Brahe. He worked for much of the time as an engineer, working on the fortifications of various cities. Like many other mathematicians and scientists of that period, Vernier worked on cartography and on surveying. He collaborated with his father in making a map of the Franche-Comté area. His interest in surveying led him to develop instruments for surveying and this prompted the invention for which he is remembered by all scientists. In his publication La Construction, l'usage, et les propriétés du quadrant nouveau de Mathématiques, he explains the use of the auxiliary scale in making measurements – now called the Vernier scale. He also compiled a huge table of natural sines – a table from which the angle of a triangle can be obtained if the length of the sides of the triangle is known, about which you will learn in your maths class.

L.C. (of the instrument) = 1 MSD – 1 VSD

If on the other hand, the size of the object being measured is 0.2mm long and the auxiliary scale is butted against the object the second vernier marking will coincide with the second main scale division (object length, 0.2mm + two vernier divisions, 1.8mm = 2.0mm). Going the other way around, if we did not know the size of the object and we observed that the second vernier division coincided with the second main scale division we could say that the size of the object is 0.2mm.

object length, 0.2mm = 2.0mm, the second main scale division – two x vernier divisions, 1.8mm

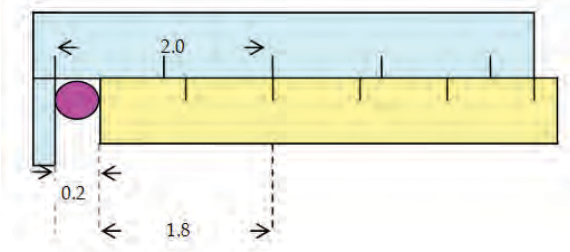
There is a pattern here and we could try extending by using the same logic and saying that if the object was 0.4mm long then the fourth vernier division would coincide with the fourth main scale division. Further if it was 0.9mm long, then the ninth vernier division would coincide with the ninth main scale division. I could write this as:

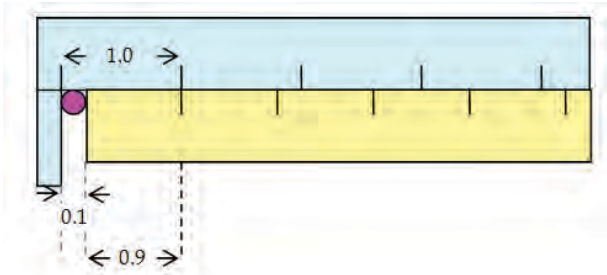
Object length, 0.9mm = 9.0mm, the ninth main scale division – nine x vernier divisions, 8.1mm

0.9mm = 9*Main scale division – 9*Vernier scale division

Isn't this quite an ingenious way of measuring correct to 0.1mm, when you have two scales with much larger least count?

We have discovered a pattern and we know how to extend the pattern using the




same logic. Now let us try to generalise. To generalise means to write the same thing in terms of an unknown variable(X) which we call a formula - a formula which will be valid for all real values of X. So let us say that the Xth vernier division coincides with a main scale division. Then :-

object length, 0.X mm = X*Main scale division – X* Vernier scale divisions

object length, 0.X mm = X(Main scale division – Vernier scale division)

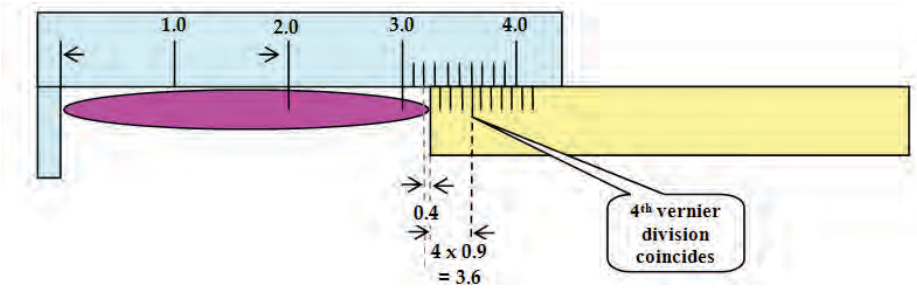
object length, 0.X mm = X(Least Count).....[remember? Least count = 1 MSD – 1 VSD]

Let us consider a case where the size of the object is something like 3.24 cm (32.4mm). On the main scale, the edge of the object would lie between 3.2cm and 3.3cm. This could be written as 32mm+ X mm.

The 0.4mm of length extending beyond the 3.2cm (32mm) mark would be the extent of uncertainty as read on the main scale. When the auxiliary scale is slid in place, the fourth vernier division would coincide with some main scale division (we don't really care which). Using the formula given above, we know that the extra length can be obtained by multiplying the vernier coincident 4, by the least count which in the example happens to be 0.1mm. Therefore,

Object length, 32.X mm = 32+X*(Least Count)

We finally arrive at the most useful form of the formula which is:




Object length = Main scale reading + (Vernier coincident*least count)

### 5.5.3. Description of vernier caliper

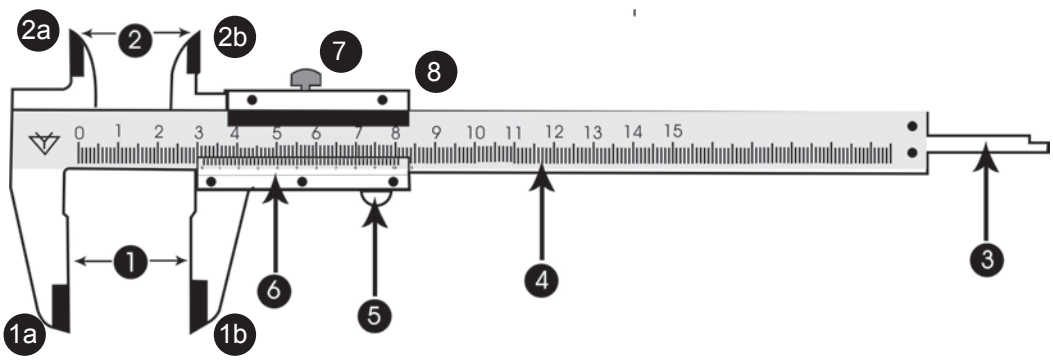
The Vernier Caliper used in the laboratory is a modern version of the age-old one. A picture of a Vernier Caliper is shown below.

The Vernier Caliper consists of :-

- A thin long steel bar graduated in cm and mm (4). This is the Main scale.
- Fixed perpendicular to the bar at the left end of the steel bar carrying the main scale is an upper fixed jaw and a lower fixed jaw.
- To the right of the fixed jaws mounted on the steel bar is a slider with a upper movable jaw and a lower movable jaw.
- The slider can be fixed to any position using the tightening screw or friction nut.
- The Vernier scale (6) is marked on the slider and moves along with the movable jaws and the slider.
- The lower jaws (1) are used to measure the external dimensions and the upper jaws (2) are used to measure the internal dimensions of objects.
- The thin bar attached to the Vernier scale at the right side (3) is called the depth probe and is used to measure the depth of hollow objects.

### 5.5.4. Using the vernier caliper

The first step in using the vernier Caliper is to find out its characteristics Least count, Range and Zero error.




1. Lower Jaws
1a. Lower Fixed Jaw
1b. Lower Movable Jaw
2. Upper Jaws
2a. Upper Fixed Jaw
2b. Upper Movable Jaw
3. Depth Probe
4. Main Scale
5. Retainer
6. Vernier
7. Friction Nut
8.Slider

### Least Count:

The least count is ascertained using the formula we obtained earlier in para 5.5.2.

L.C (of the instrument) = 1 MSD – 1 VSD

The main scale division is easily obtained by inspecting the main scale. Invariably it will be in centimeters, further divided into millimeters. The least count of the main scale or main scale division is therefore usually one millimeter. The vernier scale division is obtained by measuring the vernier scale against the main scale. In the vernier Caliper, nine main scale divisions would be divided into ten equal parts (9mm/10 = 0.9mm). The least count would therefore be 1 MSD – 1VSD, 0.1mm (1mm – 0.9mm).

### Zero Error:

Loosen the friction nut and close the jaws of the Caliper by moving the slider to the extreme left position. Check whether the zero markings of the main scale and the vernier scales coincide. Suppose the zero mark of the vernier is shifted slightly to the right, then we need to remember to subtract that amount from the observed value to get the measured value. The error is therefore considered positive and the correction you need to apply is negative (subtract). On the other hand, if the vernier zero is shifted to the left of the main scale zero marking then it is considered negative zero error and the correction for it is to add (+) the error value to the observed value. Rarely will the zero error exceed a mm, since the Vernier Caliper is an accurate instrument.

### Positive zero error:

To obtain the value of the zero error simply count the number of the vernier scale division that coincides with any one of the main scale division and multiply it with the LC of the instrument. Suppose the fifth vernier division coincides with a main scale division, then multiply five with the least count (0.1mm) to get + 0.5mm.

### Negative zero error:

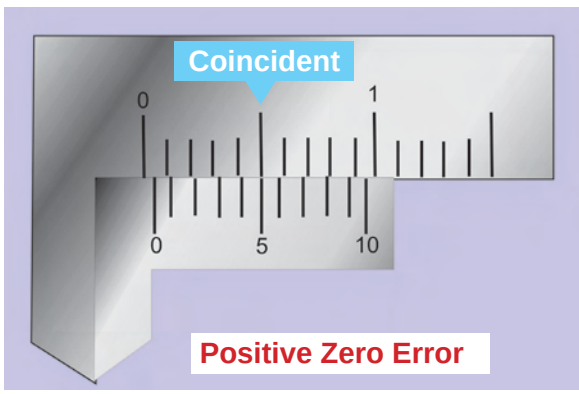
If the zero error is negative, then you need to imagine the main scale extending backwards by one division which we shall call negative 1(-1.0 mm). Therefore, we would need to add the vernier reading to -1.0mm. Let us say we find the 8th vernier division which coincides with any main scale division. Using the formula we evolved earlier:

Object length = Main scale reading + (Vernier coincidence*least count)

We get zero error = (-)1.0+8*0.1 = (-)1.0+0.8 =(-) 0.2mm

Range: Now move the slider to the extreme right position without slipping off the bar. Note the maximum value that can be read off the main scale. The range of the instrument decides the maximum size object that can be measured using Vernier Caliper.

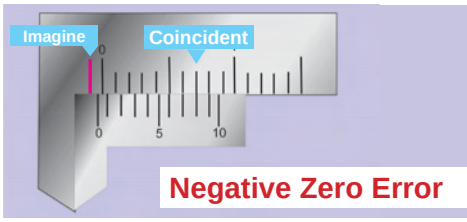
Measure the dimensions of familiar objects using the Vernier Caliper. You could try measuring length, width and height of objects and calculate their volume. For example, you could measure the inner diameter of a beaker (use the appropriate jaws) as well as its depth (use the depth probe) and calculate the inner volume of the beaker.




SCIENCE

Tabulate the values as shown in the sample table below.

Least Count …….cm Zero Error …(+ or-)…….cm Zero Error Correction … (- or +)……cm

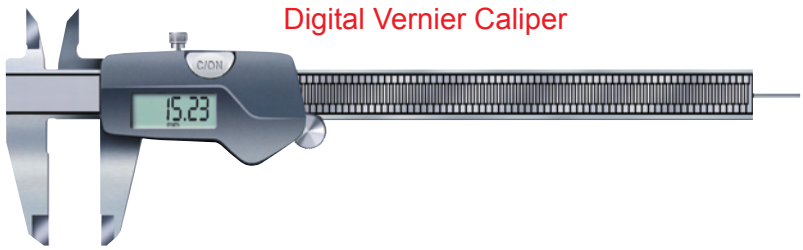



| S.No | Main Scale Reading (MSR) | Vernier Coincidence (VC) | Observed Reading(OR) = MSR+(VC x LC) | Corrected or Measured Reading OR ± ZEC |
|---|---|---|---|---|
| | cm | divisions | cm | cm |
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |

### 5.5.5. Digital vernier caliper

Digital Vernier Caliper has a digital display on the slider. The slider also houses the electronic calculator which calculates the measured value that is then displayed. The user need not manually calculate the least count, the zero error etc. or take the trouble of finding the vernier coincident manually.

Digital Vernier Caliper




## 5.6. MEASURING MASS

When we go to a shop to buy something, say a kg of rice, we often buy it in terms of the 'weight'. In layman's parlance what is called 'weight' is actually mass in science parlance. Many things are measured in terms of the mass in the commercial world. We buy gold which is measured in grams or milligrams, medicines in 500mg or 250mg values, load trucks in terms of tons etc. Can we use the same instrument for measuring milligrams of medicine or gold and the tens of tons of cargo that is loaded on an aeroplane? What kinds

**ACTIVITY 5.4** **I DO**

*Take a cylindrical glass beaker from your school lab and using a vernier caliper find the volume of glass used to make the beaker. Plan out the activity and discuss with your teacher.*

*Hint: You would need to use both pairs of jaws and the depth probe.*

*Can you think of other ways of doing the same thing?*

of instruments are used in measuring such quantities? In this section, we will go over some of the instruments that are used for measuring mass.

### Common (beam) balance

A beam balance compares the sample mass with a standard reference mass (known masses such as 100g, 200g etc.). Least counts of 20g to 50 mg are possible.

### Two pan balance

This type of balance is commonly used for measuring mass in shops. This balance too compares the sample mass with a standard reference mass. The pans rest on top of the beam and can be conveniently placed on a table top. Least counts are generally in the region of 10g to 50g.

**ACTIVITY 5.5**

*This activity needs to be done in the company of an adult with whom you need to visit as many of the following places and find out the least count, range and zero error (if any) of the instrument used to measure mass.*

- *Provision shop – Beam balance*
- *Grocery store – Two pan balance*
- *Jewellery shop*
- *Railway parcel office*

### Physical balance

It is used in laboratories. It is similar to the beam balance but is a lot more sensitive and can measure mass of an object correct to a milligram.

## 5.7. MEASURING TIME

The pendulum as a reliable measure of time was first articulated by Galileo in 1602. In those days many lamps would be mounted on a large glass arrangement suspended from the ceiling. Such an elaborate arrangement was called a "chandelier". Watching the glass chandelier of the church move to and fro in the wind, Galileo realized that a simplified form of the pendulum could be used to keep time.

### 5.7.1. The pendulum

A pendulum is a heavy bob suspended by a light thread. The length [L] of the pendulum is measured from the point of suspension or pivot to the centre of gravity of the bob. When the pendulum is displaced from the centre position and released, it begins to swing to and fro. One complete to and fro motion is called an oscillation. The maximum displacement of the bob from the mean position is called the amplitude of the oscillation. The time taken for one oscillation (one complete to

and fro movement) is called the time period of the pendulum (T). The time period of the pendulum:

- does not depend on the amplitude and this can be verified experimentally.
- is proportional to the square root of the length of the pendulum. [ $T \alpha \sqrt{L}$ ].
- is inversely proportional to the square root of the acceleration due to gravity. [ $T \alpha \frac{1}{\sqrt{g}}$ ].

Putting both together along with the constant of proportionality, $2\pi$, we get the final form of the formula:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

You will be doing an experiment related to this formula in your practical class, giving the time period of the pendulum. Alternatively, knowing the length, L; the time period, T; we can determine the acceleration due to gravity, g.

### 5.7.2. Clocks

#### Sundial

The sundial has a stick or object to cast a shadow on the horizontal surface. As the sun moves across the sky, the position of the shadow moves on the dial face to indicate time. The least count of such sundials again varied a great deal and improved from about one hour to about 15 minutes in the later years.

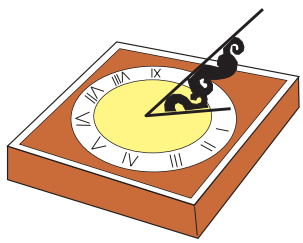
#### Water Clock

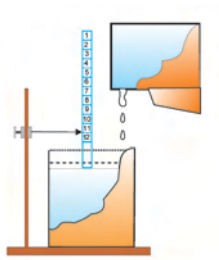
It was an evenly marked container with a float and pointer into which water dripped in at a fixed rate. As the water dripped into the container, the level of water increased. The time was read off on the level markings on the wall of the container. Since the rate of flow of water depended on the level of water in the upper container it was

**MORE TO KNOW**

*The prehistoric man, by simple observation of the stars, change of seasons, and the day-night cycle came up with very primitive methods of measuring time. This was necessary for planning nomadic activity, farming, sacred feasts, etc. The earliest time measurement devices before clocks and watches were the sundial, the hourglass and the water clock. The Egyptians, in about 3500 B.C. built tall pillars to use the shadow as a way of telling time. Over time, these grew into more sophisticated instruments such as the sundial, yet they could not read the time at night or in cloudy weather or when the length of the days changed with the seasons.*

*The Greeks invented the water clock and the sand hourglass. Both these were great improvements over the sundial. They could give the time during the day as well as the night and had a much better least count.*

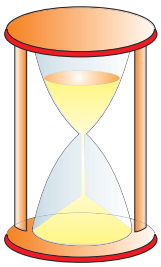




improved to provide a constant rate of flow as shown in the diagram alongside. The least count of such instruments varied a great deal but people were happy to have a least count of about a quarter of an hour.

### Sand Clock

It was made up of two rounded glass bulbs connected by a narrow neck of glass, between them. When the hourglass is turned upside down, a measured amount of sand particles stream through from the top bulb to the bottom bulb of the glass. These were more like timers which measured one hour typically and were therefore also called "hourglass" and had to be inverted every hour. They can also be built to measure smaller units of time for special purposes.



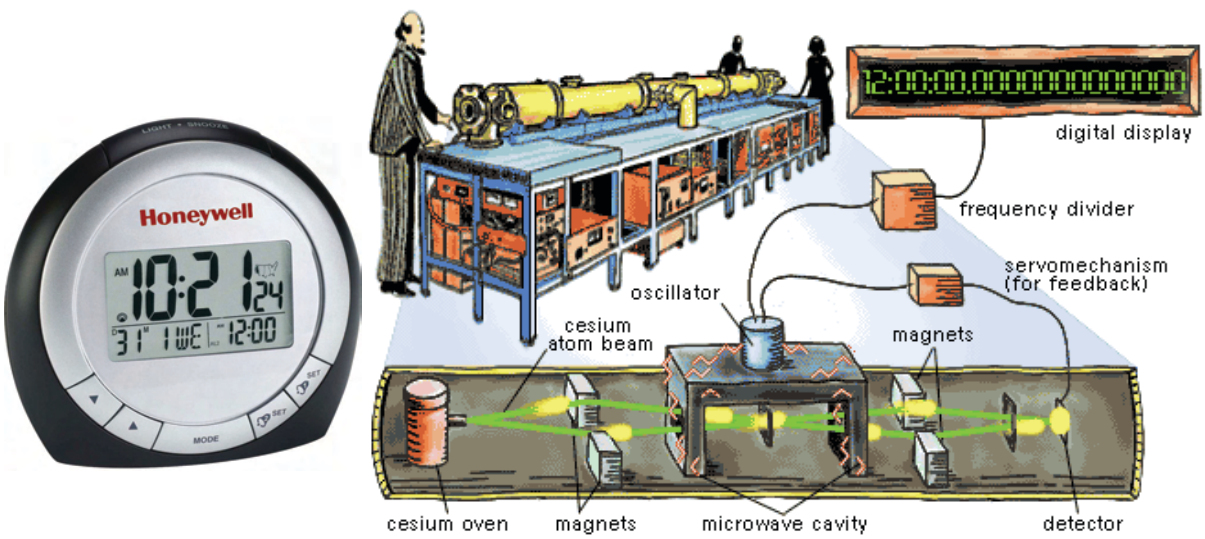
## 5.7.3. Another characteristic of instruments - accuracy

You would have observed that some watches keep correct time, while some lose or gain time. Some watches lose or gain as much as five minutes in a day (24 hrs.). Some watches, on the other hand, lose or gain about five minutes in a whole month. The latter are said to be more accurate than the former.

Do not confuse accuracy with least count. If we take two clocks with the same least count of 1 second but one loses 5 minutes every day and the other loses five minutes in 30 days; the second clock is said to be more accurate since the time measured by the second clock is closer to the actual value.

## 5.7.4. Atomic clock

Atomic clocks are the most accurate timekeepers ever known. The best ones lose or gain 1 second in $10^9$ days (approximately 2739726 years). This means that once synchronized, for generations your family members need not reset the clock. Therefore, these clocks are used as primary standards for international time. Atomic clocks can be made to look like any other clock with a least count of one second or with a least count of one millisecond for scientific purposes.




SCIENCE

**ACTIVITY 5.6** **I DO**

Try building your own sundial or water clock at home. Plan out the activity and discuss with your teacher. Present what you did in the class.

**MORE TO KNOW**

In India, the time standard is provided by the atomic clock kept at the National Physical laboratory, New Delhi.

## MODEL EVALUATION

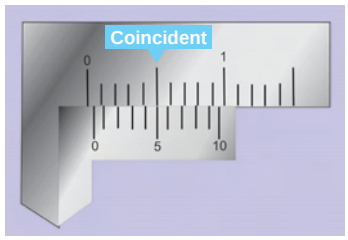
### PART A

1. $5 \times 10^7$ μs is equivalent to _____ .

   a) 0.5 s  b) 5 s  c) 50 s  d) 500 s

2. Which of the following parts of a Vernier caliper are used to measure the internal diameter of a cylindrical pipe?
   (depth probe, retainer, lower jaws, upper jaws)

3. Write the Zero error of the Vernier caliper shown in the adjacent diagram.
   Zero error = _____ .




4. What is the least count of your wrist watch? Is it same for all kinds of watches?

5. Name the clock which is used to measure the short time intervals accurately.

6. The wavelength of monochromatic light is 6000 $A^0$. Write this value in nm.

### PART B

1. Match the following:

| Sl.No. | Device | Place of use |
|---|---|---|
| 1. | Beam balance | Jewellery shop |
| 2. | Medical scale | Laboratories |
| 3. | Physical balance | Hospitals |
| 4. | Digital balance | Markets |

2. In a Vernier caliper, the difference between I MSD and 1 VSD is found to be 0.1 mm. What does it represent?

3. Kavitha wants to measure the thickness of a sheet of paper of her science textbook, which contains 250 pages, using a Vernier caliper. Explain how she can do this appropriately.

4. *A student measures the diameter of a bead using a digital Vernier caliper. The reading on the digital caliper scale is 4.27 cm. If he wants to verify the result with the ordinary Vernier caliper with no error,*

   *i) where will the zero of the vernier lie in the main scale?*

   *ii) which divisions of the Vernier scale reading will coincide with the main scale reading?*

5. *Calculate the correct readings of the Vernier caliper from the given table:*

   *Least count =0.01 cm;  Zero correction = Nil*

| Sl.No. | MSR | VC | Observed Reading = MSR + (VC x LC) cm | Correct Reading OR ± ZC cm |
|---|---|---|---|---|
| 1. | 3 | 4 | | |
| 2. | 3 | 7 | | |

6. *Complete the table choosing the right term from the list given in brackets:*

   *($10^9$, micro, d, $10^{-9}$, milli, m, M)*

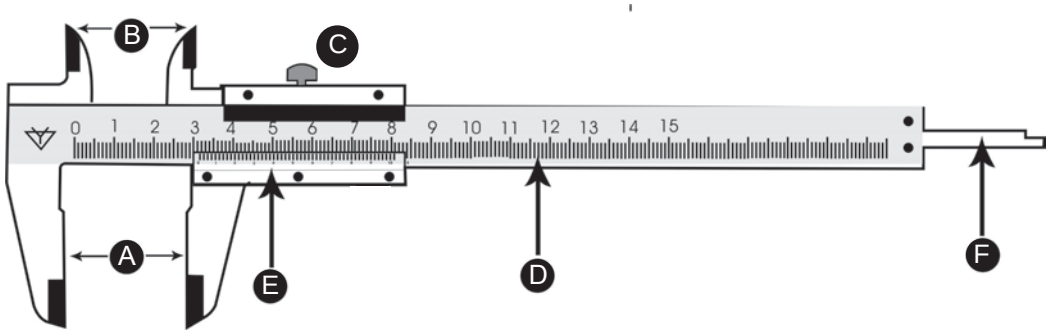
| Factor | Prefix | Symbol |
|---|---|---|
| $10^{-1}$ | deci | |
| $10^{-6}$ | | μ |
| | giga | G |
| $10^6$ | mega | |

7. *What is the need of measurement? Explain.*

8. *Copy and complete the table shown below:*

| Measurement | Unit | Symbol |
|---|---|---|
| Length | | |
| | Kilogram | |
| | | s |

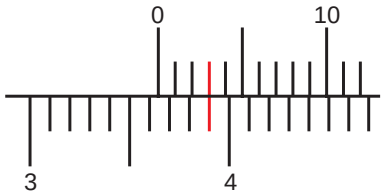
9. *The diagram shows a Vernier caliper.*




   *a) In the diagram, label the parts marked A,B,C,D,E and F.*

   *b) State the functions of the parts A,B,C and F.*

10. Read the main scale and the vernier scale of the Vernier caliper shown in the figure given below. What is the length recorded by this caliper?




11. A Vernier caliper has a zero error +0.06 cm . Draw a neat labelled diagram to represent it.

12. A student writes the length of an object measured from a metre ruler as 4.20 cm. Is he justified in writing this value? Explain.

13. Which is more sensitive: a stop watch or a stop clock? Give a reason to your answer.

14. Name any two units of length which are bigger than the metre. Write the relation between each of those units and the metre.

## PART C

1. i) Define the least count of an instrument.

ii) Explain the types of Zero error of the Vernier caliper.

iii) Write the steps involved in measuring any dimension of a given object using a Vernier caliper.

### Explore and Answer

1. The sundial cannot be used during the nights. Give reason.

2. Match the following:

| | | | |
|---|---|---|---|
| a) IST | b) Quartz Clock | c) Digital Balance | d) Spring Balance |
| i) Strain gauge | ii) Weight | iii) Liquid Crystal Display | iv) GMT |

3. Which one has more quantity of matter, a cricket ball or an iron sphere of the same size? Why?

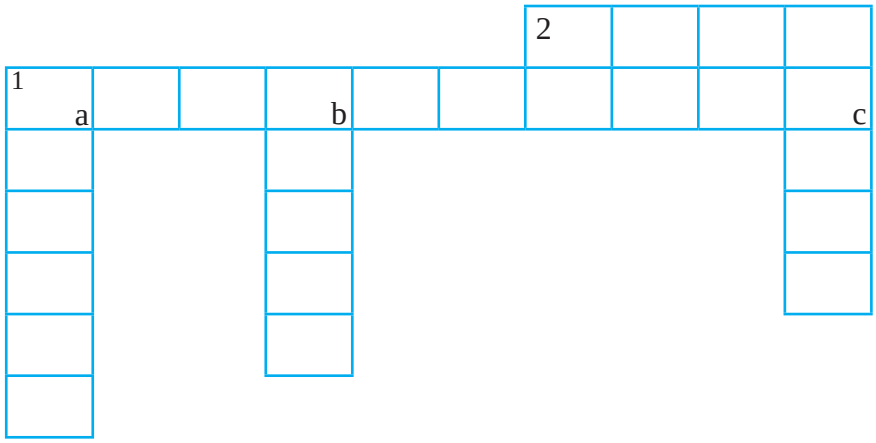
4. Solve the crossword puzzle:

Left to Right

1. The smallest measurement that can be measured with a device.
2. The prefix of $10^{-9}$

Top to Bottom

a. Separation between two ends of a thread.
b. A measuring device used in classroom.
c. 'Second' is the unit of this quantity.




5. *A device works on the principle of periodic vibrations taking place within a ceasium atom. Give the significance of the device.*



## FURTHER REFERENCE

*Books:* 1. Fundamentals of Physics - David Halliday & Robert Resnick JohnWiley
2. Complete Physics for IGCSE – Oxford publications

*Webliography:* http://www.nist.gov/pml/
http://www.teach-nology.com
http://www.splung.com
http://www.khanacademy.org

Chapter 6

# MOTION

- Types of motion
- Distance and displacement
- Speed, velocity and acceleration
- Graphical representation of motion
- Equations of motion
- Uniform circular motion

Karthik and his parents were travelling to their native place by train to celebrate the Pongal festival. Karthik was watching the scenery through the window. He was surprised to see the trees going backwards. He asked his mother whether the trees really moved backwards. The mother explained that the trees were at rest. The trees seem to be receding because the train is moving forward. Let us explain 'rest' and 'motion' to Karthik and others.

## 6.1 REST AND MOTION

How do we know whether an object is stationary or is moving? Sitting in a train, it seems as if the trees are moving in the opposite direction. Looking at another train overtaking ours it appears as if our own train is moving in the opposite direction (i.e. backwards). Let us look deeper into this question. Some scientists who went quite deep into this question were Newton and Einstein.

**ACTIVITY 6.1** **I DO**

*Try this small activity. The whole class can divide themselves into small groups. Discuss the questions given below:-*

- *How do you know if an object is stationary?*
- *How do you know if an object is moving?*
- *How do we know if one object is moving faster than another object?*
- *Present a summary of the discussions to the class and request your teacher to give her / his feedback.*

In activity 6.1, perhaps you arrived at the conclusion that if the position of an object does not change over time, then we know that it is not moving. But position itself is measured relative to another object. Therefore, to know if an object is moving or not, we need another object that we are sure is not moving. To check if the second object is not moving, we need a third object that we are sure is not moving…. Now this is proving to be more difficult than what we thought. So where do we start? We shall start with the understanding that, the idea of rest and movement are very relative.

On the earth, we take a point on the ground and we measure all distances with respect to this point which we call the datum. Of course we know that the earth itself is moving around the sun and the sun in turn is moving through space. But then, we sort of ignore all that, since we are only going to discuss movement of objects on the earth. You can select any point on the earth and call it your own datum. You make all measurements relative to your datum. You could then draw imaginary lines horizontally to represent the x and y axes and a third line vertically through the

point to represent the z axis. The three imaginary lines representing the three axes together with the datum is called the frame of reference. It is helpful to take a prominent point or object that is easily recognisable as the datum.

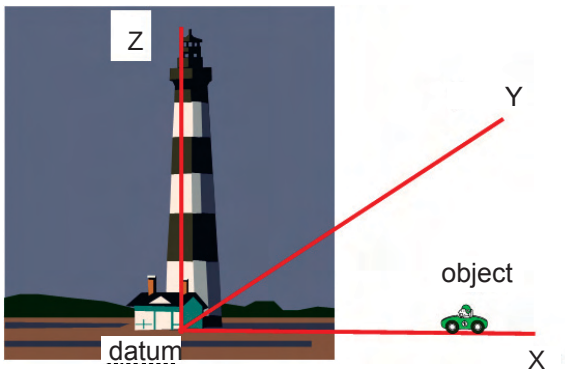



Fig 6.1 Position of object
X = 500m
Y = 10m
Z = 0m

Secondly, you have to determine the position of the object under observation in relation to the datum. This is easy and can be done by representing the position of the object in terms of its x distance, y distance and z distance exactly, as you would on a graph paper, if only this is in three dimensions.

Thirdly, you have to observe the object over a period of time say an hour or so. If the position of the object does not change during this time, then we could conclude that the object has been at rest with respect to the datum or frame of reference during the period of observation. If the position of the object changes with respect to the datum or frame of reference during this period, then we say that the object has moved during the period of observation.

A body is said to be in the state of rest when it remains in the same position relative to a datum over time.

**MORE TO KNOW**

*One of the real mysteries of life is to find an object that is truly and absolutely at rest. Objects on the earth seem stationary but we know the earth itself is moving and is a part of the solar system. The solar system itself is moving around and is part of a larger galaxy. The galaxy itself is moving around amidst many other galaxies. Is there any object in this universe, which we could say with certainty that it is at rest?.....`*

A body is said to be in the state of motion, when it changes its position with respect to a datum over time.

To summarise, therefore, to determine whether an object is 'at rest' or 'in motion' three parameters are required. They are:

- A datum and a frame of reference
- The position of the object in relation to the datum or frame of reference
- Time

## 6.2. TYPES OF MOTION

Movement can be classified under the following heads for convenience sake:

- Linear motion – where the object moves along a straight line.
- Circular motion – where the object moves along a circular path.
- Oscillatory motion – where an object describes a repetitive to and fro movement retracing its original path in the opposite direction.
- Random motion – where the motion of the object does not fall in any of the above categories.

## 6.3. DISTANCE AND DISPLACEMENT

Distance : It is the length of the actual path followed by an object or body while

moving from one point to another. In the example shown alongside, the length of the left side path is 1.5km and we say that the distance between the two points following the left hand path is 1.5km, while the distance is 2.5km following the right hand path. Distance is a scalar quantity and the direction is not important. It always increases with time.

Displacement : It is the shortest distance between two points and is a vector quantity where direction is an essential feature. It is not merely sufficient to state the shortest distance between the two points but it is also necessary to state the direction. In the example above, the displacement of the destination is one km in the north easterly direction from the originating point.

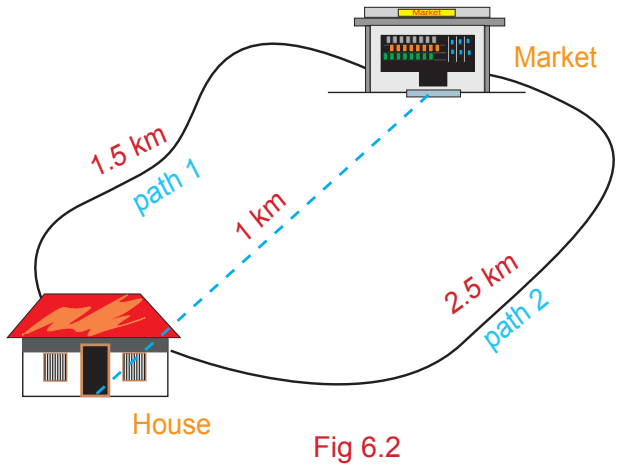
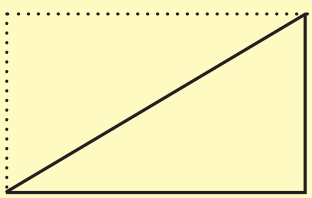


Fig 6.2

Let us compare the two terms, distance and displacement to understand the similarities and differences:-

| Distance | Displacement |
|---|---|
| It is the length of the actual path followed by an object or body, while moving from one point to another. | It is the shortest distance between two points. |
| It is a scalar quantity (having only magnitude). | It is a vector quantity (having magnitude and direction) |
| It is measured in metres in the SI system. | It is measured in metres in a particular direction in the SI system. |
| It is not a unique quantity and is always path dependent. | It is only dependent on the starting point and the ending point and is independent of the path followed. It is unique to a given pair of points. |
| It can either be equal to or greater than displacement. | It is either equal to or lesser than the distance. |
| Distance in any direction would be a positive quantity, since direction is inconsequential. | It can be a negative quantity. If displacement in one direction is assumed to be positive then the displacement in the opposite direction would be a negative quantity. |

**ACTIVITY 6.2** **I DO**

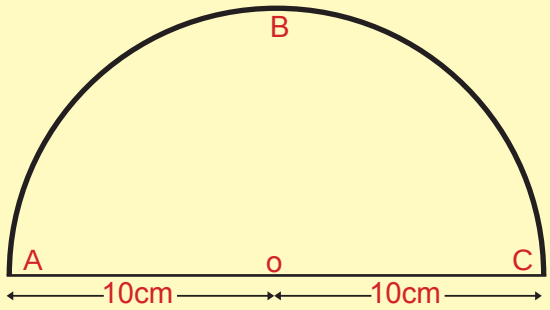


*I walk from one corner of my classroom to the opposite corner along the sides. I measure the distance, I have covered. Now I walk diagonally across to the opposite corner and measure the displacement. I note the difference.*

_____

SCIENCE

**ACTIVITY 6.3** **I DO**




*I draw a semicircle of radius 10cm and I measure the path ABC (distance) and AOC (displacement).*

*I can observe that the distance = 31.4 cm and the displacement = 20 cm.*

## 6.4. SPEED, VELOCITY AND ACCELERATION

Speed is the rate of change of distance with respect to time or the distance travelled per unit time. The SI unit of speed is metres per second. It is a scalar quantity.

Velocity is the rate of change of displacement with respect to time. It is the displacement per unit time. The SI unit of velocity is metres per second. It is a vector quantity and therefore, the direction must always be specified along with the magnitude and the units.

Let us compare the two terms speed and velocity to understand the similarities and differences:-

| Speed | Velocity |
|---|---|
| It is the rate of change of distance with respect to time. | It is the rate of change of displacement with respect to time. |
| It is a scalar quantity (having only magnitude) | It is a vector quantity (having magnitude and direction). |
| Speed is velocity without a particular direction. | Velocity is speed in a particular direction. |
| It is measured in metres per second in the SI system. | It is measured in metres per second in a particular direction in the SI system. |
| Distance can either be equal to or greater than displacement. | Displacement is either equal to or lesser than the distance. |
| Speed in any direction would be a positive quantity, since distance in any direction is a positive quantity. | Velocity can be a negative quantity. If velocity in one direction is assumed to be positive, then the velocity in the opposite direction would be a negative quantity. |

Acceleration:

Acceleration is the rate of change of velocity with respect to time or it is the rate of change of velocity in unit time. It is a vector quantity. The SI unit of acceleration is m/s per second, also written as $m/s^2$ or $ms^{-2}$.

The velocity of a car moving in a particular direction changes from 10 m/s to 50 m/s in 10 seconds. What will be its acceleration? Look at the box on the right to find it out. The acceleration is 4m/$s^2$, which means that every second the velocity increases by 4m/s. If the velocity is reduced from 50m/s to 10m/s, then we would get an acceleration value that is negative, indicating that the velocity is reducing. Try and work this out by yourself and ask your teacher for a feedback.

$$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{time}}$$

$$= \frac{\text{Final velocity - initial velocity}}{\text{time taken}}$$

$$= \frac{50\text{m/s} - 10\text{m/s}}{10\text{s}} = \frac{40\text{m/s}}{10\text{s}}$$

## 6.5. GRAPHICAL REPRESENTATION OF MOTION ALONG A STRAIGHT LINE

### 6.5.1. The distance/displacement -time graph

Plotting a graph of distance/displacement or speed/velocity on a graph helps us visually understand certain things about time and motion. The following table shows the distance walked by Murugan at different times.

| Time (minute) | Distance (metre) |
|---|---|
| 0 | 0 |
| 5 | 500 |
| 10 | 1000 |
| 15 | 1500 |
| 20 | 2000 |
| 25 | 2500 |

A graph is drawn by taking 'time' along the x-axis and 'distance' along the y axis. The graph is known as distance – time graph.

When we look at the distance-time graph of Murugan's walk, we notice certain things. Firstly, it looks like a straight line. We also notice that Murugan covers equal distances in equal intervals of time. We could therefore conclude that Murugan walked at a constant speed. Can you find the speed at which Murugan walked? Think about this for some time before you read on. See if you can find that out by yourself.

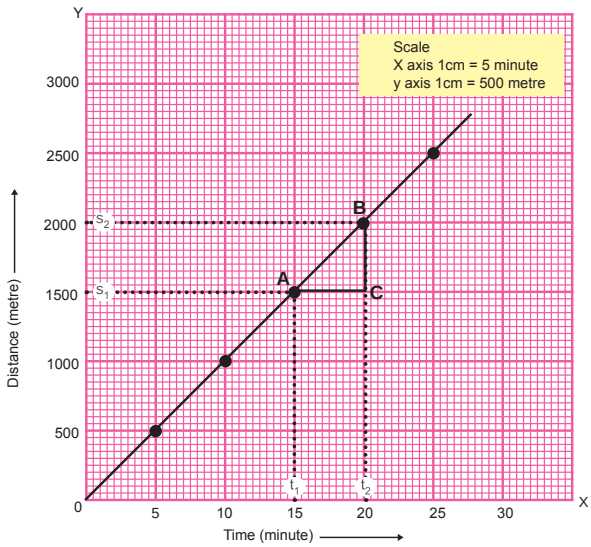



Fig 6.3

The speed at which Murugan walks can be found from the distance-time graph as shown in Fig 6.3. Consider a small part AB. From B, draw a line perpendicular to x axis. From A, draw a line parallel to x axis. These two lines meet each other at C to form a triangle ABC. Now on the graph, BC corresponds to the distance covered ($s_2$-$s_1$), and AC denotes the time interval ($t_2$-$t_1$). The speed at which Murugan walks can be calculated as follows:-

The parameter  is referred to as the slope of the line. The steeper the slope (in other words the larger the value ) the greater is the speed.

Let us take a look at the distance time graphs of three different people – Murugan walking, Kavitha cycling and Swamikannu going in a car, along the same path. We

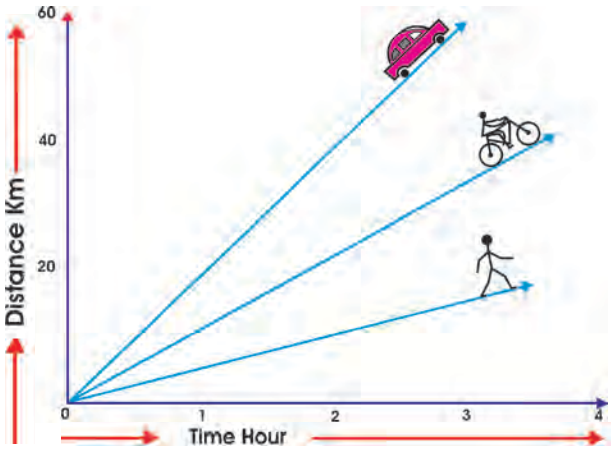



Fig 6.4

know that cycling can be faster than walking, and a car can go faster than a cycle. The distance time graphs of the three would look something like that given in fig. 6.4. The slope of the line on the distance – time graph becomes steeper as the speed increases.

If we plotted displacement in the graph instead of distance, then we would be able to calculate the velocity of the object. We need to note that the direction is not indicated on the graph and needs to be stated in words separately. If it is not stated then it is assumed that the displacement is in a single direction.

### 6.5.2. Uniform and non-uniform speed/ velocity

In the case that we discussed in the previous section, the speed/velocity of all objects were uniform. Uniform speed/ velocity means that the speed/velocity remains constant over time. In the world around us, we notice that the speed of objects keeps changing from time to time. In such a case the distance/displacement – time graphs would not be a straight line.

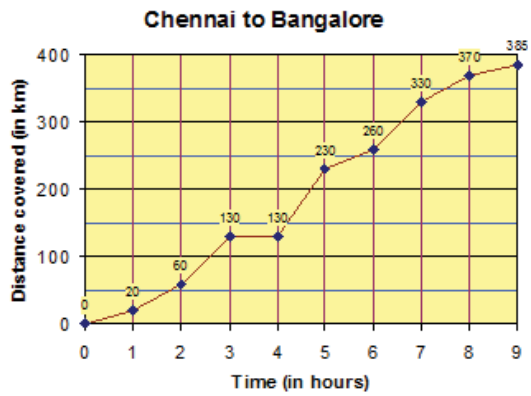



Fig 6.5

**ACTIVITY 6.4** **WE DO**

*The whole class can divide themselves into small groups. Study the graph of the bus travelling from Chennai to Bangalore and discuss the questions given below.*

- *What is the total distance between Chennai and Bangalore?*
- *How long did the bus take for the full journey?*
- *Was the speed of the bus constant?*
- *Did the bus halt for some time during the journey?*
- *If it halted, how long was the halt?*
- *Simply by looking at the inclination of the graph line, can you tell when the speed was the greatest?*
- *What was the maximum speed that the bus attained during the journey?*

### 6.5.3. The velocity-time graph

The magnitude of the velocity of an object moving in a straight line can be

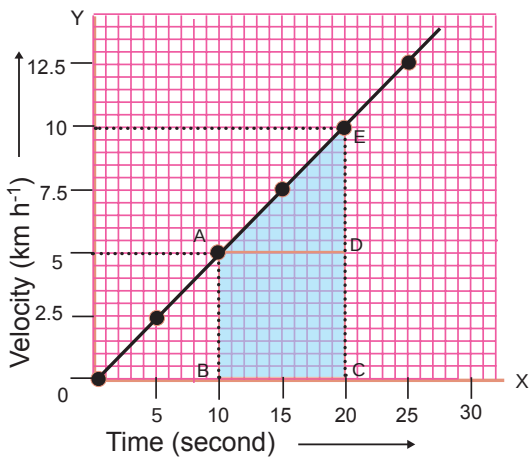



Fig 6.6.

**ACTIVITY 6.5** **I DO**

*Study the velocity-time graph of the car in fig 6.6 and answer the questions given below:-*

- *What is the maximum value of velocity during the journey?*
- *Was the velocity constant during any part of the journey? If so, when was it?*
- *What was the maximum value of acceleration during the journey? When did it occur?*
- *When did the car slow down?*
- *What was the value of acceleration during the final slowdown?*
- *Show your working to your teacher and obtain a feedback.*

plotted against time to give a velocity-time graph. What can we learn from a velocity time graph? The following table shows the velocity of a car at regular intervals during a test drive. The velocity-time graph for the motion of the car is shown as in Fig 6.6. When we look at the velocity-time graph of the car, we notice certain things.

Firstly, it looks like a straight line. We also notice that the car velocity is increasing steadily by equal amounts in equal intervals of time. We could therefore conclude that the car is moving with uniform acceleration. Can you find the rate of acceleration of the car? It would be possible to do that and the method is quite similar to finding the speed from a distance-time graph.

The value DE/AD is called the slope of the line. The steeper the slope of the velocity-time graph, the greater is the acceleration. Sometimes the acceleration need not be uniform and may vary over time.Fig 6.6 shows the velocity-time graph of a moving car.

**ACTIVITY 6.6** **I DO**

*Study the velocity-time graph of the car on a test drive and answer the questions given below:-*

- *What is the change in velocity in the time interval t1 = 10 seconds and t2= 20 seconds?*
- *What is the time interval t2-t1 ?*
- *Recall the formula for finding the value of acceleration. If you cannot recall the formula then refer to the book and find out. Try to do this by yourself. Do not ask anyone.*
- *What is the value of acceleration?(calculate using the formula)*
- *What are the units of acceleration in this case?*
- *Show your working to your teacher and obtain a feedback.*

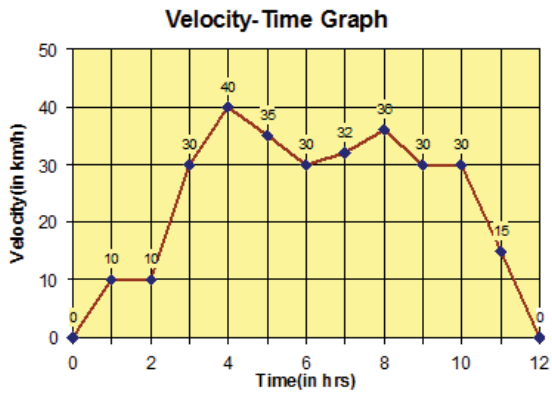



Fig 6.7

### 6.5.4. Finding displacement from the velocity-time graph

Let us see how we can find the displacement from a velocity-time graph (or distance from a speed-time graph). The following graph shows the velocity-time graph for a car moving with uniform velocity of 40km/h. In this graph, time is taken along the x axis and velocity is taken along the y axis. We notice that the velocity time graph

is a straight line that is horizontal ( parallel to the x –axis) indicating that the value of velocity remains unchanged. If we take a time interval of say two hours from t1=1h to t2=3h (shown in blue on the graph), we would notice that AC or BD represents the velocity and AB or CD represents the duration. Since the velocity is constant, if we multiply the velocity by time we would get the distance covered in the two hour duration, which is represented by the area of the rectangle (width x length). We could conclude that the area under a velocity-time graph represents the displacement. This would be true even if the velocity is not constant. Let us take a look at the graph given if fig. 6.8, which is reproduced alongside. To find the area under the graph from t=4h to t=8h, we split it up into a rectangle and a triangle. The area would therefore be:

(40x4)+ (½ X4X40)=160+80=240KM

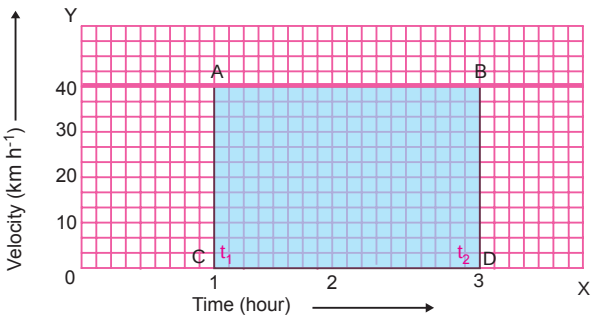



Fig 6.8

## 6.6. EQUATIONS OF MOTION

Instead of plotting a graph and calculating the area, slope etc. in order to find the displacement or acceleration, it is possible to evolve some formulae which can enable us to calculate these values. The three standard equations of motion are:

$v = u + at$

$s = ut + ½ at^2$

$v^2 – u^2 = 2as$

Where u is the initial velocity, v is the final velocity, a is the acceleration and s is the displacement.

These equations can be derived from the graphs. Consider the velocity- time graph in fig 6.9 where the velocity changes from u at point A to v at point B. From A, draw two perpendiculars, one to the x axis (AC) and another to the y axis (AD). Similarly, perpendicular lines are drawn from B (BE & BF). AG is the perpendicular drawn from A to BE.

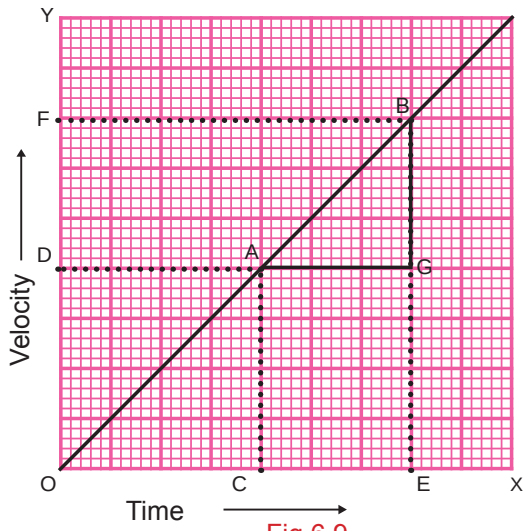



Fig 6.9.

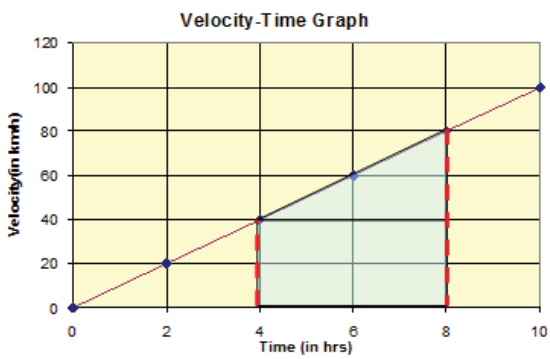



Fig 6.10

### Equation for velocity at a time

By definition, using the symbols we could say Rearranging we get,

$$\text{Acceleration} = \text{slope} = \frac{BG}{AG}$$

$$= \frac{\text{change in velocity}}{\text{time}}$$

$$= \frac{\text{final velocity - initial velocity}}{\text{time elapsed}}$$

$$a = (v-u)/t$$

This can be rearranged to become,

$$v = u + at$$

### Equation for displacement after a given time

To obtain the second equation we need to find 's' the displacement, which is nothing but the area under the line AB. This as we know can be obtained by adding the areas of the rectangle ACEG and the triangle AGB. The area of rectangle ACEG is given by multiplying AC(initial velocity, u) with AG(time elapsed, t) which is equal to ut. To this, we add the area of the triangle AGB which is half the base multiplied by the height. The base is AG which is nothing but the elapsed time, t. The height of the triangle is BG which is nothing but the change in velocity, v-u which in turn is equal to 'at'. Thus,

Total area of ABEC
= area of ACEG + area of AGB

$$s = ut + \frac{1}{2} \times t \times at = ut + \frac{1}{2} at2$$

### Equation for velocity at a given position

In the graph,

Displacement = Area of the trapezium CABE

$$s = \frac{1}{2} x(u+ v) \times t$$

$$\Rightarrow 2s = (u+ v) \times \frac{(v-u)}{a}$$ (Substituting the value of **t** from the equation v = u+ at)

$$\Rightarrow 2as = v^2 - u^2$$

$$\Rightarrow v^2 - u^2 = 2as$$

### Acceleration due to gravity

What do we observe when a body is thrown vertically upwards?

The velocity of the body gradually decreases and becomes zero at which stage, it reaches its maximum height. The velocity then gradually increases in the downward direction till the body reaches the ground. There is a constant acceleration in the downward direction due to gravity, which is responsible for the decrease in velocity followed by an increase in velocity in the downward direction. This constant downward acceleration is referred to as the acceleration due to gravity denoted by the letter 'g'. The average value of 'g' is 9.8 $m/s^{-2}$. The velocity of the body thrown vertically upwards will decrease by 9.8m/s every second and the velocity of a body falling down increases by 9.8m/s every second. Since the acceleration due to gravity is a constant value, the equations of motion can be applied to any object that falls vertically or is thrown up vertically.

## 6.7. CIRCULAR MOTION

### 6.7.1. Uniform circular motion

The movement of an object in a circular path is called circular motion. Some examples of circular motion are :-

- A person sitting on a merry-go-round goes around in a circular path.
- A car moving on a circular road or a curved racing track follows a circular path.
- An electron having a circular orbit around the nucleus.
- A stone tied to a string and whirled around – in athletics, such a sport is called the hammer throw.

In real life, some of the objects may not follow an exactly circular path but may follow a near circular path as for example, the electrons or the planets that orbit around the sun. If the object moves at uniform speed on a perfectly circular path then we call it uniform circular motion. In this section, we will discuss the ideal case of a perfectly uniform circular motion.

### 6.7.2. Centripetal Acceleration

Uniform circular motion is a special case, where the speed of an object remains constant but the direction keeps on changing. We could therefore say that the velocity changes when the direction of motion changes. Since the velocity is changing then there must be acceleration, since the change in velocity must be happening over a period of time. Further, since the speed is uniform, the object is changing direction at a uniform rate and therefore we could conclude that the acceleration is uniform. You will later learn how to derive an expression for this acceleration and also prove mathematically that it is a constant acceleration. This uniform acceleration that causes uniform circular motion is called Centripetal acceleration. Centripetal acceleration always acts perpendicular to the direction of the velocity and always acts radially towards the centre. Can you give reasons why the centripetal acceleration should be perpendicular to the velocity and always act radially towards the centre? Think about it for some time and check your reasoning with that given in the text box.

**TWO REASONS....**

1. *If the acceleration were to act in the direction of the velocity, then the magnitude of the velocity (speed) would change. We however see that the speed does not change; therefore, we could conclude that it must be perpendicular to the velocity.*
2. *The arrow representing the velocity is a tangent to the circle. The line perpendicular to it must be radial (passing through the centre of the circle) as we know, the property of a circle is that the tangent is perpendicular to the radius.*

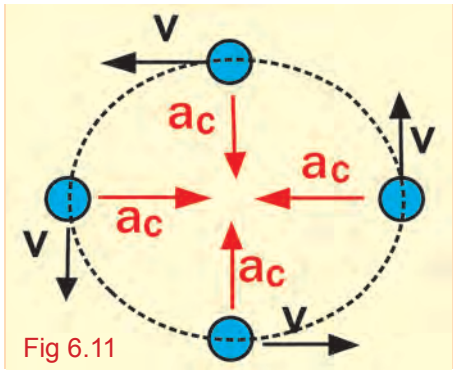


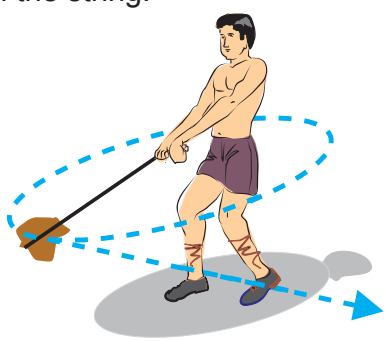
Fig 6.11

### 6.7.3 centripetal force

Tie a stone to a piece of rope and rotate it in a circle. You will find that you have to exert a force (in the direction shown by the arrow in the diagram) to keep the stone going around in a circle. If you let go of the rope, the stone along with the rope, will fly off in a straight line as shown in the diagram (tangent to the circle). This force that keeps the body going around in circular motion is called the Centripetal force. The Centripetal force acts perpendicular to the velocity and is always directed radially inwards towards the centre of the circle.

E.g.:

1. In the case of the stone tied to the end of a string and rotated in a circular path, the centripetal force is provided by the tension in the string.



2. When a car takes a turn on the road, the frictional force between the tyres and the road provides the centripetal force.
3. In the case of electrons revolving round the nucleus, the centripetal force is provided by the electrostatic force of attraction between the nucleus and the electron.

## MODEL EVALUATION

### PART A

1. Arrange the following speed in the ascending order.

   (7 m/s, 15 km/h, 2km/minute, 0.1 m/millisecond)

2. When a body starts from rest, the acceleration of the body after 2 seconds is _____ of its displacement. (half, twice, four times, one-fourth)

3. The gradient or slope of the distance-time graph at any point gives _____.

   (acceleration, displacement, velocity, time)

4. The area under the velocity-time graph represents the _____ the moving object.

   (velocity of, displacement covered by, acceleration of, speed of)

5. In a 100 m race, the winner takes 10 s to reach the finishing point. The average speed of the winner is _____ m/s.

   (5 , 10 , 20, 40)

6. Give an example of a motion in which the displacement is zero, but the distance travelled is not zero.

7. Is acceleration a scalar or a vector quantity?

8. What determines the direction of motion of an object - velocity or acceleration?

9. What is the nature of the displacement time graph of a body moving with constant acceleration?

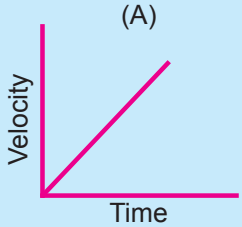
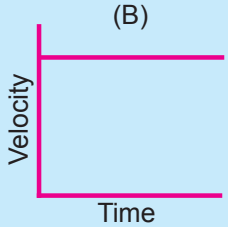
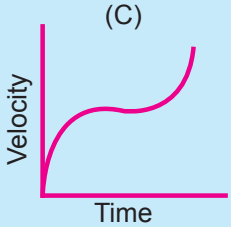
### PART B

1. Complete the table:

| Sl. No | Physical quantity | Unit |
|---|---|---|
| 1 | Velocity | |
| 2 | Acceleration | |
| 3 | Angular displacement | |
| 4 | Angular velocity | |

2. i) Match the following graphs with their corresponding motions.

   ii) What is the value of acceleration in graph 'B'?

| Motion | a) Unaccelerated motion | b) Non-uniformly accelerated motion | c) Uniformly accelerated motion |
|---|---|---|---|
| Graph | (A)   | (B)   | (C)   |

3. *A motorcycle travelling at 20 m/s has an acceleration of 4 m/s$^2$. What does it explain about the velocity of the motorcycle?*

4. *A bus travels a distance of 20 km from Chennai Central to Airport in 45 minutes.*

   *i) What is the average speed?*

   *ii) Why does the actual speed differ from the average speed?*

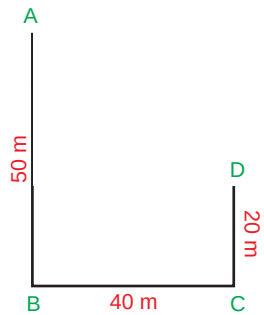
5. *Statement: 'In a uniform circular motion, the magnitude and direction of velocity at different points remain the same'. Check whether the above statement is correct or incorrect. Reason it out.*

6. *A car moving along a straight line covers a distance of 1km towards the east in 100 s. Find (i) the speed of the car. (ii) the velocity of the car.*

7. *A student takes 15 minutes to travel from his home to school with a uniform speed of 5km/h. What is the distance of his school from the home?*

8. *The speed of a particle is constant. Will it have an acceleration? justify with an example.*

9. *A boy moves along the path ABCD. What is the total distance covered by the boy? What is his net displacement?*




10. *State whether the following statements are true or false:*

    *(a) The velocity – time graph of a particle falling freely under gravity would be a straight line parallel to the axis.*

    *(b) If the velocity- time graph of a particle is a straight line inclined to time axis, then its displacement - time graph will also be a straight line?*

11. *Mention the uses of velocity- time graphs.*

12. *A car manufacturer advertises that the brakes are so perfect that when applied, the car would stop instantaneously. Comment on this.*

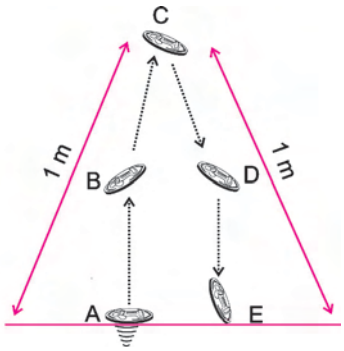
13. *Can the speed of a body be negative?*

14. *The value of 'g' remains the same at all the places on the earth's surface. Is this statement true?*

15. *A car starting from rest acquires a velocity of 180 m/s in 0.05 h. Find its acceleration.*

## PART C

1. A coin is tossed with a velocity of 3 m/s at A.

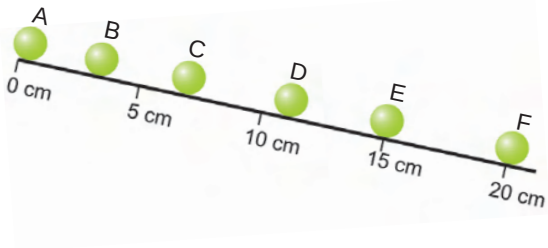



a) What happens to the velocity along AB, along DE and at C?

b) What happens to the acceleration of the coin along AC and CE?

c) What is the distance and vertical displacement covered by the coin between A and E.

2. The diagram shows the position of a ball as it rolls down a track. The ball took 0.5 s to roll from one position to the other.



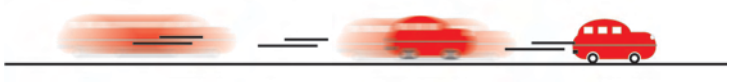

a) State whether the motion of the ball is uniform or non-uniform.

b) What is the distance travelled by the ball in 2.5 s?

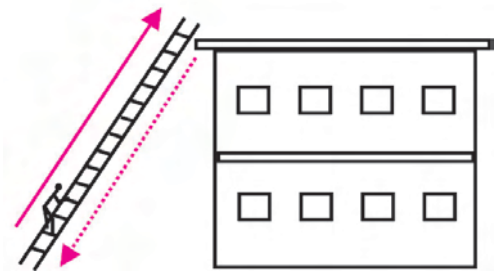
c) Find the average velocity of the ball from A to F.

3. Consider the motions in the following cases.

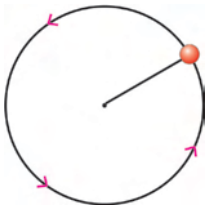
(i) A moving car



(ii) A man climbing up a ladder to the terrace and coming down

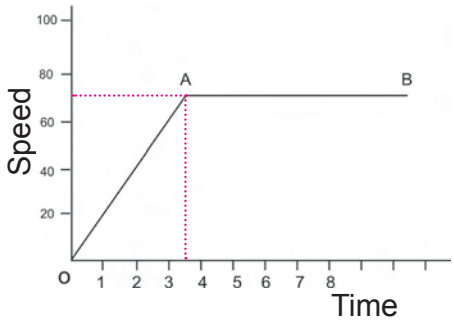


*(iii) A ball that has completed one rotation*



*a) In which of the above cases the displacement of the object may be zero.*
*b) Justify your answer.*

*4. The following graph shows the motion of a car.*

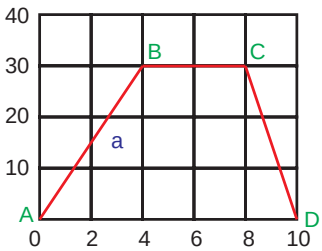



*a) What do you infer from the above graph along OA and AB?*

*b) What is the speed of the car along OA and along AB?*

*5. Derive the three equations of motion by graphical method.*

*6. The adjacent diagram shows the velocity-time graph of a body.*




*a) During what time interval is the motion of the body accelerated?*

*b) Find the acceleration in the time interval mentioned in Part (a).*

*c) What is the distance travelled by the body in the time interval mentioned in Part(a).*

*7. Complete the following sentences:*

*a) A body is thrown vertically upwards with a velocity of 1000 m/s. Its velocity when it reaches the point of projection, during the fall will be _____.*

*b) The acceleration of the body that moves with a uniform velocity will be _____.*

*c) A train travels from station A to station B with a velocity of 100km/h and returns from station B to station A with a velocity of 80km/h. Its average velocity during the whole journey is _____ and its average speed is _____.*

## Explore and Answer

1. *A student measures the circumference of a sector formed by an arc of a circle, which forms the angle one radian at its centre as 3 times the radius. Is his answer correct? Justify.*
2. *A girl observes the motion of a crab which makes a forward motion of 2 cm and reverse motion of 1 cm every time. If it takes a time of 1 second to move 1cm, plot a graph to find out how long it will take to reach a point, 5 cm from the start.*
3. *A particle moves at a constant speed in a circular path. Is it accelerated? Give reason for your answer.*
4. *From the following table, check the shape of the graph.*

| v (m/s) | 0 | 20 | 40 | 40 | 40 | 20 | 0 |
|---|---|---|---|---|---|---|---|
| t (s) | 0 | 2 | 4 | 6 | 8 | 10 | 12 |

5. *A girl starting from a point walks in a circular park of radius 70 m and comes back to the same point. Is the distance covered and the displacement, the same? Justify.*
6. *Observe the following motions and classify them as uniform motion, non-uniform motion and circular motion. Motion of a football player, motion of a fan, motion of an ant, motion of a town bus, motion of the moon, motion of spectators in an auditorium, motion of the arms of clock.*
7. *Find the displacement of a car which increases its speed from 20 m/s to 80 m/s in 12 seconds.*



### FURTHER REFERENCE

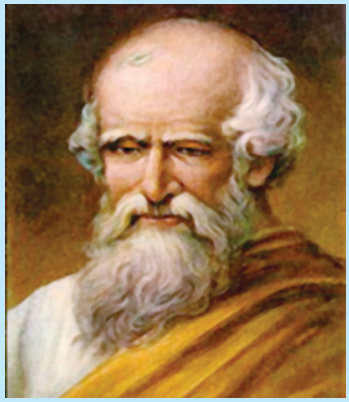
Books: 1. General Physics - Morton M. Sternhein - Joseph W. Kane - John Wiley
2. Fundamentals of Physics – David Halliday, Robert Resnick & John Wiley

Webliography: http://www.futuresouth.com
http://www.splung.com

Chapter 7

# LIQUIDS

- Liquids
- Up thrust and buoyancy
- Archimedes
- Some applications of Archimedes' Principle
- Relative density
- Explanation for a body, wholly or partially immersed in a liquid



Archimedes (BC 287 – BC 212) was one of the greatest Greek thinkers, mathematician, physicist, engineer, inventor, and astronomer of his times. He discovered many important principles of statics (physics relating to stationary objects) and hydrostatics (science relating to liquids at rest) and put them into practice. He was the son of an astronomer and a friend and relative of Hiero, king of Syracuse. He received his training and education in Alexandria, in Egypt which was the centre of learning in those days.

He invented the water screw for lifting water from a lower level to a higher level to irrigate the fields of Egypt. He discovered the principle of lever and is reported to have said to the king: "Give me a long enough rod and a place where I may rest it and I will move the world". He invented many mechanical devices.

One of his greatest discoveries later named after him – the Archimedes' Principle has remained one of the most important principles of hydrostatics. There is a popular story that is linked to the discovery of the principle that would be interesting to read about.

The story goes that the king had ordered a jeweller to make a crown of gold which he wanted as an offering to God. When the crown was delivered, the king suspected it might be mixed with silver which in those days was considered a less valuable and cheaper metal than gold. So the king asked Archimedes to look into the matter. The challenge before Archimedes was to find out whether the gold crown had any silver mixed in it without actually destroying or damaging the crown in any way.

The intense man that he was, Archimedes pondered over the question a great deal but the real breakthrough came when he was having a bath. He noticed that the level of water rose in the tub and overflowed. His quick mind immediately recognized that objects with identical weights but made of different materials, when immersed in water, would displace different quantities of water. It is said that he was so excited by the discovery that he jumped out of the bath and ran to the palace shouting 'Eureka' 'Eureka' not realising that he still hadn't got his clothes on !! Eureka in ancient Greek means 'I found it'. It is said that he obtained an equal weight of pure gold from the royal treasury and immersed the crown and the pure gold piece into a tub filled with water to the brim. If the crown displaced a different quantity of water compared to the pure gold piece, it would clearly indicate that the crown was not made of pure gold. Quite ingenious! What the outcome of the test was is not known but the story of the discovery and the principle itself has outlived the result of the test!!!

What is this principle that so excited Archimedes? Shall we find out?

## 7.1. PRESSURE IN A LIQUID

Let us quickly recapitulate certain things we already know about liquids before going further.

### 7.1.1. Pressure and Depth

The pressure at a point inside a liquid increases as the depth increases. The pressure depends only on the vertical distance from the surface of the liquid. In scientific language we say that the pressure is proportional to the depth. This is written in mathematical language as follows:-

$$p \propto d$$

where $p$ is the pressure and $d$ is the depth.

### 7.1.2. Direction of Pressure at a point inside the liquid

Experiments reveal that the pressure at a point acts in all directions. The pressure does not depend on the shape, size or area of the container.

### 7.1.3. Pressure and Density of liquids

At a point at the same depth in two different liquids, the pressure depends on the density of the liquid. Stated in scientific language, the pressure is proportional to the density of the liquid and can be written as follows:-

$$p \propto \rho$$

where p is the pressure and the greek letter ρ (pronounced 'roh') stands for the density of the liquid.

### 7.1.4. Pressure and Acceleration due to gravity

At a point in the same liquid at the same depth, the pressure is proportional to the acceleration due to gravity and can be written as follows:-

$$p \propto g$$

Thus, if the pressure at a point in a beaker of liquid is $10 N/m^2$, it would be about $1/6^{th}$ on the surface of the moon since the acceleration due to gravity on the moon is about $1/6^{th}$ than that on the earth.

### 7.1.5. Pressure at a point in a liquid

We usually combine the three and write a simple formula to calculate the pressure at a point in a liquid.

$$p = d\rho g$$

## 7.2. RELATIVE DENSITY

You have already learnt what density of a substance is; it is the mass per unit volume of a substance.

$$Density = \frac{mass}{volume}$$

Relative Density of a substance is the ratio of the density of the substance to the density of water.

$$RD = \frac{density\ of\ subtance}{density\ of\ water}$$

## 7.3. BUOYANT FORCE OR UPTHRUST

### 7.3.1. Buoyant Force on an Object Immersed in a Liquid

If you have stood inside water in a pond or a swimming pool, you would have noticed that the body feels much lighter inside the water than outside it. It is very easy to stand on the tip of the toes while you are inside the water but it is difficult when you stand outside the water. This force that opposes the weight of the body is referred to as the buoyant force or upthrust. The buoyant force comes into existence whenever a body is immersed in any fluid (liquid or gas).

Let us consider a cylindrical body immersed in a liquid of density ρ. There is

force $F_1$ acting on the top of the cylinder perpendicular to it, as shown in the diagram alongside. At the same time, there is a force $F_2$ acting on the bottom surface of the cylinder as shown in the diagram. Both these forces $F_1$ and $F_2$ are in opposite directions. Hence the net force acting on the cylinder due to the fluid would be ($F_1$ - $F_2$). Remember, however, that the force $F_2$ would always be greater than the force $F_1$. Pause on that statement for a few minutes and think why. Do not read further till you have thought for sometime.

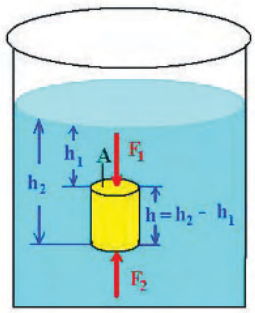



Fig. 7.1.

The force acting on the top surface of the cylinder $F_1$ would be equal to the product of the pressure, $P_1$ on the top surface and area, A . Remember that the pressure is proportional to the depth. Since $h_2$ is deeper than $h_1$, the pressure at $P_2$ would be greater than pressure $P_1$. Thus the force $F_2$ would be greater than F1 and the net force acting on the cylinder would be the difference between the two forces ($F_2 - F_1$).

$F_2$-$F_1$ = $h_2\rho gA$-$h_1\rho gA$

= $A\rho g(h_2-h_1)$ = $A\rho gh$,

where h is the height of the cylinder,

= $V\rho g$,

since the area of the base X height would be equal, the volume of the cylinder,

= Mg

since the volume of the cylinder multiplied by the density of the liquid equals the mass of the liquid displaced.

**MORE TO KNOW**

*Can we really measure our true weight on the earth….?*

*Imagine the earth's atmosphere to be a giant ocean of gas. Our bodies are immersed in this ocean of air and therefore experience a buoyant force that acts opposite to the direction of weight. The buoyant force would be equal to the weight of air displaced by the body. So can you really measure the true weight of any body?*

= Weight of the liquid displaced by the cylinder

### 7.3.2. Equal Volumes Feel Equal Buoyant Forces

You have equal sized spheres of cork, aluminium and lead, which have respective relative densities of 0.2, 2.7 and 11.3. If the volume of each is say 10 cubic centimeters, then their masses are 2, 27 and 113g respectively. When wholly immersed in water, each would displace 10cc of water thus suffering a 10gf loss of weight. The aluminium ball would weigh 17gf (27gf – 10gf) and the lead ball would weigh 103gf (113gf – 10gf). The cork however weighs only 2gf in air. Therefore, when an upthrust equivalent to 10gf acts on it; it would 'weigh' (-)8gf (2gf - 10gf ). The cork sphere would accelerate upwards towards the surface, since the net force acting on it is equivalent to 8gf in the upward direction (The force of gravity acting on a body is called weight. The weight

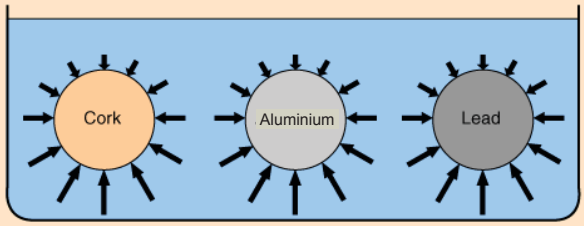



Fig. 7.2.

SCIENCE

of a mass equivalent to 8g is referred to as 8 grams force and represented by the symbol 8gf).

## 7.4. ARCHIMEDES' PRINCIPLE

### 7.4.1. The Statement of the Principle

Archimedes' principle states that:

When a body is immersed in a fluid, (liquid or gas) it experiences an apparent loss of weight which is equal to the weight of the fluid displaced.

The reason for the apparent loss of weight we know is the buoyant force.

### 7.4.2. Verification of Archimedes' Principle

- Suspend a piece of stone from the hook of a spring balance.
- Note the weight of the stone in air ($w_1$)
- Gently lower the stone into an overflowing jar filled with water as shown in the figure.
- Now note the weight of the stone ($w_2$).
- Collect the overflowing water in the beaker whose weight is known ($w_3$).
- Weigh the beaker with water ($w_4$).
- Find the weight of the displaced water ($w_4 - w_3$).
- Find the loss of weight of the stone ($w_1 - w_2$).

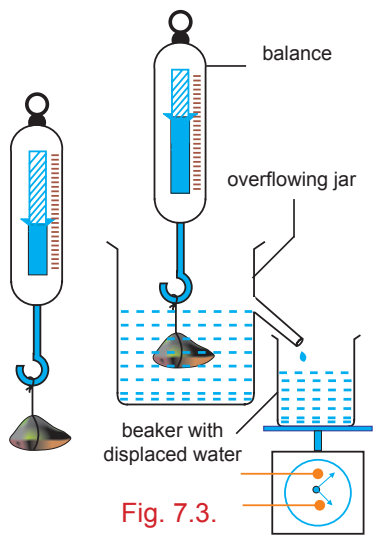



Fig. 7.3.

We find that $(w_1 - w_2) = (w_4 - w_3)$.

Thus the Archimedes' Principle is verified.

## 7.5. SOME APPLICATIONS OF ARCHIMEDES' PRINCIPLE

Some of the applications to which Archimedes Principle is put to use are as follows:-

- Finding the volume of irregular shaped solids (knowing the density of water).
- Finding the density of irregularly shaped solids (knowing the density of water).
- Finding the relative density of a liquid.
- Finding the density of liquids (knowing the density of water).

### 7.5.1. Finding the Volume of Irregularly Shaped Solids

To find the volume of an irregularly shaped object, such as a stone for example, suspend the stone from the hook of the spring balance as you did earlier and note its weight in air ($W_1$). Now immerse it in WATER and weigh the stone once again ($W_2$). According to the Archimedes' principle the loss of weight ($W_1$grams – $W_2$grams) would be equal to the weight of water displaced. Since the weight of 1cc of water is 1g we can calculate the volume of the liquid displaced ($W_1 - W_2$) cc. This in turn would be the volume of the stone. Thus if the loss of weight of an object immersed in water is W grams then, its volume would be W cc. By Archimedes principle,

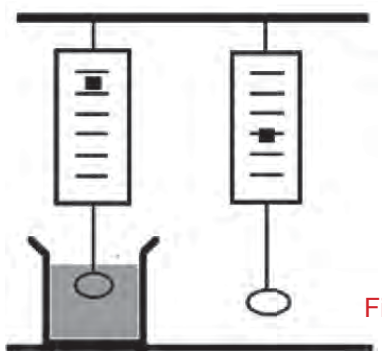


Fig. 7.4.

Loss of weight = weight of water displaced

weight in air – weight in water
= density of water x volume of solid

Volume of solid
$$= \frac{\text{weight in air - weight in water}}{\text{density of water}}$$

Note that the density of a solid is mass per volume which is numerically the same as the weight (in gravitational units) per unit volume. To give an example, the weight of 1000 cc of water is 1000gf. The mass of 1000cc of water is 1000g, which is numerically the same as the weight.

Note:

In this method, you do not need a measuring jar to find the volume of an irregular object. Using the spring balance you could dip the stone in a basin of water, in pond or any water body which has fresh water and not salt water.

### 7.5.2. Finding the Density of Irregularly Shaped Solids

In the previous section, we found the volume by first weighing the stone in air ($W_1$) and then weighing it when immersed in water ($W_2$). Having found the volume using the procedure outlined above, we could find the density using the following :-

$$\text{Density of solid (Numerically)} = \frac{W_1}{W_1 - W_2} \text{ X Density of Water}$$

### 7.5.3. Finding the Relative Density of a Liquid

First weigh any solid in air ($W_1$), then weigh the same solid in water ($W_2$) and in any other liquid ($W_3$). To find the relative density of a liquid, find the loss of weight in water ($W_1 – W_2$) and the loss of weight in the liquid ($W_1 – W_3$).

By Archimedes' principle,

Loss of weight in water = weight of water displaced

$W_1 - W_2$ = weight of water displaced = Mass of water x acceleration due to gravity

= Volume of solid x density of water x acceleration due to gravity

Therefore $W_1 - W_2$

= V x density of water x g ……..(1)

By Archimedes' principle,

Loss of weight in liquid = weight of liquid displaced

$W_1 – W_3$ = weight of liquid displaced

= Mass of liquid x acceleration due to gravity

= Volume of solid x density of liquid x acceleration due to gravity

Therefore, $W_1 - W_2$ = V x density of liquid x g ……(2)

Dividing equation (2) by equation (1)

$$\text{Relative Density of the liquid} = \frac{W_1 - W_3}{W_1 - W_2}$$

### 7.5.4. Finding the Density of Liquid

In the previous section, we learnt how to find the relative density of a liquid. Having found the relative density of the liquid, the density can be obtained by multiplying it by the density of water.

$$RD = \frac{\text{density of substance}}{\text{density of water}}$$

Density of substance = RD x density of water

## 7.6. BUOYANCY AND FLOATATION

When solids are immersed in liquids we find that some solids float and some sink.

SCIENCE

This phenomenon can be explained using the Archimedes' Principle.

Any solid immersed in a liquid will experience an apparent loss of weight due to the buoyant force acting on the object. The buoyant force acts vertically upward and is equal to the weight of the liquid displaced (in section 7.3, we calculated that the Buoyant force = Vρg [Volume x density x acceleration due to gravity]

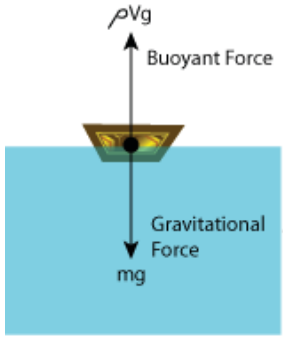



Fig. 7.5.

ρ = density of water
V = volume submerged

The second force that acts on the solid is its weight (or the force of gravity which acts vertically down). Thus the object immersed in a liquid is under the influence of two opposite forces. When one of the two forces is larger than the other, then the object will move in the direction of the resultant force, that is upwards if the buoyant force is larger or downwards if the weight is larger. The object can be at rest only if these two forces are equal. Note that in the diagram shown alongside, the hull shaped object is not fully immersed in the liquid but the volume of water displaced is such that its weight is equal to the weight of the object. We could represent this by an equation as follows:-

$$V\rho g = mg$$

$$\Rightarrow V\rho = m$$

Therefore, the object will 'float' if the mass of the object is equal to the mass of the liquid displaced.

An interesting oft-quoted example is that, an iron ball will sink if immersed in water but a huge ship weighing several thousand tons will float. This can happen only if the shape of the iron is changed in such a way that the weight of the liquid displaced is made equal to the weight of the ship.

Ball : Displaced water weight is much lesser than the ball
Hull : Displaced water

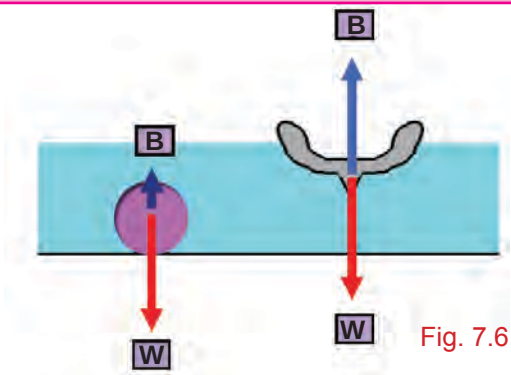
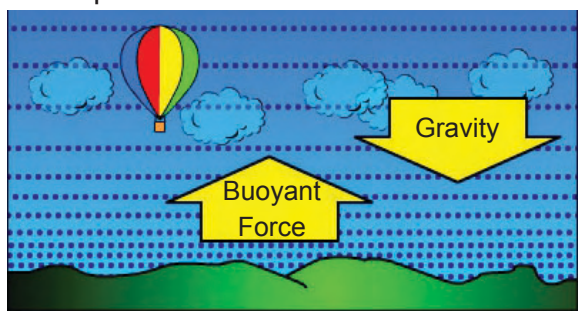



Fig. 7.6.




The density of air is 14 times greater than that of hydrogen. The weight of a hydrogen filled balloon is much lesser than the weight of the air it displaces. The difference between the two weights gives the lifting capability of the balloon. Thus hydrogen filled balloon flies high in the air.

## 7.7. HYDROMETER

The common hydrometer, based on the Archimedes' principle, is an instrument that can be used to find the relative density (specific gravity) of a liquid. To find the specific gravity of the liquid, float the hydrometer in the liquid. The reading on the stem at the level of the liquid indicates the specific gravity of the liquid. It consists of a narrow uniform stem of glass, closed at the top and provided with a glass bulb at the

bottom. The bulb is weighed with mercury or lead shots to make the hydrometer float vertically in liquids. Usually, two different hydrometers are provided-one for liquids denser than water, and the other, for liquids lighter than water.

The hydrometer has a fixed weight. It can float in a liquid only if the weight of the liquid displaced is equal to its weight. If the liquid has a lower density, the hydrometer has to sink deeper in the liquid to displace sufficient liquid to equal the weight of the hydrometer. If the density of the liquid is higher, then it has to sink less into water to displace sufficient liquid to equal the weight of the hydrometer. A hydrometer used to check the purity of milk by floatation is called a lactometer. Similarly, a special hydrometer is also used to check the density of the acid in a car battery.

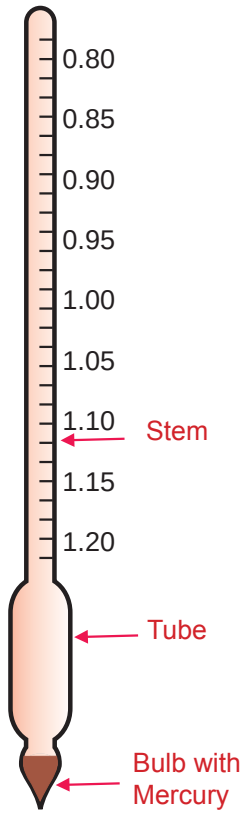
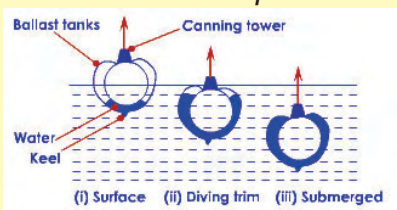



Fig. 7.7. Common Hydrometer

**ACTIVITY 7.1** **I DO**

*Submarines float on the surface of the water and can also submerge below the surface of the water. They have ballast tanks which can be filled with sea water when the submarine wants to submerge. When it wants to float on the surface, the tanks are emptied by blowing compressed air.*

*Can you explain how the submarine floats and submerges using the Archimedes' Principle?*




**ACTIVITY 7.2** **WE DO**

*This activity can be done in small groups…..*

*A Challenge: There is a toy boat floating in a pool. Note the level of water in the pool. Place a lead ball in the boat (without sinking it), and note the level of water in the pool. Now take the ball out of the toy boat and drop it into the pool, and note the level of water again.*

- *Will the two water level measurements be different? If so, which will be higher?*
- *What would be the reason for this difference?*

SCIENCE

## MODEL EVALUATION

### PART A

I. Choose the most appropriate answer:-

1. Pick the odd one out from the following with respect to the properties of a liquid.
   a) They have definite volume. b) Liquids are incompressible.
   c) They have their own shape. d) They have definite mass.
2. Every liquid exerts an upward force on the objects immersed in it. The upward force is called _____.
   a) Gravitational force b) Buoyant force
   c) Mechanical force d) Magnetic force
3. The upward thrust is equivalent to _____.
   a) hg b) mg
   c) Pg d) hp
4. If the density of a liquid increases, the upthrust will _____.
   a) increase b) decrease
   c) increase or decrease d) remain the same
5. Buoyant force acting on an object is equal to the _____ .
   a) mass of the solid b) weight of the solid
   c) weight of the liquid displaced by the object
   d) mass of the liquid displaced by the object.

### PART B

1. State the Archimedes' principle.
2. An object weighs 20 g in air and 18 g when it is immersed in water. Calculate the relative density.
3. Explain what makes objects seem lighter when they are immersed in liquids.
4. What is the relative density of the object immersed in water?
5. Describe an experiment to verify the Archimedes' Principle.
6. Why is it easier to swim in sea water than in river water?
7. Solve these numerical questions:
   a) A solid weighs 80 N in air and 60 N when completely immersed in water. Calculate the _____
      i. Upthrust ii. Volume of the solid
      iii. Relative density of the solid iv. Density of the solid

b) A body weighs 40 N in air, 36.4 N in a liquid and 36 N in water. Calculate the .....

i. the relative density of the body ii. relative density of the liquid

iii. volume of the solid

8. A beaker contains a liquid of density 'ρ' upto a height (h), such that 'PA' is the atmospheric pressure and 'g' is the acceleration due to gravity.

Answer the following questions:

a) What is the pressure at the free surface of the liquid?

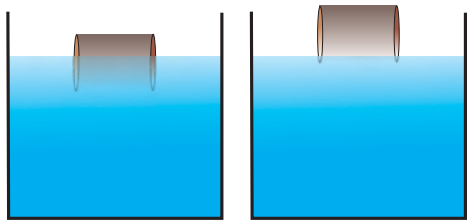
b) What is the pressure at the base of the beaker?

c) What is the lateral pressure at the base on the inner walls of beaker?

9. The base of a cylindrical vessel measures 300cm$^2$, water is poured into it upto a depth of 6cm. Calculate the pressure of water on the base of the vessel. (g=10 m/s$^2$; density of water = 1000 kg/m$^3$)

10. Why is the storage water tank of a building kept on the roof top?

11.




A solid object is floating in liquid A. The same object is made to float in liquid B. Study the diagram and answer the following:

a) Which liquid is denser 'A' or 'B'?

b) In which liquid does the solid object experience greater buoyant force. Justify your answer.

c) How is the buoyant force related to the weight of the solid in both the cases?

12. Why does not a ship made of iron sink in water, while an iron nail sinks in it?

13. Why is it easier to lift a stone under water, than in air? Explain.

14. How are the relative density and the density of a substance related? What is the unit of relative density?

15. A body of mass 'm' is floating in a liquid of density 'd'.

a) What is the apparent weight of the body?

b) What is the loss of weight of the body?

16. Gold is normally weighed on a beam balance, rather than on a spring balance. Explain the reason.

17. 1 kg of iron and 1 kg of cotton are allowed to fall from the roof top of a building simultaneously. Which one do you think will reach the ground first. Justify your answer.

18. A stone of density 3000 kgm$^{-3}$ is lying submerged in water of density 1000 kgm$^{-3}$. If the mass of the stone in air is 150kg, calculate the force required to lift the stone. (g=10 ms$^{-2}$)

19. An object floats in the water at room temperature. Explain your observation when…

i) the water is heated.

ii) the water is cooled to $4^0$C.

20. A trawler is fully loaded with sea water to its maximum capacity. What will happen to the trawler, if moved to river water? Explain.

21. Hot air balloon can rise in air but cold air balloon cannot. Why?

22. A hydrometer is constructed to measure the relative density of liquids lighter than water. What change is needed in the hydrometer, if it has to be used to measure the relative density of the liquids heavier than water?

23. The volume of an irregular object cannot be measured by a simple calculation.

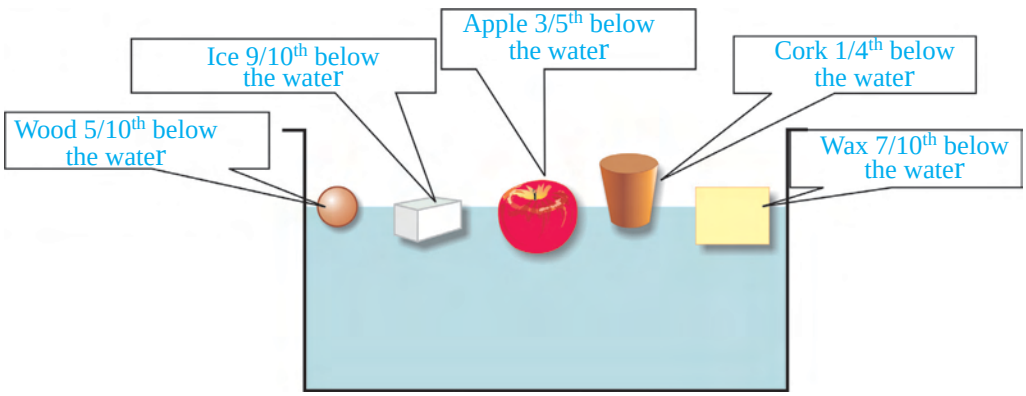
i) Suggest a method to find its volume.

ii) Name and state the principle used in the above case.

## PART C

1. Study the diagram given alongside and calculate the relative density of the floating objects. Write them down with the appropriate units.

a. Wood b. Ice c. Apple d.Cork e. Wax

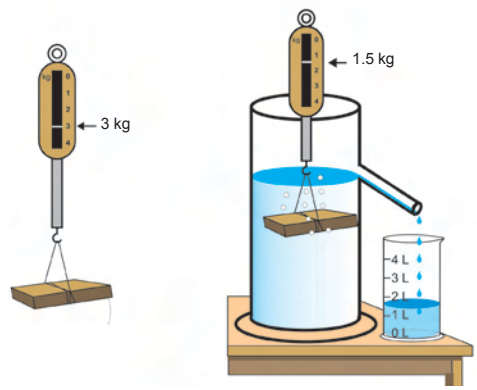



2. A goldsmith claims that the ornaments he make are made of pure gold (of relative density 19.3). He sells a gold article to a customer which weighs 34.75g in air. The customer weighs the article by completely immersing it in water and finds that it weighs 31.890g. By doing suitable calculations, find out whether the article sold by the goldsmith is pure or not.

3. Analyze the diagram and answer the following:

i) What is the apparent loss in weight of the block inside the water?

ii) What do you infer from the diagram?



4. *Answer the following questions with respect to a hydrometer:*

   *i) Why is the stem made long and narrow?*

   *ii) Why is the bottom of the bulb filled with mercury or lead?*

   *iii) Why is the scale graduated from the top to the bottom?*

5. *A weather forecasting balloon of volume $15m^3$ contains hydrogen of density $0.09\ kgm^{-3}$. The volume of equipment carried by the balloon is negligible compared to its own volume. The mass of the empty balloon is 7.15kg. The balloon is floating in the air of density $1.3kgm^{-3}$.*

   *i) Calculate the mass of hydrogen in the balloon.*

   *ii) Calculate the mass of air displaced by the balloon.*

   *iii) Calculate the mass of the equipment.*

6. *A solid object weighs 50gf in air and 30gf in water.*

   *i) Find the buoyant force acting on the object.*

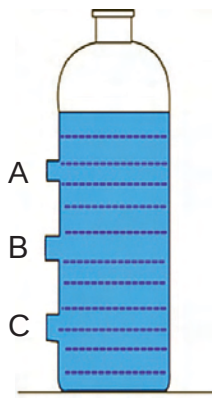
   *ii) Find the volume and the density of the object.*

   *iii) Now water is replaced by a liquid of relative density 2.5. Find the apparent weight? Will the solid object sink or float in the liquid? Justify your answer.*

7. *Water is kept in a cylindrical container having three holes 'A','B' and 'C' as shown in the given diagram.*

   *i) Copy the diagram and show the flow of water from each hole.*

   *ii) From which hole will water flow to the longest distance and why?*




SCIENCE

**FURTHER REFERENCE**

Books: 1. General Physics - Morton M. Sternhein - Joseph W. Kane - John Wiley
2. Fundamentals of Physics – David Halliday & Robert Resnick – John Wiley

Webliography: http://www.futuresouth.com

http://www.splung.com

# PRACTICALS

## LIST OF PRACTICALS

| Sl. No. | Name of the Experiment | Aim of the Experiment | Apparatus/ Materials required | Time |
|---|---|---|---|---|
| 1 | Plant Cell | To prepare a temporary mount of the onion peel for study of plant cells | onion bulb, watch glass, coverslip, slide, methylene blue or safranin, glycerine, blotting paper and microscope | 40 minutes |
| 2 | Paramoecium | To identify the prepared slide of paramoecium | compound microscope, paramoecium slide | 40 minutes |
| 3 | Microorganisms | To identify the microorganisms in pond water | pond water in a beaker, compound microscope, glass slide | 40 minutes |
| 4 | Measurement of volume of liquid | To measure the volume of solutions using pipette | pippette (20 ml) beaker (250 ml) | 40 minutes |
| 5 | Classification of Mixtures | To prepare different types of mixtures and classify them as homogeneous or heterogeneous | china dish, beaker (100ml), sugar, glucose, starch powder, sodium chloride, copper sulphate, distilled water, nickel spatula | 40 minutes |
| 6 | Finding the diameter of a spherical body | To determine the diameter of a spherical body using Vernier caliper. | Vernier caliper, spherical object (simple pendulum bob) | 40 minutes |
| 7 | Determining the relative density of a solid | To determine the relative density of a solid object heavier than water using Archimedes' principle | spring balance, brass bob, beaker with water | 40 minutes |

## 1. TO STUDY A PLANT CELL

### Aim:

To prepare a temporary slide of the onion peel for study of plant cells.

### Materials Required:

An onion bulb, watch glass, coverslip, glass slide, methylene blue stain or safranin, glycerine, blotting paper and microscope.

### Procedure:

i. Cut a small piece of onion and separate a peel from one of its inner layers.

ii. Place the peel on a glass slide on a drop of water.

iii. Put a drop of methylene blue or safranin on the peel.

iv. Wash it in water to remove the excess stain.

v. Put a drop of glycerine and cover it with a coverslip.

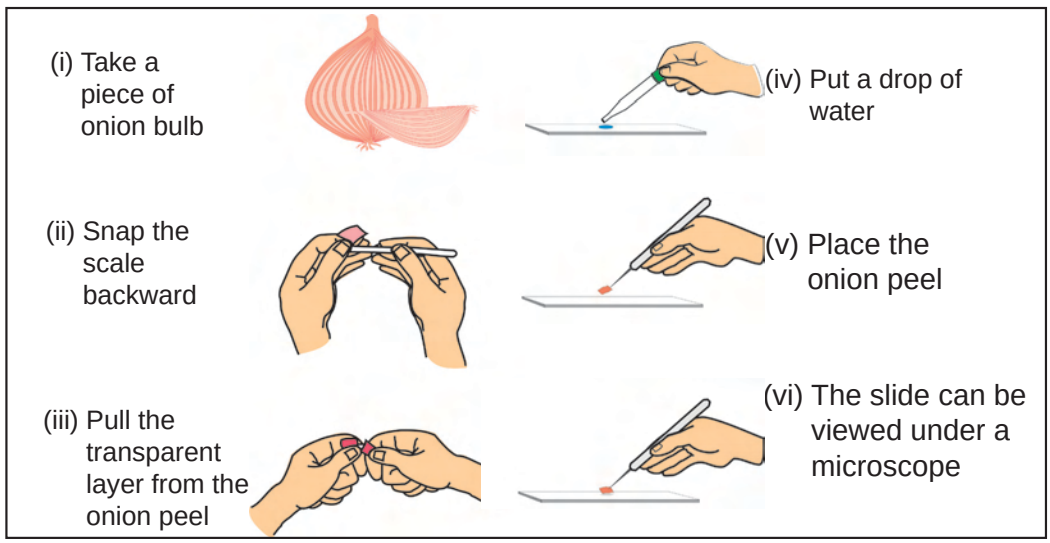
vi. Remove excess glycerine from the edges of coverslip with the help of a piece of blotting paper.

vii. Observe the slide under the microscope, first in low power and then in high power.

### Observation:

Elongated and rectangular cells arranged in a brick-like fashion, can be observed. Each cell has a rigid cell wall outside the plasma membrane and deeply coloured rounded nucleus surrounded by granular cytoplasm. The central part of the cell is occupied by the central vacuole.

### (vi) Stages to show the mounting procedure on a slide.

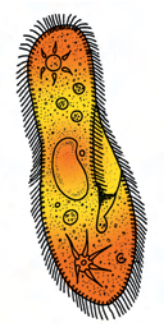



Draw a diagram of the cells as seen under microscope and label the parts Nucleus, Vacuole and Cell wall.

## 2. TO IDENTIFY PARAMOECIUM

Observe a prepared slide of paramoecium under a compound microscope. Draw and label the parts.

### Preparation of sample



Take a few strands of straw and immerse it in a beaker containing water and keep it for about 3 days.

A number of paramoecia are developed, while the straw decays.

Place a drop of water on the slide taken from the beaker and observe it under a compound microscope.

### Identification:

The slide kept for identification is a unicellular protozoan – the paramoecium.

### Observation:

1. The Structure of Paramoecium
2. The Locomotion of Paramoecium

## 3. TO DETECT MICROORGANISMS IN POND WATER

### Aim:

To identify various microorganisms (any three) present in a drop of pond water. Draw diagrams.

### Requirements:

A glass beaker with pond water, glass slide, compound microscope.

### Procedure:

A drop of pond water is put on a glass slide. The slide is kept under the microscope.

### Observation:

Any three microorganisms in the pond water may be identified and neat diagrams are drawn.

### Result:

The organisms found in pond water are:

| Name |
|---|
| 1. Diagram |

| Name |
|---|
| 2. Diagram |

| Name |
|---|
| 3. Diagram |

## 4. TO MEASURE VOLUME OF LIQUIDS

### Aim:

To measure the volume of the given colourless and coloured solutions using a pipette.

### Required Materials:

Pipette (20 ml), beaker (250 ml).

### Procedure:

Take a pipette of definite volume. Wash it with water and then rinse it with the given solution. Put the lower end of the pipette well below the surface of the liquid and suck the solution slowly, till the solution rises well above the circular mark on the stem. Take it out of your mouth and quickly close it with the forefinger. Raise the pipette till the circular mark is at level with your eye. Then release the pressure of your finger slightly to let the liquid drop out slowly until the lower part of the meniscus just touches the circular mark. (For coloured solutions, the upper meniscus should be taken into account.) To discharge, introduce the lower end of the pipette inside the receiving vessel and remove the finger. Record the volume of the liquid measured in the tabular column.

### Tabulation:

| Sl. No. | Name of liquid | Nature of colour | Nature of meniscus | Volume of liquid |
|---|---|---|---|---|
| | | | | |

### Report:

The volume of the liquid measured using the pipette is _____ ml.

### Precaution:

Never use a pipette for sucking strong acids or strong alkalies.

## 5. CLASSIFICATION OF MIXTURES

### Aim:

To prepare different types of mixtures and classify them as homogeneous or heterogeneous.

### Required Materials:

China dish, Beaker (100ml), Sugar, Glucose, Starch powder, Sodium Chloride, Copper Sulphate, Distilled water, Nickel spatula.

### Principle:

Homogeneous mixtures have only one phase and have the same properties throughout the sample.

Heterogeneous mixtures have more than one phase and do not have the same properties throughout the sample.

### Procedure:

Take 2g each of sugar and sodium chloride in a china dish. Mix them thoroughly using a nickel spatula. After mixing, observe the mixture. Do you find any change in the appearance? Identify the nature of the mixture.

Take 50ml of water in a 100ml beaker. Add sodium chloride and copper sulphate salts into it. Stir the mixture well and identify its nature.

Record your observations in the tabular column using the following mixtures and classify each of them as homogeneous or heterogeneous.

### Tabulation:

| Sl. No. | Components of the mixture | Type of mixture |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

### Report:

The given mixture is identified as _____ mixture.

## 6. FINDING THE DIAMETER OF A SPHERICAL BODY

**Aim:**

To determine the diameter of a spherical body using the Vernier Caliper.

**Apparatus required:**

The Vernier calipers, the given spherical body

**Formula:**

Diameter of the sphere = OR ± ZC x $10^{-2}$ m

OR = MSR +(VC x LC) x $10^{-2}$ m

Where, OR = Observed Reading x $10^{-2}$ m

MSR = Main Scale Reading x $10^{-2}$ m

LC = Least Count x $10^{-2}$ m

VC = Vernier Coincidence

ZC = Zero Correction x $10^{-2}$ m

**Procedure:**

- Find the Least Count of the Vernier Caliper.
- Find also the Zero Error of the Vernier Caliper.
- Place the body firmly between the two lower jaws.
- Note the Main Scale Reading and the Vernier Coincidence.
- Repeat the experiment for different positions of the object.
- Measure the diameter of the sphere using the formula,

Diameter of the sphere = OR ± ZC, OR = MSR +(VC x LC)

**Observation:**

Number of Vernier scale divisions, N =

Value of one main scale division (1MSD) =

Least Count = $\frac{1}{N}$ x 1MSD

ZE = ZC =

| S.No. | Main Scale Reading (MSR) cm | Vernier Coincidence (VC) | Observed Reading (OR) = MSR+(VC x LC) cm | Corrected Reading OR±ZC cm |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

Mean

Diameter of the sphere =

**Result :**

Diameter of the given sphere = x $10^{-2}$m

## 7. DETERMINING THE RELATIVE DENSITY OF A SOLID

**Aim:**

To determine the relative density of a solid heavier than water using Archimedes' principle.

**Apparatus required:**

spring balance, three spherical bodies of same material but different weight (e.g. 3 brass simple pendulum bobs of different size), beaker with water.

**Formula:**

$$R.D = \frac{w_1}{w_1 - w_2} \quad \text{no unit}$$

where,

R.D = Relative Density of the solid (no unit)
$w_1$ = weight of the solid in air (kg)
$w_2$ = weight of the solid in water (kg)

**Procedure:**

- Suspend the given solid from the hook of a spring balance.
- Find the weight of the solid in air ($w_1$).
- Immerse the solid in a beaker of water.
- Find the weight of the solid in water ($w_2$).
- Find the weight of the other two solids in air and water.
- Enter the readings in a tabular column.
- Take the average of the last column reading as the Relative Density of the given solid.

**Observation:**

| Sl. No. | Weight of the solid in air $w_1$ $10^{-3}$ kg | Weight of the solid in water $w_2$ $10^{-3}$ kg | $R.D = \frac{w_1}{w_1 - w_2}$ no unit |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

Mean

**Result:**

The Relative Density of the given solid = _____ no unit.

**Note:**

(i) The body should be completely immersed in water.
(ii) The body should not touch the sides or bottom of the beaker.
(iii) No air bubbles should be sticking to the solid.

# 'I can, I did'

## Student's Activity Record

**Subject:**

| Sl.No | Date | Lesson No. | Topic of the Lesson | Activities | Remarks |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |