GOVERNMENT OF TAMILNADU

SCIENCE

IX STANDARD

Untouchability
Inhuman - Crime

Department of School Education

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Chapter 1

IMPROVEMENT IN FOOD RESOURCES

1.1. IMPROVEMENT IN CROP YIELDS

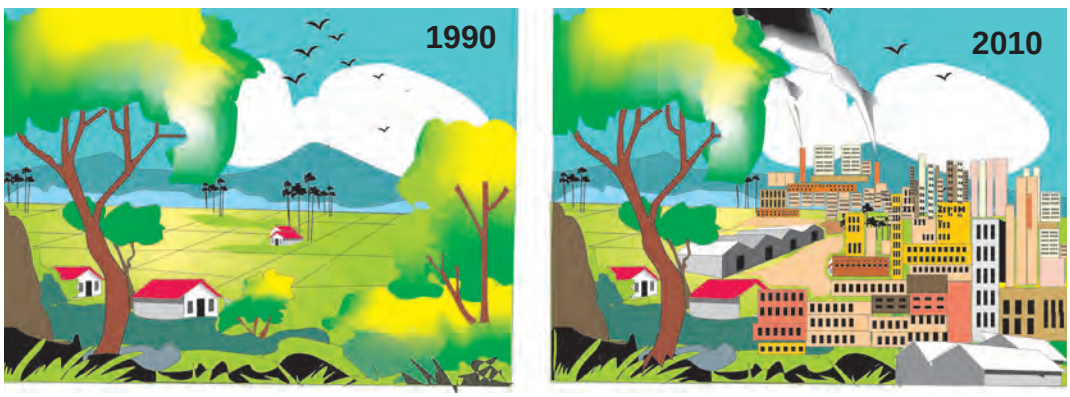
We eat several varieties of food like rice, sambar, idly, dosai, chappathi, poori, pongal, vadai, parotta, bread, sweets, fruit-salad, ice-creams, etc. All these are made from cereals, pulses, greens, vegetables, fruits and animal products like milk, egg, meat, etc.

Food, in general, is derived from plants and animals.

Food is required for growth, development and repair of the body. It also protects the body from diseases and provides energy. Food provides Proteins, Carbohydrates, Fats, Vitamins and Minerals.

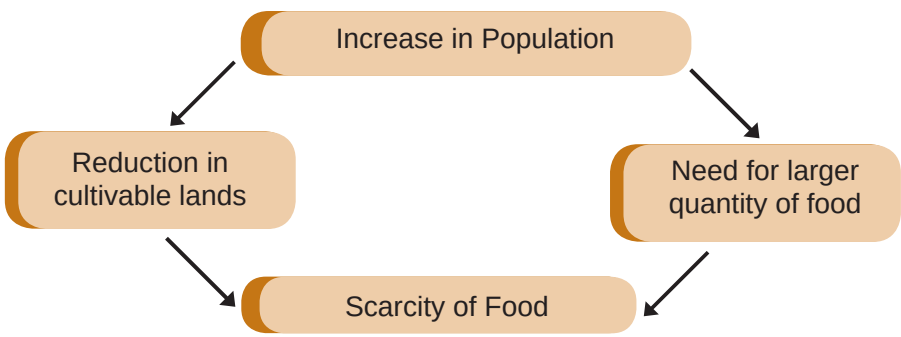
Food	Nutrient
Cereals	Carbohydrates
Pulses	Protein
Meat, (mutton, chicken....), fish and egg.	Fat and protein
Fruits and vegetables, especially green vegetables like spinach and cabbage	Minerals and Vitamins

Observe the pictures given below :



What do we infer from these pictures?

- There is an increase in population.
- Expansion of city and urbanization.
- Houses and Factories are constructed by destroying fertile lands.



Thus, we understand the reasons for the scarcity of food.

The scarcity of food can be overcome by

i) increasing the yield of crops
ii) retaining the cultivable lands without diversion to other uses.
iii) optimizing water usage for cultivation.
iv) improving the preservation and distribution system of food materials.

How to increase the crop yield?

Crop yield can be increased by

- introducing new and improved varieties
- adopting better farm practices

Cultivation or farming can be divided into four stages.

i) Selection of seeds and planting.
ii) Nurturing and protection of the plants.
iii) Harvesting and transporting the yield.
iv) Storing the yield.

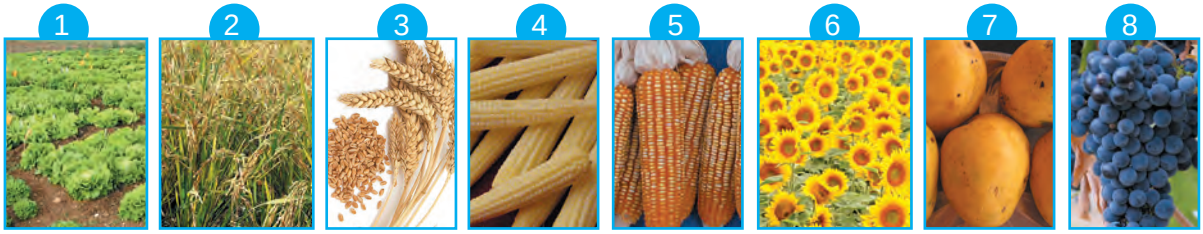
Introduction of new and improved varieties

Improved varieties or strains of crops are produced by selective breeding for various useful characteristics such as disease resistance, response to fertilizers, product quality, higher yield, etc.

Common factors for crop improvement

❍ Higher Yield	To increase the productivity of the crop per acre.
❍ Improved Quality	Quality of crop products vary from crop to crop. Baking quality in wheat, protein quality in pulses, oil quality in oil seeds, etc.
❍ Biotic and abiotic resistance	Crop production is decreased due to biotic (diseases, insects, pests, etc.,) and abiotic factors (heat, cold, salinity and drought). Varieties resistant to these stresses can improve crop production.
❍ Change in maturity pattern	Shorter maturity period; uniform maturity makes the harvesting process easy and reduces losses during harvesting.
❍ Wider Adaptability	One variety can be grown under different climatic conditions in different areas. Developing varieties of wider adaptability helps in stabilizing crop production.
❍ Desirable agronomic characters	Tallness and profuse branching are desirable characters for fodder crops. Dwarfness is desired in cereals. Developing varieties of desired agronomic characters give higher productivity.

Some improved varieties of crops and fruits:



1. Fodder crop 2. Paddy 3.Wheat 4.Baby corn 5. Maize 6. Sunflower 7. Mango 8.Grapes

1.2 NUTRIENT MANAGEMENT

The higher yields of crops mainly depend upon input applications like improved seeds, fertilizers and modern techniques of sowing and harvesting. Plants require a number of nutrients for their growth and development.

Plants get nutrients from air, water and soil.

Nearly 16 elements are essential for plant growth and reproduction.

On the basis of the requirement by the plants, they are further classified into Macro Nutrients and Micro Nutrients.

MACRO NUTRIENTS

Elements which are needed in large quantities for growth of the plants are called Macro Nutrients. They are Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorous, Sulphur, Potassium, Calcium, Magnesium and Iron.

MICRO NUTRIENTS

Elements which are needed by the plants in very small quantities are called Micro Nutrients. They are Manganese, Copper, Molybdenum, Zinc, Boron and Chlorine.

Due to lack of nutrients, deficiency diseases occur in human beings. Likewise, deficiency of macro and micro nutrients affects physiological processes in plants including growth, reproduction and susceptibility to diseases resulting in low yield or no yield at all.

1.3 USES OF MANURE AND FERTILIZERS

We can eliminate deficiency of nutrients by using manures and fertilizers.

ACTIVITY –1.1

Take two potted plants of 'Keerai'. Name them as A and B. Apply cow dung or urea and sprinkle water for potted plant A. Sprinkle water alone for potted plant B. Keep them in sunlight and observe their growth for 15-20 days.

Which one grows faster? Why?

Manure is an organic substance and is prepared by the decomposition of plant and animal wastes.

Based on the kind of biological materials used, manure can be classified as,

i) Compost & Vermi Compost

ii) Green Manure

ACTIVITY –1.2

Collect animal wastes like cow dung, plant wastes, domestic wastes, sewage wastes, etc. and allow them to decompose in a pit in your garden for some days. What do you get?

Compost prepared by using earth worms to speed up the process of decomposition of plant and animal wastes is called Vermi Compost.

Vermi Compost

Green Manures

Leguminous plants like Sunn-hemp or Cluster Bean are grown and then mulched by ploughing them back into the soil. This helps in enriching the soil with Nitrogen and Phosphorous.

Sunn-hemp

Uses of Manure

- Manure enhances the water holding capacity of the soil.
- It increases the number of friendly microbes.
- It improves the soil texture.

FERTILIZERS

Fertilizers are chemicals commercially produced in factories and used as plant nutrients. They supply Nitrogen, Phosphorous, Potassium, etc., They are used to ensure good vegetative growth giving rise to healthy plants.

Type of Fertilizers	Examples
Nitrogenous Fertilizers	Urea, Ammonium Sulphate, Ammonium Nitrate, etc.
Phosphatic Fertilizers	Single Super Phosphate, Triple Super Phosphate
Potassic Fertilizers	Potassium Nitrate, Pottassium Chloride
Complex Fertilizers	Nitrophosphate, Ammonium Phosphate, Diammonium Phosphate (DAP)

Application of fertilizers results in higher yield of crops. At the same time, it increases the cost of farming. As the fertilizers are water soluble chemicals, large part of the fertilizers applied is washed away due to excessive irrigation. They are not fully absorbed by the plants.

This excess fertilizer is washed away into the ponds, lakes, canals and rivers, resulting in the growth of unwanted plants like Water Hyacinth, algae, etc. These plants disturb the water bodies and the flow of water. As a result, fishes and other living organisms do not get sufficient sunlight and oxygen and die.

ACTIVITY –1.3

Visit a nearby paddy field where fertilizer has been applied, and observe the number of earthworms. Compare this with the number of earthworms in a garden where no fertilizer has been applied. What do you observe? why?

Differences between Manures and Fertilizers

Manures	Fertilizers
1. Manure is a natural substance obtained by the decomposition of cattle dung, human waste and plant waste.	1. Fertilizer is a mineral or chemical compound containing nutrients like Sulphur, Phosphorous, Nitrogen, etc.
2. Manures are organic substances.	2. Fertilizers are inorganic compounds.
3. Manures can be prepared in fields.	3. Fertilizers are manufactured in factories.
4. Manures contain all nutrients but in small quantities.	4. They contain higher quantities of one or more specific nutrients.
5. Manures add plenty of humus to soil and improve the texture of the soil.	5. Fertilizers do not result in the addition of humus to the soil.
6. Manures are not easily absorbed because they are less soluble in nature.	6. Fertilizers are soluble in water and it is easily absorbed.
7. Manures are less soluble; they are not easily washed away from the soil and hence their effect is long lasting.	7. Fertilizers are easily washed away by water and hence their effect is of shorter duration and require repeated application.

Fertilizers should be applied carefully in terms of proper dose, time and observing pre-and post application precautions for their complete utilization.

Fertilizers have short term benefits. But manures give long term benefits. We must balance the use of fertilizers and manures to suit the long term and short term need of plants.

1.4 PROTECTION FROM PESTS AND DISEASES

Pests are organisms of plant or animal origin which damage cultivated crops or plant products in storage. Crop yield is lost due to pests during sowing, harvest, storage and consumption. This is a great loss to the national economy.

MORE TO KNOW

Fertilizers which are derived from living organisms are called Bio-fertilizers. The main source of bio-fertilizers are bacteria, cyanobacteria and fungi. Bio-fertilizers are renewable and non-polluting sources of plant nutrients. They also improve the soil condition. Rhizobium and Cyanobacteria such as Anabaena and Nostoc are some common bio-fertilizers.

1.4.1 PEST CONTROL

There are different methods of controlling of the pests. The most common method of controlling pests is the use of pesticides.

A man spraying pesticides

Pesticides are classified as Insecticides, Fungicides, Weedicides, Rodenticides, etc., depending upon their use.

i) **Insecticides :** The chemical substances which are used to kill the insects are called insecticides. e.g. DDT (Dichloro diphenyl trichloro ethane), Malathion etc.,

ii) **Fungicides :** The chemicals used to kill fungi are called fungicides. e.g. Bordeaux mixture.

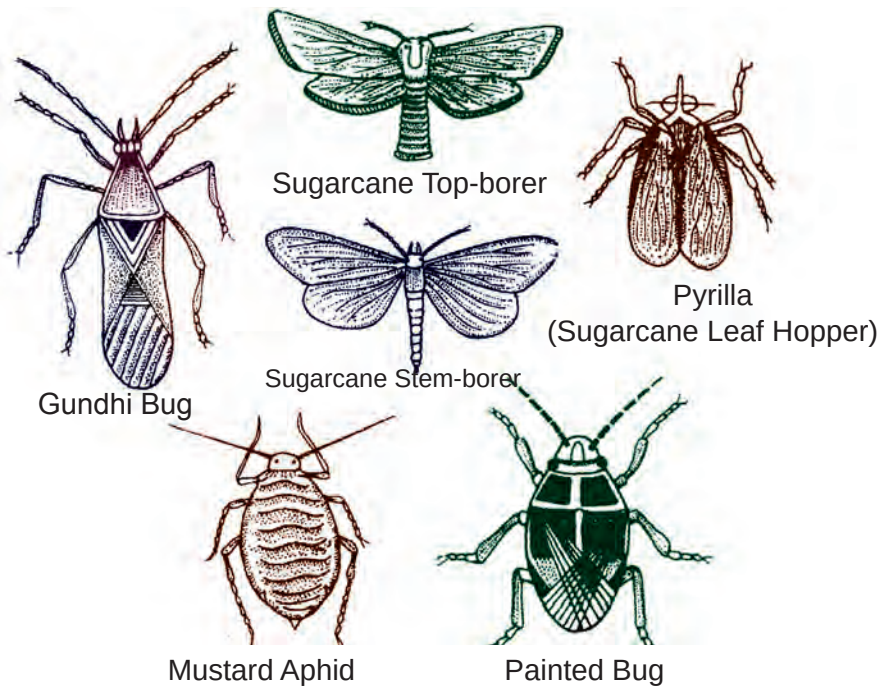
iii) **Weedicides :** The chemical substances which are used to kill the weeds are called weedicides. e.g.2-4-D. (2-4-Dichloro phenoxy acetic acid)

iv) **Rodenticides :** The chemicals used to kill rodents like rats, mice and squirrel are called rodenticides, e.g. Zinc Phosphate, Arsenic etc.

1.4.2 INSECT PESTS

Insects are serious pests of plants which attack them in all stages and parts. Based on the mode of attack, the insect pests can be classified into three types.

i) Chewing Insects: They cut and chew the root, stem and leaves of the plants. e.g. grasshoppers, caterpillars, etc.



Some common Indian Insect Pests of Crop Plants.

ii) Sucking Insects: They suck the cell sap from different parts of the plants. e.g. Leaf hoppers, aphids etc.,

iii) Borer Insects: They bore and enter different parts and feed on the plant tissues. e.g. sugarcane borer.

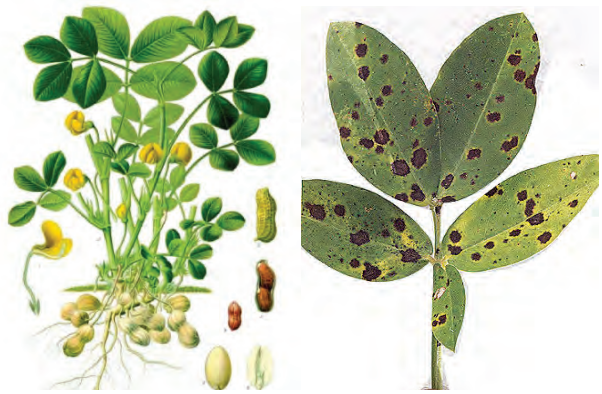
1.4.3 METHODSOFINSECT PEST CONTROL

The infestation of different types of insect pests can be controlled by the following methods.

- Root cutting insects are controlled by mixing insecticides in soil. e.g. Chloropyriphos.
- Stem and leaf cutting and boring insects are controlled by dusting or spraying contact insecticides. e.g. Malathion, Lindane and Thiodan.
- The sap sucking insects can be controlled by spraying insecticides. e.g. Dimethoate and Metasystox.

1.4.4. DISEASES OF CROP PLANTS

A wide variety of plant pathogens such as bacteria, virus and fungi exist in our environment. When they get favourable conditions for their growth and propagation, they spread and infest the crop plants causing diseases. Based on the mode of transmission, plant diseases are classified into four types.



Tikka disease of Groundnut

1.	Seed-borne diseases	They are spread through seeds. e.g. Leaf spot of rice, Loose smut of wheat.
2.	Soil-borne diseases	They are spread through the soil. They affect roots and stems in plants. e.g. Tikka disease of groundnut.
3.	Air-borne diseases	These diseases are transmitted by the air. They attack all aerial parts of the plants like leaves, flowers and fruits. e.g. Blast of rice, Rust of wheat etc.
4.	Water – borne diseases	The diseases which are transmitted through water are called water-borne diseases. e.g. Bacterial blight of rice.

1.4.5 PRECAUTIONS FOR APPLYING PESTICIDES

- Do not touch the pesticide with bare hands; use rubber gloves while handling it.
- Do not blow, suck or apply mouth to any sprinkler, nozzle or other parts of the spraying equipment.
- Do not spray pesticides against the direction of wind in the open field. Use only the prescribed dose of the pesticides for spraying.

Organic Pesticides

As the pesticides are toxic chemicals, they cause environmental pollution. Therefore we should try to avoid excessive use of such chemicals and should adopt the following preventive measures of protecting crops from pests.

- Use of resistant varieties.
- Crop Rotation and cropping system (growing different crops on a piece of land which leads to destruction of pests in the absence of specific host).
- Clean Cultivation (Proper sanitation of field before sowing the crop)
- Summer Ploughing.

Storage of Grains

Most crops are harvested once a year. In order to get food items regularly throughout the year, they are stored in safe storage.

Cereals or food grains are stored by the farmer, trader and Food Corporation of India (FCI).

During storage, grains and seeds are subjected to spoilage by various agencies. Factors responsible for such losses are

i) Biotic factors (insects, rodents like squirrel and rat, birds, fungi, mites and bacteria).

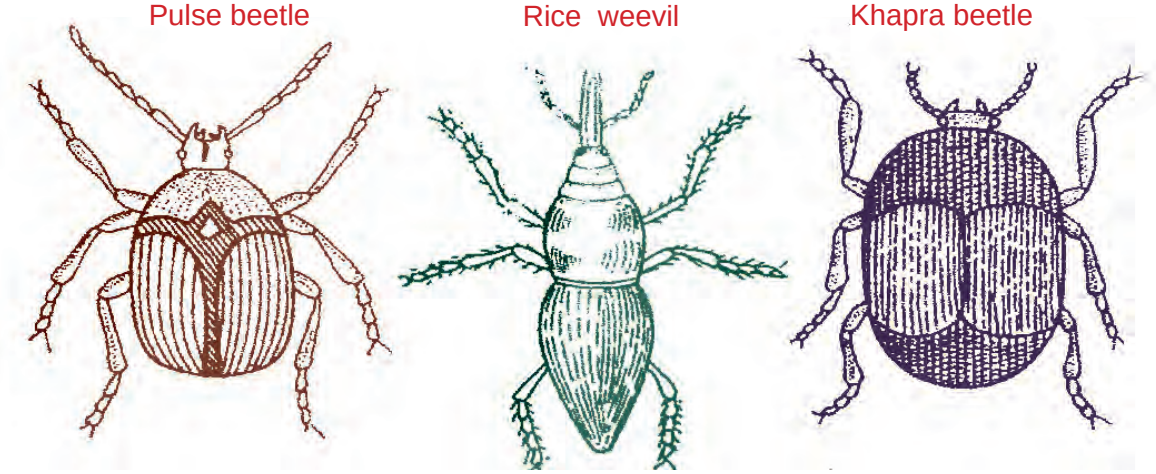
ii) Abiotic factors (moisture and temperature)

These factors cause

- infestation of insects
- degradation in quality
- loss in weight
- poor germinability
- discolouration of produce
- poor marketability.

Therefore, it is essential to protect the produce from any kind of loss during storage.

Preventive and Control Measures are used when produce is stored for future use. They include strict cleaning of the produce before storage, proper drying of the produce in sunlight and then in shade and fumigation using chemicals that kill pests.



Some insect pests of stored grains

ACTIVITY –1.4

Visit nearby crop fields and observe and identify weeds, insect pests and diseases noticed in crops.

1.5 HYBRIDIZATION IN PLANTS AND ANIMALS

1.5.1 HYBRIDIZATION IN PLANTS

Hybridization is the method of producing improved varieties by crossing two or more plants of dissimilar genotypes together. A plant variety containing as many desirable characters as possible can be produced by hybridization.

Hybridization involves selection of parents with desirable qualities. Useful characteristics are scattered in different varieties. It is possible to bring all the characters in a single variety by Hybridization.

Hybridization can be

i) Intervarietal (cross between two different varieties)

ii) Interspecific (cross between two species of the same genus)

iii) Intergeneric (cross between different genera)

Of the above three types, intervarietal hybridization is widely adopted in plant breeding.

F_1

HYBRID VARIETY OF MAIZE

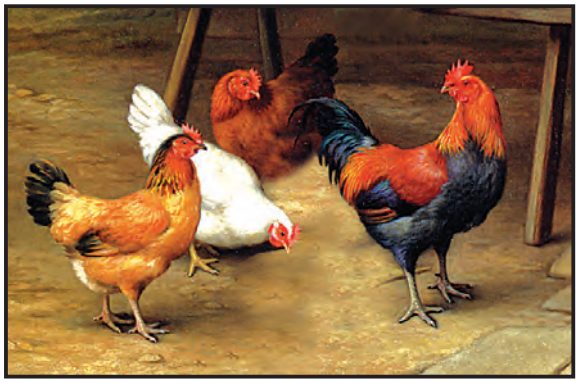
Hybridization procedure includes different steps. They are i) Selection of parents, ii) Selfing of parents, iii) Emasculation, iv) Bagging, Tagging and Labelling, v) Crossing and vi) Harvesting the hybrid seeds and raising F_1 generation.

1.5.2. HYBRIDISATION IN ANIMALS

Hybridisation is a method of breeding, where the offspring is formed by the union of two genetically dissimilar parents. It involves the application of the principles of genetics and physiology of reproduction. Hybridisation has long been used for commercial production of cattle, swine, sheep and poultry. Superior hybrids are likely to be obtained when genetically different parents are used in the cross. Practically, all hybrids of poultry and swine are produced by hybridisation.

The various characteristics of the parent animals which should be taken into consideration for animals breeding are,

1. Resistance to diseases
2. Tolerance to climatic conditions
3. General appearance
4. Size and configuration
5. Productivity
6. Good health
7. Proper age of reproduction



Poultry shed

The different methods of animal hybridisation are as follows :

Inbreeding

Breeding between closely related individuals within the same breed is known as inbreeding. The importance of inbreeding are

1. It is used as a tool primarily for building of desirable genotype and to promote homozygous desirable characters.

Inbreeding in cattle

2. To bring undesirable recessive genes to light. This enable the breeder to separate them from the stock.

3. Inbreeding promotes uniformity.

4. Inbreeding associated with selection can produce improved stocks.

Selection

It is a process of selecting productive individuals for further breeding.Modern approach of selection is based on records of performance.

Out breeding

It is a breeding of unrelated animals which may be between individuals of same breed

a) Out crossing: It involves the crossing of animals of the same breed (without a common ancestor).

b) Cross breeding: In this method, superior males of one breed are mated with superior females of another breed. It involves the fusion of two different breeds in order to combine the desirable qualities of both.

Zebu

c) Inter specific Hybridisation: In this method, male and female animals of two different species are mated. In some cases, the progeny may combine desirable features of both the parents. For example, mule is produced from a cross between female horse (mare) and male donkey. Mules are sturdier and hardier than their parental species, and are well suited for hard work in different terrains like mountainous regions. There are two methods of inter specific hybridisation.

i) Natural Method: In this method crossing of indigenous and exotic breeds takes place in order to significantly improve the yield.

ii) Artificial insemination:

It is a method used in hybridization in which stored semen of a desired male animal is introduced into the genital tract

of a selected female animal by the use of suitable instruments in order to obtain a better breed of the animal.

Advantages

1. Ensures the progeny with desirable qualities.
2. It is an economical method wherein semen from an animal is used to impregnate many females.
3. It provides high yielding animals with increased production of milk, eggs and meat.
4. Frozen semen can be stored for a long period and it can be transported even to the remote areas.

1.6. ANIMAL HUSBANDRY

The branch of agriculture which deals with the feeding, shelter, health and breeding of domestic animals such as cattle, pigs, horses and fowls is called animal husbandry.

The various elements of animal husbandry are :

1. Proper feeding of animals.
2. Provision for clean drinking water for animals.
3. Proper shelter for animals.
4. Prevention and cure of animal diseases.
5. Proper breeding of animals.

ACTIVITY 1.5

Visit an animal husbandry clinic to know about the common diseases of cattle.

MORE TO KNOW

Animal Product	Fat %	Protein %	Sugar %	Minerals %	Water %
Milk	3.60	4.00	4.50	0.70	87.20
Egg	12.00	13.00	Trace	1.00	74.00
Meat	3.60	21.10	Trace	1.10	74.20
Fish	2.50	19.00	Trace	1.30	77.20

1. Cattle feed

Cattle feed has two types of substances roughage and concentrates. Roughage is a coarse and fibrous substance having low nutrient contents. The concentrates are cotton seeds, oil seeds, oil cakes, cereal grains etc.,

2. Shelter

Domestic animals should be provided with proper houses and shelter which can protect them from heat, cold, rain, predator and disease causing organisms. The shelter should be clean, airy, well lighted and well ventilated so that they are safe guarded from various diseases. Proper arrangement should be made for removal of dung and the drainage of animal urine.

Protection of animal health

Protection involves prevention, control and cure of animal diseases to keep them fit and healthy. The diseases are mainly due to virus, bacteria, fungi, etc., Vaccination against infections should be administrated to protect animals from contagious diseases.

NUTRITIONAL VALUE OF MILK

SL.NO.	CONSTITUENTS	FUNCTION
1.	CALCIUM	Builds and maintains bone mass
2.	VITAMIN D	Promotes Calcium Metabolism
3.	PROTEIN	Builds and repairs muscles.
4.	POTASSIUM	Maintenance of Blood Pressure.
5.	VITAMIN B2	Cellular Metabolism
6.	VITAMIN B4	Functioning of Enzymes
7.	VITAMIN B12	Maturation of Red Blood Cells.

White revolution

White revolution attributes to increase in milk production by using new improved breeds of cattle. Dr. V.Kurien is the founder chairman of National Dairy Development Board (NDDB). This board designed and implemented the world's largest dairy development programme called **OPERATION FLOOD**. Dr. V.Kurien is considered as Father of White revolution.

1.7. POULTRY FARMING

Poultry farming is defined as rearing and breeding of avian species for the purpose of egg and meat. Chicken occupy 90% of the total poultry.

The term poultry includes chicken, ducks, geese, turkeys, pigeons, guinea fowls, etc., The poultry industry with its production in the form of eggs and meat is of particular importance in providing a balanced diet for the human population. Proper management of poultry includes methods of hatching, rearing, housing, sanitation, prevention of diseases and a sound marketing system.

Silver revolution

The increase in egg production brought about the 'Silver Revolution' in the area of animal husbandry.

There are more than hundreds of breeds of fowls. The fowls are classified on the basis of their utility to man. They are 1.meat type 2.egg type and 3. Dual type.

Breeds of fowl

Indian breeds – Chittagong, Aseel, Karakanth and busra are four breeds of indigenous fowls in India.

Asiatic Breeds – Brahma and Langshan are asiatic breeds.

Exotic breeds – Plymouth rock, Leghorn, Rhode island, Black Minorca are examples for exotic breeds.

MORE TO KNOW

Vegetarian eggs: Fertile eggs rot more rapidly than infertile eggs. Hence the production of infertile eggs is desired. Hens are capable of laying eggs without the presence of cock and the eggs obtained are infertile. Such eggs are called vegetarian eggs.

MORE TO KNOW

White leghorn is the most high egg yielding breed in the world.

India ranks fifth in the world poultry production.

Examples for cross breeds of Poultry are – HH-260, IBL-80, B-77, IIS-82

Advantages of Cross breeds

1. Cross breeds lay more number of eggs.
2. The eggs produced are larger in size.
3. They yield more meat.

Nutritional value

Eggs and meat are a good source of protein. Eggs also contain calcium, Phosphorus, sodium, Vit. B1, B12, D, etc,

Housing of Birds

The two principal methods of birds keeping generally used in India.

They are a) semi-intensive method and b) intensive method.

Poultry farm

Poultry feed

Poultry diets are composed primarily of a mixture of cereal grains, soya bean meal, Fish meal, Bone meal, Wheat bran, groundnut cake, barley, oats, maize, animal by product meals, etc. Trace minerals such as Zinc, iron, copper iodine, manganese, selenium etc. must be included in the poultry feed.

Poultry disease and control

Poultry are often affected by diseases and attacked by predators (eg. Cat, Dog, Fox). Some of the common diseases found in Indian fowl are Tick fever (Spirochaetosis), Tuberculosis, Fowl Cholera, Fowl Pox, Flu, etc.,

Disease control

Poultry diseases can be controlled by vaccination, Isolation of affected ones, improving the sanitary conditions, removing dampness and exposure to sunlight. Feeding poultry a well balanced diet will prevent them from developing deficiency diseases.

Poultry industry in Tamilnadu

The Tamilnadu Government is giving much importance to poultry industry. Namakkal, Palladam and Chennai are well known for poultry industries. Each child is given an egg on all school working days in Tamilnadu.

ACTIVITY –1.6

Visit a nearby poultry farm to observe rearing, feeding and breeding of birds.

1.8. PISCICULTURE

The process of rearing and breeding of fishes in rivers, streams, ponds, irrigation canals, paddy fields, etc., is known as pisciculture.

Pisciculture has an important place in Indian economy. It provides income and employment to millions of fishermen and

Common carp

farmers, particularly in the coastal areas.

Factors to be considered for pisciculture

1. Topography or location of pond.
2. Water resources and quality of water.
3. Soil quality (Nutrients)
4. Temperature of the water.

Types of fish culture

a. **Extensive fish culture** – growing fish on natural feed.

b. **Intensive fish culture** – Growing fish on artificial feed to maximize production

c. **Monoculture** – Growing a single type of fish in a given water body.

d. **Poly culture** - Growing one or more types of fishes with different feeding habits together in a water body.

e. **Integrated fish culture** – Growing fish with agricultural crops or other animals.

Types of fishing ponds

Fish culture requires different types of ponds for the various stages of growth of fish. The types of ponds are as follows,

1. **Breeding ponds:** Sexually mature males and females are collected and left in these ponds for the breeding.
2. **Hatchery ponds:** The seeds collected from breeding ponds are placed in order to hatch the young fishes called fish fries.
3. **Nursery pond:** 3 to 5 day old fish fries are fed well and retained for about 20 days.
4. **Rearing ponds:** These are deeper ponds in which fish fries from the nursery ponds are transferred and maintained here for about three months. The fish fries grow to a size of about 125 mm length and are now called fish fingerlings.
5. **Stocking ponds:** These are larger ponds and the fingerlings are fed with artificial feed. Organic and inorganic fertilizers are used in increase growth. Antibiotics are used to prevent infectious diseases. When the fishes attain the required size, they are harvested.

Nutritional value of fishery products

Fishes are rich in animal protein, vitamins and minerals. The vitamin-A content of fish liver helps in good vision. Vitamins such as B6, B12, Biotin, Niacin, D and minerals such as phosphorus, potassium and iron promotes normal growth of human body. Fish meal for cattle and poultry is prepared from the non-edible parts of fishes.

MORE TO KNOW

Facts about Indian fisheries (both capture and culture)

1. Total fish production
   – 7th position in the world.
2. Marine fish production
   – 10th position in the world.
3. Aquaculture production
   – 2nd in south east Asia.
4. Fish industry contribution
   – Rs. 400 Crores annually as foreign exchange.

1.9. APICULTURE

The scientific method of rearing honeybees for honey and wax is called 'Apiculture' or 'Bee keeping'. Honey bees are social insects. They live in colonies. They exhibit team work and division of labour. They feed on the pollen and nectar of flowers. The honey bees collect nectar from various flowers. The nectar is swallowed by the bees. In the stomach, the nectar is converted into honey and stored in the honey combs.

There are three types of bees in a colony.

a. **Queen** – The only fertile female in the hive and it's function is to lay eggs.

b. **Drones** – These are fertile male bees and it's function is to mate with queen bee and fertilize the eggs.

c. **Workers** – These are sterile females. They take care of the queen and young bees, collect nectar build honey combs and protect the bee hive.

Honeybee varieties

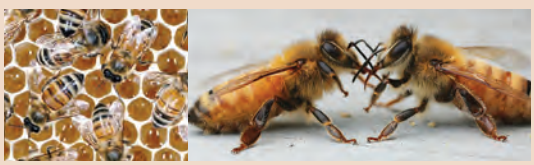
a. Indigenous varieties

i. Apis Indica – Common Indian honey bee.

ii. Apis dorsata – Rock bee

iii. Apis florea – Little bee.

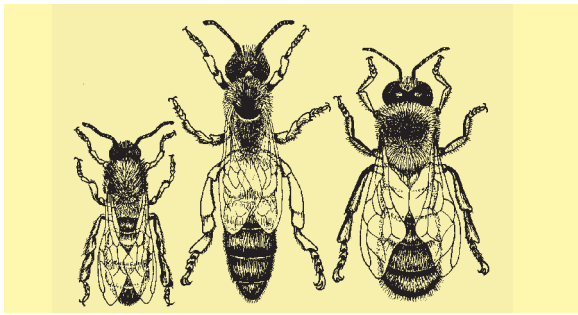
MORE TO KNOW



Round dance Waggle dance

HONEYBEECOMMUNICATION (Dance forms)

Round dance indicates that the source of nectar is within 100 mts., Waggle dance signifies a long distance. The dance movements specifies the direction of nectar with respect to the sun. In 1973 KARL VON FRISCH received Noble prize for deciphering this language.



Worker Queen Drone

b. Exotic varieties

i. Apis mellifera (Italian bee)

ii. Apis adamsoni (South African bee)

Economic importance of honey bees

Honey bees are used in the production of honey and bee wax.

Uses of honey

1. Honey is an energy rich food. For eg. 1 Kg of honey contains 3200 calories of energy.
2. Honey contains sugars, minerals, vitamins, enzymes and pollen.
3. Honey is an antiseptic and contains formic acid as the preservative.
4. Honey is a blood purifier, a cure against cough, cold,sore throat, ulcers of tongue, stomach and intestine.
5. Honey is helpful in building up the haemoglobin content of the blood.
6. Honey is used in the preparation of bread, cakes and biscuits.

Bee wax

It is utilized in the manufacture of cosmetics, lubricants, cold creams, shaving creams, polishes, candles, ointments and in medical preparations.

1.10. AQUACULTURE

Aquaculture deals with the farming of economically important aquatic organisms both plants and animals under controlled condition in a confined environment. Aquaculture includes culture of prawn, lobsters, fish, pearl oysters, mussels, crabs, etc.,

EVALUATION

Section – A

Choose the correct answer :

1. Tallness and profuse branching are desirable characters for (oil seed varieties, fruit trees, vegetables, fodder crops).
2. Nutrients are provided to the plants by air, soil and (rock, fossil, water, volcano).
3. Anabaena is a (cyanobacteria, green alga, brown alga, red alga).
4. 2,4 – D is a (insecticide, fungicide, rodenticide, weedicide).
5. An insect which cut and chew the root, stem and leaves of the plants (cotton ball, weevil, aphid, grasshopper, leafhopper)

Section – B

6. complete the table with suitable answer.

Name of the crop	Disease	Type of disease
Rice	?	Seed- borne
Ground nut	Tikka	?

7. As our country is the second in population in the world, it Is necessary to increase the yield of crops. How can we improve the crop yields?
8. i) Deficiency diseases occur in human beings due to the lack of nutrients. Does it occur in plants too?

   ii) If the growth of the plants in your garden is stunted, what will you do to hasten the growth?
9. Make lists of macro and micro nutrients from the following;

   Copper, chlorine, boron, calcium, nitrogen, phosphorous, potassium, sulphur, zinc, iron, magnesium.

Section C

10. i) Match the items in Column A with the items in Column B

Column A	**Column B**
1. Emasculation	a. Storage of grain
2. Fertilizer	b. Bordeaux mixture
3. Fungicide	c. Hybridization
4. FCI	d. Urea

ii) To eliminate the nutrient deficiency we use manures and fertilizers.

a) Which one is absorbed easily by plants ?

b) Explain why.

Section – A

1. In Artificial insemination method, the frozen semen is utilized to impregnate many females. Mention its advantages.

Section – B

2. Minerals are essential for the proper development of poultry animals. Mention at least four minerals.
3. Honey is a good medicine. List out any four medicinal uses of honey.
4. Rearrange Column B to match Column A

Inbreeding	--------	a) Desirable qualities
Cross breeding	--------	b) Frozen Semen
Inter specific hybridization	--------	c) Homozygous Characters
Artificial insemination	--------	d) Mule.

Section – C

5. Observe the given table with a set of 4 terms in Column A. Pick out the odd term and enter in column B. Identify the common features of the remaining three items and note down in Column C.

MODEL	A	B	C
1.	Aseel. Karknath. Busra, Leghorn.	Leghorn	Indian breeds of Poultry
2.	Inbreeding, Crossbreeding,Inter specific hybridization, Artificial insemination.		
3.	Monoculture, Polyculture, Integrated Fish Culture,Intensive Fish Culture		
4.	Apis indica, Apis dorsata, Apis florea, Apis Mellifera		

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Chapter 2

ADDICTION AND HEALTHY LIFESTYLE

2.1. ADDICTION

The term addiction is used to describe a compulsion by an individual to engage in some specific activity. Addiction leads to harmful consequences to an individual's health, mental state, and social life.

Histologically, addiction has been defined as psycho-active substances which cross blood – brain barrier temporarily altering the chemical nature of the brain.

The drugs and alcohol are misused and consumed in large quantities by an individual without the consultation of medical practitioners. They affect the central nervous system, liver spleen, kidney, heart etc., Slowly the individual becomes addicted to these drugs and alcohol. This addiction leads to personal as well as social problems.

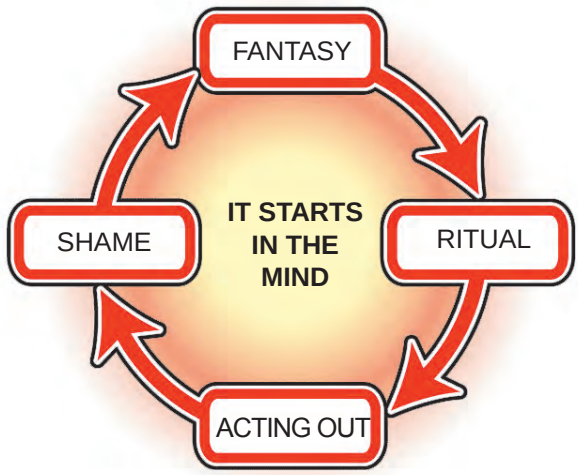
PERSONAL REASONS FOR ADDICTION

1. Genetic and mental susceptibility of an individual towards alcoholism.
2. Some use drugs for pain relief and it causes addiction.
3. Highly common reason for drug addiction is inability to cope up with emotional stress, anxiety, depression, environmental stress etc.
4. Some people become addicted due to underlying psychological disorders such as post traumatic stress disorder or attention deficit disorder.

SOCIAL REASONS FOR ADDICTION

1. Individuals become addicted because of peer compulsion.
2. Some people become addicted due to disturbing environment in the factories.

The Addiction Cycle



3. People relax after heavy physical work, and become addicted.
4. Hopelessness in life leads people to become addicted.

2.2. KINDS OF ADDICTION

a) ALCOHOLISM

Alcoholism, also known as alcohol dependence, is a disabling addictive disorder. Ethyl alcohol (C_2H_5OH) or

Fate of men after drinking alcohol

ethanol, is an intoxicating ingredient found in beer, wine and liquors. Alcohol is produced by the fermentation of yeast, sugar and starch. It is a central nervous system depressant that is rapidly absorbed from the stomach and small intestine into the blood stream.

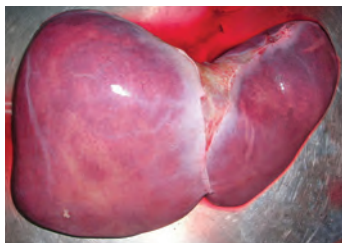
The study of alcoholism is both fascinating and frustrating . Certainly it is little understood .

HARMFUL EFFECTS OF ALCOHOLISM

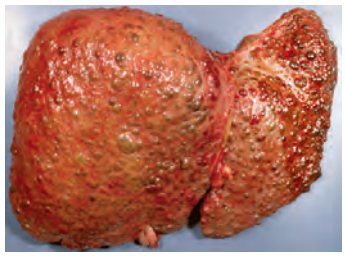
Many other physiological studies

showed that there is a physiological pre disposition towards the loss of control. Certainly the Cerebellum (small brain) is affected, that is why the skeletal muscles have an impaired function.

Liver cirrhosis: A healthy liver is able to regenerate most of its own cells when they become damaged. At the final stage of cirrhosis, the liver can no longer effectively replace damaged cells. Every year, there are about 27,000 deaths because of liver cirrhosis all over the world. Heavy alcohol use over several years can cause chronic injury to the liver. Alcohol-related cirrhosis led to more death than cirrhosis due to any other cause.



Normal Liver



Liver affected by liver cirrhosis

MORE TO KNOW

In South America Vehicles like buses are powered with ethyl alcohol. It is a very good pollution free fuel.

Ethyl alcohol is also a very good solvent for paints and varnish.

PREVENTION OF ALCOHOLISM

- Addiction of alcohol can be prevented at early stage by taking the following steps:
- The harmful effects of alcohol such as

drowsiness, Induce sleep, damaged liver cells which cause for death must be explained to the people.

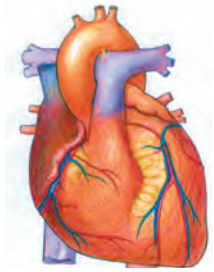
- If the addiction is developed due to being idle and by the pressure of the job, both the idleness and the nature of the jobs should be changed.
- Psychotherapy helps the patient in changing their life style.
- By educating parents and teachers to help the patients recover from alcoholic addiction.
- Drug therapy is also a valuable treatment.Medicines like Benzodi-azepines, high dose of vitamin B and antidepressant like phenothiazines are effective in the recovery of alcoholic addiction.
- A number of voluntary organizations are financially assisting to undertake the educative work in various communities and target groups.

2.2.(b). SMOKING CIGARETTES

A cigarette (French “small cigar”) is a small roll of finely cut tobacco leaves wrapped in a cylinder of thin paper for smoking.

Nicotine is one of the most frequently used addictive drug and the leading preventable cause of disease and disability and death in India. Cigrattes and tobacco in any form are illegal substance in most of the countries.

EFFECTS OF SMOKING ON HEART



Cigarette Smoking

Cigarette contains many toxic substances like nicotine, carbon, etc.

When inhaled, these toxic substance get deposited on the inner walls of the blood vessels that carry blood to the heart

This results in plaque formation

This plaque causes narrowing of the blood vessels. Blood supply to the walls of the heart is gradually reduced

As blood carries oxygen to heart, Oxygen supply is also reduced

As there is no sufficient blood supply and oxygen supply to heart, it damages the heart muscle

Leads to heart attack

Smoking causes diseases like Heart attack, Hypertension (high blood pressure), Cardiovascular diseases and finally leads to Death

LUNGS

Smoking destroys small hairs (cilia) present in the upper respiratory track (trachea). In normal persons these hairs protect lungs from germs, dust, smoke and other harmful chemicals enter lungs causing infection, cough and lung cancer. The air sacs of lungs (alveoli) get permanently damaged causing difficulty in breathing.

DIGESTIVE SYSTEM

Smoking causes heart burn, delays the healing of peptic ulcer, increases risk of Crohn's diseases and formation of gall stones. It affects liver and increases the chances of stomach cancer.

LEGS

Smoking affects blood vessels of legs causing chronic pain in legs.

EYES

The sensitive blood vessels of eyes are easily damaged by smoking. This causes redness of eyes and itching. Heavy smoking may lead to degeneration and loss of eye sight.

SKIN

Due to smoking, the skin is deprived of oxygen and it loses its texture. An average smoker looks five years older than his healthy nonsmoking counterparts. The skin loses its healthy glow and takes yellowish- grey cast. The more cigarettes smoked, the worse the skin will look. Wrinkles start appearing very quickly as smoking affects the elastic in the tissues of the skin.

BONES

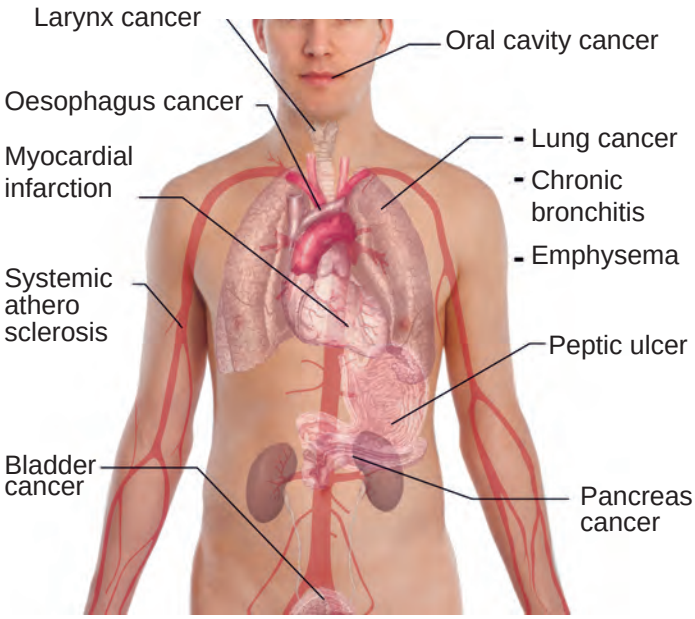
It accelerates the process of Osteoporosis.

CANCER

Smoking causes cancer in lungs, larynx, oral cavity, pharynx, oesophagus and bladder. Tobacco smoke contains more

Common adverse effects of

TOBACCO SMOKING



than 60 substances which cause cancer. 90% of lung cancer death occurs due to smoking.

REPRODUCTIVE SYSTEM

Smoking reduces fertility in both men and women.

IN WOMEN

Smoking imbalances estrogen hormone in women and it reduces blood flow to genital organs. Women who smoke can get diseases in fallopian tubes and their egg production is affected. Smoking can cause abortion. It accelerates ageing process and can cause early menopause.

The growth of baby retards when mother smokes in pregnancy. It affects the brain development of the baby and reduces its IQ. This happens even when mother is a passive smoker. The chances of miscarriage premature birth and fatel death increase.

IN MEN

Smoking causes damages to the male reproductive system in many ways.

2.2 (C). DRUG ABUSE - NARCOTIC DRUGS

In the study of addiction, the term 'drug' means unauthorized and improportionate use of chemicals which is injurious to health. Sometimes the authorized drugs are consumed in large quantities without doctors advice. It also leads to drug addiction. Consumption of such drugs for a long period of time have direct effect on the central nervous system and its related problems. Heroin, Opium, Cocaine are some of the drugs that are injurious to health. These drugs are also called narcotics.

Harmful effects of drug abuse

- Impaired health, infectious diseases , HIV / AIDS.
- Absence from school and college.
- Possible death due to frustration or illhealth.
- Drug addicts may commit crimes like theft, rape or murder.
- Corruption, Narco-terrorism.

SIGNS OF DRUG ABUSE

- Sudden change of mood and temper.
- Bouts of drowsiness or sleeplessness.
- Body pain, nausea, unsteady gait.
- Losing interest in job and studies.
- Telling lies and stealing money.

Following constitute offence in relation to illicit drugs.

- Possession even in small quantity.
- Cultivation of drug crops without permission.
- Allowing your premises to store, sell or consume.

- Illicit manufacture, sale, purchase and transportation.
- Trafficing of drugs is a non-bailable offence (Prison sentence up to 20 years and fine up to Rs.2 lakhs)
- Death penalty for repeat offenders.

What students should do

- Always resist peer pressure and say " No to Drugs "
- Drugs are not "Cool" Decide your self.
- Girl students should be cautious of taking drinks containing " date rape drugs".
- Report drug abuse or trafficking to your school, college or police.

2.3. PREVENTION OF ADDICTION

Non- addiction is a term used for the prevention of addiction. It narrates the management of alcoholism and drug abuse. There are Government and Non Government organizations in our country which have Rehabilitation centre to treat and counsel the drug addicts and alcoholics by means of medical and psychological approaches. The following are the steps taken in rehabilitation centre to deaddict the individuals.

First step	The identification of addicted individuals.
Second step	The composition of drug is analyzed.
Third step	The addicted individual is identified to find out whether the dependency is physical or psychological.
Fourth step	A suitable chemotherapy is given to the addicts to the detoxify drug consumed.
Fifth step	Treatment should be given for a long time.
Sixth step	There should be periodical observation given according to his physical, mental, social and the occupational status.

2.4 HEALTHY LIFESTYLE

Healthy lifestyle is a term given to a group of habits like healthy eating, being physically active, leading a smoke free and stress free life. Our motherland India is predicted to become the diabetic and cardiovascular disease capital of the world.

Obesity

Obesity is defined as an excessive accumulation of fat in the body that leads to increased health problems. Obesity can have its grassroots from childhood and those children are significantly much above the standard of weight for height for their age group. Lethargy, sluggishness and difficulty in carrying out activities of daily living are some of the adverse effects of obesity. The causes of obesity are unhealthy dietary

habits, lack of physical activity, genetic susceptibility, endocrine disorders and some medications.

Prevention of Heart Disease and Obesity

1. Dietary and lifestyle changes

- Eat plenty of food rich in fibers such as fruits and green leafy vegetables as part of your diet. Intake of more amount of steamed and oil free foods like idle, idiyappam, puttu etc.,
- Nuts, whole grains, seasonal fruits and vegetables can be consumed.
- Eating fish twice a week helps to prevent blood clot formation in arteries as it contains omega-3 fatty acids.
- Eat less amount of red meat (mutton, beef) and fried foods (chips, etc.,) because it raises the blood cholesterol level
- Though milk and milk products (Ghee, Butter, Cheese) are a good source of calcium, excessive amount leads to overweight.
- Avoid high calorie fast foods.
- Reducing dietary sugars(sweets, chocolates, etc.,) and salt (pickles, pappads, etc.,) in the diet.
- Cigarette smoking and alcohol consumption should be avoided.

2. Physical activity

- Reduce or limit the time of watching television, using computer, playing video games, etc.,
- Increase physical activity to burn out calories which in turn enhances optimal blood circulation. Eg., Walking for an hour every day, playing games in the play ground, jogging, running, cycling, swimming, dancing, etc.,
- Aim for ideal weight for(body mass index) by height following appropriate dietary habits and adequate physical activity.

3. Stress relieving activities

Share your feeling with family and friends, manage your time, get enough sleep, spend time in nature, listen to good music, engage yourself in gardening, painting, playing with pets, time outs for picnics with family ect., helps in relieving stress.

EVALUATION

Section – A

1. This is a wall paper pasted in many places. What does it mean?

Section – B

2. June 26 is International day against drug abuse and is trafficing day. It is proposed to conduct an awareness programme for the public. Write five messages to make people aware against the use of drugs. Explain your message.

3. This is an illustration made by the Government.

a) Write what actually this illustration tells us.

b) Write two diseases caused by smoking.

c) How can we create awareness about smoke among the people?

4. Given below are the different steps in over drinking of alcohol. Identify the missing links

Liver can no longer effectively replaced damage cells called

[1.] [2.] is the character of mammals.

It connects [3.] and [4.].

This is a problem due to over drinking of alcohol.

Section – C

5. The following are the some of the illeffects of smoking. Arrange them in a correct form with the organs.

Organs	Illeffects
1.Heart	a) Degeneration and loss of eye sight.
2.Lungs	b) Loses its texture.
3.Digestive system	c) Causes abortion.
4.Eyes	d) Air sacs get permanently damaged.
5.Skin	e) delays healing peptic uncer.
6.Bones	f) Atherosclerosis.
7. Reproductive organ (Female)	g) Osteoporosis.

Chapter 3

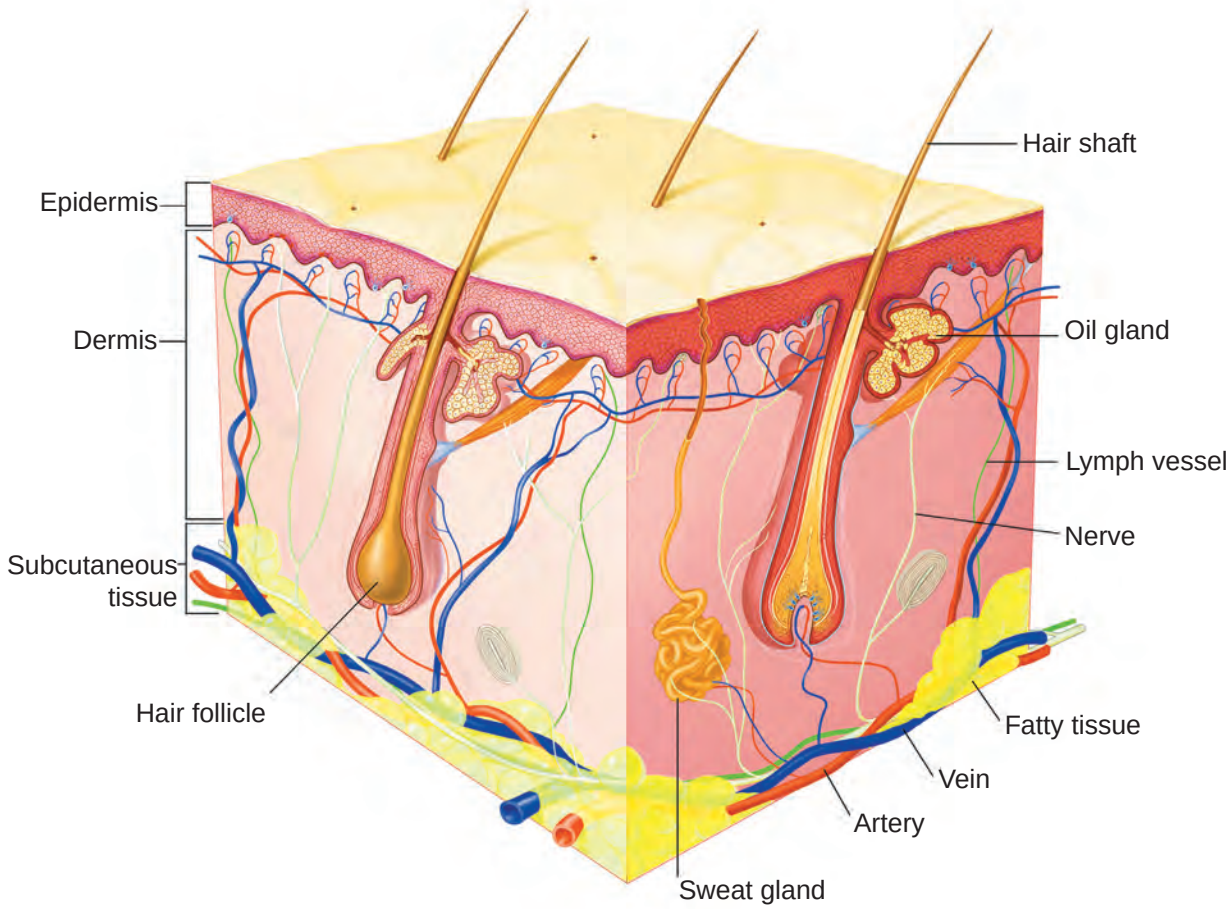
HUMAN BODY ORGAN SYSTEM

3.1. SKIN

Skin is an integumentary system that covers the outside of the body. It is highly essential to protect internal organs and prevent the entrance of pathogens.

The skin is composed of three major tissues:

1. Epidermis. 2. Dermis. 3. Hypodermis.



Structure of skin

1. Epidermis

Epidermis is the upper layer of the skin. The outer most layer consists of flat, thin and scale - like dead cells. It is separated from the dermis by basement membrane. It contains melanocytes, giving colour to the skin. The deepest layers of epidermis have the nerve endings.

2.Dermis

The dermis is the middle layer. It is thick but elastic. The dermis consists of nerves, blood vessels, hair follicles, sweat glands and sebaceous glands (oil glands). The sweat glands separate sweat from the blood.

The sebaceous gland secretes sebum which keeps the skin smooth and shiny. The arectorpili is the smooth muscle necessary to move the hair.

3.Hypodermis

It is the lower most layer, which contains large amount of adipose tissue.

Functions of Skin

1. Skin protects the internal organs of our body.
2. It prevents the entrance of infectious agents.
3. It reduces water loss.
4. Skin regulates the body temperature.
5. Skin can prepare Vitamin D with the help of sunlight.
6. It allows us to feel touch, pain and temperature.
7. Skin acts as an excretory organ and excretes sweat.

MORE TO KNOW

Skin colour of woman is determined by the melanocytes of the basement membrane. The formation of melanocytes is by hereditary. Even then there is some impact of colour by external factors like temperature, sunlight, wind and costumes.

ACTIVITY –3.1

1. Identify various derivatives of skin like hair, feather, nail and scales in various animals.

MORE TO KNOW

Wrinkles: If you pinch your skin and let go, it springs back into shape. This happens because skin contains proteins in the dermis that stretch like elastic. As people get older, their skin become less elastic, so it begins to form wrinkles.

MORE TO KNOW

The Europeans are white in colour because of the lack of melanin pigments. That is why they cannot tolerate sunlight.

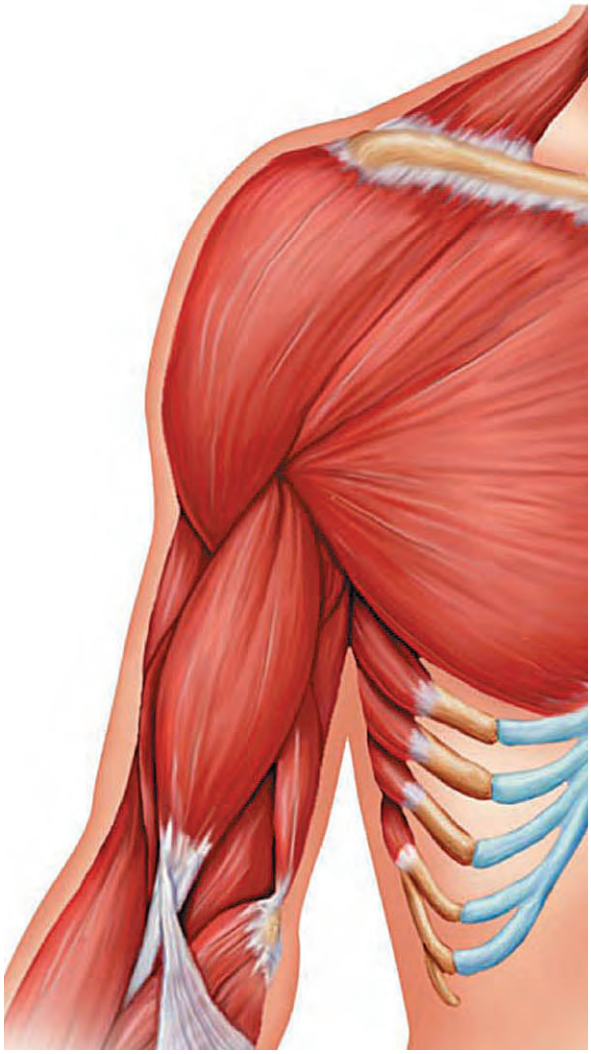
3.2. MUSCULO – SKELETAL SYSTEM

3.2.1. MUSCULAR SYSTEM

Locomotion and bodily movement are characteristic features of the animals. The movements are effected by various cell organ cells such as cilia, flagella and organ like muscles. Muscle movement is more powerful and energetic. Human body contains 700 to 800 muscles.

Various animals and their locomotory organs

Animals		Locomotory organs
1	Amoeba	Pseudopodia
2	Paramecium	Cilia
3	Euglena	Flagella
4	Earthworm	Body setae
5	Star fish	Tube feet
6	Fish	Fins
7	Birds	Wings
8	Bat	Petagium



Skeletal Muscles:

Based on the structure, function and occurrence, three different types of muscle tissues have been identified. They are the skeletal, visceral and cardiac muscles.

Skeletal Muscles

The skeletal muscles are attached to bones by tendons which helps in transfering the forces developed by skeletal muscles to the bones. These muscles are covered by sheets of connective tissues called fascia.

Tendons

These are connective tissue structure showing slight elasticity. They are like cords or straps strongly attached to bones. The tensile strength of tendons is nearly half that of steel. A tendon having 10 mm diameter can support 600 – 1000 kg.

Fascia

These are assemblages of connective tissue lining skeletal muscles as membranous sheets. The fascia may be superficial or deep. The superficial fascia is a layer of loose connective tissue found in between skin and muscles. The deep fascia are collagen fibers found as a tough, inelastic sheath around the musculature. They run between groups of muscles and connect with the bones.

Distribution of muscles

There are five different sets of muscles in our body.

1. Muscles of the head.
2. Muscles of the neck.
3. Muscles of the trunk region
4. Muscles of the upper limb.
5. Muscles of the lower limb.

MORE TO KNOW

1 sq.cm of muscle can lift 3.5kg.

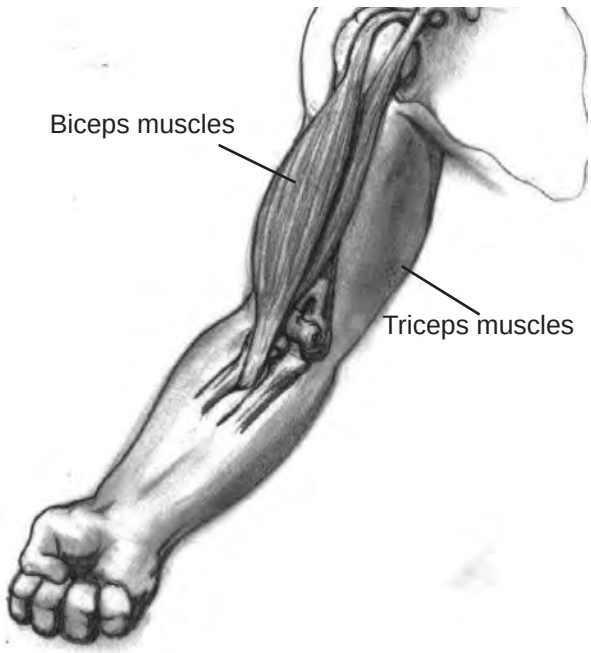
Few muscles and their functions

Facial Expressions

Facial expression, such as looking, shocked or smiling, are tiny voluntary movements made by more than 30 different muscles. Although they are voluntary, we often make these movements without our knowledge.

Breathing

Four important thoracic muscles are associated with the process of breathing. The process of inspiration is due to scalene and external intercostal muscles. The expiration is performed due to internal intercostal muscles and transverse thoracis. Major breathing movement is due to diaphragm, a curved musculo fibrous sheath that separates thoracic cavity from abdominal cavity.



Biceps and triceps muscles:

MORE TO KNOW

Sound is not produced while the muscles function. But machines are producing sounds. If muscles make noise imagine how a rat will escape from a cat.

LUIGI GALVANI

By accident, the Italian professor of Anatomy, Luigi Galvani (1737-98) discovered that a dead frog's legs contracted if they were pegged to an iron frame with brass pins. Galvani thought that frog's muscles movement made electricity, which caused the contractions. Galvani was right to think that electricity made the muscle move, but in fact it was the two metals acting together that made the electricity. We now know that in living animals, electrical signals from the nerve make the muscles contract.

Functions of muscles

1. Muscles are responsible for locomotion.
2. It provides beautiful shape to our body.
3. The inner smooth muscles of the visceral organs make them work like a machine all through our life.

ACTIVITY –3.2

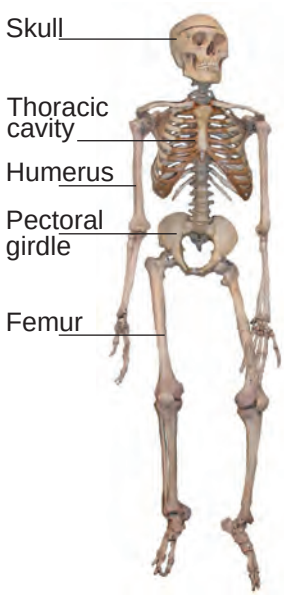
1. Go to the Government Medical college hospital and observe the different types of human muscles and organs.

Significant muscles, their location and movement

S.no	Name	Location	Movement
1	Trapezius	Upper back and each side of neck	Upper pulling movement
2	Deltoids	Shoulders	Arm raising
3	Pectorals	Chest	Horizontal pressing and drawing of arm across the body
4	Lattismus dorsi	Wide back muscle	Pulling and rowing movement
5	Biceps	Front portion of the upper arm	Arm bending and twisting
6	Triceps	Back of upper arm	Pushing and strightening of upper arm.
7	Calves	Lower leg between ankle and knee	Raising and lowering of toes.

3.2.2. SKELETAL SYSTEM

The skeletal system consists of bones, cartilages and ligaments. It is a frame on which all organs are arranged. The bones can be long, short, flat or irregular in shape.



Human skeleton

The human skeletal system is divided in two categories.

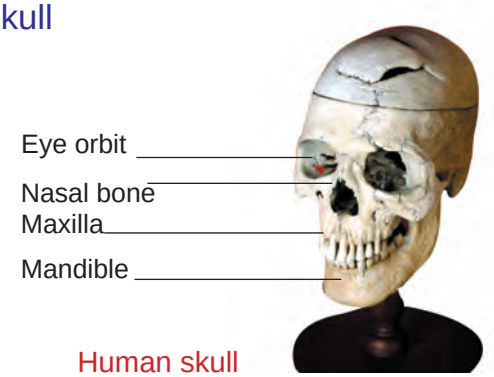
1. The axial skeleton

2. The appendicular skeleton.

Axial skeleton

It is the upright axis of the body. Axial skeleton consists of skull, hyoid bones, vertebral column and thoracic cage.

Skull



Human skull

Skull consists of 22 bones. Among the 22, 8 are head bones and remaining 14 are facial bones. Skull supports the organ of vision, hearing, smell and taste. The skull is divided into head bones and facial bones. The cranium is covered by eight bones. All are flat bones. They are joined with immovable joints. It protects the brain.

A large opening is found at the base of the skull. Through this opening the

medulla oblongata of the brain descends down as the spinal cord.

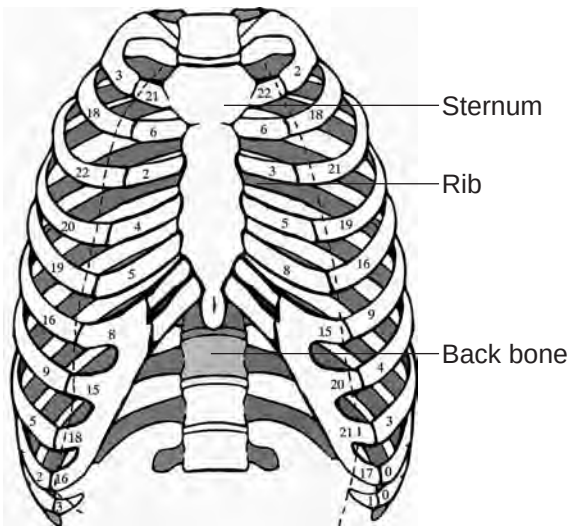
MORE TO KNOW

All animals can move their lower jaw (mandible).

Crocodile alone can move its upper jaw (maxilla).

Thoracic cavity

The thoracic cavity consists of three different types of bones. The front portion has single bone named sternum. The back portion has a long vertebral column. Both the bones are connected by ribs on the lateral side.



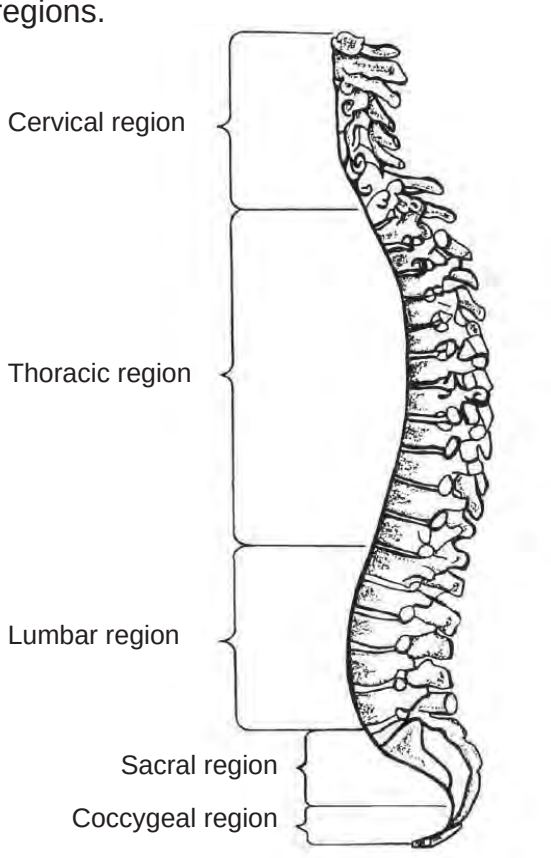
Thoracic cavity of a human

Rib Cage

There are 12 pairs of ribs. Each articulates with a thoracic vertebrae. In the front, the first ten pairs are attached with the sternum. The first seven are directly attached with sternum. They are called the true ribs. Cartilages of the 8th, 9th and 10th are fused and attached to the sternum indirectly. They are called false ribs. 11th and 12th pairs are not attached to the sternum. They are called floating ribs.

The vertebral column or vertebrae

The vertebrae make up slight “S” shaped vertebral column or back bone. Acutally back bone consists of 33 vertebrae. They are divided into 5 regions.



vertebral column of a human

They are

1. Cervical vertebrae-7
2. Thoracic vertebrae -12
3. Lumbar vertebrae -5
4. Sacral vertebrae -5
5. Coccygeal vertebrae -4

But,the sacral five bones are joined together to form one bone, and also coccygeal four bones join together to form another bone. So the total vertebrae in the back bone is only 26.

Appendicular skeleton

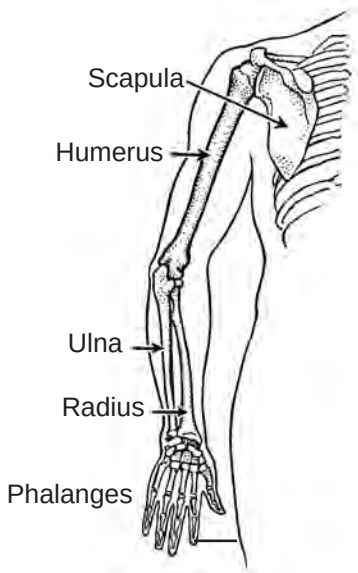
Appendicular skeleton consists of Pectoral girdle and the upper limb (hands)

Pelvic girdle and the lower limb (Legs).

Upper limb or hands

Hands are attached to the pectoral girdle. Each pectoral girdle has a pair of scapula or shoulder bones and a clavicle or collar bone.

Upper arm has a long bone named humerus. The distal end of the upper arm is articulate with two forearm bones named ulna and radius. Wrist consists of eight carpels, arranged in two rows. The frame work of the hand is formed of five metacarpels. Each hand has five digits. They include one thumb and four fingers. Each digit has small long bones called phalanges. The thumb has two phalanges and each finger has three phalanges.

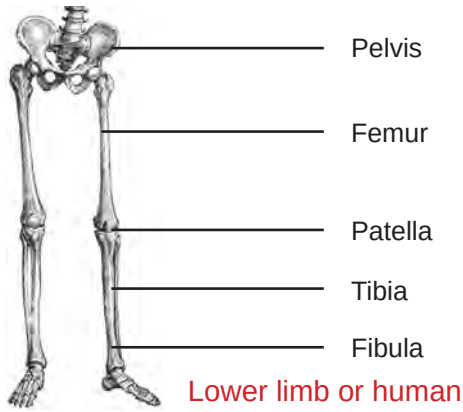


Upper limb or human hand

The pelvic girdle and leg

The pelvic girdle is a ring of bones in the hip region formed by sacrum and paired bones called coxae or hip bones.

Each coxa is formed by the fusion of three bones namely ilium, ischium and pubis. The thigh region contains the longest bone called femur. The distal end



Lower limb or human leg

of the femur has connection with lower limb tibia and fibula. The knee region has a large flat bone called the patella.

The ankle consists of seven tarsal bones. The ankle articulates with tibia and fibula through talus.

Foot is formed by metatarsals and phalanges. They correspond to the metacarpals and phalanges of the hand.

Functions of Bones

- Bones remain as region for the attachment of muscles.
- It also helps to hold weight of our body.
- They give safety to the inner organs.
- This system is useful for locomotion.
- The bones remain as a reservoir for calcium and fat.
- The bone marrow is the site for the production of red blood corpuscles.

Number of bones in human body

In human body, there are 206 bones of those 80 are in the axial skeleton, 126 are in the appendicular skeleton. Among the bones of the axial skeleton 28 bones are in the skull, 26 bones are in the vertebral column, 25 bones are in the thoracic cage and one remains as the hyoid bone.

MORE TO KNOW

Phylum mollusca is the animal group that do not have internal skeletal system.

3.3. DIGESTIVE SYSTEM

Digestion is process of conversion of larger compounds into simpler molecules that can be assimilated either by blood or by lymph.

Large compounds	Simple molecules
1. Carbohydrates	Glucose
2. Proteins	Amino acids
3. fat	Fatty acid and glycerol

Generally two major types of digestion are encountered

1. Intra cellular digestion
2. Extra cellular digestion

1. Intra cellular digestion

Amoeba like unicellular organisms digest its prey inside the food vacuole and expels the undigested food. This type of digestion is called intracellular digestion. **e.g. Amoeba.**

2. Extra cellular digestion

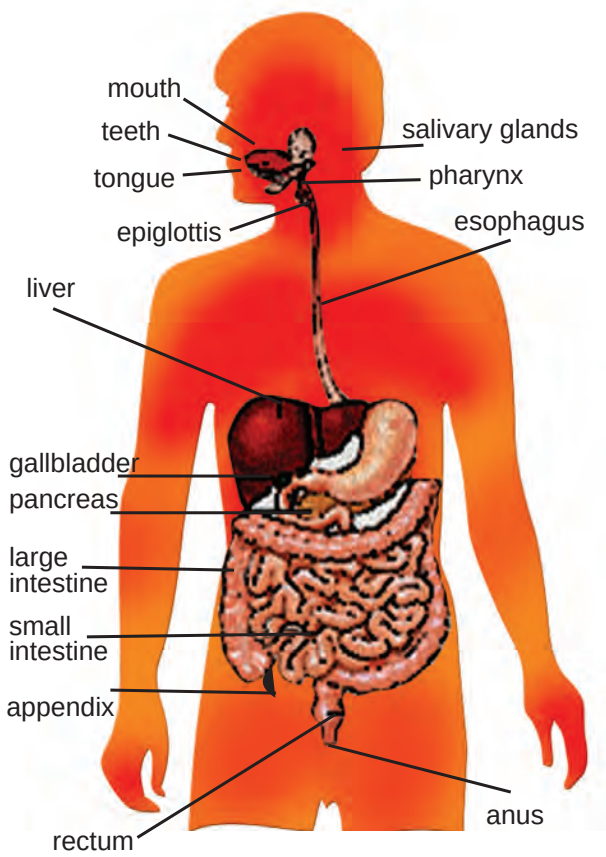
Various glands secrete enzymes into the cavity and digest the food extra cellularly. This kind of digestion outside the cell, but within the cavity is extracellular digestion. **e.g. Human.**

The alimentary canal

It is a coiled muscular tube extending from the mouth to the anus. It is about 6-9 meters long and consists of many specialized sections. Arranged sequentially, these are mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine, Large intestine, rectum and anus. It also includes, some accessory digestive organs like salivary glands, pancreas and liver.

Mouth

It is an oval shaped cavity bounded in front by lips and laterally by the jaws. The roof of the cavity is lined by the palate. The floor contains a tongue. The upper jaw and lower jaw are lined by the tooth. Mouth helps ingestion.



Organs of digestion

Teeth

In man, teeth are 32 in number. 4 incisors, 2 canines, 4 premolars and 6 molars in each jaw. The last set of molar tooth grow after the age of 20. Hence they are named as wisdom tooth.

Tongue

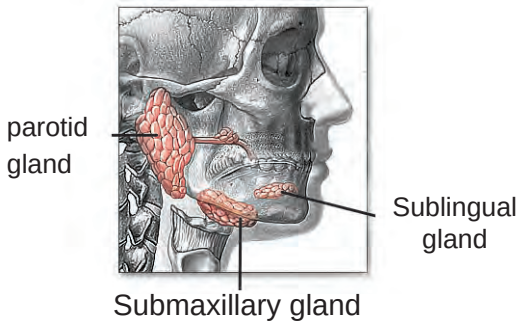
It is the organ for the sense of taste. It is attached to the floor of the mouth. Its

tip is thin and narrow. The upper surface of the tongue contains several papillae or sensory buds.

MORE TO KNOW

The hardest part of the human body is the tooth.

Salivary gland



3 pairs of salivary glands open into the mouth. They are parotid, sub-maxillary and sub-lingual.

- **Parotid glands -** It is the largest gland of the three pairs. It is found below the ear.
- **Submaxillary gland -** It is found below the jaw and irregular in shape.
- **Sublingual gland -** It is the smallest gland. It is found at the base of the tongue.

MORE TO KNOW

Parotid gland is the only salivary gland affected by mumps virus.

The three pairs of salivary glands secrete approximately 1.5 liters of saliva every day.

Salivary gland secretes saliva.

The saliva has the following

1. Ptyalin(Amylase) - enzyme
2. Bicarbonate - salt
3. Mucus - carbohydrate
4. Lysozyme - enzyme

MORE TO KNOW

If our mouth dries due to dehydration we could not develop speech.

Pharynx

Pharynx is found below the nose and mouth. It is about 11 cm in length. This region has 7 openings . They are 2 internal nostrils, 2 eustachian tubes, mouth, larynx and oesophagus.

Oesophagus

It is a musculo-membranous canal about 22 cm length. It extends from pharynx to the stomach. The inner lining has a mucus coat and it is lined by epithelium.

Stomach

Since Stomach is the main organ of digestion, it is the most dilated part of the alimentary canal. Stomach is a horizontal chamber containing 3 conspicuous regions. They are cardiac, fundus and pyloric. The stomach secretes gastric juice. The gastric juice contains the following:

1. Pepsin
2. Renin
3. Hydrochloric acid

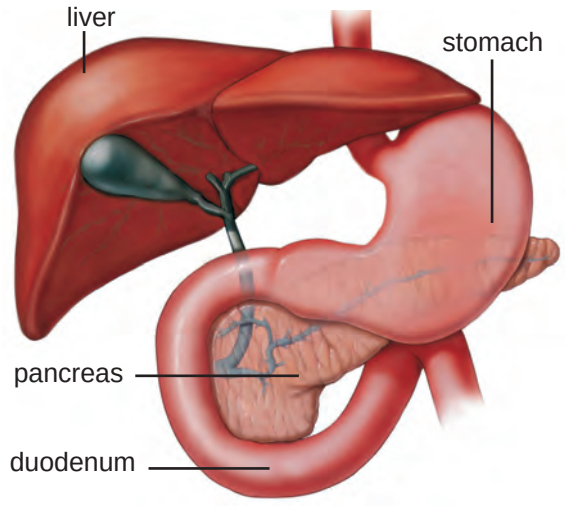
Hydrochloric acid is secreted by a special type cells in the gastric pit namely oxyntic cells.

Small intestine

The stomach opens into the small intestine through pylorus. The small intestine is divisible into 3 regions duodenum, jejunum and ileum.

Duodenum

Duodenum is around 22 cm in length. In this region where the liver and pancreas are connected to the alimentary canal.

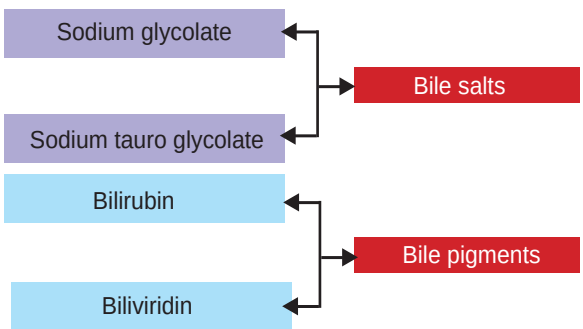


Anatomy of liver and pancreas

Liver

Liver is the largest glandular organ in human. It weighs about 1500 gms. It contains two unequal lobes. The right lobe is larger. Liver secretes bile juice which is greenish yellow in colour. The bile is temporarily stored in gall bladder. The gall bladder is attached to the bile duct. The duct opens into the duodenum. Bile juice helps the digestion of fat. It does not have any enzyme. It has bile salts and bile pigments.

Bile juice



MORE TO KNOW

Excess of eating fatty foods leads to the formation of bile stones in the gall bladder.

Pancreas

Pancreas is a long, leaf like transparent gland. It is 15 to 20 cms long. Pancreas secretes pancreatic juice and it is connected with duodenum through pancreatic duct. Pancreas acts as an exocrine gland and endocrine gland. The gland's upper surface bears the islets of langerhans. The pancreatic alpha cells secrete the hormone glucogon, and the pancreatic beta cells secrete the harmon insulin.

As an exocrine it secretes the following enzymes

1. **Trypsin,** 2. **Chymotrypsin,**
3. **Carboxy peptidase,** 4. **Amylase,**
5. **Lipase**

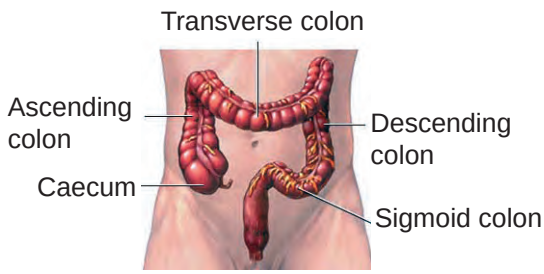
Jejunum

Jejunum constitutes 2/5th of the small intestine. It starts from the duodenum and ends with ileum. The secretion of small intestine is intestinal juice. The intestinal juice contains the enzymes:

1.**Sucrase,** 2. **Maltase,** 3. **Lactase,** 4. **Lipase**

Ileum

It is a coiled tube-like structure which constitutes 3/5th of the small intestine. It contains numerous minute finger-like projections called villi (1 mm) in length. They are approximately 4 million in number. Internally each villus contains fine blood capillaries and lacteal tubes. Food absorption takes place here.



Large Intestine

Large intestine

It extends from the ileum to the anus. It is about 1.5 metres in length. It is divided into caecum, colon, and rectum.

Caecum

Caecum is a large blind pouch and measures about 5 cm in length. The terminal part of the caecum is vermiform appendix.

CLAUDE BERNARD

The french scientist Claude Bernard (1813-78) was one of the first people to study physiology. He discovered that glucose, the main source of energy for the body, is stored in the liver as glycogen and released as and when it is needed. He also studied digestion ,how drugs change the way the body works and the nervous system.

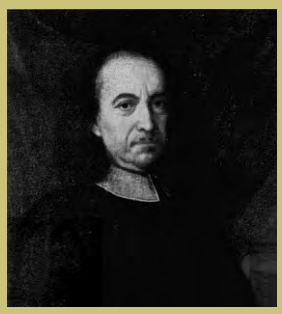
Functions of alimentary canal

1. Ingestion, 2. Digestion, 3. Absorption, 4. Assimilation, 5. Egestion

MORE TO KNOW

Dogs regulate body temperature by panting.

MARCELLO MALPIGHI (1628-1694)



Marcello Malpighi, was born in Italy in March 1628, studied Aristotelian philosophy and graduated as a medical doctor. Malpighi developed an intense interest in scientific research with a fond love for the teaching. He is considered as the founder of comparative psychology.

In 1669, Malpighi published the result of his work on the silkworm. He discovered that these insects had no lungs, but breathed through a row of holes located on the lateral side of their long bodies. Distribution of air within the insect occurs through a system of tubules that Malpighi termed as trachea. While observing dissected lung tissue, Malpighi discovered tiny, thin walled microtubules, which he named capillaries. He went on to hypothesize that the capillaries were the connection between arteries and veins that allowed blood to flow back to the heart, and these are the vital organs which do all the functions of the circulatory systems.

A number of anatomical structures still bear his name. Malpighian corpuscles in the circulatory and lymphatic systems, the Malpighian layer of epidermis (rete malphigi) and the, malpighian tube in insects. Excretion of nitrogenous waste such as uric acid and water removal from the faeces is carried out by Malpighian tubules.

3.4. EXCRETORY SYSTEM

Excretion: The process of elimination of metabolic wastes from our body.

There are three types of organisms on the basis of excretion of waste matter

1.Ammonotelism

Most teleost fish (bony fish), tadpole and acquatic insects excrete nitrogenous waste as ammonia.

2. Ureotelism

Urea excretion is called ureotelism. For example mammals and adult amphibians, marine fishes and turtles.

3.Uricotelism

Excretion of uric acid is called Uricotelism. For example Birds and reptiles.

Organs which are involved in excretion are called excretory organs.

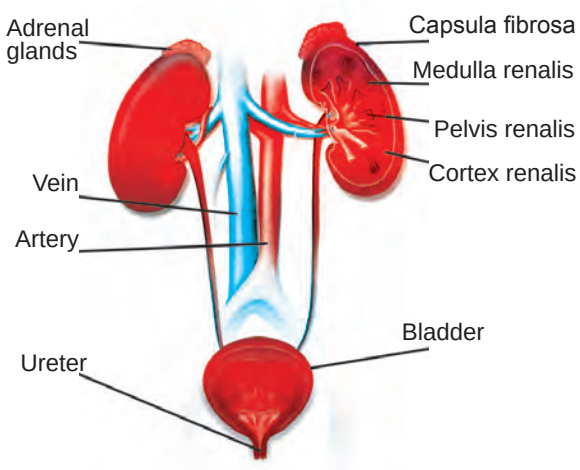
Animals and their excretory organs

1.	Amoeba	-	Contractile Vacuole
2.	Earthworm	-	Nephridia
3.	Tapeworm	-	Flame cells
4.	Insects	-	Malphigian tubules
5.	Mammals	-	Kidneys

Human excretory system consists of a pair of kidneys, a pair of ureters, a urinary bladder and urethra.

Kidneys

Kidney is a chief excretory organ. It is a pair of dark red, bean shaped organ placed behind the abdomen, on each side of the vertebral column. The average adult kidney measures about 12 cm in length, 6 cm in width, and 3 cm in thickness.



Urinary system

The outer surface of the kidney is convex and the inner surface is concave and it faces the vertebral column. The right kidney is just lower than that of the left kidney because the right side of the body is occupied by the the liver. Each kidney is surrounded by a fibrous membrane called capsule. Two ureters join the kidneys with urinary bladder. Urinary bladder is the temporary storage organ of urine. Urine is expelled through the urethra to the exterior.

Nephron

Kidneys are made up of millions of nephrons, which are the structural and functional unit of kidneys. Each kidney consists of about one million of nephrons.

Other excretory organs in human body

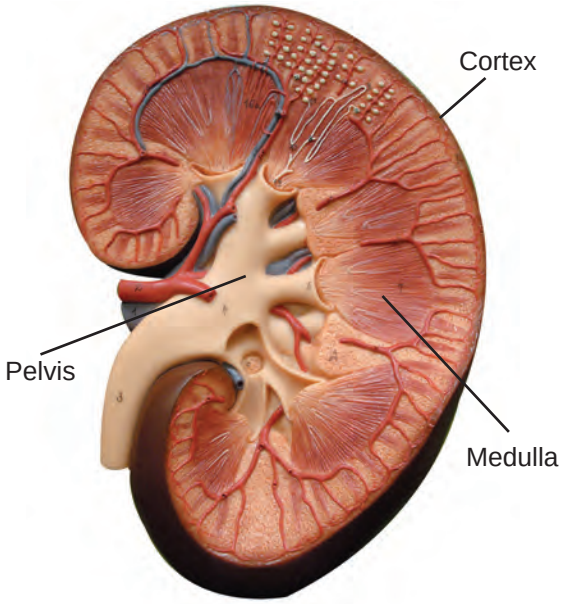
Lungs : Lungs excrete CO_2 and water from the blood.

Skin : Skin excretes sweat. The sweat consists of dissolved urea, uric acid and lactic acid.

Liver : Liver excretes bile pigments, formed during the breakdown of haemoglobin. It is incharge for the formation of urea through ornithin cycle.

Functions of kidney

1. It excretes nitrogenous wastes (urea) formed as a result of protein metabolism.
2. It helps to maintain the fluid and electrolyte balance of our body .
3. It helps to regulate acid-base balance of blood.
4. It helps to maintain osmotic pressure in blood and tissue.
5. It helps to retain important plasma constituents like glucose, amino acids, etc,.



Longitudinal section of Kidney

MORE TO KNOW

Kidney functions are the basis of blood pressure.

1. There are approximately 1 million nephrons in each kidney. At least 450,000 of them must remain functional to ensure survival.
2. Every minute kidneys receive 1/5th blood of the cardiac output that is approximately 1.250 liters every minute.

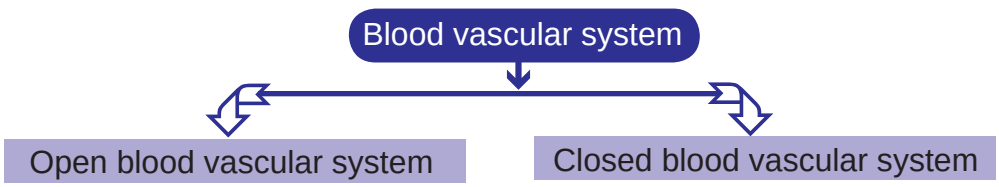
MORE TO KNOW

Among reptiles only the crocodiles have a four chambered heart.

3.5. CIRCULATORY SYSTEM (BLOOD VASCULAR SYSTEM)

Circulatory System Or Blood vascular system

Circulatory system is a special system which contains heart, blood vessels and blood. This system makes the blood to circulate around the body because of the contraction and expansion of heart.



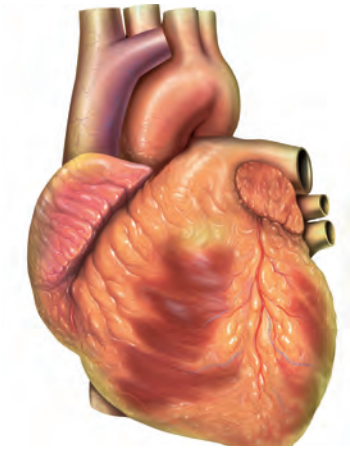
Open blood vascular system

In open type, the blood is pumped by the heart into the blood vessels that opens into blood spaces(cavities). There is no capillary system e.g. most arthropods. These cavities are called haemocoel. The pressure of the blood here is very low. e.g. cockroach

Closed blood vascular system

The blood is circulating through the blood vessels and it creates blood pressure inside the blood vessels e.g. human blood vascular system.

Heart



The heart is a hollow, muscular organ. It is somewhat conical in shape. The heart is covered with double walled membrane called pericardium. The space between the pericardial membrane is called pericardial space, which is filled with pericardial fluid. The pericardial fluid protects the heart from shock. The heart is placed inside the thoracic chamber in between the two lungs in the mediastinum.

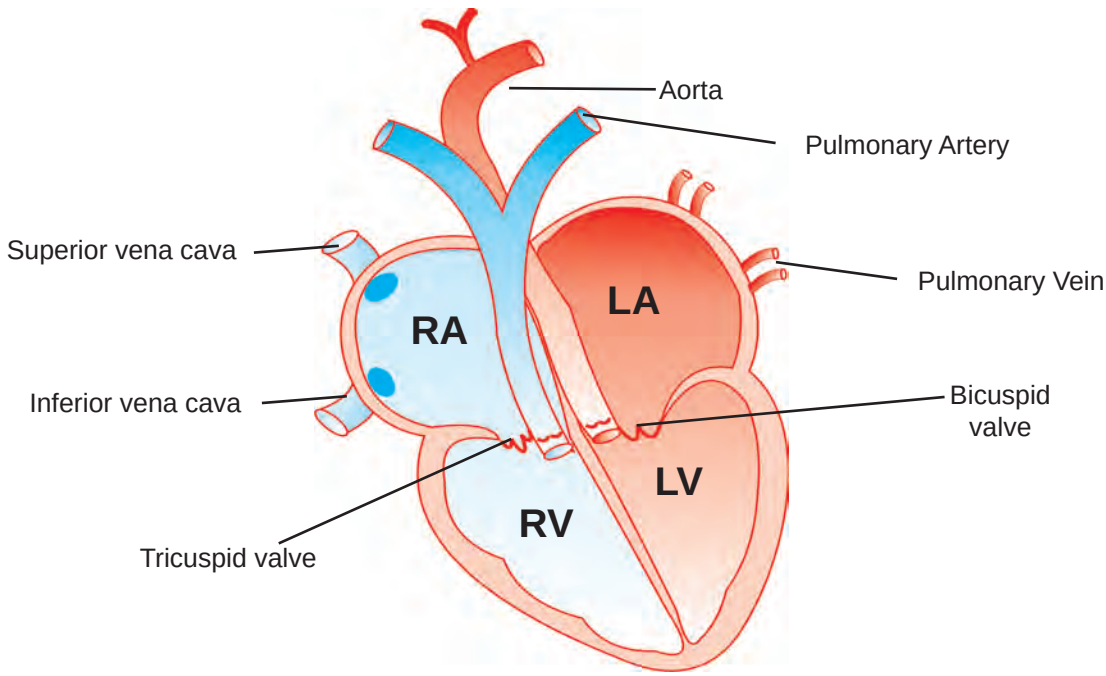
Animals and their hearts:			
1.	Earthworm	:	8 pairs of lateral hearts
2.	Cockroach	:	13 chambered heart
3.	Fish	:	2 Chambered heart
4.	Amphibians	:	3 chambered heart
5.	Reptiles	:	3 chambered heart, ventricle is partially separated.
6.	Birds	:	4 chambered heart
7.	Mammals	:	4 chambered heart

MORE TO KNOW

The total voulme of blood in blue whale is 12 tonnes. It can be pumped by its heart.

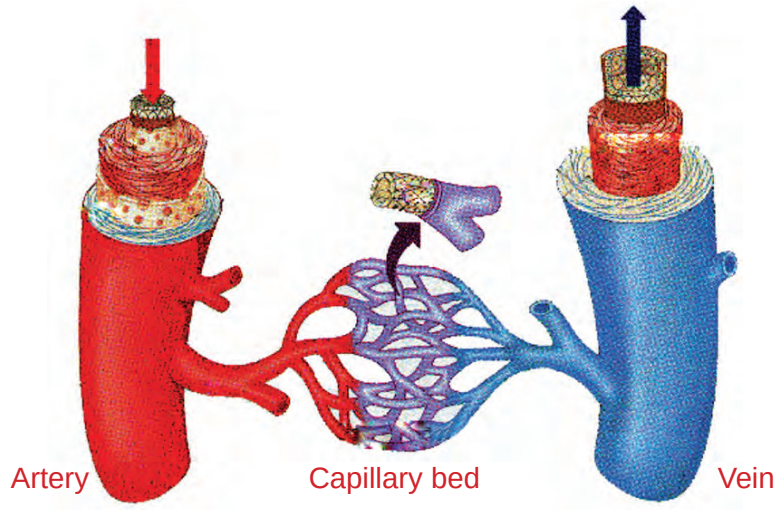
Internal structure of human heart

Human heart consists of four chambers. Two upper thin chambers are called artria (Singular-artrium) and two lower thick chambers are called ventricles. The right side of the heart is separated from the left side by a longitudinal wall named inter artrio-ventricular septum.



Blood vessels connected with heart

Right Atrium receives	-	a) Superior venacava b) inferior venacava c) Coronary vein
Right Ventricle	-	Pulmonary artery (Deoxygenated blood)
Left Atrium receives	-	Pulmonary veins (Oxygenated blood)
Left Ventricle	-	Aorta



Valves in heart

1. **Tricuspid Valve:** Located in between right atrium and right ventricle.
2. **Bicuspid Valve(Mitral valve):** Lies in between left atrium and left ventricle.
3. **Semi lunar valves:** Present near the mouth of pulmonary artery and aorta.

Arteries

The blood vessels carrying blood away from the heart are the arteries. Generally, the arteries carry oxygenated blood except pulmonary artery.

Veins

Generally, the veins carry deoxygenated blood except pulmonary veins.

Capillaries

Capillaries are fine, small tubes found spreading in the midst of the cells. They perform all the functions of blood vascular system. It is considered as a vital tube of the blood vascular system.

MORE TO KNOW

72x60x24x365x80

This is the number of heart beat for a human living up to the age of 80.

Human blood

Human blood consists of two components.

1. Plasma
2. Blood corpuscles

Difference between artery and vein

No	Arteries	Veins
1	It carries blood from the heart to the organs.	It carries blood from the organs to the heart.
2	It carries oxygenated blood except pulmonary artery.	It carries deoxygenated blood except pulmonary veins.
3	The wall is thick and elastic.	The wall is thin and less elastic.
4	It is found deep inside the muscles.	It is found superficialy.
5	Valves are absent.	Valves are present.

1. Plasma

It is an extra cellular fluid of about 55 per cent of the blood volume. It is a faint yellow colour fluid, which is alkaline in nature.Plasma contains proteins, enzymes, hormones, wastes and elements.

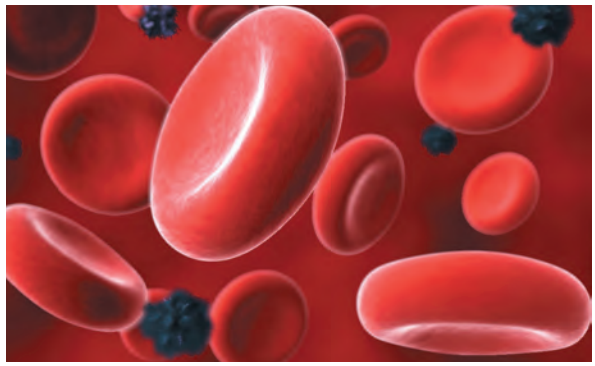
2. Blood corpuscles

Nearly 45 per cent volume of blood contains corpuscles. The blood corpuscles are of three types.

1. Erythrocytes or red blood corpuscles(RBC)
2. Leucocytes or white blood corpuscles(WBC)
3. Thrombocytes or blood platelets.

1. Erythrocytes

They are red, biconcave and disc shaped cells. The red colour of the RBC is due to the presence of respiratory pigment haemoglobin. Haemoglobin helps in transporting oxygen and carbon-di-oxide in our body. One cubic mm of blood contains 5 millions of RBC. The life span of RBC is 120 days. They are destroyed in the liver and spleen. RBC's are prepared by red bone marrow.

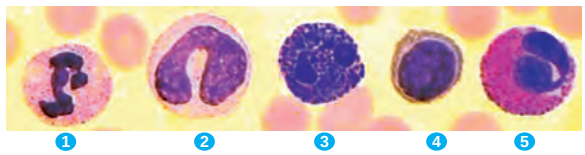


Red blood corpuscles (RBC)

2. Leucocytes

They are colourless, irregular and nucleated cells. The WBC's are fewer in number compared to RBC's and they are larger in size. One cubic mm of blood contains 8000 WBC's. There are 5 types of WBC which are monocytes, lymphocytes, neutrophils, eosinophils and basophils. The life span of WBC is 4 weeks.

They are prepared by yellow bone marrow and lymphatic tissue. WBC's attack the invading germs and protect our body.



1. Neutrophil, 2. Monocyte, 3. Eosionophil, 4. Basophil, 5. Lymphocytes

White blood corpuscles (WBC)

3. Thrombocytes (Blood Platelets)

These are small, non-nucleated and colourless structures floating in the plasma. In one cubic mm of blood there are 2,00,000 to 4,00,000 thrombocytes.

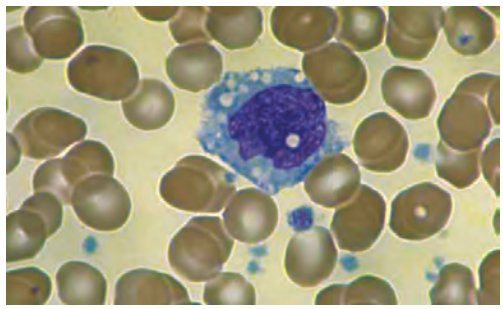
Whenever there is an injury, the thrombocytes disintegrate to give rise to thromboplastin, which helps in the clotting of blood.

Functions of blood

1. Blood distributes the digested food.
2. Blood carries the metabolic wastes to the excretory organs.
3. Blood carries hormones, which are the secretions of endocrine glands.
4. Blood distributes the heat evenly throughout the body.
5. Blood keeps all the tissues moist.

ACTIVITY –3.3

1. Observe the human blood smear under compound microscope and identify RBC and WBC.



Thrombocytes (Blood Platelets)

3.6. RESPIRATORY SYSTEM

Respiration

The phenomenon of release of energy by oxidation of various organic molecules is known as respiration.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy (2900 KJ)}$$

Glucose + oxygen ⟶ carbon dioxide + water.

Respiration is of two types on the basis of usage of oxygen.

1. Aerobic Respiration
2. Anaerobic Respiration

Aerobic Respiration

Respiration, with saturated amount of oxygen. This type of respiration is found in higher animals.

Anaerobic Respiration

Respiration, without oxygen. In this process little amount of energy is liberated. For example Bacteria.

Breathing

Breathing is entirely different from that of respiration. It is an initial step in respiration. Inhaling of atmospheric air and exhalling of carbon-di-oxide is called breathing.

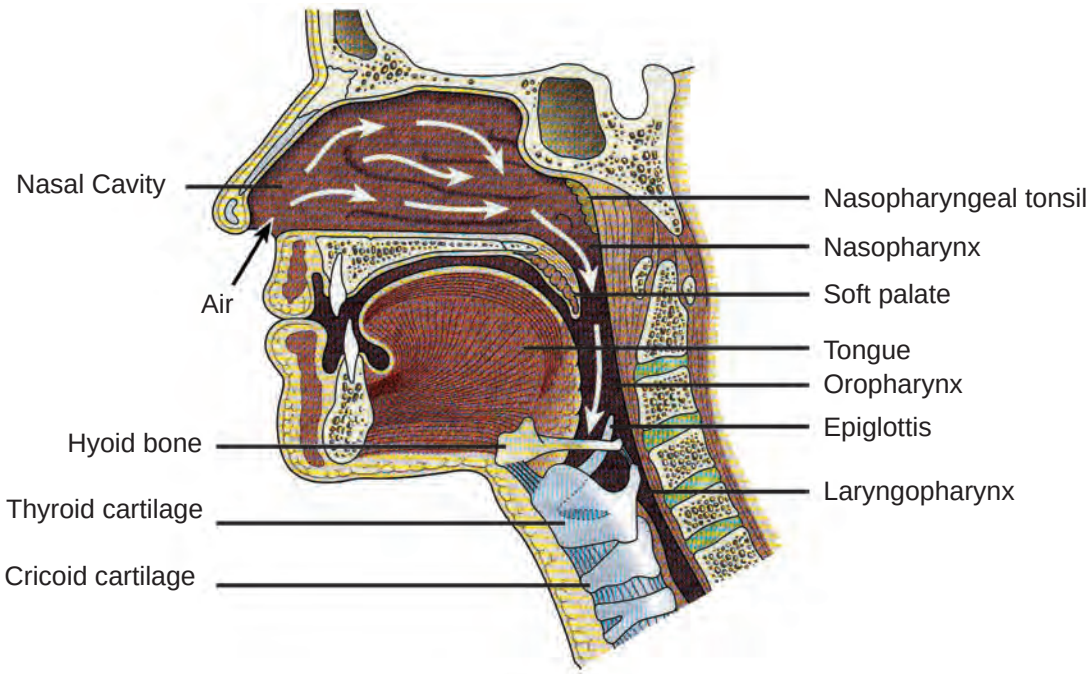
Breathing activity

Count, how many times do you breath every minute.(i) at rest (ii) after climbing a stair case. Compare your results with those of your friends. You will notice that the breathing rate goes up with exercise. When you exercise, your body needs more energy and therefore more oxygen.

Animals and their mode of Respiration

1.	**Amoeba**	:	simple diffusion
2.	**Cockroach**	:	through tracheoles
3.	**Sea cucumber**	:	through respiratory trees
4.	**Fishes**	:	through gills
5.	**Frog**	:	a) cutaneous respiration(skin) b) Pulmonary respiration (lungs) c) Buccal cavity respiration (buccalcarity)

3.6.1. HUMAN RESPIRATORY SYSTEM



The pathway of air from the nose to the larnyx

The respiratory organs include nasal cavity, pharynx, larynx, trachea, bronchi and lungs.

The nasal cavity follows the external nose. The nose is a visible prominent structure. The nasal passage opens outside through external nostrils. It opens inside the internal nostrils at pharynx.

The trachea (or wind pipe) is a membranous tube supported by 'C' shaped cartilage rings. The inner wall is lined by mucous membrane. It consists of ciliated columnar epithelium.

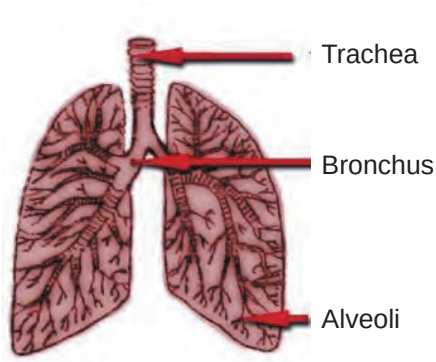
MORE TO KNOW

The cartilage ring found at the basal region is called carina. Foreign objects reaching carina stimulate a powerful cough.

Respiratory area

The total surface of the alveoli will be around 80-100 metre square and equals the size of the tennis court.

Lungs



Structure of Lungs

The pair of lungs are the actual organs of respiration. It is conical in shape and placed inside the thoracic chamber. The base of the lungs rests on the diaphragm. The right lung has three lobes and left lung has two lobes.

Each lung is surrounded by a double wall membrane called pleura. The region inside the pleural membrane is named as the pleural cavity. The cavity is filled with pleural fluid.

The primary bronchi on entering into each lung is divided further into secondary bronchi. The secondary bronchi in turn gives rise to tertiary bronchi. They divide still further and finally gives rise to bronchioles. The bronchioles divide several times to become still smaller terminal bronchioles. The terminal bronchioles end in small air filled chambers called alveoli. This is the place, where exchange of gases takes place. Exchange of gases is only by simple diffusion. Human lungs have about 300 million alveoli. Every minute lung contracts and expands between 12 to 15 times.

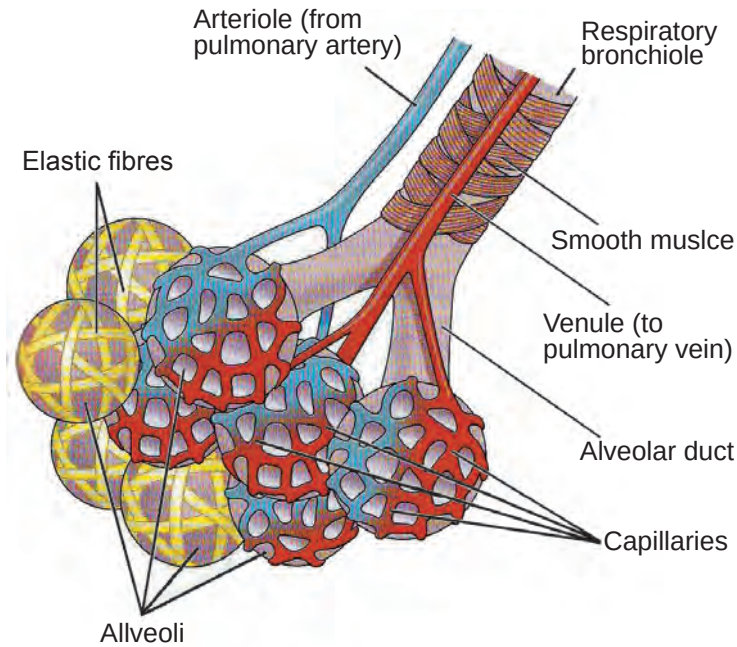
Functions of Lungs

1. The lungs separate CO_2 from the blood.
2. It can excrete water vapour.

MORE TO KNOW

People suffer due to smoke. Smoke contains large amount of CO, a toxic gas.

The respiratory pigment haemoglobin has affinity towards O_2, more affinity towards CO_2 and most affinity towards CO. That is why people entering into the burning place die due to suffocation.



Enlarged view of the alveolus and its capillary network

EVALUATION

Section – A

1. Study the relationship of the given pair and write the missing word or sentences

   a) Heart : Pericardium ; Lung : _____

   b) Mouth : Saliva ; Liver : _____

   c) Skin : Prevents the enterance of infectious agents WBC _____

2. Study the relationship and write the name of the missing muscle.

   Inspiration : Scalene and external intercostal muscles.

   Expiration : 1) _____ 2) _____

3. Bile salts : _____: _____

   Bile Pigments : _____ : _____

4. Renin, Lactase, Lipase : Enzymes

   Glucogon, Insulin : ----------

Section – B

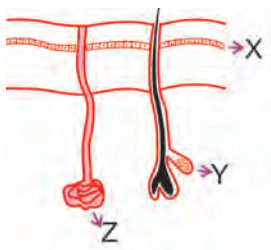
5. Observe the given diagram of skin.

   a) What are X, Y and Z ?

   b) Write the importance of X.

   c) Name the secretions of Y and Z.

   d) Write the importance of the secretions.



6.Match the Column A with B.

A. Animals	B. Locomotory organs
1. Amoeba	a) Flagella
2. Paramoecium	b) Pseudopodia
3. Euglena	c) Tube feet
4. Earthworm	d) Cilia
5. Starfish	e) Body setae.

7. Assertion : A) Skin colour of woman is determined by the presence of melanosytes present in the skin.

   Reason : B) The skin colour of woman cannot be changed by cosmetics.

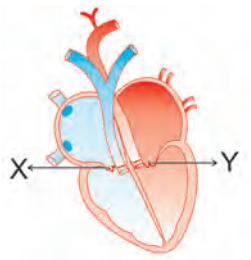
   a) A is right B is wrong. b) A is wrong, B is right.

   c) B explains A d) B does not explain A.

8. Which one is not correctly matched?

Organs	Enzymes
1. Salivary glands	Ptyalin
2. Stomach	Pepsin
3. Pancreas	Sucrase
4. Jejunum	Maltase

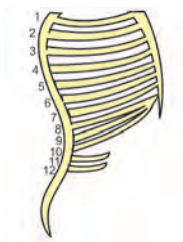
9. It is an illustration of human heart.



1) What is X and Y ?
2) Where are they?
3) Write their functions.

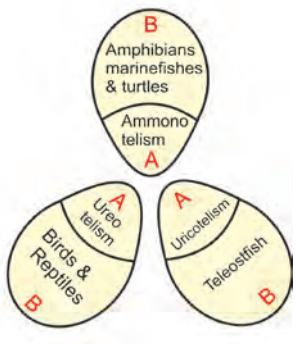
Section – C

10. Diagram of human chest is given. Copy the diagram and mark parts.



a) 1 to 7 ribs are called ----------. Why?
b) 8 to 10 ribs are named ----------. Reason.
c) Write the significance of 11 and 12 ribs.
d) Name to organs in the thoracic chamber.

11. Complete the sehematic representation of animals and their mode of excretion.



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Websites

http://www.enchantedlearning.com

Chapter 4

STRUCTURE AND PHYSIOLOGICAL FUNCTIONS OF PLANTS

4.1. PLANT CELLS

Cells are the structural and functional units of all living organisms. They form the building blocks of organisms. Cells of living organisms could be observed only after the discovery of microscope. The study about the structure and function of the cell is called Cytology or Cell biology.

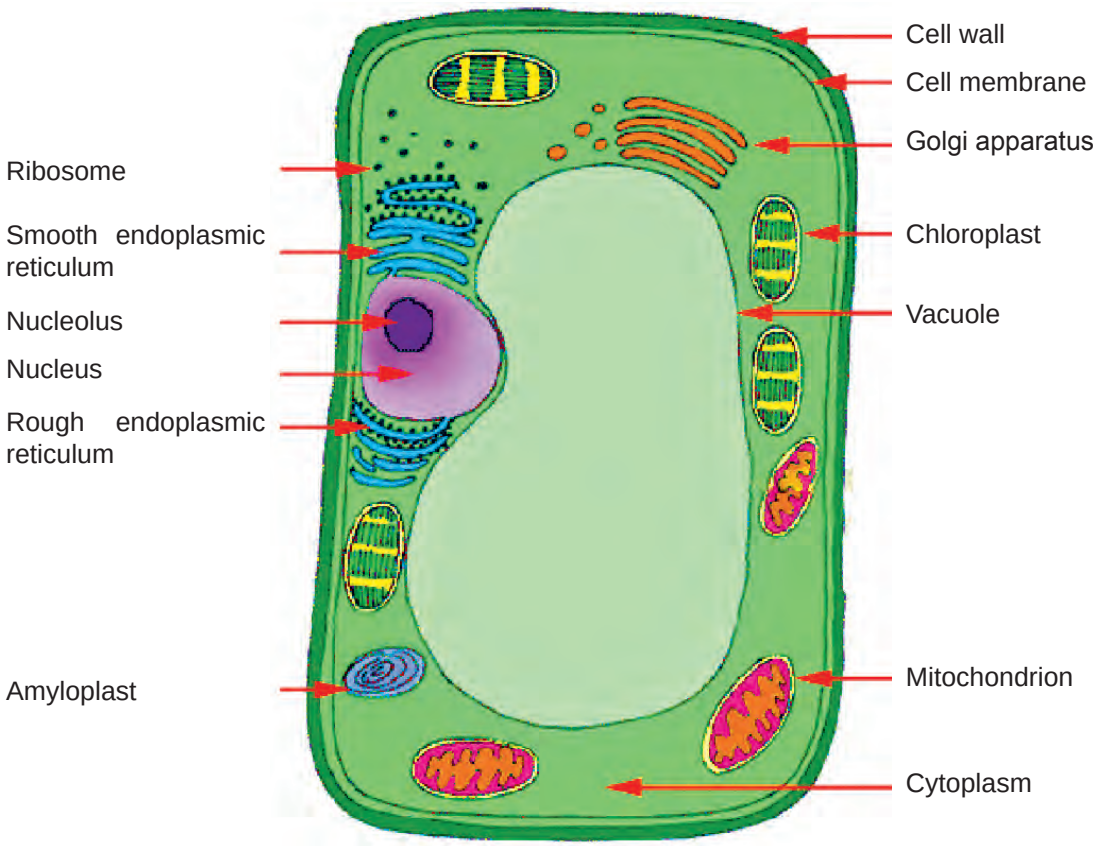
All living organisms are made up of one or more cells. Organisms which are made up of only one cell are called unicellular organisms. e.g. Chlamydomonas. Organisms which are made up of many cells are called muticellular organisms. **e.g.** Most plants and animals.

ACTIVITY –4.1

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 cell membrane is called cytoplasm.

Structure of a Plant Cell



Ultra structure of a plant cell (an eukaryotic cell)

The plant cell may be spherical or rectangular or hexagonal in shape. It consists of a cell wall and protoplast. Cell wall is absent in animal cells. Protoplast denotes the whole of protoplasm present in a cell. It is differentiated into plasma membrane, nucleus, cytoplasm and vacuoles. Various cell organelles like endoplasmic reticulum, mitochondria, chloroplast, golgi bodies, ribosomes, etc are embedded in the cytoplasm.

4.2. PLANT TISSUES

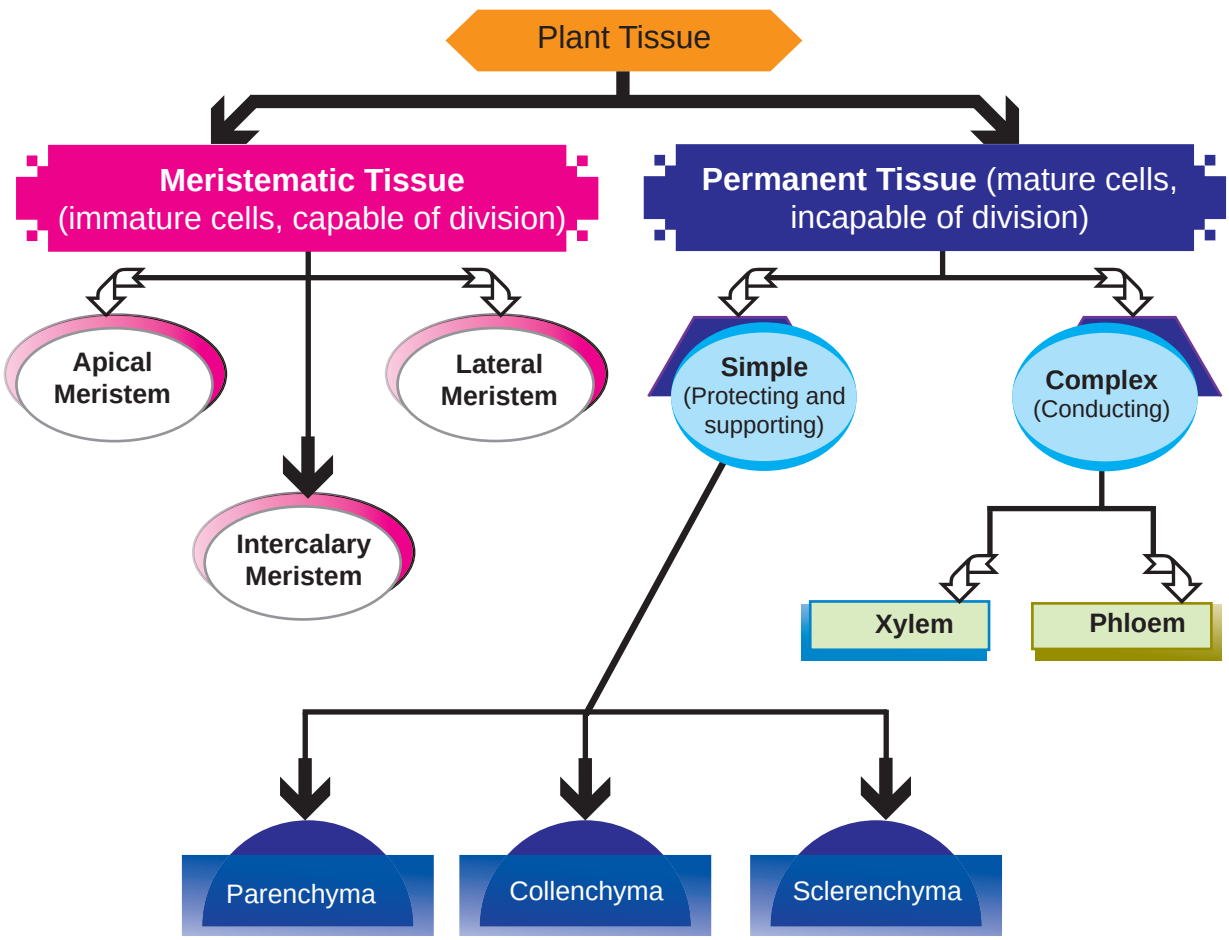
The body of plants and animals is made up of different types of cells. These cells originate from a single cell by repeated divisions and get differentiated during development.

In unicellular organisms all the body functions are performed by a single cell. But in multicellular organisms, different functions are performed by different groups of cells.

The groups of cells having a common origin and performing similar functions are called tissues. Several tissues are organized to form tissue system and the tissue systems form the organs and several organs into organism.

Cells → Tissues → Tissue systems → Organs → Organisms

CLASSIFICATION OF TISSUES



4.3. PLANT FUNCTIONS

Plants germinate from seeds, grow, develop, mature, reproduce and die. Plant physiology deals with how plants function.

Water is essential for all physiological activities of plants. It is an universal solvent. It plays a vital role in photosynthesis, respiration, transpiration, transportation from root to leaf, etc. Presence of water in the soil is essential for the normal functioning of plants. Soil water contain minerals in dissolved state.

Plants absorb water and minerals from the soil with the help of root hairs. This process is called absorption.

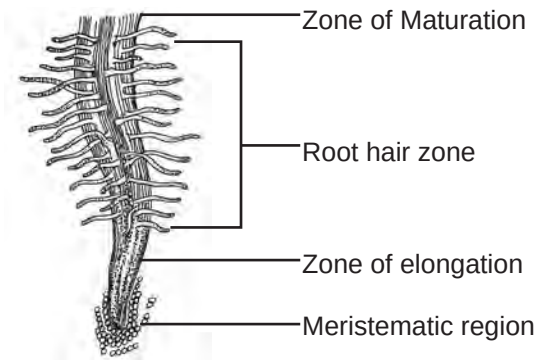
Absorption in plants is done by three forces namely

(i) **Imbibition,** (ii) **Diffusion** and (iii) **Osmosis**

(i)Imbibition:

Imbibition is the uptake of water or other solvents by substances that do not dissolve in water resulting in swelling of these substances. Such substances are called imbibants. **e.g.** wood, seeds, etc.

In plant cells, the cell wall is the imbibant. It absorbs water and forms a channel for movement of water into the cell by diffusion and osmosis.



Regions of the root

Imbibition plays a very important role in seed germination which involves absorption of water by seed coats, their swelling and rupture causing the emergence of the radicle and plumule.

ACTIVITY –4.2

Place a lighted incense stick at one corner of the room. The sweet fragrance of the incense stick spreads all over the room. Here the fragrance moves out from a region of higher concentration to a region of lower concentration till it becomes uniform.

(ii) Diffusion

Dissolved molecules move from a region of higher concentration to the region of lower concentration until the molecules are evenly distributed throughout the available space.

Gases such as Oxygen, Carbon dioxide and nutrients like minerals move into or between the cells by diffusion.

(iii) Osmosis

The movement of a solvent (water molecule) from a region of its higher concentration to the region of its lower concentration through a semipermeable membrane is called Osmosis.

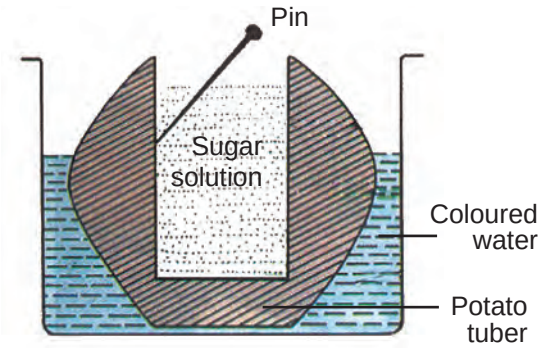
Demonstration of Osmosis

A potato is taken and peeled. Its base is cut to make it flat. A hollow cavity is made in the centre of the tuber and filled with sugar solution. The initial level of solution is marked with the help of a pin. It is placed in a beaker containing coloured water.

After sometime, it is observed that the sugar solution in the cavity of the potato becomes coloured and level rises. How has this taken place? This is due to the entry of water from the beaker into the cavity of potato through the living cells of potato. Here the living cells of potato act as a semipermeable membrane.

Active absorption and Passive absorption

Two mechanisms are involved in



Potato Osmoscope Experiment

helping soil water to enter into the root hairs. They are (i) **Passive Absorption** (ii) **Active Absorption.**

ACTIVITY –4.3

1. Take a few fresh grapes and keep in a dish containing concentrated sugar solution.
2. Take a few raisins (dried grapes). Soak them in water. Observe the changes in both the cases.

Passive Absorption

The absorption of mineral ions without the use of metabolic energy is called passive absorption.

Active Absorption

The uptake of mineral ions by using metabolic energy is called active absorption.

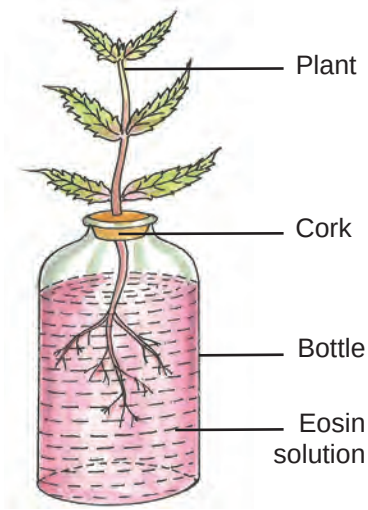
Ascent of Sap

The water, along with mineral salts, is absorbed by the root through its root hairs. The absorbed water reaches the xylem vessels and finally reaches the leaves. This movement of water and mineral salts is known as Ascent of Sap.

Demonstration of Ascent of Sap

Take an entire balsam plant without damaging the roots. Wash the roots to remove the soil particles. Insert the roots into a bottle containing dilute eosin solution or red ink solution. Leave the setup aside for sometime.

After sometime, red streaks can be observed on the stem and veins of leaves. If a section of the stem is mounted on a microscope and observed, it shows that only xylem vessels are coloured showing that ascent of sap takes place only through the xylem vessels.



Ascent of Sap Experiment

The leaf is a flattened, lateral out growth of the stem. The functions of the leaf are

a) **Photosynthesis** - *Synthesizing Carbohydrate using light energy, CO_2 and water.*

b) **Respiration** - *Taking in oxygen and giving off CO_2.*

c) **Transpiration** - *Giving out excess water as water vapour.*

d) **Food Storage** - *Leaves also serve as organs of food storage in some plants.*

e) **Vegetative reproduction** - *Buds that can develop into new plants.*

4.31. PHOTOSYNTHESIS

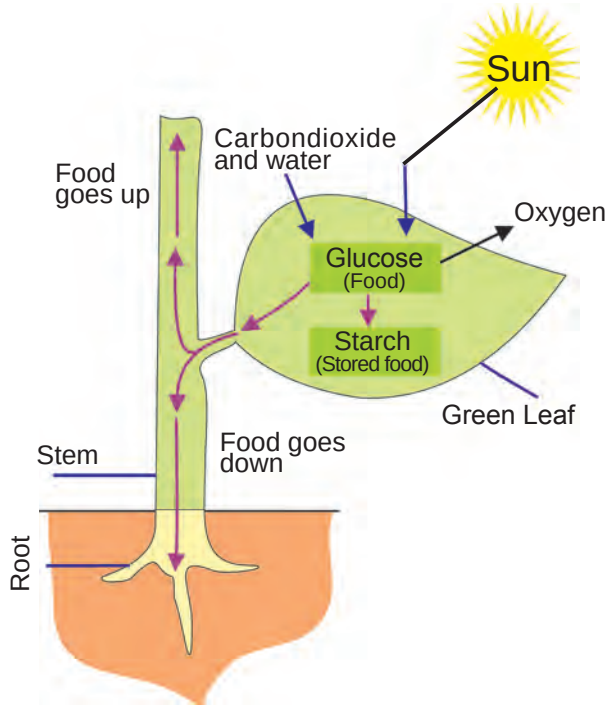
Green plants are autotrophic and synthesize their own food by the process of photosynthesis. 'Photo' means 'light' and 'synthesis' means 'to build' thus 'photosynthesis' means 'building up by light'.

How do green plants prepare food?

The process of photosynthesis takes place in the green leaves of a plant. The green leaves prepare the food by combining carbon dioxide and water in the presence of sunlight and Chlorophyll.

Carbon dioxide from the atmosphere enters the leaves through tiny pores called stomata. Water is taken from the soil. This water is transported to the leaves through roots and stem. The green pigment called Chlorophyll present in green leaves absorb light energy. The sunlight provides energy required to carryout the chemical reactions involved in the preparation of food.

The process by which green plants synthesize carbohydrate from Carbon dioxide and water by using energy from sunlight in the presence of Chlorophyll is called Photosynthesis. Oxygen is released during photosynthesis.



A schematic representation of Photosynthesis

The overall equation of photosynthesis is,

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 \text{ (glucose)} + 6O_2$$

Materials required for Photosynthesis

1) **Light energy**
2) **Chlorophyll**
3) **Carbon dioxide** and
4) **Water**

Site of Photosynthesis

Leaves which contain chloroplasts are the main photosynthetic organelles of the plant. Chloroplasts have chlorophyll pigments which are necessary for the synthesis of food.

Mechanism of Photosynthesis

The process of photosynthesis occurs in two phases. :

(i) **Light reaction** (ii) **Dark reaction.**

Light Reaction

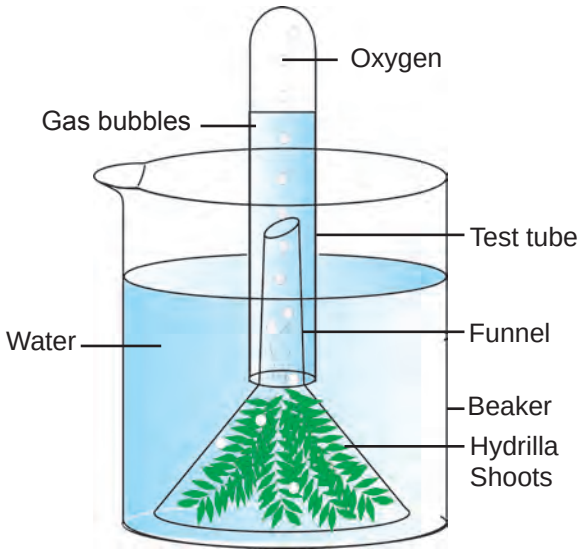
The reaction involving pigments, solar energy and water that produces ATP (Adenosine Tri Phosphate) and $NADPH_2$ (Nicotinamide Adenine Dinucleotide Phosphate- reduced form) is called light reaction.

Dark Reaction

The reaction in which CO_2 is reduced

to carbohydrate by making use of ATP and $NADPH_2$ generated by light reaction is called Dark reaction. Light is not required for this reaction. So it is called dark reaction.

Experiment to show that oxygen is evolved during photosynthesis. (Test tube and funnel experiment).



Test tube and funnel experiment

Place a few cut branches of Hydrilla in a beaker of water and invert a glass funnel over the cut branches in such a way, that the cut end faces the stem of the funnel. The stem of the funnel should be below the level of water. A test tube is filled with water and it is inverted over the stem of the funnel. A pinch of Sodium bicarbonate is added to the water as a source of Carbon dioxide.

ACTIVITY – 4.4

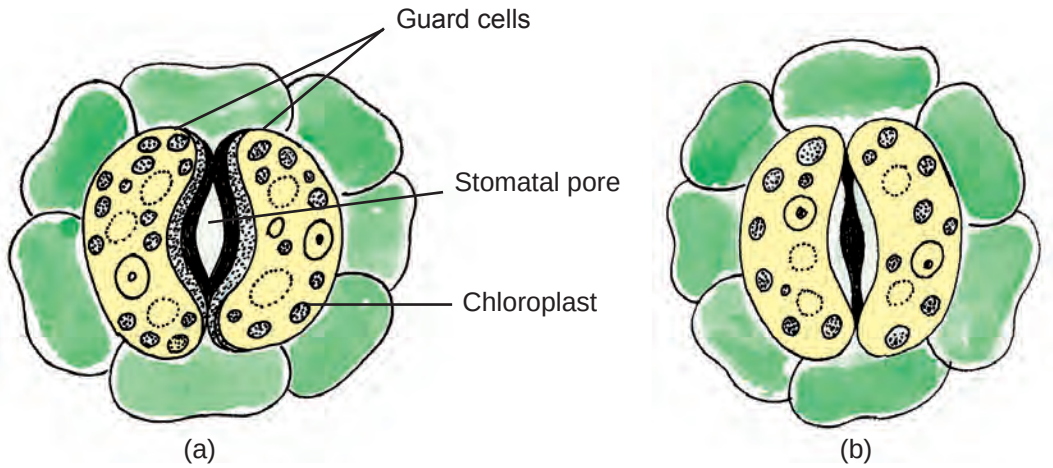
Pluck a leaf from a plant. Dip it in boiling water for 5 minutes. Then dip it in 90% alcohol to decolourize it. Wash in water and add few drops of Iodine solution. Observe the change if any. Why does the colour change?

Now the apparatus is kept in sunlight for 4 to 6 hours. The gas bubbles may be observed from the cut ends of hydrilla branches kept with in the funnel. These gas bubbles are collected in the test tube by downward displacement of water. The gas is tested for oxygen. When a burnt splinter is taken near the mouth of the tube, it glows brightly and this proves that the gas is oxygen. This experiment proves that oxygen is evolved during photosynthesis.

Factors affecting Photosynthesis

Photosynthesis is influenced by various factors. They are light, temperature, CO_2, Chlorophyll distribution, Water, Mineral salts and age of the leaf.

4.3.2. TRANSPIRATION



(a) Open and (b) closed stomatal pore

Plant absorbs a large quantity of water from the soil by the root hairs. They use only a fraction of this absorbed water. A large amount of water is lost by plants in the form of water vapour. The loss of water through the aerial parts of the plant such as leaves and green shoot is known as Transpiration.

Types of Transpiration

There are three types of transpiration

i) **Stomatal transpiration.**

ii) **Cuticular transpiration**

iii) **Lenticular transpiration**

ACTIVITY – 4.5

Apply some nail polish (very light pink) on the lower surface of the leaves of a potted plant. After a few minutes, gently peel of the nail polish. Now place one such nail polish peeling on a drop of water placed on a slide. Fix a cover slip and observe this peeling under a microscope.

Through the microscope you can see the impression of the cells and the stomatal openings on the lower surface of a leaf.

Stomatal transpiration

Stomata are tiny pores in the epidermis of leaves and other aerial parts of the plant like stem. They are surrounded by two kidney shaped cells called guard cells. Each guard cell has an elastic outer thin wall and a thick inner wall. When the guard cells are turgid (full of water), the outer walls are stretched and the stomata remains open. This happens during day time. At night, the guard cells become flaccid by losing water to the surrounding cells. The inner walls come closer. This reduces the stomatal opening. The transpiration of water through stomata is called stomatal transpiration. A large quantity of water is lost through the stomata during transpiration.

ACTIVITY – 4.6

Take some Coriander leaves and keep them in a polythene bag for few hours. Observe what happens.

Cuticular transpiration

Cuticle is the waxy layer lying over the epidermis of the leaf. Only a small amount of transpiration occurs through the cuticle. This is known as cuticular transpiration.

Lenticular transpiration

Lenticels are minute pores found on the barks of woody plants. A small amount of transpiration occurs through lenticels also. This is known as lenticular transpiration.

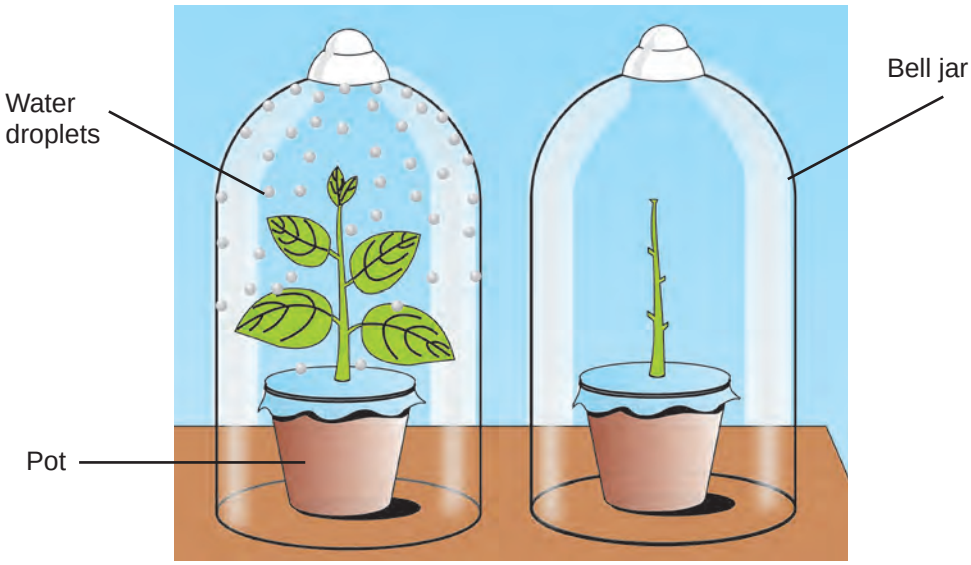
Experiment to show that transpiration takes place through the leaves (Bell Jar Experiment)

Take two identical potted plants with broad leaves. Cover the surface of the pot with rubber sheet so that the soil is not exposed. In one plant, remove all the leaves and apply vaseline to the cut ends of the leaves. Cover both the potted plants separately with two dry bell jars. Leave this set up for few hours. Observe what happens?

Droplets of water are seen on the inner surface of the bell jar which covered the plant with leaves, where as no water droplet is seen in the other bell jar. The presence of water droplets proves that transpiration takes place only through leaves.

Factors affecting transpiration

Light, temperature, wind, quantity of water in the soil, number of stomata and surface area of the leaf are the factors that affect transpiration.



Bell Jar Experiment

4.3.3. RESPIRATION

All living organisms perform various functions. For this, energy is required.

The process of breathing is very much related to the process of release of energy from food. All the energy required for life processes is obtained by the oxidation of food.

Mitochondria are the seats of biological oxidations which furnish energy for the various activities of the cell. The process by which food (Carbohydrate) is broken down and the energy is released for use in other activities is called oxidation. It is commonly referred to as biological oxidation or respiration.

Respiration is defined as a biochemical process consisting of oxidation and degradation of food with the release of energy.

The energy released during respiration is stored in the form of ATP (Adenosine Tri Phosphate) molecules in the cells and are used by the organism as and when required.

ATP has a high energy content. So ATP is known as the energy currency of the cell.

Types of respiration

Oxidation of food can occur in the presence of oxygen as well as in the absence of oxygen. Based on this, there are two types of respiration.

i) **Aerobic respiration**
ii) **Anaerobic respiration**

Aerobic respiration (Aerobic – with air)

This type of respiration occurs normally in all plants. In this type of respiration glucose is completely oxidized in the presence of oxygen, releasing CO_2, water and energy.

$$C_6H_{12}O_6 \text{ (glucose)} + 6O_2 \longrightarrow 6CO_2 + 6\,H_2O + 2900 \text{ KJ energy}$$

Aerobic oxidation of glucose occurs in 4 steps

1) **Glycolysis** 2) **Oxidation of Pyruvic acid** 3) **Kreb's Cycle**

4) **Electron transport chain**

Anaerobic Respiration (Anaerobic - without air)

Organisms like Bacteria and Yeast undergo respiration in the absence of oxygen. It is called anaerobic respiration. In this type, oxidation of food material is incomplete.

$$C_6H_{12}O_6 \text{(glucose)} \xrightarrow[\text{Zymase (enzyme)}]{\text{Yeast}} 2C_2H_5OH + 2\,CO_2 + 50 \text{ KJ energy}$$

Glycolysis is common for both aerobic and anaerobic organisms.

Factors affecting respiration:

Oxygen, Temperature, Water, Light, CO_2, and Glucose are some of the factors that affect respiration.

4.3.4. TRANSPORTATION

What is meant by transport?

"Transport" means 'to carry things from one place to another'.

In biology, transport is a life process by which a substance absorbed or made in one part of the body of an organism is carried to the other parts of the body. Special tissues and organs are needed for the transport of substances in plants and animals.

TRANSPORT IN PLANTS

Due to the branching shape of a plant, all the cells of a plant can get oxygen for respiration and carbon dioxide for photosynthesis directly from the air by diffusion.

So, the substances which are to be supplied to a plant through a transport system are water and minerals. Another work of the transport system of plants is to transport food prepared in the leaves to the various parts of the plants like stem, roots etc.

The plants have two transport systems

1. **Xylem** 2. **Phloem**

The transport of materials in a plant can be divided into two parts.

i) Transport of water and minerals in the plant.

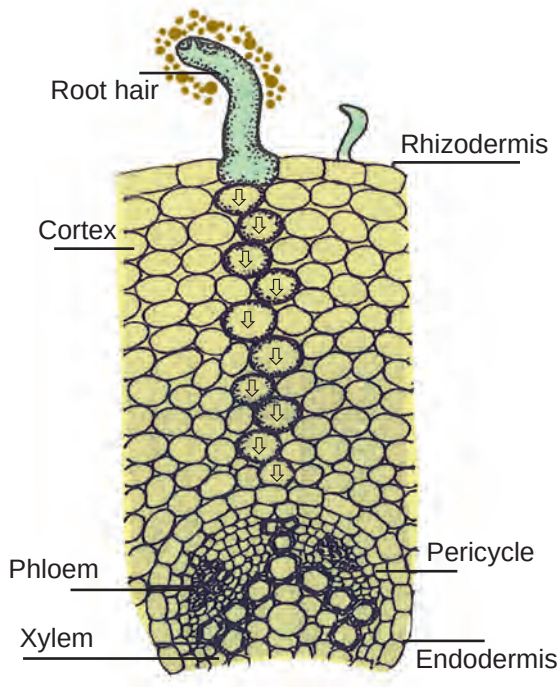
ii) Transport of food and other substances like hormones in the plant.

Transport of Water and minerals

Water and minerals are absorbed from the soil by the roots of the plant and transported to the various parts of the plant like stem, leaves and flowers. The

MORE TO KNOW

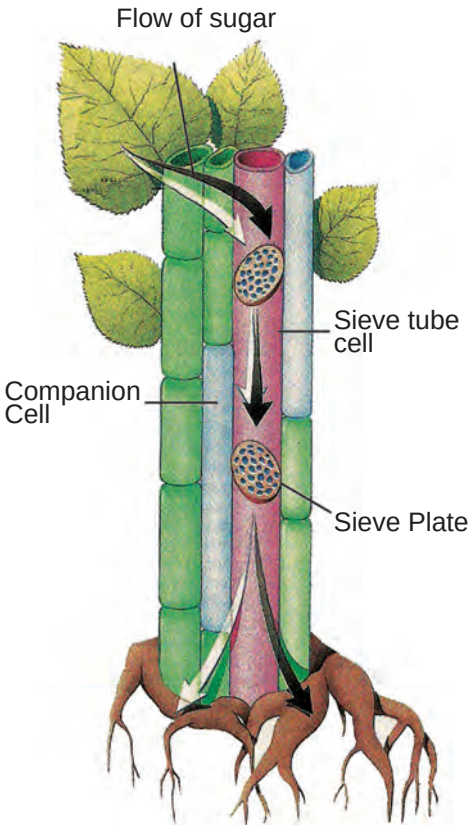
The world's tallest tree in the giant Sequoia, water has to travel to an incredible 84m (275 ft) before it reaches the highest leaves at the top of the tree.



Path of Water across the root

water and minerals dissolved in it move from the roots to the other parts through the two kinds of xylem cells called xylem vessels and tracheids.

In Pteridophytes and Gymnosperms, tracheids are the only water conducting tissue. In Angiosperms either only xylem vessels transport water or both xylem vessels and tracheids transport water.



Food Transportation

Transport of Food and other substances

The transport of food from leaves to the other parts of the plant is called translocation. The movement of food materials through phloem depends on the action of living cells called sieve tubes.

The food is made in the mesophyll cells of a leaf. The food made by the mesophyll cells of a leaf enters into the sieve tubes of the phloem. Once the food enters the sieve tubes in the leaves, it is transported to all other parts of the plant body by the network of sieve tubes present in all parts of the plant like stem and roots.

The movement of water and dissolved salts in xylem is always upwards and it is caused by the suction of water at the top because of low pressure created by transpiration from leaves.

The movement of food in phloem can be, upwards or downwards or lateral depending upon the needs of the plant.

4.4. PLANT NUTRITION

Autotrophs

All living organisms require a continuous supply of carbon containing compounds for growth and for building up their body structures. Energy is also required to maintain their daily activities. It is derived by oxidizing either organic or inorganic compounds. Intake of nutrients into the body by an organism is called nutrition. All the nutrients required by organisms are obtained through the food they consume.

Organisms differ in their modes of nutrition. There are mainly two modes of nutrition.

1) **Autotrophic nutrition.**
2) **Heterotrophic nutrition**

Autotrophic nutrition

In autotrophic nutrition, the organism synthesizes its own food. Organisms which are able to synthesize their own food materials are called autotrophs. They convert carbon dioxide and water into various organic compounds with the help of energy. Depending on how the plants obtain energy for converting carbon dioxide to organic compounds, they are classified as

1) **Photo autotrophs**
2) **Chemo autotrophs**

Photo autotrophs

Organisms which use energy from sunlight for the synthesis of food are called photo autotrophs. e.g. Green sulphur bacteria, purple sulphur bacteria and all green plants.

Chemo autotrophs

Organisms which use chemical energy

ACTIVITY – 4.7

Take a piece of bread, moisten the bread with water and keep it in a closed box for a few days.

What do you see?

for the synthesis of carbon compounds are called chemo autotrophs. They get energy by oxidizing simple inorganic compounds such as hydrogen, sulphur containing compounds, hydrogen sulphide, ammonia, etc. eg. Nitrosomonas

Heterotrophic nutrition

Some organisms cannot synthesize their own food. They depend on other organisms for their food directly or indirectly. Organisms which are not able to synthesize their own food are called heterotrophs.

Heterotrophic nutrition is of two types

i) **Saprophytic nutrition**

ii) **Parasitic nutrition**

Saprophytic Nutrition

Plants which obtain nutrition from dead or non-living organic matter are called Saprophytes. e.g: Mucor (Fungus), Bacillus subtilis (Bacteria) and Monotropa (Angiosperm)

Parasitic Nutrition

In parasitic nutrition, an organism derives its food from the body of other living organism (host).

Cuscuta (Dodder plant)

Some plants get their nourishment from other living plants or animals. They are called parasitic plants. The plants or animals from which the parasites get their nourishment are called hosts. They have some special structures which penetrate the host and absorb food, water and minerals. These special structures are called haustoria.

e.g: Xanthomonas citri (bacteria)
Cercospora personata (fungus)
Cuscuta (angiosperm)

Monotropa (Indian pipe)

Mushroom

MORE TO KNOW

Some plants are capable of synthesizing food by photosynthesis but they are not able to synthesize proteins due to the deficiency of nitrogen. They overcome this deficiency by catching small insects and digesting them. Such plants are called insectivorous plants. e.g. Nepenthes, Drosera and Utricularia.

Nepenthes (Pitcher plant)

Drosera (Sundew plant)

Utricularia (Bladderwort)

Symbiotic Nutrition

In this type of nutrition there is an association of two different living organisms. When two organisms live together, they exchange nutrients and are benefited mutually. Such type of nutrition is called symbiotic nutrition and the organisms are called Symbionts. e.g. Lichen, Mycorrhiza and Rhizobium.

Lichen

Rhizobium

4.5. MOVEMENTS IN PLANTS

Can plants move?

The plants are fixed at a place with their roots in the ground. So they cannot move from one place to another. They lack the power of locomotion. Movements of the individual parts or organs of plant are possible when they are subjected to some external stimuli like light, water, chemical substances and touch.

The plant movements made in response to external stimuli fall into two main categories.

1) **Tropisms** 2) **Nasties**

Tropisms

A growth or movement of a plant part in response to an external

stimulus in which the direction of stimulus determines the direction of response is called tropism.

If the growth or movement of a plant part, is towards the stimulus, it is called positive tropism.

If the growth or movement of a plant part, is away from the stimulus, it is called negative tropism.

Stimulus	Type of tropism
Light	Phototropism
Gravity	Geotropism
Chemical	Chemotropism
Water	Hydrotropism
Touch	Thigmotropism

Phototropism

The movement of a plant part in response to light is called phototropism. If the plant part moves towards the light, it is called positive phototropism. If the plant part moves away from the light, it is called negative phototropism. The stem always grows towards light and root always grows away from sunlight.

Phototropism

ACTIVITY – 4.8

i) Take a potted plant growing in a transparent glass jar in a normal position. You can see that its roots are growing downwards and its stem is growing upwards.

ii) Now tilt the potted plant and keep the pot horizontally on its side.

What is the position of the roots?

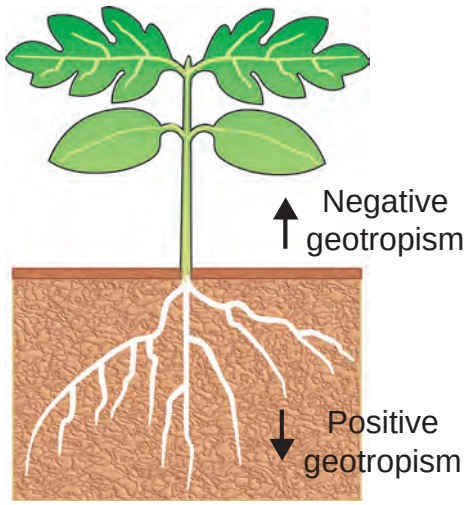
What is the position of the stem?

Are they both parallel to the ground or not?

iii) Allow the plant to remain in this position for a few days. After a few days what do you observe?

Geotropism

The movement of plant part in response to gravity is called geotropism. If the plant part moves towards the direction of gravity, it is called positive geotropism. If the plant part moves against the direction of gravity, it is called negative geotropism. Roots of a plant always grow down wards in the direction of gravity and stem always grows upwards against the direction of gravity.



Geotropism

ACTIVITY – 4.9

1. Take a potted plant growing in a transparent glass jar. Keep it in the open space.

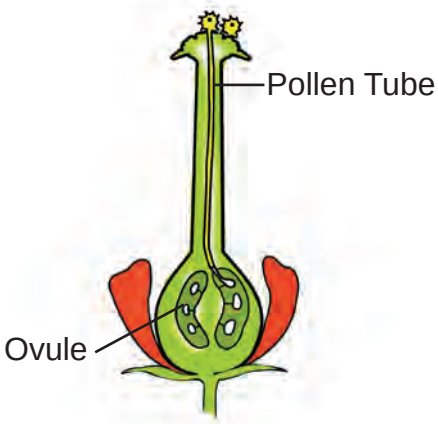
   What do you observe?

2. Take another potted plant and keep it having a straight stem and root near the window in a dark room so that sunlight falls on it through the window only.

   What do you see?

Chemotropism

The movement of a plant part in response to a chemical stimulus is called chemotropism. If the plant part shows movement towards the chemical, it is called positive chemotropism. On the other hand if the plant part shows movement away from the chemical, then it is called negative chemotropism.

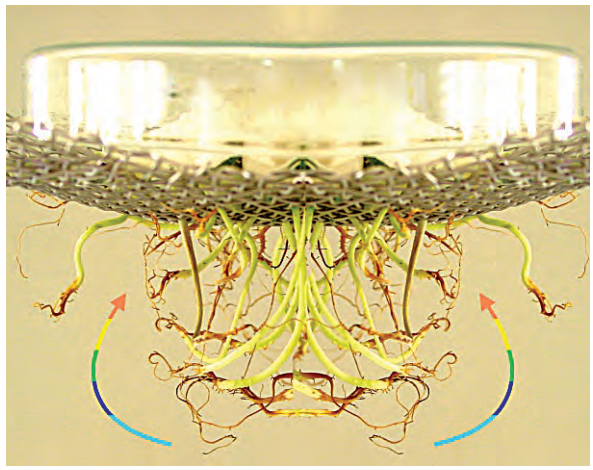


Chemotropism

The growth (movement) of a pollen tube towards the ovule induced by a sugary substance as stimulus, is an example of chemotropism. The ripe stigma in the carpel of a flower secretes a chemical substance (sugary substance) into the style towards the ovary. This sugary substance acts as a stimulus for the pollen grains which fall on the stigma of the carpel. The pollen grain responds to this stimulus by growing a pollen tube in the downward direction into the style of the carpel and reaches the ovule in the ovary of the flower for carrying out fertilization.

Hydrotropism

The movement of a plant part in response to water is called hydrotropism. If the plant part moves towards water, it is called positive hydrotropism. On the other hand if the part moves away from water it is called negative hydrotropism. The roots of a plant always go towards water and they are positively hydrotropic.



Hydrotropism

Thigmotropism

Climbing plants have weak stems, so they cannot stand erect. They have climbing organs called tendrils.

Tendrils are the thin, thread-like growths on the stems or leaves of climbing plants. Tendrils are sensitive to touch or contact of other objects. When a tendril touches an object, then the side of tendril in contact with the object grows, slower than its other side. This causes the tendril to bend towards the object by growing towards it, wind around the object and cling to it. The winding movement of the tendril of a climbing plant is an example for thigmotropism.

ACTIVITY – 4.10

i) Take two glass troughs A and B and fill each one of them with two – thirds of soil.

ii) Plant a tiny seedling in trough A.

iii) Plant a similar seedling in trough B and also place a small 'clay pot' inside the soil.

iv) Water the soil in trough A daily and uniformly.

v) Do not water the soil in trough B but put some water in the clay pot buried in the soil.

vi) Leave both the troughs for a few days.

vii) After a few days, dig up the seedlings carefully from both the troughs without damaging their roots.

What do you observe?

Is the root of seedling in trough A straight or bent?

Is the root of a seedling in trough B bent? Why?

Thigmotropism:

NASTIES

The movement of a plant part in response to an external stimulus in which the direction of response is not determined by the direction of stimulus is called nastic movement.

Example :

i) The folding up of the leaves of a sensitive plant (Mimosa pudica) – touch.

ii) The opening of the petals of Dandelion flowers in morning in bright light and closing in the evening – light.

iii) The closing of the petals of moon flower in the morning in bright light and opening at dark – light.

The folding up of the leaves of a sensitive plant on touch is not a growth movement but the opening and closing of petals of flowers is growth movement.

Some of the nastic movements are as follows:

i) Thigmonasty (Seismonasty)

The non-directional movement of a plant part in response to the touch of an object is called thigmonasty. The best example for thigmonasty is Mimosa pudica (Touch-me-not plant). It we touch the leaves of the sensitive plant with our fingers, then its leaves fold up and droop immediately.

Before touch After touch

Mimosa pudica (Touch-me-not plant)

ii) Photonasty

Dandelion

The non-directional movement of a plant in response to light is called photonasty. The opening of leaves and flowers during day time and their closure at night is an example.

A Dandelion flower opens up in the morning in bright light but closes in the evening when the light fades and it gets dark.

iii) Thermonasty

The non-directional movement of a plant in response to temperature is called thermonasty. In Crocus, the flowers open at high temperature and close at low temperature.

4.6. SENSITIVITY IN PLANTS

i) When a torch light is focused to our eyes, we automatically close our eyes.

ii) When we come in contact with a hot surface unexpectedly, immediately we withdraw our hands.

All these things happen because human beings as well as animals are sensitive to stimuli like light, heat, etc.

When we touch the leaves of Mimosa pudica, suddenly the leaves fold up. Even though the plants don't have any nervous system, they respond to stimuli. How?

The petiole of Mimosa pudica leaves are pulvinate. (pad – like swellings at the base of leaf). The pulvini (singular pulvinus) contain a lot of water in their cells. Due to the internal 'water pressure' in them, all the pulvini are very firm and hold the leaves above them upright. The pulvini have also large intercellular spaces between their cells.

The folding up of the leaves of a sensitive plant on touching is due to the loss of water from the Pulvini. The pulvini lose their firmness causing the leaves to droop and fall.

When the leaves of sensitive plants are touched with a finger, then an electric impulse is generated which travels through ordinary cells. This electrical impulse acts on a plant hormone. The plant hormone makes the water migrate from the cells of one half of a pulvinus to the intercellular spaces in the other half of pulvinus. This loss of water forces the leaf to fold. Similarly, all the pulvini lose firmness and become limp. As a result all the leaves above them collapse and droop. After a gap of 15 to 30 minutes, water usually diffuses back into the same cells of pulvinus from which it left, and the leaf returns to its original position.

EVALUATION

Section – A

Choose the correct answer

1. A plant cell differs from an animal cell in the presence of (cell membrane, endoplasmic reticulum, plasma membrane, cell wall).
2. A parasitic plant (mushroom, mucor, cuscutta, yeast).
3. The loss of water from the aerial parts of the plant is known as (photosynthesis, transpiration, reproduction, respiration).
4. The movement of a plant part in response to light is called (geotropism, hydrotropism, phototropism, thigmotropism).
5. The energy currency of cell (FAD, NADP, NAD, ATP)

Section – B

6. i) Is man an autotroph or heterotroph?

   ii) Explain why.
7. Complete the equation

   $6CO_2$ + _____ $\longrightarrow$ $C_6H_{12}O_6$ + _____
8. Plants absorb water and minerals from the soil with the help of root hairs. Name the forces involved in absorption.

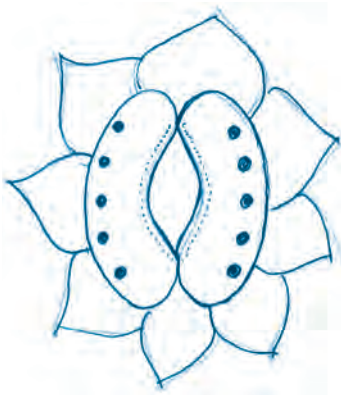
Section C

9. a) Plants prepare their own food.

   i) Name the process by which plants make food.

   ii) Apart from carbondioxide and water, what other things are required for making food.

   b) Observe the diagram



   i) Copy the diagram and label the following parts

   a) stomatal pore b) chloroplast

   ii) Point out the function of each part labelled.

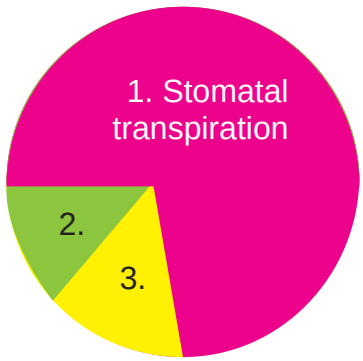
10. Respiration is defined as biochemical process consisting of oxidation and degradation of food with release of energy.

a) Differentiate Aerobic and Anaerobic respiration.

b) $C_6H_{12}O_6 \xrightarrow[\text{zymase}]{\text{yeast}} \_\_\_\_\_ + 2CO_2 + 50KJ$ energy

c) List out the factors affecting respiration.

11. a) Complete the pie chart which shows the types of transpiration.



b) Match the column A with column B

Stimulus (A)	Type of Tropism (B)
Gravity	Chemotropism
Chemical	Thigmotropism
Touch	Geotropism

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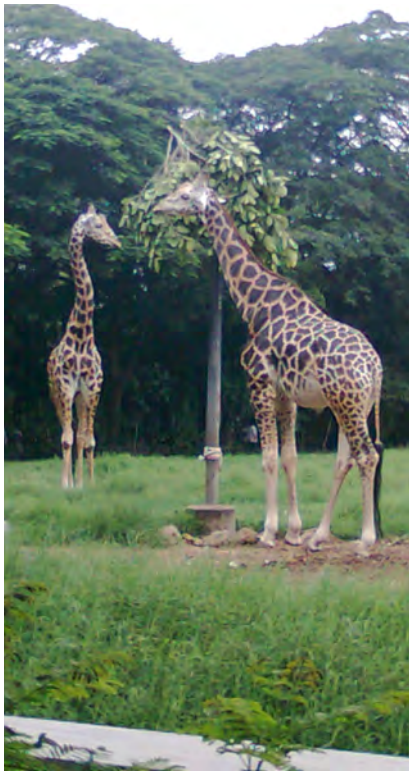
Chapter 5

ANIMAL KINGDOM





Introduction

Animals originated approximately 600 million year ago. More than 2 million existing varieties of animals have been identified. Of these more than 12,72,000 are invertebrates and fewer than 62,000 species are vertebrates.

TAXONOMY

The branch of biology dealing with identification, description, nomenclature and classification is called taxonomy. Biological classification helps us to identify organisms and later recognize those already classified.

MORE TO KNOW

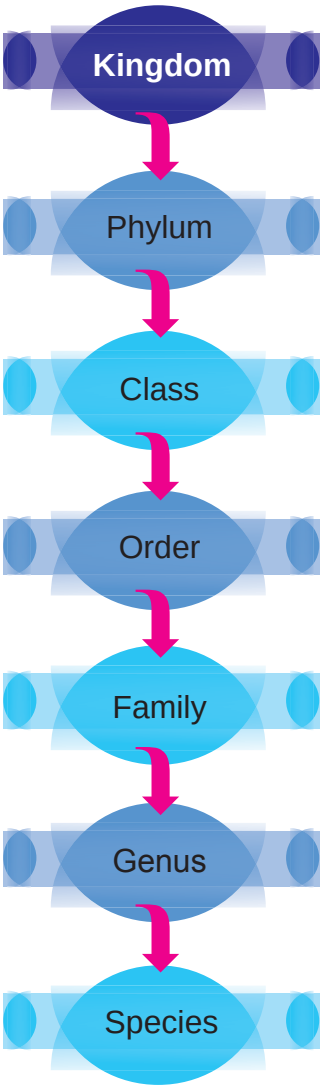
Aristotle, the father of Zoology was the first to classify animals based on their similarities and differences.

MORE TO KNOW

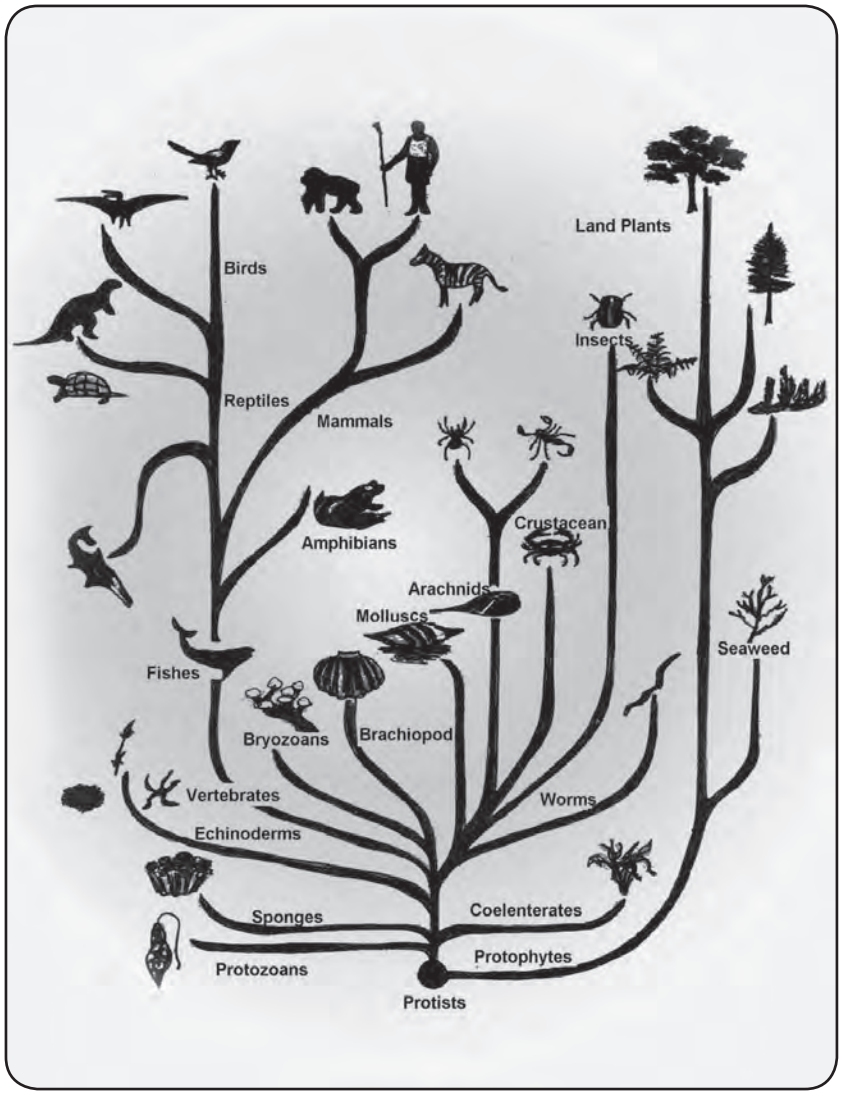
Carl Linnaeus, the Swedish Botanist is regarded as the father of modern taxonomy.

Levels of classification

Based on similarities and differences in the structure, animals are divided into small groups called taxons. Linnaeus classified organisms into kingdom, phylum, class, order, family, genus and species.



Units of Taxonomy



Evolutionary Tree

Criteria for classification

1. Grade of organisation – animals are grouped into unicellular and multicellular based on the number of cells.
2. Germ layers – the multicellular animals are classified into diploblastic (two germ layers) and triploblastic (three germ layers) animals.
3. Symmetry – it refers to the arrangement of body parts. Based on symmetry, animals are classified into

a. Assymetrical (eg. Amoeba)

b. Radially symmetrical (eg. Hydra)

c. Bilaterally symmetrical (eg. Earth worm)

4. Coelom – the space between the body wall and digestive tract is called coelom. Based on the nature of coelom, animals are divided into

a. Acoelomate – Animals without a coelom (eg. Tape worm)

b. Pseudocoelomate – Animals with a false coelom (eg. Round worm)

c. Eucoelomate – Animals with a true coelom (eg. Earth worm)

Toad

5. Body temperature – animals are classified into two groups on the basis of their ability to regulate body temperature into

a. Poikilothermic animals – whose body temperature varies with that of environment. (eg. Fish, frog)

b. Homeothermic animals – whose body temperature always remains constant irrespective of changes in the surrounding. (eg. Birds, man)

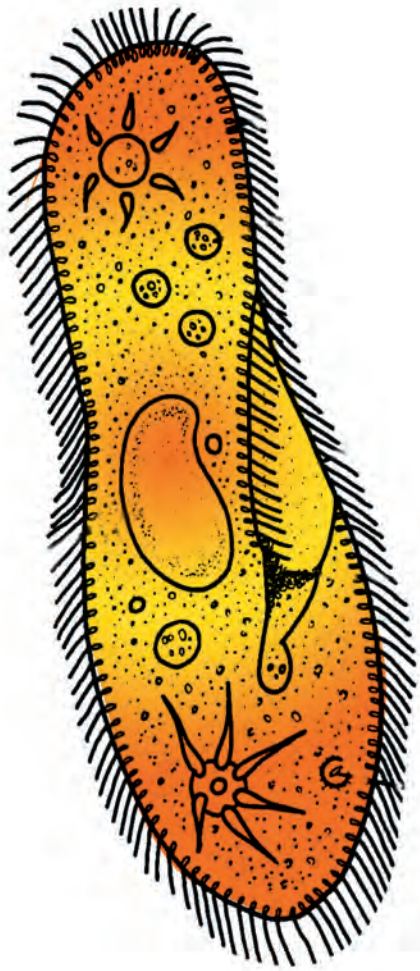
Animals are classified into two major groups, namely invertebrates and vertebrates based on the absence or presence of back bone (Vertebral column)

5.1. INVERTEBRATES

Invertebrates are classified into nine phyla namely

1. Phylum Protozoa (eg. Amoeba)
2. Phylum Porifera (eg. Sponges)
3. Phylum Coelenterata (eg. Hydra)
4. Phylum Platyhelminthes (eg. Tape worm)
5. Phylum Aschelminthes (eg. Ascaris)
6. Phylum Annelida (eg. Earth worm)
7. Phylum Arthropoda (eg. Cockroach)
8. Phylum Mollusca (eg. Snail) and
9. Phylum Echinodermata (eg. Star fish)

Phylum Protozoa



Paramoecium

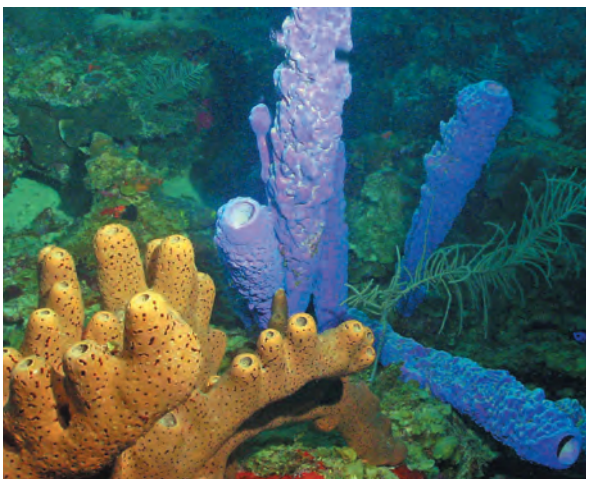
These are generally unicellular microscopic animals. Locomotion takes place by cilia, flagella or pseudopodia. Mode of nutrition may be holozoic, saprozoic or parasitic. They reproduce asexually through binary or multiple fission and sexually by conjugation.

ACTIVITY –5.1

- Collect a sample of water from a fresh water pond. Prepare a micro slide after adding a drop of methylene blue stain to the water. View the slide under a microscope. Try to find an amoeba.

Phylum Porifera

These are non-motile marine animals attached to some solid support such as rocks or shells. These are multicellular animals with perforated bodies. The cells are loosely arranged without the formation of tissues.The pores lead to a canal system which helps in circulating water throughout the body to bring in food and oxygen. They possess an internal skeleton made up of calcareous or silicious spicules. Reproduction is both by asexual (budding or gemmule formation) or sexual method (fusion of male and female gametes)



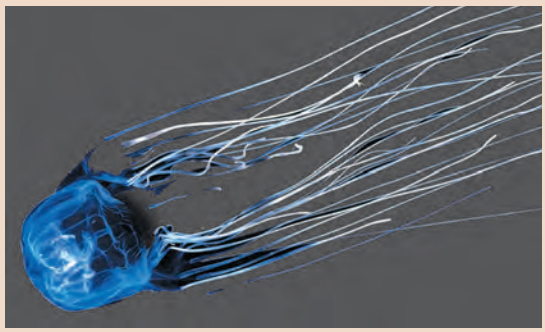
Sponges

Phylum Coelenterata

Sea anemone

These animals are aquatic with radial symmetry. There is a distinct body cavity called coelenteron or gastro vascular cavity. The body bears slender, flexible tentacles around the mouth. The tentacles at their tip bears stinging cells called cnidoblasts for offence and defence. Reproduction takes place either by asexual (budding or fission) or by sexual method (by gametes).

MORE TO KNOW



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

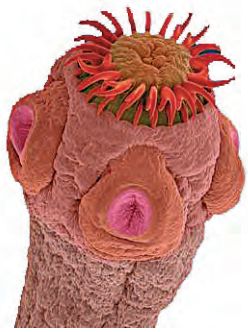
ACTIVITY –5.2

Observe a permanent slide of hydra under a dissection microscope. Observe the mouth, tentacles and basal disc of hydra and draw a neat labelled diagram.

Phylum Platyhelminthes (flat worms)

These are triploblastic, bilaterally symmetrical and acoelomate animals. These are either free living (eg. Planaria) or parasitic (eg. Tape worm). Parasites have organs of attachment such as hooks and suckers. They are mostly hermaphrodites (i.e. male and female sex organs are present in the same individual).

Planaria



Tape worm

Phylum Aschelminthes (round or thread worms)

The body is cylindrical, unsegmented and covered by a resistant cuticle. The animals are bilaterally symmetrical, triploblastic and pseudocoelomate. Circulatory and respiratory systems are absent. Sexes are separate and fertilization is internal. These are familiar as parasitic worms causing elephantiasis (filarial worm) and ascariasis (ascaris).

Ascaris

MORE TO KNOW

Earthworms are referred to as "Farmer's Friend"? Why?

Earthworm plays a vital role in improving the fertility of the soil. It ploghs 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.

Phylum Annelida

Do you know about vermicompost?

Which animal plays a vital role in vermicomposting?

Earthworm

Earthworms and leeches are familiar examples of annelids. The body is long, cylindrical and segmented (i.e. the body is divided into compartments called segments). They move with the help of setae and parapodia. They exhibit cephalisation (formation of a distinct head) and metamerism (segmental repetition of identical organs).

MORE TO KNOW

HIRUDIN - is a naturally occurring protein in the salivary glands of Leeches that has a blood anticoagulant property. Hence blood fails to clot ensuring continuous flow of blood when the leech sucks the blood. This property is widely used in the field of medicine and used in the treatment of blood clotting disorders and in the development of anticoagulant pharmaceuticals .

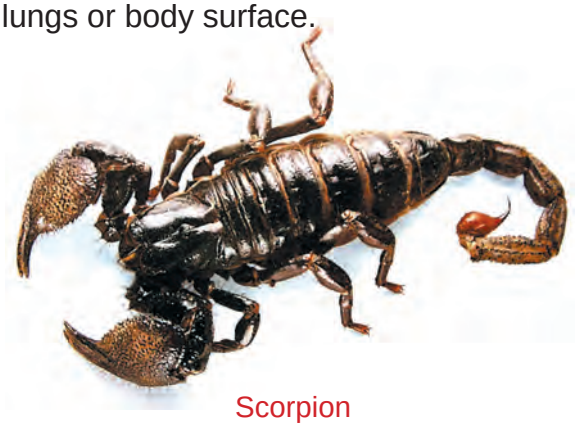
Phylum Arthropoda

Butterfly

Do you know which is the largest phylum?

Do you know which is the most successful group of animals on earth?

Arthropods are the largest group of organisms and insects are the most successful group of animals. These forms have jointed legs with a chitinous exoskeleton. They show open type of circulation and possess compound eyes. They respire by gills, tracheae, book lungs or body surface.



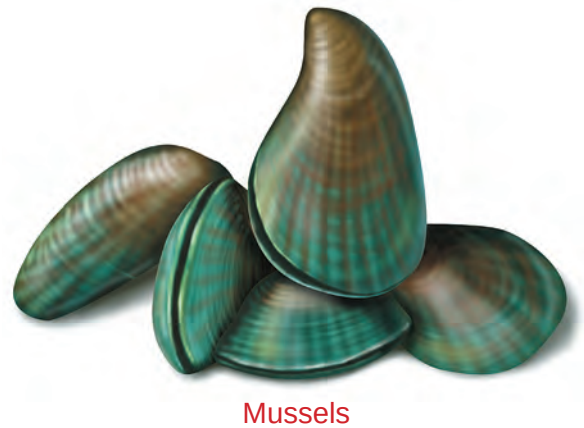
Scorpion

MORE TO KNOW

Insects form one of the most successful groups of animals. More than a million species of insects are known today.

Phylum Mollusca

Body is soft, unsegmented and without appendages. It is surrounded by a thin, fleshy structure called mantle which a secretes hard calcareous shell. They move around with the help of a muscular foot. Respiration is usually by gills called ctenidia.



Mussels

Phylum Echinodermata

These are spiny skinned organisms. Body is covered by calcareous spines. water vascular system is a characteristic feature of this group. These animals move with the help of tube feet and show great power of regeneration.

Starfish

ACTIVITY –5.3

Observe the preserved specimens of invertebrates. Draw neat diagrams.

List out the different poisonous invertebrates.

Biodiversity of India

India is endowed with an immense variety of plants and animals. It is a home to 2000 species of fishes, 182 species of amphibians, 453 species of reptiles, 1200 species of birds and 350 species of mammals. India ranks within the top 10 countries in the world in the biodiversity of vertebrates.

5.2. VERTEBRATES

Vertebrates are groups of animals which have a true vertebral column and internal skeleton. These are coelomate, triploblastic animals with a notochord and nerve chord.

How do vertebrates differ from invertebrates?

S.No.	Invetebrates	Vertebrates
01.	They do not have a back bone.	They have a distinct back bone.
02.	They include both unicellular and multi cellular organisms.	They include only multi cellular organisms.
03.	They have diversified locomotory organs such as pseudopodia, flagella, cilia, etc.,	They have two pairs of limbs for locomotion.
04	Organisms may be free living or parasitic.	All organisms are free living.
05.	Systems are simple in organisation.	Systems are complex and highly organised.
06.	Reproduction is by asexual or sexual methods.	Reproduction is only by sexual method.

Vertebrates are classified into five classes as follows.

1. Class Pisces.
2. Class Amphibia
3. Class Reptilia
4. Class Aves and
5. Class Mammalia

Class Pisces

These are aquatic animals and their skin is covered with scales which form the exoskeleton. The Endoskeleton is made up of either cartilage (eg. sharks) or bone (eg. catla). The body is streamlined. Respiration is by gills which are covered by an operculum on either side. Heart is two chambered (one Auricle and One Ventricle). Air bladder is present above the alimentary canal which regulates buoyancy. These are cold blooded animals. They are either oviparous or viviparous.

Lion fish

MIGRATION IN FISHES

Fishes can migrate vertically up and down the water column or horizontally across ocean or along rivers many Marine fishes make daily vertical migrations.

Types of Horizontal Migration are

1. **Anadromous Migration** – Fishes live in the ocean mostly and breed in fresh water.
2. **Catadromous Migration** – Fishes live in fresh water and breed in the ocean.
3. **Amphidromous Migration** – Fishes move between fresh and salt water during their life cycle but not for breeding.

Class Amphibia

Salamander

Amphibians are cold blooded vertebrates which can live on land as well as in water (dual life). Body is divisible into head and trunk. Skin is moist and slimy. The heart is three chambered (Two Auricles and one Ventricle). Respiration is by gills (tadpole), skin and lungs (adult). Fertilisation is external. They are oviparous (egg laying) showing complete metamorphosis.

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 amphibians can show the first signs of environmental emergencies. In the last 20 years, the number of amphibian species have declined with some species becoming extinct due to acid rain, ozone depletion and chemical pollution.

MORE TO KNOW

Unforgiving fish?

The stone fish may be the highly **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.

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.

How to distinguish frogs from toads?

TOAD	FROG
Short hind legs.	Long hind legs.
Rough, warty skin.	Moist, smooth skin.
Spends little time in water.	Spends More time in water.
Walks and makes short hops.	Jumps.
Toothless.	Teeth in upper jaw.
Webless hind feet.	Webbed hind feet.

Indian Cobra

Class Reptilia

These are creeping or crawling terrestrial animals and their body is covered with dryskin or epidermal scales. Tympanum represents the ear. Heart is three chambered. Snakes and lizards shed their scales as skin cast. They are oviparous and development is direct.

Superlatives

The slowest reptile	-	Giant tortoises of Galapagos islands.
The fastest reptile	-	Spiny tailed Iguana of Costa Rica.
World's fastest snake	-	The black mamba of Africa
The world's longest snake	-	A reticulated python
Largest poisonous snake	-	King Cobra.
Smallest reptile	-	Gecko
Largest reptile	-	Komodo dragon.

Class Aves

Peacock

Birds are characterized by the presence of feathers, modified forelimbs (wings), beak and air filled bones (pneumatic bones). These are warm blooded and oviparous which lay cledoic eggs (with shell) with large amount of yolk (reserve food). The hind limbs are modified for walking, swimming or clasping.

Owl

MORE TO KNOW

Birds like **crows** and **ravens** have a large brain with large number of brain cells.

Birds like parrots just imitate the sounds of human.

MORE TO KNOW

- Woodpeckers not only peck the wood for insects but can also hear the sound of insects crawling inside the wood.
- Penguins can survive freezing cold temperatures because of a thick layer of the fat below their skin which act as heat insulator.
- Owls can easily hunt in darkness, since their eye balls are elastic and can be focused instantly at any distance. They can widely open their pupil to allow more light to enter.

Vedanthangal Birds 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 (Resident and Visitors) include Cormarants, Darters, Herons, Egrets, Open billed stork, Spoon bills, white ibis, Little grebe, Blackwinged suits, Grey pelican etc.

November to February is the ideal season to visit the sanctuary.

Vedanthangal birds sanctuary

Class Mammalia

Mammals are higher chordates characterised by a presence of milk

Dolphins

producing glands (mammary glands). Their skin has hairs as well as sweat and oil glands. Heterodont dentition (different types of teeth), external ears or pinnae, diaphragm (muscle which separate thorax and abdomen), pulmonary respiration (lungs), internal fertilization and viviparity are other salient features.

Echolocation in Bats

Bat

Echolocation is also called bio sonar which is used by several animals like bats. These animals emit ultrasound waves and listen to the echoes of those calls that return from various object 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.

MORE TO KNOW

- Mammals like Echidna and Platypus are egg laying.
- Whales and dolphins are mammals.
- African elephant is the biggest land mammal and blue whale is the biggest aquatic mammal.
- Kangaroos can leap up to 30 feet in one bounce.
- Pygmy shrew is the slowest mammal.
- Bats are the only mammals which can fly.

ACTIVITY –5.4

- Make a visit to the zoo and note down the different animals and their feeding habits.

5.3. VARIOUS MODES OF REPRODUCTION IN ANIMALS

Hippopotamus with young one

Lion with cub

Reproduction in the capacity of an organism to produce young ones of their own kind. Reproduction in an inherent capacity of organisms to ensure the sustenance of their species.

Major types of reproduction

All animals from protozoans to mammals have the ability to reproduce. Reproduction is basically of two types namely Asexual and sexual reproduction.

S.No.	Asexual Reproduction	Sexual Reproduction
01.	It involves a single parent.	It involves two parents (male and female) each capable of producing gametes.
02.	It doesnot involve the fusion of gametes.	It involves the fusion of male and female gametes [(i.e.) Sperm and ovum] resulting in the formation of zygote.

Asexual Reproduction

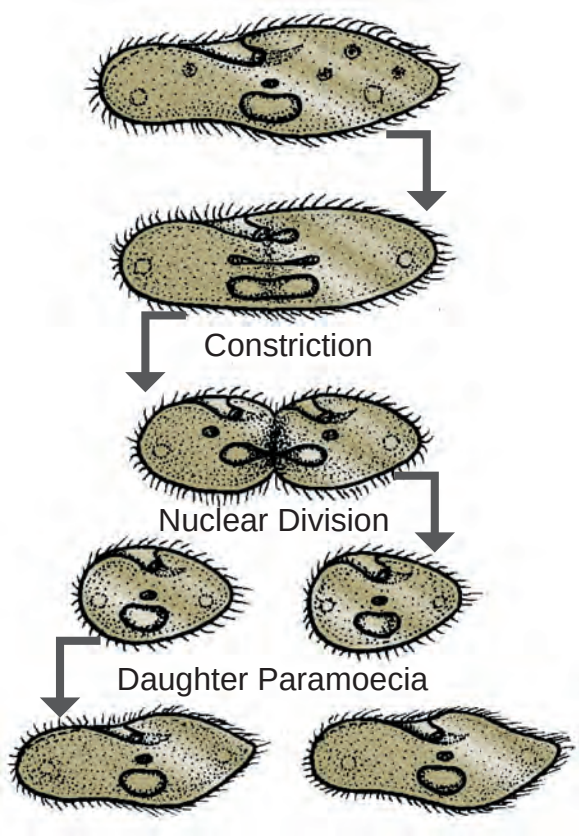
In asexual reproduction, new individuals are formed from a single parent. It may involve the whole body of an organism or body cells. These include multiple fission, binary fission, budding, regeneration gemmule and spore formation, etc.,

Binary fission : eg. Paramoecium

Paramoecium is an unicellular organism which 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 is divided into two.

Multiple Fission

Many protozoans reproduce by multiple fission under unfavorable condition. In this process, the nucleus of the parent cell divides repeatedly to form a number of daughter nuclei. Each daughter nucleus is surrounded by cytoplasm and plasma membrane and thus a number of daughter cells are formed. Each cell separates and leads an independent life.



Binary fission in paramoecium

ACTIVITY –5.5

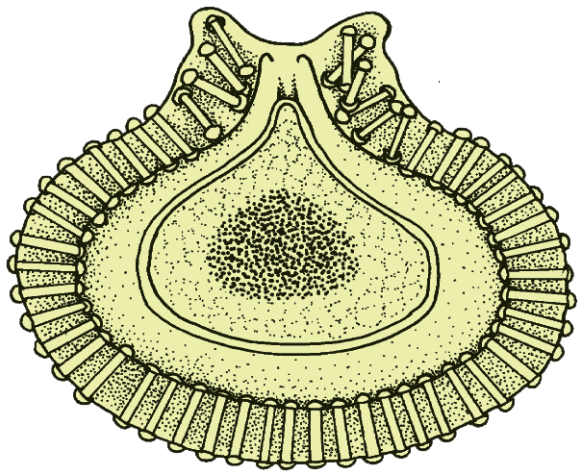
Observe a microslide of binary fission in amoeba.

Budding

Hydra reproduces asexually by budding. During budding the body wall of hydra produces an outgrowth (bud) due to repeated cell division at one specific site. This bud gradually grows in size and develops a mouth and tentacles at the free end. Soon a constriction appears at the point of contact and the daughter hydra gets separated from the mother and lead an independent life.

Budding

Gemmules



Gemmule

Gemmules are internal buds found in sponges and are resistant to unfavourable condition.

These buds have an outer thick layer with numerous air spaces and two inner chitinous layers. During favourable conditions, the cell mass comes out of the gemmule through an opening called the micropyle. Later the cell mass develops into a young sponge.

Spore and cyst formation

This type of reproduction is common among protozoan parasites such as plasmodium (malarial parasite). This method is also called sporulation. During unfavourable conditions, the protoplasm is condensed and covered by a thick, protective covering called the cyst. When conditions are favourable, the cyst gets dissolved. The protoplasm regains its original nature and the organism undergoes fission.

Regeneration

Animals like sponges, Hydra, Planaria and star fish exhibit regeneration. It is a complex process which involves the repair of damaged cells or tissues or redevelopment of severed part or formation of whole body from a small fragment.

Autotomy

It refers to the power of self cutting of body parts for defense. Examples – Regeneration of arms in star fish, regeneration of tail in house lizard.

Regeneration in man

Regeneration is highly limited in higher animals due to more specialization and complex organisation.

Examples of regeneration in man

1. Healing of wounds.
2. Replacement of dead or worn out blood cells.
3. Replacement of the horny layer of the skin.

Advantages of Asexual reproduction

1. It requires only one parent.
2. It donot involve gametes and fertilization.
3. The young ones have identical characteristics of their parents.

Disadvantages of Asexual reproduction

1. It does not result in large variations and hence donot lead to speciation and evolution.
2. Transmission of undersiable characters from parent to offspring without any change.

Sexual reproduction

All higher animals and a few lower organisms can reproduce sexually.

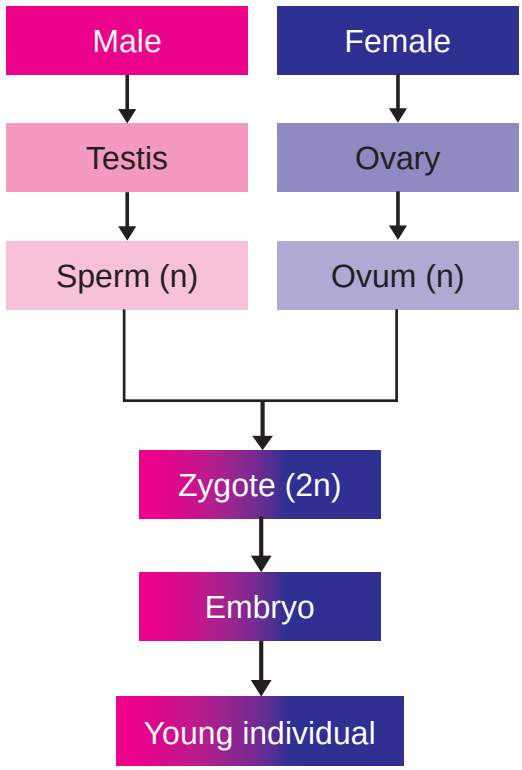
On the basis of the presence of gonads, organisms are classified into two types.

1. **Unisexual organisms** – with only one type of gonad (i.e. either testis or ovary) eg. - Human beings.
2. **Bisexual organisms** or Hermophrodites – Organism with both testis and ovary) eg - Tapeworm, Hydra.

Conjugation in paramecium

Lower organisms like paramecium reproduce sexually by conjugation. It involves the transfer of nuclear materials.

Schematic representation of sexual reproduction

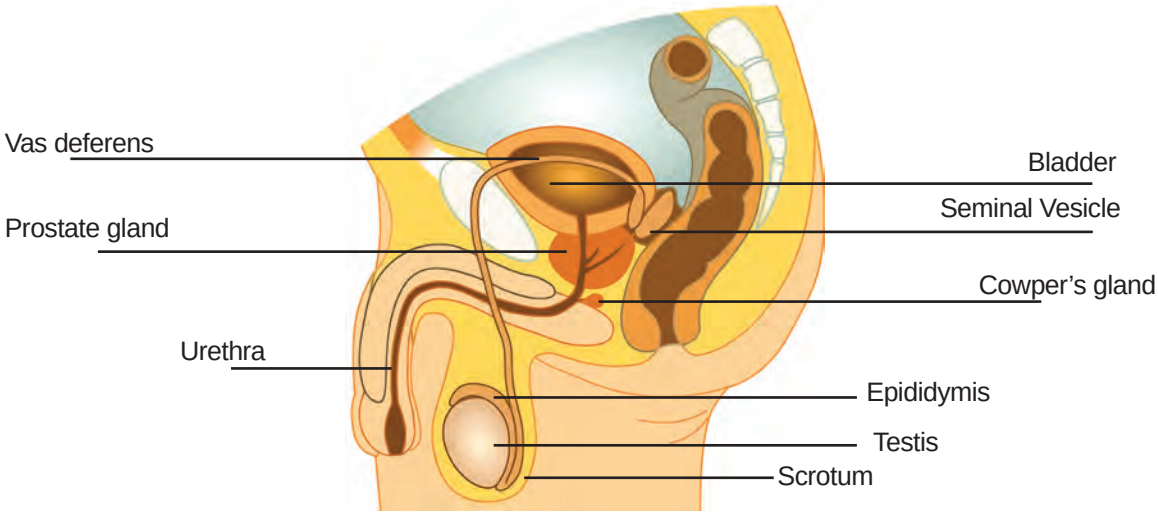


In higher organisms, two individuals of a species (male and female) are involved in sexual reproduction. The male reproductive organ is the testis which

produce the sperms. The female reproductive organ is the ovary which produce the ova or eggs. A sperm and an egg fuse to form a zygote. The fusion of sperm and ovum is called fertilization. The zygote further develops into an embryo and later becomes an adult.

5.4. REPRODUCTION IN HUMAN

Male reproductive system



Human male reproductive system

The male reproductive system includes the primary sex organs and accessory organs. The primary sex organs are the testis and the accessory organs are seminal vesicles, prostrate glands, urethra and penis.

A pair of testis are located in the scrotum outside the abdominal cavity because sperm formation requires a lower temperature than the normal body temperature. Each testis contains a coiled mass of tubules known as seminiferous tubules which produce sperms. The process of formation of sperms is known as spermatogenesis. The interstitial cells of the testis also secrete the male sex hormones (androgens) which control spermatogenesis and the appearance of male sexual characters such as growth of beard, moustache, body hair, hoarse voice, etc.,

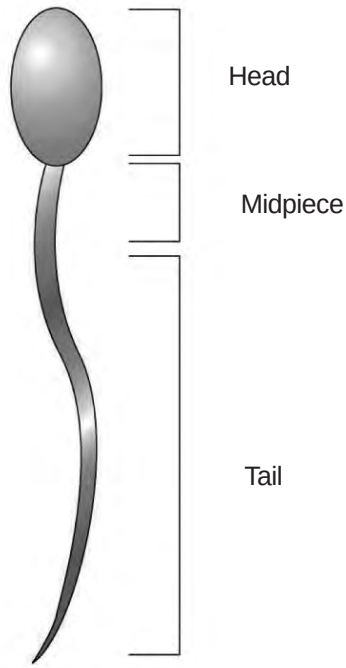
The sertoli cells of the testis provide nourishment to the developing sperms.

The sperms are delivered through the vas deferens which unites with the urethra which form a common passage for both sperms and urine. Along the path of vas deferens lies seminal vesicles and prostrate glands which add their secretions so that sperms are released in a fluid called semen. This fluid provides nutrition and helps in the transport of sperms.

Structure of a mature sperm

The sperm consists of four parts namely head, neck, midpiece and tail. The head contains a condensed nucleus containing haploid set (n) of chromosomes and a terminal acrosome (Golgi apparatus) containing hyaluronidase and protealytic enzymes. The neck contains a proximal and a distal centriole. The distal centriole is continuous with axial filament. The

midpiece contains the spirally coiled mitochondria. The tail represents the remnants of cytoplasm and propels the sperm in the liquid medium.

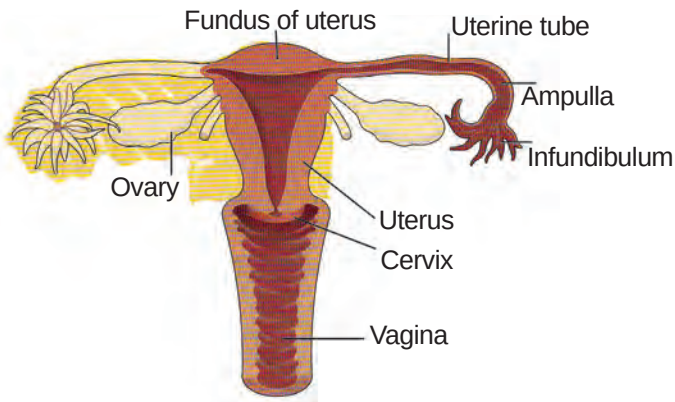


Sperm

MORE TO KNOW

Anton van Leeuwenhock (1632 - 1723) was the first observe and draw sperm cells.

Female reproductive system



Human female reproductive system

The female reproductive system consists of ovaries and accessory organs such as fallopian tubes, uterus, cervix and vagina. The ovary produces an egg for every 28 days (menstrual cycle) as well as female sex hormones oestrogen and progesterone.

MORE TO KNOW

Sperm Bank

Sperms are collected in the form of semen and can be stored in sperm bank viable for several years in frozen state in liquid nitrogen at a very low temperature. These sperms are useful in invitro fertilization and artificial insemination techniques.

Each ovary consists of follicle cells which produce the ovum by a process known as oogenesis. The uterus is a hollow, thick walled muscular organ formed of three layers and the fertilized ovum is embedded and nourished in the uterus. Vagina is a muscular tube which connects the cervix and the external genitalia. It serves to receive sperms and as a birth canal. The oestrogen is responsible for oogenesis and for the appearance of female secondary sexual characters such as development of breasts, growth of hair, feminine voice, etc.,

Structure of egg of human ovum

The egg of human is alecithal (without yolk) and contain cortical granules and yolk platelets. The egg is surrounded by a number of egg membranes.

1. **Vitelline membrane** – The ovum is surrounded immediately by a thin transparent membrane.

2. **Zona pellucida** – It is a thick transparent membrane above the vitelline membrane.

3. **Corona radiata** – The outermost thick membrane formed by the follicle cells.

Menstrual cycle

The rhythmic series of changes in the female sex organs that occur for about 28 days throughout the reproductive life of women from puberty to menopause (except during pregnancy) is known as menstrual cycle. After ovulation, the mature ovum is brought to the fallopian tube and may get fertilized. When the ovum is not fertilized, the ovum along with the uterine wall is ruptured and discharged with blood and uterine tissue by a process called menstruation.

It involves three phases namely

1. The follicular phase (5th day – 14th day)
2. The luteal phase or Premenstrual phase (15th day – 28th day)
3. The menstrual phase (1st day – 5th day)

Menstrual cycle

1. Follicular phase: This phase is initiated by the secretion of Follicle Stimulating Hormone (FSH) of pituitary. During this phase primary ovarian follicles begin to grow and the mature graffian follicles burst and release the ovum into the fallopian tube (ovulation).

2. Luteal phase: This stage is influenced by Lutenising Hormone (LH) of pituitary gland.

After the release of the ovum, the ruptured part of graffian follicle is transformed into a transitory endocrine gland called corpus luteum. It secretes the pregnancy hormone called progesterone. This hormone causes the thickness of endometrium and prepares the uterus to receive the fertilized ovum. If the ovum is not fertilized, the ovum and uterine wall gets ruptured and discharged during menstrual phase.

3. Menstrual phase: The decline in progesterone and oestrogen initiates the shedding of unfertilized egg and endometrium with severe bleeding in a process called mensus or menstruation. At the termination of menstruation, the corpus luteum is converted into a scar tissue called corpus albicans.

5.5. FERTILIZATION

Fertilization is a process of fusion of male and female gamete to form a diploid zygote.

Types of fertilization

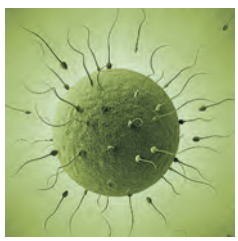
The two types of fertilization are

(a) **External fertilization** – The fusion of the gametes occurs outside the body of the animal. (eg. Frogs, Echinoderms).

(b) **Internal fertilization** – The fusion of the gametes occur within the body of the female. (eg. Reptiles, Birds and Mammals).

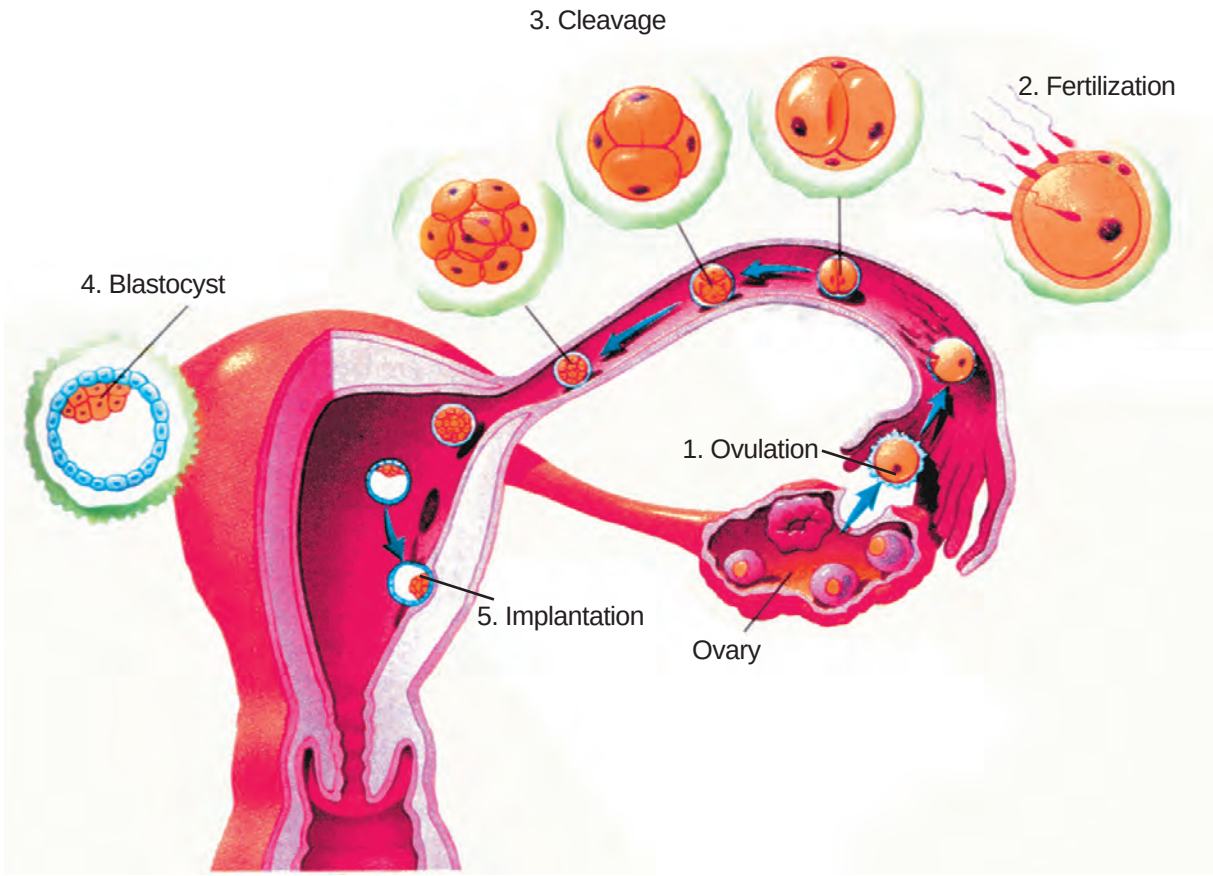
Mechanism of fertilization

At the time of ovulation, the ovum is fully matured and it enters the infundibulum of the uterine tube and passes into the ampulla. Fertilization of the ovum occurs in the ampulla of the uterine tube. Only one spermatozoan pierces the egg membrane Zona pellucida and enters the ovum. Polygamy (entry of more sperms) is prevented by the fertilization membrane around the ovum.



Fertilization

5.6. DEVELOPMENT OF EMBRYO



Blasttulation to implantation

The fertilized ovum is called the zygote. As soon as it is formed, it becomes activated and mitotic divisions sets in. This is the first phase of embryo's development called the cleavage. As a result a ball of cells called the blastula is formed. The outer surface forms the trophoblast and the embryo gets attached to the wall of the uterus. This process is known as implantation. The implanted embryo develops the extra embryonic membranes such as amnion, allantois, chorion and yolk sac. Amnion provides a fluid medium to the developing embryo. It prevents dessication of the embryo and function as a shock absorber. The chorion and allantois fuse to form the placenta. It helps in the exchange of gases between the mother and the foetus and also the elimination of nitrogenous wastes from the foetus. The embryo and the placenta are connected by the umbilical cord which is derived from the allantois.

Stages in the development of the human foetus.

Gestation period : From the fertilization of the ovum to the birth of the baby it takes about nine months. The period during which the foetus remains inside the uterus is called the gestation period.

The development of foetus can be studied as phases of three month period – the first, second and third trimesters.

First trimester

During this period, the proliferation of cells takes place and gradually a single cell is transformed into a foetus. Organogenesis takes place resulting in the formation of organs.

Development of Human embryo

Second trimester

The foetus grows rapidly. The respiratory and circulatory systems become well developed and functional. The bones and muscles are well formed.

Third trimester

The length and weight of the foetus increases very rapidly and the development is completed.

Child birth

A few days before birth, the foetus turns head downwards in the uterus just above the cervix.

At the onset of childbirth, the uterus begins to contract rhythmically under the influence of oxytocin hormone. These contractions become stronger and more frequent. This marks the onset of labour pain. With continued powerful contractions, the amnion ruptures and the amniotic fluid flows out through the vagina.

Finally, the muscular contractions of the uterus and the abodmen expel the child through the dilated cervix and vagina. The umbilical cord that still connects the child to the placenta is tied and cut. A few minutes later, the placenta breaks away from the uterus and is expelled as 'after birth'.

Lactation

The first milk which comes out from the mother's mammary gland just after childbirth is known as colostrum. It is rich in proteins and nutrients. It also contains antibodies that provide immunity for the newborn infant. The secretion of milk is stimulated by the pituitary hormone prolactin.

Advantages of mother's milk

- It is easily available, clean, uncontaminated and sterile.
- It is available at a correct temperature for the baby's needs.
- It contains antibodies which shield the baby from external viral and bacterial infections.
- In rural areas breast milk is used as eye drops for viral conjunctivitis and minor eye infections as a first aid.
- The calorific value of breast milk is 70 per 100 ml of milk and this fully meet the requirements of the infant.
- Lactoferin a protein in breast milk, provides considerable protection against intestinal and respiratory infections.

MORE TO KNOW

The test tube babies are formed by the technique of invitro fertilization in which fertilization and early development takes place in an artificial medium outside. Steptoe and Edwards of UK were successful in producing the first test tube baby.

5.7. VIVIPAROUS ANIMALS

Vivipary means directly giving birth to young ones (e.g placental mammals). The young ones directly receives food and oxygen from the mother through the placenta and also excretes the wastes through it.

5.8. OVIPAROUS

Cledoic eggs

Non cledoic eggs

Oviparous animals lay eggs laden with yolk. The embryonic development takes place outside the body of the mother. Land dwelling animals lay eggs with shell (cledoic eggs). The shell gives protection and prevents dessication. These eggs are laid outside after the process of internal fertilization (e.g. Reptiles and insects).

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. eg. Vipers

5.9. YOUNG ONES TO ADULT

The young ones which emerge from the egg either has resemblance or no resemblance with the adult. The young one has to pass through morphological, anatomical and physiological changes and get transformed into an adult. These changes which transform the young ones into adults are known as metamorphosis.

Metamorphosis in insects

In insects, the outer skin is cast off periodically and this process is known as moulting or ecdysis. The larval stages between two successive moultings are called stadia (singular - stadium). Thus the insect grows by a series of changes and these growing stages are called instars.

MORE TO KNOW

Moulting hormone

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

Types of metamorphosis

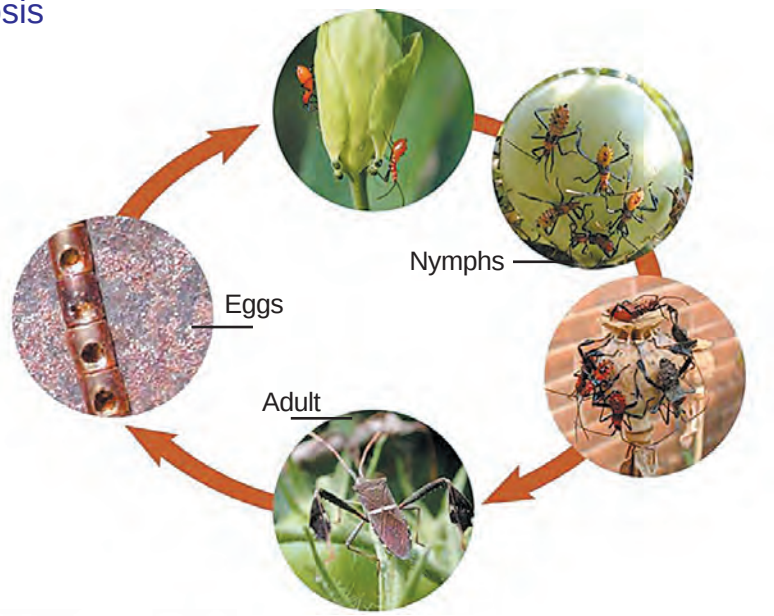
Incomplete metamorphosis

Lifecycle of Grasshopper:

The newly hatched young ones resembles the adult except in size, lack of wings and reproductive organs. the young ones (nymphs) undergo several intermediary stages through successive moultings to become an adult.

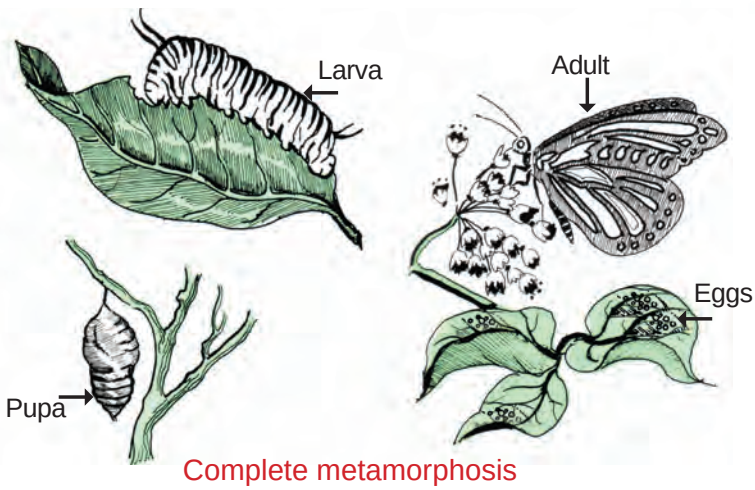
Egg ⟶ Nymph ⟶ Adult

e.g Grasshopper, Mayfly



Incomplete metamorphosis

Complete metamorphosis



Complete metamorphosis

Lifecycle of Butterfly

The young ones are strikingly different from the adults and the process of development starts with larva which hatch out of the egg. It is worm like and termed as caterpillar. The larva feeds voraciously on leaves and increase in size. Then the larva enters a resting stage the pupa and develops a pupal case (cocoon) around it. After a period of time, the adult or imago emerges out of the cocoon.

Egg ⟶ Larva ⟶ Pupa ⟶ Adult

e.g. Butterfly, silk moth.

EVALUATION

Section – A

1. The arrangement of body parts in an organism is known as symmetry. Classify organisms based on symmetry.

2. Reptilia → Pisces → Aves → Mammalia → Amphibia
   Arrange in correct sequence according to the evolutionary trend.

3. The eggs of mammals are alecithal (Without yolk). How do the mother feeds the young ones?

4. In some organisms both the male and female sex organs are present in a single individual. Name such organisms. Give an example.

5. The process of menstrual cycle stops during pregnancy and resumes after child birth. Name the hormone involved and mention its function.

6. During the time of delivery, the mother experiences severe labour pain. Name the hormone responsible for it and mention its significance.

Section – B

7. Millions of organisms inhabit the earth. They are classified and placed under different groups. Mention the need for classification.

Organisms	Locomotory organs
Paramoecium	Limbs
Fishes	Webbed feet
Frogs	Wings
Aves	Fins
Mammals	Cilia

8. a) Match the organisms with their locomotory organs.
   b) Correlate the locomotory organs with their mode of existence.

9. Bats are nocturnal animals. But, they could navigate in total darkness. Explain.

10. The eggs of birds are Cledoic (shell) and contains yolk.
    Mention the role of the shell and yolk in birds.

11. Most of the birds can fly. List out the structural adaptations which enable them to fly.

12. Earthworms can increase soil fertility. Justify.

13. The testis are located in the scrotum outside the abdominal cavity. Give reason.

14. In higher organisms the male and female can be distinguished by certain external features called secondary sexual characters. List out some male and female characters in human.

15. Both the Sperm and Ovum contains haploid set (n) of chromosomes. Give reason.

16. The developing foetus can communicate with the mother through the placenta. Mention the role of placenta.

17. The gestation period in human is about nine months which is divided into three divisions called trimesters. List out the changes which occur during the first trimester.

18. Mother's milk is the wholesome food for the child. Justify your answer.

19. In insects during metamorphosis, the outer skin is cast off periodically. Name the process and mention its significance.

Section – C

20. Match the following columns A, B and C to make meaningful sequences.

Column A	Column B	Column C
Tapeworm	Vermi compost	Calcareous spines
Earthworm	Spiny Skin	Parasite
Starfish	Locomotion	Soft body
Paramoecium	Shell	Organic farming
Mussels	Hooks and suckers	Flagella

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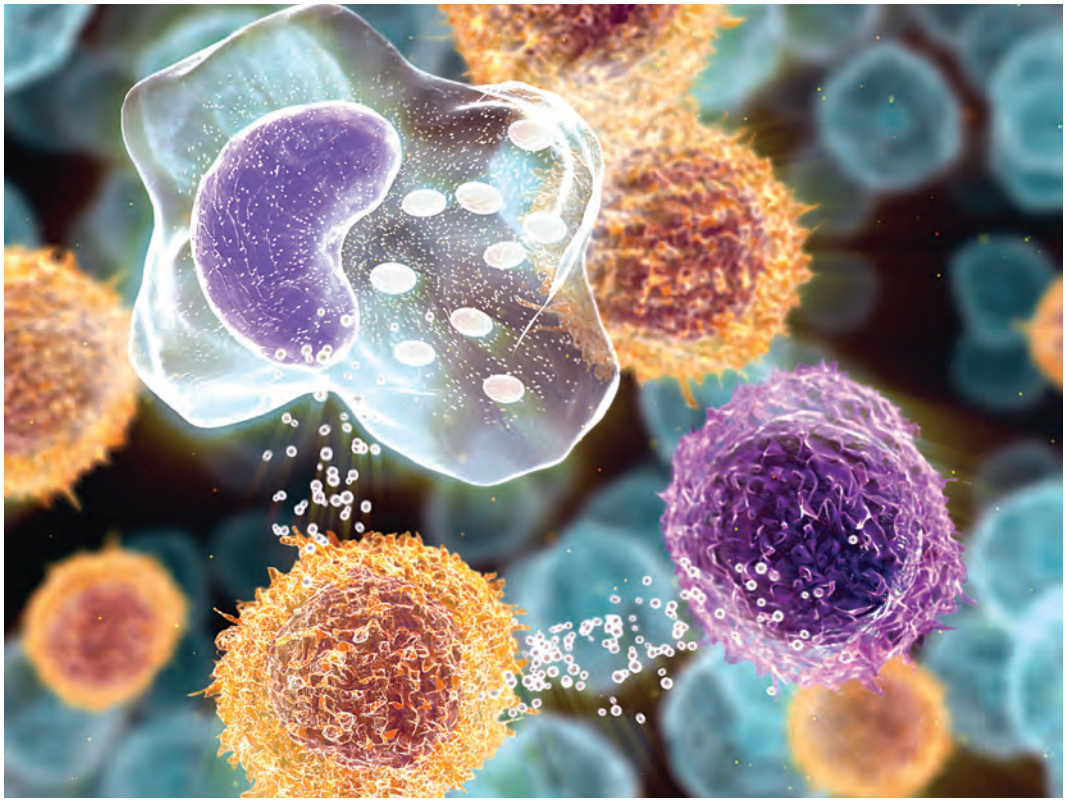
Chapter 6



CELLS AND TISSUES

6.1. PROKARYOTIC AND EUKARYOTIC CELLS

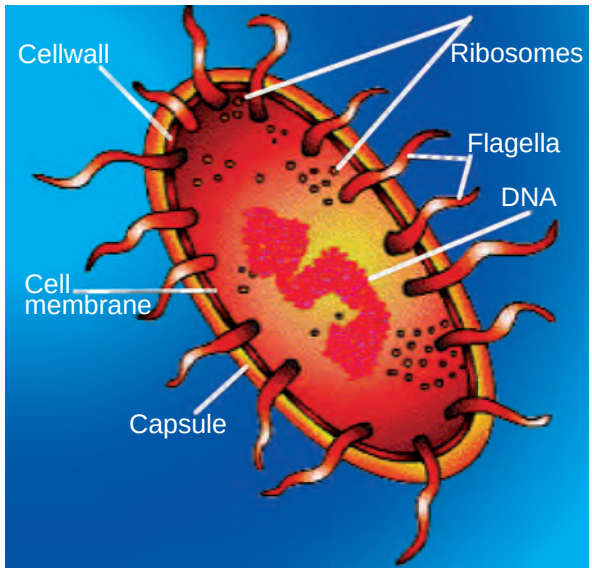
Based on the complexity of organization, especially nuclear organization, the cells are classified into two types.

i) Prokaryotic cells.

ii) Eukaryotic cells.

Prokaryotic cells

The cells of Bacteria and Cyano Bacteria (blue green algae) lack a well organised nucleus and are called prokaryotic cells. Their DNA (Deoxyribo Nucleic Acid) is not enclosed by a nuclear membrane. They also lack membrane bound organelles. The organisms which possess prokaryotic cells are called prokaryotic organisms or prokaryotes. They are considered to be primitive organisms.



A Prokaryotic cell (Bacteria)

Eukaryotic Cells

The cells of all plants (except bacteria and cyano bacteria) and animals possess a well organised nucleus and are called Eukaryotic cells. Their genetic material is enclosed by a nuclear membrane. They possess membrane bound organelles like Endoplasmic reticulum, golgi body, mitochondria, plastids and vacuoles. The organisms which possess eukaryotic cells are called Eukaryotic organisms or eukaryotes.

Differences between Prokaryotic cell and Eukaryotic cell

Prokaryotic Cell		Eukaryotic Cell	
1.	It is generally smaller (1-10 micro metre) in size	1.	It is comparatively larger (5-100 micro metre) in size.
2.	It lacks a well organised nucleus as its nuclear material is not surrounded by a nuclear membrane.	2.	It contains a well organized nucleus as its nuclear material is surrounded by a nuclear membrane.
3.	It has a single chromosome	3.	It has more than one chromosome.
4.	Nucleolus is absent	4	Nucleolus is present
5.	It lacks membrane bound cell organelles.	5.	It possess membrane bound cell organelles.
6.	Cell division occurs by fission or budding. Mitotic and meiotic divisions are absent	6.	Cell division takes place by mitosis and meiosis.
7.	Ribosomes are smaller	7.	Ribosomes are larger

6.2. MULTICELLULAR ORGANISMS

Do you know?

1. What is meant by unicellular organism?
2. Give one example for unicellular organism.
3. What are multicellular organisms?

The organisms having many cells in their body are called multicellular organisms. e.g. Most plants and animals. Multicellular level of organization represent an advanced state among living organisms. Multicellular organisms have different kinds of cells to perform different functions.

6.3 CELL AS A BASIC UNIT OF LIFE

Higher organisms contain organs; organs are composed of tissues; tissues are made up of cells and cells are formed from molecules. However, in all living organisms the cell is the functional unit. All biological activities revolve around the activity of the cell. Cell is defined as a unit of an organism delimited by a plasma membrane in animal cells, and cell wall and plasma membrane in plant cells. Thus, cell forms the basic unit of life.

MORE TO KNOW

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

Leeuwenhoek Microscope

Compound Microscope

CELL SIZE, SHAPE AND NUMBER

There is much variation in size, shape and number of cells in different organisms, and also in various parts of the body. Most of the cells are only a few micrometres in diameter and are visible only with the help of a microscope.

Cells may be spherical, spindle shaped, elongated, polyhedral or irregular in shape. The shape of the cells is determined by the specific function they perform.

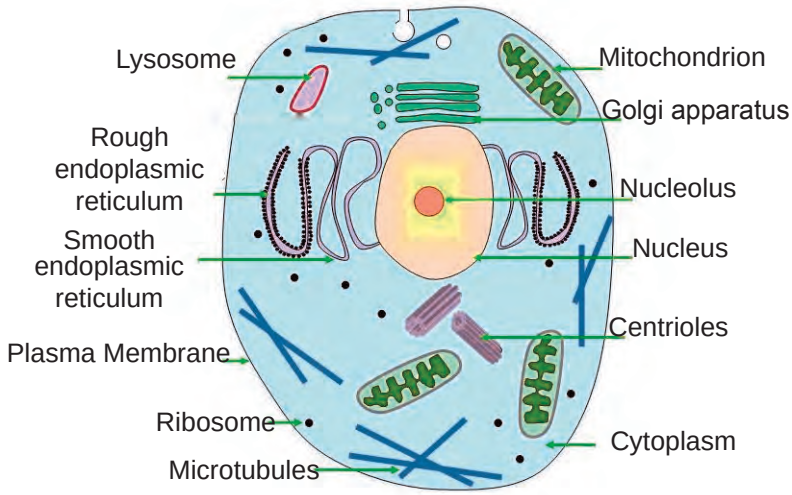
The number of cells is related to the size of the organ or body. Thus, small organisms have limited number of cells, while the larger ones such as elephant, whale or banyan tree have a countless number of cells.

STRUCTURAL ORGANIZATION OF A CELL

A cell is made of life giving substance called protoplasm. The protoplasm is a highly organised jelly like, viscous, semifluid, composed of molecules of various chemicals. Most of these are

organic molecules such as proteins, carbohydrates, fats, nucleic acid etc. Protoplasm is commonly called the 'physical basis of life'.

A plant cell consists of a cell wall and protoplast. Cell wall is absent in animal cells. Protoplast denotes the whole of protoplasm present in a cell. It is differentiated into plasma membrane, nucleus and cytoplasm.



Ultra structure of an Animal cell

Various cell organelles are suspended in the cytoplasm. Plant cells differ from animal cells in many ways.

Differences between Plant cell and Animal cell

S.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 occur in minute sizes.
4.	Centrosome is present only in the cells of some lower plants.	All the animal cells have 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.

6.3.1. CELL MEMBRANE AND CELL WALL

Cell Membrane (Plasma membrane or Plasmalemma)

The contents of the cell are enclosed by a thin, delicate living membrane called cell membrane. It is the outer boundary of the cell. Cell membrane is flexible and is made up of a continuous bilayer of lipid molecules and protein molecules on both of its surfaces and also embedded in it.

Functions

- Plasma membrane selectively regulates the entry and exit of the substances into and out of the cell. Therefore, it is called a selectively

permeable membrane or semi-permeable membrane.

- It provides an outer boundary to the cell and protects the cell from injury.
- It allows the flow of materials and information between different organelles of the same cell, as well as between the adjacent cells.
- It provides some organic connections between the adjacent cells.

CELL WALL

Cell wall is present only in plant cells. It is a rigid protective covering outside the plasma membrane. Presence of cell wall in plant cells distinguishes them from animal cells. Most of the plant cell walls are made of cellulose.

The cell wall consists of three layers namely, middle lamella, primary wall and secondary wall. The middle lamella is a thin amorphous cement like layer between two adjacent cells. Primary wall is the first formed wall of the cell and is produced inner to the middle lamella. The secondary wall is a thick layer found inner to the primary wall.

Functions of cell wall

1. Cell wall gives a definite shape to the plant cells.
2. It provides mechanical strength to the cell.
3. It protects the protoplasm against injury.
4. It gives rigidity to the cell.

6.3.2. CYTOPLASM

Cytoplasm is a viscous, translucent, homogeneous and semifluid mass of protoplasm excluding the nucleus. The portion of cytoplasm immediately below the cell membrane is gel like and is called ectoplasm. The cytoplasm between the ectoplasm and nuclear membrane is liquefied and is called endoplasm.

Cytoplasm consists of vital molecules such as carbohydrates, lipids, proteins, amino acids, minerals and water. It is the seat of cellular metabolism. Different types of cell organelles are embedded within the cytoplasm. Each type of organelle performs specific functions in the cell.

Functions of Cytoplasm

- Cytoplasm helps in intracellular distribution of enzymes, nutrients and other biomolecules within the cell.
- Synthesis of different types of biomolecules such as proteins, nucleotides, fatty acids etc., takes place in the cytoplasm.

6.3.3. CELL ORGANELLES

A cell performs a variety of functions such as i) Synthesis of complex molecules and their breakdown, ii) Production of energy, iii) Secretion of certain substances, etc.. These activities of the cell are performed by different cell organelles. These organelles are enclosed by membranes. To understand the functioning of the cell, it is necessary to know briefly about the structure of cell organelles.

Endoplasmic Reticulum

Endoplasmic reticulum is a complicated and interconnected system of membrane bound channels and tubules. It is spread throughout the cytoplasm and

is continuous with the plasma membrane and nuclear membrane.

There are two types of Endoplasmic Reticulum.

a. Rough Endoplasmic Reticulum. (RER)

b. Smooth Endoplasmic Reticulum. (SER)

Rough endoplasmic reticulum

(Granular endoplasmic reticulum)

They are found in cells which synthesize proteins. This type of endoplasmic reticulum possesses rough walls because the ribosomes remain attached with membrane of endoplasmic reticulum.

Smooth endoplasmic reticulum

(Agranular endoplasmic reticulum)

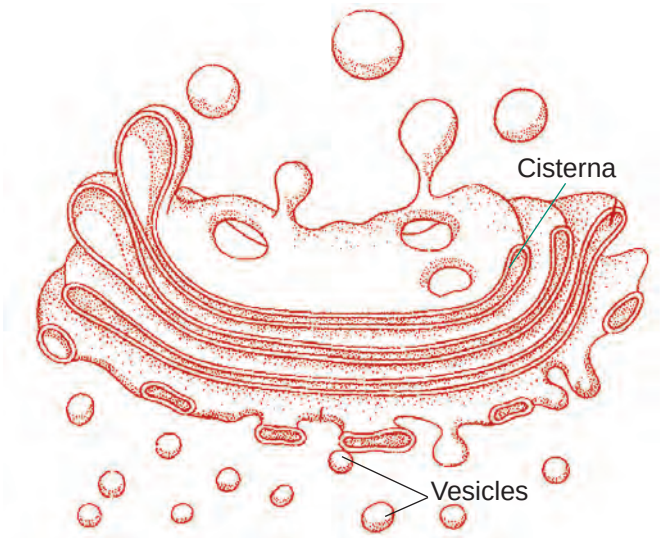
They are found in cells which synthesize lipid. The walls are smooth and ribosomes are not attached to its membrane.

Functions

1. Endoplasmic Reticulum (E.R) 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 steroid, hormones and lipids.

Golgi Complex or Golgi apparatus

The Golgi apparatus was first described by Camillo Golgi. Golgi complex consist of saucer-like compartments called cisternae, network of interconnecting tubules, vesicles and vacuoles at the peripheral regions. In plant cells, Golgi apparatus is referred to as dictyosomes.



Golgi complex

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.

Lysosomes

Lysosomes are small membrane bound vesicles which contain various types of digestive enzymes. These serve as intracellular digestive system, hence they are called digestive bags. They are produced by the joint activity of Endoplasmic reticulum and Golgi apparatus. If the membrane of Lysosome happens to get ruptured, the enzymes of Lysosome would digest the entire cellular structure causing death of the cell. So Lysosomes are called 'suicide bags'.

MORE TO KNOW

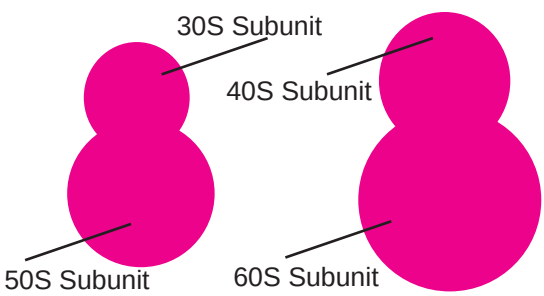
Lysosomes are involved in the destruction of aged and wornout cellular organelles. They are therefore also called demolition squads or scavangers or cellular housekeepers.

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.

Ribosomes

Ribosomes are small granular structures made up of ribo nucleic acids (RNA) and proteins. They occur free in the cytoplasm as well as attached to the outer surface of the rough endoplasmic reticulum. Each ribosome consists of two subunits – a small subunit and a large subunit. At the time of protein synthesis many ribosomes get attached to messenger RNA and form a structure called polyribosome or polysome.



70S Ribosome 80S Ribosome

There are two types of ribosomes

a. 70S – Ribosome. It is small and consists of 30S and 50S subunits. It is seen in prokaryotic cells.

b. 80S – Ribosome. It is made up of 40S and 60S subunits. It is seen in eukaryotic cells.

Functions

Ribosomes play an important role in protein synthesis. So they are called, 'protein factories' of the cell.

Vacuoles

Vacuoles are fluid– filled sacs bound by a single membrane and are present in plant cells as well as in certain protozoans as food vacuoles and contractile vacuoles. In plant cells, major portion of the cell is occupied by vacuoles and are bound by the definite membrane called tonoplast. Vacuoles of plants are filled with cell sap containing minerals, sugars, amino acids and dissolved waste products.

Functions

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

ii) They maintain proper osmotic pressure in the cell for its turgidity and absorption of water.

Mitochondria

Mitochondria are globular or cylindrical organelles. Each mitochondrion is bound by two membranes – an outer continuous membrane and an inner membrane thrown into folds called cristae. These cristae divide the inner chamber incompletely. The inner chamber is filled with homogenous dense material called the matrix. The cristae have pin headed bodies called F_1 particles or Oxysomes which play an important role in respiration.

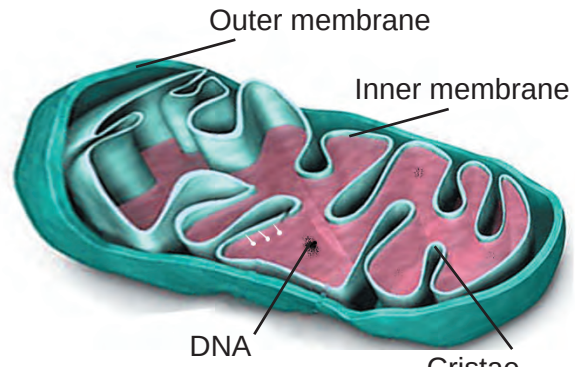
The matrix of mitochondria contains enzymes necessary for the oxidation of food during respiration and release of energy in the form of ATP molecules. Therefore mitochondria are called power houses of the cell. The mitochondria contain proteins, lipids and a small amount of DNA.

Functions

i) Mitochondria synthesize energy rich compounds such as ATP.

ii) Mitochondria provide important intermediates for the synthesis of several biochemicals like

chlorophyll, cytochromes, steroids, aminoacids etc.



Mitochondrion

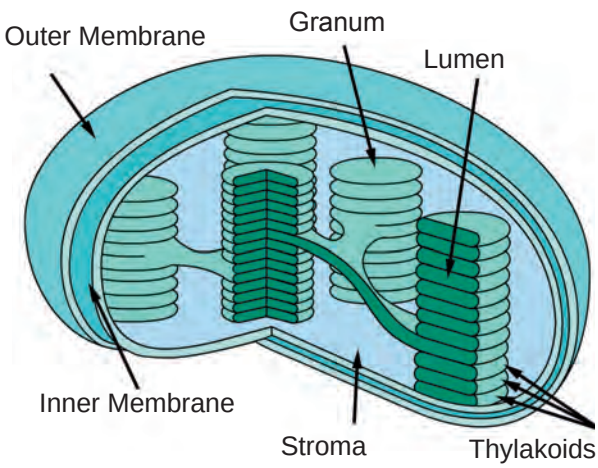
Plastids

Plastids are disc or oval shaped organelles which occur in plant cells only. Plastids are of three types. They are Leucoplasts, Chromoplasts and Chloroplasts.

i) **Leucoplasts:** These are colourless plastids which store food in the form of starch, lipids and proteins

ii) **Chromoplasts:** These are yellow or reddish in colour due to the presence of pigments other than chlorophyll. Chromoplasts provide colour to many flowers and fruits.

iii) **Chloroplasts:** These are green coloured plastids which possess the photosynthetic pigment chlorophyll.



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 pile of coins. These are called the grana. Each granum consists of disc shaped membranous sacs called thylakoids. Inside these grana, the chlorophyll is located. 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 in higher plant cells. It is located near one pole of the nucleus. It contains a pair of small, hollow granules called centrioles.

Functions

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

6.4. NUCLEUS

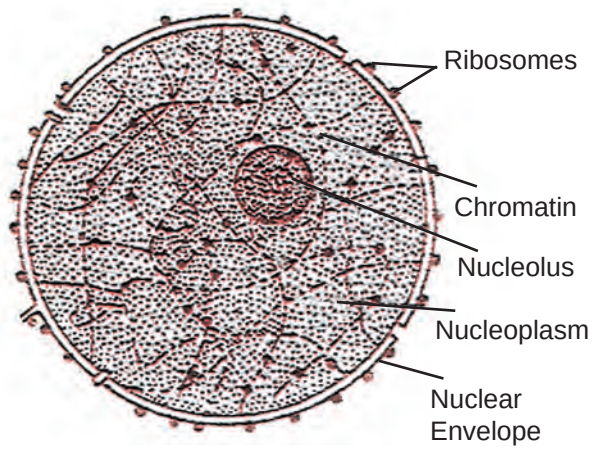
Nucleus is the major central structure in the cell. It is a dense spherical structure embedded in the cytoplasm. Nucleus has a double membraned envelope called nuclear envelope. Nuclear envelope encloses a ground substance called nucleoplasm or karyolymph. The nuclear envelope possesses many pores called nuclear pores.

The nucleoplasm has two types of nuclear structures i) the nucleolus and, ii) 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 chromatin is a network of fine threads composed of genetic material DNA (Deoxyribo nucleic 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.



Nucleus

Functions:

i) Nucleus controls all the metabolic activities of the cell.

ii) It controls the inheritance of characters from parents to off-springs.

iii) It controls cell division.

6.4.1. CHROMOSOMES

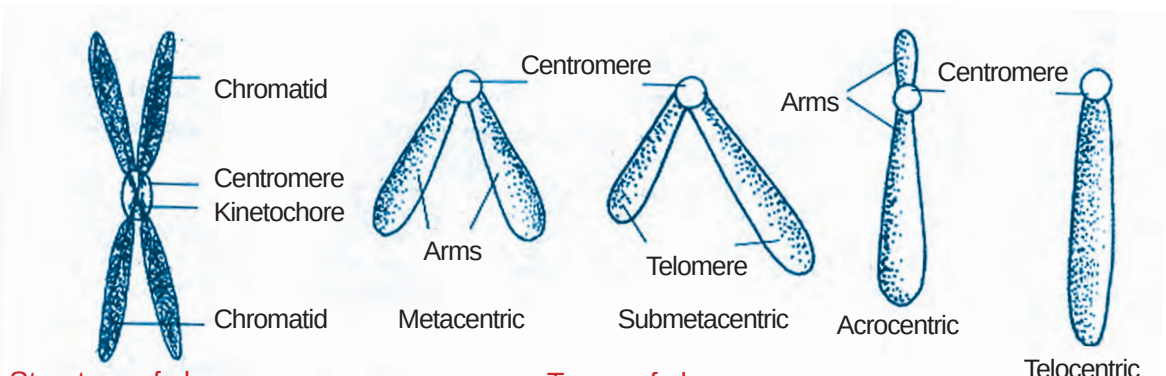
Chromosomes are thread-like condensed chromatin fibres which contain hereditary information and are visible only during cell division.

Each chromosome consists of two similar structures called chromatids. Both the chromatids are joined at a particular point called centromere. The primary constriction is the region of chromosome occupied by the centromere. The terminal part of chromosome is telomere.

Types of chromosomes

Depending upon the position of the centromere, the chromosomes are of 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.
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.

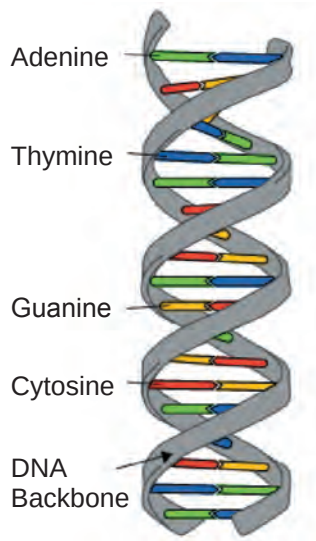


Structure of chromosome

Types of chromosomes

DNA Structure

DNA (Deoxy ribonucleic acid) is the genetic material in most of the organisms and higher organisms. DNA 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.



DNA structure

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.

The two strands run in antiparallel and opposite directions. (i.e. they run in opposite direction 5' to 3' and 3' to 5' end). The two strands are intertwined in clockwise direction. The diameter of DNA molecule is $20A^0$ (Armstrong units).

6.5. CELL DIVISION AND TYPES

Let us take a seed and break it open. There is no plant inside the seed. Similarly if we break open an egg, there is no chick inside. But the seed, when sown in soil and watered, gives a plant which may grow into a tree. Similarly, the egg, when incubated, gives a chick. Have we ever thought how this is possible?.

Plants or animals make their beginning from a single celled zygote. This zygote divides several times to produce a plant or an animal. This process is called development and it occurs by cell division.

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

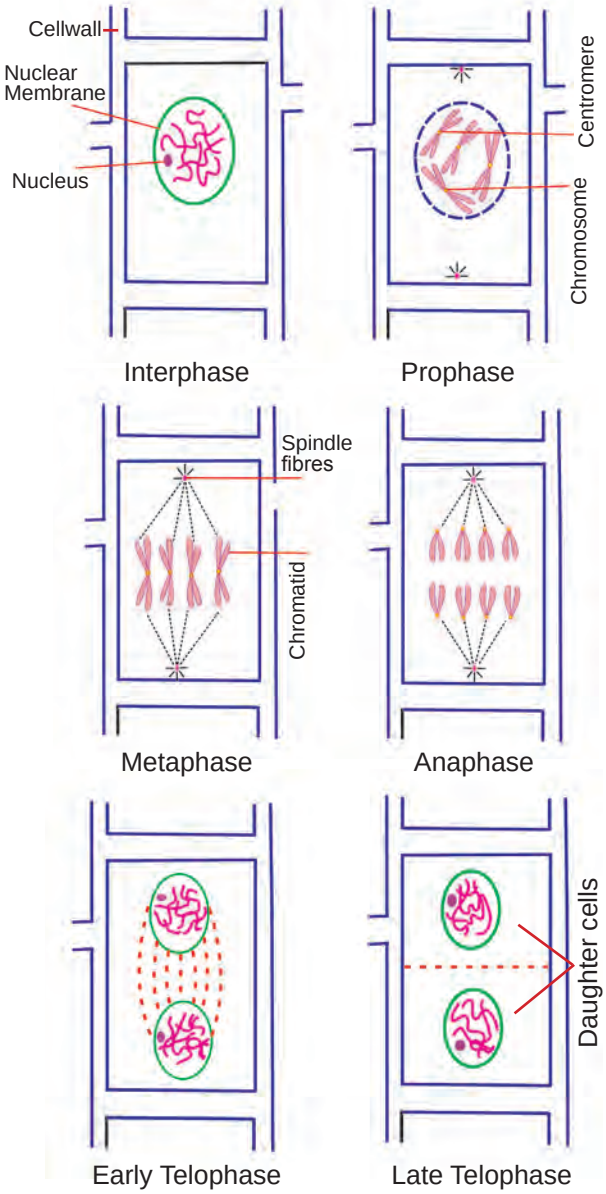
Amitosis is a simple method of cell division. It is also called direct cell division. The nucleus elongates and develops a constriction around its middle. The constriction gradually deepens and finally divides the nucleus into two daughter nucleus. This is followed by the constriction of the cytoplasm 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). It is a continuous process and takes place in four phases. These are Prophase, Metaphase, Anaphase and Telophase.

Interphase

Before a cell undergoes mitotic



Mitosis

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

Prophase

- Chromatin network begins to coil and appears as long thread-like structures called chromosomes.
- 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 process can be observed in the formation of gametes.

6.6. DIFFUSION OR EXCHANGE OF SUBSTANCES BETWEEN CELLS AND THEIR ENVIRONMENT.

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

Passive Transport

It is a type of diffusion in which an ion or molecule crossing a membrane moves its electrochemical or concentration gradient. No metabolic energy is consumed in passive transport.

Passive transport occurs by three processes namely (i) Osmosis (ii) Simple diffusion (iii) Facilitated diffusion

i) **Osmosis:** The to and fro movement of water molecules through the plasma membrane occurs due to differences in the concentration of the solutes on either side. 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.

ii) **Simple diffusion:** In simple diffusion, molecules of gases such as oxygen and carbon dioxide enter the cell through the plasma membrane without the help of any permease (transport proteins).

iii) **Facilitated diffusion:** This is a special type of passive transport. Ions or molecules cross the membrane rapidly. Specific permeases in the membrane facilitates their crossing. Like simple diffusion, it also does not require any metabolic energy. It occurs only in the direction of a concentration gradient.

Active transport

Active transport is the movement of any substance through the cell membrane that requires energy. It is always against the concentration gradient. (i.e. from lower concentration to higher concentration). In this process the solute particles move against their chemical concentration or electrochemical gradient. Energy is required for this process. Some membrane proteins act as carrier molecules and transport the solute to the other side of the membrane.

Bulk transport

Cells continuously import or export large molecules across the plasma membrane. Macromolecules are secreted out from the cell by exocytosis and are injested into the cell from outside by endocytosis.

Exocytosis:

The outward transport of substances by means of carrier molecules is known as exocytosis. It is quite common in secretory or excretory cells.

Endocytosis

Endocytosis occurs by infolding or extension of the plasma membrane to form a vesicle or vacuole. It is of two types :

1) Phagocytosis
2) Pinocytosis

Phagocytosis (cell eating)

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).

Pinocytosis (Cell drinking)

Substances are taken up in fluid form. (e.g. Amoeboid protozoans and certain kidney cells). Pinocytosis occurs in plants also.

6.7. TISSUES

TYPES, STRUCTURE AND FUNCTION OF PLANT TISSUES

The progressive evolution in plants has resulted in increasing complexity of structures. In higher plants, roots, stem, leaves and flowers carry out different functions. Due to this division of labour, the cells of the plants are differentiated to form different tissues. (See the flow chart in 4.2)

Meristematic tissues

ACTIVITY –6.1

Observe the growth of a small plant. It grows straight. Now cut the tip of the shoot apex and observe its growth.

Does the plant continue to grow even after removing the shoot tip?

The growth of plants occurs only in certain specific regions. This is because the dividing tissue also known as meristematic tissue (Meristos – divisible) is located only at these points.

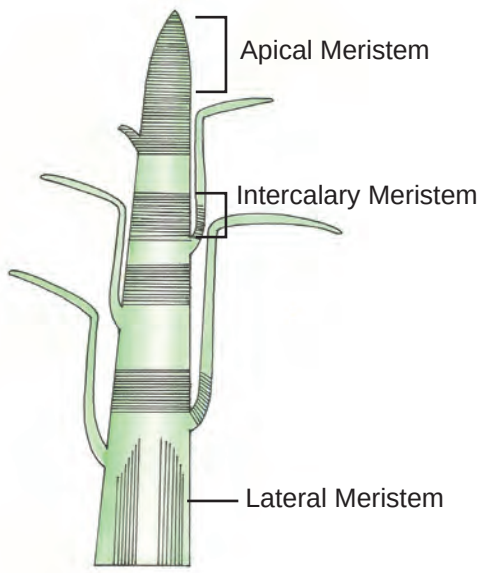
The meristematic tissues are made up of group of similar and immature cells, which can divide and form new cells. Meristematic cells divide continuously and thus help in increasing the length and thickness of the plant. Depending upon the position, meristematic tissues are of three types. They are as follows:

i) **Apical meristems:** Apical meristem is present at the growing tips of stems and roots and increases the length of the plant body.

ii) **Intercalary meristems:** These meristems occupy base of the leaves and the base of the internodal regions in plants such as grasses (mostly in monocotyledonous plants). These help in elongation of the internodes.

iii) **Lateral meristems:** This includes the meristematic tissues occupying the lateral regions of the stems and roots which bring about increase in the width of the plant body. (e.g. Cork cambium and Vascular cambium).

Meristematic Tissue



Longitudinal section of a shoot showing position of meristems

Characteristic features of meristematic tissues

- The meristematic cells may be round, oval, polygonal or rectangular in shape.
- Their cell walls are thin, elastic and made up of cellulose.
- They are closely arranged without intercellular spaces.
- They have dense cytoplasm with large nucleus.

Permanent Tissues

ACTIVITY –6.2

- Take a plant stem and cut it into very thin slices or sections.
- Now, stain the slices with saffranin. Place one neatly cut section on a slide and put a drop of glycerine.
- Cover with a cover-slip and observe under a microscope. Observe the various types of cells and their arrangement.
  a. Are all cells similar in structure?
  b. How many types of cells can be seen?

What happens to the cells formed by meristematic tissues?

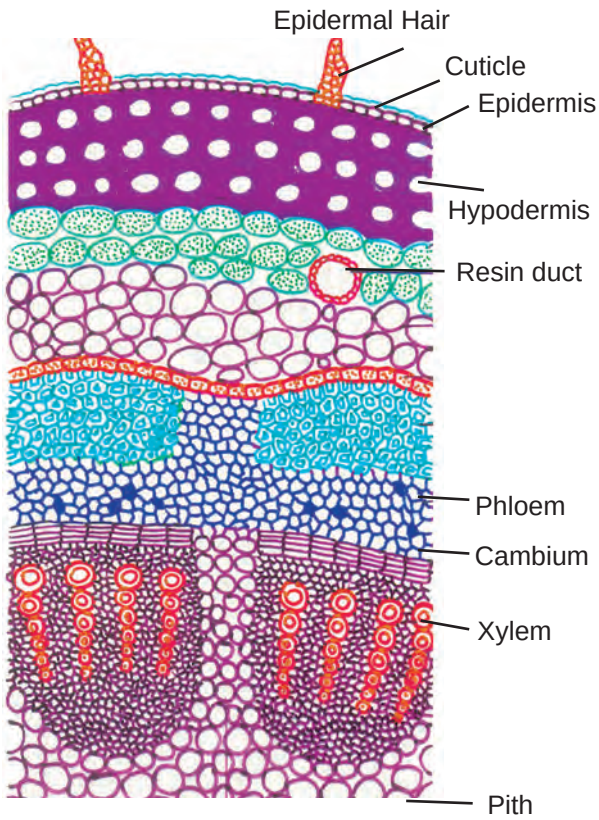
Some cells produced by meristematic tissues stop dividing and form a permanent tissue.

They have definite structure and function. They are differentiated into various types to perform different functions.

The permanent tissues are classified as

i) Simple tissues and

ii) Complex tissues



Transverse section of a sunflower stem

Simple tissues

A tissue with the cells of similar structure (one type of cells) and function is called simple tissue. It is of three types.

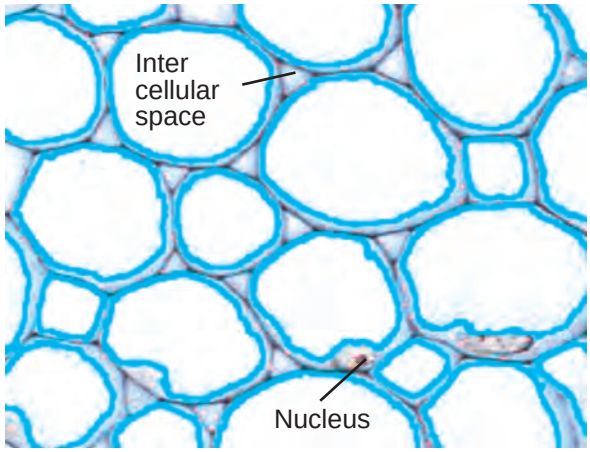
a. Parenchyma

b. Collenchyma

c. Sclerenchyma

Parenchyma

The cells of the parenchyma are generally thin walled with intercellular

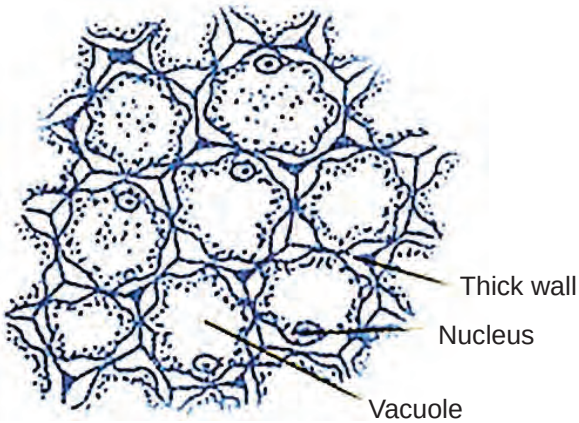


Parenchyma

spaces. They are living cells. They are generally present in all organs of a plant. They are oval or spherical or rectangular or cylindrical in shape. The cell wall is made of cellulose and pectic materials.

In general, the parenchyma cells serve to store and conduct food materials, water and minerals.

Collenchyma



Collenchyma

The cells of collenchyma are polygonal in cross section and have unevenly thickened walls. These thickenings are due to the deposition of more cellulose, hemi-cellulose and pectin.

The thickening is confined to the corners of the cells. They generally occur in the dicot stem in two or more layers below the epidermis. It is absent in the roots. It also occurs in petiole and pedicel. Like Parenchyma, Collenchyma is also a living tissue. The main function of Collenchyma is to provide strength and flexibility to the growing organs like young stem.

Sclerenchyma

It is a dead tissue. The cells are thick with lignified walls. They give mechanical support to the organs. This has two types of cells – Sclereids and Fibres.

Sclereids

Sclereids are stone cells which are commonly found in shells of the nut, pulp of certain fruits such as Pear and Sapota.

Fibres

The fibres are elongated strands with simple pits throughout its length.

Complex permanent tissues :

Xylem

Xylem is mainly concerned with the transport of nutrients, water and minerals upwards in the plant body. It forms a continuous tube through the roots, stems, leaves, flowers and fruits by the fusion of elongated cells.

It is composed of different kinds of cells namely,

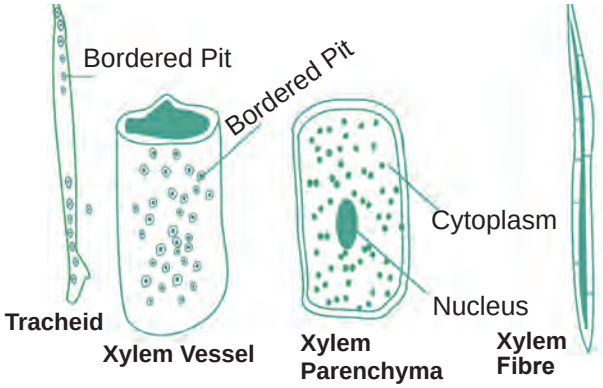
a. Tracheids
b. Xylem vessels.
c. Xylem fibres
d. Xylem parenchyma.

a. Tracheids

Tracheids are elongated, tapering cells with blunt ends. They have lignified secondary wall. They are the chief water conducting elements in Pteridophytes and Gymnosperms.

b. Xylem vessels

Xylem vessels have perforations at the end and are placed one above the other



Kinds of Xylem cells

like a long pipe line. They are seen in the xylem of angiosperms. They conduct water, mineral nutrients and also provide mechanical strength to the plant body.

c. Xylem Fibres

The fibres of Sclerenchyma associated with the xylem are known as xylem fibres. They give additional mechanical strength to the plant. They are also called wood fibres.

d. Xylem Parenchyma

The parenchyma cells associated with xylem are known as xylem parenchyma. It is the only living tissue amongst xylem cells. They store food reserves in the form of starch and fat. They also help in conduction of water.

Phloem

Phloem conducts food materials from leaves to the other parts of the plant. It is made up of four types of cells.

a) Sieve elements
b) Companion cells
c) Phloem fibres
d) Phloem parenchyma

Sieve elements

Sieve elements are the conducting elements of the phloem. Sieve elements are of two types – sieve cells and sieve tubes.

Sieve cells are present in Pteridophytes and Gymnosperms where as sieve tubes are present in Angiosperms.

Companion cells

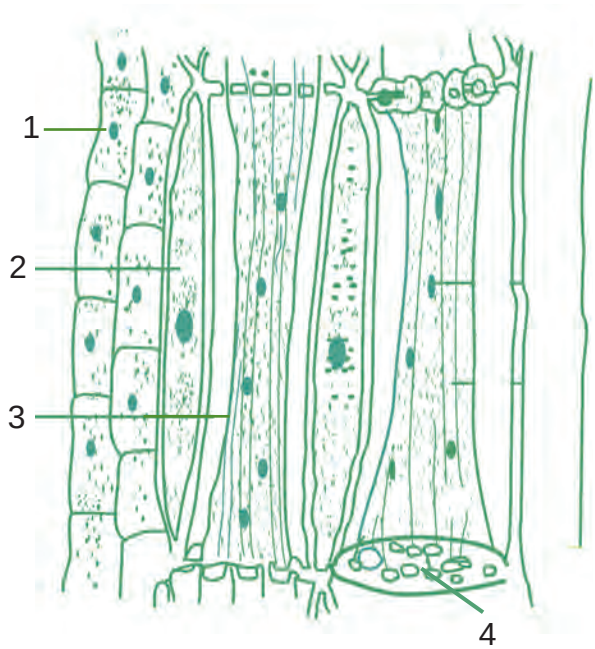
Companion cells are thin walled elongated specialized Parenchyma cells. They are associated with sieve elements. They have a prominent nucleus and cytoplasm. They help the sieve tube in conduction of food materials in angiosperms.

Phloem fibres

The fibres of sclerenchyma associated with phloem are called phloem fibres. They are also called bast-fibres. They give mechanical support to the plant. Among the four types of phloem cells, phloem fibres are the only dead tissues.

Phloem parenchyma

The parenchyma cells associated with phloem are called phloem parenchyma. They store starch and fats.



Phloem Tissue

1. Phloem Parenchyma
2. Companion Cell
3. Sieve tube
4. Sieve plate

EVALUATION

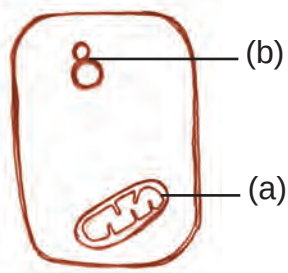
Section A

Choose the correct answer

1. Power house of the cell (chloroplast, nucleus, mitochondrion, lysosome).
2. The membrane of vacuole
   (cell membrane, nuclear membrane, plasma lemma, tonoplast).
3. The cell division common in prokaryotes
   (mitosis, amitosis, meiosis, both mitosis and meiosis).
4. Substances taken up in fluid form
   (phagocytosis, exocytosis, receptor-mediated endocytosis, pinocytosis).
5. The only living tissue amongst xylem cells
   (vessels, tracheids, xylem parenchyma, xylem fibres).

Section B

6. Observe the given figure of a cell and answer the following questions.



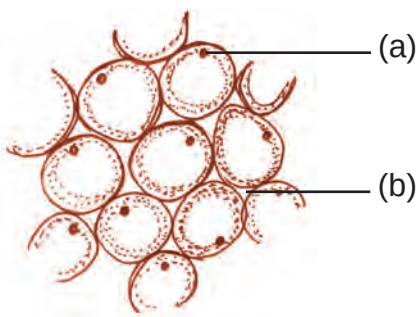
   i) Name the parts of the figure marked (a) and (b)

   ii) Give one function of each of the parts.

7. Phloem is a food conducting tissue it is made up of following four types of cells. Two cells are missing. Complete the missing cells.

   i) sieve elements ii) _____ iii) phloem fibres iv) _____

8. Observe the figure.



   i. Identify the tissue depicted in figure.

   ii. Copy the diagram and label the parts (a) and (b)

9. Complete the table

Name of the chromosome	Shape of the chromosome
1. Metacentric	1.
2.	2. 'J' shaped chromosome
3. Acrocentric	3.
4. Telocentric	4.

10. Read the following statements and correct them.

i) Golgi apparatus was first described by Watson and Crick.

ii) Cell wall is present in animal cells.

Section C

11. A) Write the technical terms of the following.

i) An organism whose body is made up of many cells.

ii) An organism which is made up of only one cell.

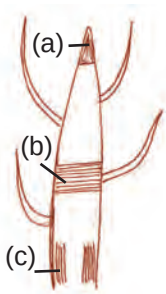
iii) An organism whose cells have well organized nucleus.

B) Fill in the blanks.

i) Division of cytoplasm is known as _____.

ii) Prokaryotic cells do not have well organized _____.

12. Answer the questions related to figure.



i) Copy the diagram and name the parts of the diagram marked a to c.

ii) Which part of the figure is responsible for elongation of stem?

iii) Which part of the figure is responsible for secondary growth?

iv) Name the part which is responsible for elongation of internodes.

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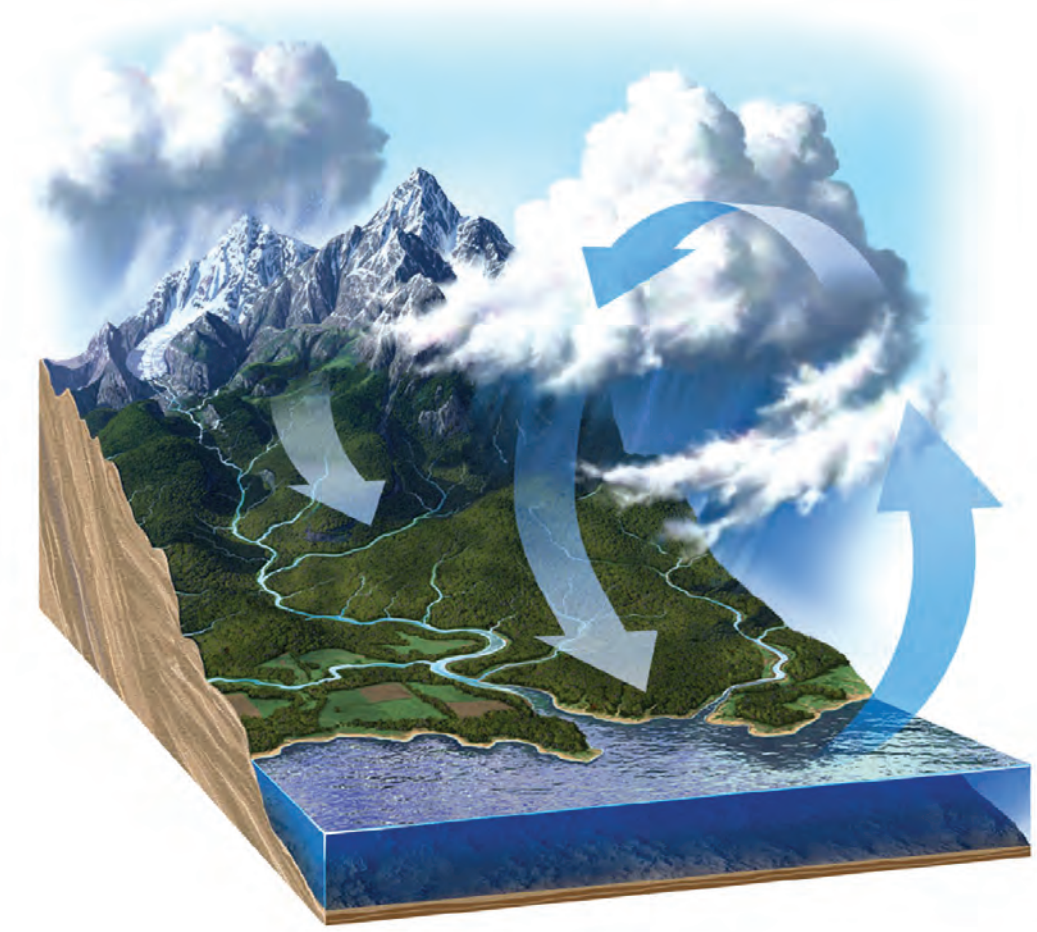
Chapter 7



BIO-GEO CHEMICAL CYCLE

7. BIO-GEO CHEMICAL CYCLE

Both abiotic (non-living) and biotic (living) components of the biosphere constantly interact with each other to form a dynamic, but stable system. Such interaction includes transfer of matter and energy between the different components of the biosphere.

All living organisms require Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur, Phosphorous, Potassium and Calcium in large amounts. They get the nutrients from air (Atmosphere) water (Hydrosphere) and soil (Lithosphere).

The nutrient elements derived from the earth by the living organisms for use in their growth and development are called bio-geo chemicals. These bio-geo chemicals are used by the living organisms and are released to the environment, when the dead bodies of the organisms and their excreta are decomposed. These chemicals become available again for reuse and recycling.

The cyclic flow of elements or compounds between non-living environment (soil, rock, air, water) and living organisms is known as bio-geo chemical cycle.

7.1. LIFE AND NON-LIFE INTERACTIONS (BIOTIC & ABIOTIC FACTORS)

Environment means the surroundings in which animals and plants live including both the physical factors and other organisms. Thus, each and everything which surrounds and affects the living organisms constitute its environment.

The branch of biology which deals with the inter-relationships of organisms and their environment is called Ecology.

The organisms and the physical environment of the habitat form an ecological complex termed ecosystem.

Ecosystem (Environmental system) includes two essential components.

i) Abiotic components (Physical or non-living)

ii) Biotic components (living)

ABIOTIC COMPONENTS

The abiotic components of the environment are air, water, soil, light and temperature. Thus, abiotic components of our environment tend to affect us and all the living organisms variously. They play a vital role in their growth, development and survival. Green plants need light, water and carbon dioxide for photosynthesis. Animals need food, water and oxygen for their survival.

BIOTIC COMPONENTS

The biotic components of environment include all living organisms including human beings. Plants and animals are interdependent.

'Interdependence' – means the way in which the living organisms depend on each other in order to remain alive,

Interaction between insects and plants

grow and reproduce. For example bees depend for their food on pollen and nectar from flowers. Flowers depend on bees for pollination.

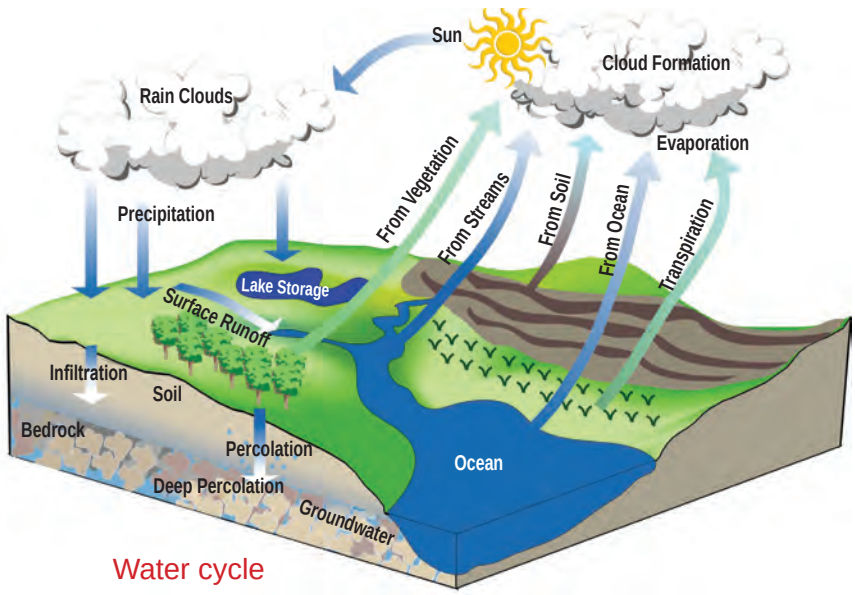
The green plants (autotrophs) are the producers of food for all living organisms. Solar energy is captured by autotrophs to synthesize food materials. The energy is transferred to herbivores when they consume plants. When carnivores feed on herbivores, the energy is transferred to carnivores. The final breakdown of organic wastes and dead materials are carried out by decomposers to return the energy to the environment. Thus the energy trapped by green plants is relayed through a series of heterotrophic organisms. This forms the food chain.

Grass - Rabbit - Fox -Tiger

Man and animals take in oxygen during respiration and give out carbon dioxide. The plants absorb this CO_2 during photosynthesis and liberate oxygen in to the atmosphere. Thus plants and animals are interdependent.

7.2. WATER CYCLE

Water is an important component of the environment and is essential for living beings. Oceans are the biggest store houses of water from which water evaporates to form clouds. Water also evaporates from other water bodies like rivers, lakes, ponds etc, to form clouds. On Condensation, water vapour in the clouds comes down as rain. The rainwater passes through rivers and eventually reaches the oceans.



Water cycle

The circulation of water also occurs through plants and animals. Plants absorb water from the soil or water reservoir and add it to the air (atmosphere) as vapour by transpiration. Water transpired by trees cools the surrounding air and plays a role in determining the micro climate around them. Animals take water from the water reservoir or with food. They return it to the air as vapours by respiration or to the soil as fluid by excretion. Mammals excrete water as sweat which evaporates from their bodies.

Water is also added to the environment by death and decay of organisms. Water vapour formed by transpiration and respiration form clouds. Rain adds water to soil for reuse by plants and animals.

MORE TO KNOW

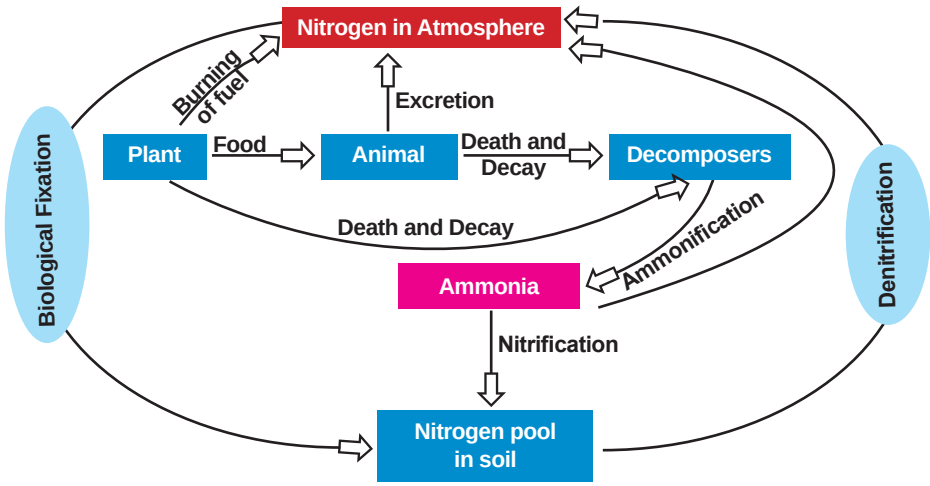
About two-thirds of our body is made up of water.

The Earth's water supply is made up of 97% oceans, 2% ice caps, 1% fresh ground water.

In 20 minutes, one thunderstorm can send down over 125,000,000 gallons of water. (One gallon is equivalent to 4.5 litres)

7.3. NITROGEN CYCLE

Nitrogen is an essential element required by organisms to synthesize proteins and nucleic acids. Though atmosphere contains about 78% of Nitrogen, it cannot be utilised by living organism unless it is converted into ammonia, amino acids or nitrates. These compounds which are available in the soil are cycled and recycled through the ecosystem.



Nitrogen Cycle in Nature

The process by which these forms get interconverted to maintain a constant amount of nitrogen in atmosphere, by physical and biological processes is called Nitrogen Cycle. The Nitrogen Cycle involves

i) **Nitrogen fixation**

ii) **Nitrogen assimilation**

iii) **Ammonification**

iv) **Nitrification** and v) **Denitrification**

Nitrogen fixation

During nitrogen fixation, nitrogen is oxidized to oxides by lightning and these oxides get dissolved in rain water and get precipitated. During biological nitrogen fixation, the nitrogen fixing bacteria such as Azotobacter, Rhizobium and blue green algae like Nostoc convert gaseous nitrogen to ammonia and nitrates.

Nitrogen assimilation

The nitrates absorbed by plants is utilized for making organic matter such as proteins, nucleic acids etc. Plant proteins and other nitrogenous compounds consumed by animals are converted into animal proteins.

Ammonification

Animal proteins are excreted out in the form of urea, uric acid or ammonia. When the plants and animals die, their proteins

are broken down to release ammonia by the action of bacteria and fungi. This process of ammonia formation is called ammonification.

Nitrification

During this process, the ammonia is converted into nitrites and nitrates by soil bacteria such as Nitrobacter and Nitrosomonas which are then absorbed by plants through their roots.

Denitrification

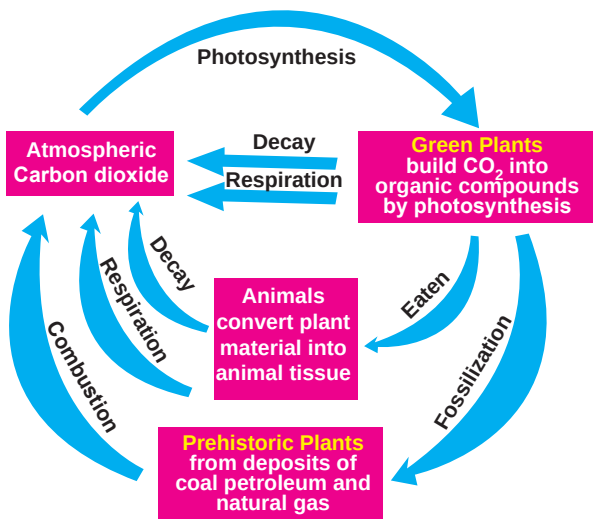
Free living soil bacteria such as Pseudomonas reduce nitrate ions of soil into gaseous nitrogen which returns to the atmosphere.

Organisms involved in Nitrogen cycle

Activity	Name of organism
Nitrogen Fixation	Rhizobium, Azotobacter and Nostoc.
Ammonification	Ammonifying bacteria and fungi.
Nitrification	Nitrosomonas and Nitrobacter.
Denitrification	Pseudomonas.

7.4. CARBON CYCLE

Carbon is the most significant element in the environment. All organic compounds contain carbon. The three main sources of carbon are i) CO_2 of the air and CO_2 dissolved in oceans, ii) Carbonate rock in the earth's crust and,



Carbon Cycle

iii) Fossil fuels like coal and petroleum. Being a main element involved in the fixation of energy by photosynthesis, it is closely linked to energy flow. The basic movement of carbon is from atmospheric reservoir to producers, to consumers and then to decomposers.

The atmospheric carbon dioxide enters into the living world, i.e. green plants, through the process of photosynthesis to form carbohydrates (food). The plant food is taken by herbivores and then passes through small and large carnivores.

The respiratory activities at each trophic level return carbon dioxide quickly to the atmosphere. Carbon dioxide is also returned to the atmosphere through decomposition of dead organic materials, burning of fossil fuels and volcanic activities.

MORE TO KNOW

Without the carbon cycle, carbon would not recycled, resulting in the inability for living things to survive.

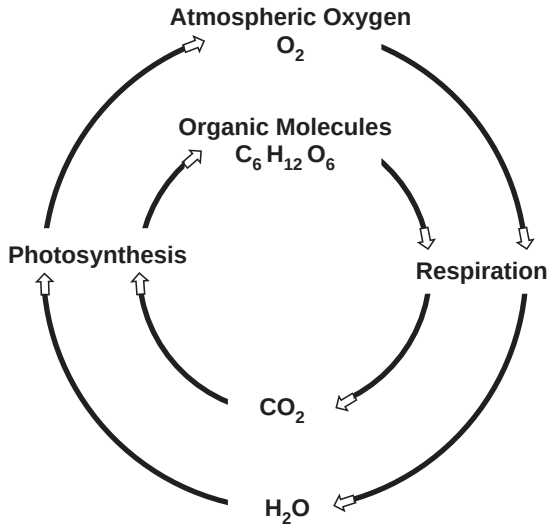
7.5. OXYGEN CYCLE

All living organisms require oxygen for respiration. Oxygen is one of the

constituents of water and forms about 20% of the air in the atmosphere.

Oxygen enters the living world through respiration. It oxidizes the food materials and produces energy and carbon dioxide. Oxygen is also used up in the burning of the materials and carbon dioxide is produced.

The carbon dioxide is utilized by the plants to produce food materials during the process of photosynthesis and oxygen is released. Oxygen combines with nitrogen to produce oxides of nitrogen, which are taken up by the plants to produce amino acids and proteins. These compounds, after breaking down, release oxygen in the atmosphere and maintain balance in the environment.



Oxygen Cycle

EVALUATION

Section A

Choose the correct answer

1. The life sustaining zone of the earth, where lithosphere, hydrosphere and atmosphere interact is called (ozonosphere, stratosphere, biosphere, none of these).
2. Biggest storehouses of water (river, lake, pond, ocean).

Section B

3. Construct atleast two food chains with the help of the organisms given

   (Lion, Tiger, Grass, Deer, Fox, Rabbit).
4. Study the relationship between the words in the first pair and then fill the missing word in the following pair.

   i) Denitrifying bacteria : Pseudomonas, ii) Nitrifying bacteria : ……..
   iii) Nitrogen fixing bacteria : …….

Section C

5. A) Plants and animals are inter-dependant.

   i) Do you agree with this statement? ii) Comment.

   B) List out biotic and abiotic components

   Air, Deer, Water, Dog, Man, Soil, Light, Plant.

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Chapter 8

POLLUTION AND OZONE DEPLETION

8. POLLUTION AND OZONE DEPLETION

Can you say that the air we breathe in is pure or the water we use is clean? Is the heat during the summer months unbearable? What are the reasons for these changes?

The reason is pollution

What is pollution? Is it natural or man-made? What are its causes and effects? Let us try to find out the answers.

Definition

Pollution is an undesirable change in physical, chemical and biological characteristics of our land, air or water caused by excessive accumulation of pollutants (i.e. Substances which cause pollution).

8.1. KINDS OF POLLUTION

The pollution is of four major types namely air pollution, water pollution, land pollution and noise pollution. In terms of origin it may be natural or anthropogenic (man-made).

8.1.1. AIR POLLUTION

Degradation of air quality and natural atmospheric condition constitute air pollution. The air pollutant may be a gas or particulate matter.

MORE TO KNOW

Black Lung disease

It is common among coal miners due to the inhalation of carbon particulates which lead to Lung Cancer.

Air pollutants and their effects

1. **Particulate matter** – it comprises of small suspended particles such as soot, dust, pesticides, etc., and biological agents such as spores, pollen and dust mites. It causes respiratory ailments such as asthma, chronic bronchitis, etc.,

2. **Carbon monoxide** – is a product of incomplete combustion of fossil fuels in automobiles. It is highly poisonous to most animals. When inhaled, carbon monoxide reduces the oxygen carrying capacity of blood.

3. **Hydrocarbons** – hydrocarbons such as methane, are evolved from soil microbes (methanogens) in flooded rice fields and swamps. They are also generated during the burning of coal and petroleum products.

Brown air

4. **Sulphur dioxide** – is released from oil refineries and ore smelters which use the sulphur containing fuels. It causes harmful effects on plants and animals. It causes chlorosis (loss of chlorophyll) and necrosis (localised death of tissues). In human, it causes health problems such as asthma, bronchitis and emphysema.

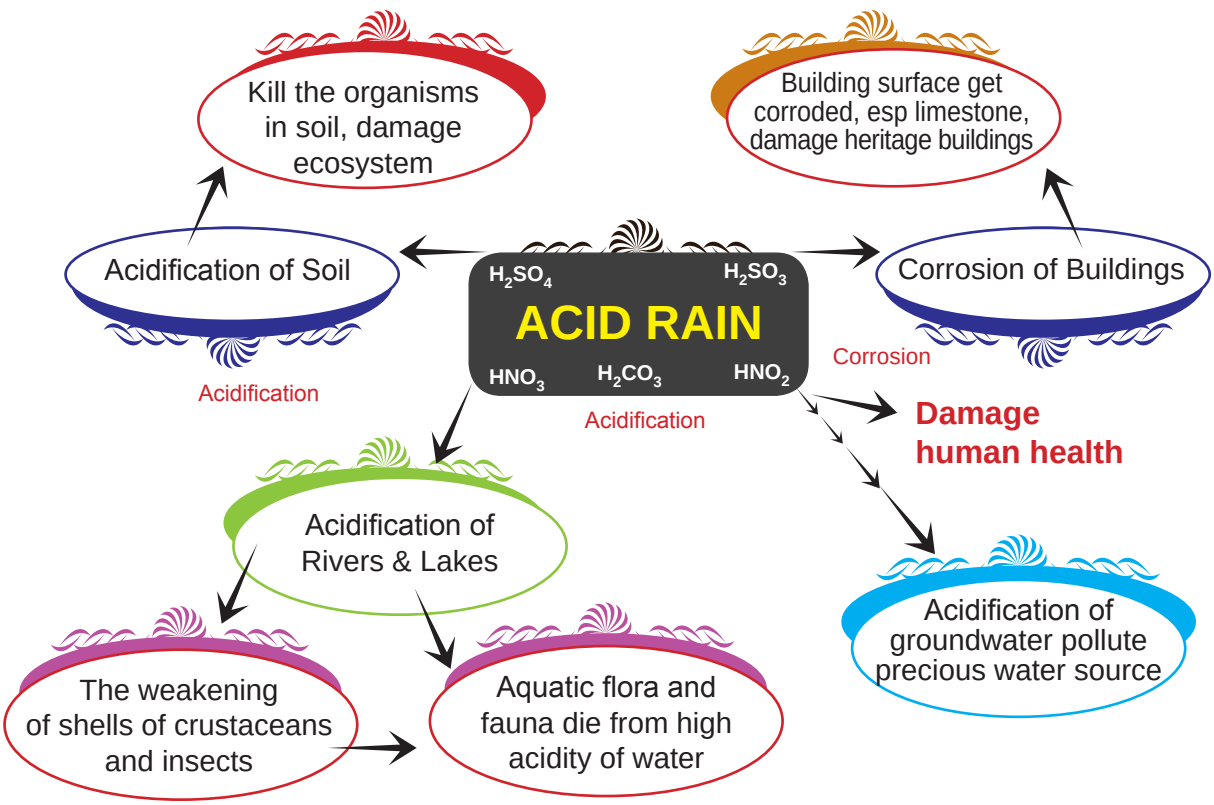
5. **Nitrogen oxides** – It causes reddish brown haze (brown air) in traffic congested city air which contributes to heart and lung problems.

Secondary effects of air pollution

Photochemical smog – Smog is a mixture of smoke and fog. It is formed in the atmosphere under the influence of sunlight by the photochemical reactions of hydrocarbons, oxides of nitrogen and oxygen, resulting in the formation of PAN (peroxy acetyl nitrate). PAN damages the chlorophyll and thus reduces photosynthesis and growth. It also causes acute irritation of eyes and throat. Visibility of the surrounding is reduced due to smog.

Acid rain – gases such as Sulphur di oxide and Nitrogen oxides are oxidized to form sulphuric and nitric acids along with water, and precipitate as acid rain. It damages building materials, plants and animals. It also makes the soil acidic.

Sculpture affected by acid rain



MORE TO KNOW

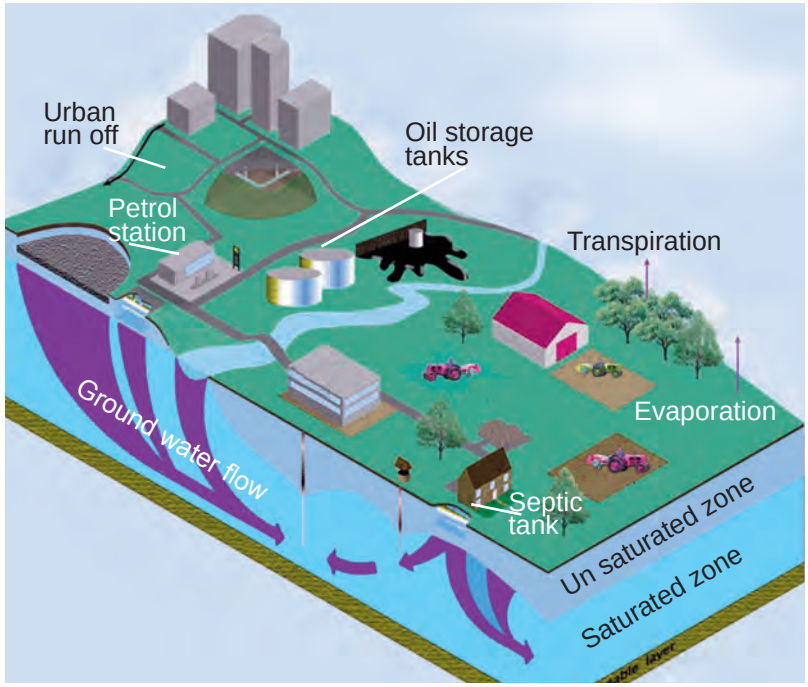
BHOPAL GAS TRAGEDY (2nd & 3rd Dec' 1984) refers to the industrial disaster which killed thousands of people and animals due to the inhaling of **methyl iso cyanate** (MIC) gas which leaked out from a fertilizer factory owned by Union Carbide Company. Many people who inhaled the gas, still suffer from respiratory, immunological and neurological disorders, cardiac failure, birth defects, etc,.

Control of air pollution

1. The particulates emitted by industries should be controlled by devices such as scrubbers, precipitators and filters.
2. Use of unleaded or low sulphur fuel is to be encouraged.
3. Shifting to non-conventional sources of energy (e.g solar energy, hydel energy, tidal energy, etc.,) in order to reduce the dependance of conventional sources.
4. Smoking in public places should be prohibited, because the cigarette smoke contains carcinogens such as benzopyrene. An average smoker runs the risk of developing heart and lung diseases.
5. Planting of trees along the road sides and around industrial areas.

8.1.2. WATER POLLUTION

Water pollution is defined as the adding of unwanted substances or the change of physical and chemical characteristics of water in any way which makes it unfit for human consumption. It is caused by waste products of industries (effluents), domestic sewage, oil spillage, agricultural and industrial run off etc.,



Sources and effects of water pollution

1. **Industrial wastes** –The industrial effluents containing heavy metals and chemicals such as arsenic, cadmium, copper, chromium, mercury, zinc, nickel, etc,. are directly released into the water bodies such as lakes, ponds and rivers without proper treatment. These wastes contaminate the water bodies and make them unsuitable for human consumption. Hot water is another noted pollutant from industries. Many

industries use water as a coolant for the machinery and release of hot waste water into the water bodies causing thermal pollution which affect both the plant and animal life.

2. **The surface run off** - the surface run off from agricultural land is contaminated with pesticides and residues of inorganic fertilizers. The run off from urban and industrial are rich in organic and inorganic compounds. These pollutants contaminate both surface and ground water resources.

3. **Oil spills** – An oil spill is an accidental discharge of petroleum products in oceans and estuaries from capsized oil tankers, offshore drilling and exploration operations. It can cause drastic damage to the marine and coastal bio diversity.

4. **Domestic Sewage** – It is rich in organic matter and detergents. Decomposition of organic matter increases the nutrient content of the water bodies. Availability of excess nutrients results in algal bloom on the surface of water resulting in the deficiency of oxygen content(BOD – Biological Oxygen Demand). This in turn leads to the death of aquatic organisms. This process is known as Eutrophication.

MORE TO KNOW

Biological magnification of **DDT** (Dichloro diphenyl trichloroethane) is seen in aquatic food chain. The concentration of DDT gradually increases at each trophic level. DDT inhibits calcium carbonate deposition in the oviducts of certain birds which result in the laying of thin shelled eggs. These eggs can easily break during incubation and the developing embryos are destroyed.

MORE TO KNOW

MINAMATA DISEASE

Mercury poisoning due to the consumption of fish captured from mercury contaminated **Minamata Bay** in **Japan** was detected in **1952**. Mercury compound in waste water are converted by bacterial action into extremely toxic **methyl mercury** which can cause numbness of limbs, lips and tongue. It can also cause deafness, blurring of vision and mental derangement.

Control of water pollution

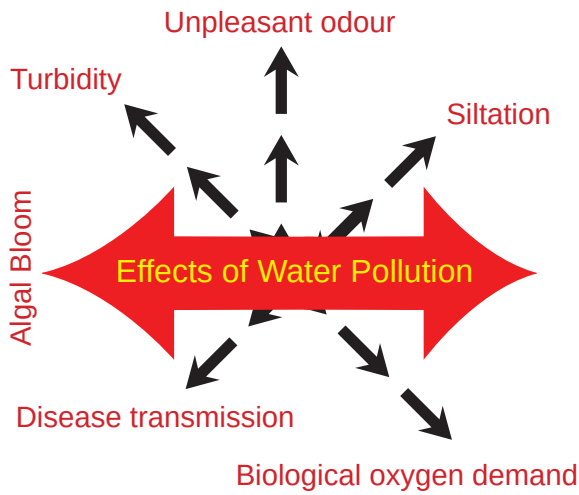
1. Sewage treatment plants should be installed to treat sewage before releasing into water bodies.

2. Excessive use of pesticides, herbicides and fertilizers should be avoided.

3. Biological control of insect pests and organic farming is to be followed in order to reduce the dependence on pesticides and inorganic fertilizers.

4. By legislation and strict enforcement.

5. By creating social awareness among people about the water pollution and the need for pure water.



MORE TO KNOW

REVERSE OSMOSIS (RO)

It is the most efficient way of obtaining purified drinking water. During this process, pressure is applied on the solution which has more concentration. This reverses the natural direction of water flow and osmosis from high gradient to low gradient. This process involves energy expenditure. The membranes used for RO process have a dense barrier layer which allow only the water to pass through and prevents the passage of solutes. Hence, it is best suited for **desalination** of sea water (removal of salt).

8.1.3. SOIL POLLUTION

Soil pollution is the unfavourable alteration of soil by the addition or removal of substances which decrease soil productivity and ground water quality. It usually results from different human activities like dumping of waste, use of agro chemicals, mining operations and urbanization.

Causes and effects

The industrial solid waste and sludge contain toxic organic and inorganic compounds as well as heavy metals. The radio active waste from nuclear power plants and nuclear explosions also contaminate the soil. Fly ash contains fine particulates which are released from thermal power plants. It settle on the ground and cause pollution.

The domestic waste is rich in organic matter and undergo decomposition. The hospital waste contains a variety of pathogens that can seriously affect human health.

Agricultural chemicals such as pesticides, insecticides and inorganic fertilizers may pollute drinking water and can change the chemical properties of the soil adversely affecting the soil organisms.

Control of soil pollution

Management of soil wastes include collection and categorization of wastes. Recovery of resources like scrap metals, plastics, etc., for recycling and reuse and safe disposal with a minimum environmental hazards is to be followed. Other notable methods of waste disposal include incineration (burning in the presence of oxygen) and pyrolysis (burning in the absence of oxygen). Afforestation and reforestation should be undertaken on a large scale to prevent soil erosion and loss of soil nutrients.

8.1.4. RADIOACTIVE POLLUTION

Nuclear power plant

The emission of protons, electrons and electromagnetic radiations released by the disintegration of radioactive substances such as radium, thorium, uranium, etc,. cause air, water and land pollution.

Effects :-

- The ionising radiations can cause mutations.

Nuclear explosion

- Strontium-90 accumulates in bones causing bone cancer.
- Iodine-131 can damage bone marrow, spleen, lymph nodes and can cause leukemia (blood cancer).

MORE TO KNOW

Chernobyl disaster (Ukraine)

The explosion at the Chernobyl nuclear power station was undoubtedly the world's worst nuclear disaster. The deadly radioactive material was released into the atmosphere. The inhabitants of Chernobyl were exposed to radioactivity which was hundred times greater than Hiroshima bomb. Babies were born with infirmities and people suffered from serious diseases like thyroid cancer.

Preventive measures

- Care should be taken to prevent the leakage of radioactive substances from nuclear reactors.
- Radioactive wastes should be disposed off safely.
- Strict measures should be followed in the construction and maintenance of nuclear power plants to prevent nuclear accidents.
- Control or prevention of nuclear tests.

8.1.5. NOISE POLLUTION

Noise may be defined as an unwanted and unpleasant sound that may have adverse effects on animals and humans. The unit of sound level is decibels (db). Noise level above 120 db is considered harmful to human beings.

MORE TO KNOW

Jet Aircraft (take off)	145 db
Heavy city traffic	90 db
Vaccum cleaner	85 db
Window Air conditioner	60 db
Normal speech	60 db

Sources

The different sources associated with noise pollution are industrial machinery, road, rail and air transport, loudspeakers, construction equipments, household appliances, crackers, etc,.

Effects

Noise seriously affects heartbeat, breathing, and can cause constriction of blood vessels. It can cause headache, sleeplessness, irritability and may seriously affect the productive performance of human. Loud noises (above 130 db) can cause damage to the ear drum, hair cells of cochlea (organ of hearing) and thereby

resulting in temperory or permanent loss of hearing. It can also seriously affect the concentration of students while learning.

Control measures

The industries should be established away from residential areas. Trees should be planted along roadside or highways to reduce noise levels. The industrial machinery and motor vehicles should be properly maintained in order to minimize the noise. The use of loudspeakers and bursting of crackers should be restricted. Effort must be made to create awareness among people about the harmful effects of noise and the need to control it.

MORE TO KNOW

Various laws and rules have been promulgated by the government of India from time to time to control pollution. Some of them are 1974 - Water (prevention, control of pollution) Act.

1980 - Forest Act.

1981 - Air (prevention, control of pollution) Act.

1986 - Environmental pollution Act.

1988 - Motor vehicles Act

8.2. GLOBAL WARMING

- July 1998 was the hottest month world over.
- In 1998 India had the hottest period in 50 years.
- Since 1988 nine of the hottest years in more than a century have been recorded.
- There is a rapid melting of snow and subsequent rise in sea level.

What could be the reason for these alarming changes in the climate and environment?

The answer is global warming which refers to an average increase in the temperature of the atmosphere or simply it is the warming of the earth.

Melting of glaciers

The root cause of this adverse climatic change is the greenhouse effect caused by greenhouse gases.

8.2.1. GREEN HOUSE EFFECT

The trapping of energy from the sun by green house gases in the atmosphere leading to rise in earth's temperature is known as the green house effect. The green house gases such as carbondioxide, methane, nitrous oxide, chloro fluro carbons, etc,. absorb and reflect infra red waves radiated by the earth causing increase in temperature as in a green house.

GREEN HOUSE

A green house

A green house is a structure primarly of glass or plastic in which temperature

and humidity can be controlled for the cultivation or production of plants.

Green house gases

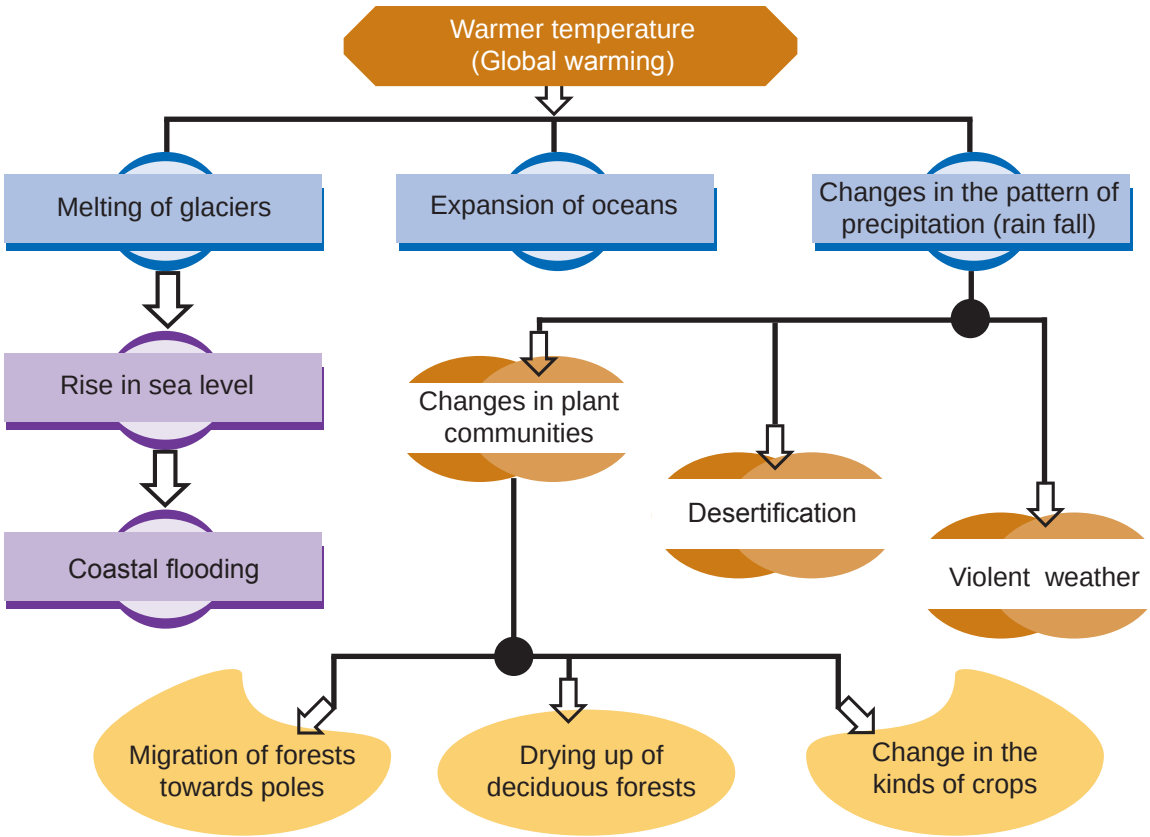
- **Carbondioxide** – most abundant greenhouse gas released by burning of fossil fuels, deforestation, respiration of animals, decaying of organic matter, etc,. At present there is an increase of 31% of carbondioxide.
- **Methane** – it is produced by the incomplete decomposition of organic compounds by methanogenic bacteria under anaerobic condition. It is also produced by the enteric fermentation in the cow and from the flooded rice fields.
- **Nitrous oxide** – is released by burning of fossil fuels, industrial processes, agricultural practices like ploughing etc,.
- **Chloro fluro carbons** – are coolant gases used in refrigerators, aerosols, solvents, etc,.

Effects of global warming

- The level of the sea rises due to the melting of glaciers and thermal expansion of water which will submerge many parts of countries.

Arctic Bear in melting snow

- Due to global warming the rise in temperature could create unexpected changes in weather conditions – making some regions hotter and others colder.



- The rainfall pattern could also change causing drought in some areas and flooding in others.
- Crops and forests may be affected by insect pests and plant diseases resulting in severe damage.
- Water borne and insect borne diseases such as malaria and dengue could spread to temperate countries.
- It can also result in the loss of bio diversity due to the extinction of coral reefs and other key species.

Control measures

Global warming can be controlled by reducing the use of fossil fuels, reforestation, carbon sequestration (trapping Co_2), shifting to renewable sources of energy such as solar power, wind power, hydel power, etc,.

Ten things you can do to reduce Global warming

1. Use less heat and air-conditioning.
2. Drive less (automobiles) and drive smart (bicyles).
3. Buy energy efficient products (★rated).
4. Use CFL (Compact Fluorescent Light) bulbs.
5. Reduce, reuse and recycle resources.
6. Use less hot water.
7. Use the “off” switch when needed.
8. Plant a tree.
9. Encourage others to conserve energy.
10. Do the energy auditing of household appliances.

MORE TO KNOW

EL NINO EFFECT

It causes erratic weather patterns which occur due to the interaction of unusually warm or cold sea surface temperatures in the eastern and central pacific oceans. It was once a rare cyclical weather condition which has become more frequent, persistent and intense.

Compact fluorescent light

CFLs are a great way to save energy eventhough they cost a little more and are slower to brighten up than an ordinary bulb. They produce less amount of heat.

8.3. OZONE DEPLETION

The ozone layer in the stratosphere is protective in function as it filters the harmful ultraviolet rays of the sun. This ozone is continously broken down and reformed; these two processes perfectly balance each other. But due to human activity, this balance is upset leading to the thinning of ozone layer (ozone holes). The decrease in the amount of ozone in the stratosphere is called ozone depletion.

Ozone depletion

Reasons

The ozone hole is due to chlorine and bromine formed in the atmosphere. The common ones are chloroflurocarbons, methyl bromide, nitrogen oxides, etc,. which are released from freezers, air conditioners, aerosol products, industrial solvents, etc,.

Effects

- In humans, it can cause the incidence of skin cancer, cataracts and poor immune response.
- In plants, it can affect crop yield and productivity.
- The UV radiation can also cause the death of phytoplanktons (producers), young fishes and larval forms.

Control measures

Controlling the production, use and emission of ozone depleting substances, recycling of chemicals and adoption of protection measures from sun's radiation are some of the measures to control ozone depletion.

8.4. SCIENCE TODAY – OIL SPILL

Do you know about the recent environmental problem in the Gulf of Mexico and USA?

What is an oil spill and what are its environmental implications?

An oil spill is a release of liquid petroleum hydrocarbons into the environment, mainly due to human activities. It includes the release of crude oil from tankers, offshore platforms, drilling rigs and wells.

Environmental impacts

Oil spill affects the physical, chemical and biological characteristics of water and land. It forms a thick black layer above the sea water and considerably increase its viscosity which interfere with the locomotion of organisms.

The oil floating on top of the water reduces the penetration of sunlight, limiting photosynthesis by marine plants and phytoplanktons (producers). It will, in turn, affect the other members of the marine food chain. The oil also drenches the plumage of birds and impairs their ability to fly and escape from predators. Birds may ingest the oil while preening their feathers resulting in kidney damage, altered liver function and metabolic imbalances.

The oil which covers the coats of aquatic mammals such as seals can reduce their heat insulation capacity, resulting in hypothermia (decrease in body temperature).

Crude oil contains a mixture of volatile hydrocarbons like benzene, toluene, xylene, etc,. which are carcinogenic in nature (cancer causing). Symptoms of exposure include dizziness, headaches, nausea, rapid heart beat and dehydration.

Control and preventive measures

- The oil spills can be controlled by preventing the release of oil or hydrocarbons during transit, exploration or accidents.
- The sea food should be thoroughly tested for contaminants before consumption.
- The oil spills may be cleared by using certain micro organisms such as bacteria. This process of clearing the oil spills by using bacteria is known as bio remediation.

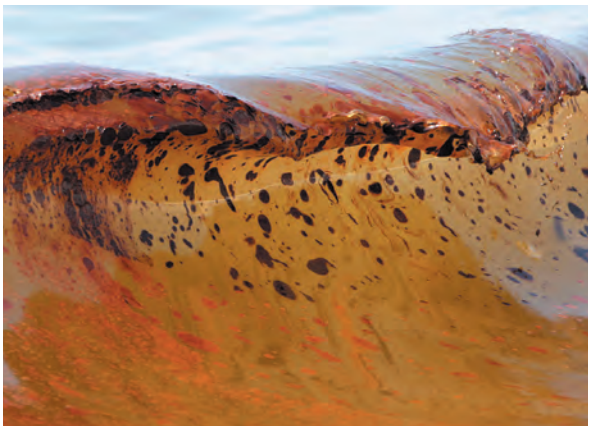
PSEUDOMONAS BACTERIA

Dr.Ananda Mohan Chakraborty

One of the notable achievements in bio remediation is the invention of Pseudomonas putida, a genetically engineered bacterium by an Indian American scientist Dr.Ananda Mohan Chakraborty. It is a rod shaped saprotrophic soil bacteria with a diverse metabolism to degrade hydrocarbons and organic solvents like octane and toluene.

Recent episodes of Oil spills

Deep water horizon oil spill



Oil spill in gulf of mexico

It is a massive oil spill in the Gulf of Mexico and is the largest offshore spill in US history. It stemmed from a sea floor oil gusher that resulted from the April 2010 deep water horizon drilling rig explosion. The resulting oil slick covers atleast 2500 sq. miles fluctuating from day to day depending on weather conditions.

The spill continues to cause extensive damage to marine and wildlife habitat as well as fishing and tourism industries. The spill threatens an environmental disaster due to factors such as petroleum toxicity and oxygen depletion. More than 400 species which live in the Gulf of Mexico are at risk.

Mumbai oil spill (August 2010)

The spill occurred due to the collision of two oil tankers MSC Chitra and MV Khalijia off the coast of Mumbai. An estimated 400 tonnes of oil was spilled into the Arabian sea. The oil spill is proved to cause extensive damage to the marine eco-system, as well as the sensitive mangrove plants.

Agencies of Environmental Management

C.P.R – Environmental Education Centre, Chennai:

This centre promotes environmental awareness among the public. It gives guidance for environmental laws, environmental impacts and environmental management studies. It promotes the use of renewable sources of energy.

Madras Naturalists Society:

It creates environmental consciousness through seminars, camps, video shows and visits to wild life sanctuaries and national parks. It conducts surveys regarding pollution and deforestation.

MSSRF (M.S.Swaminathan Research Foundation):

It is a non-profit research organisation and was established in 1998. It carries out research and development in six major areas such as Bio-diversity, Bio-technology, Food scarcity, Coastal system research, Information and Education and Communication.

EVALUATION

Section – A

1. Bursting of crackers and use of loud speakers are restricted at night time due to noise pollution. Mention any two harmful effects of noise.

2. On 10/10/10 at 10 p.m. lights were put off all over the world for an hour marking the 'earth hour'. Mention its significance.

Section – B

A	B	C
Fossil fuels, Carbon Mon-oxide, Blood	Sulphur tri oxide, Acid rain, Damage monuments	PAN, Photochemical smog, Visibility

3. a) What is common in the above mentioned boxes A, B and C.
   b) PAN – PHOTOCHEMICAL SMOG.Construct two more pairs
   c) Relate the data in box A and B and prepare notes.

4. Water pollution due to domestic sewage leads to algal bloom and eutrophication. How can it damage the aquatic ecosystems.

5. Prepare two posters containing slogans to create awareness about harmful effects of noise.

6. We can realize the changes in the climate and seasons due to global warming. Mention any two changes.

7. Planting of green trees is encouraged. At the same time felling of trees also occur at an alarming phase. How can your strike a balance?

Section – C

8. The non conventional sources of energy are Solar Energy, Hydel Energy, Tidal energy etc., Write a note regarding their role in reducing pollution.

9. Oil spills in seas and oceans are of frequent occurrence due to oil explorations, tanker accidents etc., write a note on the influence of oil spills on marine life.

FURTHER REFERENCE

Books

1. Elements of Ecology - Clarke G.L., John wiley & sons, Newyork.
2. Fundamentals of Ecology - Odum E.P., W.B.Saunders Company, Philadelphia.

Websites

http://www.ecology.com
http://www.nationalgeographic.com

Scientific names, Common names and Tamil names of some plants and animals

S.No.	**Scientific Name**	Common Name	Tamil Name	How is it called locally?
1.	Brassica oleracea	Cabbage	முட்டைக்கோசு	
2.	Cyamopsis tetragonoloba	Cluster bean	கொத்தவரை	
3.	Arachis hypogea	Ground nut	நிலக்கடலை	
4.	Oryza sativa	Rice(Paddy)	நெல்	
5.	Vasella rubra	Spinach	பசலைக்கீரை	
6.	Crotalaria juncea	Sunn-hemp	சணப்பை	
7.	Eichhornia crassipes	Water hyacinth	ஆகாயத்தாமரை	
8.	Triticum vulgare	Wheat	கோதுமை	
9.	Impatiens balsamina	Balsam	காசித்தும்பை	
10.	Utricularia polyvaloides	Bladderwort	யுட்ரிகுலேரியா	
11.	Coriandrum sativum	Coriander	கொத்துமல்லி	
12.	Taraxacum officinale	Dandelion	டேண்டலியான்	
13.	Cuscutta reflexa	Dodder plant	அம்மையார் கூந்தல் (அல்லது)சடதாரி	
14.	Monotropa uniflora	Indian pipe	புகையிலைக் காளான்	
15.	Agaricus campestris	Mushroom	நாய்க்குடை	
16.	Allium cepa	Onion	வெங்காயம்	
17.	Nepenthes khasiana	Pitcher plant	குடுவைத்தாவரம்	
18.	Solanum tuberosum	Potato	உருளைக்கிழங்கு	
19.	Crocus sativus	Saffron	குங்குமப்பூ	
20.	Drosera burmannii	Sundew plant	எறும்புத்திண்ணி (சூரியப்பனித்துளித் தாவரம்)	
21.	Mimosa pudica	Touch-me-not plant (Sensitive plant)	தொட்டாற்சுருங்கி (தொட்டாற்சிணுங்கி)	
22.	Amoeba proteus	Amoeba	அமீபா	
23.	Paramoecium caudatum	Paramoecium	பாரமீசியம்	
24.	Hydra vulgaris	Hydra	ஹைடிரா	
25.	Obelia geniculata	Jelly fish	நொங்குமீன்	
26.	Periplaneta americana	Cockroach	கரப்பான்பூச்சி	
27.	Pila globosa	snail	நன்னீர் நத்தை	
28.	Lamellidans lamellidans	Freshwater mussel	நன்னீர் மட்டி	
29.	Asterias rubens	Star fish	நட்சத்திர மீன்	
30.	Naja naja	Cobra	நல்ல பாம்பு	
31.	Pavo cristatus	Peacock	மயில்	
32.	Tyto alba	Owl	ஆந்தை	

Chapter 9

IS MATTER AROUND US PURE?

Consider a balloon filled with air. Its mass is higher than an empty balloon. Increase in mass is due to the air filled. It shows that air has a certain mass. Similarly fine sand, rice, stone etc., have definite masses. Thus any substance that occupies a volume with characteristic mass can be called as matter.

All matters in the universe exist in three states. There are two ways of classification of matter.

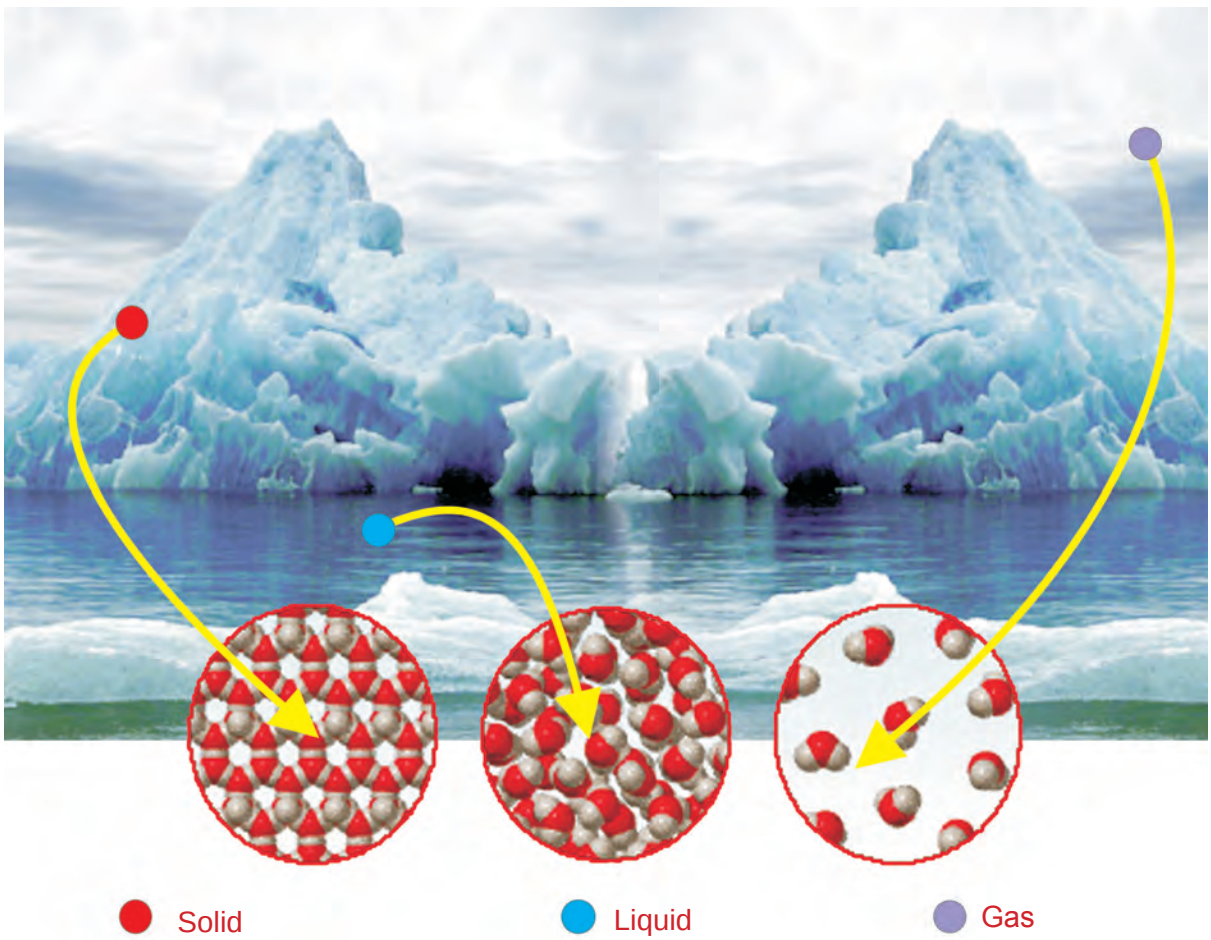
1. According to physical state as solid, liquid or gas.
2. According to its composition as element, compound or mixture.

PHYSICAL STATES OF MATTER

Solid: Solids have a definite shape and a definite volume. The shape of a solid does not change much with temperature. It is 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 their container. They have a definite volume. They are not appreciably compressed by moderate pressures. They expand more than solids on heating and changes into the gaseous state. They have lower densities than solids.

Gas: Gases have no definite shape and volume and take the shape of the container and fill the entire container. They are easily compressed by even small pressures and also expand more than liquids on heating. They have low densities.



Is matter around us pure?

Matter may be classified as a pure substance or a mixture of two or more pure substances.The nature of matter can be determined by studying its properties and its composition.

Colour, odour, density, melting point and boiling point are often treated as physical properties of matter. The physical properties of a substance can be observed or measured without changing its composition.

During a chemical reaction, the compositions of substances are changed. For example, when the gaseous hydrogen element combines with oxygen, the compound, water is formed.

Hydrogen + oxygen ⟶ water

Water contains hydrogen and oxygen but the properties of water are different from those of hydrogen and oxygen. Most forms of matter that we encounter, for example the air we breathe, the gasoline for cars are not chemically pure.

The term “impure” is different from adulteration. According to scientists, the term “pure” means single form of matter.

A pure substance is a distinct type of matter. A substance has the same properties throughout the whole sample.

9.1. MIXTURES

Pure water is a familiar example of a substance. All samples of pure water have the same boiling point, whereas, seawater is not a pure substance. It contains both salt and water along with other dissolved substances.

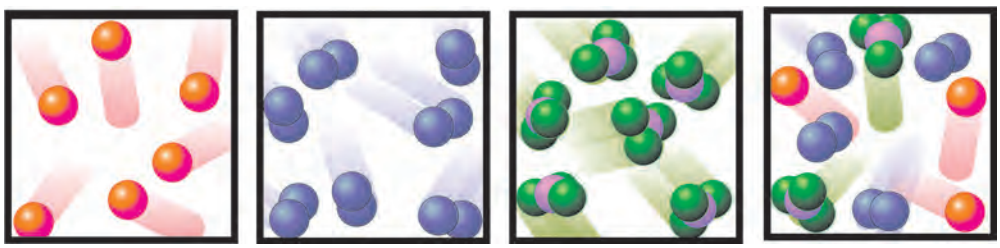
Thus a pure substance should consist of a single type of particle or matter whereas, substances like seawater, minerals, soil etc are examples of mixtures.

In mixtures, elements are physically mixed in any ratio and no new compound is formed.

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° C, freezes at 0° C and has a density of 1.0 g cm^{-3} is water.

A pure substance is either an element or a compound.



a b c d

a) Atoms of an Element b) Molecules of an Element c) Molecules of a compound
d) Mixture of atom, element and a compound

ACTIVITY –9.1

Classify the following substances as element, mixture and compund.

(i)Ink (ii) Paint (iii) Oxygen (iv) Air (v) Water

9.2. CHARACTERISTICS OF MIXTURES

To understand the differences between mixtures and compounds, let us consider a mixture of iron and sulphur as an example of a mixture. Here iron and sulphur make a mixture.

Mixture has the properties of individual components. For example, mixture of iron and sulphur has their own properties. When touched with magnet, iron is attracted by the magnet. On the other hand, when burnt, sulphur escapes in the form of sulphur dioxide gas. Consider the chemical reaction between iron and sulphur.

Iron+Sulphur ⟶ Ferrous sulphide

Here, ferrous sulphide is a compound and not a mixture. The compound, ferrous sulphide does not have the properties of individual components, iron and sulphur.

Left - Sulphur and Iron
Right - Ferrous sulphide

ACTIVITY –9.2

The figure shows copper sulphate in one dish and copper sulphate with sodium chloride in another dish. Identify pure substance and mixture.

Examples of mixtures

Mixtures made up of two components are called binary mixtures and those containing three components are called ternary mixtures. Air and sea water are neither elements nor compounds but mixtures. Pure substances have fixed compositions. Composition of a mixture can vary. A cup of sweetened coffee, for example can contain either a little sugar or a lot. Similarly air may contain 0 to 5% by weight of water vapour.Sea water may contain 3.5 to 30% salt. Thus a mixture contains more than one kind of pure constituents or components.

The substances making up a mixture are called constituents or components.

ACTIVITY –9.3

Is air around us pure? Write reasons.

MORE TO KNOW

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

What is a Compound?

Compounds are substances composed of two or more elements combined in fixed ratio by weight. The compound always has the same physical and chemical properties. A compound always contains the same percentage (by weight) of each element. For example, all samples of pure water are 11.19% (by weight) hydrogen and 88.81% (by weight) oxygen. This summary of many observations is called the law of constant composition.

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.

Types of mixtures	Examples
Solid in solid	Coins, alloys
Solid in liquid	Sea water
Solid in gas	Smoke(carbon particles in air)
Liquid in solid	Amalgam
Liquid in liquid	Alcohol and water
Gas in solid	Gas adsorbed by charcoal
Gas in liquid	Soda drinks
Gas in gas	Air

ACTIVITY – 9.4

Can you identify the different states or phases present in a glass of fruit juice with ice-cubes in it.

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 -196^{O}C and -183^{O}C.
- If air were a compound, the composition of air expelled from water should not be different from the composition of air around us. But it is known that during respiration, exhaled air is richer in oxygen than ordinary air.

ACTIVITY – 9.5

Classify the following into mixture or compound.

(i) Alloys (ii) Smoke (iii) Juice (iv) Milk (v) Common salt (vi) Coffee (vii) Carbon di oxide (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

ACTIVITY –9.6

Aspirin is a medicine for headache. It is composed of 60% carbon, 4.5% hydrogen and 35.5% oxygen by mass, regardless of its source. Is aspirin a mixture or a compound?

9.2.1. 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.

9.3. TYPES OF MIXTURES

There are two types of mixtures. They are,

i. Homogeneous mixture

ii. Heterogeneous mixture

9.3.1. HOMOGENEOUS MIXTURES AND THEIR TYPES

Homogeneous mixtures have only one phase. They have the same properties throughout a sample although the properties of different samples may be different. Homogeneous mixtures are called solutions.

There are three types of homogeneous mixtures.

Solid homogeneous mixture - Alloys

Liquid homogeneous mixture - Alcohol in water

Gaseous homogeneous mixture - Air

ACTIVITY –9.7

Which of the following are physical changes and which are chemical changes?

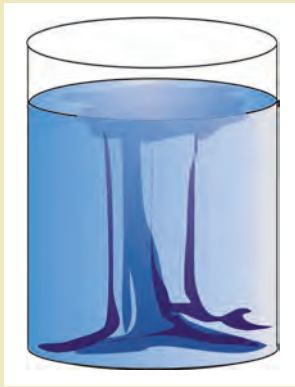
(1) Rusting of iron. (2) Melting of ice. (3) A seed grows into a plant. (4) Aluminium metal is rolled into a foil. (5) Candle burns.

Homogeneous Mixtures

Salt in water Strong tea Weak tea

ACTIVITY –9.8

A drop of ink mixes with water. Is it a homogeneous mixture or a heterogeneous mixture?



9.3.2. HETEROGENEOUS MIXTURES AND THEIR TYPES

Heterogeneous mixtures have more than one phase. They do not have the same properties throughout a sample. Bits of the phases can be seen either with the eye or with a microscope. The phases can be in the same or different physical states.

Solid - solid heterogeneous mixture - mixture of sugar and salt

Solid - liquid heterogeneous mixture - ice cubes in water

Gaseous heterogeneous mixtures - smoke in air.

ACTIVITY –9.9

This beaker contains a solution of copper sulphate salt dissolved in water. Is it a homogeneous mixture or a heterogeneous mixture? Support your conclusion.

ACTIVITY –9.10

Classify each of the following as homogeneous or heterogeneous

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

Classification of matter

Matter

Mixtures

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

Compounds

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

9.4. SEPARATION OF DIFFERENT COMPONENTS OF A MIXTURE

People have used methods of separating and purifying materials since ancient times.

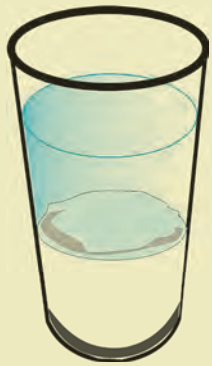
Today,

- The oil industry refines crude oil and separates it into fuels, lubricants and raw materials for chemical industry.
- The mining industry is based on the separation of metals and some non-metals from their ores.
- Pharmaceutical companies separate and purify natural and synthetic drugs etc.

In the laboratory, different methods of separation are used to get the individual component from a mixture. Some of the physical methods are,

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. Distillation: Used to separate a non-volatile solid and a volatile liquid present together as a solution.
4. Fractional distillation: Used for separating a mixture containing two or more liquids with an appreciable difference in their boiling points.
5. Separating funnel: To separate two completely immiscible liquids.
6. Sublimation: Used for separating a mixture of two solids, one of which sublimes.
7. Chromatography: Used to separate two substances based on the difference in the force of attraction between the substances and a solid (adsorption).

ACTIVITY –9.11



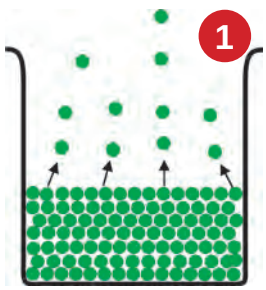
In a beaker, mix together an equal quantity of fine salt and white flour. Pour water into the beaker and stir well. Observe the solubility of flour and salt in water. Flour settles on the bottom of the beaker. Mention a suitable method of separation of flour from salt.

9.4.1. SEPARATION OF MIXTURES BY SUBLIMATION

By sublimation, a volatile solid substance is separated from a mixture containing a non-volatile solid substance.

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 making the solid substance into vapour.

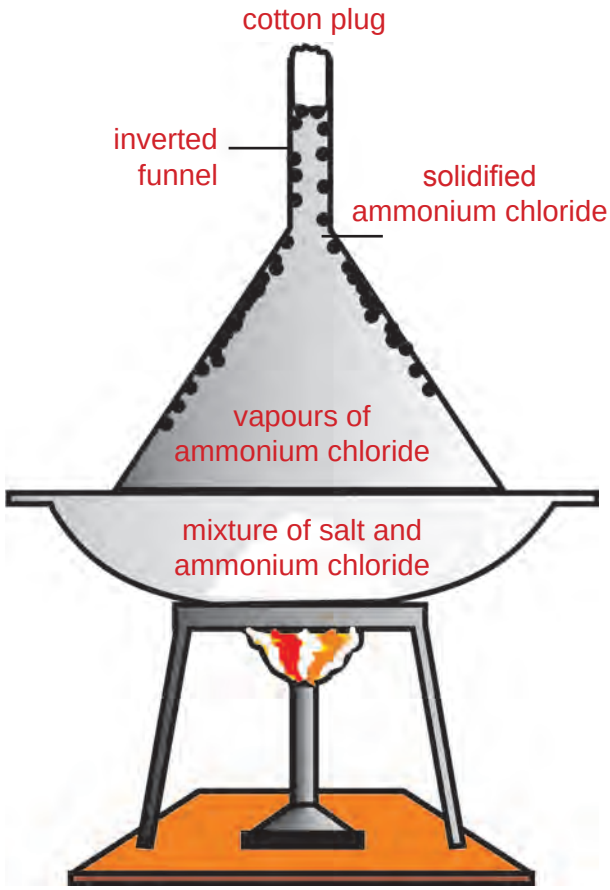


1. Solid molecules evaporate

2. Iodine crystal vapourises

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

Consider a mixture containing common salt and ammonium chloride. Both common salt and ammonium chloride are solid substances. Common salt is a non-volatile substance. It does not undergo sublimation. Ammonium chloride is characteristic of undergoing sublimation. Hence Ammonium chloride can be separated from common salt by sublimation.



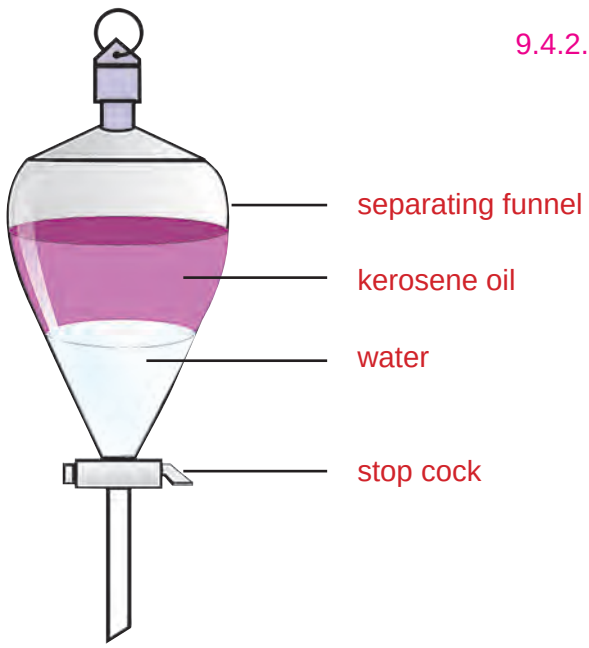
ACTIVITY –9.12

Take a mixture containing common salt and camphor in a china dish

- Keep it on a stand.
- Invert a funnel over the dish.
- Close the funnel stem by means of cotton.
- Heat the china dish.
- Observe the physical change.

MORE TO KNOW

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



9.4.2. SEPARATION OF A MIXTURE CONTAINING IMMISCIBLE LIQUIDS

Immiscible liquids are usually separated by using a device named "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 –9.13

- 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?

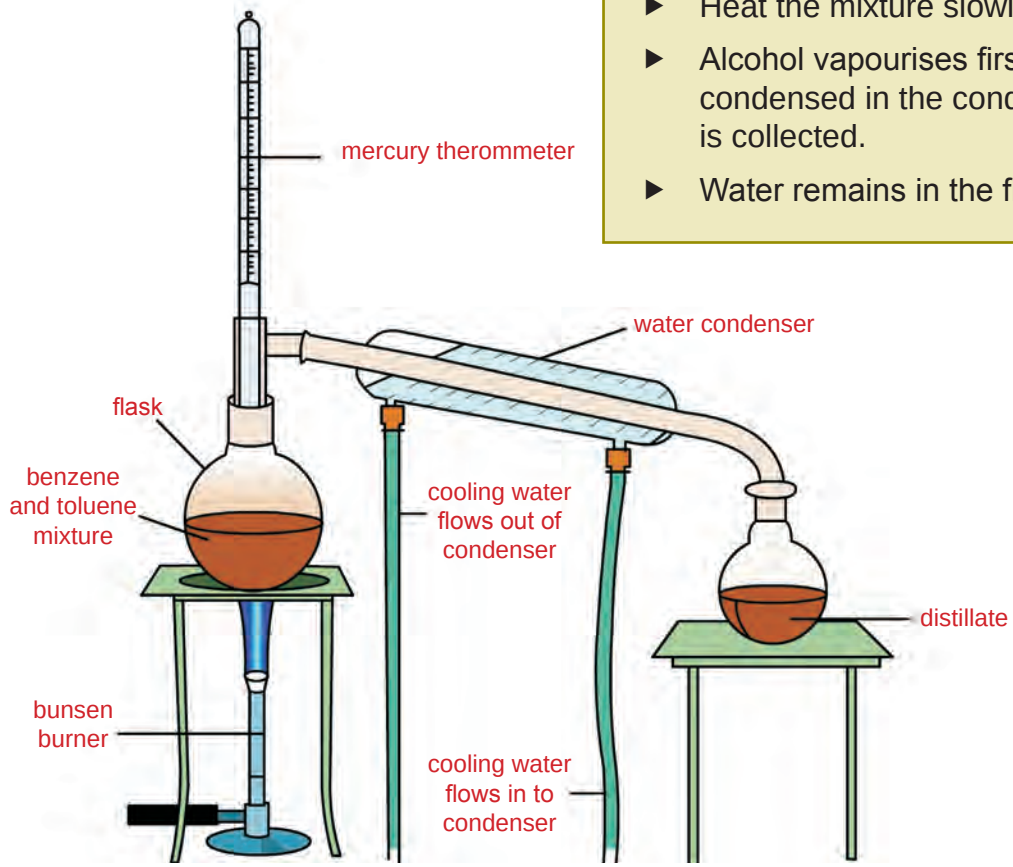
9.4.3. SEPARATION OF A MIXTURE CONTAINING MISCIBLE LIQUIDS

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°C.

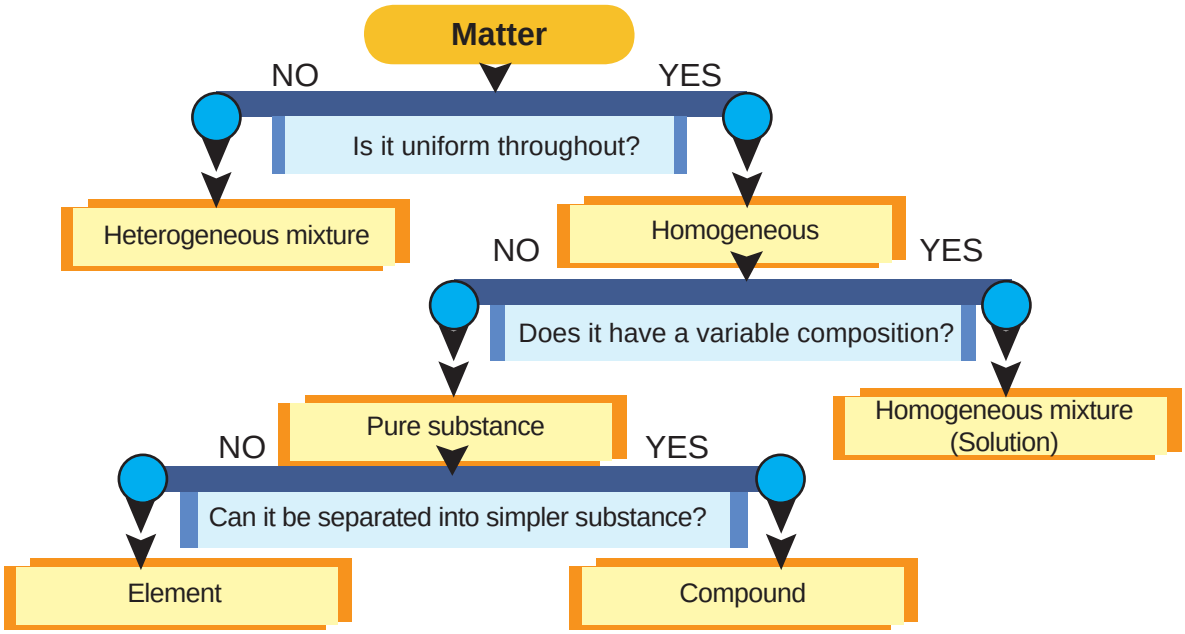
- Consider a mixture containing two liquids namely benzene and toluene.
- Both the liquids are miscible with one another.
- They can be separated by fractional distillation.
- Boiling point of benzene is 353 K.
- Boiling point of toluene is 384 K.
- The difference in their boiling points is 31 K.

ACTIVITY–9.14

- Take a mixture of alcohol and water in a distillation flask.
- Fit a thermometer.
- Fit a condenser.
- 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.



EVALUATION

SECTION – 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. (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 pair of items are given below. Could you identify the correct 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 technics. Components of liquid air can be separated by adopting _____ physical method. (fractional distillation , distillation , sublimation)
6. Rusting of iron is a chemical change. The melting of ice is _____ (physical change , chemical change).

SECTION – B

7. Pure substance contains a single type of particles. Is sea water pure or not? justify.

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

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

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

11. (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.

12. A liquid 'A' has a boiling point of 353 K and another 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.

SECTION – C

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

    (a) How does a mixture differ from a compound?

    (b) What are the types of mixtures?

    (c) Write one example each for either type?

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

    (a) Why do solid substances have definite shape?

    (b) Write any two properties of a solid substance?

    (c) Will the solid substance expand on heating? Why?

FURTHER REFERENCE

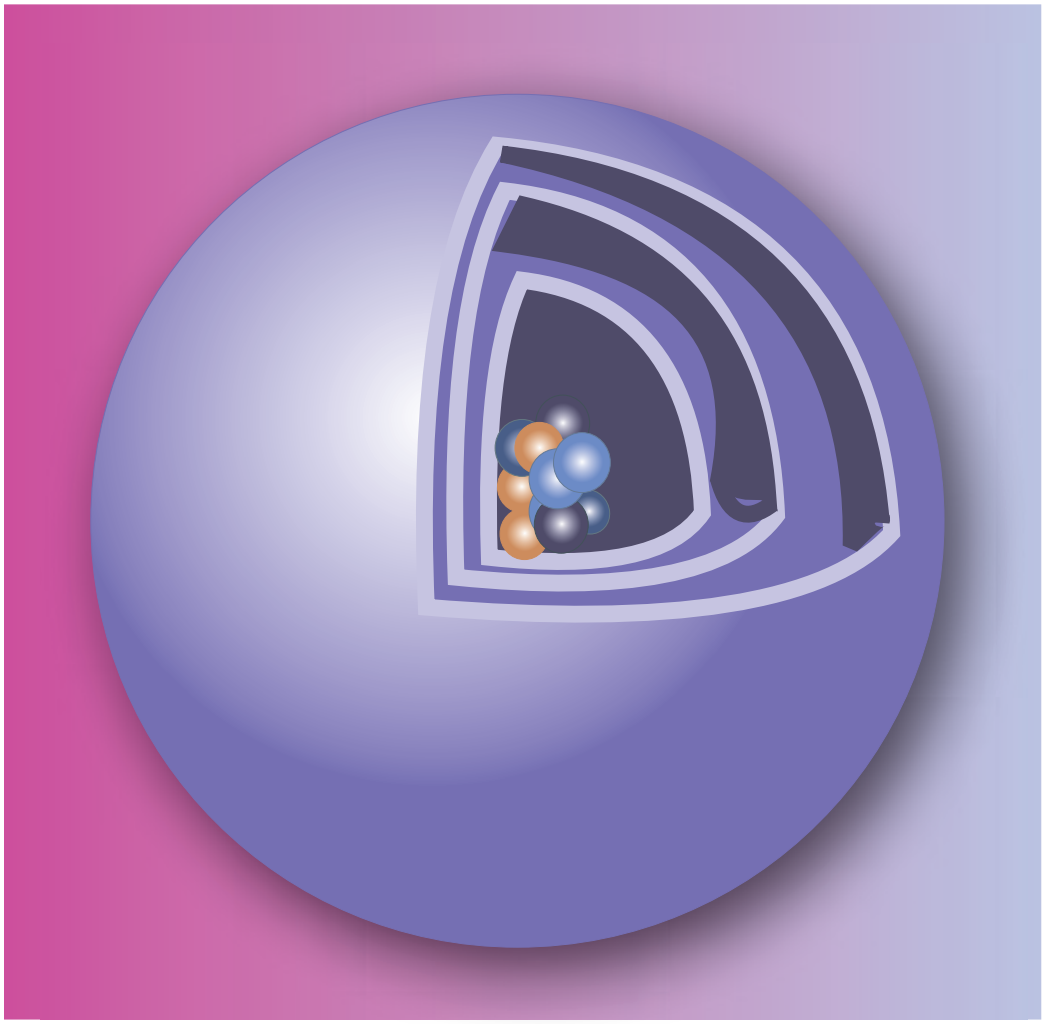
Book

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

Websites

http://www.tutorvista.com

Chapter 10



ATOMIC STRUCTURE

Take a stone. Break it into several pieces. Powder all the pieces. Each particle of powder is composed of atoms. There is no particle without atoms. Once it was believed that atoms couldnot be divided. But today scientists have revealed that each atom consists of further smallest particles. The study of internal structure of atom proves the presence of such particles.

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

10.1. DISCOVERY OF THE NUCLEUS

Rutherford's contribution

Rutherford observed what happens to 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 Nobel Prize for his contribution in structure of atom in 1908.

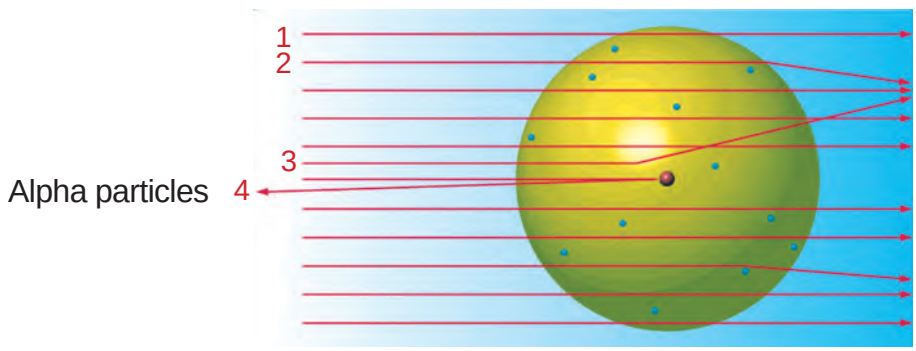
MORE TO KNOW

Alpha particles are helium ions He^{2+} .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.

10.2. 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^o .Rarely the path of 1 in 20,000 alpha particles scored a direct hit on the nucleus and returned by an angle of 180^o.

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

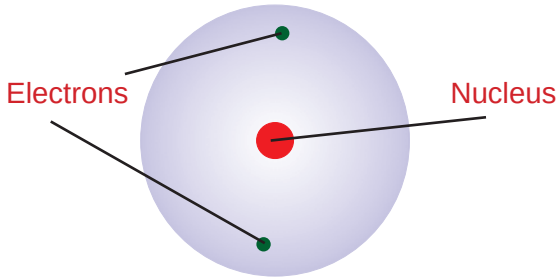


1. Not scattered at all 2. Slightly scattered 3. More scattered 4. Returned at 180^o

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

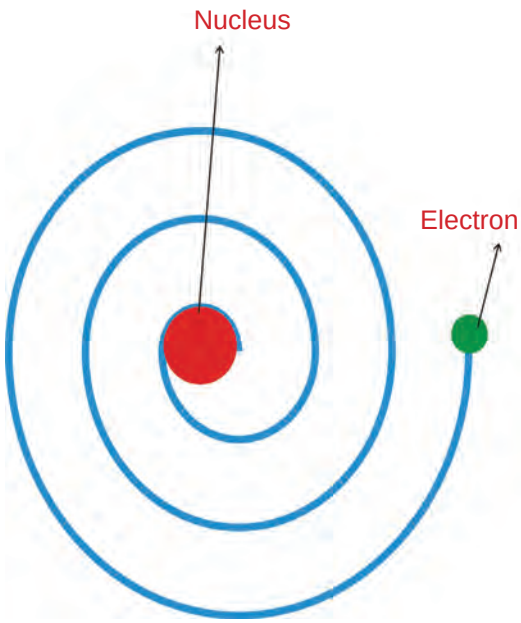
10.3. RUTHERFORD'S MODEL OF ATOM

Rutherford pictured the atom as consisting of a small, dense, positively charged nucleus containing most of the mass of the atom with the electrons in the space outside the nucleus .The moving electrons occupy most of the volume of the atom. The electrons must be moving very rapidly in the space around the nucleus.



10.3.1. LIMITATIONS

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



ACTIVITY –10.1

In Rutherford's experiment,

1.Why did majority alpha particles pass through the foil unaffected?

2.Why were very few alpha particles deflected?

3.Is the size of nucleus small or large with respect to the size of atom?

MORE TO KNOW

Remember a small boy swinging a stone on 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.

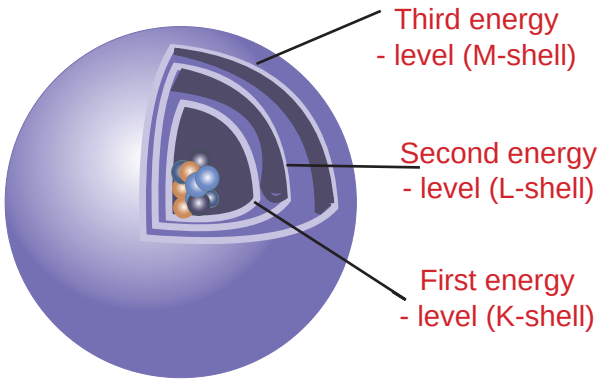
Niel's Bohr (1885 - 1962)

Niel's 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 Manchestor. Bohr's theory became the basis for modern physics known as Quantum Mechanics.Bohr received the Nobel Prize for physics in 1922.

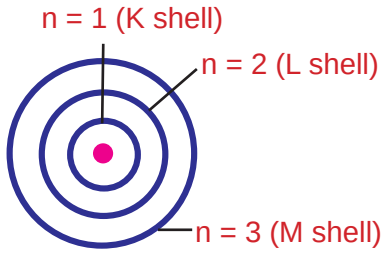
10.4. BOHR'S MODEL OF ATOM

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

- In atoms, the 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).
- Smaller the size of orbit, smaller is the energy of the orbit.
- As we move away from nucleus, energy of orbit is constantly increasing.
- Maximum number of electrons that can be accommodated in an energy level (n) is given by $2n^2$.



- 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.



Orbit

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

10.5. 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 given off. These emitted particles carried no electrical charge. Hence they were called as neutrons.

Beryllium + alpha ray ⟶ carbon + neutron

MORE TO KNOW

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

Characteristics of neutron

- Neutrons are particles with no charge.ie neutral particles.
- Neutrons are present in the nuclei of all atoms except hydrogen atom.
- 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 as isotopes of the element.
- Neutron is also regarded as a sub-atomic particle.

10.6. CHARACTERISTICS OF FUNDAMENTAL PARTICLES

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.

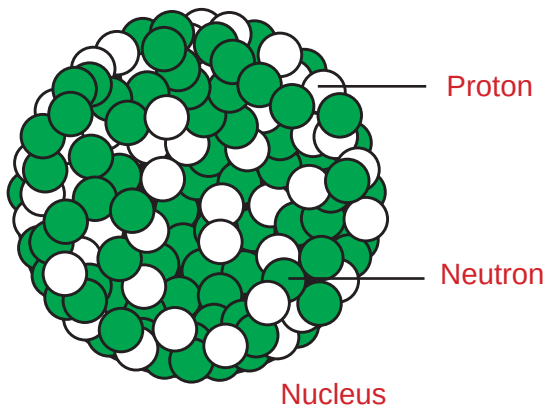
Neutrons: They are neutral particles. They are present inside the nucleus.

10.6.1. COMPOSITION OF NUCLEUS

Electrons have 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 positively charged protons and contribute to the force that holds the particles in the nucleus together.



ACTIVITY –10.2

A has 11 protons, 11 electrons & 12 neutrons.

B has 15 protons, 15 electrons & 16 neutrons.

C has 4 protons, 4 electrons & 5 neutrons.

Identify the elements A, B and C?

10.7. ATOMIC NUMBER AND MASS NUMBER

Atomic number

We know that, an atom consists of positively charged protons and negatively charged electrons. Atom as a whole is electrically neutral. It is so, due to the presence of equal number of protons and electrons. This number is referred to as atomic number.

Atomic number of an atom can be defined as,

- The number of protons in the nucleus (OR)
- The number of electrons revolving around the nucleus.

ACTIVITY –10.3

Can you write the atomic numbers of (i) Beryllium (ii) Carbon (iii) Nitrogen (iv) Neon (v) Magnesium

Mass number

We learnt that the mass of an atom entirely resides on the mass of nucleus. The mass of the lightest atom, hydrogen has been chosen as the unit of mass.Since the nucleus of an atom contains protons and neutrons, mass number (A) is defined as, the sum of the number of protons and neutrons in the nucleus of an atom

Mass Number (A) = Number of protons + Number of neutrons

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 ratio.

ACTIVITY –10.4

Complete the following table

Species	Atomic number	number of protons	number of neutrons
Boron	5		
Sodium	11		
Phosphorus	15		
Neon	10		

Representation of Atomic number and Mass number

Superscript represents mass number.

Subscript represents atomic number.

For example,

Atomic number of nitrogen is 7.
Mass number of nitrogen is 14.

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

ACTIVITY –10.5

Which elements have the same number of neutrons?

1.Lithium-${}_{3}Li^{7}$

2.Carbon-${}_{6}C^{12}$

3. Nitrogen -${}_{7}N^{14}$

4.Beryllium-${}_{4}Be^{8}$

5.Oxygen-${}_{8}O^{16}$

MORE TO KNOW

Chlorine has fractional atomic mass.

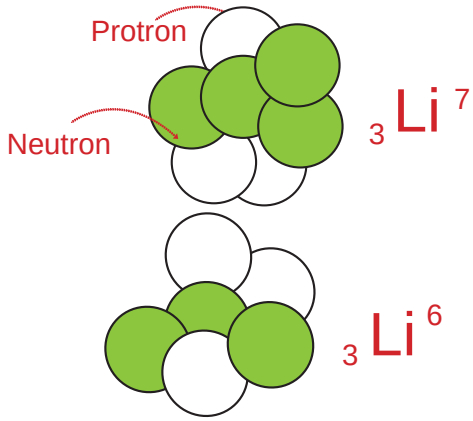
Chlorine-35 exists by 75%

Chlorine-37 exists by 25%

Average atomic mass of chlorine is,

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

10.8. ISOTOPES



Isotopes of lithium

American scientist, T.W.Richards observed to his amazement that lead from samples collected in different places differed in atomic mass. This suggested that all atoms of an element are not exactly alike. It is clear that 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 having the same atomic number.

Characteristics of isotopes

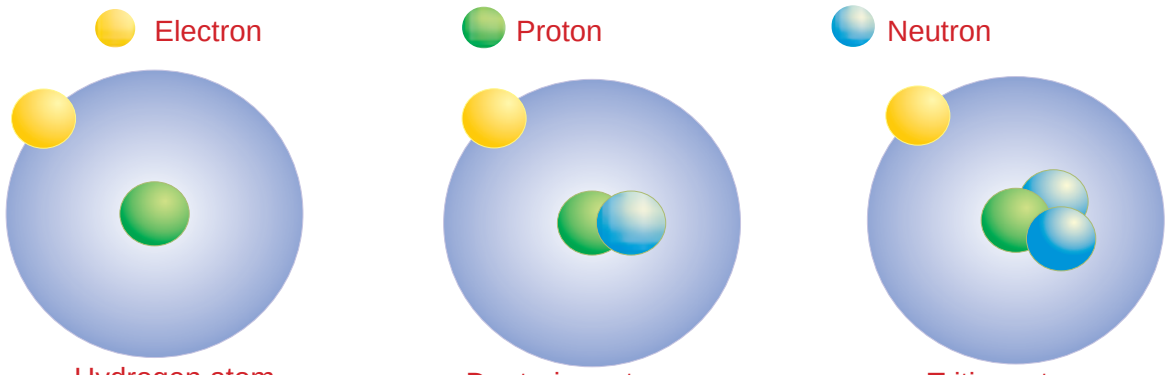
- Isotopes of an element differ in mass numbers only.
- Difference in mass number is due to difference in number of neutrons.
- Isotopes of an element have the same physical properties.
- However, variations in chemical properties are noted in isotopes.
- Elements having isotopes exhibit fractional atomic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

ACTIVITY –10.6

(i) Can you calculate the number of neutrons in the isotopes.

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

(ii) What do you infer from the result?



Hydrogen atom (Common hydrogen)

Deuterium atom (Heavy hydrogen)

Tritium atom (Radioactive hydrogen)

Element	Isotope	Representation
Hydrogen	Protium Deuterium Tritium	$_1H^1$ $_1H^2$ (or) $_1D^2$ $_1H^3$ (or) $_1T^3$
Chlorine	Chlorine-35 Chlorine-37	$_{17}Cl^{35}$ $_{17}Cl^{37}$
Carbon	Carbon-12 Carbon-14	$_6C^{12}$ $_6C^{14}$
Uranium	Uranium-235 Uranium-238	$_{92}U^{235}$ $_{92}U^{238}$

ACTIVITY –10.7

The element bromine has the following isotopes.

Bromine-79 (49.7%) and Bromine-81 (50.3%)

Can you calculate the average atomic mass of Bromine?

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 for treatment of goiter.
- Cobalt-60 isotope is used in the treatment of cancer.
- Phosphorous-32 isotope is used in eye treatment.
- Carbon-11 isotope is used in the treatment of brain scan.

ACTIVITY –10.8

From the given average atomic mass, which element does exist with least number of isotopes?

- Chlorine-35.5
- Hydrogen-1.008
- Oxygen-16.0

10.9. ELECTRONIC CONFIGURATION OF ATOMS

It is known that atoms consist of a positively charged nucleus with protons and neutrons in it. Negatively charged particles called electrons constantly revolve around the nucleus in 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 Niel's Bohr.

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

- For the first **orbit n = 1**, and the number of electrons it can hold is $\mathbf{2x1^2=2}$.
- For the second **orbit n = 2**, and it can hold a maximum of $\mathbf{2x2^2=8}$ electrons.
- For the third **orbit n = 3**, and it can hold a maximum of $\mathbf{2x3^2=18}$ electrons.

It must be understood that the second orbit begins 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.

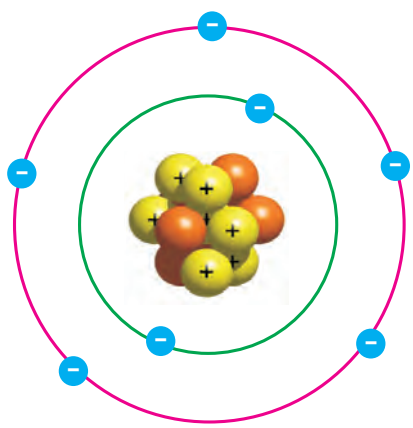
Atomic number of **sodium** = Total number of electrons in sodium = **11**

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.**

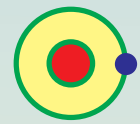
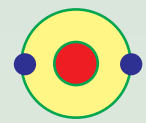
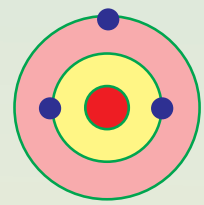
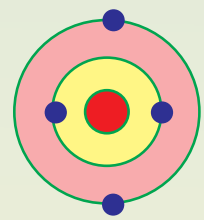
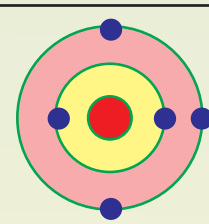
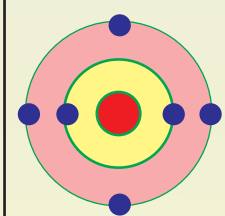
Electron distribution in nitrogen (2,5)



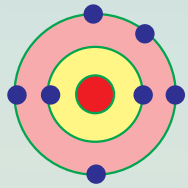
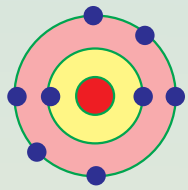
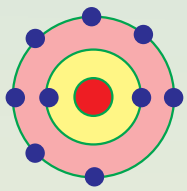
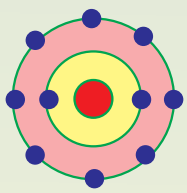
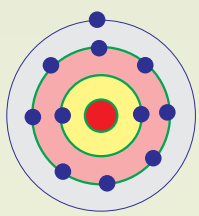
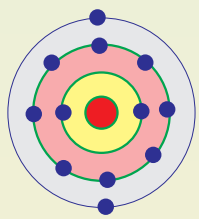
MORE TO KNOW

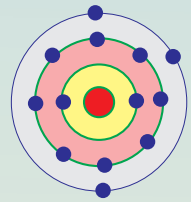
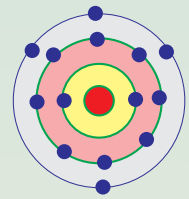
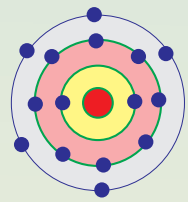
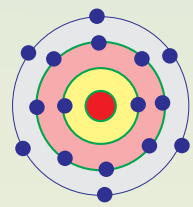
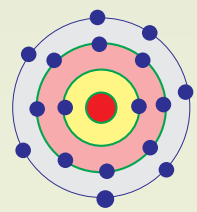
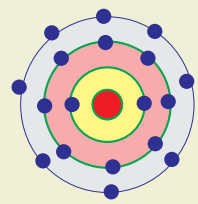
Much of the experimental evidence for electronic configuration comes from atomic spectra.

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

ACTIVITY –10.9

Write the electron distribution

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

10.9.1. 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 (electron)

(n=2) L Shell 1 (remaining electron)

Outer most 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.

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 –10.10

Calculate the valence electrons and determine the valency.

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

EVALUATION

SECTION - 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 can be present in first orbit is _____.
2. Goldstein discovered protons. It is present in the nucleus. Charge on the protons are _____ (negative, positive, neutral).
3. A subatomic particle is revolving around the nucleus in orbits. It is nagatively charged. It was discovered by J.J.Thomson. Name the particle.
4. Number of neutrons present in $_3Li^7$ is 4. Find the number of neutrons present in $_8O^{16}$ element.
5. Nucleus of an atom has two components. They are proton and _____ (neutron, electron)
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.

Element	Mass number	Number of protons	Number of neutrons
Sodium	23	?	12

7. Atomic number and mass number of $_{17}Cl^{35}$ are 17 and 35 respectively. What is the number of protons present in it?
8. _____ (Iodine – 131, Phosphorus – 32, Iron – 59) isotope is used for the treatment of goiter.
9. The electron distribution of fluorine is 2, 7. What is the valency of the element?
10. Electron distribution of sodium is 2, 8, 1. What is its valency?
11. Every atom has equal number of protons and electrons. Both are oppositively charged. Neutron is electrically neutral. What is the nature of atom?

SECTION - B

12. 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?

13. K shell of $_7N^{14}$ has 2 electrons. How many electrons are present in the L shell?
14. $_{17}X^{35}$ is a gaseous element. Its atomic number is 17. Its mass number is 35. Find out the number of electrons, protons and neutrons.

15. Many Isotopes are used in medical field.

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

b) Which one is used in eye treatment?

16. Write the electron distribution in the following elements.

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

17. Find the valence electrons and valency.

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

18 . Atoms of the same element, having same atomic number and different mass numbers are known as Isotope. Mention the names of isotopes of hydrogen.

SECTION - C

19. Name the completely filled orbits.

Element	Atomic Number	Names of completely filled orbits
Nitrogen	7	
Neon	10	
Magnesium	12	
Sulphur	16	
Argon	18	

20. Correlate the facts with properties.

(i)	More dense part of an atom	valency
(ii)	Chargeless particle	Atomic number
(iii)	Outermost orbit	nucleus
(iv)	Number of electons in outermost orbit	Valence shell
(v)	Number of protons	Neutron
		Proton

FURTHER REFERENCE

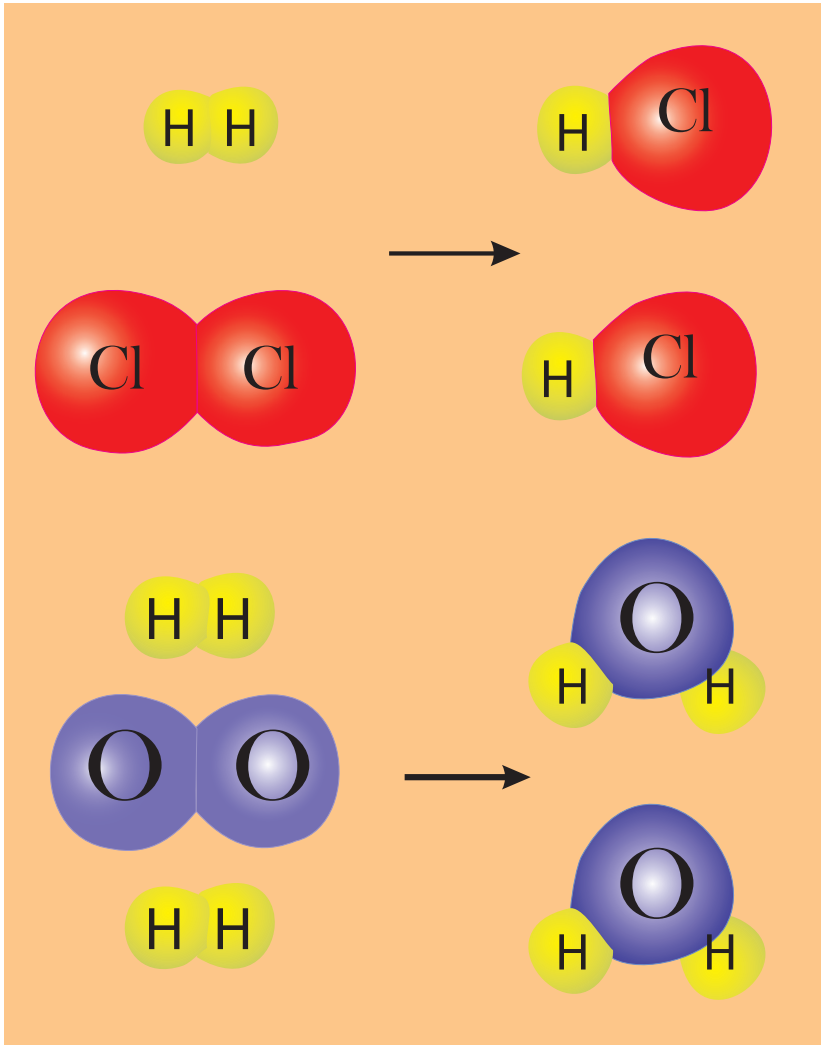
Book

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

Websites

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

Chapter 11



CHEMICAL EQUATION

11. CHEMICAL EQUATION

Plants produce their food (carbohydrate) during photosynthesis. Essential requirements for photosynthesis are (i) sunlight, (ii) carbon dioxide, (iii) water, (iv) chlorophyll. The event of photosynthesis can be represented in a short way in the form of an equation,

$$\text{Carbon dioxide + Water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Carbohydrate + Oxygen}$$

Thus, chemical equations summarise information about chemical reactions. To write a chemical equation, you must identify the substances that are present before and after reaction.

11.1. TYPES OF IONS AND RADICALS

Ions are charged particles formed by the transfer of electrons from one element to another element. When atoms of reactive metals such as sodium combine with atoms of non-metals like fluorine to form compounds, enough electrons are transferred from one atom to another so as to attain the stable electronic distribution like noble (inert) gases with closest atomic number. Because the negative charge of the electrons in an atom equals the positive charge on the nucleus, the loss of an electron leaves an ion with a positive charge.

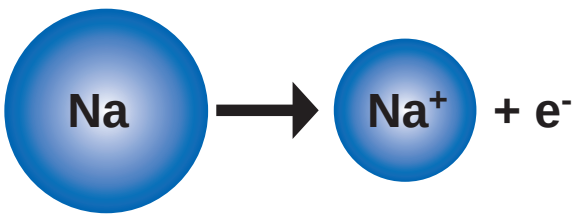
Formation of sodium ion from sodium atom

Atomic number of sodium is 11 and sodium atom has 11 electrons outside its nucleus. The inert gas closest to sodium is neon with atomic number 10. Hence, to get the same number of electrons as a neon atom, a sodium atom must lose one electron. Because atoms are electrically neutral, loss of one electron leaves a sodium ion with a +1 charge.

Sodium atom loses one electron

It is shown as

$$\underset{\substack{\text{(Sodium atom)}\\ \text{11 protons \&}\\ \text{11 electrons}}}{Na} \longrightarrow \underset{\substack{\text{(Sodium ion)}\\ \text{11 protons \&}\\ \text{10 electrons}}}{Na^+ + e^-}$$



Positively charged ions, such as Na^+ are called **cations**. **Metals usually form cations.**

Formation of fluoride ion from fluorine atom

Non-metals usually gain electrons when they form ions. Fluorine is a non-metal. Atomic number of fluorine is 9. The inert gas that has an atomic number closest to 10 is neon, with atomic number 10. To get the same number of electrons as a neon atom, a fluorine atom must gain one electron. Since, atoms are electrically neutral, a gain of one electron gives a fluoride ion with a -1 charge.

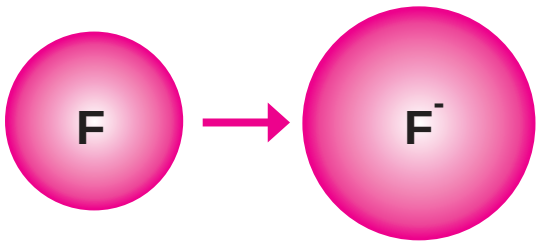
Fluorine gains one electron

It is shown as

$F + e^- \longrightarrow F^-$

(Fluorine atom) 9 protons & 9 electrons

(Fluoride ion) 9 protons & 10 electrons



Negatively charged ions such as F^- are called anions. Nonmetals usually form anions.

Mono atomic ions

Mono atomic ions are formed from one atom.

Sodium ion (Na^+) is a mono atomic cation.

Fluoride ion (F^-) is a mono atomic anion.

Polyatomic ions

A poly atomic ion is a charged particle formed from more than one atom. These are group of atoms of different elements which behave as single units, and are known as polyatomic ions.

Consider the compound, sodium sulphate. It is made up of two parts, namely sodium and sulphate. The sodium found as a part of sodium sulphate compound is not sodium atom but it is sodium ion and sulphate is radical.

MORE TO KNOW

You cannot say how many cations and anions are found in a compound simply from the name.

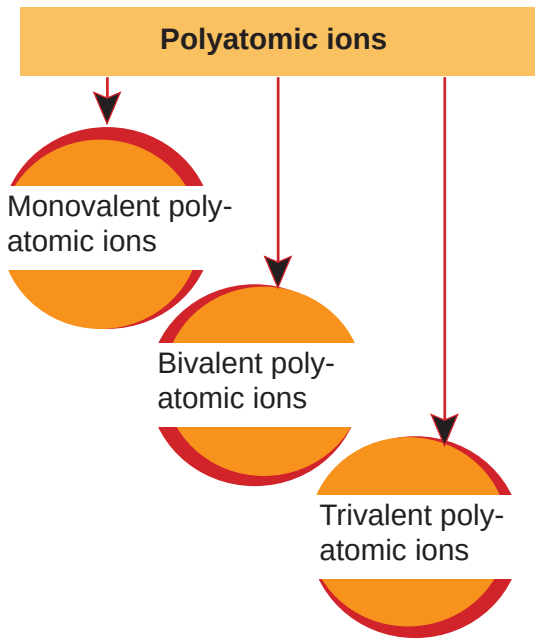
ACTIVITY –11.1

Write the formulas of the following mono atomic anions.

1. Bromide ion
2. Chloride ion
3. Fluoride ion
4. Hydride ion
5. Iodide ion
6. Oxide ion
7. Nitride ion
8. Sulphide ion

MORE TO KNOW

The names of most mono atomic negative ions end with suffix “ide”.



Radical

A radical is defined as a positively or negatively charged monoatomic ion or polyatomic ion.

The compound sodium sulphate may be thought of as the product obtained when the base sodium hydroxide reacts with sulphuric acid.

Sodium hydroxide + Sulphuric acid ⟶ Sodium sulphate + water

In the compound sodium sulphate, sodium is called the basic radical, because it comes from the base sodium hydroxide and sulphate is called the acid radical because it comes from sulphuric acid.

MORE TO KNOW

Compounds that contain polyatomic ions are ionic in nature

Monovalent polyatomic ions

Name	Formula
Bisulphate ion	HSO_4^-
Bisulphite ion	HSO_3^-
Chlorate ion	ClO_3^-
Chlorite ion	ClO_2^-
Cyanide ion	CN^-
Hydroxide ion	OH^-
Hypochlorite ion	ClO^-
Nitrate ion	NO_3^-
Nitrite ion	NO_2^-
Perchlorate ion	ClO_4^-
Permanganate ion	MnO_4^-

Bivalent polyatomic ions

Name	Formula
Carbonate ion	CO_3^{2-}
Chromate ion	CrO_4^{2-}
Dichromate ion	$Cr_2O_7^{2-}$
Manganate ion	MnO_4^{2-}
Peroxide ion	O_2^{2-}
Sulphate ion	SO_4^{2-}
Sulphite ion	SO_3^{2-}
Thiosulphate ion	$S_2O_3^{2-}$

Trivalent polyatomic ions

Name	Formula
Borate ion	BO_3^{3-}
Phosphate ion	PO_4^{3-}

ACTIVITY –11.2

Identify and write cations and anions in the following compounds.

1. Silver nitrate
2. Magnesium sulphate
3. Aluminium oxide
4. Lead nitrate
5. Potassium carbonate
6. Barium chloride
7. Zinc sulphate
8. Copper nitrate

MORE TO KNOW

Ammonium ion is a polyatomic monovalent cation.It is represented by NH_4^+

ACTIVITY –11.3

Identify the polyatomic ions

1.Chloride ion
2.Chlorite ion
3.Oxide ion
4.Hydroxide ion
5.Phosphide ion
6.Phosphate ion

Multivalent cations or polyvalent cations

Formula	Name	Formula	Name
Au^{+}	Gold (I) or Aurous	Au^{3+}	Gold (III) or Auric
Ce^{3+}	Cerium (III) or Cerous	Ce^{4+}	Cerium (IV) or Ceric
Co^{2+}	Cobalt (II) or Cobaltous	Co^{3+}	Cobalt (III) or Cobaltic
Cr^{2+}	Chromium (II) or Chromous	Cr^{3+}	Chromium (III) or Chromic
Cu^{+}	Copper (I) or Cuprous	Cu^{2+}	Copper (II) or Cupric
Fe^{2+}	Iron (II) or Ferrous	Fe^{3+}	Iron (III) or Ferric
Mn^{2+}	Manganese (II) or Manganous	Mn^{3+}	Manganese (III) or Manganic
Pb^{2+}	Lead (II) or Plumbous	Pb^{4+}	Lead (IV) or Plumbic
Sn^{2+}	Tin (II) or Stannous	Sn^{4+}	Tin (IV) or Stannic

ACTIVITY –11.4

Write the names of following cations.

(i) Fe^{2+} (ii) Hg^{+}

(iii) Fe^{3+} (i) Hg^{2+}

MORE TO KNOW

A molecule formed by combination or association of two molecules is known as a dimer.

Hg_2^{2+} Mercurous ion exists as a dimer only.

Chemical symbols and valencies

Valency = 1	Valency = 2	Valency = 3	Valency = 4
Bromine (Br)	Barium (Ba)	Boron (B)	Carbon (C)
Chlorine (Cl)	Calcium (Ca)	Aluminium (Al)	Silicon (Si)
Fluorine (F)	Magnesium (Mg)		
Hydrogen (H)	Oxygen (O)		
Iodine (I)	Sulphur (S)		
Lithium (Li)			
Sodium (Na)			
Potassium (K)			

MORE TO KNOW

Most of the polyatomic names end with suffixes “-ite”,”-ate”.

11.2. LEARNING TO WRITE CHEMICAL SYMBOLS AND CHEMICAL FORMULAE BY CRISSCROSSING VALENCIES

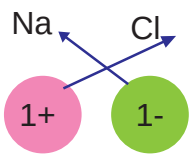
Chemical formula of the compound is the symbolic representation of its composition. To write chemical formula of a compound, symbols and valencies of constituent elements must be known. The valency of atom of an element can be thought of as hands or arms of that atom.

Writing a chemical formula

- The symbols or formulas of the component radicals of the compound are written side by side.
- Positive radicals are written left and negative radicals on the right.
- The valencies of the radicals are written below the respective symbols.
- The criss-cross method is applied to exchange the numerical value of valency of each radical. It is written as subscript of the other radical.
- The radical is enclosed in a bracket and the subscript is placed outside the lower right corner.
- The common factor is removed.
- If the subscript of the radical is one, it is omitted.

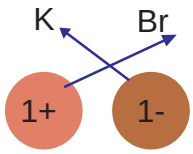
ILLUSTRATIONS

1. Sodium chloride



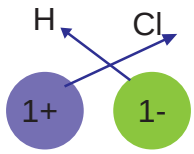
$NaCl$

2. Potassium bromide



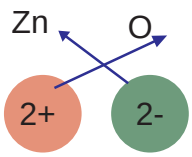
KBr

3. Hydrogen chloride



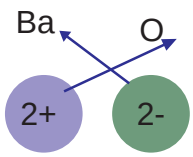
HCl

4. Zinc oxide



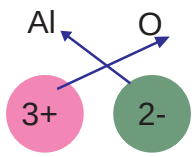
ZnO

5. Barium oxide



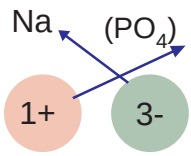
BaO

6. Aluminium oxide



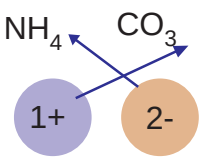
Al_2O_3

7. Sodium phosphate



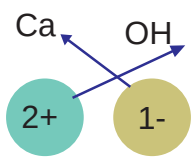
Na_3PO_4

8. Ammonium carbonate



$(NH_4)_2CO_3$

9. Calcium hydroxide



$Ca(OH)_2$

Common Greek Prefixes

Prefix	Number
Mono -	1
Di -	2
Tri -	3
Tetra -	4
Penta -	5
Hexa -	6
Hepta -	7
Octa -	8
Nona -	9
Deca -	10

ACTIVITY –11.5

Write the chemical formula of the following compounds.

1. Sodium hydroxide
2. Sodium carbonate
3. Calcium hydroxide
4. Ammonium sulphate
5. Phosphorous trichloride
6. Sulphur hexafluoride
7. Copper (II) nitrate
8. Cobalt (II) chloride

MORE TO KNOW

Of over 13 million compounds known, 91% of them contain carbon.

1 million = Thousand thousands = (10 lakh)

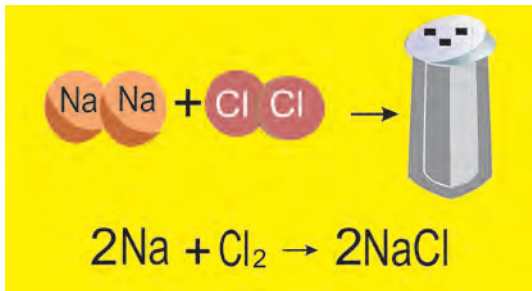
11.3. INTRODUCTION TO WRITE CHEMICAL REACTIONS

The first reaction known to be carried out by humans was combustion (burning). Combustion is the rapid reaction of materials with oxygen. Both heat and light are usually given off during combustion.

Fig: Combustion Reaction

The symbolic expression of a chemical reaction using symbols of reactants and products is called a chemical equation.

- Reactants are the substances that are present before a reaction takes place.
- Products are the substances that are formed in a reaction.
- The arrow sign means “react to form”.
- The plus sign means “and”.
- Any special conditions needed to make the reaction to take place are written above or below the arrow mark.



Thus, chemical equation is a short hand method of representing a chemical change.

The rules for naming inorganic compounds are summarized as,

Inorganic Compounds

Metal – Non-metal compounds

With one cation

Rule: Name of metal
+
Name of anion

Example:

Aluminium oxide (Al_2O_3)
Barium chloride ($BaCl_2$)
Calcium carbonate ($CaCO_3$)
Magnesium sulphate ($MgSO_4$)
Sodium nitrate ($NaNO_3$)

With more than one cation

Rule: Show cations with Roman numerals

Example:

Copper (I) oxide (Cu_2O)
Copper (II) oxide (CuO)
Iron (II) chloride ($FeCl_2$)
Iron (III) chloride ($FeCl_3$)
Tin (II) oxide (SnO)
Tin (IV) oxide (SnO_2)

Nonmetal – Non-metal compounds

Rule :

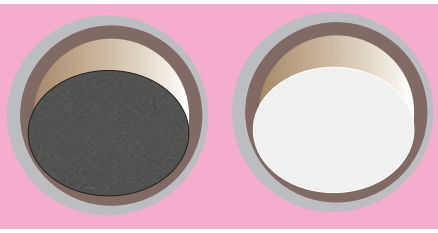
(i) Elements in left of the periodic table first.

(ii) If both elements are from the same group, lower one first.

(iii) Use Greek prefixes to show the number of atoms.

Example:

Carbon monoxide (CO)
Carbon dioxide (CO_2)
Sulphur dioxide (SO_2)
Sulphur trioxide (SO_3)



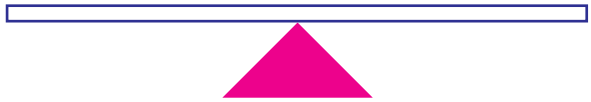
White – Tin (IV) oxide (SnO_2)
Black - Tin (II) oxide (SnO)

11.4. BALANCING THE CHEMICAL EQUATION

1. Identify reactants and products and write the equation in sentences.
2. Write symbols for elements and formulae for compounds.
3. Balance by changing coefficients in front of the symbols and formulae.
4. Do not change formulae or add or remove substances.
5. Check to be sure whether the same number of each kind of atom is shown on both sides.
6. If the coefficients have a common divisor, simplify.
7. If the product formed is a precipitate (solid separates from solution), use a downward arrow mark (↓).
8. If the product formed is gas, an upward arrow mark (↑) is used.

Balancing of chemical equations

$2H_2 + O_2 \longrightarrow 2H_2O$



It involves the following steps

1. Write the skeleton equation with correct formula of reactants and products.
2. Count the number of atoms of various elements on both the sides of the sign of equality and make them equal on both sides by multiplying the formulae by a suitable integer.
3. In case of diatomic gases appear as reactants or products; balance the equation by keeping the gases in atomic form.

Example 1: Reaction between Iron and Chlorine

Skeleton equation : $Fe + Cl_2 \longrightarrow FeCl_3$

Balance Cl atom : $Fe + 3Cl_2 \longrightarrow 2FeCl_3$

Balance Fe atom : $2Fe + 3Cl_2 \longrightarrow 2FeCl_3$

Example 2: Reaction of Sodium Carbonate with Hydrochloric acid

Skeleton equation : $Na_2CO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$

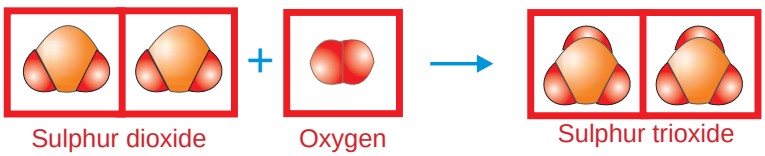
Balance sodium atom: $Na_2CO_3 + HCl \longrightarrow 2NaCl + H_2O + CO_2$

Balance hydrogen, chlorine and oxygen atoms:

$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

Balanced equations : Illustration 1

Reaction between sulphur-di-oxide and oxygen to form sulphur-tri-oxide:



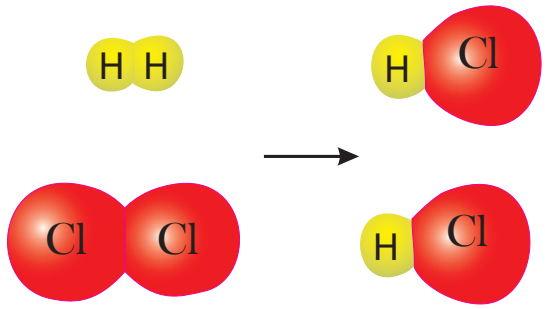
$2SO_2 + O_2 \longrightarrow 2SO_3$

ACTIVITY –11.6

Take 3ml of sodium hydroxide in a test tube. Add 5 ml of dilute hydrochloric acid. Name the salt formed. Write a balanced chemical equation

Illustration : 2

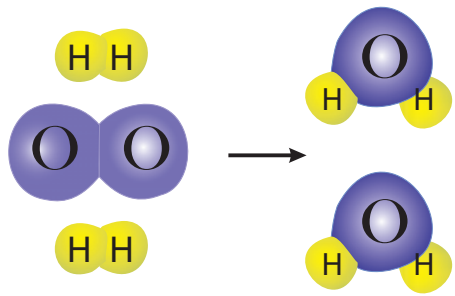
Reaction between hydrogen and Chlorine to form Hydrogen Chloride:



$H_2 + Cl_2 \longrightarrow 2HCl$

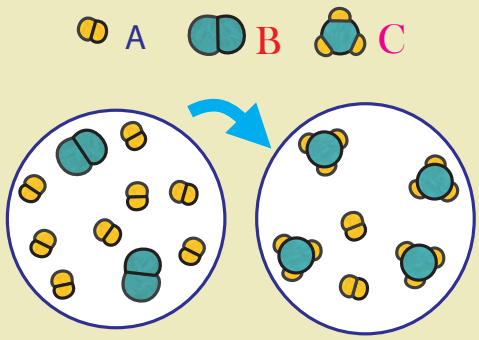
Illustration : 3

Reaction between hydrogen and oxygen to form water:



$2H_2 + O_2 \longrightarrow 2H_2O$

ACTIVITY –11.7



From the diagram write the equation for the reaction between A and B to give the product C.

ACTIVITY –11.8

Balance the chemical equations.

1. $N_2 + O_2 \longrightarrow NO$
2. $CaCO_3 + HCl \longrightarrow CaCl_2 + H_2O + CO_2$
3. $Na + H_2O \longrightarrow NaOH + H_2$
4. $KClO_3 \longrightarrow KCl + O_2$
5. $N_2 + H_2 \longrightarrow NH_3$
6. $NH_3 + O_2 \longrightarrow N_2 + H_2O$

MORE TO KNOW

Most of the reactions take place in aqueous solutions. Example: All biological reactions,many geological processes, industrial reactions, including most of the reactions carried out in chemistry laboratory.

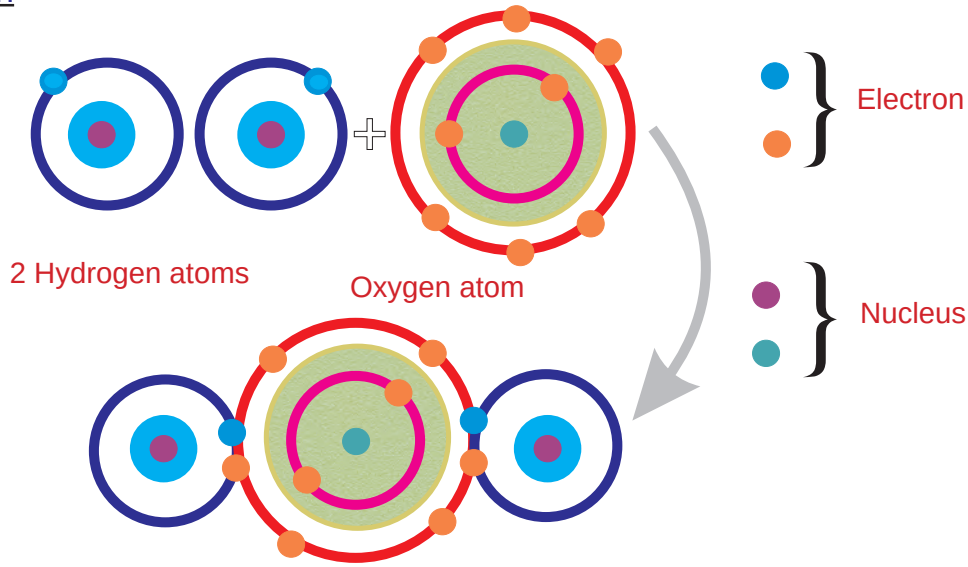
11.5. INFORMATIONS CONVEYED BY CHEMICAL EQUATIONS

- Reactants and products.
- Number of molecules.
- Number of moles.
- Relative masses.
- Relative volume.

11.6. INFORMATIONS NOT CONVEYED BY CHEMICAL EQUATIONS.

- Nature of reactants and products.
- Heat changes.
- Reaction condition.
- Concentration.
- Time factor.
- Isotopes.

Illustration



$2H_2 + 0_2 \longrightarrow 2H_20$

The above balanced equation provides the following informations

(i) Reactants and products

In this reaction, hydrogen and oxygen are reactants and water is the product obtained.

(ii) Number of molecules

The equation shows that two hydrogen molecules and one oxygen molecule combine to form two molecules of water. The two molecules of water are made up of four hydrogen atoms and two oxygen atoms all together.

(iii) Number of moles

The relative number of moles of hydrogen, oxygen and water are in the ratio 2:1:2.

(iv) Relative masses

The relative masses of hydrogen, oxygen and water are in the ratio 4:32:36 which is equal to 1:8:9.

(v) Relative volumes

The relative volumes of hydrogen, oxygen and water are in the ratio 2:1:2.

The following informations are not conveyed by the chemical equation

(i) Nature of reactants and products

This equation does not convey any information about the physical states of hydrogen, oxygen and water.

(ii) Heat changes

A chemical reaction is always accompanied by heat changes. Such an information is not conveyed.

(iii) Reaction conditions

The favourable conditions of temperature and pressure to carry out the reaction are not mentioned.

(iv) Concentrations

The concentrations of hydrogen, oxygen and water are not furnished.

(v) Time factor

The time required for completion of the reaction is not specified.

(vi) Isotopes

There is no particular information about the isotopes of the elements hydrogen and oxygen.

Know the occurrence of natural chemical reaction

Some chemical reactions take place naturally during lightening. Nitrogen in the atmosphere combine with oxygen to form nitrogen di oxide.

$$N_2 + 2O_2 \longrightarrow 2NO_2$$

Oxygen present in the atmosphere is converted to ozone.

$$3O_2 \longrightarrow 2O_3$$

This acidic oxide like nitrogen di oxide mixes with tiny droplets of water vapour to produce acid rain which is harmful to plants.

EVALUATION

Section A

Choose the correct answer

1. Sodium atom is electro positive in nature. Atomic number of sodium is 11. Then number of electrons in sodium ion is _____ (9,10,12)
2. If an atom undergoes loss of electron it becomes electro positive ion. Number of electrons lost by Fe^{2+} ion is _____ (2,3,0)
3. A chemical compound contains acid radical and basic radicals. The basic radical present in zinc sulphate compound is _____ (Zinc ion, Sulphate ion, both)
4. A polyatomic ion is a charged particle formed from more than one atom. Identify the polyatomic ion from the following

   Cl^- , O^{2-} , Na^+ , NH_4^+
5. An electronegative ion is formed by gaining of electrons. Select the mono atomic anions from the following

   CN^- , PO_4^{3-} , I^- , NO_2^-

6. An ion is produced as a result of gain or loss of electrons by an atom.

   In Au^{3+} ion, 3 electrons are _____. (gained, lost)

7. Reactants are the substances that are present before the chemical reaction takes place.

   $2Fe + 3Cl_2 \longrightarrow 2FeCl_3$. Name the reactants

8. A chemical formula is a symbolic representation of the constituents of a compound.

   Pick out the correct chemical formula of sodium carbonate.

   $Na_2(CO_3)_2$, $2NaCO_3$, Na_2CO_3

9. Valency of sodium is 1. Valency of chlorine is 1. Write the formula of sodium chloride.

10. The number of atoms of the reactants and products of various elements on both side are equal in a balanced chemical equation. Balance the following equation.

    $N_2 + H_2 \longrightarrow NH_3$

Section B

11. $Na \longrightarrow Na^+ + e^-$

    $Cl + e^- \longrightarrow Cl^-$

    a) Is sodium a metal or non-metal?

    b) Write the name of Cl^- ion.

12. A compound is formed by the combination of both acid and basic radicals. Mention the acid radical in the following compounds.

    a) K_2CO_3 b) $BaCl_2$

13. Match:

Cl^-	-	polyatomic anion
Cr^{2+}	-	monoatomic anion
NH_4^+	-	monoatomic cation
PO_4^{3-}	-	polyatomic cation

14. Name the anions present in the following compounds.

    a) NaCl b) KNO_3

15. Pickout the odd one

    a) NO_3^-, NO_2^-, MnO_4^-, Cl^-

    b) $BaCl_2$, $NaNO_3$, $MgSO_4$, Cu_2O

16. The given sentences are wrong. Correct the mistakes wherever necessary and write the correct sentences.

    a) Change the formulae wherever necessary.

    b) If the product formed is a precipitate, use upward arrow mark (↑).

17. Pick up the poly atomic anions from the following.

    Chloride ion, Fluoride ion

    Phosphate ion Sulphate ion

18. Atomic number of fluorine is 9. It becomes fluoride ion, after gaining an electron. Give the reason for its acceptancy nature of electron.

19. Valency of Zn is 2

    Valency of Oxygen is 2

    Construct the formula for zinc oxide by using the above hints.

20. Formula of Aluminium oxide is Al_2O_3. Find the valency of Aluminium and Oxygen.

Section – C

21. The formula of a compound formed between silicon and Oxygen is SiO_2. Predict the formula of the compound formed between

    (i) Carbon and Oxygen

    (ii) Silicon and Chlorine

    (iii) Carbon and Sulphur

    (iv) Calcium and Nitrogen

    (v) Aluminium and Fluorine

22. Identify the elements and compounds

    (i) Br_2 (ii) HF (iii) P_4 (iv) NH_3 (v) S_8

FURTHER REFERENCE

Book

General Chemistry - Jean B. Umland & Jon.M.Bellama
West publishing company

Websites

http://www.visionlearning.com

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Chapter 12

PERIODIC CLASSIFICATION OF ELEMENTS

12. PERIODIC CLASSIFICATION OF ELEMENTS

In a fruit shop, there are different types of fruits. Are they kept in a heap?

They are arranged in a proper way. The stacking of fruits in the fruit stall involves

(i) types of fruits, (ii) their size, (iii) colour.

This type of arrangement is called classification. Similarly, in chemistry hundreds of elements have been discovered. It is necessary to classify them on the basis of some properties, which makes us useful to refer an element easily.

History of Periodic Table

More than one hundred elements, are known today. Inorder to track so many elements in a logical and semantic way, scientists studied many properties of elements. There are groups of elements having similar physical and chemical properties. For example, sodium vigorously reacts with water. Similarly, potassium also vigorously reacts with water. In addition, sodium and potassium are silvery white metals and are very soft. A similar prediction can be made about rubidium and cesium. Attempts have been made from time to time to classify the elements on the basis of their physical and chemical properties. This resulted in the concept called 'periodicity'.

12.1 EARLY ATTEMPTS OF CLASSIFICATION OF ELEMENTS

Lavoisier's classification of elements

In 1789, Lavoisier first attempted to classify the elements into two divisions namely Metals and Non-metals. However this classification was not satisfactory as there were many exceptions in each category.

Dobereiner's classification of elements

In 1817, Johann Wolfgang Dobereiner grouped three elements into what he termed triads.

In each case, the middle element has an atomic mass almost equal to the average atomic masses of the other two elements in the triad.

Chemically alike elements could be arranged in a group of three in which the atomic mass of the middle element was approximately the arithmetic mean of the two extreme elements.

For example, elements like lithium, sodium and potassium have atomic masses 7, 23 and 39 respectively. They are grouped together into a triad as,

Li (7)	Na (23)	K (39)

Note that the atomic mass of sodium is the average of atomic masses of lithium and potassium.

Limitation of Dobereiner's law

Only a limited number of elements could give such triads and this law failed to accommodate other elements resembling a lot with triads.

ACTIVITY –12.1

Element	Atomic Mass
Calcium	40
Strontium	88
Barium	137
Chlorine	35.5
Bromine	80.0
Iodine	127.0

Arrange the above elements in two groups of triads.

Newland's classification of elements

In 1863, John Newland suggested another classification of elements. He arranged the elements in the order of their increasing atomic masses. He noted that there appeared to be a repetition of similar properties in every eighth element. Therefore he placed seven elements in each group. He then arranged the 49 elements known at that time into seven groups of seven each. Newland referred to his arrangement as the Law of octaves.

If elements be arranged in ascending order of their atomic masses then every eighth element was a kind of repetition of the first one either succeeding or preceding it like eighth note in octave of music.

For example,

Note	1 (Sa)	2 (re)	3 (ga)	4 (ma)	5 (pa)	6 (dha)	7 (ni)
Element	Li	Be	B	C	N	O	F
	Na	Mg	Al	Si	P	S	Cl
	K	Ca	Cr	Ti	Mn	Fe	-

Note: Sodium is similar to Lithium.

Similarly Magnesium is similar to Beryllium.

ACTIVITY –12.2

Write the name of element with similar properties	
Element	**Element with similar property**
Aluminium	
Silicon	
Phosphorous	
Sulphur	
Chlorine	

Periodicity is the recurrence of similar physical and chemical properties of elements when arranged in a particular order.

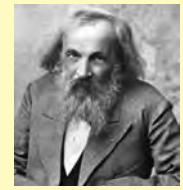
Limitations of Newland's classification

At that time inert gases were not discovered. Later, with the inclusion of inert gas, 'Neon' between 'Fluorine' and 'Sodium', it was the 9th element which became similar to the first. Similarly inclusion of inert gas 'Argon' between 'Chlorine' and 'Potassium' also made it the 9th element similar to the first.

Lothar Meyer's classification of elements

In 1864, Lothar Meyer plotted atomic weight against atomic volume of various elements. He found that elements with similar properties and valency fell under one another. However, this also could not give the better understanding.

Mendeleev, a Russian chemist who was the first to propose that the seemingly different chemical elements can be sorted out according to certain similarities in their properties. The arrangement he proposed is called the periodic table. His table proved to be a unifying principle in chemistry and led to the discovery of many new chemical elements.



Mendeleev (1834-1907)

12.2 MENDELEEV'S PERIODIC TABLE

Groups	I	II	III	IV	V	VI	VII	VIII
Oxide : Hydride:	R_2O RH	RO RH_2	R_2O_3 RH_3	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4
Periods	A B	A B	A B	A B	A B	A B	A B	Transition Series
1	H 1.008							
2	Li 6.941	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	
3	Na 22.99	Mg 24.31	Al 26.98	Si 28.09	P 30.97	S 32.06	Cl 35.453	
4 First Series	K 39.10	Ca 40.08	--	Ti 47.90	V 50.94	Cr 52.20	Mn 54.94	Fe 55.85 Co 58.93 Ni 58.69
Second Series	Cu 63.55	Zn 65.39	--	--	As 74.92	Se 78.96	Br 79.90	
5 First Series	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc 98	Ru 101.07 Rh 102.9 Pd 106.4
Second series	Ag 107.87	Cd 112.41	In 114.82	Sn 118.71	Sb 121.76	Te 127.90	I 126.90	
6. First series	Cs 132.90	Ba 137.34	La 138.91	Hf 178.49	Ta 180.95	W 183.84	--	Os 190.2 Ir 192.2 Pt 195.2
Second series	Au 196.97	Hg 200.59	Tl 204.38	Pb 207.2	Bi 208.98			

Fig: Mendeleev's Periodic Table
("R" is used to represent any of the elements in a group)

12.3 MENDELEEV'S CLASSIFICATION OF ELEMENTS

The first successful arrangement of elements was done in 1869 by Russian chemist Dimitri Ivanovich Mendeleev.Mendeleev published a periodic table of elements on the basis of a law called mendeleev's periodic law which states that,

"The physical and chemical properties of elements are the periodic functions of their atomic masses".

ACTIVITY –12.3

Name the elements missing in the Mendeleev's periodic table with atomic masses 44, 68 and 72.To which group do they belong? Is there any group for noble gases?

Characteristics of Mendeleev's Periodic table

- Mendeleev felt that similar properties occurred after periods (horizontal rows) of varying length.
- Mendeleev made an eight-column table of elements.
- He had to leave some blank spaces in order to group all the elements with similar properties in the same column.
- Mendeleev suggested that there must be other elements that had not been discovered.
- He predicted the properties and atomic masses of several elements that were known at that time. Later on, when these elements were discovered their properties remarkably agreed with the predicted one.

For example, He left a gap below silicon in group IV A, and called the yet-undiscovered element as 'Eka silicon'. Discovery of 'Germanium' during his life time proved him correct.

Property	Mendeleev's prediction in 1871	Actual property of Germanium discovered in 1886
1.Atomic Mass	About 72	72.59
2.Specific gravity	5.5 g cm^{-3}	5.47 g cm^{-3}
3.Colour	Dark grey	Dark grey
4.Formula of oxide	EsO_2	GeO_2
5.Nature of chloride	$EsCl_4$	$GeCl_4$

- Similarly Scandium for 'eka-boron' and Gallium for 'eka-aluminium' vacancies were later discovered during his life time.
- Eight out of ten vacant spaces left by Mendeleev were filled by the discovery of new elements.
- Incorrect atomic masses of some arranged elements were corrected. For example, atomic mass of Beryllium as corrected from 13 to 9.

ACTIVITY –12.4

Write down the names of elements belonging to I and II groups in Mendeleev's periodic table.

Group	IA	IB	IIA	IIB
Elements				

ACTIVITY –12.5

Using Mendeleev's periodic table, write the formula of oxides of

1.Lithium, 2. Boron, 3.Sodium, 4.Beryllium, 5. Calcium.

MORE TO KNOW

The difficulty in the Mendeleev's periodic table is overcome by introduction of Modern periodic table. It is also known as Long form of periodic table. In this table, properties of elements are dependent on their electronic configurations (distributions). Hence, modern periodic law is defined as the properties of elements are the periodic function of their atomic numbers.

Groups↓ Periods →	I A B	II A B	III A B	IV A B	V A B	VI A B	VII A B	VIII			0 (ZERO)
1	1.008 H 1										4.003 He 2
2	6.941 Li 3	9.012 Be 4	10.81 B 5	12.011 C 6	14.007 N 7	15.999 O 8	18.998 F 9				20.18 Ne 10
3	22.99 Na 11	24.31 Mg 12	26.98 Al 13	28.09 Si 14	30.97 P 15	32.06 S 16	35.45 Cl 17				39.95 Ar 18
4	39.10 K 19	40.08 Ca 20	44.96 Sc 21	47.90 Ti 22	50.94 V 23	52.20 Cr 24	54.94 Mn 25	55.85 Fe 26	58.93 Co 27	58.69 Ni 28	83.90 Kr 36
	63.55 Cu 29	65.39 Zn 30	69.72 Ga 31	72.61 Ge 32	74.92 As 33	78.96 Se 34	79.90 Br 35				
5	85.47 Rb 37	87.62 Sr 38	88.91 Y 39	91.22 Zr 40	92.91 Nb 41	95.94 Mo 42	98 Tc 43	101.07 Ru 44	102.91 Rh 45	106.4 Pd 46	131.30 Xe 54
	107.87 Ag 47	112.41 Cd 48	114.82 In 49	118.71 Sn 50	121.76 Sb 51	127.90 Te 52	126.90 I 53				
6	132.9 Cs 55	137.34 Ba 56	138.9 La* 57	178.49 Hf 72	180.97 Ta 73	183.84 W 74	186.2 Re 75	190.2 Os 76	192.2 Ir 77	195.2 Pt 78	222 Rn 86
	196.97 Au 79	200.59 Hg 80	204.38 Tl 81	207.20 Pb 82	208.98 Bi 83	209 Po 84	210 At 85				
7	223 Fr 87	226 Ra 88	227 Ac** 90								

6	* Lanthanides	140.12 Ce 58	140.91 Pr 59	144.2 Nd 60	145 Pm 61	150.4 Sm 62	152.0 Eu 63	157.3 Gd 64	158.9 Tb 65	162.5 Dy 66	164.9 Ho 67	167.3 Er 68	168.9 Tm 69	173.0 Yb 70	174.9 Lu 71
7	** Actinides	232.04 Th 90	231 Pa 91	238.02 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	252 Es 99	257 Fm 100	258 Md 101	259 No 102	260 Lr 103

Fig: Modified Mendeleev's periodic table

Characteristics of Modified mendeleev's periodic table

1. Elements are arranged in the increasing order of their atomic masses.
2. Vertical columns are called 'groups' and horizontal rows are called 'periods'.
3. There are 'nine groups' numbered from I to VIII and O.
4. I to VII groups are sub divided into sub groups A and B.
5. There are 'seven periods'.
6. The first three periods contain 2, 8, 8 elements respectively. They are called 'short periods'.
7. The fourth, fifth and sixth periods have 18, 18 and 32 elements respectively.
8. The seventh period is an incomplete period.
9. Blank spaces are left for elements to be discovered.
10. The series of 'fourteen elements' following lanthanum is called 'Lanthanide series'.
11. The series of 'fourteen elements' following actinium is called 'Actinide series'.
12. Lanthanides and actinides are placed at the bottom of the periodic table.

Limitations of modified Mendeleev's periodic table

1. Few elements having a higher atomic mass were placed before elements having a lower atomic mass.

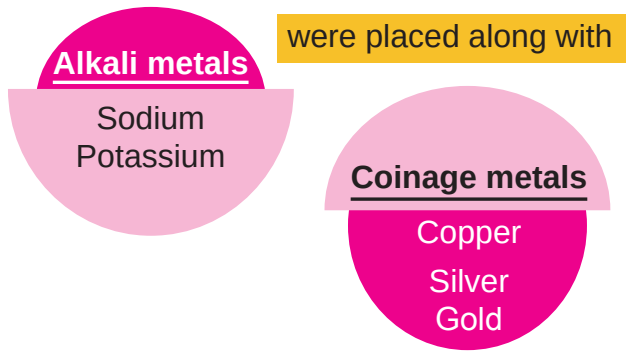
Example: Argon (39.9) was placed before Potassium (39.1)

Cobalt (58.9) was placed before Nickel (58.6)

Tellurium (127.9) was placed before Iodine (126.9)

2. There were no provisions for placing Isotopes.
3. Position of hydrogen in the periodic table was not certain about keeping it with either in group IA or in group VII A.
4. Chemically dissimilar elements were placed in the same group.

For example,



MORE TO KNOW

Gallium is a metal. It has a melting point of 29.8°C. Hence temperature of human body is enough to melt the metal.

12.3.1. METALS AND NON-METALS

All the elements in the periodic table are broadly divided into

- Metals
- Nonmetals
- Semi-metals (Metalloids)

Metals

Metals are shiny if their surfaces are clean. All metals (except mercury) are solids under ordinary conditions of temperature and pressure. Metals usually conduct heat and electricity well and can be rolled or hammered into sheets and

pulled into wires. Their chemical properties vary tremendously.

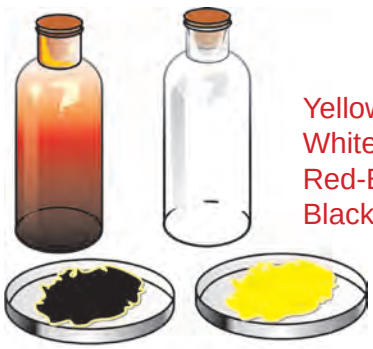
'Gold' and 'Platinum' are used in jewellery because they do not react with water or oxygen in the air. Rubidium not only reacts violently with water but begins to burn if it is exposed to air.

Native form

Platinum Gold Silver

Nonmetals

Elements that do not have the properties of metals are called nonmetals.



Yellow-Sulphur, White-Phosphorous, Red-Bromine, Black-Carbon

Metalloids (Semi-metals)

Elements that have some metallic properties and some nonmetallic properties are called metalloids. They are all solids and look rather like metals.

Eg.Silicon, Germanium.

12.3.2. PHYSICAL PROPERTIES OF METALS AND NON-METALS

1.Physical state

Metals exist in solid state except mercury. Nonmetals may exist in solid, liquid or gaseous state.

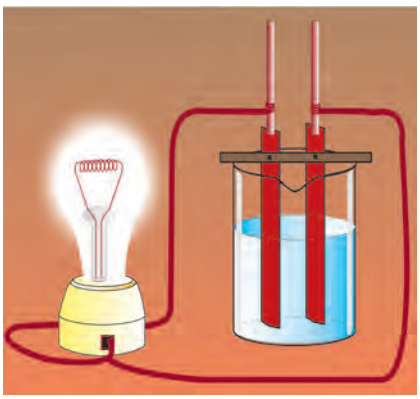
2. Density

Metals have usually high density. Nonmetals are less denser substances.

3. Conductivity

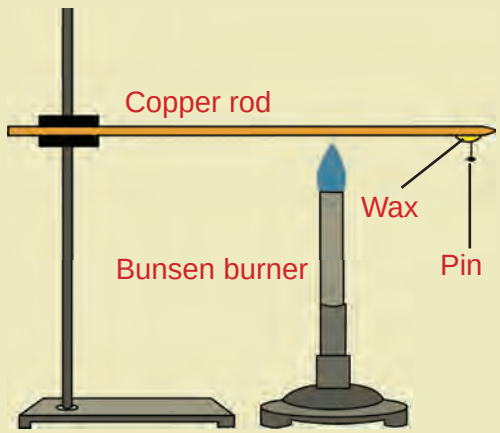
Metals are good conductors of heat and electricity.

Nonmetals are poor conductors or non-conductors of heat and electricity.



ACTIVITY –12.6

- Take a copper rod.
- Clamp this rod on a stand.
- Fix a pin to the free end of the rod using a wax.
- Heat the rod using a Bunsen burner as shown in the figure.
- Observe that, after sometimes, the pin falls down.
- Write down the reason.



4.Metallic Lusture

Metals in pure state, have polished surface and reflect the light falling on the surface producing a characteristic shining.

This property is known as metallic lusture.

Generally non-metals have no lustrous character. However graphite is a nonmetal with lustrous character.

ACTIVITY –12.7

- Take samples of iron, copper, aluminium and magnesium.
- Note the appearance of the sample first.
- Clean the surface of each sample by rubbing them using sand paper.
- Now note the appearance of the sample again.
- Name the elements in the decreasing order of lustrous character.

MORE TO KNOW

- Among metals, silver is the best conductor of electricity.
- Among nonmetals, graphite is the only conductor of electricity.
- Mercury is a metal with a very low melting point and it becomes liquid at room temperature.

5. Malleability

Malleability is the ability of metals to be hammered or squeezed. Hence metals are malleable.

Nonmetals cannot be hammered and hence they are not malleable.

6. Ductility

Ductility is the ability of metals to be pulled or stretched into different shapes. Hence metals are ductile. Nonmetals are non-ductile.

ACTIVITY –12.8

Ductility is the ability of metals to be drawn into thin wires

- Consider iron, magnesium, lead, copper, aluminium and calcium.
- Which of the above metals are also available in the form of wires?

MORE TO KNOW

- Tungsten has the highest melting point of any metal-over 3300^{o}C.
- The lightest metal is lithium. It weighs about half as much as water.
- Osmium is the heaviest metal. It is about 22 times heavier than water and nearly 3 times heavier than iron.

7. Sonority

It is the phenomenon of producing a characteristic sound when a material is struck.

Metals are sonorous in nature.

Nonmetals are nonsonorous.

ACTIVITY –12.9

- Take pieces of iron, copper and aluminium.
- Take one by one and strike it using a hammer several times.
- Observe the sound produced.
- Repeat with other metals.
- Record the sonorous character of these metals.

8. Hardness

Substances with high density are hard, whereas less denser substances are soft.

Metals are hard. Hence they have high melting point except mercury.

Nonmetals have low density and hence they are soft.

12.3.3 CHEMICAL PROPERTIES OF METALS AND NON METALS

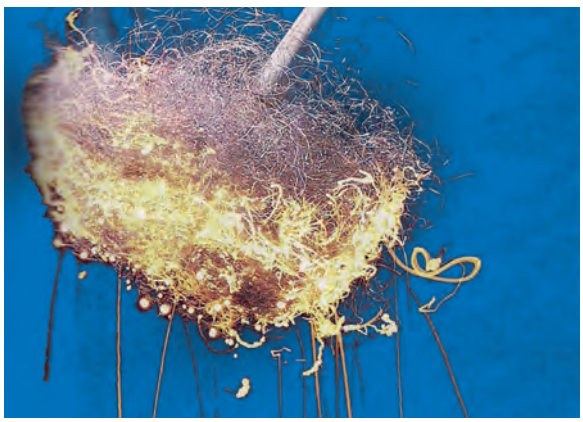
1. Action of oxygen(combustion)

(i) Metals

Metals combine with oxygen to form metallic oxides.

Magnesium burns in oxygen to form magnesium oxide.

$$2Mg + O_2 \longrightarrow 2MgO$$



Magnesium burns in oxygen

Aluminium combines with oxygen to form a layer of aluminium oxide.

$$4Al + 3O_2 \longrightarrow 2Al_2O_3$$

Formation of aluminium oxide over a surface of aluminium

Iron wool (threads) burns in oxygen to form iron oxide along with release of thermal energy and light energy.

$$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$$

Iron wool (made into thin fibres) burns in oxygen to produce both heat and light energy.

(ii) Non-metals

Sulphur burns in air at 250° C with a pale blue flame to form sulphur dioxide.

$$S + O_2 \longrightarrow SO_2 \uparrow$$

Phosphorous burns in air to form phosphorous pentoxide.

$$4P + 5O_2 \longrightarrow 2P_2O_5 \uparrow$$

Carbon burns in air to form carbon monoxide and carbon dioxide.

$$2C + O_2 \longrightarrow 2CO \uparrow$$

$$C + O_2 \longrightarrow CO_2 \uparrow$$

ACTIVITY –12.10

Classify the following oxides into acidic or basic oxides.

1. Sodium oxide
2. Zinc oxide
3. Aluminium oxide
4. Carbon dioxide
5. Sulphur dioxide

2. Action of water

(i) Metals

Metals like sodium and potassium react with cold water vigorously and liberate hydrogen gas.

$2Na + 2H_2O \longrightarrow 2NaOH + H_2\uparrow$

$2K + 2H_2O \longrightarrow 2KOH + H_2\uparrow$

Magnesium and Iron react with steam to form magnesium oxide and iron oxide respectively. Hydrogen is liberated.

$Mg + H_2O \longrightarrow MgO + H_2\uparrow$

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

Aluminium slowly reacts with steam to form aluminium hydroxide and hydrogen.

$2Al + 6\,H_2O \longrightarrow 2Al(OH)_3 + 3\,H_2\uparrow$

Other metals like copper, nickel, silver, gold have no reaction with water.

(ii) Nonmetals

Carbon reacts with water to form carbon monoxide and hydrogen.

$C + H_2O \longrightarrow CO\uparrow + H_2\uparrow$

3. Action of acids on metals

Metals such as sodium, magnesium, aluminium react with dilute hydrochloric acid and liberate hydrogen gas.

$Mg + 2HCl \longrightarrow MgCl_2 + H_2\uparrow$

$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2\uparrow$

ACTIVITY –12.11

- Take 10 ml of dilute hydrochloric acid in a test tube.
- Add a small piece of iron into it.
- Observe the changes.

4. Action of chlorine

(i) Metals

Metals like sodium, calcium react with chlorine to form their chlorides.

$2Na + Cl_2 \longrightarrow 2NaCl$

$Ca + Cl_2 \longrightarrow CaCl_2$

(ii) Nonmetals

Sulphur reacts with chlorine to form sulphur mono chloride.

$2S + Cl_2 \longrightarrow S_2Cl_2$

5. Action of hydrogen

(i) Metals

Very few metals like sodium, potassium, calcium react with hydrogen to form their hydrides.

$2Na + H_2 \longrightarrow 2NaH$

$Ca + H_2 \longrightarrow CaH_2$

(ii) Nonmetals

Sulphur reacts with hydrogen to form hydrogen sulphide which has characteristic rotten egg odour.

$S + H_2 \longrightarrow H_2S\uparrow$

Carbon reacts with hydrogen in the presence of electric arc to form acetylene.

$2C + H_2 \longrightarrow C_2H_2\uparrow$

12.3.4 REACTIVITY SERIES

In single – replacement reactions, one element takes the place of another element in a compound. Very reactive metals react with water at room temperature. The reactive metal, takes the place of hydrogen in water.

At room temperature, sodium reacts with water more vigorously.

$2Na + 2H_2O \longrightarrow 2NaOH + H_2\uparrow$

Calcium reacts with water slowly.

$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2\uparrow$

Magnesium does not react with water.

$Mg + H_2O \longrightarrow$ No reaction

These observations lead to the conclusion that the order of reactivity of these metals towards water is,

Na > Ca > Mg

ACTIVITY –12.12

Reactivity series of metals:

Potassium(K)	These metals react with water
Sodium(Na)	
Calcium(Ca)	
Magnesium(Mg)	These metals react with dilute acids.
Aluminium(Al)	
Manganese(Mn)	
Zinc(Zn)	
Chromium(Cr)	
Iron(Fe)	
Nickel(Ni)	
Tin(Sn)	
Lead(Pb)	
Copper(Cu)	These metals do not react with dilute acids.
Silver(Ag)	
Gold(Au)	

MORE TO KNOW

Reactivity of metals appears to decrease from left to right across a period in the periodic table and reactivity increases from top to bottom of a group in the periodic table.

12.3.5 USES OF REACTIVITY SERIES

1. Metals which react with water are placed first in the reactivity series.
2. Metals at the beginning of the series react with dilute acids.
3. Metals at the bottom of the series do not react with water.
4. Metals at the bottom of the series do not react with dilute acids.
5. Metals in the middle of the series react with dilute acids.
6. Metals upper in the reactivity series displace the metals in the bottom of the series.

12.3.6 ALLOYS

The idea of making alloys is not new. It was known by people in ancient times. Thousands of years ago, people discovered that they could use copper instead of stone to make their tools. About 3500 B.C. it was found that if tin, a fairly soft metal was combined with copper, a very hard material was produced. This material was the alloy called “bronze”. Bronze was a better material for many purposes than either of the two metals that composed it.

Alloys are homogeneous mixture consisting of two or more metals fused together in the molten state in fixed ratios.

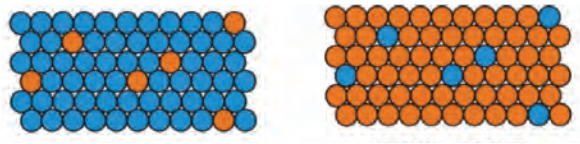
Composition of Alloys

There are two types of alloys. They are,

(i) Substitutional alloys

(ii) Interstitial alloys

In substitutional alloys, atoms of one metal randomly take the place of atoms of another metal.



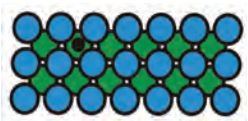
90% Ni - 10% Cu

=Ni

10% Ni - 90% Cu

=Cu

Substitutional alloy



= Fe in top layer

= Fe in second layer

= Carbon

Interstitial alloy

In interstitial alloys, small non-metallic atoms such as H(Hydrogen), B(Boron), C(Carbon) and N(Nitrogen) occupy the holes in the crystal structure of the metal.

Types of alloys:

There are two types of alloys. They are,

- Ferrous alloys - contain iron as base metal.
- Non-ferrous alloys - contain a little or no iron.

MORE TO KNOW

Alnicos are alloys of Iron, Aluminium and Nickel and Cobalt. Alnicos are used to make magnets, up to 25 times as strong as ordinary magnets.

12.3.7 USES OF ALLOYS

Name	Composed of	Uses
Brass	Copper Zinc	Screws, windows and door fittings
Bronze	Copper Tin	Statues, machine parts
Solder	Tin Lead	In electrical and plumbing industries to join metal surfaces without melting them.
Steel	Iron, Carbon, Chromium, Nickel, Tungsten	Construction of bridges, buildings, household products, cooking utensils
Duralumin	Aluminium, Copper Manganese, Magnesium	Aircraft parts, cars, ships and nails.

Characteristics of alloy

1. It enhances the hardness of metal.
2. It enhances the tensile strength of the base metal.
3. It improves corrosion resistance.
4. It modifies the colour.
5. It provides better castability.

MORE TO KNOW

Amalgam is an alloy in which one of the constituents is mercury.

12.3.8. NANO SCIENCE

Nanoscience is the study of atoms, molecules and objects whose size is on the nanometre scale (1-100 nm).

1 nanometre = 10^{-9} metre

Nanotechnology

- It involves making ultra-small devices .
- They are about a nanometre.
- One nanometre is equal to one billionth of a metre in length.
- It is roughly the size of ten atoms placed end to end.

Objective of nanotechnology

When the size of the matter is reduced to a few nanometers, there is an increase in surface area. The increased surface area assumes a critical role such as in "chemical catalysis".

Applications of nanotechnology

- Tiny computers can be produced, which are many times faster than ordinary ones.
- It is used to make miniature pumps,which are useful in medical field.
- Nanostructured materials are used as catalysts to improve the efficiency of batteries.
- It makes a significant contribution to the fields of semiconductors and biotechnology.
- It converts a particular wavelength of light into heat.
- It finds use in the treatment of cancer.
- It is used in textile industry to provide better stain-resistance in fabrics.
- It is useful to reduce the degradation of food and vegetables.

EVALUATION

Section A

Choose the correct answer

1. Classification of elements into two divisions namely metals and non-metals was firstly attempted by_____(Dobereiner, Lavoisier, Mendeleev).
2. As per Newland's 'Law of octaves' which of the two elements in the given table have repetition of similar properties.

1	2	3	4	5	6	7	8
Na	Mg	Al	Si	P	S	Cl	K

3. In Mendeleev's periodic table, all the elements are sorted in the periodic functions of their _____ (Mass number, Atomic number)
4. One of the coinage metals is _____ (Copper, Sodium, Nickel)
5. Liquid metal at room temperatrue is (Mercury, Bromine, Tin)

6. Osmium is the heaviest metal. It is _____ (22½, 3, about half) times heavier than iron.

7. Metalloids have some metallic properties and some nonmetallic properties. An example for metalloid is_____ (Silicon, Argon, Iodine)

8. Complete $Mg+O_2 \longrightarrow$?

9. Sodium reacts with water and gives sodium hydroxide and _____ (O_2, H_2, Cl_2)

10. Sulphur reacts with hydrogen to give hydrogen sulphide. The odour of hydrogen sulphide is _____ (rotten egg, pleasant)

11. Arrange the following elements in the ascending order, based on their reactivity. Na, Ca, Mg

12. Bronze is an alloy of _____ (copper and tin, silver and tin, copper and silver)

13. An alloy used in manufacturing Aircraft parts is _____ (solder, brass, duralumin)

14. The technology that is useful to reduce the degradation of food and vegetables is _____(Nano technology, biotechnology, genetic engineering)

Section B

15. Mendeleev's periodic table is constructed into vertical columns and horizontal rows.
    a. Mention the name of vertical columns
    b. Mention the name of horizontal rows.

16. In the periodic table the position of hydrogen was not certain. Give reason.

17. Pick the odd one out.
    a. Coins, Brass, Copper, Gold ornaments
    b. Bromine, Carbon, Hydrogen, Aluminium

18. What is an alloy? Give one example.

19. $2Na+ Cl_2 \longrightarrow NaCl$
    a. Name the product.
    b. Name the colour of Cl_2 gas.

20. Mention the objective of nano science.

Section C

21. Mendeleev arranged elements in periods and groups.
    a. Total number of periods in modified periodic table
    b. Total number of groups in modified periodic table
    c. Number of elements in first period
    d. Mention the incomplete period
    e. Where are the Lanthanides and Actinides placed?

22. Answer the following
    a. Metals are sonorous in nature. But non-metals are non-sonorous . Give reason.
    b. Which is the most ductile and malleable metal?
    c. Metals are good conductors of heat and electricity. Can you say the metal which is the best conductor of electricity?
    d. Metals are hard. Non metals are soft. Give reason.

23. Answer the following
    a. Aluminium reacts with oxygen to form a layer. Write the name and chemical formula of the layer.
    b. Sodium reacts with water to form sodium hydroxide. But magnesium does not react with water. Give reason.
    c. P_2O_5 is acidic or basic?

24. Answer the following
    a. Mention any two applications of nanotechnology?
    b. Name the alloy that is used to make statues.
    c. Write the composition of solder.

FURTHER REFERENCE

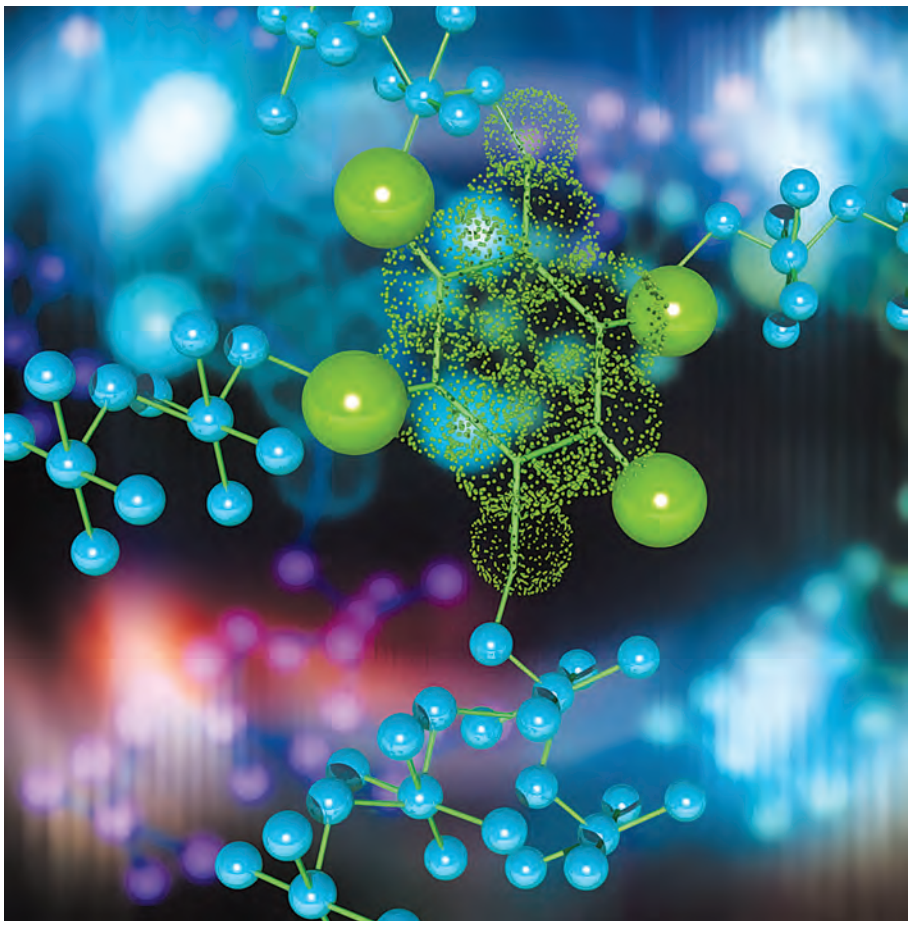
Book

ext book of Inorganic chemistry - P.L. Soni
Sultan chand & Sons

Websites

http://www.chymist.com

Chapter 13



CHEMICAL BONDS

13. CHEMICAL BONDS

In a garland, the flowers are tiedup by means of a thread. Unless the flowers are tied, they cannot be held together. The role of thread is to hold all the flowers together. It is more or less equivalent to a bond.

Molecules of chemical substances are made of two or more atoms joined together by some force acting between them. This force which results from the interaction between the various atoms that forms a stable molecule is referred to as the chemical bond.

A chemical bond is defined as a force that acts between two or more atoms to hold them together as a stable molecule.

13.1 OCTET RULE

Gilbert Newton Lewis used the knowledge of electronic configuration of elements to explain "why atoms joined to form molecules". He visualized that inert (noble) gases have a stable electronic configuration, while atoms of all other elements have unstable or incomplete electronic configuration.

In 1916, G.N.Lewis gave the "electronic theory of valence". This electronic theory of valence could well be named as the "octet theory of valence".

Atoms interact by either electron-transfer or electron-sharing, so as to achieve the stable outer shell of eight electrons. This tendency for atoms to have eight electrons in the outer shell is known as "octet rule" or "Rule of eight".

ACTIVITY –13.1

Which among the following elements share or transfer electrons to obey octet rule?

1. Helium
2. Argon
3. Lithium
4. Chlorine

MORE TO KNOW

Elements with stable electronic configurations have eight electrons in their outermost shell. They are called inert gases.

Ne (Atomic number 10) = 2, 8 and Ar (Atomic number 18) = 2, 8, 8

ACTIVITY –13.2

The following elements have no stable electronic configuration. Write the electron distribution.

Element	Atomic number	Electron distribution
Sodium		
Carbon		
Fluorine		
Chlorine		

MORE TO KNOW

Lewis used dot-symbols to represent the valence electrons which make bonds.

Lewis Symbol	Electron distribution	Valence electrons
H	(1)	1
Be	(2,2)	2
B	(2,3)	3
C	(2,4)	4
N	(2,5)	5

13.2 TYPES OF CHEMICAL BOND

Scientists have recognized three different types of bonds.

They are,

- Ionic or electrovalent bond
- Covalent bond
- Co-ordinate covalent bond

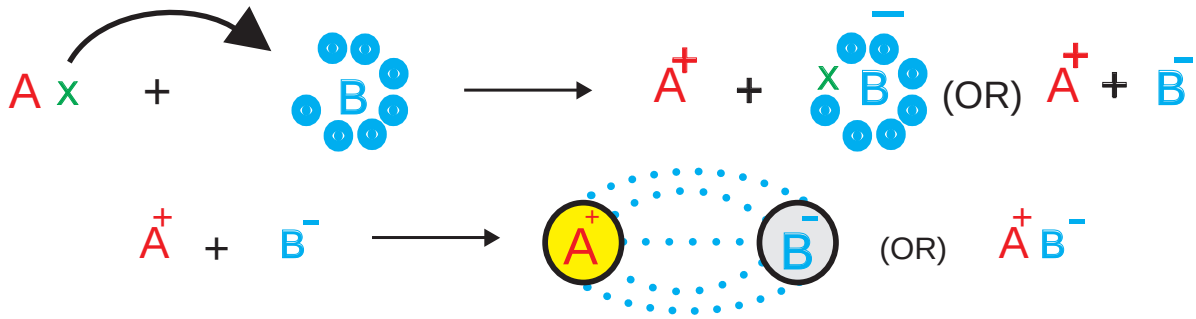
MORE TO KNOW

Electrostatic attraction is found between oppositively charged ions. It is also known as coulombic force of attraction.

13.3 FORMATION OF IONIC AND COVALENT BOND

1. Formation of ionic (or) electrovalent bond

Let us consider two atoms A and B. The atom A has 1 electron in its valence (outermost) shell.B has 7 electrons in its valence shell. Hence A has 1 electron excess and B has 1 electron shorter than the stable octet configuration. Therefore, A transfers an electron to B.In this transaction both the atoms A and B acquire a stable electron-octet configuration. A becomes a positive ion (cation) and B becomes a negative ion (anion). Both the ions are held together by electrostatic force of attraction. Formation of ionic bond between A and B can be shown as,



Thus electrostatic attraction between cation (+) and anion (-) produced by electron transfer constitutes an ionic or electrovalent bond. The compounds containing such a bond are referred to as “Ionic or electrovalent compounds”.

ACTIVITY –13.3

The atom which gives off electron becomes cation and which accepts electron becomes anion. Which atoms do form cations or anions?

1. Lithium
2. Sodium
3. Fluorine
4. Chlorine

Conditions favourable for the formation of ionic bond

(i) Number of valence electrons

The atom A should possess 1, 2 or 3 valence electrons while the atom B should have 5, 6 or 7 valence electrons.

(ii) Net lowering of energy

To form a stable ionic compound, there must be a net lowering of energy. In other

words, energy must be released as a result of electron transfer from one atom to another.

(iii) Attraction towards electrons

Atoms A and B should differ in their attracting powers towards electrons.

A has less attraction of electrons and hence gives off the electron while B has more attraction towards electron and hence gains electrons.

MORE TO KNOW

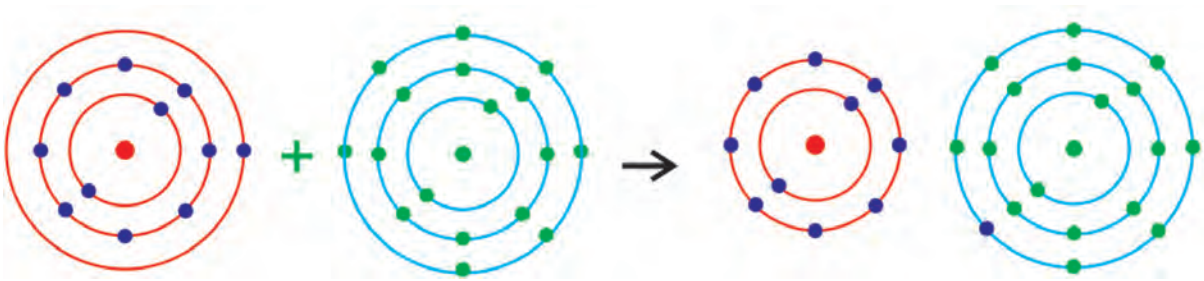
Attracting power of bonded pair electrons by an atom is known as electro negativity. Atom with more attraction towards bonded electrons is called more electronegative element and lesser attraction towards bonded electrons is known as lower electronegative element.

Illustration: 1

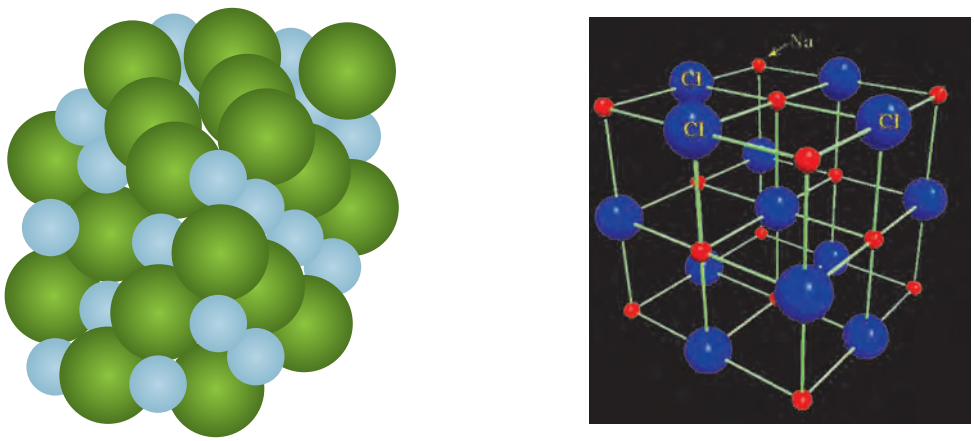
Formation of Sodium chloride

Sodium chloride is formed from an atom of sodium and one atom of chlorine. Electronic configuration of Na atom=2, 8, 1 (Atomic number 11)

Electronic configuration of Cl atom=2, 8, 7 (Atomic number 17).Sodium transfers its one valence electron to chlorine and both achieve stable electron octet configurations. Hence sodium (Na) becomes, sodium cation (Na^+) and Chlorine (Cl) becomes chloride anion (Cl^-) both the ions are joined together by electrostatic force of attraction to make an ionic bond. In the Crystalline state, each Na^+ ion is surrounded by 6 Cl^- ions and each Cl^- ion is surrounded by 6 Na^+ ions.



2,8,1 Sodium atom | 2,8,7 Chlorine atom | 2,8 Sodium cation | 2,8,8 Chloride anion



Structure of sodium chloride

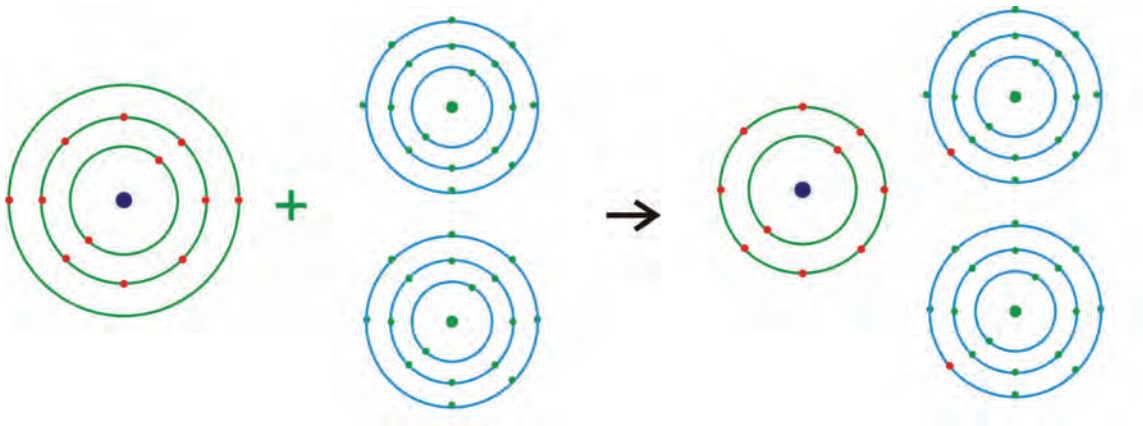
Illustration: 2

Formation of Magnesium chloride

Atoms	Atomic number	Electron distribution
Magnesium	12	2,8,2
Chlorine	17	2,8,7

Magnesium has 2 valence electrons while chlorine has 7 valence electrons. Magnesium atom transfers 2 electrons one to each chlorine atom and thus all the three atoms achieve the stable octet electronic configuration.

Magnesium atom becomes Mg^{2+} ion and the 2 chlorine atoms become 2 Cl^- ions forming Magnesium chloride as $MgCl_2$.

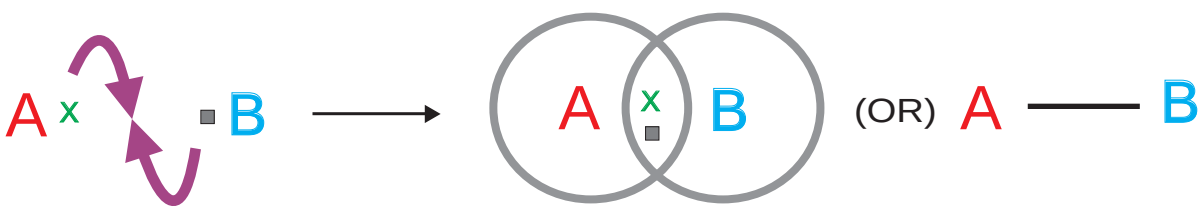


2,8,2 Magnesium atom | 2,8,7 Chlorine atom | 2,8 Magnesium cation | 2,8,8 Chloride anion

2. Formation of Covalent bonds

G.N.Lewis suggested that two atoms could achieve stable 2 or 8 electrons in the outer shell by sharing electrons between them. Atom A has 1 valence electron and atom B has 1 valence electron. As they approach each other, each atom contributes one electron and the resulting electron pair fills the outer shell of both the atoms.

Blue - copper sulphate
White - sodium chloride
Red - cobalt chloride
} Ionic compounds



Thus a shared pair of electrons contributes a covalent bond or electron pair bond.

The compounds containing a covalent bond are called covalent compounds.

Conditions for formation of covalent bond

Number of valence electrons

Each of the combining atoms A and B should have 5, 6 or 7 valence electrons so that both the atoms achieve the stable octet electronic configuration by sharing 3, 2 or1 electron pair.

Equal electron attraction

Both the atoms A and B should exhibit nearly equal attraction towards bonded pair of electrons, ie. equal electronegativity.

Equal sharing of electrons

Both the atoms A and B should have nearly equal attraction towards bonded electron pair.

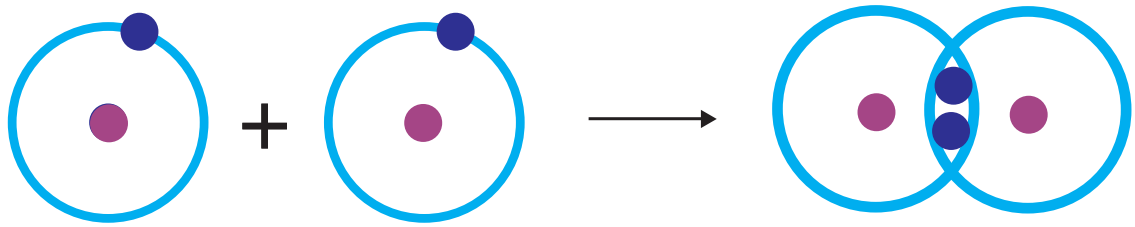
MORE TO KNOW

Multiple bonds enable more atoms to achieve an octet electronic configuration.

Illustration: 1

Formation of hydrogen molecule

Hydrogen molecule is made up of two hydrogen atoms. Each hydrogen atom has one valence electron. Each hydrogen atom contributes an electron to the shared pair and both the atoms attain stable electronic configuration.

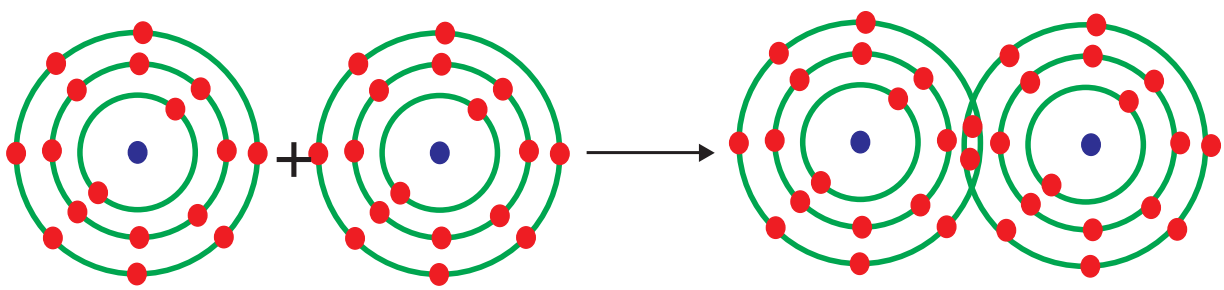


Hydrogen atom Hydrogen atom Hydrogen molecule

Illustration: 2

Formation of chlorine molecule

Each chlorine atom (2, 8, 7) has seven valence electrons. Each of them share an electron and attain stable electronic configuration.

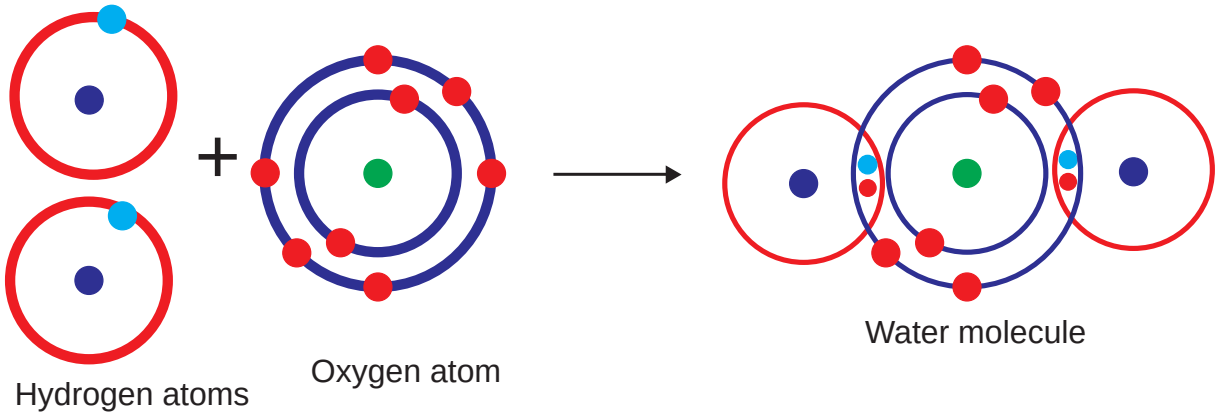


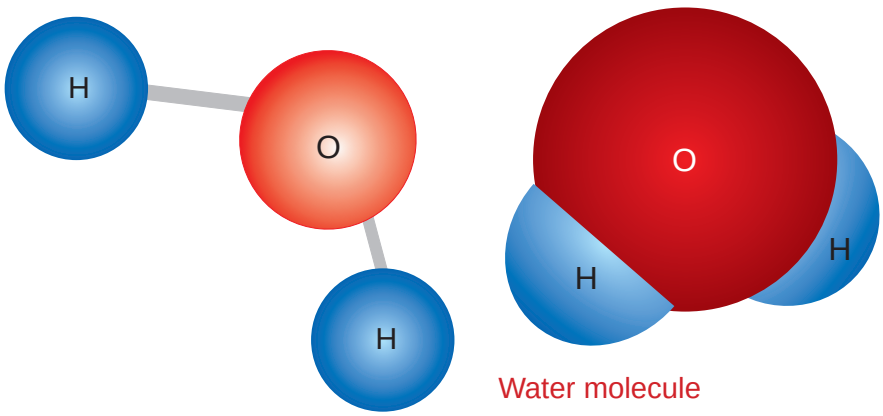
Chlorine atom Chlorine atom Chlorine molecule

Illustration: 3

Formation of water molecule

Oxygen atom (2, 6) has six valence electrons. Hydrogen atom has one valence electron each. Oxygen atom shares two electrons one each with two hydrogen atoms.





MORE TO KNOW

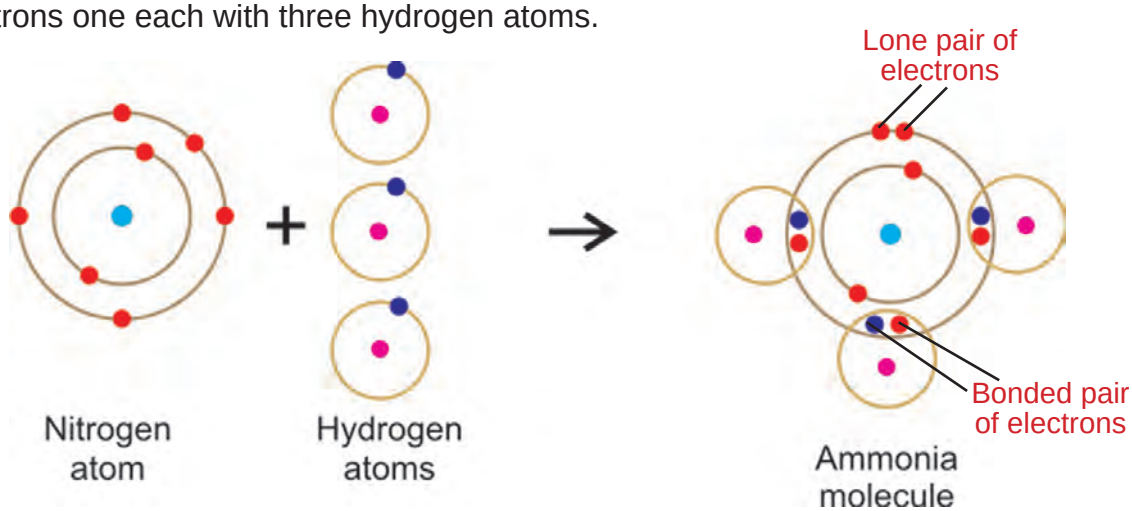
Lone pair of electrons are the electrons, that are not involved in bond formation.

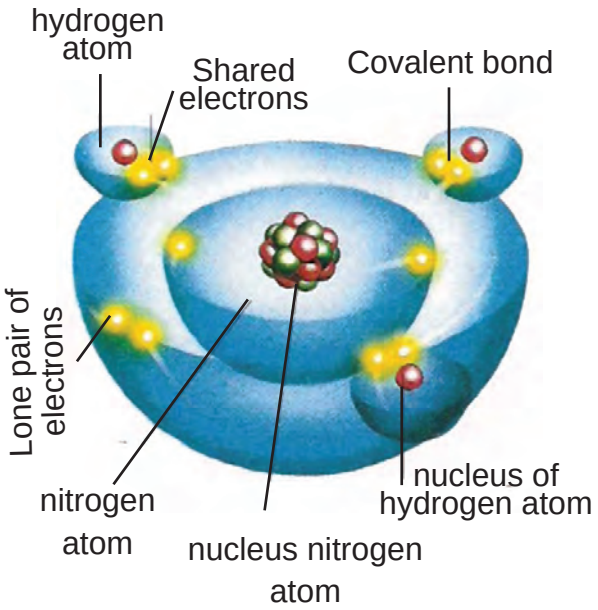
Illustration: 4

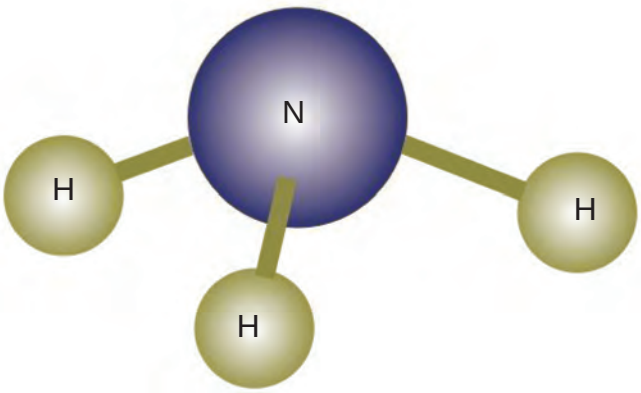
Formation of ammonia molecule

Nitrogen atom (2, 5) has five valence electrons.

Hydrogen atom has one valence electron each. Nitrogen atom shares three electrons one each with three hydrogen atoms.







Ammonia molecule

ACTIVITY –13.4

Write the Lewis formula and predict the number of covalent bonds in

1. Chlorine
2. Ammonia
3. Fluorine

13.3.1. COMMON PROPERTIES OF IONIC COMPOUNDS

Solids at room temperature

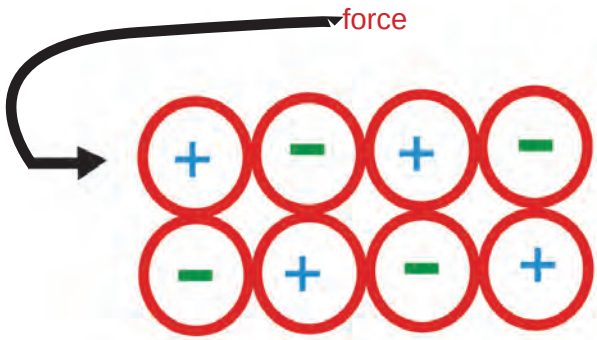
On account of strong electrostatic force between the opposite ions, these ions are not in a free movement. Hence ionic compounds are solids at room temperature.

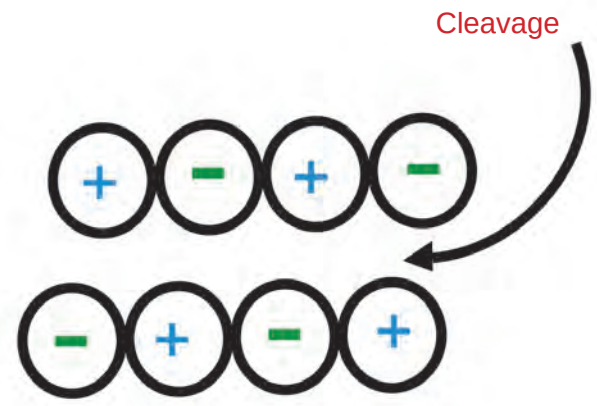
High melting point

Since the (+) and (-) ions are tightly held in their positions, only at high temperature, these ions acquire sufficient energy to overcome the attractive force causing movement. Hence ionic compounds have high melting point.

Hard and brittle

Their hardness is due to strong electrostatic force of attraction. When external force is applied slight shift takes place bringing like-ions in front of each other. It causes repulsion and cleavage occurs.



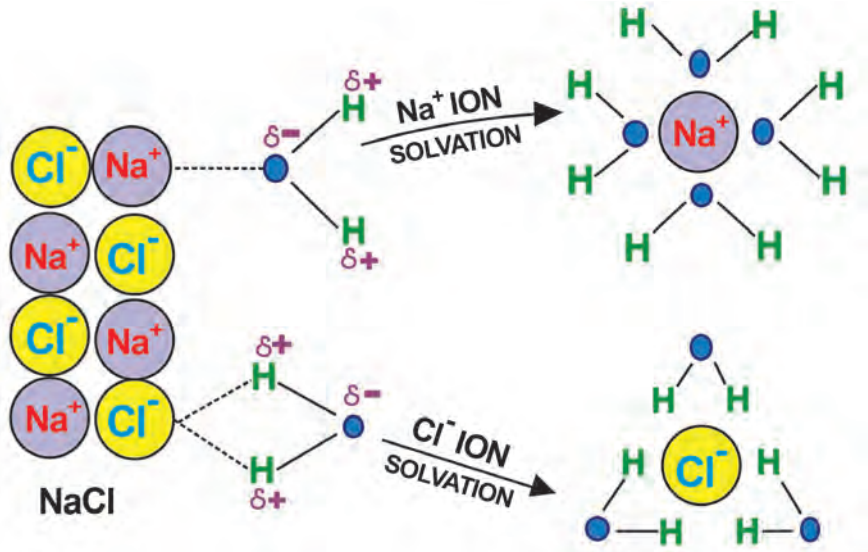


MORE TO KNOW

Refractory materials are heat resistant materials. They have very high melting points. They are used in the extraction of metals from their ores. Some refractory materials are ionic compounds.

Soluble in water

When a crystal is put in water, the polar water molecules separate the (+) and (-) ions making the crystal soluble.



ACTIVITY –13.5

1. Take two beakers.
2. Take little water in one beaker and little kerosene in another beaker.
3. Add sodium chloride salt to each of the beakers.
4. Observe the solubility.

Conductors of electricity

In the solid state, the ions are fixed in their positions. Hence they are poor conductors of electricity. In molten stage and in water solutions, the ions are free to move. Hence they conduct electricity in molten state or in aqueous solutions.

Ionic reactions are fast

Ionic compounds give reactions between ions. Hence their reactions are fast.

13.3.2. COMMON PROPERTIES OF COVALENT COMPOUNDS

Gases, liquids or solids at room temperature

Due to weak intermolecular forces between the molecules, covalent compounds exist as gases, liquids or relatively soft solids.

Low boiling point

In solids, the molecules are held by weak forces of attraction. When heat is applied the molecules are readily pulled out and get free movement as in liquid.

Soft solids

A molecular layer in the crystal easily slips relative to adjacent layers. Thus the crystals are easily broken.

Soluble in organic solvents

These compounds readily dissolve in non-polar solvents like toluene, benzene etc.The solvent molecules easily overcome the weak inter molecular forces of attraction.

MORE TO KNOW

Bonds in which electron pairs are equally shared are non-polar bonds. Bonds in which electron pairs are not equally shared are polar bonds.

ACTIVITY –13.6

Classify the following solvents into polar and non-polar.

1. Benzene 3. Ether
2. Water 4. Chloroform

Non-conductors of electricity

Since there are no (+) and (-) ions in covalent molecules, they are not capable of conducting electricity in molten state or in solution state.

Molecular reactions are slow

In reaction of covalent compounds, the molecules as a whole undergo a change. There is no electrical force to speed up the reactions. Hence these reactions are slow.

ACTIVITY –13.7

- Take sodium chloride and paraffin wax.
- Take two solvents namely water and turpentine in separate beakers.
- First add sodium chloride to both the solvents and note the solubility.
- Then add paraffin wax to both the solvents separately in another beakers and note the solubility.
- Differentiate the solubility.

13.4 DIFFERENCES BETWEEN IONIC AND COVALENT COMPOUNDS

Ionic bond	Covalent bond
Formed by transfer of electrons from a metal to a non-metal atom.	Formed by sharing of electrons between non-metal atoms.
Consists of electrostatic force of attraction between (+) and (-) ions.	Consists of weak force of attraction between atoms.
Non-rigid and non-directional	rigid and directional
Properties of compound	**Properties of compound**
Solids at room temperature	Gases, liquids or soft solids at room temperature.
Has high melting and boiling points.	Has low melting and boiling points.
Hard and brittle.	Soft, much readily broken.
Soluble in polar solvents and insoluble in organic solvents.	Soluble in non-polar solvents and insoluble in polar solvents.
Conductor of electricity in molten or solution state.	Non-Conductor of electricity in molten or solution state.
Undergoes ionic reactions which are fast.	Undergoes molecular reactions which are slow.

13.5 COORDINATE COVALENT BOND

In a normal covalent bond, each of the two bonded atoms contributes one electron to make the shared pair. In some cases, a covalent bond is formed when both the electrons are supplied entirely by one atom. Such a bond is called coordinate covalent or dative bond.

Thus coordinate covalent bond is a covalent bond in which both the electrons of the shared pair come from one of the two atoms or ions. The compounds containing a coordinate bond are called coordinate compounds.

MORE TO KNOW

Sharing of two pairs of electrons make a double bond. Sharing of three pairs of electrons make a triple bond. These are called multiple covalent bonds.

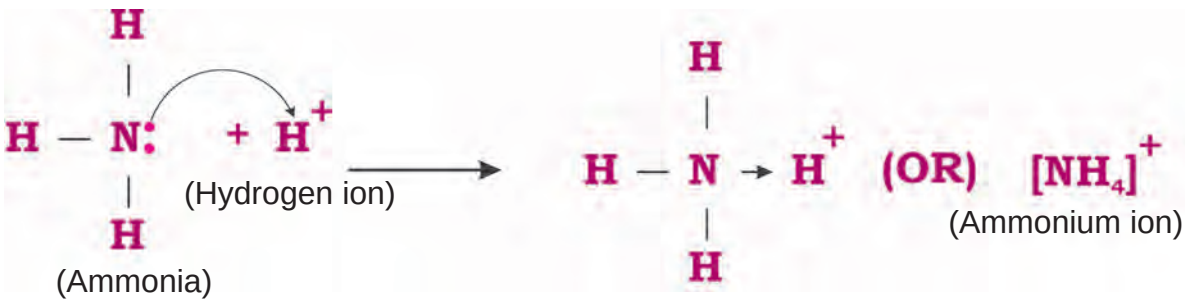
1. Carbon dioxide O=C =O (two double bonds)
2. Oxygen O=O (one double bond)
3. Nitrogen N≡N (one triple bond)

If an atom 'A' has an unshared pair of electrons (lone pair) and another 'B' is short of two electrons, then a coordinate bond is formed. 'A' donates the lone pair (2 electrons) to 'B' which accepts it.

Illustration

Ammonium ion (NH_4^+)

Ammonium ion is formed by the addition of hydrogen ion (H^+) with ammonia (NH_3). In ammonia molecule, the central nitrogen atom is linked to three hydrogen atoms and yet nitrogen has an unshared pair of electrons. Nitrogen donates this lone pair of electrons to hydrogen ion of an acid forming ammonium ion.

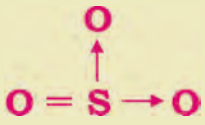


MORE TO KNOW

Under ordinary conditions of temperature and pressure, carbon dioxide is a gas because molecules of carbon dioxide are non-polar.

Water is a liquid as a result of the great polarity of water molecules

ACTIVITY –13.8

Sulphur tri oxide (SO_3) has the structure, 

How many coordinate linkages are present in this molecule? Identify the acceptor and donor atoms.

ACTIVITY –13.9

Carbon monoxide is a gas. It is a coordinate compound.

Structure of carbon monoxide is 

Identify the donor and acceptor atoms.

13.5.1. COMMON PROPERTIES OF COORDINATE COMPOUNDS

Conductors of electricity

They do not give individual ions in water and are poor conductors of electricity.

Soluble in organic solvents

They are sparingly soluble in water and dissolve in organic solvents.

Melting and boiling points

They are semi polar in nature. They possess melting and boiling points higher than those of purely covalent compounds, but lower than ionic compounds.

Exceptions to the Octet Rule

It is true that quite a few molecules had non-octet structure. Atoms in these molecules could have a number of electrons in the valence orbit short of the octet or in excess of the octet.

(i) Four electrons around the central atom

Beryllium di chloride ($BeCl_2$)

	Beryllium	Chlorine
Atomic number	4	17
Electron distribution	2,2	2,8,7
Valence electrons	2	7

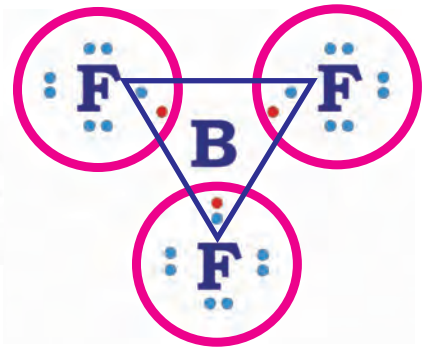
Each chlorine atom is surrounded by 8 electrons but beryllium atom has only 4 electrons around it.

(ii) Six electrons around the central atom

Boron tri fluoride (BF_3)

	Boron	Fluorine
Atomic number	5	9
Electron distribution	2,3	2,7
Valence electrons	3	7

Each fluorine atom is surrounded by 8 electrons but boron atom has only 6 electrons around it.



ACTIVITY –13.10

Atomic number of phosphorous is 15.Write the electron distribution in phosphorous. Atomic number of chlorine is 17.Write the electron distribution of chlorine. One phosphorous atom combines with five chlorine atoms to form phosphorous penta chloride (PCl_5).Which atom will have the octet?

EVALUATION

Section A

Choose the correct answer

1. As per the Octet rule, noble gases are stable in nature. This is due to the presence of _____ (eight, seven, six) electrons in their outermost shell.
2. The element that would form cation due to loss of electron during the chemical reaction is _____ (chlorine, lithium, fluorine)
3. Atomic number of magnesium is 12. Then its electron distribution is _____ (2,2,8 / 2,8,2 / 8,2,2)
4. An element X has 6 electrons in its outermost shell. Then the number of electrons shared by X with another atom to form covalent bond is _____ (3, 2, 6)
5. The compound that possess high melting point is _____ (NH_3, NaF)
6. Bond in which the electron are equally shared is _____ (polar bond, non polar bond, ionic bond)

7. Pickout the wrong statement about the properties of covalent compounds.

   a) They are neither hard nor brittle.

   b) Molecular reactions are fast.

Section B

8. NaCl is an Ionic compound. How is an ionic bond formed?

9. All the elements tend to attain eight electrons in their outer most shell either by sharing or transfer of electron. From the electronic distribution of the following, which one undergoes loss of electron or sharing of electrons.

   X = 2, 7 Y = 2, 8, 1

10. $MgCl_2$ is a solid compound. It does not conduct electricity in solid state. When it is in molten state it conducts electricity. Find the reason.

Section - C

11. $Na + Cl \longrightarrow Na^+ + Cl^- \longrightarrow Na^+Cl^-$

    (2,8,1) (2,8,7) (2,8) (2,8,8)

    The above equation represents the formation of sodium chloride. Observe the above equation and answer the following.

    (a) How many electrons are transferred from Na to Cl?

    (b) Name the force acting between Na^+ and Cl^-.

    (c) Name the nearest noble gas to Cl^-

    (d) Name the bond between Na^+ and Cl^-

    (e) How many electrons are present in Na^+ ion?

12. Ammonia molecule is formed by the sharing of electrons between Nitrogen and hydrogen. For the molecules of ammonia., answer the following.

    (a) State whether ammonia is a covalent or ionic molecule.

    (b) Number of covalent bonds between N and H

    (c) Does ammonia conduct electricity

    (d) Draw the structure of ammonia

FURTHER REFERENCE

Book

Essentials of Physical Chemistry - B.S.Bahl,G.D.Tuli,Arun Bahl.
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Websites

http://www.beyondbooks.com

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Chapter 14

MEASURING INSTRUMENTS

MEASURING INSTRUMENTS

Kannan and his father went to market to buy nylon ropes for their house. They left home by 5:05:00 p.m and reached the shop by 5:23:39 p.m. That is they took 18 minute and 39 second to reach the shop from home. Kannan's digital watch was used to verify the time taken. Now they asked for twenty metre rope from the shopkeeper. The shopkeeper took the rope and weighed 375 gram using digital balance.

Thus measurement is an integral part of our day-to-day life. Let us see how various things are measured.

14.1. CONCEPT OF SMALL MEASUREMENTS

Physics is based on the study of systematic measurement. It is necessary to measure things accurately.

Why should measurements be made accurate?

When we fill petrol at a petrol bunk for our vehicle, the meter may stop at two digits (say 1.9 litre), but at another bunk, it may show a reading of three digits (say 1.92 litre) which is the actual quantity for the same amount. Such accurate measurement is possible with an electronic meter.

14.2. MEASURING LENGTH

In a laboratory, a small metre scale is used to measure the length of any object. In a metre scale, the smallest length that can be measured is 1 mm. This is called the Least Count of a metre scale.

For example when we measure a substance which has a length of 1 inch (2.54 cm), we get a reading of either 2.5 cm or 2.6 cm. This measurement is not accurate.

Now, it is possible to measure such a reading with the help of a secondary scale called Vernier Scale, designed by a French scientist, Pierre Vernier. With the help of a Vernier Scale along with a metre scale, it is possible to measure length correct to 0.1 mm or 0.01 cm.

Least count

The smallest measurement that can be measured using a device or instrument is called least count of that instrument.

ACTIVITY –14.1

Find the least count of the different ammeters and voltmeters used in your school physics laboratory.

Least Count of a Vernier

Least Count (LC) of a Vernier is equal to the difference between a main scale division (MSD) and a Vernier scale division (VSD).

L.C = 1 MSD – 1 VSD

ACTIVITY –14.2

Measure the growth of your nail in one week. Find the growth per day and per hour.

14.2.1. VERNIER CALIPERS (SLIDE CALIPERS)

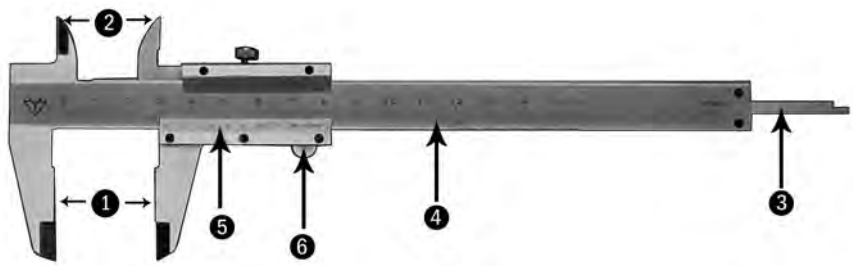
This instrument is based on the principle of Vernier.

The name Vernier is now applied to the small movable scale attached to a Caliper, Sextant, Barometer or other graduated instruments.

- The Vernier Calipers consists of a thin long steel bar graduated in cm and mm. This is called the Main scale.
- At the left end, an upper jaw and a lower jaw are fixed perpendicular to the bar called fixed jaws.
- To the right of the fixed jaws of the vernier calipers is found, the vernier scale consisting of an upper and a lower movable jaws that slides over the main scale.
- The Vernier scale can be moved or fixed at any position by using screws provided on it.

- The lower jaws are used to measure the external dimensions and the upper jaws are used to measure the internal dimensions of objects.
- The thin bar attached to the Vernier scale at the right side is used to measure the depth of hollow objects.

Vernier calipers



Parts

1. Lower Jaws
2. Upper Jaws
3. Depth Probe
4. Main Scale
5. Vernier
6. Retainer

ACTIVITY –14.3

Assume that your nail grows 2 mm per month. Calculate the growth per day, per hour and per minute.

Least count of a vernier calipers

Consider 1 cm of a main scale. It is divided into 10 equal parts of length 1 mm. the Vernier scale has 10 equal divisions (VSD) equal to 9 Main scale divisions (MSD).

10 VSD = 9 MSD

1 VSD = 9/10 MSD

1 MSD = 1 mm

1 VSD = 9/10 mm

L.C = 1 MSD – 1 VSD

= 1 mm – 9/10 mm

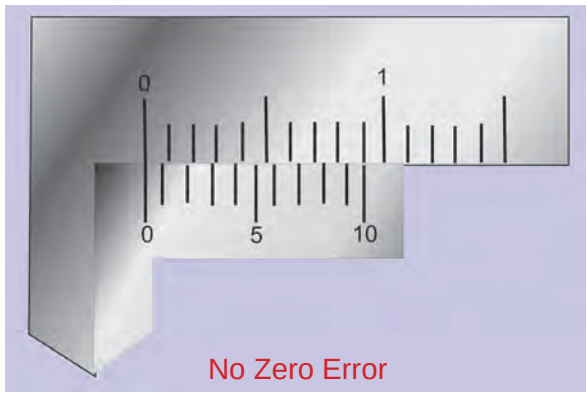
= 1/10 mm

L.C = 0.1 mm = 0.01 cm

Error

Error may be defined as the deviation from the actual value. If the value is greater than that of actual value, it is called positive error. If the value is less than that of actual value, it is called negative error.

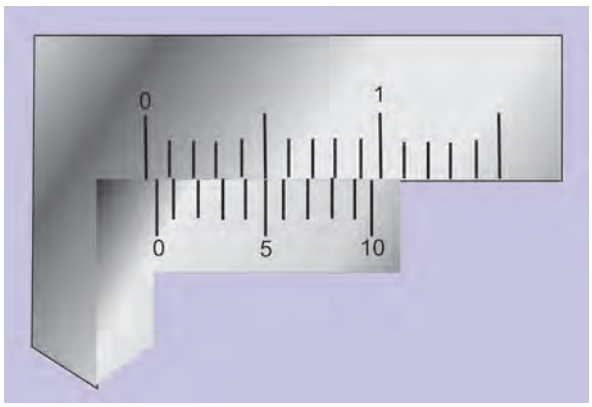
Zero Error of a vernier calipers



No Zero Error

Bring the two lower jaws into contact. If the zero of the Vernier scale coincides with the zero of the Main scale there is no zero error.

Positive Error

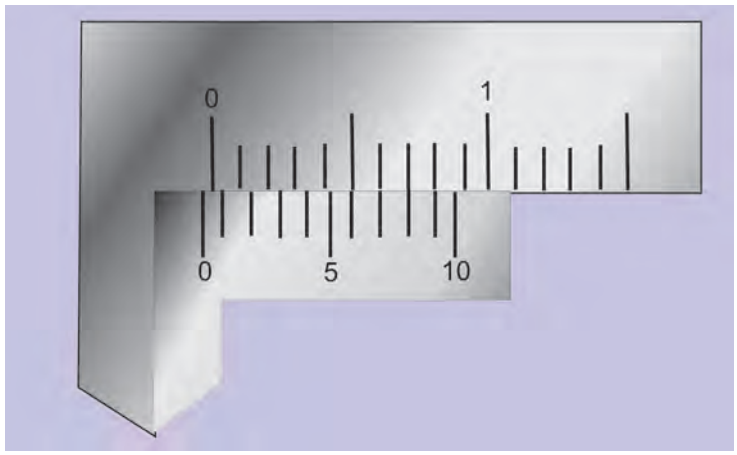


Positive Zero Error

If the zero of the Vernier scale is to the right of the Main scale zero, the zero error is positive and the zero correction (ZC) is negative.

For example, if the n^{th} division of the Vernier scale coincides with any division of the Main scale the Zero Error = + (n x L.C)

Negative Error



Negative Zero Error

If the zero of the Vernier scale is to the left of the Main scale zero, the zero error is negative and the zero correction (ZC) is positive. For example, if the n^{th} division of the Vernier scale coincides with a division of the Main scale the

Zero Error = – (10 – n) x L.C

Measuring the length of a cylinder

First find least count and zero error of a vernier calipers.

Now grip the cylinder whose length is to be measured between the two lower jaws.

Note the Main scale reading (MSR) just before the zero of the Vernier.

Note the division of the Vernier Scale which coincides (VC) with a Main Scale reading.

The observed length of the cylinder = MSR + (VC x LC)

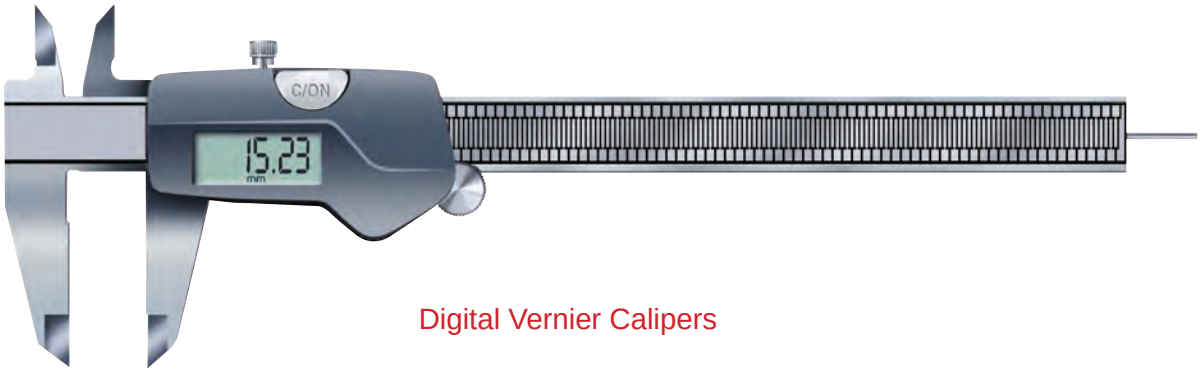
The correct length of the cylinder = MSR + (VC x LC) ± ZC

Take readings at different points on the cylinder.

Take the mean of the last column reading as the correct length of the object.

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				

Digital Vernier calipers that are used nowadays give visual readings at once, that is they show the measurements as numerical display.



Digital Vernier Calipers

ACTIVITY –14.4

Find the volume of your geometry box / lunch box using Vernier calipers.

14.3. MEASURING MASS AND WEIGHT

When we look at the composition of different elements on the wrapper of drugs, it is given in milligram. This small measurement is possible by electronic (digital) balance. We can see a digital balance of accuracy 0.001g in a Jewellery shop.

Mass

Mass of a body is the measure of the quantity of matter contained in the body. It does not vary from place to place. The SI unit of mass is kilogram. It is measured using different types balances, which are the following.

Common (beam) balance

A beam balance compares the sample mass with a standard reference mass using a horizontal beam.

Two pan balance

This type of balance is commonly used for measuring mass in shops.

Physical balance

It is used in laboratories, to measure mass of an object correct to a milligram.

Weight

Weight is a measure of gravitational force on a body. It varies from place to place. It is measured using spring balance.

Spring balance

It measures weight by the distance a spring stretches under its load.

Medical scale

It is used to measure the body weight of human beings, it has a spring which compresses in proportion to the weight.

Digital balance

Now a days digital balance is used for accurate and quick measurement of weight. It works on strain gauge (length sensitive electrical resistance) scale principle.

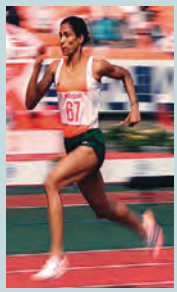
Weigh bridge

It is used to measure weight of very heavy objects such as lorries and trucks using principle of strain gauge.

Hydraulic scale

It is used to measure very heavy loads lifted by cranes which makes use of hydraulic force, to measure weight.

14.4. MEASURING TIME

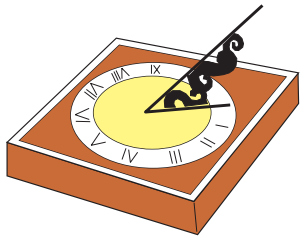


1984 Olympics was disastrous for P.T.Usha as she lost the bronze medal in 400m hurdles by 0.01s (1/100 s). How is the small time like 0.01s measured? Recently digital clocks, atomic clocks and quartz clocks allow the measurement of small times accurately.

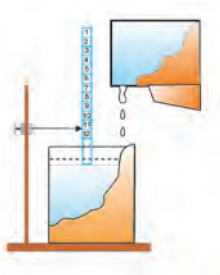
In ancient times, time was measured by sun dials, water clocks, sand clocks and graduated candles. During the night the position of stars (celestial bodies) in the sky was used to find time. All these methods were inaccurate.

Sun dial

It is based on the principle of the shadow of an object being formed on the ground when the sun rises and the sun sets.

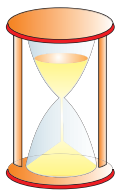


Water clock



These clocks are based on containers which are slowly filled with water coming out at a steady time. Markings on the inside surface is used to measure the passage of time.

Sand clock



These clocks work similar to water clocks. Sand is used instead of water.

Mechanical clock

Galileo's discovery of the pendulum led to the invention of pendulum clock. Watches and small clocks were invented with hair spring (a spiral spring), in which balance wheel is used to keep accurate time.

Quartz clock

Quartz crystal watches offer better performance and accuracy. Quartz crystals vibrate with high frequency. These vibrations are used to indicate time in a liquid crystal display (LCD) digitally.

Atomic clock

The most accurate clocks used now a days are atomic clocks. It is based on the principle of periodic vibration taking place within the ceasium atom.

MORE TO KNOW

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

Local time and Standard time

The local time differs from place to place as it is calculated by the position of the sun. When the sun reaches the highest position in the sky over a place, the time is taken as 12 noon at that place. This is called local time.

Each country selects a standard meridian to set a uniform time irrespective of distances. The standard meridian of India is 82.5^0 E to calculate standard time. This time is called Indian Standard Time (IST)

The standard meridian of England is Greenwich Meridian is called Greenwich Mean Time (GMT). IST is 5½ hour ahead of GMT. i.e. 12 noon in England will be 5.30 pm in India.

An imaginary line drawn between north and south poles of the globe is called meridian. The earth is divided in to 24 time zones spacing 15^0 of longitudes, one for each hour of the day.

The meridian passing through the Royal observatory in Greenwich, England is taken as prime meridian with the origin of 0^0. When it is 7.00 am in New York city, it is 12.00 noon in London, UK and already 9.00 pm in Tokyo, Japan.

Symbols of measurement factors

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

ACTIVITY –14.5

Find your friends weight and time taken for 100 m race and fill it in the following table.

S.No.	Name	weight (kg)	time (s)

EVALUATION

Section A

1. 5×10^{7} μs is equivalent to

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

2. While using Vernier calipers, to measure the internal diameter of a cylindrical pipe, pick out from the parts of the Vernier caliper given below.

   Depth probe, retainer, inside jaws, outside jaws

Section B

3. Match the following.

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

4. In a vernier calipers, the difference between I MSD and 1VSD is found to be 0.1 mm. What does it represent?

5. Kavitha wants to find the thickness of a page of her science textbook which contains 250 pages using vernier calipers. Explain how she might do this appropriately.

6. Calculate the correct readings of the vernier calipers from the given table.

Laest count =0.01 cm Zero correction = Nil

S.No.	MSR	VC	Observed Reading = MSR + (VC x LC) cm	Correct Reading OR ± ZC cm
1.	3	20		
2.	3	25		

7. 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	

8. A student measures the diameter of a bead using a digital vernier calipers. The reading in the vernier caliper is 4.27 cm. If he wants to verify the result with the ordinary vernier calipers with no error,

i) Where would be the zero of the vernier lie in the main scale?

ii) Which divisions of the vernier scale reading coincides with main scale reading.

Section C

9. i) Define least count of an instrument.

ii) Explain types of Zero error of vernier calipers.

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

FURTHER REFERENCE

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2. Complete Physics for IGCSE – Oxford publications

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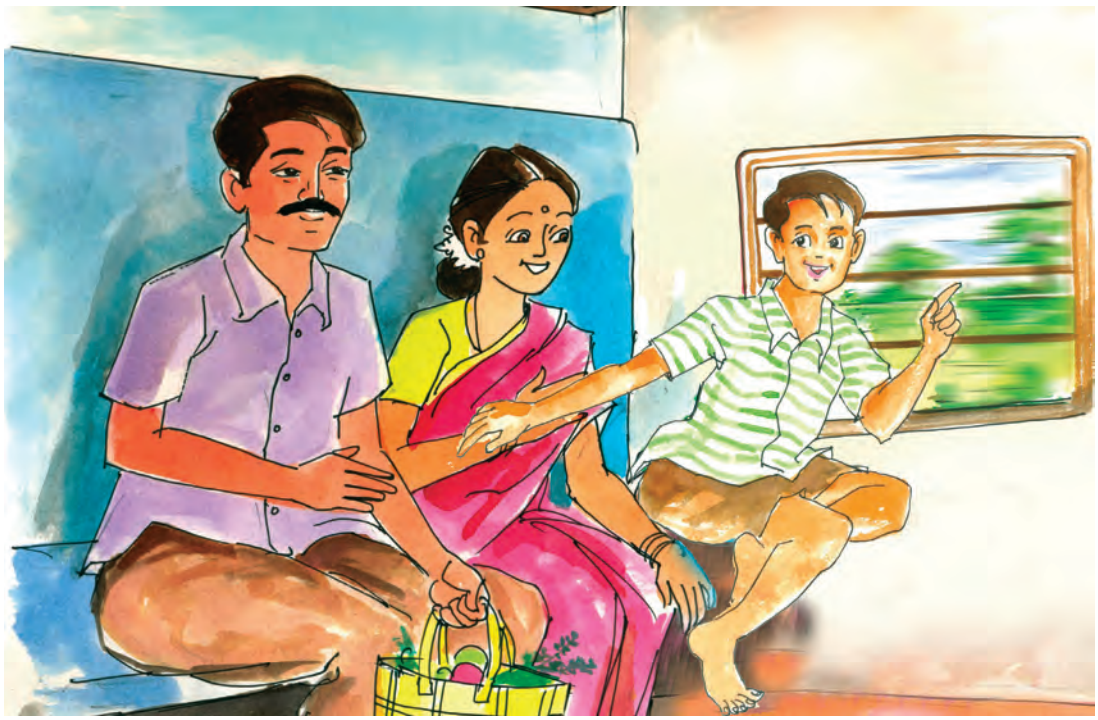
Chapter 15

MOTION AND LIQUIDS

MOTION



Karthik and his parent were going to their native place by train to celebrate pongal festival. Karthik was watching the scenary through the window. He was surprised to see that the trees were seen to be receding. He asked his mother whether the trees really moved backwards. Mother explained that the trees were at rest. The trees seem to be receding because the train is in motion. Let us explain to Karthik and others about rest and motion.

15. MOTION

In the figure, the position of trees around the building is not changing with respect to the building. Then the trees are at rest.

When you are cycling or running, you are changing position with respect to trees and buildings. You are said to be moving.

Inference

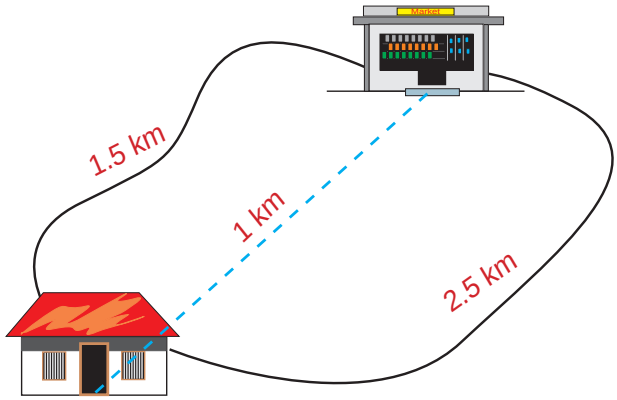
A body is said to be in the state of rest when it remains in the same position with respect to time. A body is said to be in the state of motion, when it continuously changes its position with respect to time.

ACTIVITY –15.2

Discuss which of the objects in the class room are at rest and which are in motion.

Measuring the rate of motion

A farmer takes vegetable from his house to the market everyday. He may travel along two paths to reach the market.



Answer the following questions by observing the figure.

1. What is distance? How much distance does the farmer travel everyday? Distance is the length of the path covered. The farmer travels a distance of 1.5km, when he takes path1 and 2.5 km when he travels along path 2.

Inference

The distance between the two places is not the same; it depends upon the path chosen.

2. What will be the shortest distance between the house and the market? It is the distance covered when travelled along a straight line. It is 1 km. This is known as displacement.

Inference

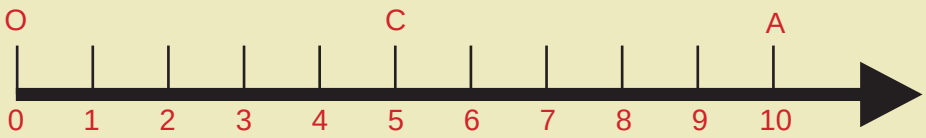
The shortest distance, or distance travelled along a straight line, is known as displacement.

ACTIVITY –15.1

List out certain things which are at rest or in motion related to you.

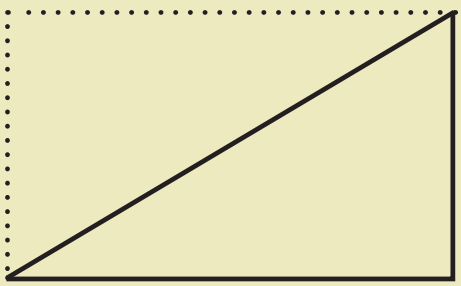
S. No.	Rest	Motion
01	House	Sun
02		
03		
04		
05		

ACTIVITY –15.3



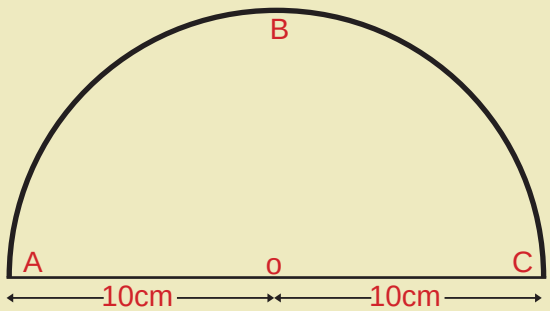
Consider the motion of an ant along a straight line path. The ant starts its journey from 'O'. Let 'A' and 'C' represent the position of the ant at different instances. At first, the ant moves through C and reaches A. Then it moves back along the same path and reaches C. Find the distance travelled by the ant and displacement.

ACTIVITY –15.4



Walk from one corner of your classroom to the opposite corner along the sides. Measure the distance covered by you. Now walk diagonally across to the opposite corner, and measure the displacement. Note the difference.

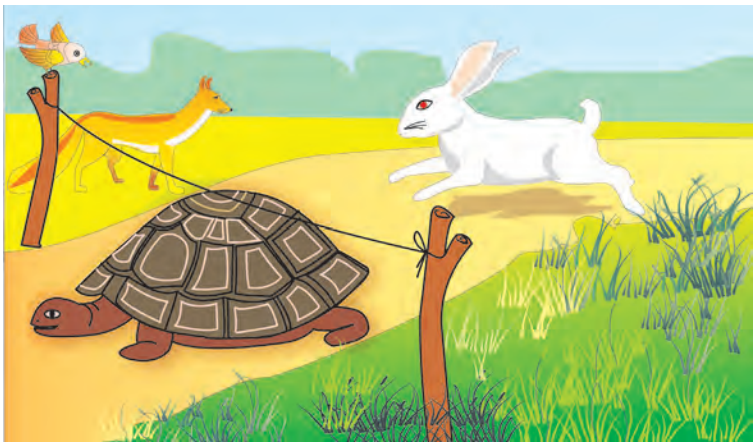
ACTIVITY –15.5



Draw a semicircle of radius 10cm. Measure the path ABC(distance) and AOC(displacement). You can observe that distance = 31.4cm and displacement = 20cm.

15.1. UNIFORM MOTION AND NON UNIFORM MOTION

Consider the race between the hare and the tortoise. The data regarding the motion of the two are given in the table.



Time (minute)	Distance travelled by hare(m)	Distance travelled by tortoise(m)
5	10	5
10	30	10
15	35	15
20	35	20
25	35	25
30	35	30
35	35	35
40	35	40
45	35	45
50	48	50

From the data, we notice that the tortoise covers 5m in every 5 minute. It covers the same distance in a particular time throughout its motion. This type of motion is known as uniform motion.

If an object covers equal distances in equal intervals of time, it is said to be in uniform motion.

The hare, in its motion, covers different distances in a particular time. This type of motion is known as non-uniform motion.

If an object covers unequal distance in equal intervals of time, it is said to be in non-uniform motion.

15.2. MEASURING THE RATE OF MOTION

Speed

A car starts from Salem and reaches Chennai in 6 hour. A bus takes 8 hour to travel the same distance.

Which has moved faster? Why?

The car travels faster than the bus, because it covers the distance in a short time.

Inference

When a body covers a distance in a short time, it is said to be fast. If it takes more time to cover the distance, it is said to be slow.

Speed is the quantity used to say whether the motion is slow or fast. Speed is the distance travelled in one second (or) rate of distance travelled.

$$\text{Speed} = \frac{\text{Total Distance travelled}}{\text{Time taken}}$$

Speed is measured in m/s (or) ms^{-1}

It can also be expressed in km/hour (or) kmh^{-1}

Example

A train moves with a speed of 100 km/hour, means it will cover a distance of 100km in 1 hour.

ACTIVITY –15.6

List some examples of uniform and non uniform motion.

Uniform	Non-uniform
Oscillation of pendulum of a wall clock.	Movement of a car in a crowded street.

Try this:

A car takes 6 hours to cover a distance of 300 km. What is its speed?

If the same car travels with a speed of 60km/hour, how much time it will take to travell the same distance?

If it has to cover the distance in 5 hour, what will be the speed?

Velocity

When we speak of speed, the direction of motion is not considered. If we take into account the direction of motion also, then we can understand the motion clearly. (The speed with direction is known as velocity).

To measure the velocity, we should consider displacement instead of distance.

Velocity is the displacement made in one second (or) rate of change of displacement.

Rate of change means, change per second.

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

It is also expressed in m/s

Uniform Velocity

Equal displacement covered by a body in equal intervals of time is known as uniform velocity.

15.3. RATE OF CHANGE OF VELOCITY

During uniform motion of an object along a straight line, the change in the velocity of the object for any time interval is zero. However, in non-uniform motion, velocity varies with time. How can we now express the change in velocity of an object?

For this, we have to introduce another physical quantity called acceleration.

Acceleration is the change in velocity of an object per second or rate of change of velocity.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time taken}}$$

The unit of acceleration is m/s^2 or ms^{-2}

If the velocity of the body increases with time, the acceleration is positive, and the kind of motion is called accelerated motion. If the velocity of the body decreases with time, the acceleration is negative (retardation), and the motion is called decelerated motion.

Uniform Acceleration

If an object travels in a straight line and its velocity increases or decreases by equal amount in equal intervals of time, then the acceleration of the object is uniform.

Example

A car moves with a uniform acceleration of 8 m/s^2, means its velocity increases by 8 m/s for every second.

A train moves with a uniform acceleration of -10 m/s^2 or retardation of 10 m/s^2, means its velocity will decrease by 10 m/s for every second.

The velocity of a car changes from 10 m/s to 50 m/s. What will be its acceleration?

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time taken}}$$

$$a = \frac{(\text{final velocity - initial velocity})}{\text{Time}}$$

$$a = \frac{(50 - 10)}{10}$$

$$a = \frac{40}{10}$$

$$a = 4\ m/s^2$$

From the above example, we can give a formula for acceleration.

$$a = \frac{v - u}{t}$$

where,

u - initial velocity

v - final velocity

t - time

MORE TO KNOW

S.No.	Motion	Speed	
		ms^{-1}	Kmh^{-1}
1	Rat	0.5	1.8
2	Man	1.0	3.6
3	Bee	5.0	18
4	P.T.Usha	9	32.4
5	Cheetah	24	90
6	Speed of sound	340	1224
7	Speed of light	$3x10^8$	$10.8x10^8$

ACTIVITY –15.7

From the following motion of different buses, find whether the acceleration is (a) uniform positive (b) non uniform positive (c) zero (d) uniform negative and (e) non uniform negative.

Time (s)	Speed (km h^{-1})				
	Bus A	Bus B	Bus C	Bus D	Bus E
2	10	10	0	3	20
4	10	8	4	6	18
6	10	6	6	9	14
8	10	4	9	12	8
10	10	2	12	15	3
12	10	0	14	18	0

15.4 GRAPHICAL REPRESENTATION OF MOTION

Distance - time graph

We can easily understand the relation between time and distance by using a graph.

Taking a suitable scale, 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.

Uniform 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

ACTIVITY –15.8

The time of arrival of a lorry at Madurai, Thirnelveli and Nagarcoil from Trichy and the corresponding distance from Trichy are given in the following table.

station	distance (km)	time of arrival
Trichy	0	5.00 am
Madurai	120	8.00 am
Thirunelveli	270	11.45 am
Nagarcoil	350	1.45 pm

Plot the distance-time graph for the lorry and find the speed of the lorry from the graph.

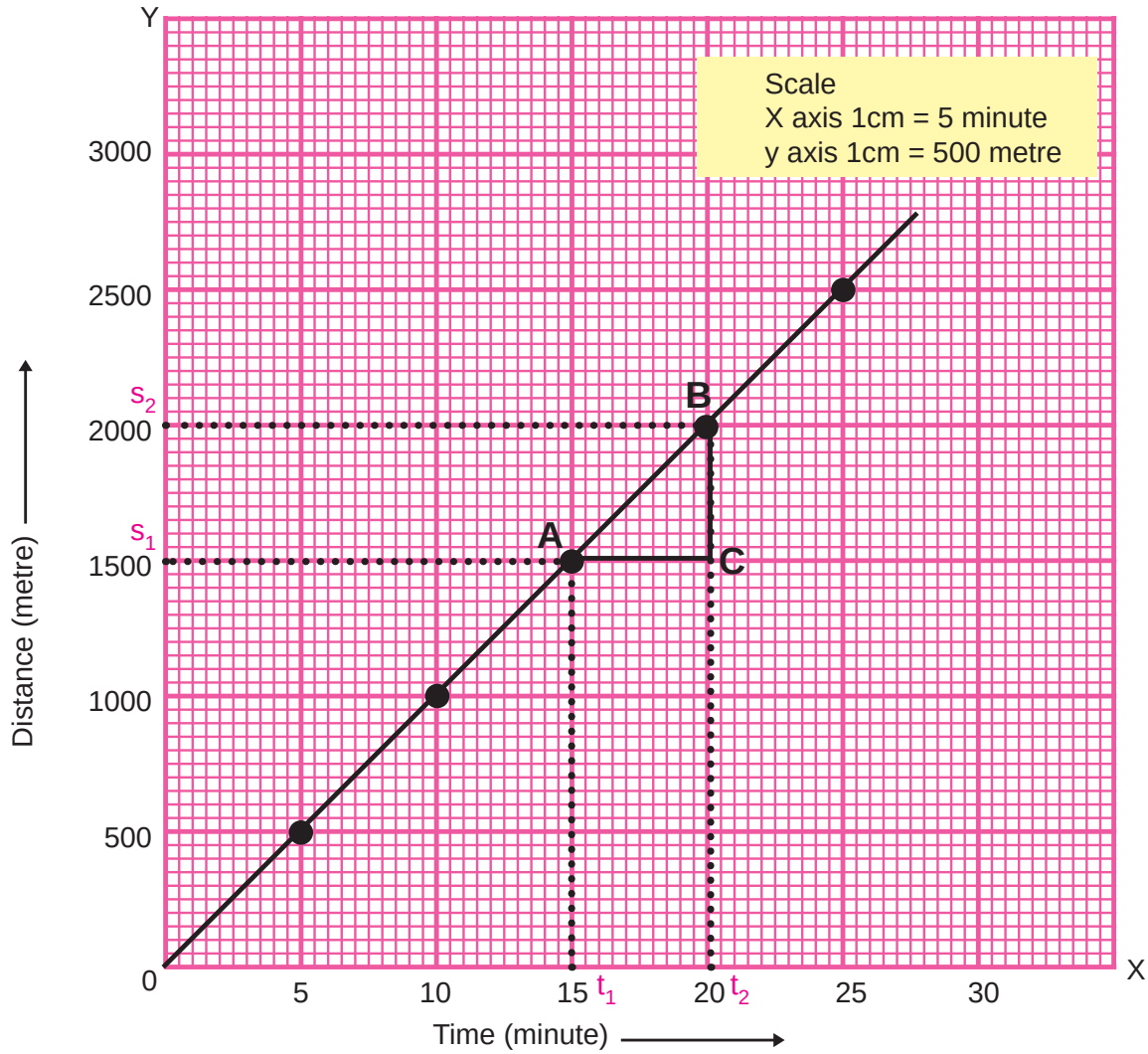


Fig 15.1

Here, Murugan covers equal distance in equal intervals of time. He walks with uniform speed. The graph is a straight line for uniform speed.

The speed of Murugan can be found from the distance-time graph as shown in Fig 15.1. Consider a small part AB. From B draw a 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 (s_2-s_1) and AC denotes the time interval (t_2-t_1). Speed of the object,

$$v = \frac{(S_2 - S_1)}{(t_2 - t_1)} = \frac{BC}{AC}$$

Accelerated motion (Non uniform velocity)

The following table shows the distance travelled by a car in a time interval of 2 s.

Time s	0	2	4	6	8	10	12
Distance m	0	1	4	9	16	25	36

The distance - time graph, for the motion of the car, is shown in Fig 15.2.

The nature of the graph shows, non-linear variation of the distance travelled by the car. Thus the graph represents motion with non-uniform speed.

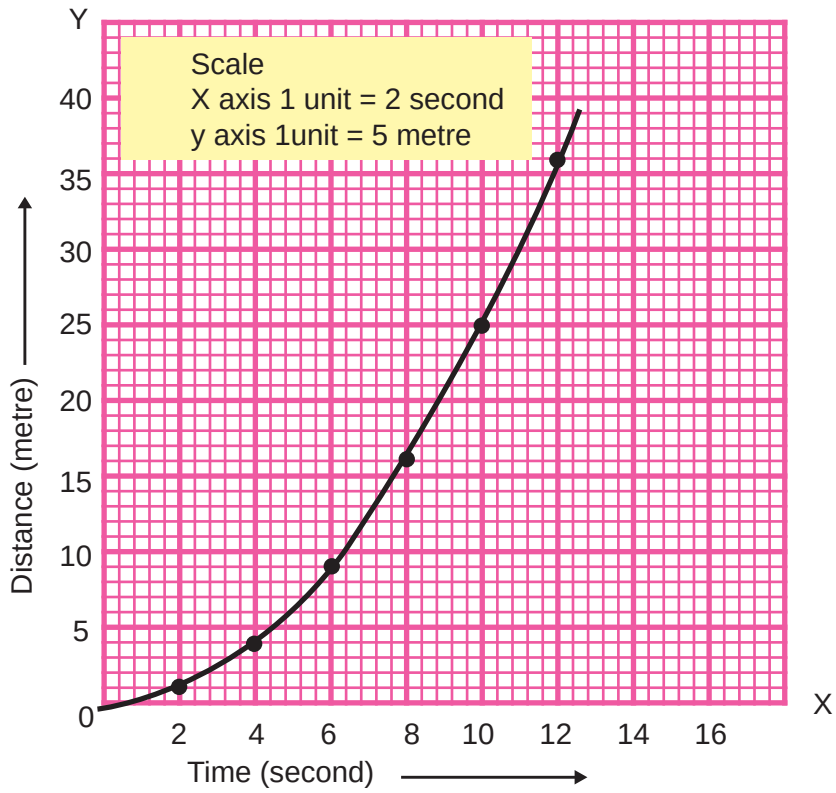


Fig 15.2.

Velocity-Time graph

The variation in velocity with time for an object moving in a straight line can be represented by a velocity-time graph.

Uniform velocity (Un-accelerated motion)

The following graph shows the velocity-time graph for a car moving with uniform velocity of 40kmh^{-1}.

In this graph, time is taken along the x axis and velocity is taken along the y axis.

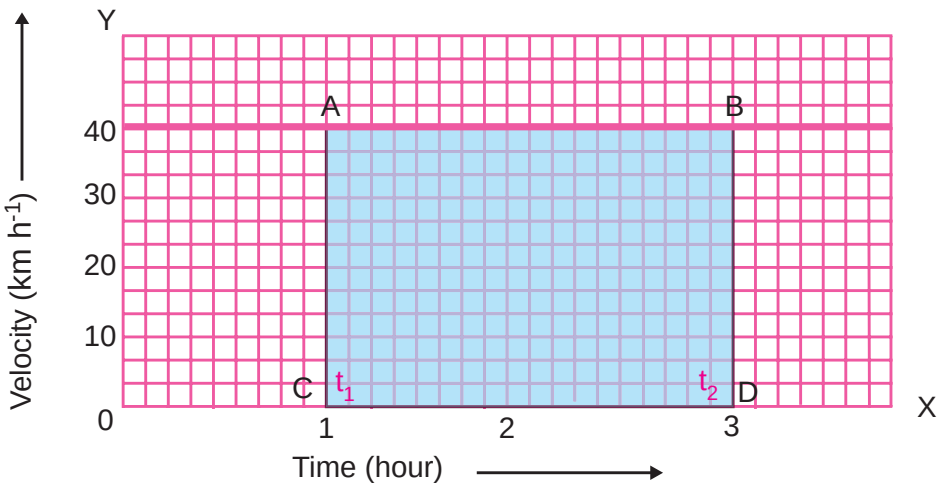


Fig 15.3.

In the graph (Fig 15.3), AC or BD represents the velocity and CD or AB represents time $t_2 - t_1 = 3 - 1 = 2$ hour.

We have,

Displacement = velocity x time

s = AC x CD or AB x BD

= 40 x 2

= 80 km

Uniformly accelerated motion

The following table shows the velocity of a car at regular intervals during a test drive.

Time (s)	Velocity (km h^{-1})
0	0
5	2.5
10	5.0
15	7.5
20	10.0
25	12.5

The velocity-time graph for the motion of the car is shown as in Fig 15.4.

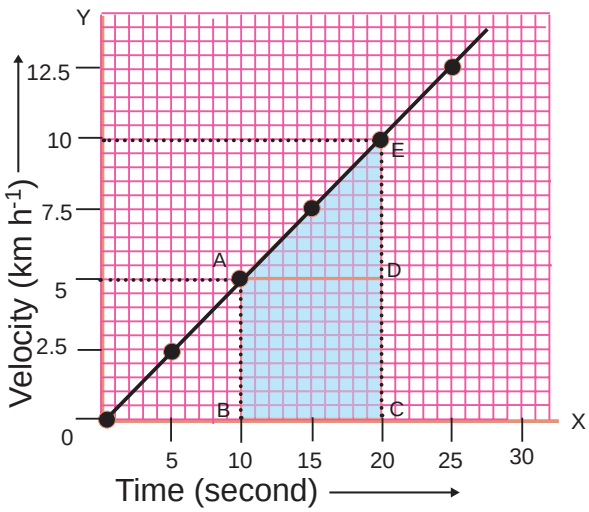


Fig 15.4.

The nature of the graph shows that velocity changes by equal amounts in equal intervals of time. The displacement 's' of the car will be given by area ABCDE under the velocity-time graph.

s = Area ABCDE

s = Area of the rectangle ABCD + area of the triangle ADE

$$s = AB \times BC + \frac{1}{2}(AD \times DE)$$

Non-uniformly accelerated motion

In the case of non-uniformly accelerated motion, velocity-time graph can have any shape.

The following velocity-time graph, as shown in Fig 15.5, represents the non-uniform variation of velocity of a car with time.

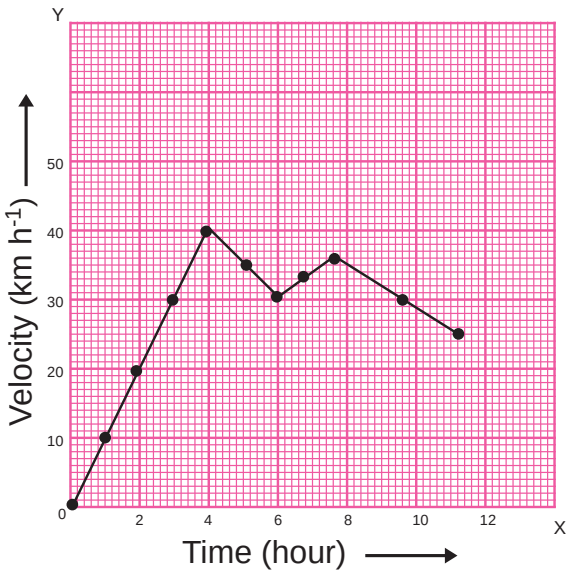


Fig 15.5.

ACTIVITY –15.9

Form two groups A & B consist of 5 students each. The two groups stand at two junctions of the road separated by a distance of 500 m. Let the two groups record the vehicle number, types of vehicle and time of crossing the junctions on either side for 15 minute. From the data, calculate the speed of different vehicles and the number of vehicles violated the speed limit.

ACTIVITY –15.10

Rahul and his sister Ramya go to school on their bicycles. Both of them start at the same time from their home, they take different time to reach school, although they follow the same route.

The following table shows the distance travelled by them in different times.

Time	Distance travelled by Rahul (km)	Distance travelled by Ramya (km)
8.00 am	0	0
8.05 am	1.0	1.0
8.10 am	2.0	1.9
8.15 am	3.0	2.7
8.20 am	4.0	3.5
8.25 am	--	4.0

Plot the distance-time graph for their motions on the same scale and explain.

15.5. EQUATIONS OF MOTION (GRAPHICAL METHOD)

Consider an object moving along a straight line with a uniform acceleration 'a'. The velocity of the object changes from u to v in a time t. s is the displacement of the object, in the time t.

The velocity-time graph of the object is shown in Fig 15.6.

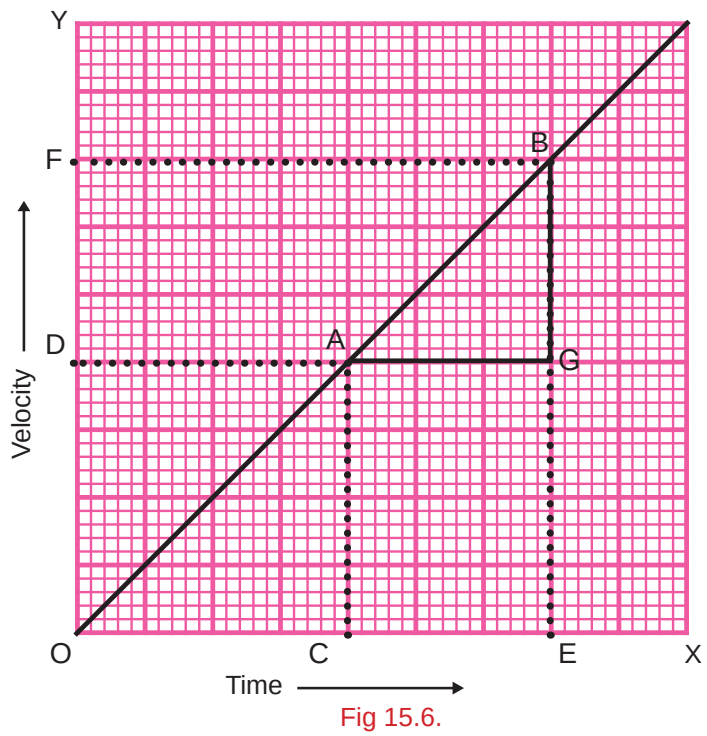


Fig 15.6.

A and B are two points taken on the graph. The velocity at A is the initial velocity u and that at B is the final velocity v.

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.

Equation for velocity at a time

In the graph, AC gives the initial velocity (u). BE gives the final velocity (v). CE represents the time taken t. DF gives the change in velocity.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time}}$$

$$a = \frac{DF}{CE} = \frac{OF-OD}{OE-OC}$$

But OE - OC = t

$$a = \frac{v-u}{t}$$

$v - u = at$ …… (i)

$v = u+at$ ……(I)

Equation for displacement

Let 's' be the displacement of the body in a time t.

In the graph,

Displacement = Area CABE

s = Area of the rectangle CAGE + Area of the triangle ABG.

$s = AC \times CE + \frac{1}{2}(AG \times GB)$

Here AC = u

CE = t

AG = t

GB = v-u = at [from(i)]

$s = ut + \frac{1}{2} \times t \times at$

$s = ut + \frac{1}{2} at^2$ ……. (II)

Equation for velocity at a position

In the graph,

Displacement = Area of the trapezium CABE

$s = \frac{1}{2}(AC+EB) \times CE$

Here AC = u

EB = v, CE = t

$s = \frac{u + v}{2} \times t$ ……(ii)

From (i), $t = \frac{v - u}{a}$

Substituting the value of t,

$s = \frac{u + v}{2} \times \frac{v - u}{a}$

$s = \frac{v^2 - u^2}{2a}$

$v^2 - u^2 = 2as$

$v^2 = u^2 + 2as$ ……(III)

(I), (II) and (III) are the equations of motion.

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 a maximum height.The body is decelarated or retarded.

When the body is allowed to fall down, the velocity gradually increases. Now the body is accelerated.

The decelaration or acceleration due to the gravitational force of earth is known as accelaration due to gravity, denoted as '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 for every second and the velocity of a body falling down increases by 9.8m for every second.

The equations of motion for this body can be obtained from the equations of motion.

$v = u + at$

$s = ut + \frac{1}{2} at^2$

$v^2 = u^2 + 2as$

For the body thrown upwards, equations can be obtained by substituting a = -g and s = h

we get, $v = u - gt$

$h = ut - \frac{1}{2} gt^2$

$v^2 = u^2 - 2gh$

When a body allowed to fall freely, u = 0. a = g and s = h

Now, the equations will be

$v = gt$

$h = \frac{1}{2} gt^2$

$v^2 = 2gh$

15.6. UNIFORM CIRCULAR MOTION

An athlete runs along the circumference of a circular path. This type of motion is known as circular motion.

The movement of an object in a circular path is called circular motion. When an object moves in a circular path with a constant velocity, its motion is called uniform circular motion.

In uniform circular motion, the magnitude of the velocity is constant at all points and the direction of the velocity changes continuously.

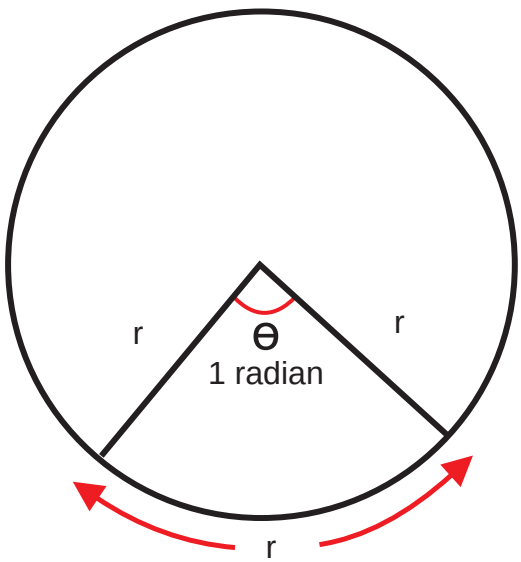
How is the velocity of the body moving along a given circular path?

Already we have given the velocity by using displacement. This is termed as linear velocity. Now we can give the velocity in another way by considering the angle covered by the body. This is known as angular velocity.

In what unit, do we measure angle?

Angle is measured in degree. But we can have another unit called radian.

One radian is the angle subtended by an arc of a circle of length equal to its radius at the centre of the circle.



Angular displacement

The angle covered by the line joining the body and the centre of the circle (radius vector). It is measured in radian.

Angular velocity

The angular displacement in one second (rate of change of angular displacement) is called angular velocity.

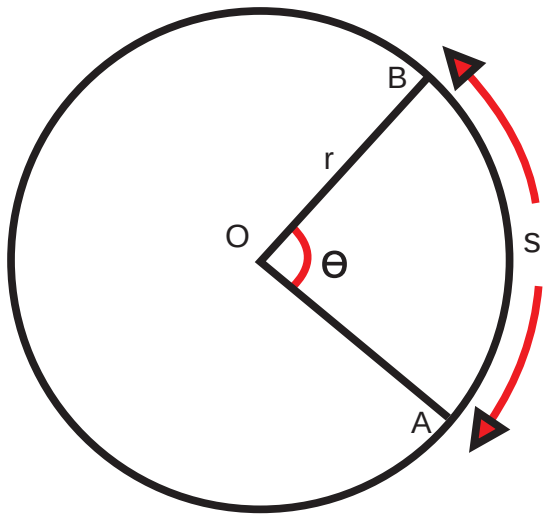
$$\text{Angular velocity} = \frac{\text{angular displacement}}{\text{time taken}}$$

$$\omega = \frac{\theta}{t}$$

Can you give the unit of angular velocity?

It is radian / second.

Relation between linear velocity and angular velocity



Consider a body moving along the circumference of a circle of radius r with linear velocity v. Its angular velocity is ω. Let the body moves from A to B in a time t and θ is the angle covered.

Let AB = S = displacement

Linear velocity = displacement / time

$$v = \frac{AB}{t}$$

$$v = \frac{S}{t} \quad \ldots\ldots\ldots\ldots(1)$$

If θ is the angle subtended by an arc of length s and radius r. Then

$S = r\theta$ ……(2)

Substituting (2) in (1),

$$v = \frac{r\theta}{t}$$

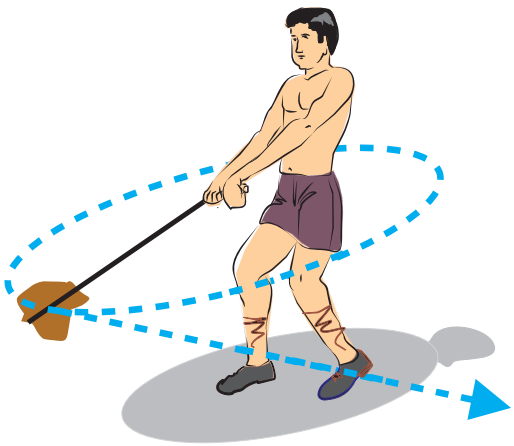
But $\frac{\theta}{t} = \omega$ = angular velocity

$v = r\omega$

Linear velocity = Radius of the circle x Angular velocity

15.6.1. CENTRIPETAL FORCE AND CENTRIFUGAL FORCE

Take a piece of thread and tie a stone at one of its ends. Move the stone to describe a circular path with constant speed by holding the thread at the other end as shown in the figure.



Now let the stone go by releasing the thread. Repeat the activity for few times and release the stone at different positions. Check the direction of motion of the stone.

We notice that the stone moves along a straight line tangential to the circular path. This is because once the stone is released, it continues to move along the direction it has been moving at that instant. This shows that the direction of motion changed at every point when the stone was moving along the circular path.

This shows that there is a force acting along the string directed inwards, makes the body move in the circular path. This force is known as centripetal force.

The constant force that acts on the body along the radius towards the centre and perpendicular to the velocity of the body is known as centripetal force.

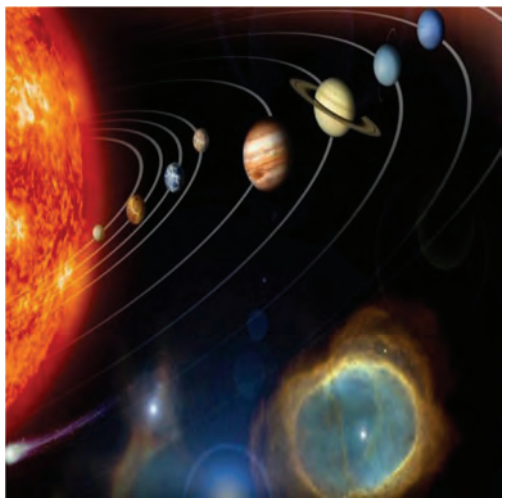
Let us consider an object of mass m, moving along a circular path of radius r, with an angular velocity ω and linear velocity v.

$$F = \frac{mv^2}{r}$$

Again, centripetal force, $F = mr\omega^2$ (since $v = r\omega$)

Examples

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 planets revolving round the sun or the moon revolves around the earth, the centripetal force is provided by the gravitational force of attraction between them.



4. For an electron revolving around the nucleus in a circular path, the electro static force of attraction between the electron and the nucleus provides the necessary centripetal force.

In the first example (stone), not only is the stone acted upon by a force (centripetal force) along the string towards the centre, but the stone also exerts an equal and opposite force on the hand away from the centre along the string.

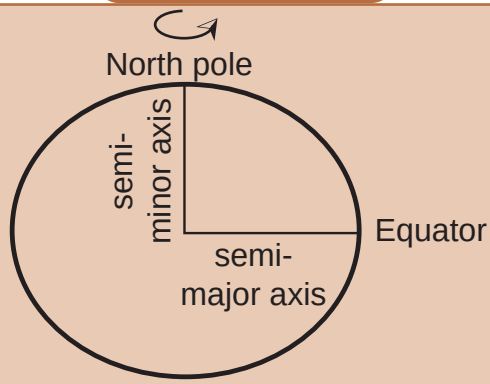
The force, which is equal in magnitude but opposite in direction to the centripetal force is known as centrifugal force.

Examples

1. While churning curd, butter goes to the side due to centrifugal force.

2. A cyclist turning a corner leans inwards. Now the frictional force (centripetal force) is balanced by the centrifugal force $\frac{mv^2}{r}$

MORE TO KNOW



The earth is flattened at the poles and bulged at the equator. The diameter of the earth is 48 km more at the equator than at the poles. The velocity of the particles at the equator is more than the velocity of the particles at the poles. So centrifugal force acting on the particles is more at the equator. This is the reason for the bulging of the earth at the equator.

15.7. LIQUIDS

Liquids flow from one place to another. They have a definite volume. They take the shape of the container. Liquids show very little change in volume even when large compressive forces are applied. So we assume that liquids are incompressible.

15.7.1. UPTHRUST AND BUOYANCY

ACTIVITY –15.11

Take a piece of cork, press it inside water in a beaker. What do you feel? press it to more depth. What difference do you notice at various depths?

You will find it more difficult to push it as it goes deeper. This indicates that water exerts force on the cork in the uphold direction. The upward force exerted by water goes on increasing as the cork is pressed deeper.

We know that, pressure at any point inside a liquid is p = hdg. This shows that pressure increases with depth.

When a body floats or immerses in a liquid, the pressure on the bottom surface is more than that the pressure on the top surface. Due to the difference in pressure, an upward force acts on the body. This upward force is called upthrust or buoyant force. The buoyant force is equal to the weight of the liquid displaced.

The buoyant force (upthrust) acts through the centre of gravity of the displaced liquid which is known as centre of buoyancy.

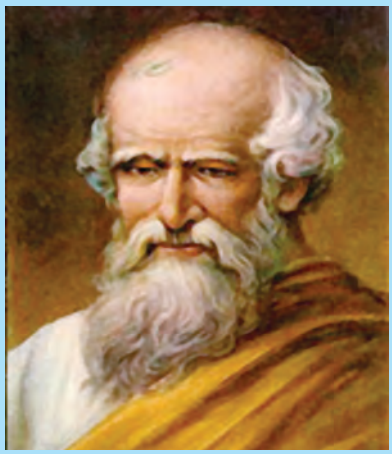
Due to the upthrust exerted on the body by the liquid, the weight of the body appears to be less when the body is immersed in the liquid.

For example, when we immerse a mug into a bucket of water, the mug filled with water appears to be lighter as long as it is under water. But when it is lifted up out of the water we feel that the mug is heavier. This shows that the weight of the body under water is less than its weight when it is above the surface of water.

15.7.2. ARCHIMEDES

Archimedes

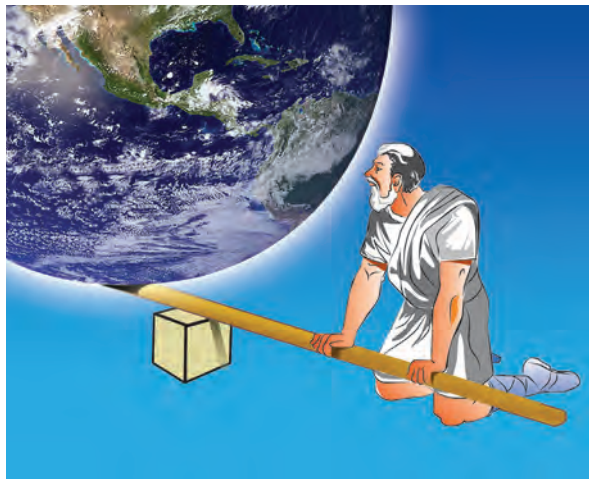
Archimedes was a Greek scientist (287 – 212 BC)



Archimedes discovered many important principles of statics and hydrostatics 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, which was the centre of learning in those days.

Lever

He invented the water screw for irrigating the fields of Egypt. He discovered the principle of lever and is reported to have said to the king : “Give me a place where I may stand and I will move the world”. He invented many mechanical devices to drop heavy weights on Roman ships which attacked the Greeks.



Eureka

The famous principle in hydrostatics, known as Archimedes principle is said to have been proposed under very peculiar circumstances. The king had ordered a jeweller to make for him a crown of gold as an offering to God. When the crown was delivered, the king suspected it, be adulterated with silver and so he asked Archimedes to investigate. When Archimedes kept pondering over the matter; one day, during his bath, he observed that his limbs were buoyed up. It at once struck him that all bodies immersed in water would lose weight in

this way. This excited him so much that forgetting to dress himself up, he ran out of his bath shouting "EUREKA" which means, "I have found it".

ACTIVITY –15.12

Perform a skit in the school on the life history of Archimedes.

Archimedes Principle

When a body is immersed in fluid (liquid or gas) it experiences an apparent loss of weight which is equal to the weight of the fluid displaced.

Experiment to verify 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 in to the water of an overflowing jar filled to its maximum capacity with water as shown in figure.

Now note the weight of the stone (w_2)

Find the weight of a beaker (w_3)

Collect the overflowing water in the beaker.

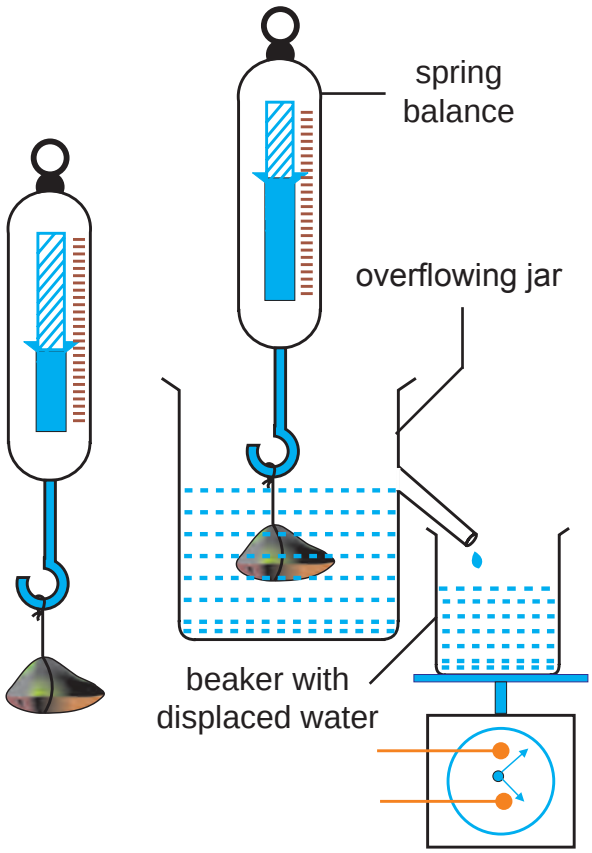
Weigh the beaker with water (w_4)

Find the weight of the displaced water ($w_4 - w_3$)

Find the loss of weight of the stone ($w_1 - w_2$)

We find that $(w_1 - w_2) = (w_4 - w_3)$.

Thus Archimedes Principle is verified.



15.7.3. RELATIVE DENSITY

Density

Density of a body is defined as the mass per unit volume of the body.

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

Unit of density is Kg m^{-3}

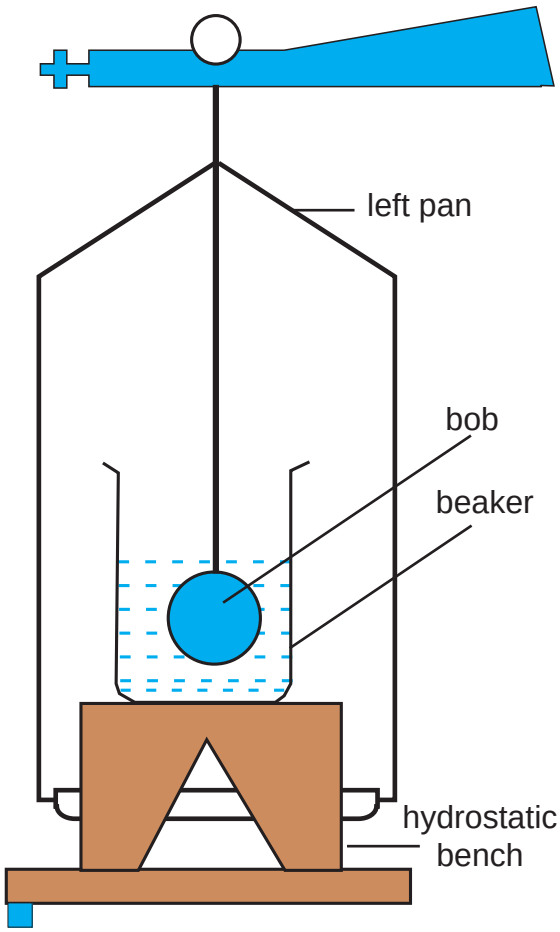
Relative density

Relative density is defined as the ratio of density of the body to the density of water.

It has no unit.

Determination of Relative density

1. To determine the relative density of a insoluble solid heavier than water using Archimedes principle.



Suspend the given body from the hook of the left scale pan of the physical balance.

Find the mass in air. (m_1)

Immerse the body in a beaker of water placed on a hydrostatic bench.

Find the mass in water. (m_2)

Take care that there are no air bubbles sticking to the body, that the body is not touching the sides or bottom of the beaker and that the body is completely immersed inside water.

Calculation

Mass of the solid in air = m_1 g

Mass of the solid in water = m_2 g

Loss of mass in water = $(m_1 - m_2)$ g

Mass of displaced water = $(m_1 - m_2)$ g

Volume of water displaced = $(m_1 - m_2)$ cc

(since 1 gm of water has a volume of 1 cc)

Volume of the body = $(m_1 - m_2)$ cc

Density of the solid

$$= \frac{\text{Mass of the substance}}{\text{Volume of the substance}}$$

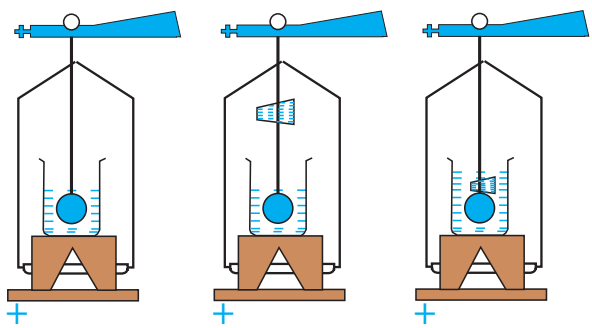
$$= \frac{m_1}{m_1 - m_2} \text{ g cm}^{-3}$$

$$\text{Relative density of the solid} = \frac{m_1}{m_1 - m_2}$$

no unit

(since the density of water = 1 g cm^{-3})

2. Relative density of a solid lighter than water (cork)



A brass bob can be used as a sinker in order to keep the cork in water.

Suspend the brass bob from the left scale pan.

Immerse it in a beaker of water placed on a hydrostatic bench.

Find the mass. (m_1)

Tie the cork to the same string in such a way that it is in air and the brass bob is in water.

Find the mass. (m_2)

Tie the cork together with the bob.

Immerse both of them in water.

Find the mass. (m_3)

Mass of the cork in air = $(m_2 - m_1)$ g

Mass of the cork in water = $(m_3 - m_1)$ g

Loss of mass of cork in water = $(m_2 - m_1) - (m_3 - m_1)$ g = $(m_2 - m_3)$ g

Relative density of cork

$$= \frac{\text{Mass in air}}{\text{Loss of mass in water}}$$

$$= \frac{m_2 - m_1}{m_2 - m_3} \quad \text{(no unit)}$$

3. Relative density of a liquid

Take a brass bob which is insoluble either in water or in the given liquid.

Suspend the brass bob from the hook of the left scale pan.

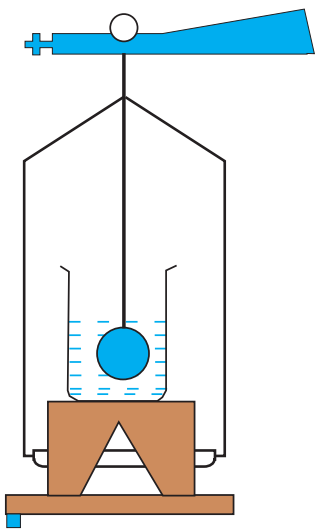
Find the mass. (m_1)

Immerse the bob in a beaker of water placed on a hydrostatic bench.

Find the mass. (m_2)

Now immerse the bob in the given liquid.

Find the mass. (m_3)



Calculations

Mass of the solid in air = m_1 g

Mass of the solid in water = m_2 g

Mass of the solid in liquid = m_3 g

Loss of mass in water = $(m_1 - m_2)$ g

Loss of mass in liquid = $(m_1 - m_3)$ g

Volumes of water displaced and liquid displaced are equal.

Relative density of the liquid

$$= \frac{\text{Loss of mass in liquid}}{\text{Loss of mass in water}}$$

$$= \frac{m_1 - m_3}{m_1 - m_2} \quad \text{(no unit)}$$

15.7.4 EXPLANATION FOR A BODY WHOLLY OR PARTIALLY IMMERSED IN A LIQUID

ACTIVITY –15.13

Take a beaker filled with water.

Take a piece of cork and an iron nail of equal mass.

Place them on the surface of water.

observe what happens?

The cork floats while the nail sinks. This is because of the difference in their densities. The density of cork is lesser than the density of water. This means that the upthrust of water on the cork is greater than the weight of the cork. So it floats.

The density of the iron nail is more than the density of the water. This means that the upthrust of water on the iron is lesser than the weight of the nail. So it sinks.

An iron piece floats in mercury, but sinks in water .This is because the density of mercury (13600 kg m^{-3}) is greater than

the density of water (1000 kg m^{-3}). Even though the volumes of mercury and water displaced are equal to the volume of the iron piece, the weight of mercury displaced by the iron piece (upthurst) is greater than the weight of iron piece. But the weight of water displaced is lesser than the weight of iron piece.

A ship made up of iron floats in water. This is because the ship is hollow and contains air. The large space inside the ship enables it to displace a volume of water much greater than the actual volume of iron that was used in the construction. So the weight of water displaced is greater than the weight of the ship.

A body which floats in a liquid is in equilibrium under the action of the two forces. (a) It's weight acting vertically downwards and (b)the resultant thurst on it due to the liquid acting upwards. These two forces must be equal and opposite. The resultant upthurst may be equal to or greater than the weight of the liquid by the body, and that it acts through the centre of gravity of the displaced liquid.

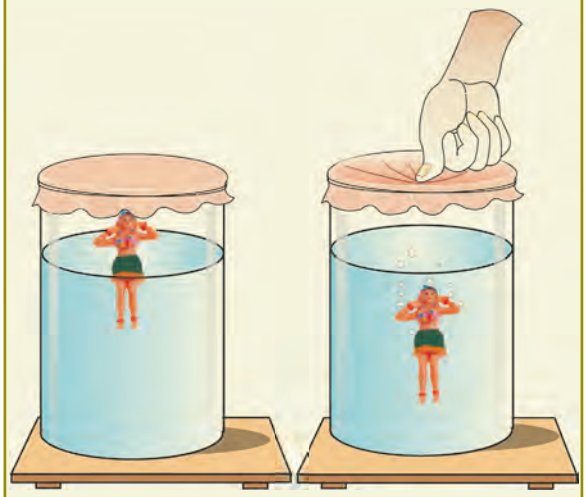
Laws of floatation

1. The weight of the floating body is equal to the weight of the liquid displaced by it .
2. The centre of gravity of the floating body and the centre of gravity of the liquid displaced (centre of buoyancy) are in the same vertical line.

MORE TO KNOW

The density of air is 14 times grater than that of hydrogen. The weight of a hydrogen filled balloon is much less than the weight of the air it displaces. The difference between the two weights gives the lifting power of the balloon. Thus a hydrogen filled balloon flies high in the air.

ACTIVITY –15.14



Take a small hollow plastic doll. Put a hole. Take a container with water. Cover the mouth of the container with a rubber sheet. Press the rubber sheet. Now the doll sinks in water.

When the rubber sheet is pressed, the pressure inside the container increases and it forces the water to enter into the doll through the hole. the weight of the doll is now more than the weight of the water displaced by it.

Hydrometers

The laws of floatation are made use of in the construction of hydrometers used for the determination of the specific gravities of solids and liquids.

There are two types of hydrometers (1) The constant immersion hydrometer, in which the weight of the hydrometer is adjusted to make it sink to the same fixed mark in all liquids.

(2) The variable immersion hydrometer in which the weight of the hydrometer remains the same , but the depth to which it sinks in different liquids vary.

The common hydrometer

The common hydrometer is of variable immersion type. It is graduated such that the specific gravity of a liquid can be directly determined. 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 leadshots to make the hydrometer to float vertically in various liquids as shown in Fig 15.7. To find the specific gravity of the liquid, float the hydrometer in the liquid. The reading on the stem indicates the specific gravity of the liquid.

Usually, two different hydrometers, one used for liquids denser than water, and the other, for liquids lighter than water are provided.

A common hydrometer used to test the purity of milk by noting its specific gravity is called a LACTOMETER.

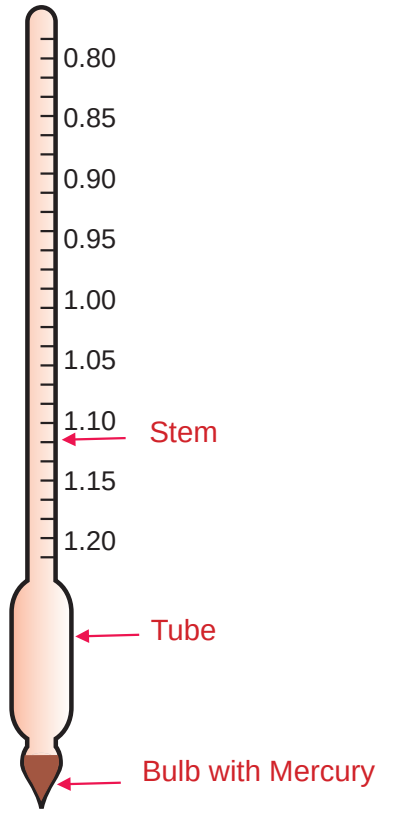
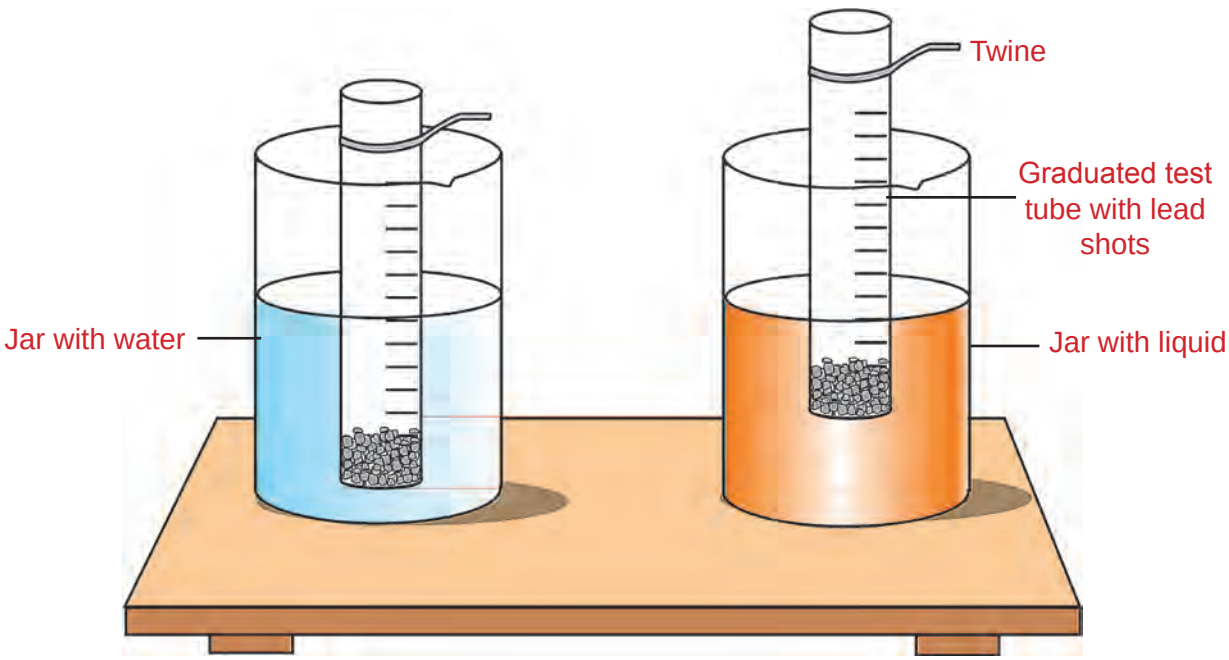


Fig. 15.7. Common hydrometer

Test tube float



A test tube float consists of a flat bottomed test tube of uniform area of cross section. It is graduated in centimetre from the bottom to the top to measure the depth of immersion in a liquid. The float is made heavy by adding lead shots or sand to enable it to float vertically.

Experiment to find the specific gravity of a liquid using a test tube float as a variable immersion hydrometer

Take two tall jars of the same capacity. Fill one of them with water and the other with the given liquid whose specific gravity is to be found.

Take a graduated test tube and add lead shots or sand to make it heavy so that it floats vertically.

Tie a long thread near the mouth of the test tube to enable us to lower the float in to the jar. Immerse the loaded float first in the jar of water. Take care that the float does not touch the sides or bottom of the jar and there should be no air bubbles sticking to the sides of the float. Note the depth of immersion in water (h_1) without parrallax error. Gently take the float out from the water . Wipe the water droplets on the sides with a clean cloth.

Now gently lower the float into the jar containing the liquid.(Do not add or remove any lead shots). Note the depth of immersion of the float in the liquid (h_2).

Specific gravity of the liquid =

$$\frac{\text{Depth of immersion of the float in water}}{\text{Depth of immersion of the float in liquid}} = \frac{h_1}{h_2}$$

Now add or remove a few lead shots and repeat the experiment.

Note down $h_1$and h_2 in each case .Repeat the experiment and tabulate the readings.

Take the average value of $\frac{h_1}{h_2}$ as the specific gravity of the liquid .

Theory

Weight of water displaced = ah_1d_1g

Weight of liquid displaced =ah_2d_2g

Where, a-area of cross section of the float

d_1-density of water

d_2-density of liquid

g-acceleration due to gravity

Since the weight of the test tube float is the same in both the cases

Weight of liquid displaced=weight of water displaced

$$ah_2d_2g = ah_1d_1g$$

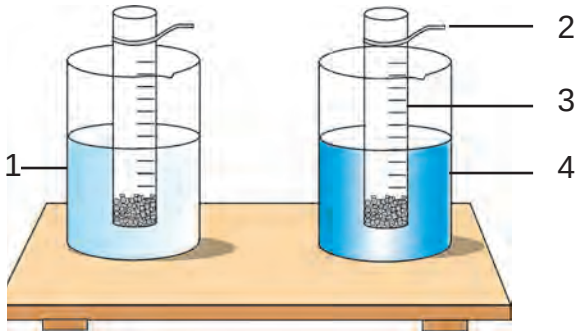
$$\frac{d_2}{d_1} = \frac{h_1}{h_2}$$

Specific gravity of the liquid = $\frac{h_1}{h_2}$

Sl.no	Depth of immersion of the float		Specific gravity of the liquid = $\frac{h_1}{h_2}$ (no unit)
	in water (h_1) cm	in liquid (h_2) cm	
1			
2			
3			
4			
5			

Experiment to find the specific gravity of a liquid using a test tube float as a constant immersion hydrometer

Make the test tube float to float in water vertically to a certain height 'h'. Take care that the test tube float does not touch the sides or bottom of the jar . Take the float out and wipe the outside dry. Find the weight of the float in water(w_1) . Now make the test tube float to float in the given liquid. Add or remove lead shots so that it floats to the same depth 'h'. Take the test tube float out , wipe the outside dry. Find the weight of the float in liquid (w_2).Repeat the experiment for different depths and tabulate the readings.



1. Jar with water 2. Twine
3. Graduated test tube with lead shots
4. Jar with liquid

S.no	Weight of the float		Specific gravity = $\frac{w_2}{w_1}$ (no unit)
	In water (w_1) kg	In liquid (w_2) kg	
1			
2			
3			
4			

As the depth of immersion of the float is the same in both cases , the volume of water and the liquid displaced are same. According to the law of floatation the weight of the floating body is equal to the weight of the liquid displaced.

Weight of the water displaced, $w_1 = ahd_1g$ ---------- 1

Weight of liquid displaced, $w_2 = ahd_2g$ ---------- 2

Equ. 2 divided by equ. 1, $\frac{w_2}{w_1} = \frac{d_2}{d_1}$

$$\text{Specific gravity of the liquid} = \frac{\text{weight of the float in liquid}}{\text{weight of the float in water}}$$

ACTIVITY –15.15

Take a water bottle cap. Paste a piece of graph sheet at the side. Take water in one glass tumbler and salt solution in another glass tumbler. Float the cap vertically (add some sand if necessary) in water and in salt solution. Note the depth of immersion. Find the specific gravity of the salt solution. Change the concentration of the salt solution and find the specific gravity at different concentrations.

EVALUATION

Section A

1. Arrange the following speeds in the ascending order.

   (7 m/s, 15 km/h, 2km/minute, 0.1 m/millisecond)

2. When a body rotating along the circular path has unit linear velocity, its angular velocity is equal to _____ of the circular path.

   (the radius, square of the radius, reciprocal of the radius, square root of the radius)

3. If a body start from rest, the acceleration of the body after 2 second is _____ of its displacement.

   (half, twice, four times, one fourth)

4. The gradient or slope of the distance-time graph at any point gives _____.

   (acceleration, displacement, velocity, time)

5. The area under the velocity-time graph represents the _____ the moving object.

   (velocity of, displacement covered by, acceleration of, speed of)

6. In a 100 m race, the winner takes 10 s to reach the finishing point. The average speed of the winner is _____

   (5 m/s, 10 m/s, 20 m/s, 40 m/s)

7. Pick out odd one from the following with respect to the properties of a liquid.

   a) They have definite volume. b) Liquids are incompressible.

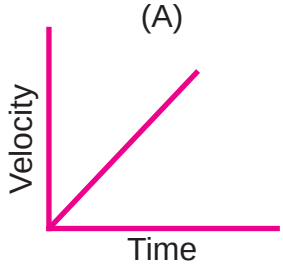
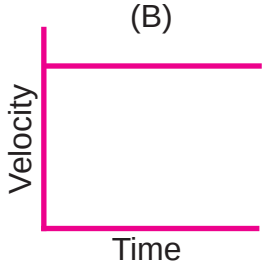
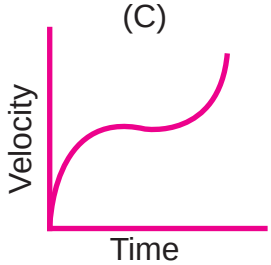
   c) They have their own shape.

Section B

8. Complete the table from the list given below;
   (m/s, rad/s^2, rad, m/ s^2, rad/s)

Sl. No	Physical quantity	Unit
1	Velocity	
2	Acceleration	
3	Angular displacement	
4	Angular velocity	

9. i) Match the following graph with their corresponding motion.

Motion	a) Unaccelerated motion	b) Non-uniformly accelerated motion	c) Uniformly accelerated motion
Graph	(A) 	(B) 	(C) 

ii) What is the value of acceleration in graph 'B'?

10. A motorcycle traveling at 20 m/s has an acceleration of 4 m/s^2. What does it explain about velocity of the motorcycle?

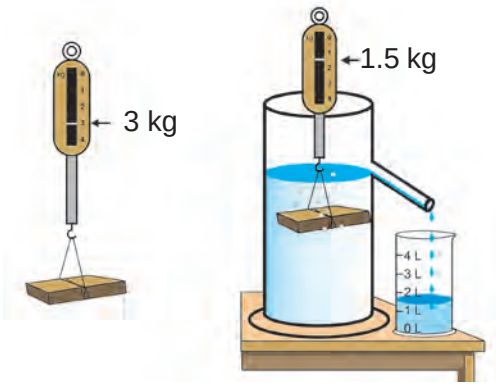
11. A bus travels a distance of 20 km from Chennai Central to Airport in 45 minutes.

    i) What is the average speed? ii) Why actual speed differs from average speed?

12. Analyze the diagram and answer the following

    i) What is the apparent loss in weight of the block inside the water?

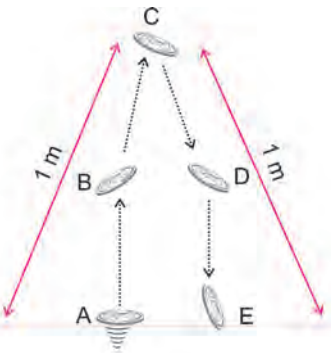
    ii) What do you infer from the diagram?



13. Statement. 'In 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 out.

Section C

14. A coin is tossed with a velocity 3 m/s at A.

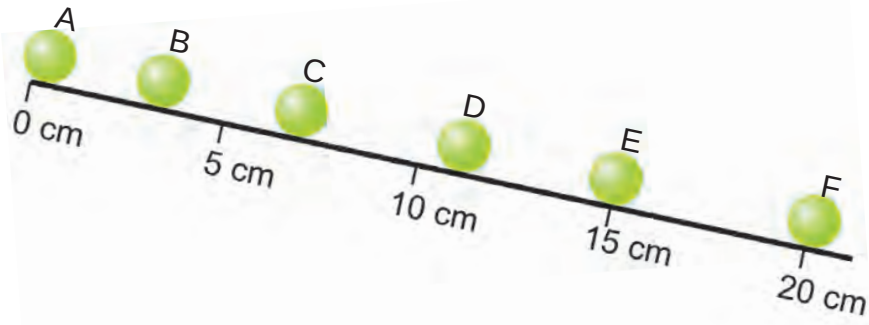


a) What happens to the velocity along AB, along DE and at C?

b) What happens to acceleration of the coin along AC and CE?

c) The distance and vertical displacement covered by the coin between A & E.

15. The diagram shows the position of a ball as it rolled down a track. The ball took 0.5 s to roll from one position to other.



a) State whether the motion of the ball is uniform or non-uniform motion.

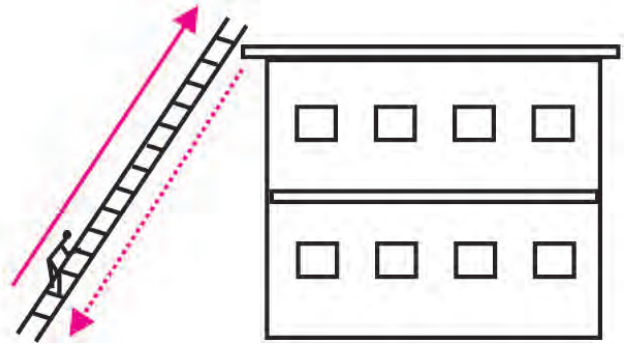
b) What is the distance traveled by the ball in 2.5 s?

c) Find the average velocity of the ball from A to F.

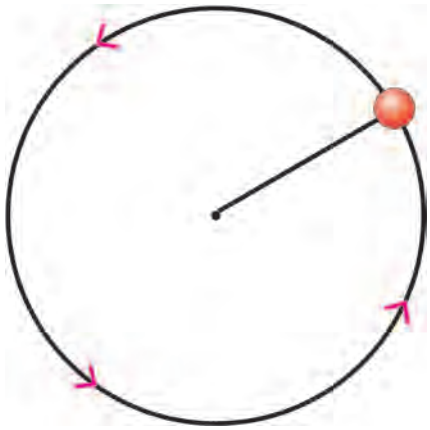
16. Consider the motions in the following cases.

(i) moving car

(ii) a man climbed to terrace and got down



(iii) ball completed one rotation



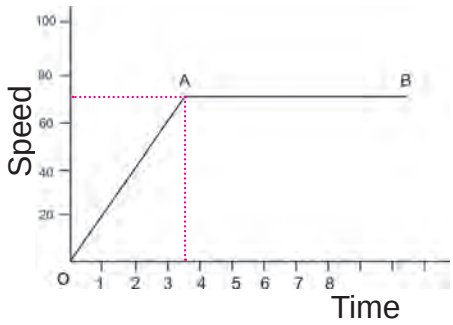
a) In which of the above cases the displacement of the object may be zero.

b) Justify your answer.

17. 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?



18. Derive the three equations of motion by graphical method.

FURTHER REFERENCE

Books

1. General Physics - Morton M. Sternhein - Joseph W. Kane - JohnWiley
2. Fundamentals of Physics – David Halliday & Robert Resnick – JohnWiley

Websites

http://www.futuresouth.com

http://www.splung.com

Chapter 16

WORK, POWER, ENERGY AND HEAT

WORK, POWER, ENERGY AND HEAT

One day Kumar went to see his father at their paddy field. Workers were loading paddy bags into a lorry. He saw the worker Ramu loading as many as 32 bags in an hour. But, at the same time, Somu loaded only 26 bags. He asked his father why was it so? Father replied that, Ramu has more energy compared to Somu. Because of that only the difference arose. Let us help Kumar and others to understand more about energy, work and power in a detailed manner.

16.1. WORK

The meaning of work in our daily life is different from that of physics.

Anything that makes us tired is known as work. For example, reading, writing, painting, walking, etc.

In physics work (W) is said to be done, when a force (F) acts on the body and point of application of the force is displaced (s) in the direction of force.

work done = force x displacement

W = F s

(i) If the body is displaced in the same direction of force, work is done by a force as shown in Fig. 16.1.

Fig. 16.1. Work done by a man

(ii) If the displacement is against a force, the work is done against the force.

(iii) If the displacement is perpendicular to the direction of the force, work done is zero.

Unit of work

Unit of work is joule (J). One joule of work is said to be done when a force of 1 newton acting on a body displacing it by a distance of 1 m.

Larger units of work are

i) kilojoule (1000 joule)

ii) megajoule (10 lakh joule)

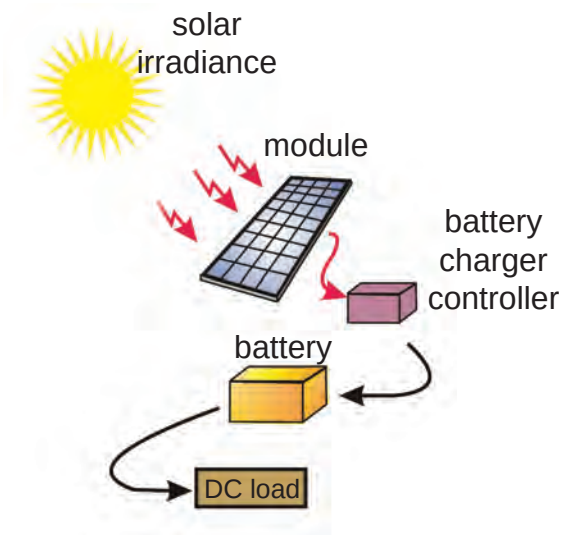
James Prescott Joule

James Prescott Joule was an outstanding British physicist. He is best known for his research in electricity and thermodynamics. Amongst other things, he formulated a law for heating effect of electrtic current. He also verified experimentally the law of conservation of energy and discovered the value of mechanical equivalent of heat. The unit of energy and work called joule, is named after him.

16.2. ENERGY

Life is impossible without energy. The demand for energy is ever increasing. Living things and machines need energy in order to work.

The energy of the body is defined as its capacity to do work.



Solar energy

ACTIVITY –16.1

List some energy sources.

1. Sun. 2.....

3..... 4. .....

Unit of energy

Energy is measured in terms of work. Unit of energy is also joule. One joule of energy is required to do one joule of work.

Different forms of energy

We live in a world where we have energy in many different forms. Some important forms of energy are mechanical energy, chemical energy, light energy, heat energy, electrical energy, nuclear energy and sound energy.

Mechanical Energy

The energy used to displace a body or to change the position of the body or to deform the body is known as mechanical energy.

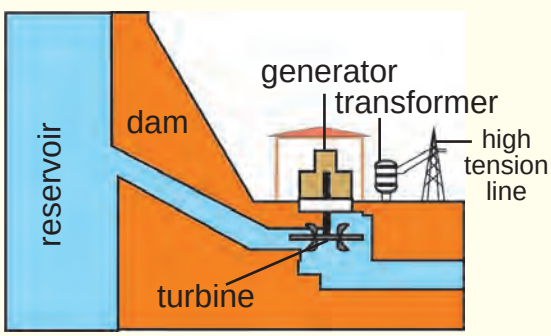
Mechanical energy is of two types i) Potential energy ii) Kinetic energy.

16.2.1. POTENTIAL ENERGY

The energy possessed by a body by virtue of its position or due to state of strain, is called potential energy.

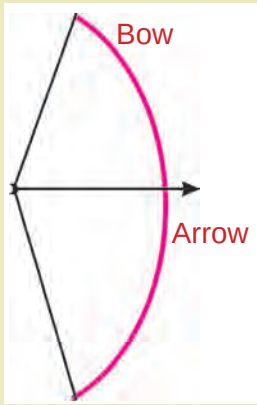
The work done to lift a body above the ground level gives the potential energy of the body. Eg. weight lifting.

Example: Water stored in reservoir has large amount of potential energy due to which it can drive a water turbine when allowed to fall down. This is the principle of production of hydro electric energy.



Hydropower Station

ACTIVITY –16.2



Bow and Arrow

Take a bamboo stick and make a bow. Place an arrow made of a light stick with one end supported by stretched string. Now stretch the string and release the arrow, which flies off. Note the change in the shape of the bow.

The potential energy stored in the bow due to the change of shape is used in the form of kinetic energy in the movement of the arrow.

Expression for potential energy of a body above the ground level

Work is done in raising an object from the ground to certain height against the gravity is stored in the body as a potential energy.

Consider an object of mass m. It is raised through a height h from the ground. Force is needed to do this.

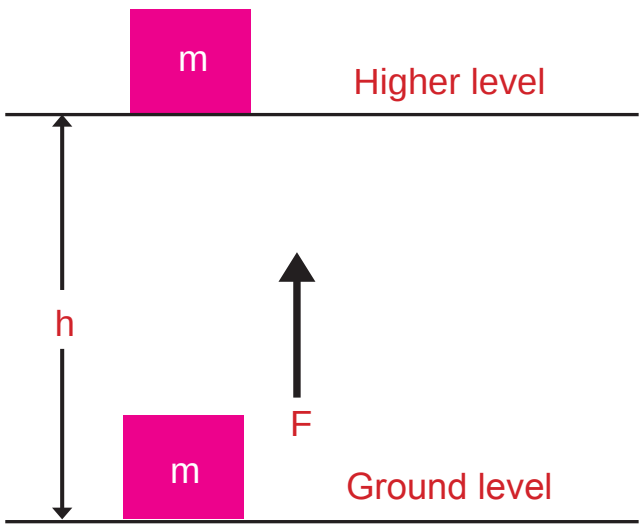


Fig. 16.2.

The downward force acting on the body due to gravity = mg.

The work has to be done to lift the body through a height h against the force of gravity as shown in Fig 16.2.

The object gains energy to do the work done (w) on it.

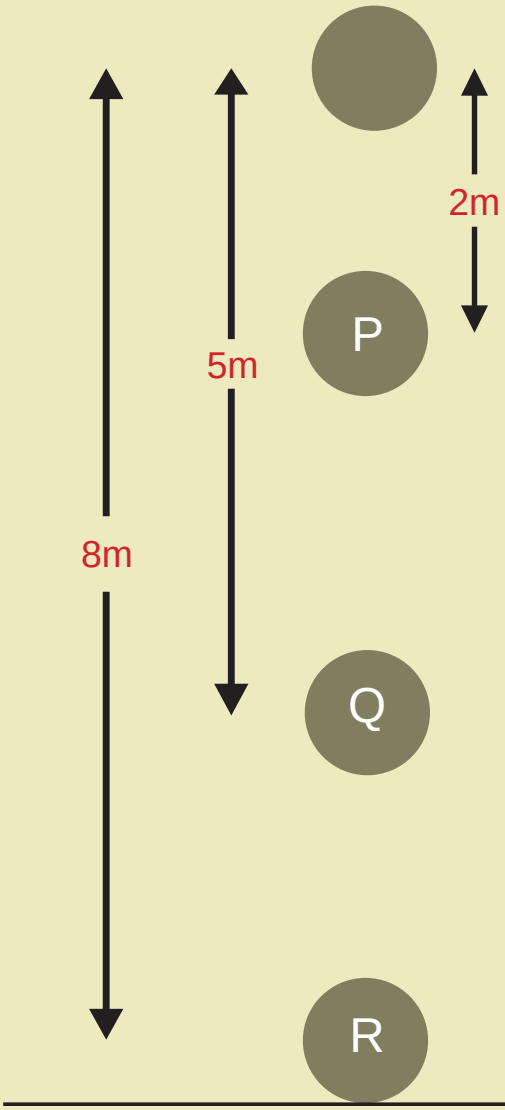
work done = force x displacement

w = F x h Since F=ma

w = mgh a=g F=mg

Work done is equal to potential energy of an object.

E_p = mgh.



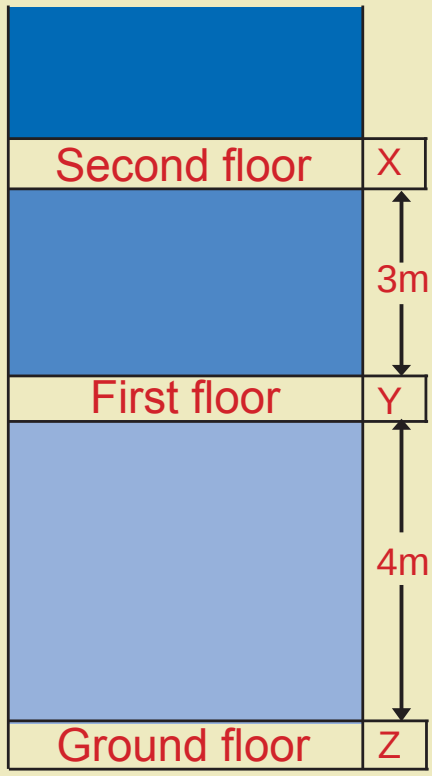
ACTIVITY –16.3

Find the value of potential energy at different points. m = 10 kg and g = 10 ms^{-2}

i. $E_p(X)$ = _____

ii. $E_p(Y)$ = _____

iii. $E_p(Z)$ = _____



ACTIVITY –16.4

Find the potential energy of a ball with respect to position P,Q and R. Take m = 5 kg and g = 10 ms^{-2}

i. Ep(P) = _____

ii. Ep(Q) = _____

iii. Ep(R) = _____

Understand that potential energy of a body at a point is different for different levels.

16.2.2. KINETIC ENERGY

Energy possessed by an object due to its motion is called kinetic energy.

Kinetic energy of an object increases with its speed. Kinetic energy of an object moving with a velocity is equal to the work done on it to make it acquire that velocity.

Example-1 Kinetic energy of a hammer is used to drive a nail into the wall.

Example-2 Bullet fired from a gun can penetrate into a target due to its kinetic energy.

Expression for kinetic energy

Let a body (ball) of mass m is moving with an initial velocity v. If it is brought to rest by applying a retarding (opposing) force F, then it comes to rest by a displacement S. Let,

E_k = work done against the force used to stop it.

$E_k = F \cdot S$ -----> (1)

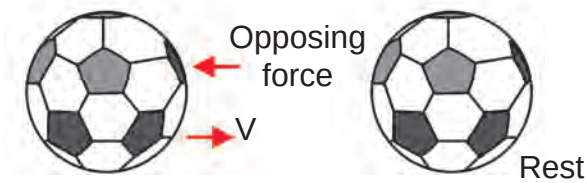
But retarding force F = ma-----> (2)

Let initial velocity u = v, final velocity v = 0

From III equation of motion

$$v^2 = u^2 + 2aS$$

Moving



applying, $0 = v^2 - 2aS$ (∵ a is retardation)

$$2aS = v^2$$

displacement, $S = \frac{v^2}{2a}$ ----> (3)

substituting (2) and (3) in (1)

$$E_k = ma \times \frac{v^2}{2a}$$

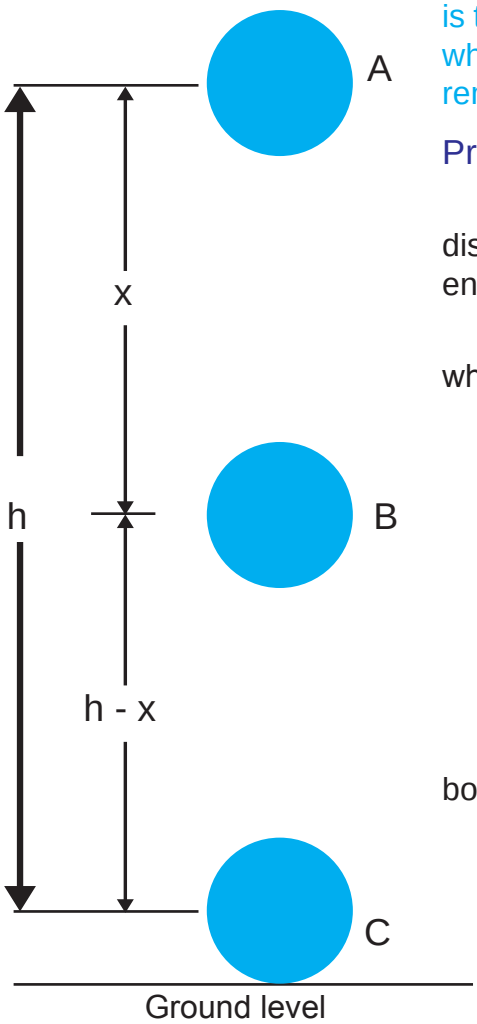
$$E_k = \frac{1}{2} mv^2$$

16.3. LAW OF CONSERVATION OF ENERGY

ACTIVITY –16.5

A steel ball of mass 5 kg (namely shot put) is dropped from a height of 5 m. Find and fill the table. (take g = 10 ms^{-2} for easy calculation)

Height of steel ball above the ground m	potential energy $E_p = mgh$ J	Kinetic energy $E_k = \frac{1}{2} mv^2$ J	Total energy $E = E_p + E_k$ J
5			
4			
3			
2			



Energy can neither be created nor destroyed, but it is transformed from one form to another. Alternatively, whenever energy gets transformed, the total energy remains unchanged.

Proof – Freely falling body

It may be shown that in the absence of external dissipative forces (frictional force) the total mechanical energy of a body remains constant.

Consider a body of mass m falls from a point A, which is at a height h from the ground as shown in fig.

At A,

Kinetic energy $E_k = 0$

Potential energy $E_p = mgh$

Total energy $E = E_p + E_k$

$= mgh + 0$

$$\mathbf{E = mgh}$$

During the fall, the body is at a position B. The body has moved a distance x from A.

At B,

velocity $v^2 = u^2 + 2as$

applying, $v^2 = 0 + 2ax = 2ax$

Kinetic energy $E_k = \frac{1}{2} mv^2$

$$= \frac{1}{2} \quad m \times 2gx$$

$$= mgx$$

Potential energy $E_p = mg\,(h - x)$

Total energy $E = E_p + Ek$

$$= mg\,(h-x) + mgx$$

$$= mgh - mgx + mgx$$

E = mgh

If the body reaches the position C.

At C,

Potential energy $E_p = 0$

Velocity of the body C is

$$v^2 = u^2 + 2as$$

$u = 0, a = g, s = h$

applying $v^2 = 0 + 2gh = 2gh$

kinetic energy $E_k = \frac{1}{2} mv^2 = \frac{1}{2} \quad m \times 2gh$

$E_k = mgh$

Total energy at C

$$E = E_p + E_k$$

$$E = 0 + mgh$$

E = mgh

Thus we have seen that sum of potential and kinetic energy of freely falling body at all points remains same.

Under the force of gravity, the mechanical energy of a body remains constant.

16.4. RATE OF DOING WORK (OR) POWER

ACTIVITY –16.6

Think and find which one of the following will have more power - Bike, Car, Bus and Aeroplane. why?.

Power is defined as the rate of doing work or work done per unit time.

$$\text{Power} = \frac{\text{work done}}{\text{time taken}}$$

$$P = \frac{w}{t}$$

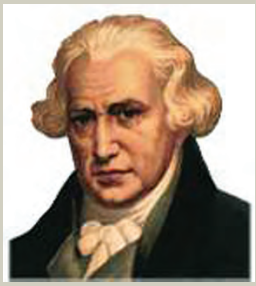
16.5. UNIT OF POWER

The unit of power is J/S known as watt, its symbol is W.

$$1 \text{ watt} = \frac{1 \text{ joule}}{1 \text{ second}}$$

$$1 \text{ W} = 1 \text{ J S}^{-1}$$

James Watt (1736-1819)



A Scottish inventor and mechanical engineer whose improvements to the steam engine were fundamental to the changes brought by the industrial revolution in the world.

Watt was interested in the technology of steam engines. He realised that contemporary engine designs wasted a great deal of energy by repeatedly cooling and reheating the cylinder. Watt introduced a design enhancement, the separate condenser, which avoided this waste of energy and radically improved the power, efficiency and cost effectiveness of steam engines. He developed the concept of horsepower. The SI unit of power, the watt, was named after him.

Commercial unit of energy is kilo watt hour

We pay electricity bill in terms of unit or kWh. It is a commercial unit of electric energy consumed by the user.

Watt hour = power in watt x time in hour.

Example : How much energy will be used when a hundred watt bulb is used for 10 hour?

Energy = 100 watt x 10 hour

= 1000 w h = 1kw h

I kwh is known as 1 unit.

One kilowatt hour means thousand watt of power is consumed in one hour.

1 kWh = 1 kW x 1 h

= 1000 W x 60 x 60 s

= 1000 Js^{-1} x 3600 s

= 3.6 x 10^6 J

1 unit = 1 kilowatt hour = 3.6x10^6 J

Try this

How long can a 40 watt bulb glow in order to consume 1 unit of energy?

How much energy is consumed, when a motor of 500 W power runs for 4 hour?.

Energy Transfermation

Water from dam	:	Potential energy into Kinetic energy
Microphone	:	Sound energy into Electrical energy
TV Camera	:	Light energy into Electrical energy
Solar Cell	:	Light energy into Electrical energy
Iron Box	:	Electrical energy into Heat energy
Loud speaker	:	Electrical energy into Sound energy
Fan	:	Electrical energy into Mechanical energy
Light	:	Electrical energy into Light energy

ACTIVITY –16.7

Find and write the power (in watt) consumed by following electrical appliances at your home.

- Tube light.....
- Ceiling fan.....
- Mixi.....
- Grinder.....
- Water heater.....
- Air conditioner.....
- ....
- ....
- ....

16.6. HEAT

We know that heat is a form of energy. The degree of hotness or coldness is given by temperature. Will the temperature give the amount of heat energy possessed by a body?

No, the temperature alone cannot give any idea about the heat energy. Then, how to measure the heat?

Heat is commonly experienced by everybody just as easily as one feels the weight of an object. But the measurement of heat is not as simple as the measurement of weight. Heat can only be measured in terms of the effects it produces.

ACTIVITY –16.8

Take three identical hard glass beakers. Take 50 ml of water in the 1st beaker, 75 ml of water in the 2nd and 100 ml in the 3rd. Note their initial temperatures. Heat the beakers one by one using spirit lamp for a certain period of time (say 5 minutes). Note the rise in temperature in each case (Here we have supplied the same amount of heat).

In the activity-16.8, will the rise in temperature be same?

No, the rise in temperature is not the same in the three cases.

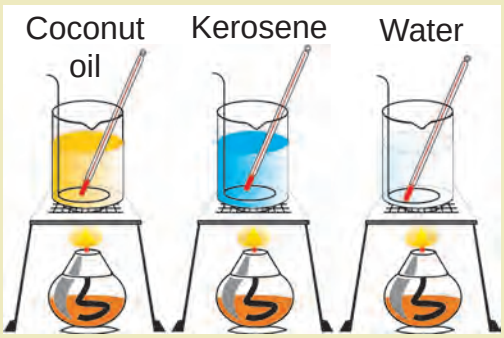
Inferences

The same amount of heat supplied to different masses of same material will not give the same rise in temperature. But we can see the product of the mass and the rise in temperature will remain the same for all.

Therefore the product of mass and rise in temperature can be taken as the measure of the quantity of heat.

ACTIVITY –16.9

Take three identical beakers and fill them with equal mass of water, kerosene and coconut oil. Note their initial temperatures. Using spirit lamps heat the three beakers for five minute. Observe the difference in the rise of temperature of different liquids.



Inference

The rise in temperature depends on the nature of the substance.

What do you infer from these activities?

The rise in temperature depends on mass and nature of the substance.

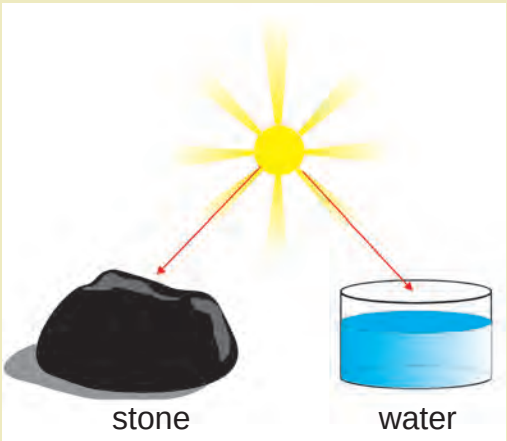
To describe the combined effect of mass and nature of the substance we introduce the term thermal capacity or heat capacity.

16.6.1. THERMAL CAPACITY

Thermal or heat capacity of a body is defined as the amount of heat required to raise its temperature by 1 K.

Its unit is joule / kelvin (J/K or JK^{-1})

ACTIVITY –16.10



Take a stone and water of same mass. Place them in the hot sun for an hour. Now touch the stone with one hand and water with the other hand. Observe that the stone is hotter than water.

From the above activity we understand that heat capacities are different for different substances.

Specific heat capacity (s)

The above activity shows that the heat capacity depends upon the nature of the substance. Different substances of same mass have different heat capacities because of this factor. We take it into account by defining a quantity called specific heat capacity.

The amount of heat energy required to raise the temperature of 1 kg of substance through 1 K.

Its unit is J kg^{-1} K^{-1}

Example

The specific heat capacity of water is 4180 J kg^{-1} $K^{-1.}$

It means that 4180 joule of heat is required to raise the temperature of 1 kg of water through 1 K.

MORE TO KNOW

Specific heat capacity of water is 30 times that of mercury. i.e., by using the same heat given to water, the temperature of 30 kg mercury can be raised by 1K.

The specific heat capacity of mercury is 140 J kg^{-1} K^{-1}.

Compare the above two specific heat capacities. What do you infer?

Shall we calculate the amount of heat energy possessed by the body?

Consider the following example.

Let us consider that the temperature of 5 kg of mercury is raised by 10 K. How much heat is required? Specific heat capacity of mercury is 140 J kg^{-1} K^{-1}

Heat capacity = heat required to raise the temperature by 1 K

Heat capacity = m s

$= 5 \times 140 = 700$ J K^{-1}

Total heat supplied = heat capacity x rise in temperature

$= 700 \times 10 = 7000$ joule

Total heat supplied = mass x specific heat capacity x rise in temperature

Quantity of heat (Q) = mass (m) x specific heat (S) x increase in temperature (θ)

$Q = mS\theta$

16.7. CHANGE OF STATE

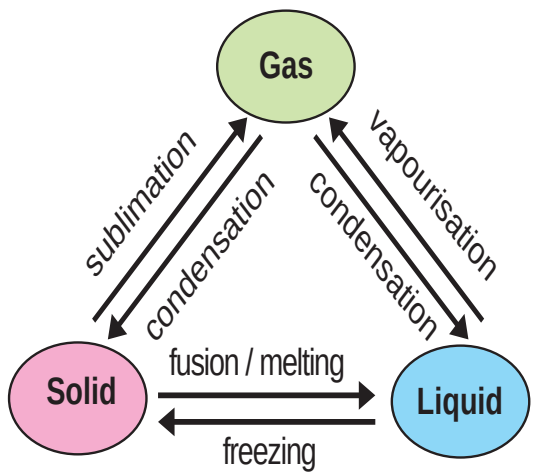
Everyone is familiar with three states of matter – solid, liquid and gas (or vapour). Of these three states, solid state is most familiar.

We are less familiar with the gaseous state of matter even though we are surrounded everywhere by the substance in the gaseous state – the air.

Solid and liquid states are the most predominant form of matter in our planet.

We shall consider the important effects arising out of addition or removal of heat energy. It is common exeperience that many substances change their state on supply or removal of heat energy.

The process of converting a substance from one state to another is called change of state.



Melting

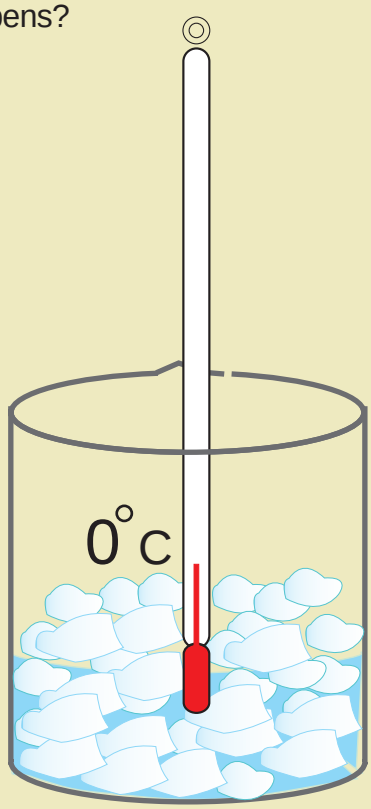
The process in which a substance changes from the solid state into liquid state on heating is called melting or fusion.

Melting point

The constant temperature at which a solid gets converted into its liquid state is called melting point.

ACTIVITY –16.11

Take ice and put it into a container. A thermometer is inserted. What happens?

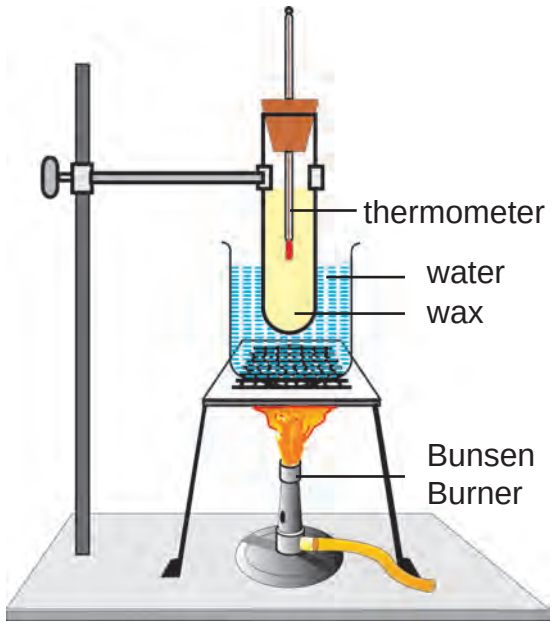


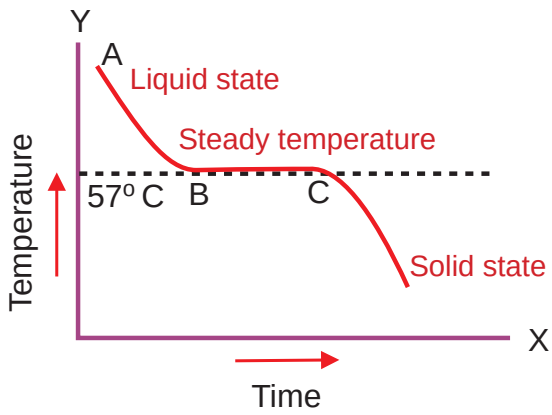
Temperature remains constant at 0°C until an ice melts and changes into water. Ice takes the heat from the atmospheric air and melted. Temperature is found to be 0°C. The change takes place at a temperature called melting point. Therefore the melting point of ice is 0°C.

Melting point of wax

A test tube with sufficient quantity of wax is taken and a thermometer is placed in the test tube through a cork. It is then placed in a beaker containing water. Water is heated till the wax in the test tube melts and gets converted completely into the liquid state.

Heating is stopped and wax is allowed to cool. The temperature of the wax is noted for every one minute till the temperature of wax falls to 30 °C.





A graph is plotted between time along the X axis and temperture along the Y axis. In the graph in the portion AB shows the wax in the liquid state and below C it is in the solid state.

The temperature corresponding to the horizontal line in the graph gives the melting point of wax. At this temperature the liquid wax is converted solid without change of temperature. The melting point of wax is 57° C. When the liquid wax changes into a solid, its volume decreases.

Boiling

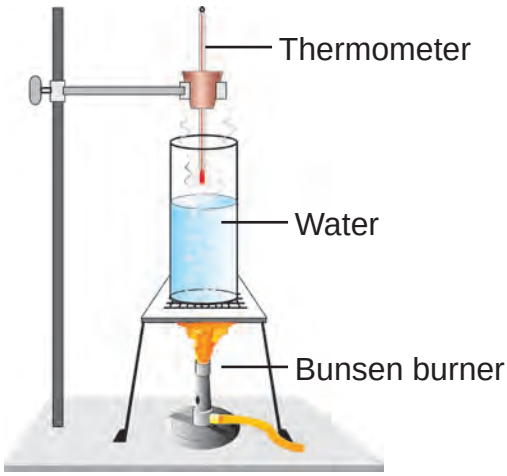
The process in which a substance in its liquid state gets converted into vapour state is called boiling.

Boiling point

The constant temperature at which a liquid is converted into its vapour is known as boiling point.

Boiling point of water

Arrange the apparatus as shown in figure.



Take some water in boiling tube. Fix the thermometer, so that its bulb remains just above the water level. The boiling tube is heated. The mercury in the thermometer rises and remains constant at a temperature 100^{o} C. This constant termperature is called as boiling point of water.

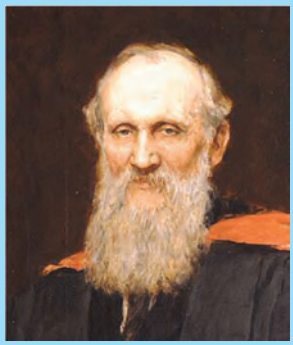
16.8. KELVIN'S SCALE OF TEMPERATURE

If a substance is cooled continuously its temperature decreases but there is a limit to the lowest temperature to which a substance can be cooled.

The lowest possible temperature is taken as zero point of the Kelvin's scale. This temperature is called as absolute zero.This is written as 0 K.

At absolute zero there is no molecular motion and hence no heat energy in a substance. At absolute zero all atomic and molecular motion stop. So absolute zero is the lowest temperature possible and denoted by 0 K or -273^{0} C.

Lord Kelvin



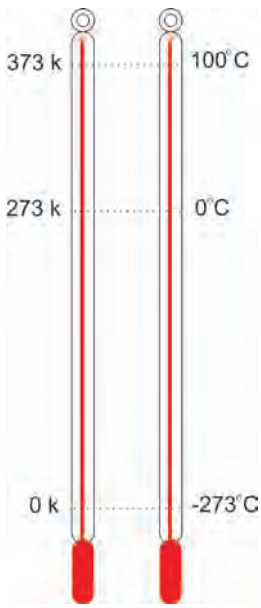
He was a physicist and an engineer. He is widely known for his eminent contribution to thermodynamics. He devised the kelvin scale of temperature. The unit of temperature was named after him to honour his outstanding contribution and achievements.

All objects at all temperature above absolute zero, emit thermal or heat energy.

Kelvin scale (K) = Celsius scale (^{0}C) + 273

Celsius scale (^{0}C) = Kelvin scale (K) – 273

If temperature is expressed in kelvin scale degree symbol is omitted.



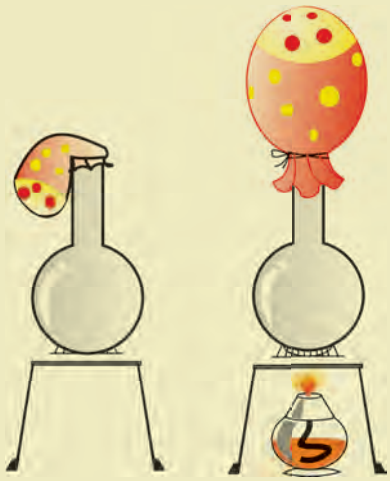
$T_k = T_c + 273$

Celsius, Kelvin scale

Expansion of gases

ACTIVITY –16.12

A balloon is fixed to the mouth of an empty and dry flask. Heat the flask over a flame and observe the balloon. It keeps growing in size on heating continuously. Why does it happen?



The pressure of air inside the flask and hence air inside the balloon increases. (The increase in pressure is due to heating). Stop heating. What happens and why?

It's size decreases which indicates the decrease of pressure.

From the activity 16.12, we infer that the bulging of the balloon is due to increase of pressure of air on heating. We can also infer that the volume of air inside the flask and balloon also increased with temperature.

Supply of heat may produce an increase in both volume and pressure of a gas. In solids and liquids we consider only volume changes.

For gases, we consider changes in volume or pressure or both with temperature.

It is convenient to study the variation of one of them with temperature by keeping the other constant.

In the activity 16.12, we have only the variation of volume with temperature. there is no change in pressure here as air is free to expand against the constant external pressure.

How can we explain the variation of pressure alone with temperature.?

What happens when a metallic container with an air tight lid is heated?

The volume is constant and pressure will be increasing. If the container is strongly heated, the lid may not be able to withstand the large pressure and may blow off.

Robert Boyle is best known for his work in physics and chemistry. He formulated Boyle's law. He is regarded as the first modern chemist. He described the element as primitive simple and perfectly complete bodies. From 1661 the term element has been reserved for material substances.

16.9. GAS LAWS & GAS EQUATION

Gas laws

The expansion of gas is usually due to variation of pressure, volume and temperature. Finding the relation between the any two by keeping third one constant, are known as gas laws.

The relation can be the change in pressure and volume by keeping temperature constant, called Boyle's law.

Boyle's law.

At constant temperature, the pressure of a given mass of gas is inversely proportional to its volume.

If P is the pressure, V is the volume at constant temperature,

$$p \propto \frac{1}{v} \qquad pv = \text{a constant}$$

Charle's law

The relation between volume and temperature by keeping pressure constant, is called Charles law or law of volume.

Law of volume: At constant pressure, the volume (v) of a given mass of gas is directly proportional to its absolute temperature (T).

$$v \alpha T, \qquad \frac{v}{T} = \text{a constant}$$

The relation between pressure and temperature by keeping volume constant, is called Charles law or law of pressure.

Law of pressure: At constant volume, the pressure (p) of a given mass of gas is directly proportional to its absolute temperature (T).

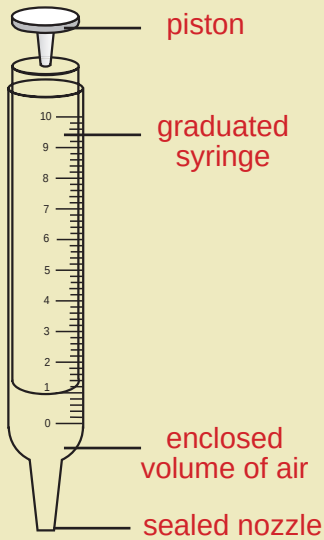
$$p \alpha T, \qquad \frac{p}{T} = \text{a constant}$$

Jacques Charles (1746 – 1823)

He was a French inventor, scientist, mathematician, balloonist and Professor of Physics in Paris. He found the relation between the temperature and volume. His experiment revealed that all gases expand and contract to the same extent when heated through the same temperature intervals. He constructed the first hydrogen balloon, which brought him popular fame and royal patronage. He also invented hydrometer.

ACTIVITY 16.13

Take a transparent syringe and seal its nozzle. Push down the piston and slowly release it as shown in fig. observe what happens.



Gas equation: The gas equation is relating the pressure, volume and temperature of perfect gas, which obeys Boyle's law and Charle's law.

Let p – pressure, v – volume,

T – Temperature

using Boyle's law, T is constant

$$p \alpha \frac{1}{v}$$

using Charle's law

v is constant, $p \alpha T$

using both the laws we get

$$p \alpha \frac{T}{v} \qquad pv \alpha T$$

$$pv = RT$$

where R is proportional constant, and is known as gas constant.

The value of R = 8.31 J mol^{-1} K^{-1}

If n is the number of mole in the gas,

$$pv = nRT$$

It is the perfect gas equation.

EVALUATION

Section – A

1. Work done by the force is said to be negative, if the displacement of a body is _____. (along the force, against the force)
2. The degree of hotness or coldness of a body is _____ (heat, temperature).
3. Pick the odd one out from the following based on the nature of energy possessed by them.

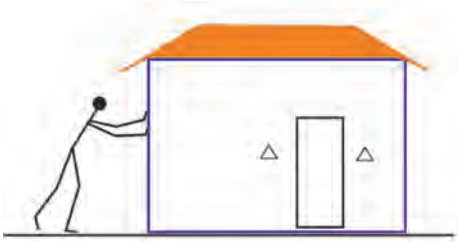
   (moving car, water stored in a tank, a book on a table, ceiling fan in OFF position)
4. Commercial unit of electrical energy is _____ .

   (joule, joule/second, watt, kilowatt hour)
5. Select the liquid from the following which has the specific heat capacity of 4180 $JKg^{-1}K^{-1}$.

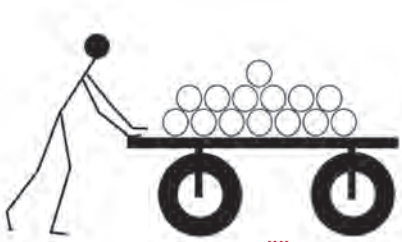
   (mercury, kerosene, water, coconut oil)

Section – B

6.



(i)



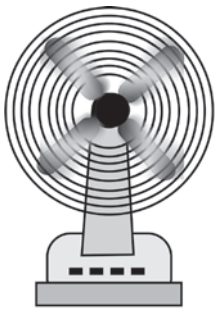
(ii)

(iii)

Observe the above figures, state and explain in each case whether work is done or not?

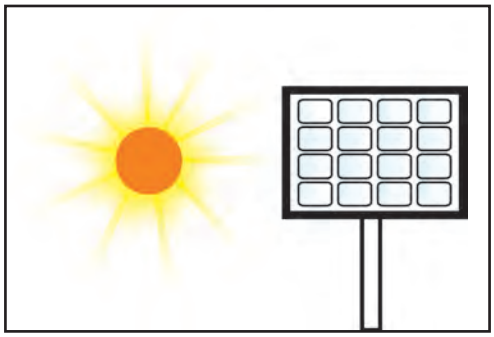
7. What is the work done by the force of gravity on a satellite moving around the earth? Justify your answer.
8. Now-a-days copper bottom vessels are used for cooking rather than other metals. Why?
9. See the following pictures. Mention the nature of energy transformation.

(i)



(ii)

(iii)



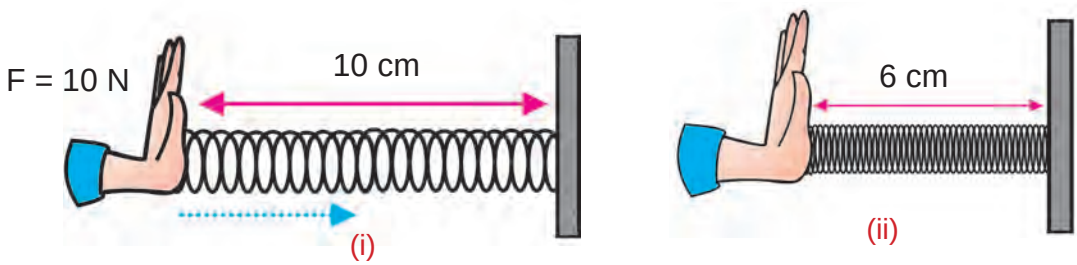
(iv)

10. Match the following

Change of state	Examples
1) vapourisation	a) burning of champhor
2) condensation	b) water changed into ice
3) freezing	c) steam
4) sublimation	d) rain

11. Raja weighing 40 kg claims up on a staircase of 20 steps, each with 16 cm height in 20 second. Find his power.

12. See the diagrams, Calculate the potential energy stored in the compressed spring?



13. The boiling point of water is 100°K. Identify the mistake(s) in the above statement and correct it in Kelvin scale.

14. Complete the following table by choosing the right answer given below.

(mechanical energy, microphone, loudspeaker)

Sl. No	Energy transformation		Device
	From	To	
1	Electrical energy		Motor
2	Sound energy	Electrical energy	

Section – C

15. Kala is doing an experiment in science laboratory to determine the melting point of wax by cooling curve method. She recorded the temperature of melted wax as below

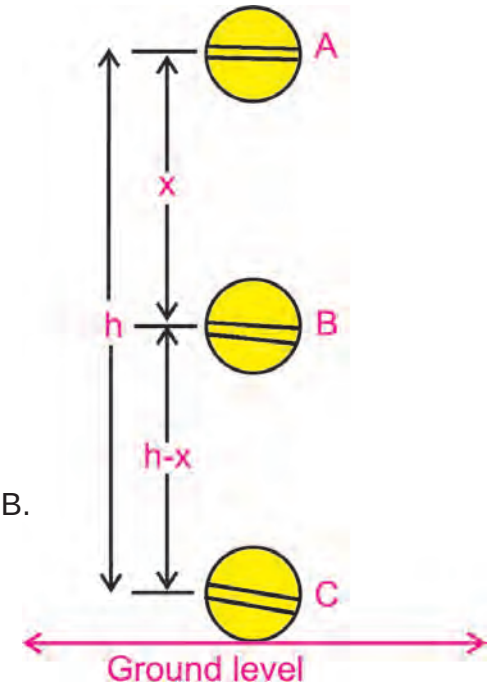
Time (minute)	Temperature (°C)
0	85
1	80
2	70
3	60
4	57
6	57
7	57
8	54
9	48

a) Draw a cooling curve by taking time along the x-axis and temperature along the y-axis.

b) Find the melting point of wax from the cooling curve.

c) What is the state of wax along the flat portion of the curve?

16. Consider the case of freely falling body given in the following figures



At A

Kinetic energy=0

Potential energy=mgh

At B

Kinetic energy=mgx

At C

Kinetic energy=mgh

Potential energy=0

a) Find the potential energy of the body at B.

b) Find the total energy at A,B and C.

c) Is there any variation in total energy? What do you infer from the result?

17. Describe an experiment to determine melting point of wax.

FURTHER REFERENCE

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2. Complete Physics for IGCSE – Oxford publications

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Chapter 17

SOUND

SOUND

Meena and her parent went for a wedding reception, she saw the members of the orchestra adjusting their instruments by plucking, tapping, beating, etc,. before the music programme began. Meena asked her father why they did such things? Father explained that by doing such adjustments they get proper vibrations and music. Let us help Meena and others to understand more about sound.

17.1. PRODUCTION OF SOUND

Sound has great importance in our daily life. Sound makes it possible for us to communicate with one another through speech.

- Musical sound gives us pleasure.
- Radio and television sound gives us information and entertainment.
- Horn sound of vehicles alert us.

ACTIVITY –17.1

Pluck the string of the Veena or the Guitar. Rub the Violin string. See the vibrating string and hear the sound.

Veena

Violin

Guitar

ACTIVITY –17.2

(i) Ring the bell / set the alarm clock and hear the sound.

(ii) Beat a drum with its stick and hear the sound.

Bell

Drums

Alarm Clock

ACTIVITY –17.3

(i) Blow a whistle

(ii) Press the horn and hear the sound.

Whistle

Horn

From the above activities, we understand that we can produce sound by scratching, rubbing, blowing, plucking, hitting and shaking different objects. All these activities set the objects vibrating, they make the surrounding air particles to vibrate and produce sound. Vibrations are small to and fro motion of objects.

ACTIVITY –17.4

Make a list of all the sounds you can think of and fit them into their families.

Sl. No.	Being Rubbed	Being blown	Being Plucked	Being hit
1.	Violin	Whistle	Guitar	Drums
2.				
3.				
4.				

17.2. PROPAGATION OF SOUND

ACTIVITY –17.5

Throw a stone into a pool of water. See the circular waves spread out from the point of disturbance and travel outward on the surface of water as shown in figure.

Sound travels through a medium from the point of generation to the listener. Sound waves travel along the to and fro movement of the vibrating objects that produce them.

Medium

The matter or substance through which sound is transmitted is called a medium. It can be a solid, liquid or gas.

Robert Boyle, the scientist, proved that sound cannot pass through vacuum or empty space. He kept an electric bell. Inside a glass container, as shown in fig 17.1. By removing the air slowly from the container using vacuum pump, the volume of sound decreases and no sound is heard when the air is removed completely. By allowing the air back to the container the sound is heard again.

A wave is a disturbance that moves through a medium when the particles of the medium set neighboring particles into motion. They, in turn, produce similar motion in others. The particles of the medium do not move forward, but the disturbance is carried forward, similar to the propagation of sound in a medium.

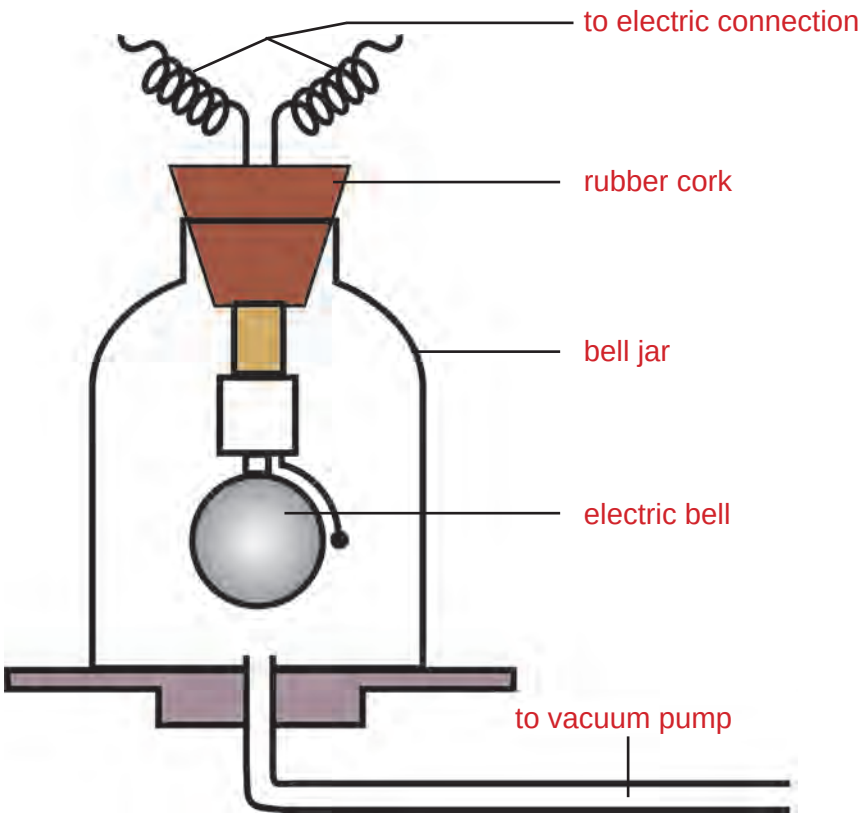
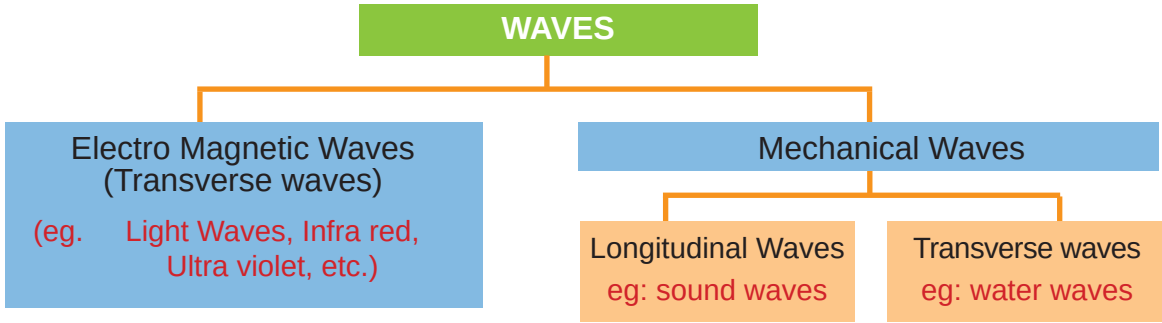


Fig. 17.1.Electric bell in jar

17.3. LONGITUDINAL AND TRANSVERSE WAVES

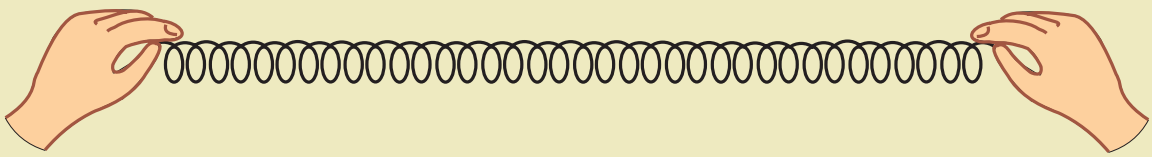


Longitudinal Waves

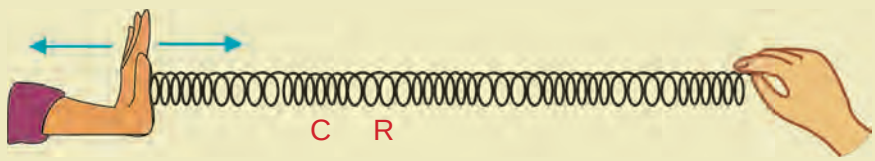
ACTIVITY –17.6

Take a spring. Hold one end and ask your friend to hold other end.

Stretch the spring as shown in fig.



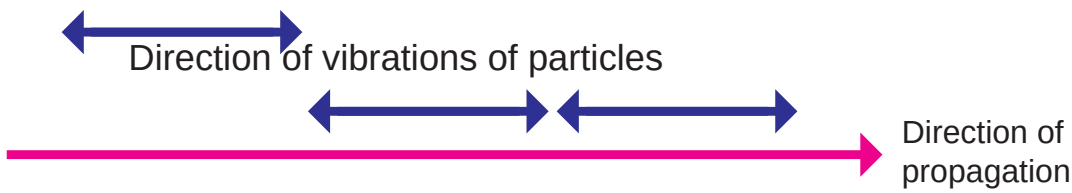
Now push the spring towards your friend. Move your hand for pushing and pulling the spring alternatively. You can see the spring as shown in fig.



C – Compression R - Rarefaction

"If the particles of a medium vibrate in a direction, parallel to or along the direction of propagation of wave, it is called longitudinal wave"

Example: sound waves



Sound waves in air or gases travel in the form of longitudinal waves.

Longitudinal wave propagate in a medium in the form of compression and rarefaction as shown fig 17.2.

Compression is the area with maximum pressure, rarefaction is the area with minimum pressure.

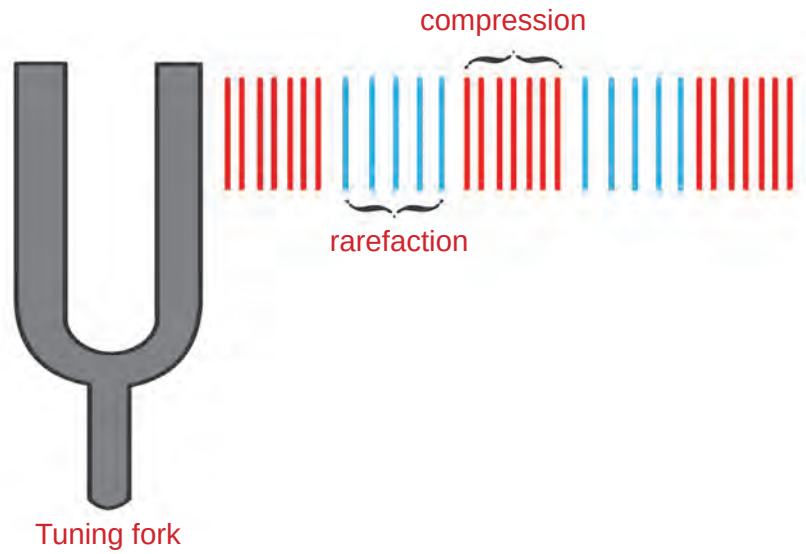
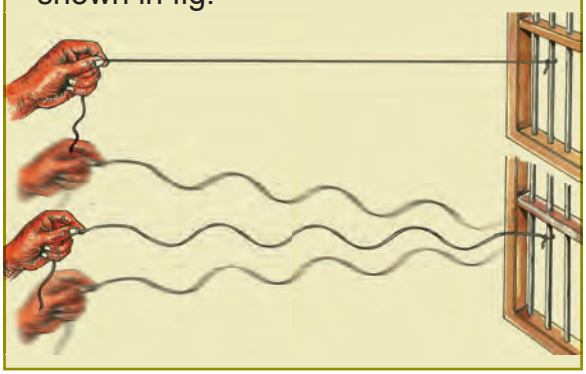


Fig. 17.2. Longitudinal waves

Transverse waves

ACTIVITY –17.7

Stretch a long rope with one end fixed and hold the other end firmly. Jerk your hand up and down. You can see an up and down movements and forming transverse wave as shown in fig.



"If the particles of the medium vibrate in a direction, perpendicular to the direction of propagation, the wave is called transverse wave."

Example: water waves, vibrations of stretched string.

Transverse waves propagate in a medium in the form of crests and troughs as shown in fig 17.3.

Crest : The maximum displacement along the upward direction.

Trough: The maximum displacement along the downward direction.

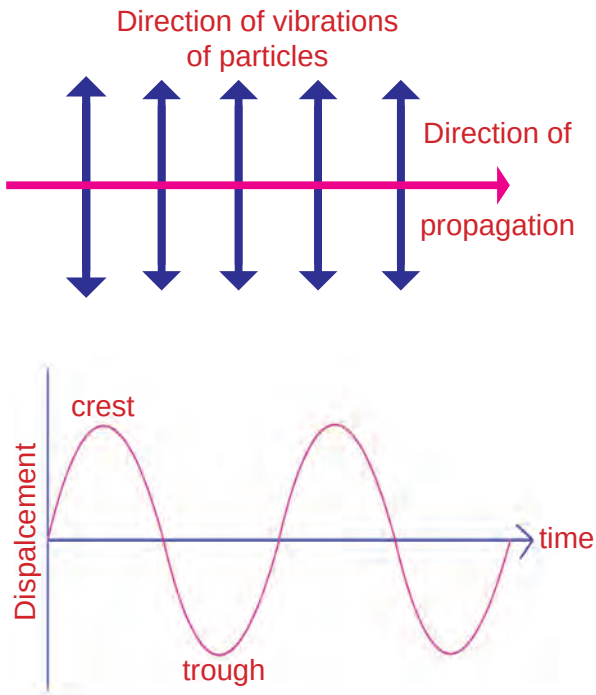


Fig 17.3. Transverse waves

Difference between Transverse and Longitudinal waves

Transverse waves	Longitudinal waves
Particles of the medium vibrate in a direction which is perpendicular to the direction of propagation.	Particles of the medium vibrate in a direction which is parallel to the direction of propagation.
Crests and troughs are formed	Compressions and rarefactions are formed.
Can travel through solids and surfaces of liquid.	Can travel through solids, liquids and gases.
eg. Water waves	eg. Sound waves.

Why transverse wave does not travel through air or gases?

Definitions

Amplitude (a): The maximum displacement of a particle from the mean position is called amplitude. Its unit is metre.

Time period (T) : Time taken by a particle of the medium to complete one vibration is called Time period. Its unit is second.

Frequency (n) : The number of vibrations completed by a particle in one second is called frequency . Its unit is hertz. $n = \frac{1}{T}$

Wave Length (λ) : Distance moved by a wave during the time a particle completes one vibration. Its unit is metre.

Velocity of a wave or Relation between Velocity, wavelength and Frequency

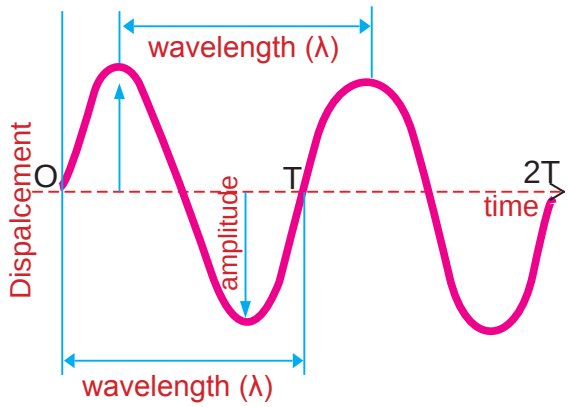
Distance travelled by a wave in T second = λ

$$\text{velocity} = \frac{\text{distance}}{\text{time}} = \frac{\lambda}{T}$$

but $n = \frac{1}{T}$

$\therefore$ $v = n\lambda$

Velocity = frequency x wavelength



MORE TO KNOW

Sound travels almost five times faster through water and twenty times faster through iron than it travels in air.

MORE TO KNOW

Speed of light ($3x10^8$ m/s) is much faster than the speed of sound (340 m/s). Light travels almost million times faster than sound. Due to this reason lightning flash is seen first and thunder sound is heard next.

17.4. REFLECTION OF SOUND

ACTIVITY –17.8

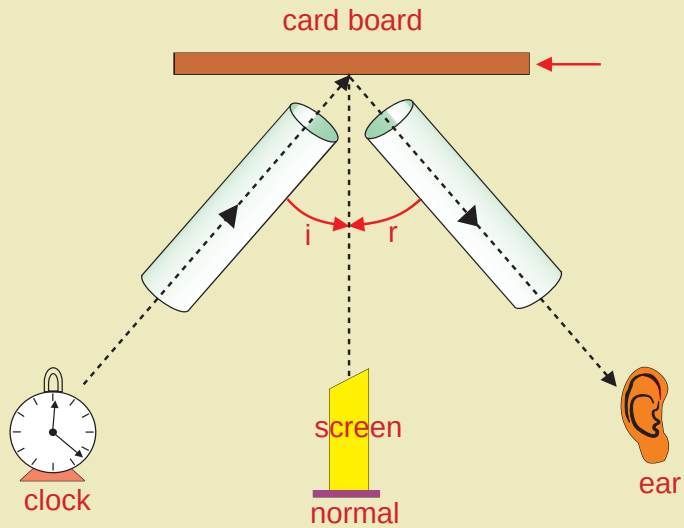
Take two identical pipes made of card board or chart paper or brown paper.

Arrange them on a table near a wall. Keep an alarm clock near the open end of one of the pipes and try to hear the sound of alarm clock through the other pipe as shown in fig.

Adjust the angles of pipes, so that you get maximum sound.

Realise that sound can also be reflected like light.

Sound can be reflected from hills and tall buildings.



17.4.1. ECHO

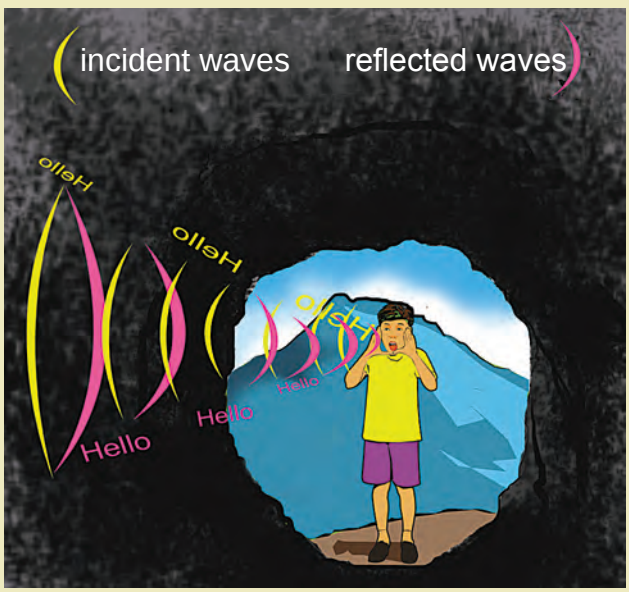
The sound waves produced by us bounce back or reflected from the forest or mountain or buildings come to our ears as Echo.

For example, the sound uttered by a person may be heard two or three times after the reflection from an object. They are called echo.

ACTIVITY –17.9

When you go to a cave or a subway and shout, you can hear the voice again, a short time after you have shouted.

The delay is caused by the time your voice has taken to travel to the walls and back again. You hear your voice as echo.



The sensation of sound persists in our brain for about 1/10th of a second. Any sound which comes as reflection to ear after 1/10th of second travels a distance of about 34 metre.

Therefore, to hear echo, the barrier reflecting the sound should be least at a distance of 17 meters. Why? Think!

$$\text{Velocity} = \frac{\text{distance}}{\text{time}}$$

$$\text{Distance} = \text{velocity X time}$$
$$= 340 \text{ X } 1/10$$
$$= 34 \text{ m.}$$

Echoes may be heard more than once due to successive or multiple reflections. The rolling of thunder is due to the successive reflections of the sound from a number of reflecting surfaces, such as cloud and land.

17.4.2. REVERBERATION

A sound created in a big hall will persist by repeated reflection from the walls until it is reduced to a value when it is no longer audible.

The repeated reflection that results in the persistence of sound is called reverberation.

Audio recording theatre

In an auditorium, big hall, theatres and audio recording theatres, etc, the excessive reverberation is highly undesirable. The reverberation time should not be more than its optimum value. For speech, it is 0.5 second, for music 1 to 1.5 second. To reduce reverberation, the roof and walls of auditorium are generally covered with sound absorbing materials like compressed fibre board, rough plaster or draperies. The seat materials are also selected on the basis of their sound absorbing properties.

17.5. RANGE OF HEARING

Sound is produced by vibrating bodies. We can hear sound of frequencies ranging from 20 Hz to 20,000 Hz. This range of frequencies, sensed by our ear is known as the audible range of sound for human beings. (One Hz= one cycle/second)

Sound of frequencies above 20,000 Hz are known as ultrasonic.

Sometimes sound produced by bats, dolphins are ultrasonic.

Sound of frequencies below 20Hz are called infrasonic.

We cannot hear ultrasonic and infrasonic. But certain animals can produce and detect ultrasonic and infrasonic.

Heinrich Rudolf Hertz (1857 - 94)

A German scientist, Hertz gave the first experimental proof of the existence of radio waves. He did research on the evaporation of liquids. He had a deep interest in meteorology also. The frequency which is measured in cycles / second was changed as hertz (Hz) after him.

Audible range of sound (in Hertz) for Human and certain animals

Human

20 - 20,000

Elephant

16 - 12,000

Cow

16- 40,000

Cat

100 - 32,000

Dog

40 - 46,000

Rabbit

1000 - 1,00,000

Bat

1000 - 1,50,000

Dolphins

70 -1,50,000

Seal

900 – 2,00,000

ACTIVITY –17.10

Try to count different sounds you hear from various living beings from morning to night.

17.6. APPLICATION OF ULTRA SOUND

Ultra sound scan is currently considered to be a safe, non- invasive, accurate and cost effective investigation of the foetus. It has progressively become an indispensable obstetric tool and plays an important role in the care of every pregnant woman.

17.6.1. SONAR (Sound Navigation And Ranging)

Sonar is a device that uses ultrasonic waves to measure the distance, direction and speed of underwater objects and depth of the sea.

Sonar consists of a transmitter and a detector, installed in a ship as shown in fig 17.4.

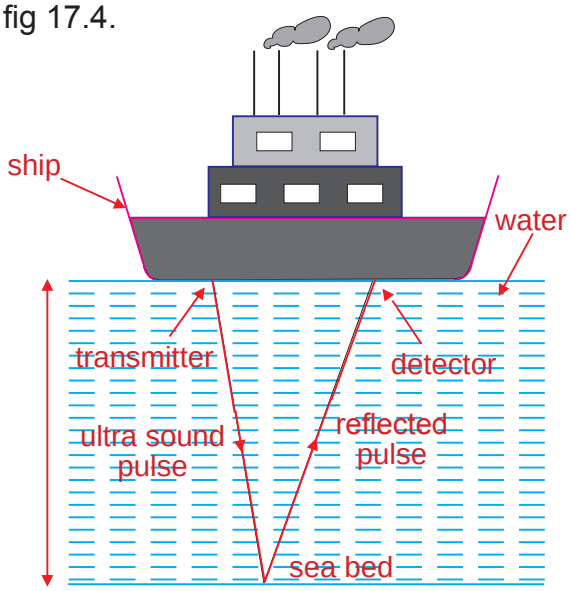


Fig 17.4. Ultra sound sent by transmitter and received by the detector

The transmitter produces and transmits ultrasonic waves. These waves travel through water and after striking the object on the sea bed, get reflected and are sensed by the detector. The detector converts the ultrasonic waves into electrical signal which are appropriately interpreted.

Echo Ranging

Set the time interval between transmission and reception of ultrasound is 't' speed of sound through water is 'v' total distance travelled (to & fro) is '2d'.

$$2d = v \times t, \qquad d = \frac{v \times t}{2}$$

This method is called Echo Ranging. It is used to determine the depth of the sea and to locate under water hills, submarine, icebergs, sunken ship, etc.

ACTIVITY –17.11

Stand on a railway platform and hear the whistle sound of the train as it approaches and leaves.

17.6.2. DOPPLER EFFECT IN SOUND

The pitch of the whistle seems higher as the train comes towards you and lower when the train goes away from you.

If an observer is situated at a fixed distance from a sound source, the frequency of sound heard by him is the same as produced by the source.

But if the sound source or the observer or both are in a state of motion, the frequency of the sound appears to be changed to the observer.

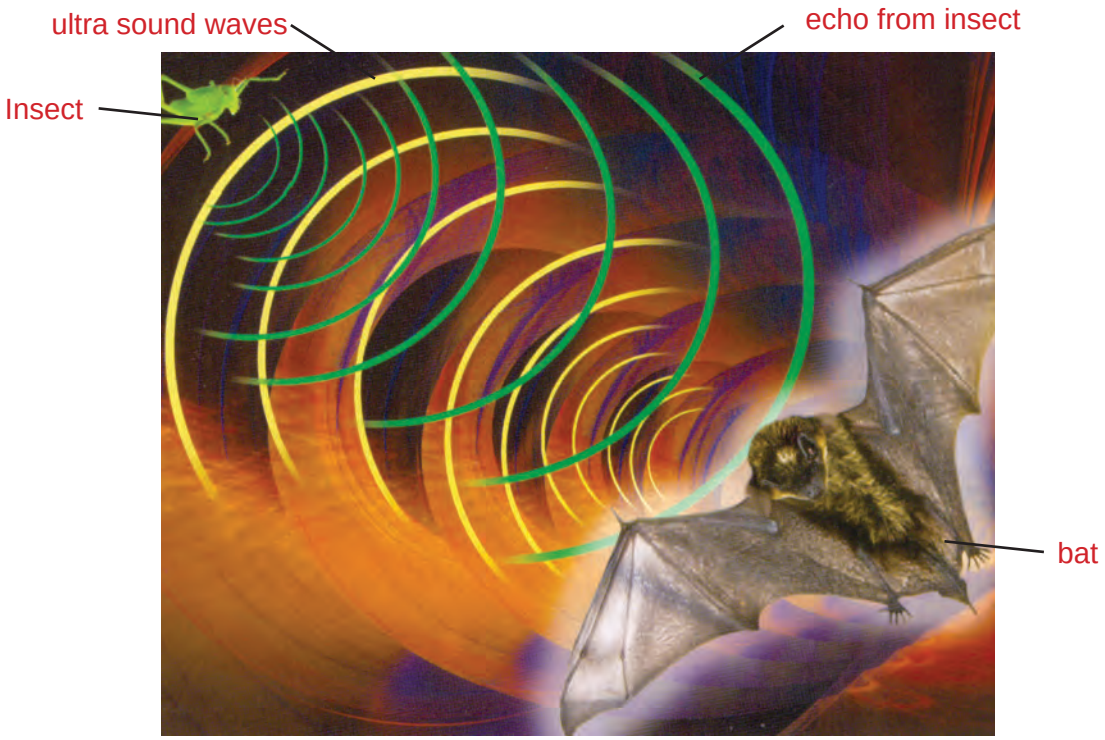
The phenomenon of the apparent change in the frequency of the source due to relative motion between the source and the observer is called as Doppler's effect.

Christian Johann Doppler (1803 – 53)

He was an Austrian mathematician and physicist. He is known for his principle. He first proposed in concerning the coloured light of double stars in 1842. This principle is known as the Doppler effect. He hypothesized that the pitch of a sound would change if the source of the sound was moving. This principle is used in velocity and distance measurements and various applications.

Uses of Doppler effect in sound

- RADAR (Radio Detection And Ranging) Doppler effect principle is used in RADAR to determine the velocities and movement of submarines and aircrafts.
- Traffic control vehicles direct microwaves on speeding vehicles. The waves reflected by the moving vehicles act as a moving source. From the Doppler shift in frequency, the speed of vehicles are detected.
- The Doppler shift of radar waves are used in airports to find the height, speed and distance of approaching aircrafts.
- Bats send out and receive ultrasonic waves reflected by the prey and obstacles. Bats detect the location, distance and movement of the prey by the Doppler shift.



EVALUATION

Section – A

1. When we hear music, the medium through which the sound transmitted is _____. (solid, liquid, gas)
2. Pick the odd one out from the following intruments on basis of prodution of sound

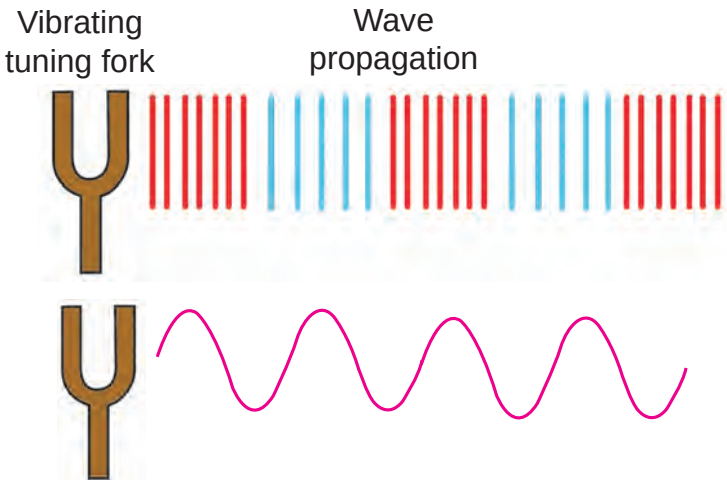

Mouth organ


Veena


Flute


Clarinet

3. In the following diagram, state in which of the following cases, the sound propagates in air.



4. From the list of frequencies, find the ultrasonic frequency.
   (2000 Hz, 20000Hz, 30000 Hz, 10000 Hz)
5. The principle on which stethoscope works is _____ (reflection, multiple reflection)
6. Find the odd one out on the basis of audiable range


Elephant


Bat


Dolphin


Rabit

Section – B

7. Match the following

a) ripples on surface of water	longitudinal wave
b) light waves	electro magnetic transverse
c) sound waves	mechanical transverse

8. Two auditoriums, named A and B are constructed adjacently. The sound engineer examined both and gave report as follows

Auditorium	Reverberation time
A	1.5 s
B	0.5 s

Select the auditorium for,

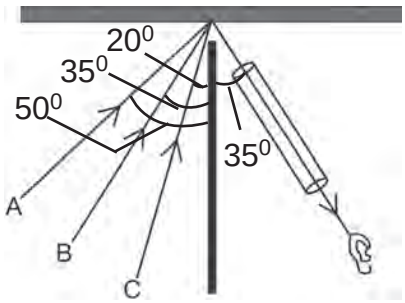
a) speech and seminar

b) cultural programmes

9. A sonar device on a submarine sends out a signal and receives an echo 5 s later. Calculate the speed of sound in water if the distance of the object from the submarine is 3625 m.

10. The echo of our sound is not heard in our living room, but it is heard distinctly in a big hall. Why?

11.



a) In which of the given position A, B or C, is an alarm clock to be placed, so that the maximum sound is heard by the observer.

b) Give reason for your answer.

12. In an auditorium or a cinema hall, the roof and walls are covered with draperies or compressed fibre board. Why?

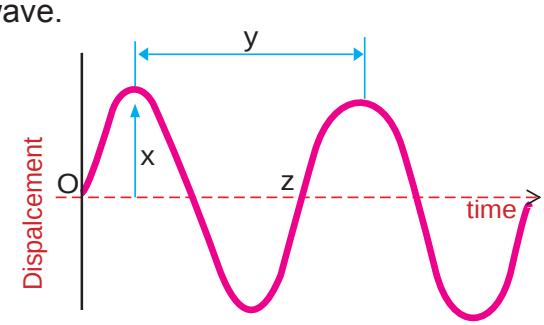
Section – C

13. The following figure represents a sound wave.

a) Draw and mark the name of the variables x, y and z.

b) Write the equation for velocity of a wave using the above variables.

c) Write any two differences between transverse and longitudinal waves.



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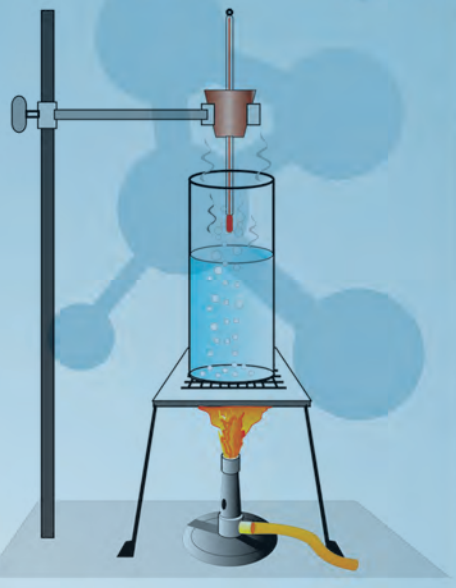
PRACTICALS



LIST OF PRACTICALS

S.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 and study of plant cells	Onion bulb, watchglass, coverslip, slide, methylene blue or safrannin, glycerine, blotting paper and microscope	40 minute
2	Osmosis	To study the phenomenon of osmosis by using potato osmoscope	Potato, knife, sugar solution, beaker, coloured water, pins, etc.,	40 minute
3	Pollen Grain	To dust the pollen grains on the slide and observe under the dissection (simple) microscope. Draw and label the parts.	Flowers, dissection (simple) microscope, glass slide and needle	40 minute
4	Ascent of Sap	To prove the ascent of sap through xylem vessels by using balsam plant.	A bottle or a beaker, water, eosin stain or red ink and balsam plant	40 minute
5	Paramoecium	To identify the prepared slide of paramoceium	Compound microscope, paramoceium slide	40 minute
6	Purity of Milk	To measure the strength (purity of milk) by using lactometer.	Milk, lactometer	40 minute
7	Micro organisms	To identify the micro organisms in pond water	Pond water in a beaker, compound microscope, glass slide	40 minute
8	Ethyl Alcohol	To find out ethyl alcohol in a medium.	Ethyl alcohol, acidified potassium dichromate, test tube	40 minute

Sl.No	Name of the Experiment	Aim of the Experiment	Apparatus/ Materials required	Time
9	Measurement of volume of liquid	To measure the volumes of solutions using pipette	Pippette (20 ml) Beaker (250 ml)	40 Minute
10	Preparation of saturated, unsaturated and super saturated solutions	To prepare solutions of different concentrations like unsaturated, saturated and supersaturated solutions	100 ml beakers, distilled water, sodium chloride	40 Minute
11	Study the characteristics of metals	To determine the relative strengths (electropositive characters) of given metals	Test tube Lead , Zinc and Copper, Pb $(NO_3)_2$ $ZnSO_4$, $CuSO_4$	40 Minute
12	Identification of acid radicals in the given salt	To identify carbonate, chloride, sulphate acid radicals present in the given salt	Test tube Carbonate salt, Sulphate salt, Chloride salt Dil. HCl, $AgNO_3$, $BaCl_2$	40 Minute
13	Finding the diameter of a spherical body	To determine the diameter of a spherical body using vernier calipers.	Vernier calipers, Spherical body (Simple pendulum bob)	40 minute
14	Finding the relation between length and time period of a simple pendulum	To find the period of oscillation and proving (l/T^2) is a constant	Simple pendulum apparatus (stand, bob, twine, split cork), stopwatch	40 minute
15	Determining density of a solid	To determine the density of a solid heavier than water using Archimede's principle	Spring Balance, brass bob, beaker with water	40 minute
16	Temperature – Time Relation	To determine the boiling point of water and to draw the cooling curve	Beaker with water, electric heater, tripod stand, wire gauze	40 minute

1. TO STUDY A PLANT CELL

Aim:

To prepare a temporary slide of the onion peel and study of plant cells.

Materials Required:

An onion bulb, watchglass, 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 in 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.

(i) Piece of onion bulb

(ii) Snap the scale backward

(iii) Pull the transparent peel steps to take out an onion peel

(iv) Drop of water

(v)

(vi) Stages to show the mounting procedure on a slide.

Draw a diagram of the cells as seen under microscope and label Nucleus, Vacuole and Cellwall.

2. TO STUDY THE PHENOMENON OF OSMOSIS

Aim:

To study the phenomenon of osmosis by potato osmoscope.

Principle:

Movement of molecules of water or solvent from a region of its higher concentration to the region of its lower concentration through a semipermeable membrane is called osmosis.

Materials Required:

Potato, knife, sugar solution, beaker, coloured water, pins, etc,.

Procedure:

a. A potato is taken and peeled.

b. Its base is cut to make it flat.

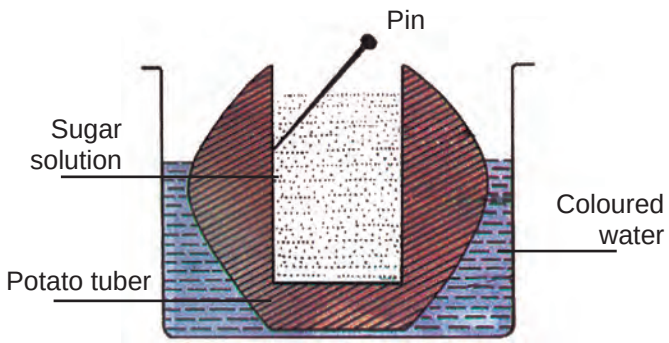
c. A hollow cavity is made in the centre of the tuber filled with sugar solution.

d. The initial level of solution is marked with the help of a pin.

e. It is placed in a beaker containing coloured water.

f. Leave the experimental set up for sometime.

g. Final level of sugar solution is measured.



Record the observations in the table

Initial levl of sugar solution (mm)	Final level of sugar solution (mm)	Difference between initial level and final level (mm)

Inference:

The level of sugar solution _____ and becomes _____ due to _____.

3. TO OBSERVE THE POLLEN GRAINS

Aim:

To dust the pollen grains on the slide and observe under the dissection (simple) microscope and draw and label the parts.

Materials Required:

Flowers, dissection (simple) microscope, glass slide and needle.

Procedure:

a. Collect the pollen grains from a given flower.
b. With the help of a needle, place the pollen grains on the slide.
c. Observe the slide under microscope.

Observation:

a. It is a single celled structure.
b. It has two layers. The outer exine which is spiny and the inner intine is thin and smooth.
c. It contains a single nucleus and cytoplasm.

Draw the structure of pollen grain as observed through microscope. Label Exine, Intine, Cytoplasm and Nucleus

4. TO PROVE ASCENT OF SAP

Aim:

To prove the ascent of sap through xylem vessels by using Balsam plant (Kasithumbai plant).

Principle:

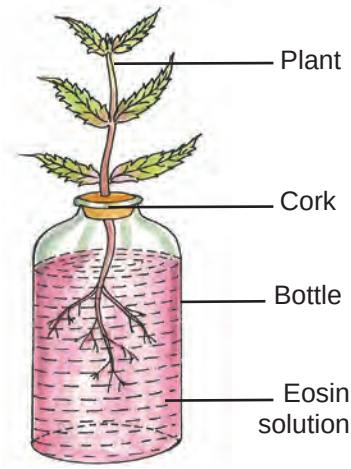
The conduction of water and mineral salts from the roots upward by the stem through the xylem vessels is known as the ascent of sap.

Materials Required:

A bottle, water, eosin stain or red ink and Balsam plant.

Procedure:

a) Take a bottle containing water and add a few drops of eosin stain or red ink.
b) Close the mouth of the bottle with a one-holed rubber cork.
c) Insert a balsam plant into it.
d) Keep the apparatus undisturbed for some time.



Record the periodical observations in the interval of 10 minute each.

Sl.No	Periodicity	Observations
1.	After 10 Minute	
2.	After 20 Minute	
3.	After 30 Minute	

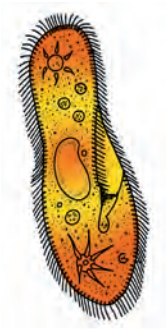
Inference:

Red streaks seen in the stem and in the veins of leaves prove that .....
.....

5. TO IDENTIFY PARAMOECIUM

Observe a prepared slide of paramoecium under a compound microscope. Draw and label the parts.

Preparation of sample



Take few pieces of straw and immerse inside a beaker containing water and keep it for about 3 days.

Number of paramoecium are developed, while the straw is decaying.

Place a drop of water on the slide from the beaker and observe it under compound microscope.

Identification:

The slide kept for identification is an unicellular protozoan – the paramoecium.

Observation:

1. Structure of paramoecium
2. Locomotion of paramoecium

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6. TO FIND OUT THE PURITY OF MILK

Aim:

To find out the strength (purity) of milk by using a lactometer.

Requirement:

Milk, lactometer.

Principle:

100ml of pure milk is taken in a beaker. The meter bulb is dipped into the beaker. The bulb just sinks and then begin to float. The reading on the meter _____ indicates the purity of milk.

Observation:

If the bulb sinks deeper, it indicates that the milk contains more water and if the reading is at mark, it shows that the milk is very rich and pure.

Sl.No	Milk	Water	Lactometer reading
1	100 ml	Nil	
2	100 ml	10ml	
3	100 ml	20ml	
4	100 ml	30ml	

Result:

Thus the lactometer is used to find out the strength (purity) of the milk.

7. TO DETECT MICRO ORGANISMS IN POND WATER

Aim:

To identify various microorganisms (any three) seen in a drop of pond water. Draw diagram.

Requirements:

A glass beaker with pond water, glass slide, compound microscope.

Procedure:

A drop of pond water is kept on a glass slide. The slide is kept under the microscope.

Observation:

Any three micro organisms 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

8. TO FIND OUT ETHYL ALCOHOL IN THE MEDIUM

Aim:

To find out ethyl alcohol in the medium.

Required Materials:

Ethyl alcohol, acidified potassium dichromate

Procedure:

Take 5 ml of acidified potassium dichromate in a test tube. Add a drop of ethyl alcohol and shake well. Slowly the colour of the mixture red orange is turned into green. It shows the presence of alcohol.

Inference:

In this reaction chromium ions (Cr VI) red orange is converted into (Cr III), which is green in colour.

Experiment	Observation	Inference
Acidified potassium dichromate is treated with a drop of ethyl alcohol	..... colour of the mixture is turned into	presence of ....

Result:

The presence of ..... is confirmed / not confirmed.

Importance of this test:

This test is used to find out a drunkard. It is a respiratory analysis.

9. TO MEASURE VOLUME OF LIQUIDS

Aim:

To measure the volumes of given colourless and coloured solutions using pipette.

Required Materials:

Pipette (20 ml), beaker (250 ml).

Procedure:

Take a pipette of definite volume. Wash it with water and then rinse 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 fore finger. 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, 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 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 liquid measured using pipette is _____ ml.

Precaution:

Never use a pipette for sucking strong acids or strong alkalies.

10. TO PREPARE UNSATURATED, SATURATED AND SUPER SATURATED SOLUTIONS

Aim:

To prepare solutions of different concentrations like ***unsaturated, saturated*** and ***supersaturated*** solutions.

Required Materials:

100 ml beakers, distilled water, sodium chloride

Principle:

- A solution which can dissolve more of the solute at a given temperature is known as an ***unsaturated solution.***
- A solution which can not dissolve any more of the solute is known as a ***saturated solution.***
- A solution which contains much greater quantity of the solute that can be normally present in the saturated solution is known as a ***supersaturated solution.***

Procedure:

Take about 25 ml of distilled water in a 100 ml beaker. Add about 2g of ***sodium chloride*** to it and stir well. The salt dissolves completely. Now note the nature of solution obtained.

Repeat the addition of salt to the above solution, till some of the added salt remains at the bottom of the beaker. Now note the nature of solution.

Add more and more quantity of the salt to the above solution. Heat the solution for few minutes to dissolve the salt. Now stop heating and allow it to settle. Observe the separation of crystals of the salt. Note the nature of solution.

Tabulation:

Sl. No.	Name of salt added	Weight of Salt added	Volume of water	Nature of Concentration of Solution

Report:

The solutions obtained are classified as _____, _____ and _____ solutions.

11. TO STUDY THE CHARACTERISTICS OF METALS

Aim:

To determine the relative strengths (electropositive characters) of given metals.

Principle:

Relative strengths of metals can be determined by the precipitation of one metal by another.

Chemicals required:

- Small pieces of ***copper***, ***lead*** and ***zinc***
- Solutions of ***leadnitrate***, ***coppersulphate*** and ***zincsulphate.***

Procedure:

Trial 1: Take about 5ml each of ***leadnitrate*** and ***zincsulphate*** in two separate test tubes. Add pieces of ***copper*** to both the tubes and observe the changes and record. (No chemical change occurs in both the tubes).

Tabulation:

Sl. No.	Solutions taken	Metal added	Observation

Trial 2 : Take about 5ml each of ***coppersulphate*** and ***zincnitrate*** solutions in two separate test tubes. Add pieces of ***lead*** to both the tubes and observe the changes (lead reacts with copper sulphate and not with zinc sulphate).

Tabulation:

Sl. No.	Solutions taken	Metal added	Observation

Trial 3 : Take about 5ml of ***coppersulphate*** and ***leadnitrate*** solutions in two separate test tubes. Add pieces of ***zinc*** to both the tubes and observe the changes (Zinc reacts with both copper sulphate and lead nitrate).

Tabulation:

Sl. No.	Solutions taken	Metal added	Observation

Report:

The order of relative strengths of the metals are____ >____ >____.

12. TO IDENTIFY ACID RADICALS

Aim:

To identify the acid radical present in the given salt.

Identification of Carbonate acid radical

Experiment	Observation
1. Take about 1g of the salt in a test tube. Add 2-3ml of **dilute hydrochloric acid**.	**Brisk effervescence** due to the liberation of **CO_2** gas.
2. To the salt solution, add few drops of **Magnesium sulphate** solution.	A **white** precipitate of **magnesium carbonate** is formed.

Report: The acid radical present in the salt is _____.

Identification of Chloride acid radical

Experiment	Observation
1. Take about 3g of the given salt in test tube.To which add very little amount of **manganesedioxide** followed by **conc.sulphuric acid**. Heat the mixture for few seconds.	Evolution of **greenish yellow chlorine** gas (Cl_2).
2. Add few drops of **silver nitrate** solution to the aqueous solution of the salt.	A **curdy white** precipitate of **silver chloride** is formed.

Report: The acid radical present in the salt is _____.

Identification of Sulphate acid radical

Experiment	Observation
1. Take a pinch of the salt in a test tube. Add water. If the salt is insoluble in water add **dil.hydrochloric acid** till the effervescence ceases. Then add **Barium chloride** solution.	Formation of a **white precipitate** of Barium sulphate.
2. Add a few drops of **lead acetate** solution to the aqueous solution of the salt.	Formation of a **white precipitate** of Lead sulphate.

Report: The acid radical present in the salt is _____.

13. FINDING THE DIAMETER OF A SPHERICAL BODY

Aim:

To determine the diameter of a spherical body using Vernier Calipers.

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 Calipers.
- Find also the Zero Error of the Vernier Calipers.
- 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 body.
- 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) =

$$\text{Least Count} = \frac{1}{N} \times 1\text{MSD}$$

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

14. FINDING THE RELATION BETWEEN LENGTH AND TIME PERIOD OF SIMPLE PENDULUM

Aim:

To find the period of oscillation of a simple pendulum and to prove that l/T^2 is a constant.

Apparatus required:

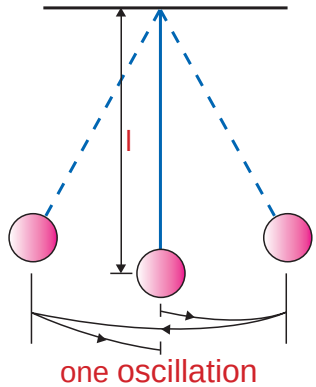
Simple pendulum apparatus, stop watch.

Formula:

l/T^2 is a constant

Where, l is the length of the simple pendulum (m)

T is the Period of oscillation of the simple pendulum (s)



Procedure:

- Suspend the simple pendulum for a length of 70 cm.
- Make the pendulum to oscillate with small amplitude.
- When the pendulum crosses the mean position towards the right, start a stop watch and count zero.
- When it crosses the mean position towards the right next time, count one.
- Like this count up to twenty and stop the stopwatch.
- Find the time taken for 20 oscillations and record in the tabulation.
- Repeat the experiment by changing the length to 80cm, 90cm, 100cm and 110cm.
- Tabulate the readings and find T, T^2 & l/T^2.
- The last column of the tabulation is found to be constant, hence proving l/T^2 is a constant.

Observation:

S. No.	Length of the simple pendulum m	Time taken for 20 oscillations s	Period T s	T^2 s^2	l/T^2 $m\ s^{-2}$
1	0.7				
2	0.8				
3	0.9				
4	1.0				
5	1.1				

Result:

From the table, it is found that l/T^2 is a constant.

15. DETERMINING DENSITY OF A SOLID

Aim:

To determine the 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:

$$d = \frac{w_1}{w_1 - w_2} \quad kg\ m^{-3}$$

where,

d = density of the solid (kg m^{-3})
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 density of the given solid.

Observation:

S. No.	Weight of the solid in air x 10^{-3} kg w_1	Weight of the solid in water x 10^{-3} kg w_2	$d = \frac{w_1}{w_1 - w_2}$ kg m^{-3}

Mean

Result:

Density of the given solid = _____ kg m^{-3}

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 sticking to the solid

16. TEMPERATURE – TIME RELATIONSHIP

Aim:

To determine the boiling point of water and to draw the cooling curve.

Apparatus required:

Beaker with water, electric heater, tripod stand, wire gauze, graph sheet.

Procedure:

- Place the beaker with water over the wire gauze placed on the tripod stand.
- Fix a thermometer to a stand and immerse it in water.
- Heat the beaker with a electric heater.
- When water boils, note the thermometer reading.
- It gives the boiling point of water.
- Stop heating and allow water to cool.
- Take the thermometer reading while switching on the stop clock.
- Find temperature interval using stop clock.
- Similarly note the thermometer reading for every one minute interval till the temperature falls upto 60^{o}c.
- Record the readings in the tabulation.

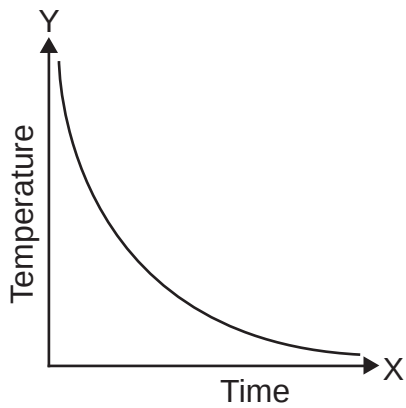
Observation:

Maximum temperature measured = ___ ^{o}c

$\therefore$ The boiling point of water = ___ ^{o}c

Time (minute)	Temperature (^{o}c)
0	
1	
2	
3	
4	
5	
6	
7	

For a suitable scale draw the cooling curve by taking time along the x axis and temperature along the y axis.



Result:

1. The boiling point of water = ___ ^{o}c
2. The cooling curve is drawn