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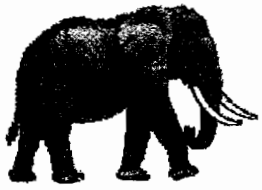
BIOLOGY

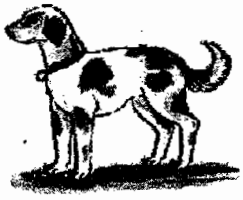
REPRODUCTION IN ORGANISM-I

- The period from birth to the natural death of an organism represents its **life span**.
- Life spans of organisms are not necessarily correlated with their sizes; the sizes of crows and parrots are not very different yet their life spans show a wide difference.
- Similarly, a mango tree has a much shorter life span as compared to a peepal tree. Whatever be the life span, death of every individual organism is a certainty, i.e., no individual is immortal, except single-celled organisms.



Elephant (65-90 years)

Rose (5-7 years)



Dog (**20**-30 years)

Butter fly (1-2 weeks)

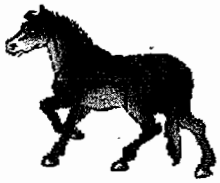
Crow (15 years)

Banana tree (20-25 years)

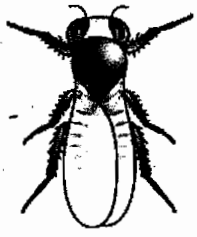
Cow (**15**-25 years)

Parrot (140 years)

Crocodile (60 years)



Horse (62 years)



Fruit fly (about **20**-30 days)

Rice plant (3-4 months)

Tortoise (100-150 years)

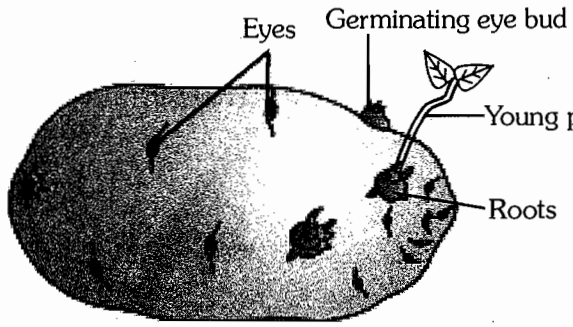
Banyan tree (**200**-300 years)

Approximate life spans of some organisms

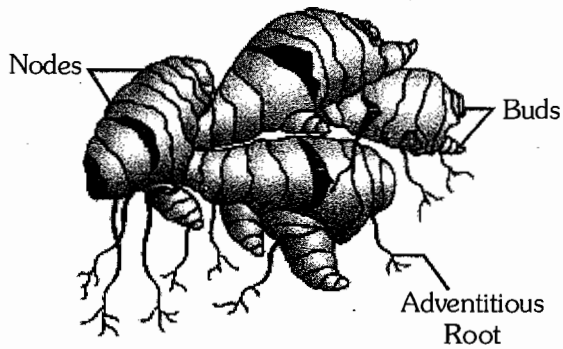
- Reproduction is defined as a biological process in which an organism gives rise to young ones (offspring) similar to itself. The offspring grow, mature and in turn produce **new offspring.** Thus, there is a cycle of birth, growth and death.
- Reproduction enables the **continuity of the species,** generation after generation.
- The organism's habitat, its internal physiology and several other factors are collectively responsible for how it reproduces.
- When offspring is produced by a single parent with or **without the involvement of gamete formation,** the reproduction is **asexual**. When two parents (opposite sex) participate in the reproductive process and also involve fusion of male and female gametes, it is called **sexual reproduction**.

ASEXUAL REPRODUCTION

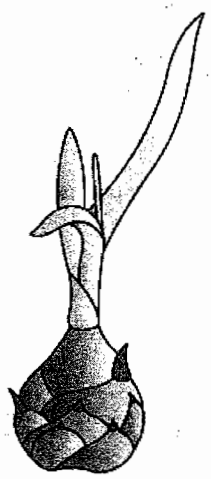
- In this method, a single individual (parent) is capable of producing offspring. As a result, the offspring that are produced are not only identical to one another but are also exact copies of their parent.
  Are these offspring likely to be genetically identical or different? Answer will be **genetically identical.**
- The term **clone** is used to **morphologically and genetically similar individuals**
- Many single-celled organisms (monerans and protists) reproduce by **binary fission.**
- Member of kingdom fungi and algae reproduce through special asexual reproductive structures called zoospores.
- Conidia (Penicillum) buds (Hydra) and gemmules (sponge) are other common asexual reprodutive structures.



(a) Potato

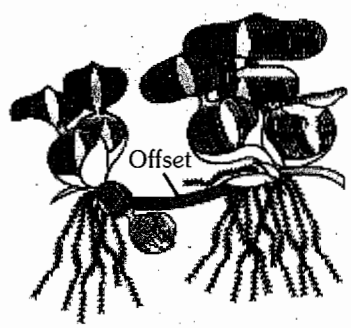


(b) Ginger



(c) Agave

(d) Bryophyllum



(e) Eichhornia

Vegetative propagules in angiosperms : (a) Eyes of potato; (b) Rhizome of ginger; (c) Bulbil of *Agave*; (d) Leaf buds of *Bryophyllum*; (e) Offset of water hyacinth (*Eichhornia*)

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MODULE - 2

GENETICS

PRINCIPLES OF INHERITANCE AND VARIATIONS

INTRODUCTION

Genetics term was given by **W. Bateson**.

Genetics = Collective study of heredity & Variations.

Heredity = Transmission of genetic characters from parent to offsprings.

Variation = individuals of same species have some differences, these are called variation.

- History of reserches in genetics.

G.J. Mendel – Father of Genetics.

W. Bateson – Father of Modern Genetics.

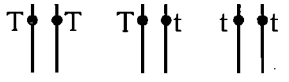
Morgan – Father of Experimental genetics
He performed experiment on *Drosophila* & proposed various concepts, like Linkage, Sex linkage, Crissing over, Criss - cross inheritance, Linkage map on *Drosophila*.

- **A. Garrod** = Father of human genetics & Biochemical genetics. Garrod discovered first human Metabolic genetic disorder which is called **alkaptonuria**(black urine disease).

SOME GENETICAL TERMS

1. **Factors** :- Unit of heredity which is responsible for inheritance and appearance of characters.
These factors were referred as genes by **Johannsen**(1909). Mendel used term **"element"** or **"factor"**.
Morgan first used symbol to represent the **factor**. Dominant factors are represented by capital letter while recessive factor by small letter.

2. **Allele** :- Alternative forms of a gene which are located on same position [loci] on the homologous chromosome is called Allele. Term allele was coined by **Bateson**.



3. **Homozygous** :- A zygote is formed by fusion of two gametes having identicle factors is called homozygote and organism developed from this zygote is called homozygous. Ex. TT, RR, tt
4. **Heterozygous** :- A zygote is formed by fusion of two different types of gamete carrying different factors is called heterozygote (Tt, Rr) and individual developed from such zygote is called heterozygous.
The term homozygous and heterozygous are coined by **Bateson**.
5. **Hemizygous** :- If individual contains only one gene of a pair then individual is said to be Hemizygous. Male individual is always Hemizygous for sex linked gene.
6. **Phenotype** :- It is the external and morphological appearance of an organism for a particular character.
7. **Genotype** :- The genetic constitution or genetic make-up of an organism for a particular character.
Genotype & phenotype terms were coined by **Johannsen.**
8. **Phenocopy** :- If different genotypes are placed in different environmental conditions then they produce same phenotype. Then these genotypes are said to be Phenocopy of each other.
9. **Hybrid vigour/Heterosis –** Superiority of offsprings over it's parents is called as **Hybrid vigour** & it develops due to Heterozygosity.

- Hybrid vigour can be maintained for long time in vegetaively propagated crops.
- Hybrid vigour can be lost by inbreeding (selfing) because inbreeding induces the Homozygosity in offsprings. Loss of Hybrid vigour due to inbreeding, is called as **inbreeding depression**.

MENDELISM

Experiments performed by Mendel on genetics and description of mechanisms of hereditory processes and formulation of principles are known as Mendelism.

Mendel postulated various experimental laws in relation of genetics.

Gregor Johann Mendel (1822 - 1884) :- Mendel was born on July 22,1822 at Heinzendorf in Austria at Silesia village. Mendel worked in Augustinian Monastery as monk at Brunn city, Austria.

In 1856-57, he started his historical experiments of heredity on pea(*Pisum sativum*) plant. His experimental work continued on pea plant till 1863 (19th century).

The results of his experiments were published in 1865.

A paper of Mendel by the name of "Experiment in plant Hybridization" was published in this journal.

Mendel was unable to get any popularity. No one understood of him. He died in 1884 without getting any credit of his work.

After 16 years of Mendel's death in 1900, Mendel's postulates were rediscovered.

Rediscovery by three scientists independently.

1. **Carl Correns** - (Germany) - (Experiment on Maize)
2. **Hugo deVries** (Holland) (Experiment on Evening Primerose)

   He republished Mendel's results in 1901 in Flora magazine
3. **Erich von Tschermak Seysenegg** - (Austria) (Experiment on different flowering plants)

The credit of rediscovery of Mendelism goes to three scientists.

Correns gave two laws of Mendelism.

Law of Heredity/Inheritance/Mendelism

Ist Law - Law of segregation.

IInd Law - Law of independent assortment.

Mendel experiments remain hidden for 34 years.

Mendel published his work on inheritance of characters in 1865 but for several reasons, it remained unrecognised till 1900. Firstly, communication was not easy (as it is now) in those days and his work could not be widely publicised. **Secondly,** his concept of **genes** (or **factors**, in Mendel's words) as stable and discrete units that controlled the expression of traits and, of the pair of alleles which did not 'blend' with each other, was not accepted by his contemporaries as an explanation for the apparently continuous variation seen in nature. **Thirdly,** Mendel's approach of using mathematics to explain biological phenomenon was totally new and unacceptable to many of the biologists of his time. **Finally,** though Mendel's work suggested that factors (genes) were discrete units, he could not provide any physical proof for the existence of factors or say what they were made of.

Reasons for Mendel's success :

1. Mendel studied the inheretance of one or two characters at a time unlike his predecessors who had considered many characters at a time. (Kolreuter-Tobacco plant, John Goss & Knight -Pea plant).
2. Selection of Material –

   Selection of garden Pea plant is suitable for studies, which have the following advantages :

   (i) Pea plant is annual plant with short life cycle of 2-3 months so large no. of offsprings can be analysed within a short period of time.

   (ii) It has many contrasting traits.

   (iii) Natural self pollination is present in pea plant.

   (iv) Cross pollination can be performed in it artificially so hybridization can be made possible.

   (v) Pea plant is easy to cultivate.

   (vi) Pea seeds are large. In addition to pea, Mendel worked on rajama and hawk weed.
3. Mendel quantitatively analyse the inheritance of qualitative characters.
4. He maintained the statistical records of all the experiments.
5. His experiments had a large sampling size.

Mendel's work : Mendel studied 7 characters or 7 pairs of contrasting traits.

Actual data obtained by Mendel in F_2 progenies in garden pea

S.No.	Character	Ch. No.	Dominant	Recessive	Ratio
1.	Length of plant (Stem height)	4th	787 (tall)	277 (dwarf)	2.84:1
2.	Flower position	4th	651 (axial)	207 (terminal)	3.14:1
3.	Shape of pod	4th	882 (inflated)	299 (constricted)	2.94:1
4.	Pod colour	5th	428 (green)	152 (yellow)	2.82:1
5.	Seed shape	7th	5,474 (round)	1,850 (wrinkled)	2.96:1
6.	Seed colour	1st	6,022 (yellow)	2,001 (green)	3.01:1
7.	Flower colour	1st	705 (violet)	224 (white)	3.15:1
	Average of all traits studied				2.98:(=3:1)

Special Point :

- **S. Blixt** concluded that the genes studied by Mendel are located on four different pairs of chromosomes.

  These are chromosome 1st, 4th, 5th, 7th
- Two of the genes are on chromosome 1st and three are on chromosome 4th. These genes are located far apart on the chromosome except genes controlling plant height and pod shape.
- In Pea plant sead coat colour and Flower colour are regulated by same gene.

  Gene which controls more than one character is called as **pleiotropic gene.**
- Mendel obtained wrinkled seeds due to absence of **Starch Branching enzyme (SBE)**

  In Wrinkled seed free sugar is more in place of starch.

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BIOLOGY

E

ECOLOGY

◆ The term ecology was coined and described by	–	**E.Haeckel**
◆ Father of ecology	–	**Reiter**
◆ Father of Indian Ecology	–	**Prof. Ram Deo Misra**
◆ First of all term ecology was employed for study of plant by	–	**Warming**

The study of interaction or inter-relationship of organisms with their environment is called ecology.

Organism ⟺ Environment

Organism and environment are organisation always interdependent, inter related or mutually reactive.

Branches of Ecology – It is based on organisation level

1. **Autecology –** Study of the relation of a single species with its environment is known as autecology
2. **Synecology –** Study of the relation of the group of different species with their environment is known as synecology.

ECOLOGICAL HIERARCHY

Organism → Population (species) → community → Ecosystem → Biome → Biosphere

size → Increase

complexity → Increase

ORGANISM

An organism is the smallest unit of ecological hierarchy and basic unit of ecological study.

- It may be small/large, unicellular/multicellular.
- Fixed life span and organized life cycle (birth to death)
- Ecology at the organismic level is essentially physiological ecology.

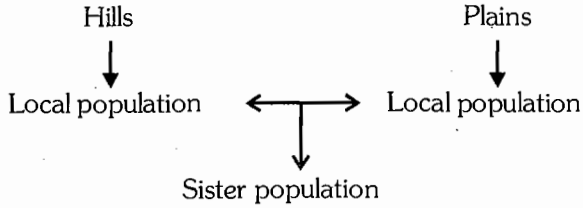
POPULATION

A group of Individuals (members) of same species living at one place (specific geographical area) constitute a population.

- **Local Population or demes (Sub groups of population) –** Population of organism inhabiting a particular area.

  eg. Homosapiens inhabiting hills, plains

- **Sister population –** Different population of same species of organisms which are found in different places are known as sister population.



- **Meta population –** A set of local population which are interconnected by dispersing individuals.

SPECIES

Definition - Species is a basic unit of classification, defined as the group of living organisms similar in structure,function and behaviour and produced by similar parents, have common gene pool, can inter breed under natural conditions and reproductively isolated from other group of organism.

SOME TERMS RELATED TO SPECIES :

- **Endemic Species or Endemism :**

  A species which is found only in a particular area is known as endemic species.

  e.g. Meta sequoia is found only in valley of China, Kangaroo in Australia

- **Key-stone Species :**

  The species which have great influence on the community's characteristics relative to their low abundance or biomass are called key-stone species. The activities of key-stone species determine the structure of the community.

  e.g. Lion in forest, Kangaroo rat in desert, fig tree in tropical forest.

- **Critical Link Species :**

  The species which establishes an essential link with other species to help the latter in some vital activity is called link species.

  e.g. Mycorrhizal fungi, many insect species which works as pollinators of flowers.

COMMUNITY

Groups of organisms of different species that live in common area, which are interrelated and interdependent. It is a natural aggregation of plants and animals in the same environment.

Biotic Community = Animal community + Plant community + Microbial community

Characteristics of a community –

1. **Species Diversity –**

   There are different types of population (species) found in community, this is called species diversity. It depends on size of the area, type of area, type of soil , altitude, climate.

2. **Dominance –**

   The highest number of organism of a species present in community, is called as the dominant species. Whole community is known by the name of that particular dominant species.

   e.g. Prosopis in Aravali hills, Pinus in Himalaya

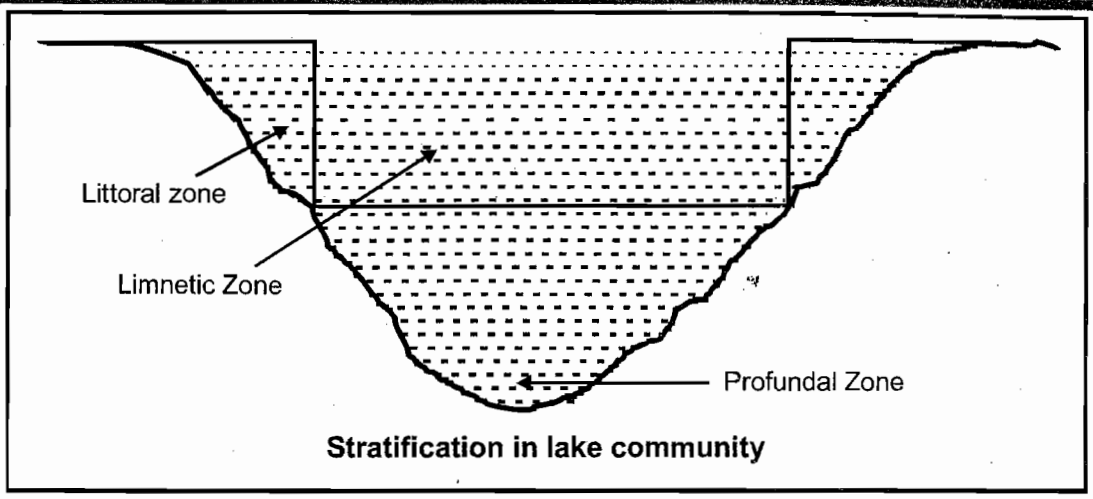
3. **Stratification –**

   The different growth form (trees, shrubs, under shrubs, herbs) determines the structure of a plant community. Stratification is based on mode of arrangement of various growth forms.

(i) Stratification in lake

In deep lake, zonation or stratification may be according to the **need of light**. There are three types of zones differentiated in a deep lake.

- **Littoral Zone –** This zone is found at bank of lake where very shallow water or marshy land is present. Rooted vegetation is found in this zone.
- **Limnetic zone –** This is the zone of lake water, where light reaches in sufficient amount to entire surface area. It means this is not too deep. In this region different types of floating plants (phytoplanktons), suspended and submerged plants are present.
- **Profundal zone –** It is very deep area of the lake where light does not reach up to the bottom. Only heterotrophs are present in this zone.



Stratification in lake community

(ii) Stratification in forest –

The clear stratification (vertical arrangement) in various growth forms of plants according to the need of light in any dense forest.

Surface dewellers → Herbs → Under shrubs → Shrubs → Trees

Note :

- The **clear stratification** is found in tropical rain forest. So it is known as **multistoried forest.**

SUCCESSION

Development of plant community on barren area is called ecological succession or Biotic succession. The replacement of existing community by new ones, in an orderly sequence in barren area with time due to change in environmental conditions. **Biotic communities are never stable**. They are changing more or less over period and space, due to presence of different types of climatic & environmental conditions. So a continuous interaction is going on between the community and environment till state of stability.

Term for community in succession :-

- **Pioneer community –** The first community to inhabit an area is called Pioneer community.
- **Climax community –** The last and stable community in an area is called climax community. This is more stable. Usually **mesophytes** are present in climax community.

An important characteristic of all communities is that composition and structure constantly change in response to the changing environmental conditions. This change is orderly and sequential, parallel with the changes in the physical environment. These changes lead finally to a community that is in near equilibrium with the environment and that is called a **climax community**.

- **Seral communities or seral stage –** In succession, communities or stages which comes in between pioneer community and climax community is called transitional or seral communities.
- **Sere –** The entire sequence of communities that successively change in a given area is called sere.

The name of sere depends on where the succession occurs or takes place.

Succession in water	→	**Hydrosere / Hydrarch**
Succession in salty water	→	**Halosere**
Succession in acidic water	→	**Oxalasere**
Succession at dry Region	→	**Xerosere / Xerarch**
Succession on rocks	→	**Lithosere**
Succession on sand	→	**Psammosere**

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BIOLOGY

E

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PLANT DIVERSITY

Taxonomy : *Taxis* = arrangement, *nomos* = law

This word was proposed by **A.P. de. Candolle** in his book "***Theories elementaire de la botanique***" (Theory of elementary botany)

Taxonomy includes study of following points

(1) Identification : A process by which an organism is recognised from the other already known organisms and is assigned to a particular taxonomic group is called identification.

(2) Nomenclature : Naming of organisms according to international scientific rules is called nomenclature.

(3) Classification : A process by which any organism is grouped into convenient categories on the basis of some easily observable characters.

Systematics :-

The term systematics was given by Linnaeus. The word systematics derived from Latin word "Systema" which means "systematic arrangment of organisms". Linnaeus used "**Systema Naturae**" as a title of his publication.

Systematics includes identification, nomenclature, classification and evolutionary relationship between organisms.

Note :- In modern taxonomical studies, taxonomists use external and internal structure, along with the structure of cell, development process and ecological information of organisms.

TYPES OF TAXONOMY

1. **Cytotaxonomy :** The use of cytological characters of plants in classification or in solving taxonomic problems is called cytotaxonomy. Cytotaxonomy is based on cytological information like chromosome number, structure and behaviour etc.

2. **Chemotaxonomy :** It is based on the chemical constituents of plants.

The basic chemical compounds used in chemotaxonomy are alkaloids, carotenoids, tannins, polysaccharide, nucleic acids, fatty acids, amino acids, aromatic compounds etc.

Some Informations :

- Practical significance of taxonomy is → **Identification of unknown organism.**
- Maximum diversity is found in tropical rain forests.
- Second maximum diversity is found in coral reefs
- The number of species that are known and described range betwen **1.7 – 1.8 million**. This refers to biodiversity or the number and types of organism present on earth.

NOMENCLATURE

Binomial system :

Given by Carolus Linnaeus

Carolus Linnaeus :- Linnaeus used this nomenclature system for the first time on large scale and proposed scientific name of many plants and animals.

- Linnaeus is the founder of binomial system.
- Linnaeus proposed scientific name of plants in his book **"Species plantarum"**. It was published on 1 May 1753. So this was the initiation of binomial system for plants.So any name proposed (for plants) before this date is not accepted today.
- Linnaeus proposed scientific name of animals in his book "Systema naturae" (10^{th} edition).
- This 10^{th} edition of **Systema naturae** was published on 1 August 1758. So initiation of binomial system for animals is believed to be started on 1 Aug, 1758.

ICBN

"International Code of Botanical Nomenclature"

- Collection of rules regarding scientific nomenclature of plants is known as ICBN.
- ICBN was first accepted in **1961**.

Main rules of ICBN :-

(1) According to binomial system name of any species consists of two components or words -

(i) Generic name - Name of genus

(ii) Specific epithet

e.g. ***Solanum tuberosum*** (Potato) ***Mangifera indica*** (Mango)

↓ ↓ ↓ ↓

Generic name Specific epithet Generic name Specific epithet

(2) In plant nomenclature (ICBN) tautonyms are not valid i.e. generic name and specific epithet should not be same in plants.

eg. Mangifera mangifera

But tautonyms are valid in animal nomenclature (ICZN-International Code of Zoological Nomenclature)

eg. Naja naja (Indian cobra), Rattus rattus (Rat)

(3) First letter of generic name should be in capital letter and first letter of specific epithet should be in small letter.

eg. Mangifera indica

(4) When written with free hand or typed, then generic name and specific epithet should be separately underlined. But during printing name should be in italics to indicate their Latin origin.

(5) Name of scientist (who proposed nomenclature) should be written in short after the specific epithet

eg. Mangifera indica Linn.

(6) Name of scientist should be neither underlined nor in italics, but written in Roman letters (simple alphabets)

(7) Scientific names should be derived from **Latin** (usually) or **Greek** languages because they are dead languages.

(8) Type specimen (Herbarium Sheet) of newly discovered plant should be placed in herbarium.

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BIOLOGY

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E

ANIMAL KINGDOM

TAXONOMY :

Taxonomy is the branch of science which deals the study of nomenclature, classification and **principles of classification**. Taxonomy word was given by **"Candolle"** (**Taxis** - arrangements. **Nomia**-distribution)

Aristotle :- He is known as the **"father of zoology"**. (Book : **Historia Animalium**)

He is also known as the father of ancient taxonomy. He classified animals into two groups on the basis of the colour of blood.

(1) **Anaima** - Those animals which don't have **red blood** or in which RBC are absent. e.g. Invertebrates like Sponges, Cnidaria, Mollusca, Arthropoda, Echinodermata.

(2) **Enaima** :- These animals have red blood. This group includes all vertebrates and it has been further divided into two sub groups.

(a) **Vivipara** :- It includes animals which give birth to young-ones. e.g. Mammals.

(b) **Ovipara** :- It includes animals which lay eggs. e.g. Pisces, Amphibians, Reptiles, Aves etc.

IMPORTANT PHYLA

1.	**Protozoa (Included in kingdom - Protista)**	-	***Amoeba*** , ***Paramoecium*** etc.
2.	**Porifera (Kingom - Animalia)**	-	Sponges (*Leucosolenia, Sycon*)
3.	**Coelenterata/Cnidaria**	-	***Hydra,*** Jellyfish etc.
4.	**Ctenophora** (minor phylum)	-	***Pleurobrachia, Ctenoplana***
5.	**Platyhelminthes**	-	Flat worms (eg : Tape worm)
6.	**Nemathelminthes/Aschelminthes**	-	Round worm (eg : ***Ascaris***)
7.	**Annelida**	-	Earthworm , Leech etc.
8.	**Arthropoda**	-	Insects , Scorpion , Fly etc.
9.	**Mollusca**	-	Snail, ***Pila***, ***Octopus*** etc.
10.	**Echinodermata**	-	Star fishes
11.	**Hemichordata**	-	***Balanoglossus***
12.	**Chordata**	-	Fish, Snake, Birds, Monkey etc.

BASIS OF CLASSIFICATION

1. Level of body organisation :-

Protoplasmic level → In protozoans, unicellular body performs all biological activities

↓

Cellular level → In sponges, cells are arranged as loose cell aggregates and division of labour occurs among cells (Tissues absent)

↓

Tissue level → In coelenterates and ctenophores, cells performing the same function are arranged into tissues

↓

Organ level → In platyhelminthes tissues are grouped together to form organs.

↓

Organ system level → In higher animals, organs further organise to form organ systems
e.g. Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Chordata

2. Symmetry :

(a) Asymmetry :- When any plane that passes through the centre does not divide the body of animals into two equal halves.

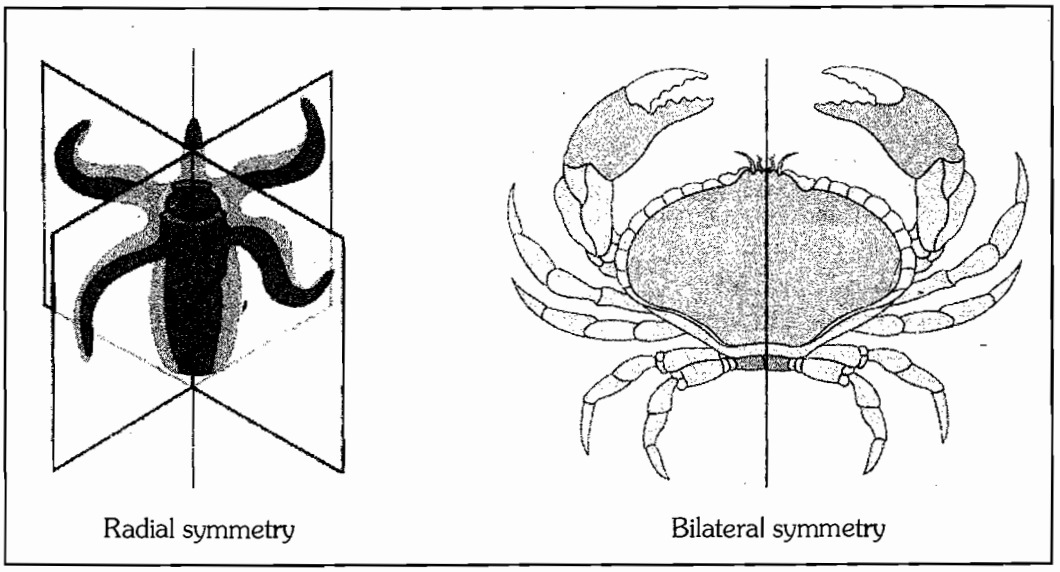
e.g : most of the sponges are asymmetrical.

(b) Radial symmetry : When any plane passing through the central axis of the body divide the animal into two identical halves.

e.g : Coelenterates, Ctenophores and Echinoderms (adult)

(c) Bilateral symmetry : When the body can be divided into identical left & right halves in only one plane.

e.g : Platyhelminthes to Chordates.

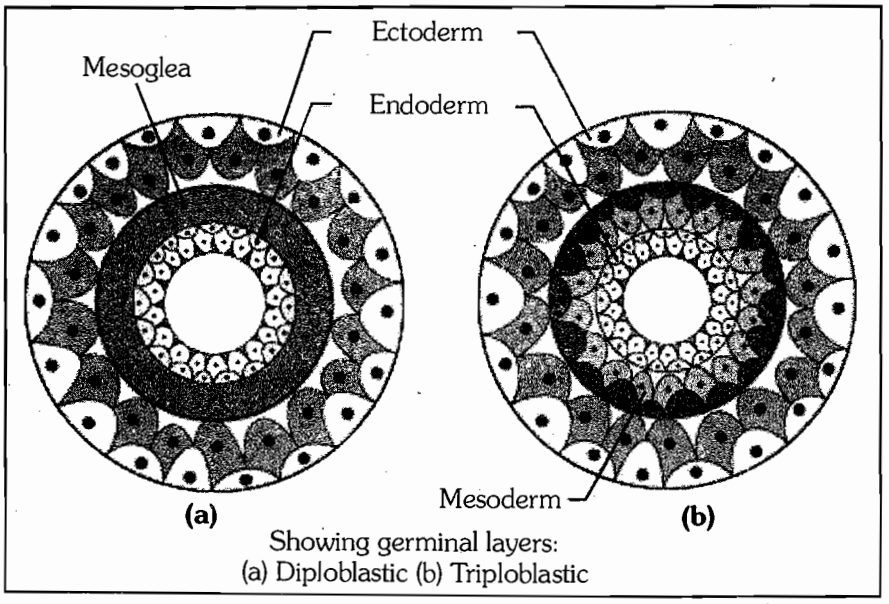


Radial symmetry Bilateral symmetry

3. Germinal layers :-

(a) Diploblastic – Animals in which the cells are arragned in two embryonic layers **ectoderm** and **endoderm** with an interveining undifferentiated mesoglea e.g. Coelenterates and Ctenophores.

(b) Triploblastic – Those animals in which the developing embryo has a third germinal layer–**Mesoderm** in between the ectoderm and endoderm e.g. Platyhelminthes to Chordates.



Showing germinal layers:
(a) Diploblastic (b) Triploblastic

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ORGANISM AND ENVIRONMENT (ECOLOGY) AND DEMOGRAPHY

E

NEET SYLLABUS

ECOLOGY AND ENVIRONMENT : Organisms and environment: Habitat and niche; Population and ecological adaptations; Population interactions-mutualism, competition, predation, parasitism. **Ecosystem:** Patterns, components; productivity and decomposition; Energy flow; Pyramids of number, biomass, energy; Nutrient cycling (carbon and phosphorous); Ecological succession; Ecological Services-Carbon fixation, pollination, oxygen release. **Biodiversity and conservation:** Concept of Biodiversity; Patterns of Biodiversity; Importance of Biodiversity; Loss of Biodiversity; Biodiversity conservation; Hotspots, endangered organisms, extinction, Red Data Book, biosphere reserves, National parks and sanctuaries. **Environmental issues :** Air pollution and its control; Water pollution and its control; Agrochemicals and their effects; Solid waste management; Radioactive waste management; Greenhouse effect and global warming; Ozone depletion; Deforestation; Any three case studies as success stories addressing environmental issues.

DEMOGRAPHY : Population attributes-growth, birth rate and death rate, age distribution.

4. **Body Cavity or Coelom :-** Presence or absence of a cavity between the body wall and gut wall is very important in classification.

(a) Acoelomates – Animals in which the body cavity is absent

e.g. Porifera, Coelenterata, Ctennophora, Platyhelminthes

(b) Pseudocoelomates – In same animals body cavity is not lined by mesoderm, instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm. Such a body cavity is called pseudocoelom.

e.g. Aschelminthes.

(c) Coelomates – Animals possessing coelom i.e. the body cavity which is lined by mesoderm on all sides

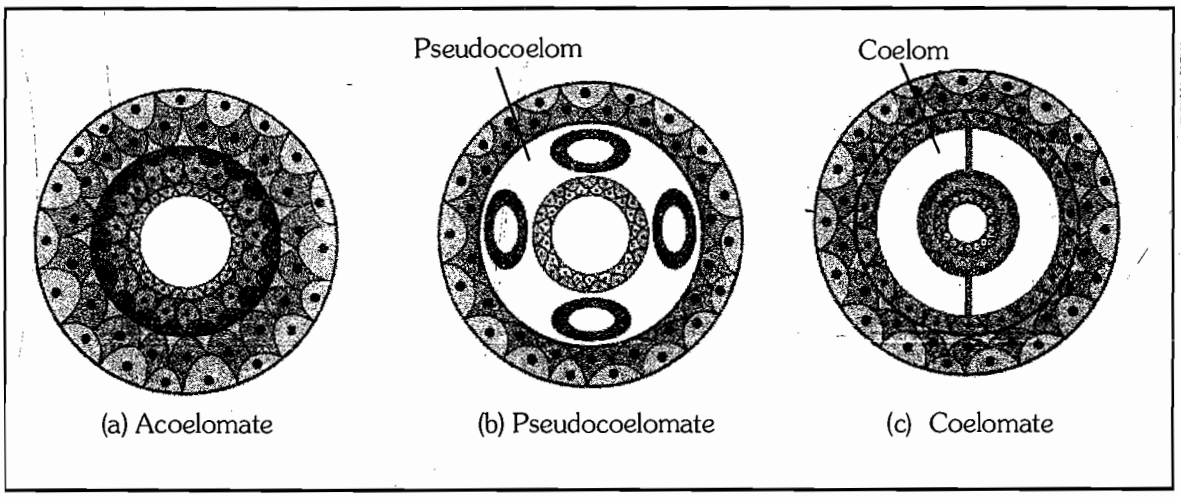
- On the basis of embryonic development, the coelom is of two types

(i) **Schizocoel** – Coelom formed by splitting of a mesodermal mass

e.g. Annelida, Arthropoda, Mollusca.

(ii) **Enterocoel** – Coelom formed by fusion of gut pouches during embryonic stage

e.g. Echinodermata, Hemichordata and Chordata.



(a) Acoelomate (b) Pseudocoelomate (c) Coelomate

5. **Body plan :**

(a) Cell-aggregate type e.g. Sponges

(b) Blind Sac type :- Animals in which digestive system is incomplete, it has only single opening to the outside of the body that serves as both mouth and anus.

e.g. Coelenterates to Platyhelminthes

(c) Tube-within-tube type :- Found in those animals having complete digestive tract i.e. with separate openings mouth and anus.

e.g. Nemathelminthes to Chordates

6. **Segmentation :-**

(a) Pseudometameric– e.g. Tapeworms

(b) Metameric – In Annelids, Arthropods and Chordates.

In these animals, the body is externally and internally divided into segments with a serial repetition of atleast some organs, this is called **metameric segmentation** and the phenomenon is known as **Metamerism.**

7. **Notochord :-** It is a mesodermally derived rod-like structure formed on the dorsal side during embryonic development in some animals.

(a) Non-chordates – Animals without notochord e.g. Porifera to Hemichordata

(b) Chordates – Animals with notochord. eg. Chordata

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BIOLOGY

E

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REPRODUCTION IN ORGANISM

E

NEET SYLLABUS

REPRODUCTION : Reproduction in organisms: Reproduction, a characteristic feature of all organisms for continuation of species; Modes of reproduction – Asexual and sexual; Asexual reproduction; Modes-Binary fission, sporulation, budding, gemmule, fragmentation: vegetative propagation in plants.

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TRANSPORT IN PLANTS

Introduction

In a flowering plant the substances that would need to be transported are **water, mineral nutrients, organic nutrients** and **plant growth regulators.**

On the basis of distance travelled by substances, transport is of two types :

(i) Short distance transport (ii) Long distance transport

(i) Short distance transport :

- Over small distances, substances move by **diffusion** and by **cytoplasmic streaming.** Cytoplasmic streaming is supported by active transport.
- For short distance transport vascular tissues (xylem and phloem) are not required.

(ii) Long distance transport :

- Transport over long distances proceeds through the vascular system (xylem and phloem) and is called **translocation.**
- Over long distances substances move by **bulk flow** or **mass flow.**

Direction of transport :

- In a flowering plant there is a complex traffic of compounds (but probably very orderly) moving in different directions, each organ receiving some substances and giving out some others.
- In rooted plants, transport of water and minerals in xylem is essentially unidirectional, from roots to the stems. Organic and mineral nutrients however, undergo multidirectional transport.

Means of transport

(1) Simple diffusion :

Movement of ions (particles) and molecules of solids, liquids and gases from region of higher concentration to regions of lower concentration till equilibrium established is called diffusion.

Features of diffusion :

(i) It is a **downhill process** (passive process) because no energy expenditure takes place.

(ii) It is a **random kinetic motion.**

(iii) It is a **slow process.**

(iv) Driving force is **concentration gradient.**

(v) It is **not dependent on a living system.**

(vi) It is **non selective process.**

(vii) It is not sensitive to inhibitors.

Factors affecting rate of diffusion :

(i) Gradient of concentration : In diffusion substances move from regions of high concentration to regions of lower concentration.

(ii) Permeability of the membrane : The rate of diffusion is directly proportional to the permeability of the membrane.

(iii) Temperature : Increase in temperature, increase the kinetic energy. Thus, causes increase in rate of diffusion.

(iv) Pressure : The rate of diffusion is directly proportional to the gradient of diffusion pressure.

(v) Density : The rate of diffusion is inversely proportional to the square root of density of particles. (Graham's diffusion law)

$$r \propto \frac{1}{\sqrt{d}}$$

Ascending order of density :
Gases < liquids < solids

Ascending order of rate of diffusion :
Solids < liquids < gases

Conclusion :

(a) Diffusion is obvious in gases and liquids.

(b) Diffusion in solids rather than of solids is more likely.

(vi) Size of particles : The rate of diffusion is inversely proportional to the size of diffusing particles.

Applications of diffusion :

- Diffusion is very important to plants since it is the only means for gaseous movement within the plant body.
- Movement of substances from one part of the cell to other part.
- Cell to cell movement.
- Movement from intercellular spaces of the leaf to outside (loss of water vapours during transpiration).

(2) Facilitated diffusion :

The diffusion of any substance across a membrane also depends on **its solubility in lipids.** (Lipid is the major structural constituent of the membrane). Substance soluble in lipids diffuse through the membrane faster (simple diffusion), while substances that have **a hydrophillic moiety** find it difficult to pass through the membrane; their movement has to be facilitated.

In other words "this is a movement of substances with hydrophillic moiety from regions of high concentration to regions of low concentration through **transmembrane proteins.**"

Site for facilitated diffusion :

Transmembrane proteins or tunnel proteins.

Features of facilitated diffusion :

(i) It is a downhill process (passive process) because no energy expenditure takes place.

(ii) Driving force is concentration gradient.

(iii) It is dependent on the living system (for transmembrane protein).

(iv) Facilitated diffusion can not cause net transport of molecules from a low to a high concentration.

(v) Transport rate reaches a maximum when all of the protein transporters are being used. This is called **saturation.**

(vi) It is sensitive to inhibitors which react with protein side chains.

(vii) It is very specific because it allows cell to select substances for uptake.

Some facts about facilitated diffusion :

- Transmembrane proteins (channel proteins) do not set up a concentration gradient: a concentration gradient must already be present for molecules to diffuse even if facilitated by the proteins.
- Some protein channels are always open while others can be controlled.
- **Porins :** They are protein channels that form huge pores in the outer membranes of the **plastids, mitochondria** and **some bacteria.** They allow molecules upto the size of small proteins to pass through.
- In plants for the bulk movement of water, **water channels** are present. They made up of **eight different types of aquaporins.**

Passive symport, antiport and uniport :

Some transport proteins allow facilitated diffusion only if two types of molecules move together.

(i) Symport : Two molecules cross the membrane in the same direction.

(ii) Antiport : Two molecules cross the membrane in opposite directions.

(iii) Uniport : When a molecule moves across a membrane independent of other molecules, the process is called uniport.

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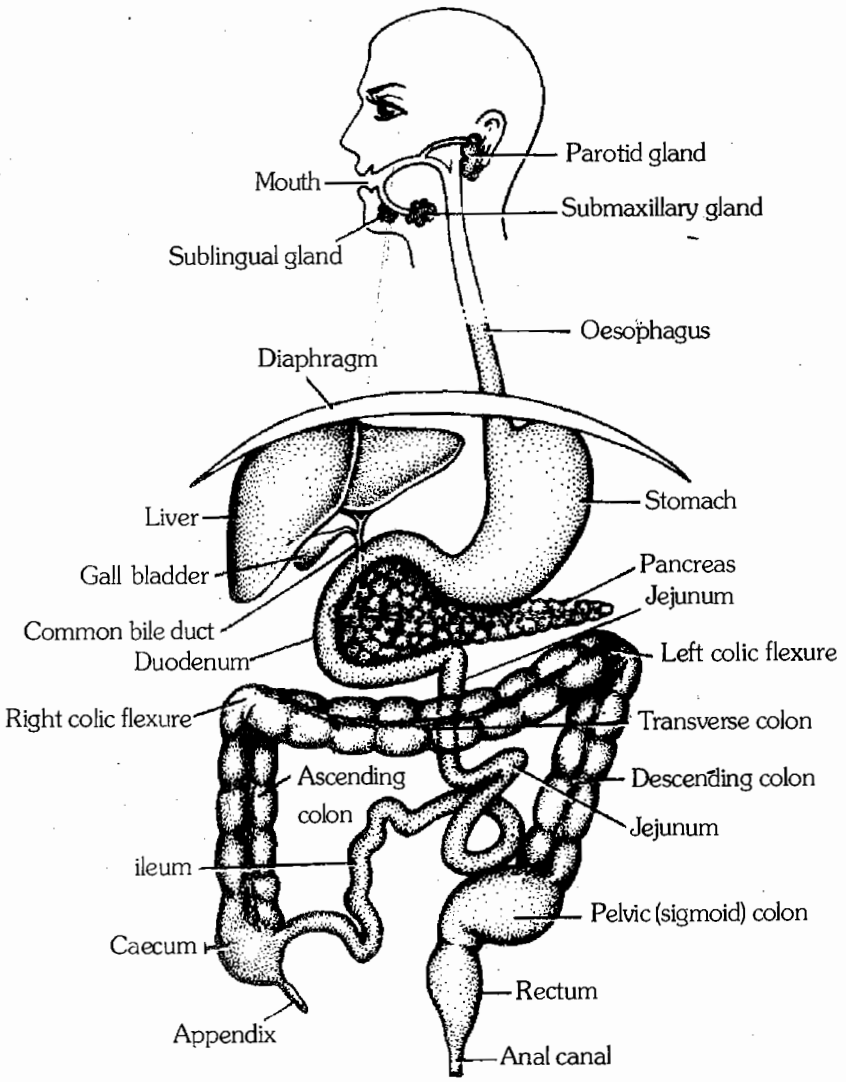
BIOLOGY

DIGESTION AND ABSORPTION

- Food is one of the basic requirements of all living organisms. The major components of our food are carbohydrates, proteins and fats. Vitamins and minerals are also required in small quantities. Food provides energy and organic materials for growth and repair of tissues. The water we take in, plays an important role in metabolic processes and also prevents dehydration of the body. Biomacromolecules in food cannot be utilised by our body in their original form. They have to be broken down and converted into simple substances in the digestive system.
- This process of conversion of complex food substances to simple and absorbable forms is called **digestion** and is carried out by our digestive system by **mechanical and biochemical methods.**

The general organisation of the human digestive system can be represented by following diagram.



Digestive tract of man

Origin

The **alimentary canal** is tubular structure which **extends** from **mouth to anus.** It develops from **ectoderm** and **endoderm.**

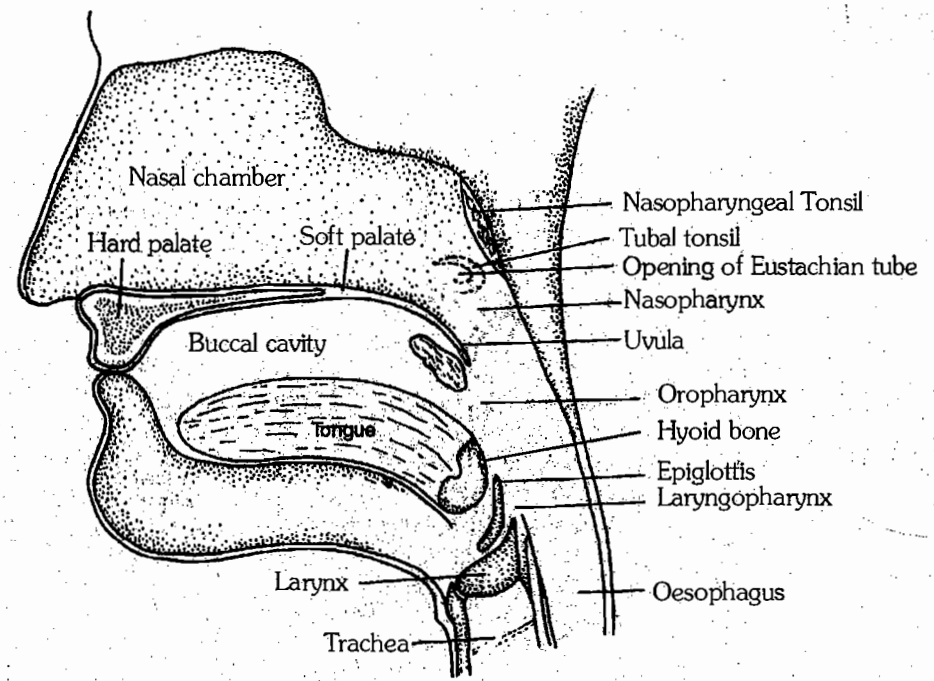
Digestive system of human

Alimentary canal
- Buccal cavity
- Oesophagus
- Stomach
- Intestine
  - **Small Intestine**
    - Duodenum
    - Jejunum
    - Ileum
  - **Large Intestine**
    - Caecum
    - Colon
    - Rectum

Accessory digestive glands
- Salivary glands
- Liver
- Gall bladder
- Pancreas

(1) MOUTH AND BUCCOPHARYNGEAL CAVITY –

Mouth is a horizontal transverse slit like aperture which is surrounded by upper and lower lip, a specific muscle is associated with lip called **orbicularis oris** muscle.



Section of head showing parts of pharynx

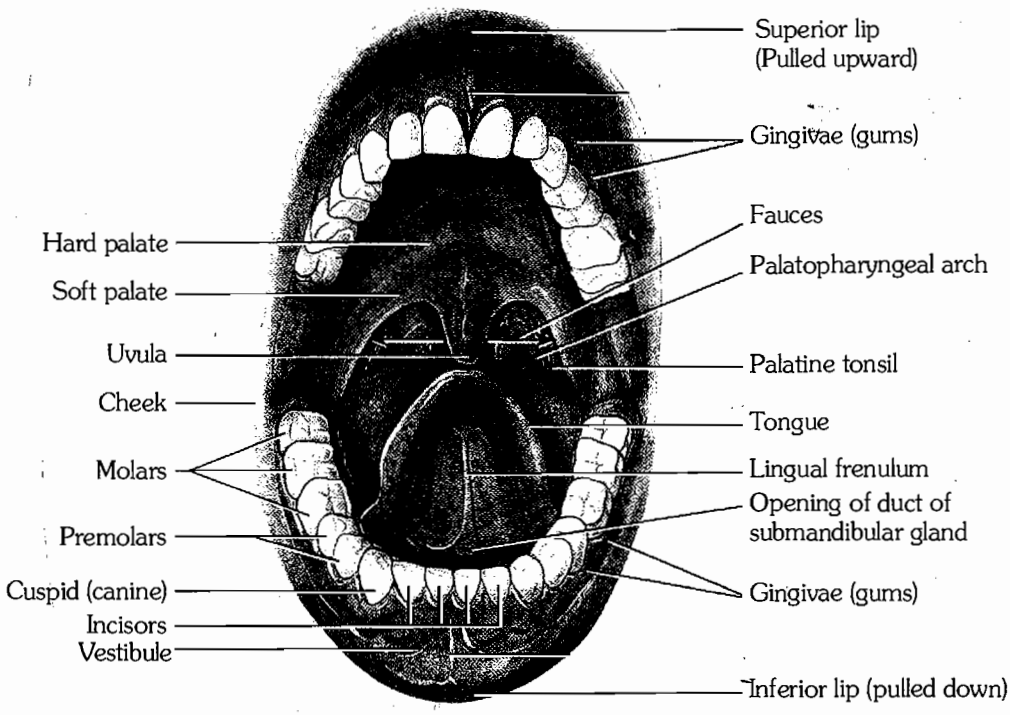
Mouth opens into buccopharyngeal cavity, this cavity is divided into two parts.

(i) Buccal vestibule – The space between the gums and cheeks where the food is stored temporarily for some time. It is a peripheral part.

(ii) Main oral cavity – It is inner and central part which is surrounded by upper and lower jaw, lined by stratified squamous epithelium.

PALATE

Palate is differentiated into two parts :



Anterior view

(i) Hard Palate –

- It is the anterior part of the palate. It is **made up of maxilla and palatine bone** in human.
- On the **ventral surface of hard palate,** some projection or transverse ridges are present which are called as **palatine rugae.**

(ii) Soft Palate –

It is the **posterior part of palate.** It is made up of muscle fibrous connective tissues and mucous epithelium. (Stratified squamous epithelium)

- The **posterior out growth** of soft palate which hangs down in the form of finger like process called as **Uvula** or **Velum palati**. On the **dorsal side of Uvula, internal nasal pores** are present.

Uvula or **Velum palati** covers the opening of internal nasal pores during ingestion of food, so food particle cannot move inside nasal chamber.

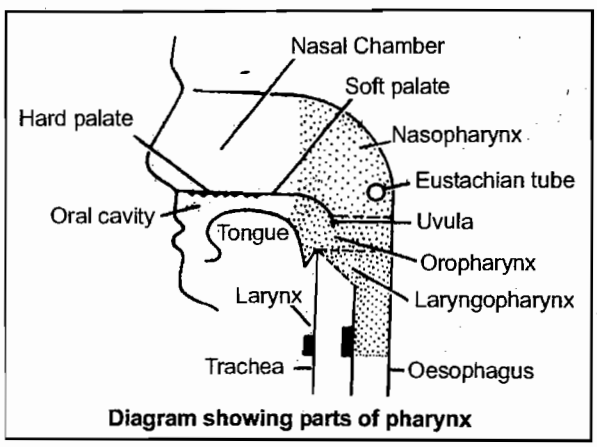


Diagram showing parts of pharynx

- **Soft palate** is situated in the pharynx and is **divided** into two parts. **Upper part** of pharynx is called **Nasopharynx** which is related to the nasal chamber. The **lower part of pharynx** is called **oropharynx** which is related to the oral cavity. One pair of openings of **Eustachian tube** is present in the nasopharynx.

Pharynx is the common path for the air and food.

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BIOLOGY

E

NEURAL CONTROL AND COORDINATION

(NERVOUS SYSTEM)

In human body the **neural system** and the **endocrine system** jointly **coordinate** and **integrate** all the activities of the organs so that they function in a synchronised fashion. **Co-ordination** is the process through which two or more organs interact & complement the functions of one another. The neural system provides an organised network of **point-to-point** connections for a quick coordination. The endocrine system provides chemical integration through hormones.

- Nervous system and endocrine system are called **Integrative system** of the body.
- Nervous system carries informations in the form of impulses to the different parts of body. High speed services are offered by this system.

NEURAL SYSTEM

- The neural system of all animals is composed of highly specialised cells called **neurons** which can detect, receive and transmit different kinds of stimuli.
- The neural organisation is very simple in lower invertebrates. For example, in Hydra it is composed of a network of neurons.
- The neural system is better organised in insects, where a brain is present along with a number of ganglia and neural tissues.
- The vertebrates have a more developed neural system.

HUMAN NEURAL SYSTEM

The human neural system is divided into two parts :

(i) Central neural system (CNS)

(ii) Peripheral neural system (PNS)

The CNS includes the brain and the spinal cord and is the site of information processing and control. The PNS comprises of all the nerves of the body associated with the CNS (brain and spinal cord). The nerve fibres of the PNS are of two types :

(a) Afferent fibres

(b) Efferent fibres

- The afferent nerve fibres transmit impulses from tissues/organs to the CNS and the efferent fibres transmit regulatory impulses from the CNS to the concerned peripheral tissues/organs.
- The PNS is divided into two divisions :-

(A) Somatic neural system (SNS)

(B) Autonomic neural system (ANS)

- The somatic neural system relays impulses from the CNS to skeletal muscles while the autonomic neural system transmits impulses from the CNS to the involuntary organs and smooth muscles of the body.
- The autonomic neural system is further classified into **sympathetic** neural system and **parasympathetic** neural system.

Central Nervous System (CNS)
- ● Brain and spinal cord
- ○ Integrative and control centers

Peripheral Nervous System (PNS)
- ● Cranial nerves and spinal nerves
- ○ Communication lines between the CNS and the rest of body

Sensory (afferent division)
- ● Somatic and visceral sensory nerve fibres
- ○ Conducts impulses from receptors to the CNS

Motor (efferent division)
- ● Motor nerve fibres
- ○ Conducts impulses from CNS to effectors (muscles and glands)

Sympathetic division
- ● Mobilizes body systems during emergency situations

Parasympathetic division
- ● Conserves energy
- ○ Promotes non emergency functions

Autonomic Nervous System (ANS)
- ● Involuntary (visceral motor)
- ○ Conducts impulses from the CNS to cardiac muscles smooth muscles and glands

Somatic Nervous System (SNS)
- ● Voluntary (somatic motor)
- ○ Conducts impulses from the CNS to skeletal muscles

NERVOUS TISSUE

Nervous tissue originates from **ectoderm** and is specialized for receiving stimuli (Excitability), transmit message (conductivity)

NEURAL TISSUES

- Neuron
  - Cyton/Cell body
  - Process of Neuron (Neurites)
    - Dendron (Highly branched)
    - Axon (Longest)
- Neuroglia (neuroglial cells)

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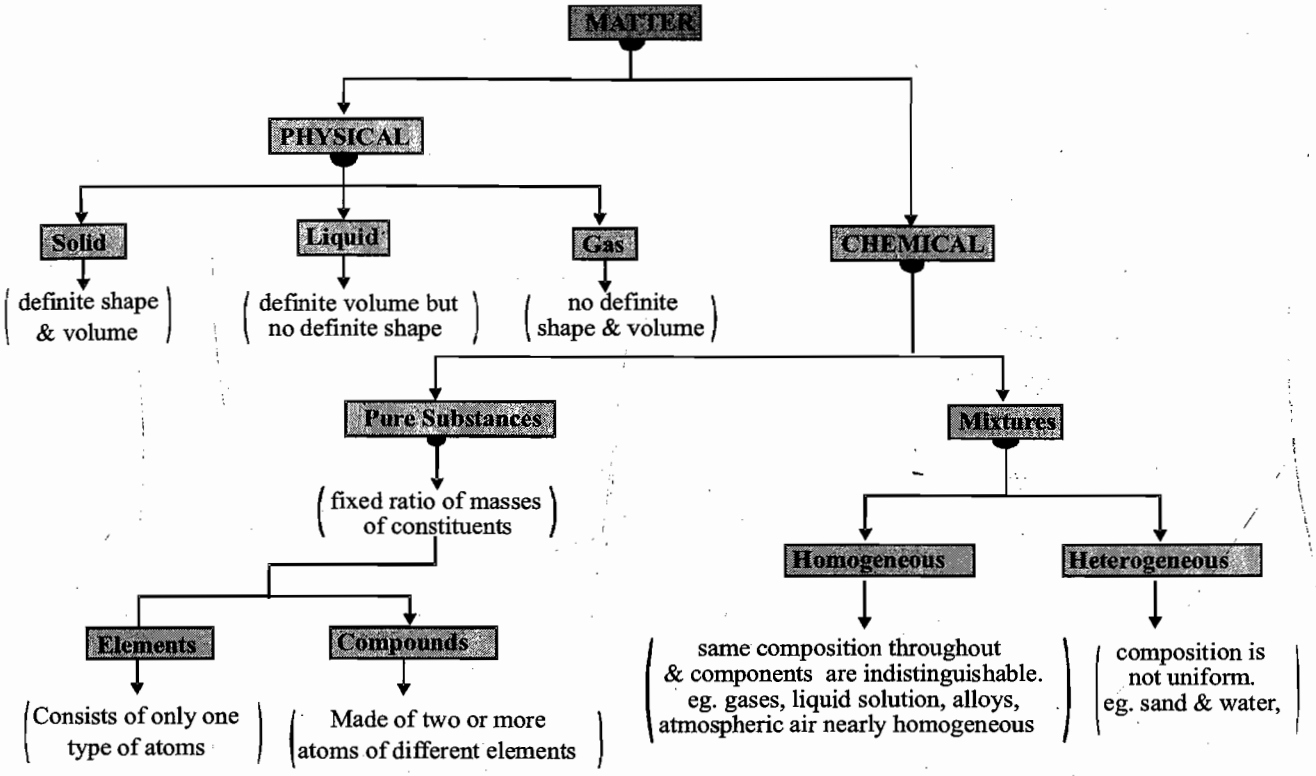
PHYSICAL CHEMISTRY

SOME BASIC CONCEPTS OF CHEMISTRY

1.0 INTRODUCTION

Chemistry deals with the composition, structure and properties of matter. These aspects can be best described and understood in terms of basic constituents of matter: **atoms** and **molecules**. That is why chemistry is called the science of atoms and molecules. Can we see, weight and perceive these entities? Is it possible to count the number of atoms and molecules in a given mass of matter and have a quantitative relationship between the mass and number of these particles (atoms and molecules)? We will like to answer some of these questions in this Unit. We would further describe how physical properties of matter can be quantitatively described using numerical values with suitable units.



Classification of universe

Universe is classified into two types i.e. matter and energy.

(A) MATTER : The thing which occupy space and having mass which can be felt by our five senses is called matter.

Matter is further classified into two categories :

(I) Physical classification (II) Chemical classification

PHYSICAL CLASSIFICATION

It is based on physical state under ordinary conditions of temperature and pressure, **so on the basis of two nature of forces matter** can be classified into the following three ways :

(a) Solid (b) Liquid (c) Gas

(a) Solid : A substance is said to be solid if it possesses a definite volume and a definite shape.

e.g. Sugar, Iron, Gold, Wood etc.

(b) Liquid : A substance is said to be liquid if it possesses a definite volume but not definite shape. They take the shape of the vessel in which they are palced.

e.g. Water, Milk, Oil, Mercury, Alcohol etc.

(c) Gas : A substance is said to be gas if it neither possesses a definite volume nor a definite shape. This is because they completely occupy the whole vessel in which they are placed.

e.g. Hydrogen(H_2), Oxygen(O_2), Carbon dioxide(CO_2) etc.

Chemical Classification

It may be classified into two types :

(a) Pure Substances (b) Mixtures

(a) Pure Substance : A material containing only one type of substance. Pure Substance can not be separated into simpler substance by physical method.

e.g. : Elements = Na, Mg, Ca ..... etc.

Compounds = HCl, H_2O, CO_2, HNO_3 ..... etc.

Pure substances are classified into two types :

(a) Elements (b) Compounds

(i) Elements : The pure substances containing only one kind of atoms.

It is classified into 3 types (depend on physical and chemical property)

(i) Metal → Zn, Cu, Hg, Ac, Sn, Pb etc.

(ii) Non-metal → N_2, O_2, Cl_2, Br_2, F_2, P_4, S_8 etc.

(iii) Metalloids → B, Si, As, Te etc.

(ii) Compounds : It is defined as pure substances containing more than one kind of elements or atoms which are combined together in a fixed proportion by weight and which can be decomposed into simpler substances by the suitable chemical methods. The properties of a compound are completely different from those of its constituent elements.

e.g. HCl, H_2O , H_2SO_4, $HClO_4$, HNO_3 etc.

(b) Mixtures : A material which contains more than one type of substance and which are mixed in any ratio by weight are known as mixtures. The properties of a mixture are same as the property individual components. The components of a mixture can be separated by simple physical methods.

Mixtures are classified into two types :

(i) Homogeneous mixtures : The mixtures in which all the components are present **uniformly** are called as homogeneous mixtures. Components of a mixture are present in single phase.

e.g. Water + Salt, Water + Sugar, Water + alcohol,

(ii) Heterogenous mixtures : The mixtures in which all the components are present **non-uniformly** are called as Heterogenous mixture.

e.g. Water + Sand, Water + Oil, blood, petrol etc.

Illustrations

Illustration 1. Which is an example of matter according to physical state at room temperature and pressure.

(1) solid (2) liquid (3) gas (4) all of these

Solution **Ans. (4)** According to the physical state at room temperature and pressure, the matter is present in 3 state solid, liquid & gas

Illustration 2. Which of the following are the types of the compound.

(1) Organic compound (2) Inorganic compound

(3) Both (1) and (2) (4) None of these

Solution **Ans. (3)** Compound is divided into 2 types. Inorganic compound & Organic compound

Illustration 3. Which of the following is an example of a homogeneous mixture.

(1) Water + Alcohol (2) Water + Sand (3) Water + Oil (4) None of these

Solution **Ans. (1)** Water and alcohol are completely mixed and form uniform solution.

Illustration 4. Which of the following is a solution.

(1) Heterogeneous mixture (2) Homogeneous mixture

(3) Both (1) and (2) (4) None of these

Solution **Ans. (2)** Homogeneous mixture is a solution.

Illustration 5. Which of the following is a compound

(1) graphite (2) producer gas (3) cement (4) marble

Solution **Ans. (4)** Marble = $CaCO_3$ = compound.

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INORGANIC CHEMISTRY

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PERIODIC TABLE

1.0 INTRODUCTION :

The arrangement of all the known elements according to their properties in such a way that the elements with similar properties are grouped together in a tabular form is called periodic table.

DEVELOPMENT OF PERIODIC TABLE

(A) LAVOISIER CLASSIFICATION :

(i) Lavoisier classified the elements simply in metals and non metals.

Metals are the one which have the tendency of losing the electrons.

$Na \rightarrow Na^+ + e^-$ and $K \rightarrow K^+ + e^-$

Non-metals are the one which have the tendency of gaining the electrons.

$F + e^- \rightarrow F^-$ and $Cl + e^- \rightarrow Cl^-$

(ii) **Drawback or Limitation :**

(a) As the number of elements increases, this classification became insufficient for the study of elements.

(b) There are few elements which have the properties of both metals as well as non-metals and they are called metalloids. Lavoisier could not decide where to place the metalloids.

(B) PROUT'S HYPOTHESIS :

He simply assumed that all the elements are made up of hydrogen, so we can say that

Atomic weight of element = n × (Atomic weight of one hydrogen atom)

Atomic weight of H = 1

where n = number of hydrogen atom = 1, 2, 3,....

Drawback or Limitation :

(i) Every element can not be formed by Hydrogen.

(ii) Atomic weight of all elements were not found as the whole numbers.

Ex. Chlorine (atomic weight 35.5) and Strontium (atomic weight 87.6)

(C) DOBEREINER TRIAD RULE [1817] :

(i) He made groups of three elements having similar chemical properties called TRIAD.

(ii) In Dobereiner triad, atomic weight of middle element is nearly equal to the average atomic weight of first and third element.

Ex.

Cl	Br	I	Ca	Sr	Ba	Li	Na	K
35.5	80.0	127	40	87.6	137	7	23	39

$\left[x = \frac{35.5 + 127}{2} = 81.2 \right]$ $\left[x = \frac{40 + 137}{2} = 88.5 \right]$ $\left[x = \frac{7 + 39}{2} = 23 \right]$

Where x=average atomic weight

(iii) Other examples – (K, Rb, Cs), (P, As, Sb), (S, Se, Te)

Drawback or Limitation : All the known elements could not be arranged as triads. It is not applicable for d and f-block elements.

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ORGANIC CHEMISTRY

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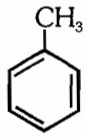
CLASSIFICATION AND NOMENCLATURE

NEET SYLLABUS

General introduction, classification and IUPAC nomenclature of organic compounds :

CLASSIFICATION & NOMENCLATURE

BEGINNER'S BOX-1

1. How many 1°, 2° & 3° H atoms are present in  [Toluene] respectively :-

(1) 3, 0, 5 (2) 3, 5, 0 (3) 4, 3, 0 (4) 0, 5, 3

2. What is hybridisation of each carbon atom in following compound

$HC \equiv C - CH = CH - CH_3$

(1) sp, sp^2, sp^2, sp^2, sp^3 (2) sp, sp, sp^2, sp^2, sp^3

(3) sp, sp, sp^2, sp^3, sp^3 (4) sp, sp^2, sp^2, sp^3, sp^3

3. Which one is not correct for a homologous series –

(1) All members have a general formula

(2) All members have same chemical properties

(3) All members have same physical properties

(4) All members have same functional group

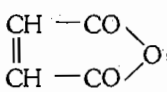
BEGINNER'S BOX-2

1. How many carbon atom are present in third homologue of methyl ether.

(1) 1 (2) 2 (3) 3 (4) 4

2. Which of the following is not a hetero cyclic compound

(1) Thiophene (2) Furane (3) Benzene (4) Pyridine

3. In structure  , how many hetero atoms are present ?

(1) 1 (2) 2 (3) 3 (4) 4

BEGINNER'S BOX-3

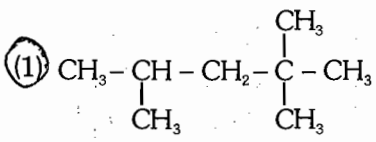
1. Which of the followings is incorrect name :-

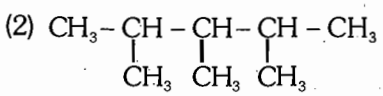
(1) Isopropyl (2) Ter. butyl (3) Neo butyl (4) Neo pentyl

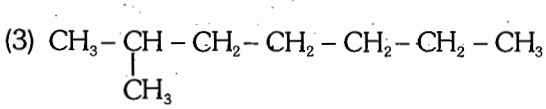
2. Which of the followings is secondary radical :-

(1) $CH_2=CH-$ (2) $(CH_3)_3C-$ (3) C_6H_5- (4) $CH_3-(CH_2)_2-CH_2-$

3. Which of the followings is isooctane :-

(1) 

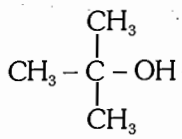
(2) 

(3) 

(4) None

BEGINNER'S BOX-4

1. Common name of given compound is :-



(1) Neobutyl alcohol (2) Isobutyl alcohol
(3) Tertiary butyl alcohol (4) Secondary butyl alcohol

2. Which of the following is Crotonic acid ?
(1) $CH_2 = CH - COOH$ (2) $CH_3 - CH = CH - CHO$
(3) $CH_3 - CH_2 - CH_2 - COOH$ (4) $CH_3 - CH = CH - COOH$

3. What is derived name of Neopentyl alcohol :-
(1) Isopropyl carbinol (2) n-Butyl carbinol
(3) Tertiary butyl carbinol (4) Ethyl methyl carbinol

Format for IUPAC, name :

s – prefix	+	p – prefix	+	word root	+	p – suffix	+	s – suffix
Substituents with locants		cyclo		Alk word according to carbon in parent C chain		– ane – ene – yne		According to main functional group given in priority table

(a) Locant : Locants are separated by (,) comma.

- Locants and alphabets are separated by hyphen (–). [2, 3 – dimethyl pentane]
- di, tri, iso, neo and cyclo are neither separated by comma nor by hyphen

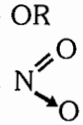
(b) Prefix :- According to substituents .
Prefix (es) are written in alphabetical order before root word.

Prefix ← 1° or p – prefix
2° or sec. – prefix

Cyclo is 1° prefix and used for cyclic compound.
2° prefix is used for substituents and written before 1° prefix.

For acyclic compounds : 2° prefix + Root word + 1° suffix + 2° suffix.

Substituents	Prefix
— R	Alkyl group
— X (F, Cl, Br, I)	Halo
— O — N=O	Nitrite
— CH_2OH	Hydroxy methyl
— NHC_2H_5	Ethyl amino

Substituents	Prefix
— OR	Alkoxy
	Nitro
— N = O	Nitroso
— CH_2Cl	Chloro methyl

(c) Word root : According to number of carbons in parent C–chain.

Number of carbons	Root word
1	Meth
2	Eth
3	Prop
4	But
5	Pent

Number of carbons	Root word
6	Hex
7	Hept
8	Oct
9	Non
10	Dec

Number of carbons	Root word
11	Undec
12	dodec
13	tridec

SOLID STATE

1.0 INTRODUCTION

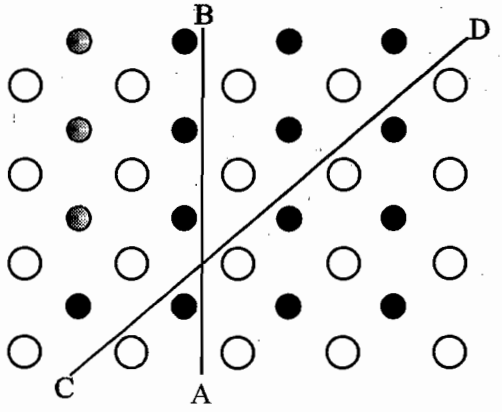
The solid are characterised by incompressibility, rigidity and mechanical strength. The molecules, atoms or ions in solids are closely packed means they are held together by strong forces and can not move randomly. Thus solids have definite volume, shape, slow diffusion, low vapour pressure and possesses the unique property of being rigid. Such solids are known as **true solids** like NaCl, KCl, Sugar, Ag, Cu etc. On the other hand the solid which loses shapes on long standing, flows under its own weight and easily distorted by even mild distortion forces are called **pseudo solids** such as glass, pitch etc.

Some solids such as NaCl, Sugar, Sulphur etc. have properties not only of rigidity and incompressibility but also of having typical geometrical forms. These solids are called as **crystalline solids**. In such solids there is definite arrangements of particles (atoms, ions or molecules) throughout the entire three dimensional network of a crystal in long-range order. This three dimensional arrangement is called **crystal lattice or space lattice**. Other solids such as glass, rubber, plastics etc. have rigidity and incompressibility to a certain extent but they do not have definite geometrical forms or do not have long range order are known as **amorphous solids**.

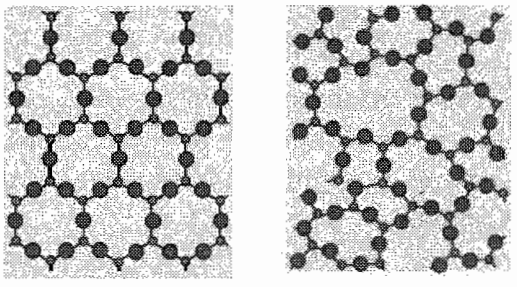
Distinction between Crystalline and Amorphous Solids

Property	Crystalline solids	Amorphous solids
Shape	Definite characteristic geometrical shape	Irregular shape
Melting point	Melt at a sharp and characteristic temperature	Gradually soften over a range of temperature
Cleavage property	When cut with a sharp edged tool, they split into two pieces and the newly generated surfaces are plain and smooth	When cut with a sharp edged tool, they cut into two pieces with irregular surfaces
Heat of fusion	They have a definite and characteristic heat of fusion	They do not have definite heat of fusion
Anisotropic nature	Anisotropic in nature (direction dependent) True solids	Isotropic in nature (direction independent) Pseudo solids or super cooled liquids
Arrangement of particles	Long range order	Only short range order.
Examples	NaCl, Metals, Diamond	Rubber, Plastics

GOLDEN KEY POINTS



Anisotropy in crystals is due to different arrangement of particles along different directions.



(a) (b)

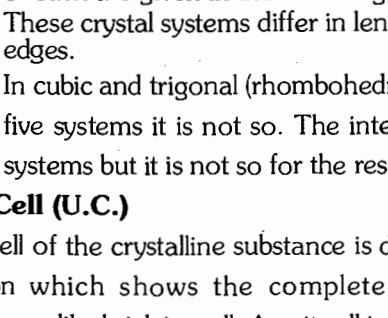
Two dimensional structure of (a) quartz and (b) quartz glass

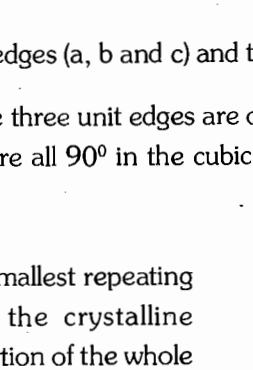
Table (a) : Classification of crystalline solids

S. No.	Type of Solid	Constituent Particles	Bonding/ Attractive Forces	Examples	Physical Nature	Electrical Conductivity	Melting Point
1.	Molecular solids (i) Non polar	Molecules	Dispersion or London forces	Ar, CCl_4, H_2,I_2,CO_2	Soft	Insulator	Very low
	(ii) Polar		Dipole-dipole interactions	HCl, SO_2	Soft	Insulator	Low
	(iii) Hydrogen bonded		Hydrogen bonding	H_2O (ice)	Hard	Insulator	Low
2.	Ionic solids	Ions	Coulombic or electrostatic	NaCl, MgO, ZnS, CaF_2	Hard but brittle	Insulators in solid state but conductors in molten and in aqueous state	High
3.	Metallic solids	Positive metal ions in a sea of delocalised e^-	Metallic bonding	Fe, Cu, Ag, Mg	Hard but malleable and ductile	Conductors in solid and in molten state	Fairly high
4.	Covalent or network solids	Atoms	Covalent bonds	SiO_2,SiC,AlN C(diamond), C(graphite)	Hard Soft	Insulators Conductor	Very high

1.1 Space Lattice/Crystalline Lattice/3–D Lattice

- Space lattice is a regular arrangement of lattice points (atoms or ions or molecules) showing how the particles are arranged at different sites in 3D–view.



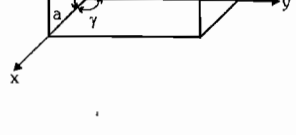


Lattice point
[Lines are used to represent geometry of crystal]

- "The three dimensional distribution of component particles in a crystal can be found by X-ray diffraction of different faces of the crystal.
- On the basis of the classification of symmetry, the crystals have been divided into seven systems. These seven systems with the characteristics of their axes (Interfacial angles and intercepts) where some examples of each are given in the following table (b).
  These crystal systems differ in length of unit cell edges (a, b and c) and the angles between the unit cell edges.
  In cubic and trigonal (rhombohedral) systems, the three unit edges are of equal lengths but for the rest five systems it is not so. The interfacial angles are all 90^0 in the cubic, tetragonal and orthorhombic systems but it is not so for the rest four systems.

1.2 Unit Cell (U.C.)

Unit cell of the crystalline substance is defined as the smallest repeating portion which shows the complete geometry of the crystalline substance like brick in wall. A unit cell is the smallest portion of the whole crystal. A unit cell is characterized by the edge lengths a, b and c along the three axes of the unit cell and the angles α, β and γ between the pair of edges bc, ca and ab respectively.



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P-BLOCK ELEMENTS

NEET SYLLABUS

***p*-Block Elements :** *General Introduction to p-Block Elements. General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous properties of first element of the Groups 13 to 18 elements.*

p–BLOCK ELEMENTS

IMPORTANT CONCEPTS :

1. **Back bonding**
2. **Dimerisation**
3. **Inert pair effect**
4. **Oxyacids**
5. **Hydrolysis**
6. **Allotropes**
7. **Silicates and Silicones**
8. **Drying agent and bleaching agents**
9. **Reactions and compounds (Group 13-18)**

1. BACK BONDING

It is formed between two covalently bonded adjacent atoms.

Conditions for back bonding :

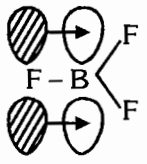
(i) Both bonded atoms must belong to 2nd period or one bonded atom must belong to 2nd period and the other must belong to 3rd period.

(ii) One bonded atom must possess vacant orbital and the other bonded atom must possess lone pair.

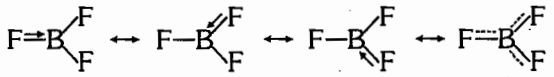
- **As a result of back bonding between the bonded atoms, bond length decreases and bond energy increases.**

Back bonding :

It is a partial sideways overlap in which there is a slight electron transference from electron rich atom to electron deficient atom. As a result the electron deficiency of the deficient atom gets slightly compensated.



F–donor
B–acceptor



(B–F) B.O = 4/3 = 1.33

Types of back bonding :

Based on type of orbital : (2 types)

(1) pπ-pπ back bonding

(2) pπ-dπ back bonding

(1) pπ-pπ back bonding :

Order of strength : 2p – 2p > 2p – 3p > 2p – 4p .....

Size ↑ extent of B.B. ↓

It is used to explain following observations :-

(a) Abnormal bond length and bond energy of B-F bond in BF_3.

(b) Lewis acidic order of **Boron** and **Beryllium** halides.

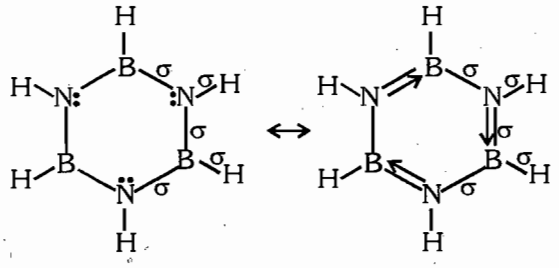
$$\underbrace{BF_3 < BCl_3}_{\text{BB effective so Lewis acid strength}\downarrow} < BBr_3 < BI_3$$

$$BeF_2 < BeCl_2 < BeBr_2 < BeI_2$$

(c) **Hybridisation :** If a lone pair participates in back bonding then it is not considered in hybridisation.

Ex. $B_3N_3H_6$ (inorganic benzine or borazene or borazole)

- Hybridisation of B as well as N = sp^2

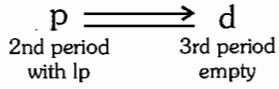


- Inorganic benzene is more reactive than organic benzene as in it the **bonds are polar,** although over all molecule is non polar.

(d) If back bonding is present then tendency to form dimer or polymer decreases.

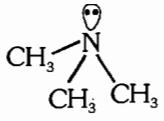
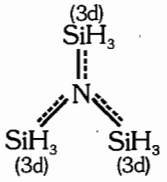
Ex. BF_3, BeF_2

(2) pπ-dπ back bonding :



it is used to explain following observations :

(a) Hybridisation

Trimethyl amine $(CH_3)_3N$	Trisilyl amine $(SiH_3)_3N$
	
• sp^3 hybrid (N)	• sp^2 hybrid (N)
• trigonal pyramidal	• trigonal planar
• Lewis base (due to presence of lp)	• Not Lewis base
	• Bond angle increases

(b) Acidic strength

$CH_3-\ddot{O}-H$	$SiH_3-\ddot{O}-H$
Methyl alcohol	Silyl alcohol
• No back bonding	• Back bonding present in conjugate base
• Less acidic	• More acidic

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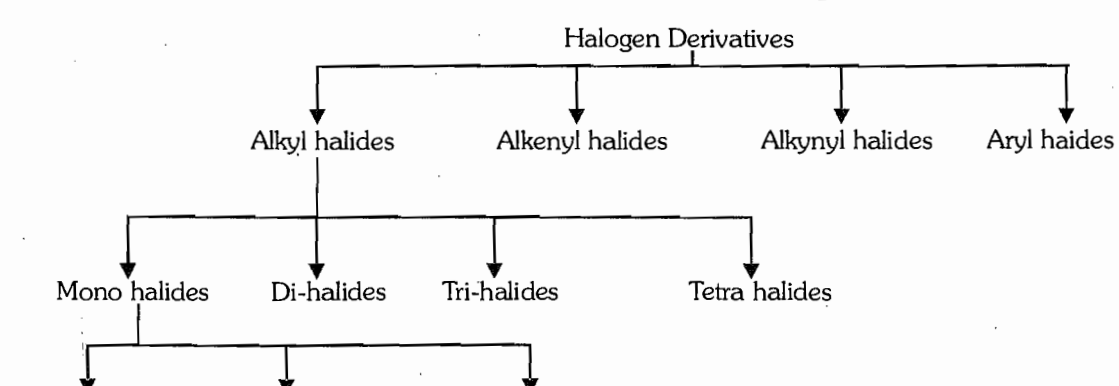
HALOGEN DERIVATIVES

1.0 HALOGEN DERIVATIVES

Compounds derived from hydrocarbons by replacement of one or more H-atoms by corresponding no. of halogen atoms are known as halogen derivatives.

2.0 CLASSIFICATION

On the basis of nature of hydrocarbon from which they are obtained, halogen derivatives can be classified as :



3.0 MONOHALIDES :

3.1 Genreal Methods of Preparation of Monohalides

(1) By direct halogenation of alkanes :

$$R{-}H + Cl_2 \xrightarrow{U.V.light} R{-}Cl + HCl$$

(excess)

(2) By the addition of H—X on alkenes :

$$R{-}CH{=}CHR + HX \longrightarrow RCH_2{-}CHXR$$

eg: $CH_2{=}CH_2 + HX \longrightarrow CH_3{-}CH_2X$

eg: $CH_3{-}CH{=}CH_2 + HX \longrightarrow CH_3{-}\underset{\displaystyle X}{\underset{|}{CH}}{-}CH_3$

Isopropyl halide

(3) By Alcohols :

(a) By the action of hydrogen halides :

$$R{-}CH_2{-}OH \xrightarrow{H\text{–}X} RCH_2{-}X$$

(b) By the action of phosphorous halides :

$$R{-}OH + PCl_5 \longrightarrow R{-}Cl + POCl_3 + HCl$$

$$3R{-}OH + PCl_3 \longrightarrow 3RCl + H_3PO_3$$

PBr_3 and PI_3 are less stable, thus for bromides ($P + Br_2$) and for iodides ($P + I_2$) mixture is used.

(c) By reaction with thionyl chloride (Darzen's procedure) :

$$R{-}OH + SOCl_2 \xrightarrow[(1\,mole)]{Pyridine} R{-}Cl + SO_2 + HCl$$

One mole One mole

Because of less stability of $SOBr_2$ and SOI_2, R—Br and RI can not be obtained by this method.

(4) Borodine – Hunsdicker's reaction :

$$R—COOAg + X_2 \xrightarrow[\Delta]{CCl_4} R—X + CO_2 + AgX$$

Silver salt of a fatty acid (Cl_2 or Br_2)

(5) By halide exchange :

$$R–Cl \text{ or } R—Br + KI \xrightarrow{\text{Acetone}} R–I + KCl \text{ or } KBr$$ **(Conant finkelstein reaction)**

$$2CH_3Cl + Hg_2F_2 \xrightarrow{\text{Water}} 2CH_3–F + Hg_2Cl_2$$ **(Swart reaction)**

Note : Finkelstein reaction can only be used to prepare R–I and swart's reaction can only be used to prepare R–F

3.2 Physical Properties

(a) The lower members CH_3F, CH_3Cl, CH_3Br, C_2H_5Cl and C_2H_5F are gases at room temp.

(b) Higher B.P. than parent alkanes.

Decreasing order of B.P. is : **R – I > R—Br > R—Cl > R—F**

among isomeric R—X, decreasing order of B.P. is : **Primary > Secondary > tertiary**

(c) R—F and R—Cl ⟶ lighter than water

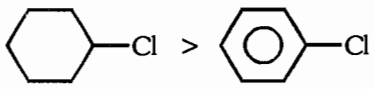
R—Br and R—I ⟶ heavier than water

Decreasing order of density is : **R—I > R—Br > R—Cl > R—F**

(d) R—X are polar co-valent compounds but insoluble in water because they can not form H–bonds. They dissolve in organic solvents.

(e) R—X (except R—F) burns with a green flame when interacted with Cu wire.(Beliestein test)

(f) Dipole moment order–

(i) $CH_3Cl > CH_3F > CH_3Br > CH_3I$ (ii) 

3.3 Chemical Properties

3.3.1 Nucleophilic substitution reaction (S_N) :

		Replacement of	Product
(a)	R—X⟶	HOH(Boil) → X by — OH	R—OH (alcohol) + HX
(b)		KOH aq. → X by — OH	R—OH (alcohol) + KX
(c)		moist Ag_2O → X by — OH	R—OH (alcohol) + AgX
(d)		KSH alc. → X by –SH (Mercapto Gp.)	R—SH + KX Alkane thiol (Mercaptane)
(e)		NaSR' → X by SR	RSR' + NaX Thioether
(f)		R' COOAg, Δ → X by(R'COO)	R' COOR + AgX (Alkyl alkanoate) ester

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PHYSICS

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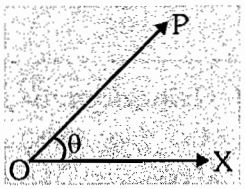
BASIC MATHEMATICS USED IN PHYSICS

Mathematics is the supporting tool of Physics. Elementary knowledge of basic mathematics is useful in problem solving in Physics. In this chapter we study *Elementary Algebra, Trigonometry, Coordinate Geometry* and *Calculus (differentiation and integration).*

1. TRIGONOMETRY

1.1 Angle

Consider a revolving line OP.



Suppose that it revolves in anticlockwise direction starting from its initial position OX .

The angle is defined as the amount of revolution that the revolving line makes with its initial position.

From fig. the angle covered by the revolving line OP is $\theta = \angle POX$

The angle

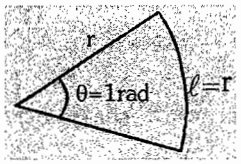
is taken **positive** if it is traced by the revolving line in anticlockwise direction and

is taken **negative** if it is covered in clockwise direction.

$1^\circ = 60'$ (minute)
$1' = 60''$ (second)

1 right angle = 90° (degrees) also 1 right angle = $\frac{\pi}{2}$ rad (radian)

One radian is the angle subtended at the centre of a circle by an arc of the circle, whose length is equal to the radius of the circle. 1 rad = $\frac{180^\circ}{\pi} \approx 57.3^\circ$



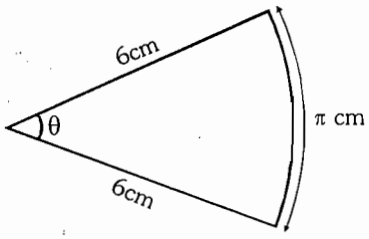
To convert an angle from degree to radian multiply it by $\frac{\pi}{180^\circ}$

To convert an angle from radian to degree multiply it by $\frac{180^\circ}{\pi}$

Illustrations

Illustration 1.

A circular arc is of length π cm. Find angle subtended by it at the centre in radian and degree.



Solution

$\theta = \frac{s}{r} = \frac{\pi \text{ cm}}{6 \text{ cm}} = \frac{\pi}{6}\text{rad} = 30^\circ$ As 1 rad = $\frac{180^\circ}{\pi}$ So $\theta = \frac{\pi}{6} \times \frac{180^\circ}{\pi} = 30^\circ$

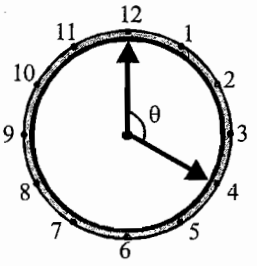
Illustration 2.

When a clock shows 4 o'clock, how much angle do its minute and hour needles make?

(1) 120° (2) $\frac{\pi}{3}$ rad (3) $\frac{2\pi}{3}$ rad (4) 160°

Solution **Ans. (1,3)**

From diagram angle $\theta = 4 \times 30° = 120° = \frac{2\pi}{3}$ rad



1.2 Trigonometrical ratios (or T ratios)

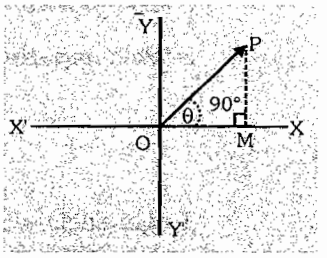
Let two fixed lines XOX' and YOY' intersect at right angles to each other at point O. Then,

(i) Point O is called origin.

(ii) XOX' is known as X-axis and YOY' as Y-axis.

(iii) Portions XOY, YOX', X'OY' and Y'OX are called I, II, III and IV quadrant respectively.

Consider that the revolving line OP has traced out angle θ (in I quadrant) in anticlockwise direction. From P, draw perpendicular PM on OX. Then, side OP (in front of right angle) is called hypotenuse, side MP (in front of angle θ) is called **opposite side or perpendicular** and side OM (making angle θ with hypotenuse) is called **adjacent side or base.**



The three sides of a right angled triangle are connected to each other through six different ratios, called trigonometric ratios or simply T-ratios :

$$\sin\theta = \frac{\text{perpendicular}}{\text{hypotenuse}} = \frac{MP}{OP} \qquad \cos\theta = \frac{\text{base}}{\text{hypotenuse}} = \frac{OM}{OP}$$

$$\tan\theta = \frac{\text{perpendicular}}{\text{base}} = \frac{MP}{OM} \qquad \cot\theta = \frac{\text{base}}{\text{perpendicular}} = \frac{OM}{MP}$$

$$\sec\theta = \frac{\text{hypotenuse}}{\text{base}} = \frac{OP}{OM} \qquad \text{cosec}\,\theta = \frac{\text{hypotenuse}}{\text{perpendicular}} = \frac{OP}{MP}$$

It can be easily proved that :

$$\text{cosec}\,\theta = \frac{1}{\sin\theta} \qquad \sec\theta = \frac{1}{\cos\theta} \qquad \cot\theta = \frac{1}{\tan\theta}$$

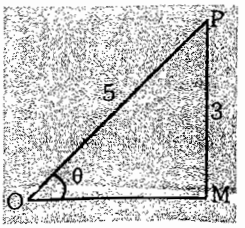
$$\sin^2\theta + \cos^2\theta = 1 \qquad 1 + \tan^2\theta = \sec^2\theta \qquad 1 + \cot^2\theta = \text{cosec}^2\theta$$

Illustrations

Illustration 3.

Given $\sin\theta = 3/5$. Find all the other T-ratios, if θ lies in the first quadrant.

Solution



In Δ OMP, $\sin\theta = \frac{3}{5}$ so MP = 3 and OP = 5

$\because$ $OM = \sqrt{(5)^2 - (3)^2} = \sqrt{25-9} = \sqrt{16} = 4$

Now, $\cos\theta = \frac{OM}{OP} = \frac{4}{5}$ $\tan\theta = \frac{MP}{OM} = \frac{3}{4}$

$\cot\theta = \frac{OM}{MP} = \frac{4}{3}$ $\sec\theta = \frac{OP}{OM} = \frac{5}{4}$ $\text{cosec}\,\theta = \frac{OP}{MP} = \frac{5}{3}$

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PHYSICS

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E

WORK, ENERGY & POWER

1. WORK

Whenever a force acting on a body, displaces it, work is said to be done by the force.

Work done by a constant force is equal to the scalar product of the force $\vec{F}$ applied and the displacement $\vec{d}$ of the point of application, $W = \vec{F}.\vec{d}$

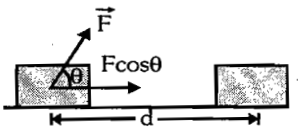
Work is a scalar quantity.

1.1 Work done by a constant force

If the direction and magnitude of a force applied on a body is constant then the force is said to be constant.
Work done by a constant force, W = Force × component of displacement along the force
= displacement × component of force along the displacement.

i.e., work done will, be $W = (F\cos\theta)\, d$
$= F\,(d\cos\theta)$

In vector form, $W = \vec{F}\cdot\vec{d}$



Note : The force of gravity (within small altitudes) is an example of constant force; consequently work done by it is an example of work done by a constant force.

1.2 Work done by a variable force

If the force applied on a body is changing in direction or magnitude or both, the force is said to be variable. Suppose a variable force causes displacement of a body from position P_1 to position P_2. To calculate the work done by the force, the path from P_1 to P_2 can be divided into infinitesimal elements; each element is so small that during the displacement of the body through it, the force is supposed to be constant. If $d\vec{r}$ be the small displacement of point of application and $\vec{F}$ be the force acting on the body, the work done by force is $dW = \vec{F}\cdot d\vec{r}$

The total work done in displacing the body from P_1 to P_2 is given by $\int dW = \int_{P_1}^{P_2}\vec{F}.d\vec{r} \Rightarrow W = \int_{P_1}^{P_2}\vec{F}\cdot d\vec{r}$

If $\vec{r}_1$ and $\vec{r}_2$ be the position vectors of the points P_1 and P_2 respectively then the total work done $W = \int_{\vec{r}_1}^{\vec{r}_2}\vec{F}.d\vec{r}$

Cartesian Form

When magnitude and direction of the force varies with position, work done by the force for infinitesimal displacement $\vec{ds}$ is $dW = \vec{F}.d\vec{s}$

The total work done for the displacement from position A to B is $W_{AB} = \int_A^B \vec{F}.d\vec{s} = \int_A^B (F\cos\theta)ds$

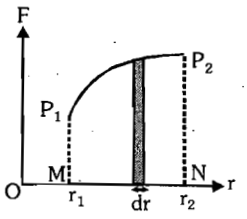
In terms of rectangular components

$\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$, $d\vec{s} = dx\hat{i} + dy\hat{j} + dz\hat{k}$

$W_{AB} = \int_A^B (F_x\hat{i} + F_y\hat{j} + F_z\hat{k}).(dx\hat{i} + dy\hat{j} + dz\hat{k}) = \int_{x_A}^{x_B} F_x dx + \int_{y_A}^{y_B} F_y dy + \int_{z_A}^{z_B} F_z dz$

1.3 Calculating work form graph

Suppose a body, whose initial position is $\vec{r}_1$, is acted upon by a variable force $\vec{F}$ and consequently the body acquires its final position $\vec{r}_2$. From position $\vec{r}$ to $\vec{r}+d\vec{r}$ or for small displacement $d\vec{r}$, the work done will be $\vec{F}.d\vec{r}$ whose value will be the area of the shaded strip of width $d\vec{r}$. The work done on the body in displacing it from position $\vec{r}_1$ to $\vec{r}_2$ will be equal to the sum of areas of all such strips



Thus, total work done, $W = \sum_{r_1}^{r_2} dW = \sum_{r_1}^{r_2} \vec{F}.d\vec{r}$ = Area of P_1P_2NM

The area of the graph between curve and displacement axis is equal to the work done.

Note : To calculate the work done by graphical method, for the sake of simplicity, here we have assumed the direction of force and displacement as same, but if they are not in same direction, the graph must be plotted between F cosθ and r.

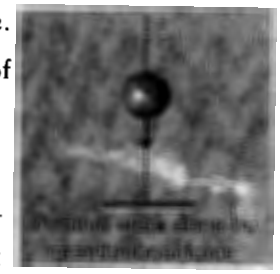
1.4 Nature of Work Done

(i) Positive work

$W = Fs\cos\theta$

If the angle θ is acute ($\theta < 90°$) then the work is said to be positive.

Positive work signifies that the external force favours the motion of the body.



- When a body falls freely under the action of gravity ($\theta = 0°$), the work done by gravity is positive.
- When a spring is stretched, stretching force and the displacement both are in the same direction. So work done by stretching force is positive.

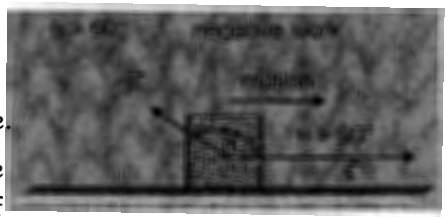
(ii) Negative work

$W = Fs\cos\theta$

If the angle θ is obtuse ($\theta > 90°$).

Then the work is said to be negative.

It signifies that the direction of force is such that it opposes the motion of the body.



- Work done by frictional force is negative when it opposes the motion.
- Work done by braking force on the car is negative.

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PHYSICS

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TEMPERATURE & THERMAL EXPANSION

1. TEMPERATURE & TEMPERATURE SCALES

- **Temperature**

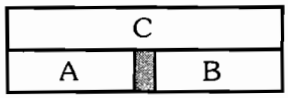
Temperature may be defined as the ***degree of hotness or coldness*** of a body. Heat energy flows from a body at higher temperature to that at lower temperature until their temperatures become equal. At this stage, the bodies are said to be in thermal equilibrium.

- **Thermal equilibrium**

Thermal equilibrium is a situation in which two objects would not exchange energy by heat or electromagnetic radiation if they were placed in thermal contact. Heat is the transfer of energy from one object to another object as a result of a difference in temperature between them.

- **Zeroth law of thermodynamics**

If objects A and B are separately in thermal equilibrium with a third object C (say thermometer), then objects A and B are in thermal equilibrium with each other. Zeroth law of thermodynamics introduces the concept of temperature. Two objects (or systems) are said to be in thermal equilibrium if their temperatures are same.



In measuring the temperature of a body, it is important that the thermometer should be in thermal equilibrium with the body whose temperature is to be measured.

- **Measurement of Temperature**

The branch of thermodynamics which deals with the measurement of temperature is called thermometry. A thermometer is a device used to measure the temperature of a body. The substances like liquids and gases which are used in the thermometer are called thermometric substances.

- **Different Scales of Temperature**

A thermometer can be graduated into following scales :

(a) The Centigrade or Celsius scale (°C)

(b) The Fahrenheit scale (°F)

(c) Kelvin scale (K)

- **Comparison between Different Temperature Scales**

The general formula for the conversion between different temperature scales is:

$$\frac{K-273}{100}=\frac{C}{100}=\frac{F-32}{180}=\frac{X-LFP}{UFP-LFP}$$

Where X→ Reading in unknown temperature scale, LFP → Lower Fixed Point, UFP → Upper Fixed Point

Change in temperature $\frac{\Delta K}{100}=\frac{\Delta C}{100}=\frac{\Delta F}{180}=\frac{\Delta X}{UFP-LFP}$

GOLDEN KEY POINTS

- Although the temperature of a body can be raised without limit, it can not be lowered without limit and theoretically limiting low temperature is taken to be zero of the Kelvin scale (i.e. no negative temperature on Kelvin scale is possible).
- Though when universe was created 10^{10} years ago, its temp. was about 10^{39} K which at present is about 3K. The highest laboratory temperature is about 10^{8} K (in fusion test reactor) while lowest 10^{-10} K (achieved in 1999 through nuclear spin cooling) Theory has established that zero Kelvin temperature can never be achieved practically.

Illustrations

Illustration 1.

Temperature of a patient is 40°C . Find the temperature on Fahrenheit scale ?

Solution :

$$\frac{F-32}{180} = \frac{40-0}{100} \Rightarrow \quad F = 104°F$$

Illustration 2.

At what temperature is the Fahrenheit scale reading equal to twice of Celsius ?

Solution :

$$\frac{F-32}{180} = \frac{C-0}{100} \Rightarrow \frac{2x-32}{180} = \frac{x-0}{100} \Rightarrow x = 160$$

Illustration 3.

The lower and upper fixed points of a faulty thermometer are 5 W and 105 W. If the thermometer reads 25 W, what is the actual temperature in Celsius scale ?

Solution : $\frac{25-5}{100} = \frac{C-0}{100} \quad \Rightarrow \quad C = 20°C$

Illustration 4.

A thermometer with an arbitrary scale has the ice point at –20° and the steam point at 180°. When the thermometer reads 5°, a Centigrade thermometer will read

(1) 7.5 °C (2) 12.5 °C (3) 16.5 °C (4) –9.37 °C

Solution :

$$\frac{C-0}{100-0} = \frac{t-(-20)}{180-(-20)} \quad \text{(Here } t = 5°\text{)}$$

$$\Rightarrow \quad \frac{C}{100} = \frac{5+20}{200} \quad \Rightarrow \quad C = 12.5 °C$$

Illustration 5.

The temperature of an iron piece is raised from 30°C to 90°C. What is the change in its temperature on the Fahrenheit scale and on the Kelvin scale?

Solution

$\Delta C = 90° - 30° = 60°C$

Temperature difference on Fahrenheit Scale $\Delta F = \frac{9}{5}\Delta C = \frac{9}{5}(60°C) = 108°F$

Temperature difference on Kelvin Scale $\Delta K = \Delta C = 60K$

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PHYSICS

E

ELECTROSTATICS

1. ELECTRIC CHARGE

Charge is the property associated with matter due to which it produces and experiences electrical and magnetic effects. The excess or deficiency of electrons in a body is the causes of net charge on a body.

Types of charge :

(i) Positive charge : It is the deficiency of electrons as compared to protons.

(ii) Negative charge : It is the excess of electrons as compared to protons.

SI unit of charge : ampere × second i.e. coulomb; Dimension : [A T]

Practical units of charge are ampere × hour (=3600 C) and faraday (=96500 C)

- Millikan determined quanta of charge and estimated it to be equal to charge of electron.
- $1\ C = 3 \times 10^9$ stat coulomb, 1 absolute - coulomb $= 10$ C, 1 Faraday $= 96500$ C.

Note : Charge of fundamental particles (i.e. electron, proton etc.) is their internal characteristic while charge on a body depends on the number of protons & electrons inside the body.

1.1 Specific Properties of Charge

- **Charge is a scalar quantity :** It represents excess or deficiency of electrons.
- **Charge is transferable :** If a charged body is put in contact with an another body, then charge can be transferred to another body.
- **Charge is always associated with mass**

  Charge cannot exist without mass though mass can exist without charge.
  - So the presence of charge itself is a convincing proof of existence of mass.
  - The mass of a body changes after being charged.
  - When a body is given a positive charge, its mass decreases.
  - When a body is given a negative charge, its mass increases.
- **Charge is quantised**

  The quantization of electric charge is the property by virtue of which all free charges are integral multiple of a basic unit of charge represented by e. Thus charge q of a body is always given by

  q = ne n = positive or negative integer

  The quantum of charge is the charge that an electron or proton carries.

  Note : Charge on a proton = (–) charge on an electron = 1.6×10^{-19} C
- **Charge is conserved**

  In an isolated system, total charge does not change with time though individual charge may change, i.e. charge can neither be created nor destroyed. Conservation of charge is also found to hold good in all types of reactions either chemical (atomic) or nuclear. No exceptions to the rule have ever been found.
- **Charge is invariant**

  Charge is independent of frame of reference. i.e. charge on a body does not change whatever be its speed.

Accelerated charge radiates energy

v = 0 (i.e. at rest)	v = constant	v ≠ constant (i.e. time varying)
⊕ Q	⊕→ Q	⊕→ Q
produces only $\vec{E}$ (electric field)	produces both $\vec{E}$ and $\vec{B}$ (magnetic field) but no radiation	produces $\vec{E}$, $\vec{B}$ and radiates energy

1.2 Conductors & Insulators

Conductors : Materials in which the outer electrons of each atom or molecule are weakly bound and these electrons are almost free to move throughout the body of the material are known as conductors.

Insulators : Materials in which all the electrons are tightly bound to their respective atoms or molecules are known as insulators. In insulators there are very few free electrons. Such materials are also called dielectrics.

1.3 Methods of Charging

- **Friction**

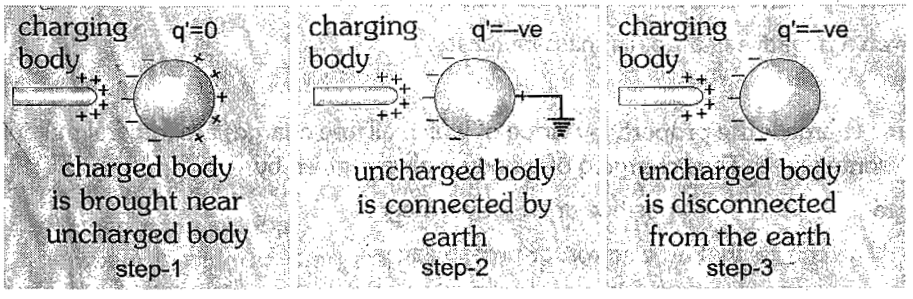
If we rub one body with another body, electrons are transfered from one body to the other.

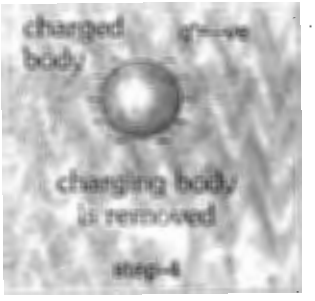
Positive charge	Negative charge
Glass rod	Silk cloth
Woollen cloth	Rubber shoes, Amber, Plastic objects
Dry hair	Comb
Cat skin	Ebonite rod
Note : Clouds get charged due to friction	

- **Electrostatic induction**

If a charged body is brought near a neutral body, the charged body will attract opposite charge and repel similar charge present in the neutral body. As a result of this one side of the neutral body becomes negative while the other positive, this process is called 'electrostatic induction'. Hence induction is a phenomena of **redistribution** of charge on a body when any other charged body is brought near it.

Charging a body by induction (in four successive steps)





In case of induction it is worth noting that :

(i) Inducing body neither gains nor loses charge.

(ii) The nature of induced charge is always opposite to that of inducing charge.

(iii) Induced charge can be lesser or equal to inducing charge (but never greater).

(iv) Induction takes place only in bodies (either conducting or non conducting) and not in particles.

- **Conduction**

The process of transfer of charge by contact of two conducting bodies is known as conduction.

If a charged conducting body is put in contact with uncharged conducting body, the uncharged body becomes charged due to transfer of electrons from one body to the other.

The charged body loses some of its charge (which is equal to the charge gained by the uncharged body).

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PHYSICS

E

MAGNETIC EFFECT OF CURRENT AND MAGNETISM

The branch of physics which deals with the magnetism due to electric current or moving charge (i.e. electric current is equivalent to the charges or electrons in motion) is called electromagnetism.

Magnetic Field

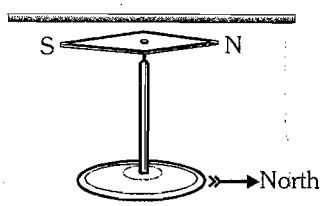
A region of space near a magnet, electric current or moving charged particle in which magnetic effects are exerted on any other magnet, electric current, or moving charged particle. It is also known as magnetic flux density or magnetic induction or magnetic field.

Unit : SI : weber/(meter)^2 or tesla (T) **C.G.S. :** gauss (1 Tesla = 10^4 gauss) **Dimensions :** $[MT^{-2}A^{-1}]$

1. OERSTED'S DISCOVERY AND BIOT-SAVART LAW

- **Oersted Discovery**

The relation between electricity and magnetism was discovered by Oersted in 1820. Oersted showed that the electric current through the conducting wire deflects the magnetic needle held near the wire.



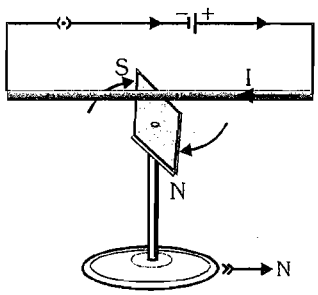
- When the direction of current in conductor is reversed then deflection of magnetic needle is also reversed.
- On increasing the current in conductor or bringing the needle closer to the conductor, the deflection of magnetic needle increases.

Oersted discovered a magnetic field around a conductor carrying electric current. Other related facts are as follows:

(a) A magnet at rest produces a magnetic field around it while an electric charge at rest produce an electric field around it.

(b) A current carrying conductor has a magnetic field and not an electric field around it. On the other hand, a charge moving with a uniform velocity has an electric as well as a magnetic field around it.

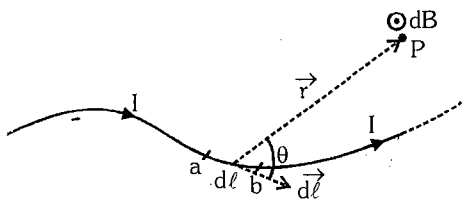
(c) All oscillating or an accelerated charge produces E.M. waves also in additions to electric and magnetic fields.



Oersted's experiment. Current in the wire deflects the compass needle

- **Current Element**

A very small element ab of length $d\ell$ of a thin conductor carrying current is called current element. Current element is a vector quantity whose magnitude is equal to the product of current and length of small element having the direction of the flow of current.



- **Biot – Savart's Law**

With the help of experimental results, Biot and Savart arrived at a mathematical expression that gives the magnetic field at some point in space in terms of the current that produces the field. That expression is based on the following experimental observations for the magnetic field $d\vec{B}$ at a point P associated with a length element $d\vec{\ell}$ of a wire carrying a steady current I.

$$dB \propto I,\ dB \propto d\ell,\ dB \propto \sin\theta \text{ and } dB \propto \frac{1}{r^2} \Rightarrow dB \propto \frac{Id\ell\sin\theta}{r^2} \Rightarrow dB = \frac{\mu_0}{4\pi}\frac{Id\ell\sin\theta}{r^2}$$

where $\mu_0/4\pi$ = constant = $10^{-7}\ \frac{T\times m}{A}$, μ_0 is permeability constant of free space.

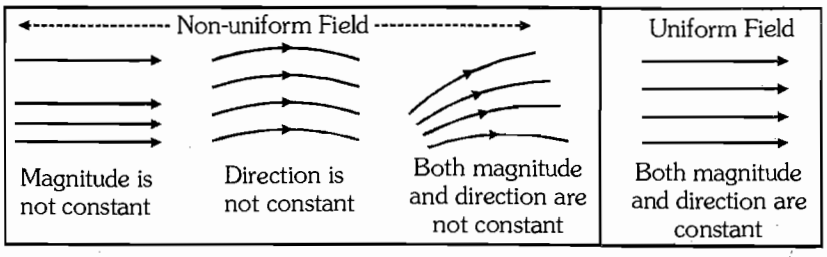
Vector form of Biot-Savart's law

$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\ell\sin\theta}{r^2}\hat{n}$ $\hat{n}$ =unit vector perpendicular to the plane of $(Id\vec{\ell})$ and $(\vec{r})$

$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{\ell}\times\vec{r}}{r^3}$ $[\because Id\vec{\ell} \times \vec{r} = (Id\ell)(r)\sin\theta\ \hat{n}]$

Magnetic field lines (By Michael Faraday)

In order to visualise a magnetic field graphically, Michael faraday introduced the concept of field lines. Field lines of magnetic field are imaginary lines which represents direction of magnetic field continuously.



- Magnetic field lines emanate from or enters in the surface of a magnetic material at any angle.
- Magnetic field lines exist inside every magnetised material.
- Magnetic field lines can be mapped by using iron dust or using compass needle.

2. SPECIAL THUMB RULES

2.1 Right Hand Thumb Rule

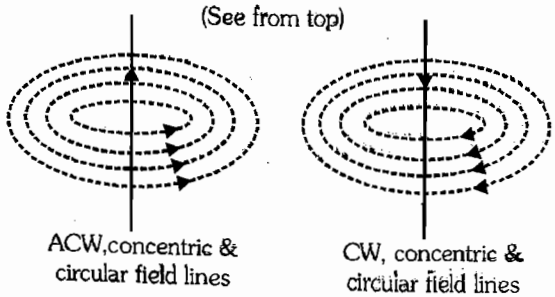
This rule gives the pattern of magnetic field lines due to current carrying straight and circuler wire.

(i) Straight current :

Thumb → In the direction of current

Curling fingers → Gives field lines pattern

Case I : wire in the plane of the paper:-



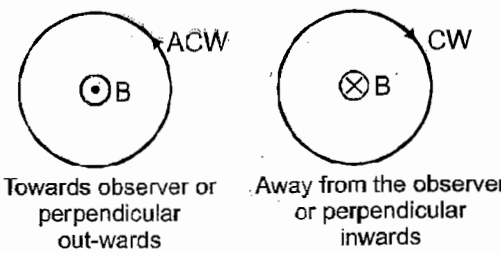
Case II : Wire is ⊥ to the plane of the paper:-

(ii) Circular current :

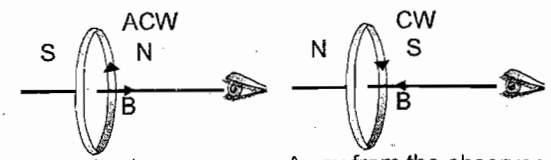
Curling fingers → In the direction of current

Thumb → Gives field line pattern

Case I : wire in the plane of the paper



Case II : Wire is ⊥ to the plane of the paper



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PHYSICS

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RAY OPTICS AND OPTICAL INSTRUMENTS

INTRODUCTION

Optics is the branch of physics which deals with the behavior of light waves. Under many circumstances, the wavelength of light is negligible compared with the dimensions of the device as in the case of ordinary mirrors and lenses. A light beam can then be treated as a ray whose propagation is governed by simple geometric rules. The part of optics that deals with such a phenomena is known as geometrical optics.

PROPAGATION OF LIGHT

Light travels along straight line path in a certain medium or in vacuum. The path of light changes only where the medium changes. We call this rectilinear (straight–line) propagation of light. A bundle of light rays is called a beam of light.

- Apart from vacuum and gases, light can travel through some liquids and solids as well. A medium in which light can travel without attenuation over large distances is called a transparent medium. Water, glycerine, glass and clear plastics are transparent. A medium in which light cannot travel is called opaque. Wood, metals, bricks, etc., are opaque. In materials like oil, light can travel some distance, but its intensity reduces rapidly. Such materials are called translucent.

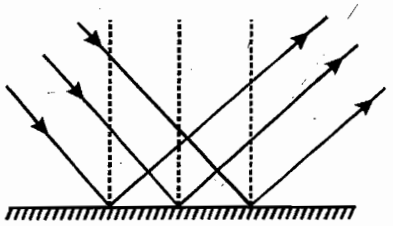
REFLECTION OF LIGHT

When light rays strike the boundary of two media such as air and glass, a part of light bounces back into the same medium. This phenomenon of light is called Reflection of light.

(i) Regular / Specular reflection :

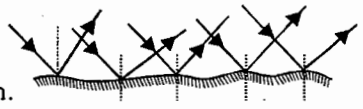
When reflection takes place from a perfect plane surface then rays remain parallel after reflection .

It is called **Regular reflection**.



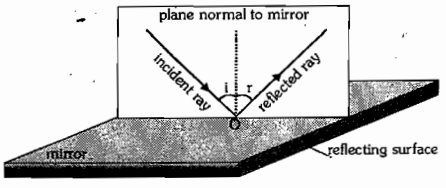
(ii) Irregular / Diffused reflection

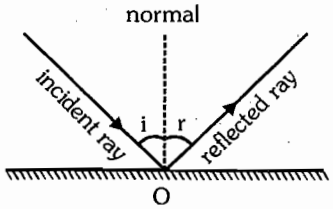
When the surface is rough, light is reflected from the bits of its plane surfaces in different directions. This is called **Irregular reflection**. This process enables us to see an object from any position.

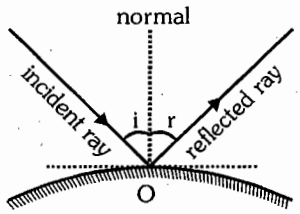


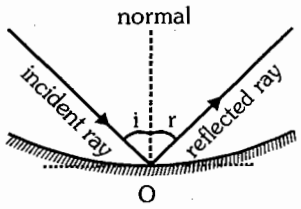
LAWS OF REFLECTION

- Incident ray, reflected ray and normal at the point of incidence all lie in the same plane.
- The angle of reflection is equal to the angle of incident i.e. $\angle i = \angle r$.







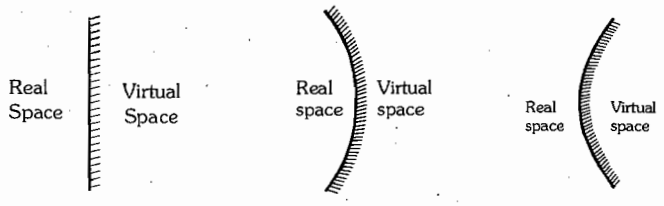


REAL AND VIRTUAL SPACES

A mirror, plane or spherical divides the space into two regions ;

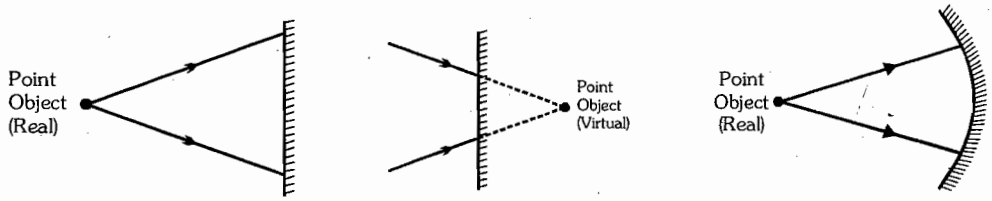
(a) Real space, the side where the reflected rays exist.

(b) Virtual space is on the other side where the reflected rays do not exist.



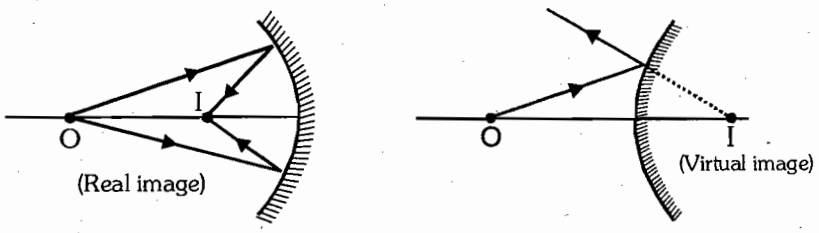
OBJECT

Object is decided by incident rays only. A point object is that point from which the incident rays actually diverge (real object) or towards which the incident rays appear to converge (virtual object).



IMAGE

Image is decided by reflected or refracted rays only. A point image is that point at which the refracted / reflected rays actually converge (real image) or from which the refracted /reflected rays appear to diverge (virtual image).



REFLECTION FROM PLANE MIRROR

A plane mirror is a mirror with perfectly plane reflecting surface.

Plane mirror is the perpendicular bisector of the line joining object and image.

- The image formed by a plane mirror suffers **lateral–inversion,** i.e., left is turned into right and vice–versa with respect to object in the image formed by a plane mirror .