



GOVERNMENT OF TAMILNADU

SCIENCE

X STANDARD

NOT FOR SALE

Untouchability is Inhuman and a Crime

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CONTENTS

Chapter	I BIOLOGY	Page No.
1. Heredity and Evolution		1
2. Immune System		17
3. Structure and Functions of Human Body Organ Systems		36
4. Reproduction in Plants		56
5. A Representative Study of Mammals		81
6. Life Processes		97
7. Conservation of Environment		116
8. Waste Water Management		133
 II CHEMISTRY		
9. Solutions		146
10. Atoms and Molecules		157
11. Chemical Reactions		169
12. Periodic Classification of Elements		192
13. Carbon and its Compounds		213
 III PHYSICS		
14. Measuring Instruments		229
15. Laws of Motion and Gravitation		233
16. Electricity and Energy		250
17. Magnetic Effect of Electric Current and light		273
Answers		306
Syllabus		308
Practicals		313

Note to the teacher...

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

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

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

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

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

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

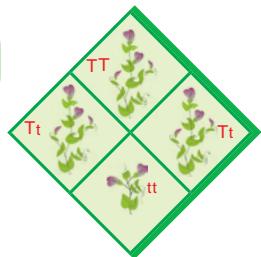
The “More to know” snippets in the text represents some unusual and interesting facts or information in which the students need not be examined.

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

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

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Chapter 1



HEREDITY AND EVOLUTION

1.1. HEREDITY AND VARIATION

A cow gives birth to a calf, a cat to a kitten and so forth. However, on close observation of a cow and its calf or a cat and its kitten, we see a number of differences such as the colour of the skin, size etc. So the conclusion to be derived is that, the offspring, by virtue of being the progeny, need not be an exact replica of its parents.

Inheritable characteristics of the parents are passed on from one generation to the next through genes. No two individuals, even biologically related individuals, are alike in every way and the differences in their characteristics are defined as variation. Living organisms show a great deal of variation.

HEREDITY

The rules of heredity determine the process by which the traits and the characteristics are relatively inherited.

"The inheritance of characteristics from one generation to another generation is called heredity."

The inheritable characteristics (traits) may be morphological / anatomical / physiological / reproductive.

If we take a very close look at the rules of inheritance, both father and mother contribute an equal amount of genetic material to the child. This

means that each trait can be influenced by both paternal and maternal genetic material – i.e. DNA.

Gregor Johann Mendel (1822-1884) conducted the first ever scientific experimental study on heredity.

Mendel, an Austrian Augustinian monk, observed variations in the characteristics of garden pea plant (*Pisum sativum*) which, he had cultivated in his monastery garden. Mendel was curious to find out the results of crossing of pea plants with variation in traits.

The visible contrasting characteristics that Mendel focussed on the garden pea plants were:

- Seed shape - Round / Wrinkled
- Seed colour - Yellow / Green
- Flower colour - Violet / White
- Pod shape - Full / Constricted
- Pod colour - Green / Yellow
- Flower position - Axillary / Terminal
- Stem height - Tall / Dwarf

ACTIVITY 1.1

- Ask your classmates to roll their tongues. Observe how many are able to roll their tongues and how many are not able to roll their tongues. Record your findings.
- Similarly record the variation in the eye colour noticed among your classmates.

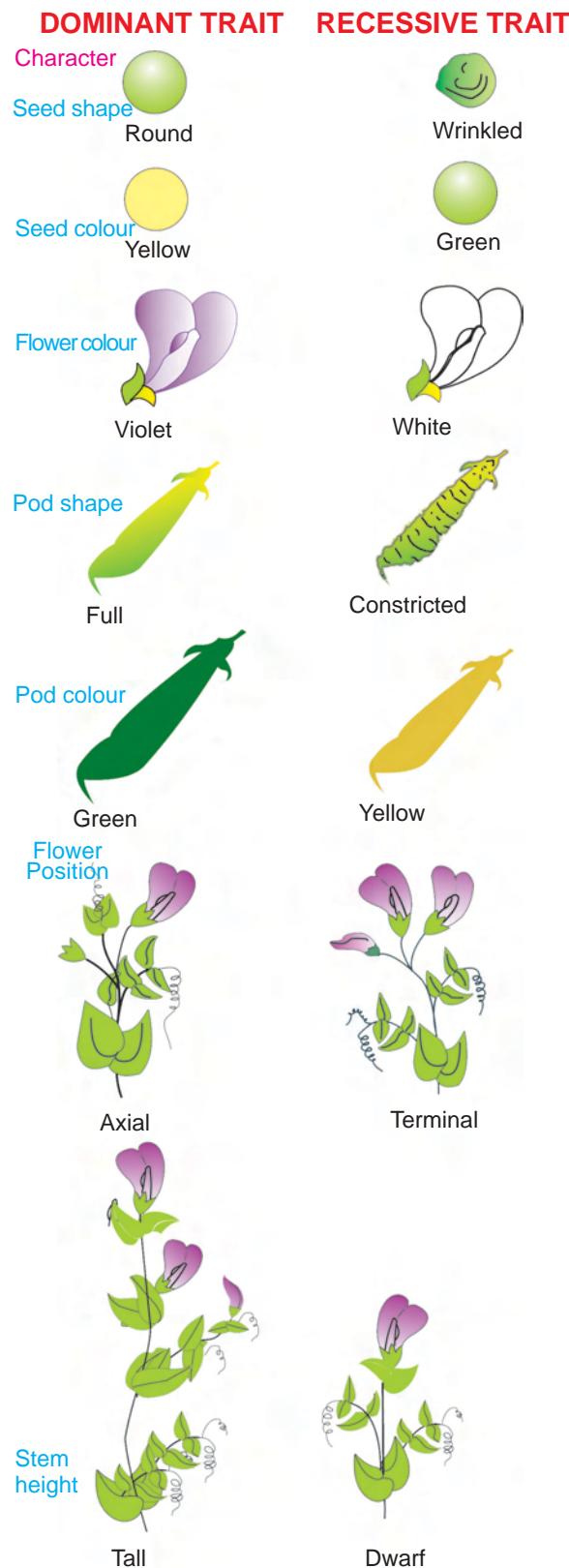


Fig. 1.1 Seven pairs of contrasting traits in Pea plant studied by Mendel.

1.1.1. Mendel's Monohybrid Cross

Mendel selected tall and dwarf garden pea plants, *Pisum sativum*, for his experiments. Mendel selected tall and dwarf pea plants for his experiments. He observed their growth for nearly two years and found that tall plants always produce tall plants and dwarf plants produce dwarf plants - generation after generation, on self pollination and under natural conditions. He termed those tall and dwarf plants as "wild types" or "pure breeding" varieties.

He crossed a tall plant with a dwarf plant, and observed how the traits are transmitted the progeny and calculated the

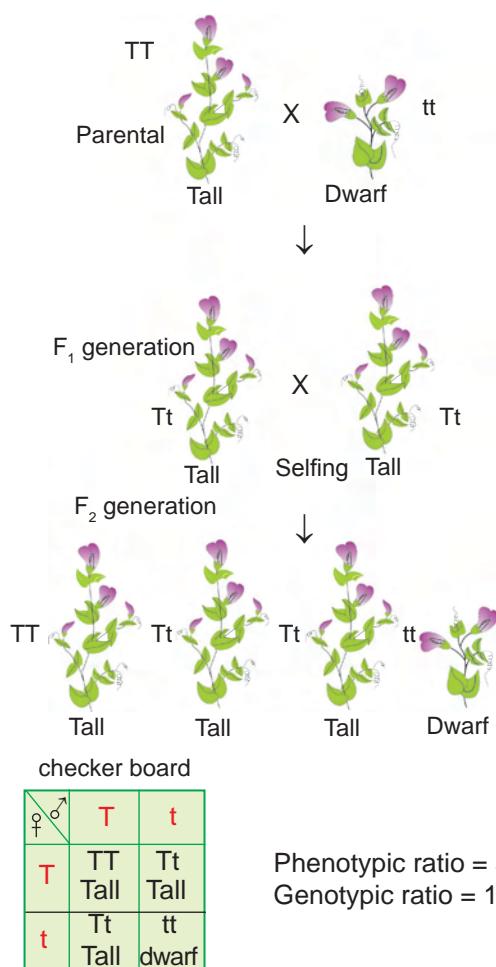


Fig. 1.2 Diagrammatic representation of Monohybrid cross

percentage of tallness and dwarfness in subsequent generations.

When a pure breeding tall plant (TT) was crossed with a pure breeding dwarf plant(tt), all plants were tall in the first filial generation(F_1) i.e. there was not any medium height plants or dwarf plants. This means that only one of the parental

Gregor Johann Mendel (1822-1884)

Mendel was educated in a monastery and went on to study science and mathematics at the university of Vienna. Failure in the examinations for a teaching certificate did not suppress his zeal for scientific quest. He went back to his monastery and set out experimenting on pea plants. Many others had studied the inheritance of traits in peas and other organisms earlier, but Mendel blended his knowledge of Science and Mathematics and was the first one to keep count of individuals exhibiting a particular trait in each generation. This helped him to arrive at the laws of inheritance that we have discussed in the main text.



ACTIVITY 1.2

Observe the plants in your locality which show different characters for the following traits. Count them and record your findings. Examples:

Coconut	Tall	Dwarf
Bean	Violet Flower	White Flower
Sugarcane	White Stem	Purple Stem
Clitoria	Blue Flower	White Flower

traits was seen and not a mixture of the two. When such an F_1 tall plant(Tt) was allowed to self-pollination, both the tall and dwarf plants appeared in second filial generation (F_2) in the ratio of 3:1. This indicates that both tallness and dwarfness were inherited in the F_1 plants but only one trait was expressed, i.e. tallness. The trait which is expressed is called dominant. The hidden trait is called the recessive trait.

The first experiment of Mendel considering the inheritance of a single trait (Height of the plant-Tall/Dwarf) is called Monohybrid Cross.

Expression of morphological characters (as tall or dwarf plant, violet or white flower) is called **Phenotype**. Genetic make up of an individual for a particular trait is called **Genotype**. The genotype of a character is influenced by certain factors.

PHYSICAL BASIS OF HEREDITY

The unit of inheritance or the determinant of a trait(character) is called gene. The genes are the factors which form the physical basis for inheritance of Characters. The alternate forms of the same gene are called alleles. The expression of contrasting pair of alleles(Tt) makes up an allelomorph. Examples : Height of plant

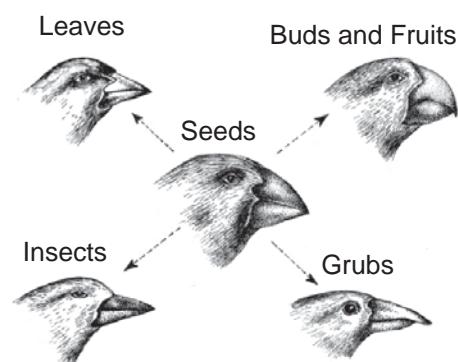


Fig. 1.3 Variations in the beaks of finches to suit their eating habits.

(Tt), shape of seed (Rr). Recombination in expressing phenotype leads to variation.

1.2. VARIATION

All around us, we see different organisms belonging to different species, differing from one another. Variation may be defined as differences in the characteristics among the individuals of the same species, (A) **Intra specific variation** or among the different genera (B) **Intergeneric variation** or among different species (C) **Inter specific variation**. No two individuals are identical. Asexual reproduction produces very closely resembling offspring. Asexual reproduction thus results in offspring with minor variations. Sexually reproducing organisms produce offspring with marked, significant and visible variations.



Fig. 1.4 Identical twins

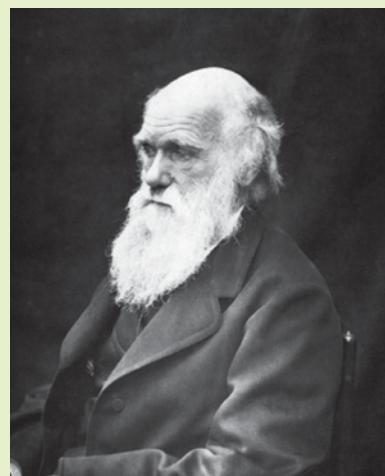
1.2.1. Types of Variations

- Somatic Variation** - It pertains to body cells and it is not inherited.
- Germinal Variation** - It pertains to germ cells or gametes and it is inheritable. It leads to speciation and evolution.

Significance of Variation

- ♦ It is the source of raw material for evolution.

Charles Darwin: (1809-1882)



Charles Darwin set out on a voyage, when he was 22 years old. The 5 year voyage took him to South America and the islands off its coast. Interestingly, after he got back to England, he never left the shores again. He stayed at home and conducted various experiments that led him to formulate his theory of evolution. He did not know the mechanism by which the variations arose in the species. Had he been enlightened by Mendel's experiments, he would have contributed more. These two great men did not know of each other or of their works.

We often associate Darwin solely with the theory of evolution, but he was an accomplished naturalist, and one of the studies he conducted with the role of earthworms in soil fertility.

- ♦ Animals are able to adapt themselves to the changing environment.
- ♦ Organisms are better suited to face the struggle for existence.
- ♦ Variations give the organisms an individuality of their own.

- Without variations there would be no science of evolution, as all individuals of a race would be identical in all aspects.

Lamarckian View on Organic Evolution

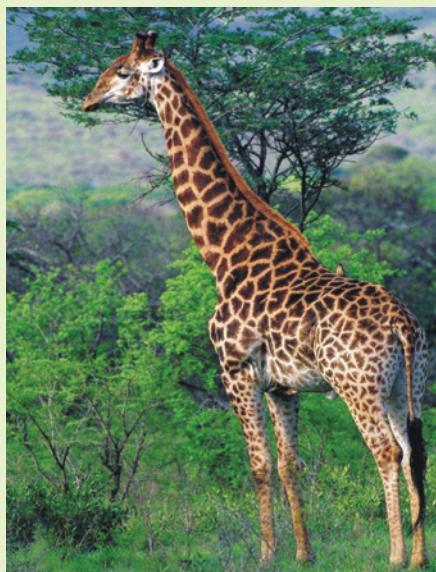


Fig. 1.5 Giraffe

Jean Baptiste Lamarck (1744-1829) postulated the *Use and Disuse Theory*. According to Lamarck, the use of a part / an organ efficiently by a species, for generations over a long period of time, results in that part / organ being well developed in the subsequent generations and disuse of part / organ for a long period would make that part / organ to diminish or degenerate.

Lamarck quotes the example of the development of the long neck of the giraffe. Giraffes were forced to extend their neck and stretch their legs to reach the leaves of tall trees. Over a long period of time, this resulted in long neck and long legs in giraffes. Lamarck remarks that the “will or want” for a character makes the organisms to possess it at a later time.

1.3. THEORY OF NATURAL SELECTION

Charles Darwin made a number of observations in many parts of the world and put forth the law of natural selection involving struggle for existence and survival of the fittest.

Variation leads to genetic diversity, which is the staircase of evolution.

1.3.1. Evolution

Evolution may be defined as a gradual development of more complex species from pre-existing simpler forms.

It is an extremely slow process and has been occurring since millions of years, as revealed by fossil evidence.

Evolution has thus resulted in the diversity of organisms, influenced by environmental selection.

1.3.2. Human Evolution

Fifteen million years ago, the hairy bodied gorilla and chimpanzees like Hominids existed in Africa. 3-4 million years ago, men like hominids walked into Eastern Africa. Evidence shows that they hunted with stone weapons but were mostly fruit eaters. They were probably not taller than four feet, but walked upright in the grass lands of East Africa. These creatures were called the first human-like beings – the Hominid. The Hominid was called *Homo habilis*.

The next stage of human evolution came into existence 1.5 million years ago with the rise of *Homo erectus* who were meat eaters.

The Neanderthal man who lived in East and Central Asia 1 million years ago, used to hide to protect themselves and buried their dead.

Archaic *Homo sapiens* arose in South Africa and moved across continents and developed into distinct races during the ice age. It is believed that homosapiens came into existence about 75,000 to 10,000 years ago. Pre-historic caves were developed about 18,000 years ago, agriculture came around 10,000 years back and human settlements started.

1.3.3. The Tree of Evolution

To understand evolution, a branching diagram (a tree diagram) is used to illustrate the inferred evolution, relationships, among

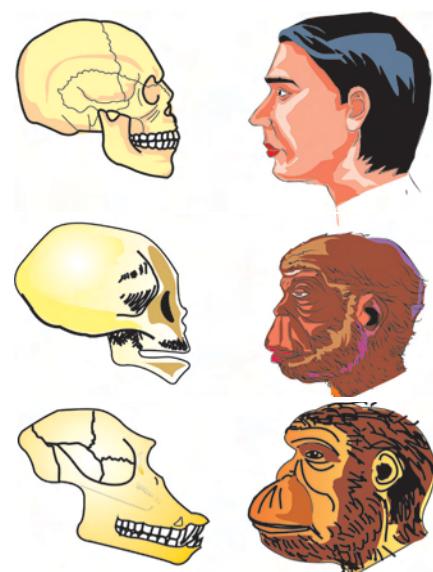


Fig. 1.6 A comparison of the skulls of: An adult modern human being, baby chimpanzee and adult chimpanzee. The skull of the baby chimpanzee is more like the adult human skull than the adult chimpanzee skull.

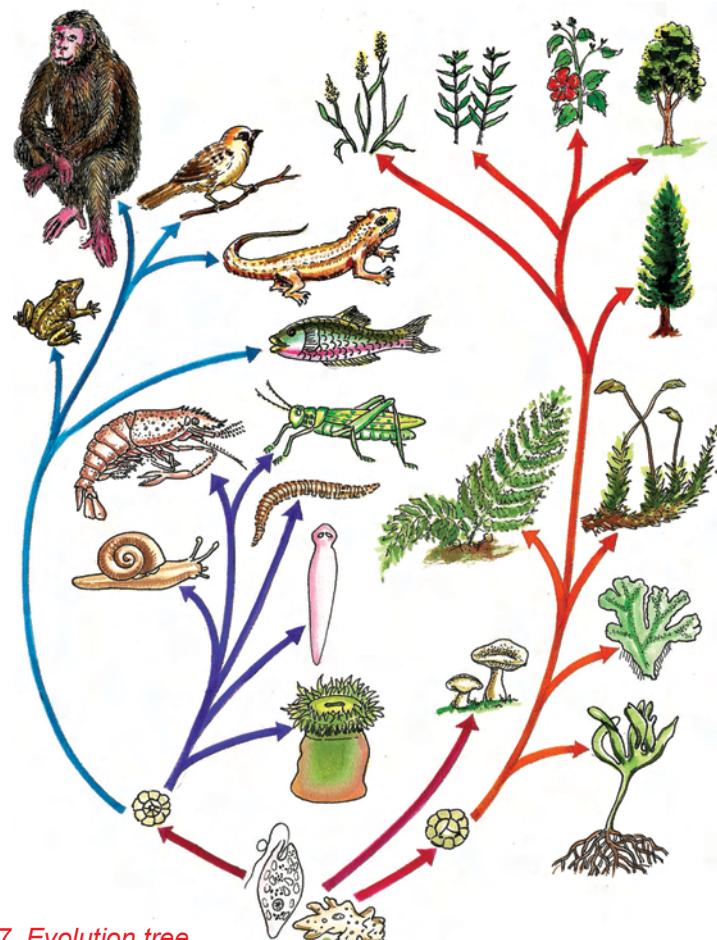


Fig. 1.7 Evolution tree

various biological species or other entities based upon similarities and differences in their physical and genetic characters.

1.4. GENETIC ENGINEERING

Genetic engineering is the modification of the genetic information of living organisms by manipulation of DNA i.e. by adding, removing or repairing part of genetic material (DNA) and changing the phenotype of the organism. It is also known as gene manipulation or Recombinant DNA Technology (r-DNA Technology)

Recent advances made in Genetics, Molecular Biology and Biochemistry have resulted in the origin of this new branch of science.

Merits of Genetic Engineering

- ◆ Understanding of the gene structure and function through basic research.

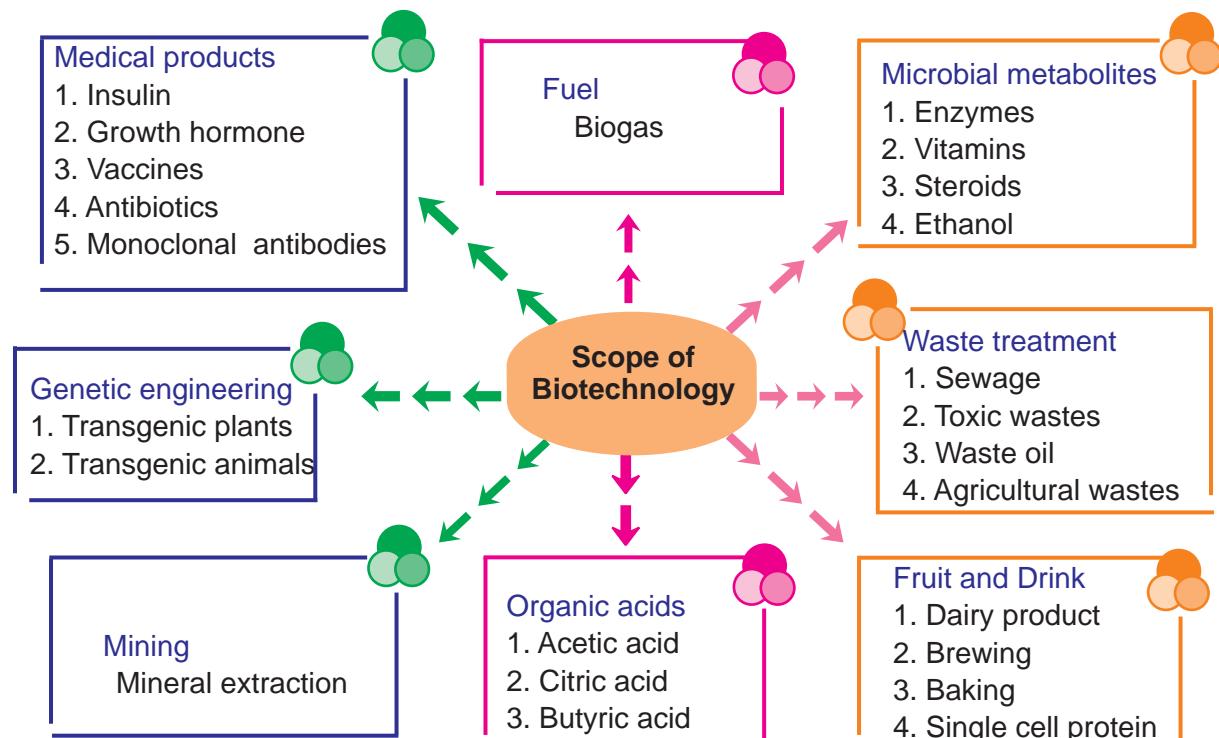
- ◆ Production of large quantities of human insulin, interferons(Anti-Viral Proteins produced by Virus infected cells) human growth hormones and vaccines for foot and mouth disease of cattle (komari – in Tamil) etc.

- ◆ This technique is also employed in the transfer of genes involved in Nitrogen fixation (Nif–genes). This will help cultivators to increase productivity.

1.4.1. Basic techniques in Genetic Engineering

Genetic Engineering has developed after the discovery of two enzymes- the enzymes which can cut DNA into fragments and the enzymes which can join such fragments.

- A. Restriction enzymes or Restriction endonucleases are molecular scissors which cut DNA at specific sites.



B. DNA ligases are the paste enzymes which help in joining the broken DNA fragments.

1.5. BIOTECHNOLOGY AND CLONING

Biotechnology uses biological organisms or biological processes through modern techniques which could be profitably used in the field of medicine, agriculture, animal husbandry and in environmental cleaning. There are several applications of Biotechnology in the field of brewing industry, enzyme technology, manufacturing of antibiotics, organic acids, vitamins, vaccines, steroids and monoclonal anti-bodies.

Brewing Industry: Fermentation of alcoholic beverages like beer, wine etc.

Enzyme Technology : Enzymes are biocatalysts that speed up reaction in cells. They can be used to catalyze the industrially important reactions and are more efficient than inorganic catalysts. Many enzymes are utilized in the pharmaceutical industry.

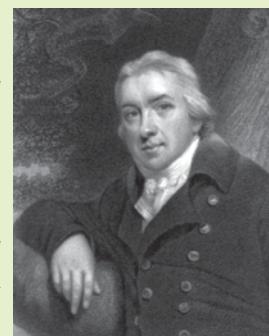
Antibiotics: These are substances produced by some microbes that help in increasing the immunity of human beings and which are toxic to other micro-organisms.

Organic Acids: Acetic acid is used for the production of vinegar.

Vitamins: These are chemical compounds present in variable minute quantities in natural foodstuffs. They do not furnish energy but are very essential for energy transformation and regulation of metabolism.

Edward Jenner (1749-1823)

In 1791, Edward Jenner coined the term vaccine and the term vaccination for protective inoculation. Vaccines produced by Biotechnology differ from others, in that they do not contain weakened or killed agents. Instead they are so refined as to consist only of the reactive material ie., the antigen protein only. The first such vaccine was used against Hepatitis B Virus (HBV)



Vaccines: Vaccines are substances that confer immunity against specific diseases. They act as antigens and stimulate the body to manufacture antibodies.

Steroids: They are derivatives of lipids eg: Cholesterol containing steroid drugs like prednisolone, produced from the fungus Rhizopus.

Monoclonal antibodies : These are the antibodies produced from cloned cells by hybridoma technology. Monoclonal antibodies are now used in treatment of cancer.

Cloning: Cloning is an experimental technique, wherein a group of morphologically and genetically identical organisms are produced.

A clone may be defined as an exact carbon copy or copies of a single genetical parent. The word 'clone' refers only to living species. If the cloning technique is applied



Fig. 1.8 Dr. Ian Wilmut with Dolly

to veterinary science, valuable animals could be cloned from desirable adult cells.

1.5.1 Types of clones

Natural clones: The natural clones are formed through a natural process. (DNA replication)

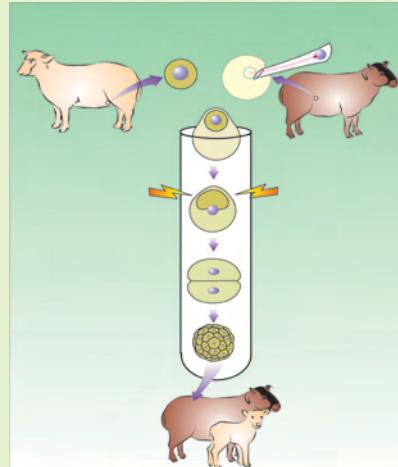
Induced clones: The induced (artificial) clones are developed by nuclear transfer into the host cell. e.g. cloning of Dolly sheep.

1.6. STEM CELL - ORGAN CULTURE

One of the most fascinating branches in applied embryology is stem cell culture. The stem cells are the most unspecialized mass of cells. They have two important characteristic features:

1. They have the potentiality of growing and multiplying into an enormous number of the same type of cells by repeated mitosis.
2. They can be induced to become any other type of tissue with specific functions i.e. they can be induced to become a cardiac muscle, beta cells of pancreas (which produces insulin), special neurons in brain etc.

Development of Dolly



Cloning

Dolly was a cloned sheep, developed by Dr.Ian Wilmut and his colleagues in Roselind Institute in Scotland in July 1996.

The scientists used the nucleus of udder cell (somatic cell taken from mammary gland) from a six year old Finn Dorset white sheep.

The nucleus of the udder cell contains, diploid number($2n$) of chromosomes with all the genes. They preserved the diploid nucleus in a suitable preservative. Then they took an ovum from the ovary of another sheep. The haploid nucleus (n) in the ovum was removed.

The diploid nucleus of the udder cell was injected into the cytoplasm of the enucleated ovum. Then the ovum with the diploid nucleus, was implanted into the uterus of the surrogate mother sheep. Since the ovum had the diploid nucleus, it developed into a young clone. It was named "Dolly" by Dr.Ian Wilmut.

1.6.1. Types of Stem Cells

There are two kinds of stem cells

1. Embryonic Stem Cells: The embryonic stem cells can be extracted from early embryo which is developed by “invitro fertilization” (fertilization done artificially in the laboratory).

After fertilization, the zygote develops into a hollow blastula by cell division. The inner mass of undifferentiated cells are isolated and they are considered as embryonic stem cells.

2. Adult or Somatic Stem Cells: The body of higher animals and human beings has many well differentiated tissues like epithelial, connective, muscular, vascular, supporting, nervous and reproductive tissues. In these tissues, there are some undifferentiated cells and are considered as the adult or somatic stem cells. They can grow, multiply and can be differentiated into same type of tissues into which they are implanted. The mechanism of adult or somatic stem cell culture is similar to that of embryonic stem cell culture. The somatic stem cells are derived from sources such as bone marrow, embryos, amniotic fluid and umbilical cord.

1.7. MICROBIAL PRODUCTION

As we discussed earlier, the field of biotechnology is very vast and has a great scope in different fields like agriculture, medicine, food industry etc.

The microbial products of everyday uses are:

Vaccine: Killed or live germs suspension which is employed to induce the production of antibodies and develops immunity.

Antibiotics: Antibiotics are chemical substances derived from microbes like fungi, bacteria etc. employed to kill infectious germs (pathogens) and cure a disease.

Vitamin B₁₂: Biotechnologically synthesized vitamin B₁₂ is used to cure pernicious anaemia.

Enzymes: Biochemically significant enzymes are derived from microbes eg: Amylase is derived from amyloproteins of bacteria.

Insulin: Diabetes is treated by the biotechnologically produced insulin.

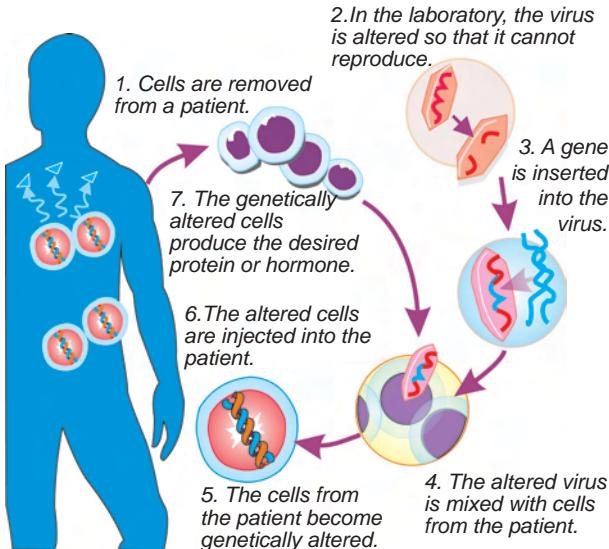
1.8. BIOSENSOR AND BIOCHIPS

Biosensor: It is a device consisting of an immobilized layer of biological material such as enzyme, antibody, hormone, nucleic acids, organelles or whole cells and its contact with a sensor. The sensor converts biological signals into an electrical signal. It is used in medical field and industries.

1. Blood glucose level can be detected.
2. Production of any toxin in the body due to infection can be detected.
3. Pollution in drinking water can be monitored.
4. Odour, freshness and taste of food can be measured.

Biochips

Biochips are microchips which are developed by employing techniques of Biotechnology. In future, biological computers will be developed using biochips. Biochips will be useful in defence, medicine etc.

**Fig. 1.9 Gene Therapy**

1.9. SCIENCE TODAY - GENE THERAPY

Insulin dependent diabetes is treated with insulin injection. Insulin dependent diabetes is caused by the degeneration of beta cells of pancreas due to a defective gene. Applying the principle of

Biotechnology, it is possible to correct the defective gene. When the defective gene is corrected with a new gene, the genetic defect developed is rectified and cured.

Gene therapy is the means to treat or even cure genetic and acquired diseases like cancer and AIDS by using a normal gene to supplement or replace the defective gene.

It can be used to treat defects in Somatic i.e. (body) or gametic (sperm or egg) cell.

Types of Gene Therapy

- Somatic gene therapy:-** The defective gene in somatic cells is replaced with a corrective gene. This change is not passed to the next generation.
- Germ line gene therapy:-** Egg and sperm of the parents are changed for the purpose of passing the changes to the next generation.

MODEL EVALUATION

PART - A

- Mendel observed 7 pairs of contrasting characters in **Pisum sativum**. Which one of the following is not a part of that?
 - i) Tall and dwarf
 - ii) Yellow and green seed colour
 - iii) Terminal and axial flower
 - iv) Smooth and rough stem
- Primitive man evolved in _____
 - i) Africa
 - ii) America
 - iii) Australia
 - iv) India
- Which of the following is inheritable?
 - i) an altered gene in sperm
 - ii) an altered gene in liver cells
 - iii) an altered gene in skin cells
 - iv) an altered gene in udder cells

4. The theory of Natural Selection was proposed by _____.
- i) Charles Darwin ii) Hugo de Vries
iii) Gregor Johann Mendel iv) Jean Baptise Lamarck
5. Somatic gene therapy causes _____.
- i) changes in sperm ii) changes in progeny
iii) changes in body cell iv) changes in ovum
6. In a pea plant, the yellow colour of the seed dominates over the green colour. The genetic make up of the green colour of the seed can be shown as _____.
- i) GG ii) Gg iii) Yy iv) yy
7. Some people can roll their tongue and this is a genetically controlled auto-somal dominant character. [Roller = RR / Rr and Non-roller = rr]
A child who can roll the tongue has one brother who is a non-roller and two sisters who are rollers. If both the parents are rollers, the genotypes of their parents would be _____.
i) RR x RR ii) Rr x Rr iii) RR x rr iv) rr x rr
8. Hydra, a multi-cellular invertebrate of phylum cnidaria(coelenterata) can give rise to new offspring by various methods. Choose the method by which the offspring are produced with significant variations.
- i) budding ii) regeneration iii) sexual reproduction iv) asexual reproduction
9. The following are the events in the formation of the first cloned animal – the sheep Dolly.
- a) Removal of haploid nucleus from the ovum.
b) Implantation of ovum with diploid nucleus into the surrogate mother.
c) Collection of udder cell from the sheep.
d) Injection of diploid nucleus of udder cell into the enucleated ovum.
e) Development of a young clone.
The correct sequential order of these events is _____.
i) abcde ii) cabed iii) cadbe iv) edcba
10. The following are statements about stem cells:
- a) There are unspecialised / undifferentiated cells.
b) They can be transformed into any type of body cell.
c) They can multiply rapidly to form a large number of similar types of cells.
d) They cannot transform into cardiac cells or nerve cells.
e) They are obtained from reproductive progeny only.
The correct statements are _____:
i) a, b, c only ii) c, d, e only iii) a, c, e only iv) b, c, e only

11. In persons suffering from insulin-dependent diabetes, _____ the cells of pancreas are degenerated.
- i) Alpha ii) Beta iii) Gamma iv) Delta
12. Identical twins are born as a result of fertilization between _____.
- i) two eggs and two sperms ii) two eggs and one sperm
 iii) one egg and one sperm iv) one egg and two sperms
13. Identify the incorrect statement about identical twins.
- i) developed from a single zygote ii) always of the same sex
 iii) look alike in many aspects iv) differ in their blood groups
14. The correct statement about Neanderthal man is:
- i) the first human like hominid ii) started agriculture
 iii) ate meat and walked erectly iv) buried the dead
15. The inheritance of characteristics through generation is called "heredity". In Mendel's Pisum sativum plant, the genetic material responsible for heredity is _____.
- i) DNA ii) RNA iii) Protein iv) Cytoplasm

PART - B

- Mendel has observed Tallness as a dominant character in the garden pea plant. Similarly, tongue rolling is a dominant character in man. In a group of 60 students, 45 can roll their tongue and 15 are non-rollers.
 - In the above context, calculate the percentage of dominant and recessive characters.
- The inheritable characters vary in different species and within the same species. Name the variation in the following cases.
The eye colour among the human beings are varied as blue, black, brown, green, etc.
 - This is called as _____ variation.
The dentition in the rabbit and the elephant are not the same.
 - This is called as _____ variation.
- Sexually reproducing organisms produce offspring with marked, significant and visible variation. Asexually reproducing offspring show minor variations.
 - Do you agree with the above statements?
 - Among the following organisms point out the asexually reproducing organism.
(Cockroach, Euglena, Earthworm and Bird)
- Here are certain important hereditary jargons. Fill in the blanks by choosing a suitable one from the list given. (allele, variation, speciation, gene, allelomorphs)
 - _____ are the factors which form the physical basis of inheritance.

- ii) _____ is the alternate forms of the same gene.
- iii) _____ are the expressions of contrasting pair of alleles.
5. A change that affects the body cell is not inherited. However, a change in the gamete is inherited. The effects of radiation at Hiroshima have been affecting generations. Analyze the above statements and give your interpretation.
6. Sequentially arrange the different species of man from primitive to modern man. (Neanderthal man, Homo habilis, Homo erectus, Homo sapiens)
7. Biotechnology, the modern science in biology, has helped in producing different types of products. One of the following groups does not have a product of biotechnology.
Pick out and give reasons.
- enzymes, organic acids, steroids, vaccines
 - vaccines, enzymes, antibiotics, inorganic acids
 - antibiotics, hormones, steroids, vaccines
 - steroids, enzymes, antibodies, vaccines.
8. What do you mean by phenotype and genotype of an individual? Explain.
9. What are variations? Mention their types.
10. Who proposed the theory of Natural Selection? Mention the two principles of this theory.
11. What are monoclonal antibodies? Mention its use.
12. What is a clone? In what way is the cloning technique useful in the field of veterinary science?
13. In dogs, the barking trait is dominant over the silent trait. Using Punnet Square, work out the possible puppies born to two barking parents with genotype (Rr).
14. In Dr. Ian Wilmut's cloning experiment, did the new born 'Dolly' resemble the udder cell donor Dorset white sheep or the surrogate mother sheep? Give reasons.
15. The excessive use of pesticides has only resulted in the occurrence of more resistant varieties of pests rather than their complete eradication. How can you link this with Darwin's theory of Natural Selection and Evolution?
16. The first clinical gene therapy was given in 1990 to a four year old girl suffering from Adenosine Deaminase Deficiency (ADA). Could you suggest a possible cure for such a disorder with the knowledge of gene therapy and its types?
17. Find the unmatched pairs:

<i>Nif genes</i>	<i>Nitrogen Fixation</i>
<i>tt</i>	<i>Alleles</i>
<i>Biochips</i>	<i>Biological computer manufacturing</i>
<i>Interferon</i>	<i>Antiproteins of Bacteria</i>
<i>stem cells</i>	<i>Unspecialised mass of cells</i>

18. For the experimental research Dr.Ian Wilmut used the nucleus of the udder cell from a six year old Finn Dorset white sheep and preserved the diploid nucleus ($2n$). He took an ovum from the ovary of another sheep. The haploid ovum was removed. The diploid nucleus of the udder cell was injected into the cytoplasm of the enucleated ovum. Then the diploid nucleus ovum was implanted into the uterus of the surrogate mother sheep. The diploid ovum developed into a young one, named "Dolly".

i) Why did Wilmut select the udder cell?

ii) Define the terms haploid and diploid.

19. Match the following by identifying the pair :

(medicines, fuel, microbes, metabolism, organic acids)

i) vaccine ii) natural gas iii) citric acid iv) monoclonal antibodies v) vitamins

20. Mention the dominant and recessive traits observed by Mendel in the garden pea plant with respect to the seed and flower.

PART - C

1. Human evolution has undergone a record of changes during the past 15 million years.

i) Name the different species of mankind in chronological order from primitive to modern man.

ii) When were the primitive caves developed?

iii) Narrate the life led by early man like hominids.

2. Describe in brief Mendel's monohybrid cross.

3. Find out who I am?

i) I am an acid used as a preservative and I have a sour taste.

ii) I am organic and present in citrus fruits and I give immunity.

iii) I am a cholesterol containing steroid obtained from bread mould. I am the steroid

iv) I am an enzyme and I cut DNA at specific sites.

v) I am the paste enzyme that joins segments of DNA.

4. State whether true or false. Correct the statements that are false.

i) Variations give the organisms an individuality of their own.

ii) Charles Darwin postulated the use and disuse theory.

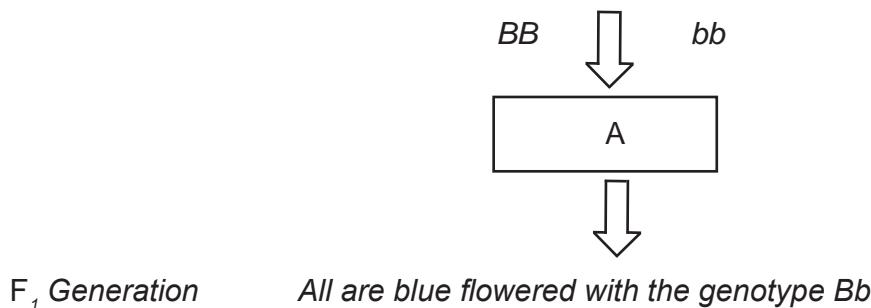
iii) To understand evolution, a branching diagram or a tree diagram is used to show the inferred evolution and the relationship among various biological species.

iv) Genetic engineering is the modification of the genetic information of living organisms by manipulation of DNA by adding, removing or repairing part of the DNA and changing the phenotype.

5. Observe the flow-chart of a monohybrid cross in a clitoria plant and write the answers for A, B, C, D:

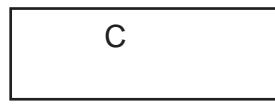
Character : Colour of the flower

Parents : Blue flowered x White flowered

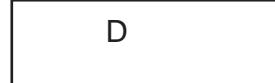


F₂ Generation

The phenotypic ratio is



The genotypic ratio is



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Chapter 2



IMMUNE SYSTEM

"Health is Wealth" is an apt proverb. There can be no wealth greater than the good health that a person enjoys. In a healthy state, a person keeps himself physically, mentally and socially, fit. Our body has a complex defense mechanism to keep itself fit and work against various agents which disturb our well being. Being exposed to diseases, we develop resistance towards diseases and gain immunity.

2.1. HEALTH AND ITS SIGNIFICANCE

"Health is a state of physical, mental and social well-being of an individual and not merely absence of a disease or infirmity".

When a person is in good health, the different organ systems, not only function

well in discharging their duties, but the body as a whole is also able to adjust itself and strike a balance with the physical, mental and social environments.

The varying environmental factors such as temperature, humidity, pollution caused by man, radiation, malnutrition, the millions of microbes in the environment and stress affect our lives and pose challenges to our health.

Dimensions of Health

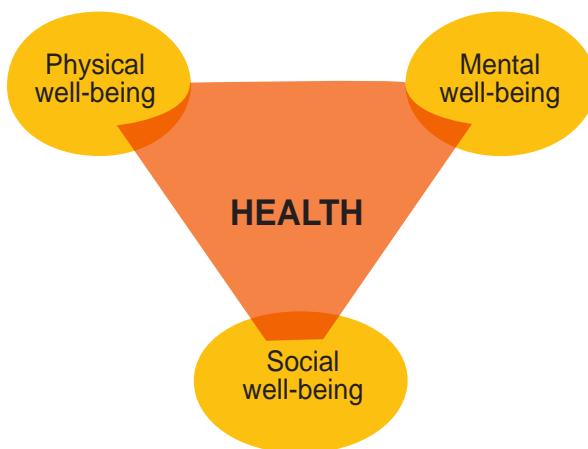


Fig. 2.1 Dimensions of health

1. Physical dimension : A person who is free from disease, looks bright with his skin shining; enjoys normal metabolism; has lustrous hair and has no dark circles around his eyes.

2. Mental dimension : Mentally healthy people know their capacities and do not overestimate or underestimate themselves. They can easily judge their shortcomings and weaknesses.

3. Social dimension : An individual who is able to adjust in society, does not find fault with other. Such a person maintains good interpersonal relationship with family members and colleagues at workspot. He is free from interpersonal conflicts and will never quarrel with others.

ACTIVITY 2.1

Following the above criteria, make a survey of your classmates/friends in your neighbourhood and record your findings.

- No. of students/friends who are healthy.
- No. of students/friends who do not have good inter personal relationship and do not enjoy social well-being.
- No. of students/friends who suffer from diseases that affect their metabolism.
- List out the positive qualities that you admire in your friend.

2.2. DISEASES AND CAUSES

The word ‘disease’ means “without ease or not at ease” and is the opposite of health. The condition of malfunctioning of the organ system or systems is called **disease**. There are numerous diseases that affect our health.

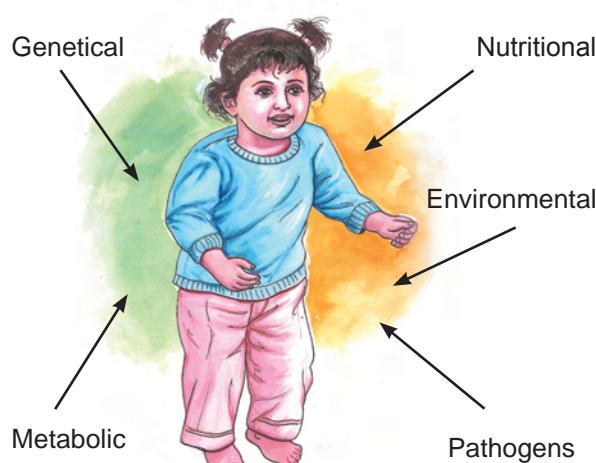


Fig. 2.2 Causes of diseases

Causes of the diseases

Diseases are caused due to various factors such as pathogens, environmental factors, nutritional factors, genetic factors, metabolic factors, etc.

Based on the causative agent, diseases are classified into two categories:

1. Diseases that are not caused by organisms.

2. Diseases that are caused by organisms.

2.2.1. Diseases not caused by organisms – Non-communicable diseases

1. Organic diseases or Metabolic disorders:

A healthy body maintains a constant blood sugar level, which is normally 80-120 mg/dl of blood under fasting conditions. When large quantities of glucose enter the blood stream, as it happens after a meal, the excess glucose is converted into insoluble glycogen and is stored in liver and muscles for future use. Later when required, glycogen is reconverted into glucose and reintroduced into the blood stream.

All these processes are controlled by the hormones, insulin and glucagon secreted by beta cells and alpha cells of Islets of Langerhans in the Pancreas. If insulin is not produced in sufficient quantity, excess of sugar cannot be stored in the liver and cannot be utilized. As a result, sugar gets accumulated in the blood and is subsequently expelled through the urine.

This leads to other complications and results in diabetes mellitus. Diabetes mellitus is a state of expulsion of excess unused glucose in the urine due to less production of insulin.

Similarly, Diabetes insipidus, coronary heart diseases, Renal failure, hypertension, obesity, Alzheimer's disease, stroke affecting the functions of the brain, etc., are all caused due to metabolic disorders.

2. Hereditary diseases or Genetic disorders: The genetic disorders are caused due to defective or mutated genes. Albinism is an inherited disorder of melanin metabolism, characterized by the absence of melanin in the skin, hair and eyes. The recessive mutant genes cause this disorder. The clinical symptoms of Albinism are milky white-coloured skin and marked photophobia (high sensitivity to light). Haemophilia, Sickle cell anaemia, Thalassemia, Down's syndrome, Colour blindness, Bubble boy syndrome, etc. are a few other genetic disorders.



Fig. 2.3 An albino

3. Nutritional Deficiency Diseases: A diet which contains all essential nutrients in correct proportion, is indispensable for maintaining good health. Deficiency in certain food constituents causes various kinds of diseases. Protein deficiency causes Marasmus and Kwashiorkar. In Marasmus, the child loses weight and suffers severe diarrhoea and it will appear as though bones are covered by skin. In Kwashiorkar, the child develops an enlarged belly with face and feet swelling.

2.2.2. Diseases caused by organisms

Robert Koch and Louis Pasteur were the first to establish the Germ Theory of Diseases. A germ or microbe gains entry into the host, such as man, multiplies so fast that it increases in large numbers, produces poisonous substances called toxins and interferes with the host metabolism and produces a characteristic set of symptoms by which, the disease can be diagnosed.



Fig. 2.4 Kwashiorkar



Fig. 2.5 Marasmus

SOME DISEASES CAUSED BY VITAMIN DEFICIENCY ARE TABULATED BELOW:

Vitamin	Deficiency disease	Symptoms
Vitamin A	Nyctalopia	Night blindness
Vitamin D	Rickets	Defective calcification of bones
Vitamin E	Sterility	Inability to reproduce
Vitamin K	Haemorrhage	Profuse loss of blood
Vitamin B ₁	Beri-Beri	Nervous disorder
Vitamin B ₅	Pellagra	Dementia, dermatitis, diarrhoea
Vitamin B ₁₂	Pernicious anaemia	Destruction of RBC
Vitamin C	Scurvy	Bleeding gums and loosening of teeth

Parasitic Microorganism: The causative organism of a large number of diseases in man, are microorganisms belonging to different groups. They are viruses, bacteria, fungi and protozoans.

1. Viruses and viral diseases in man:

Viruses are living substances inside the host cell and behave as dead particles outside the host cell. The Viral body consists of a nucleic acid, DNA or RNA and a protein cover. All the known viruses are parasitic and some of them cause deadly diseases such as polio, rabies, hepatitis, meningitis, encephalitis (brain fever), etc.

2. Bacteria and Bacterial Diseases:

Bacteria are unicellular prokaryotes and

visible under a compound microscope. Though many bacteria are harmless,



Fig. 2.6 Bacilli

some are parasitic and produce diseases. Bacteria can enter the host body through the mouth, nostrils, cuts and bruises on the skin. They multiply rapidly, producing toxins in high concentration to affect health. Some bacterial diseases in man are Tuberculosis, Leprosy, Cholera, Typhoid, Diphtheria, Pertusis, Tetanus, Plague, Pneumonia, Syphilis, Gonorrhoea, etc.

3. Fungi and Fungal Diseases: Fungi are non-green saprophytic or parasitic plants that subsist on dead and decaying organic matter or living organisms. Certain species of fungi are parasitic on man and cause Ringworm attacking the keratinized layer of skin, destroying it in circular patches. Dandruff and Athletes' foot are other fungal diseases that attack man.

Protozoan and Protozoan Diseases: Protozoans are unicellular animalcules. Some parasitic protozoans in man cause diseases such as malaria, amoebic dysentery, sleeping sickness, etc.

Parasitic macro-organisms: Infestations of the body with tapeworm, liver fluke, round worm, filarial worm, etc. cause diseases in man like Taeniasis, Ascariasis, Filariasis, etc.

2.3. DISEASES CAUSED BY MICROBES AND THEIR PREVENTION

A disease caused by a parasitic organism and transmitted from one person to another by the transfer of the parasite is known as an **infectious disease**.

We shall study the cause, spread and prevention of a few selected infectious diseases prevalent in our country so that we will know how to guard ourselves against them and other similar diseases.

2.3.1. Viral diseases

Common Cold

More than a hundred strains of viruses are responsible, for causing common cold in man. Children are more susceptible to common cold than adults.

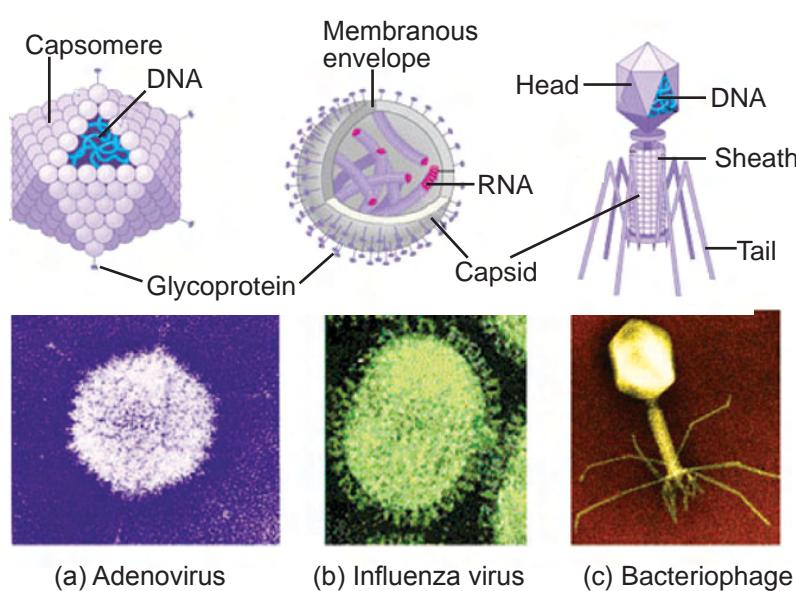


Fig. 2.7 Types of Viruses

Symptoms

1. Inflammation of upper respiratory passage – nasal epithelium.
2. Flow of mucous.
3. Headache, slight rise in temperature, etc.

It lowers body resistance, leading to a number of secondary infections like pneumonia, bronchitis, etc.

Transmission

- i) It spreads mostly through the nasal and oral discharge of the patient in the process of talking, laughing, sneezing, etc.
- ii) It may also spread through contaminated objects like handkerchief, bedding, clothes, utensils, toilet articles, etc. (called **fomites**)

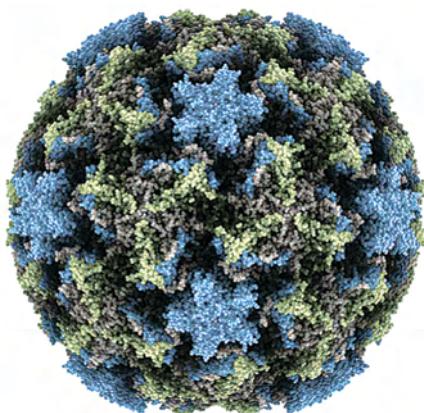


Fig. 2.8 Human rhino virus

Control and prevention: There are no effective measures to control common cold. However, eating nutritious food, avoiding contact with patients and wearing suitable clothing are suggested, to avoid common cold.

Influenza: It was once a dreadful disease and spread worldwide (pandemic) in 1970s.

Causative agent: A(H₁N₁) Virus, is spherical in shape and highly contagious, causing influenza.

Symptoms

Sudden onset of fever accompanied by aches and pains in the back and limbs.

Transmission

It spreads through the patient's nasal and oral secretions and enters into the respiratory tract of a healthy person. It also spreads through fomites.



Fig. 2.9 H1N1 Virus

Prevention

- i. Avoid contact with the patients and cover your mouth when sneeze or cough.
- ii. Wash hands to maintain good personal hygiene.

2.3.2. Bacterial diseases

Bacteria are prokaryotic organisms. Some of the bacteria are parasitic, causing diseases like Tuberculosis, Cholera, Typhoid, Dysentery etc. in man.

Tuberculosis

It is an airborne disease affecting the lungs and other parts of our body such as bones, joints, lymph glands, alimentary tract, liver, kidney, etc.

Causative agent: Mycobacterium tuberculosis, a rod-shaped bacterium causes tuberculosis (TB).

Symptoms

- The affected parts develop lesions in the form of small nodules called tubercles from which, the disease gets its name.
- Persistent cough.
- Loss of body weight.

Transmission

Tuberculosis is transmitted through air. A large number of bacteria are expelled through the sputum of the patients while eating, sneezing, talking, laughing and so on. The droplets containing viable germs may remain suspended in the air for a long time and the waxy cell wall of the tuberculosis bacillus prevents it from drying up and thus can remain viable outside the body for a long period. The germs suspended in the air may be inhaled by a healthy person.

Prevention

- Keeping oneself healthy and avoiding unsanitary conditions, overcrowding and poor-ventilation.
- Sunlight and fresh air are important agents that act as natural disinfectants, readily destroying the germs.



Fig. 2.10 Tuberculosis Bacteria

- Isolation of the patients and frequent sterilization of articles used by them are also important.
- Incineration (burning) of cloth/ clothes containing droplets/ the sputum of the patients can prevent infection.
- Immunization with BCG vaccine is an effective measure to prevent this disease.
- The patient should cover his/her mouth and nose while coughing and sneezing.

Typhoid

Causative agent: A short rod-shaped bacterium with numerous flagella – *Salmonella typhi* causes typhoid.

Symptoms

- Persistent fever.
- Inflammation and ulceration of the intestine.
- Enlargement of spleen and a characteristic red spot eruption on the abdomen.

ACTIVITY 2.2

Making a culture of live bacteria

Boil a few grams of chopped meat, carrot and potatoes in water for 15 minutes. Then filter the solid matter to obtain a fairly clear broth.

Leave the broth in open test tubes for a few hours. Plug the tubes with cotton wool and keep them in a warm place (approximately 25°C) until the broth turns stale, owing to the growth of bacteria.

What you have produced, is a bacterial culture.

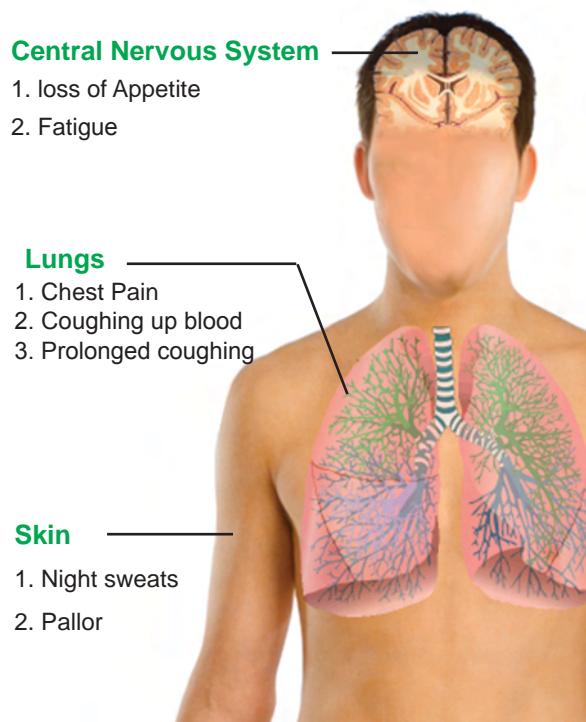


Fig. 2.11 Symptoms of tuberculosis

Transmission

Transmission of typhoid is through food and water contaminated with the germ, and through personal contact with patients and carriers. The housefly is also an important transmitting agent (vector) of this disease.

Prevention and control: Isolation of the patient, control of flies, hygienic food habits, proper sanitation are effective means of prevention of this disease. Artificial immunization with typhoid vaccine is advised.

2.3.3. Protozoan diseases

Some of the unicellular protozoans are parasitic pathogens and cause certain diseases in man.

Malaria

Causative agent: A tiny protozoan – Plasmodium is responsible for causing

malaria. Four different species of Plasmodium namely, *P.vivax*, *P.malariae*, *P.falciparum* and *P.ovale* exist in India and cause malaria. Of these, the malaria, caused by Plasmodium falciparum is malignant and fatal.

Transmission

Through the vector - the female **Anopheles** mosquito.

Symptoms

- Malaria is characterized by chills, shivering and rise in temperature. This is followed by perspiration and lowered body temperature. The patient would feel normal for some time but the fever would recur at regular intervals.
- Successive attacks of malaria result in the distension of spleen and destruction of liver tissues.

Prevention and control:

- Sanitary measures include ground fogging with disinfectants.
- Prevent water stagnation and cover ditches and drains.
- Use mosquito nets and repellants.

Amoebic dysentery (Amoebiasis)

Causative agent: *Entamoeba histolytica* – a protozoan parasite in the large intestine of man causes Amoebiasis.

Symptoms

- Fever.
- Constipation, abdominal pain and cramps.
- Stools with excess mucous and blood clot.

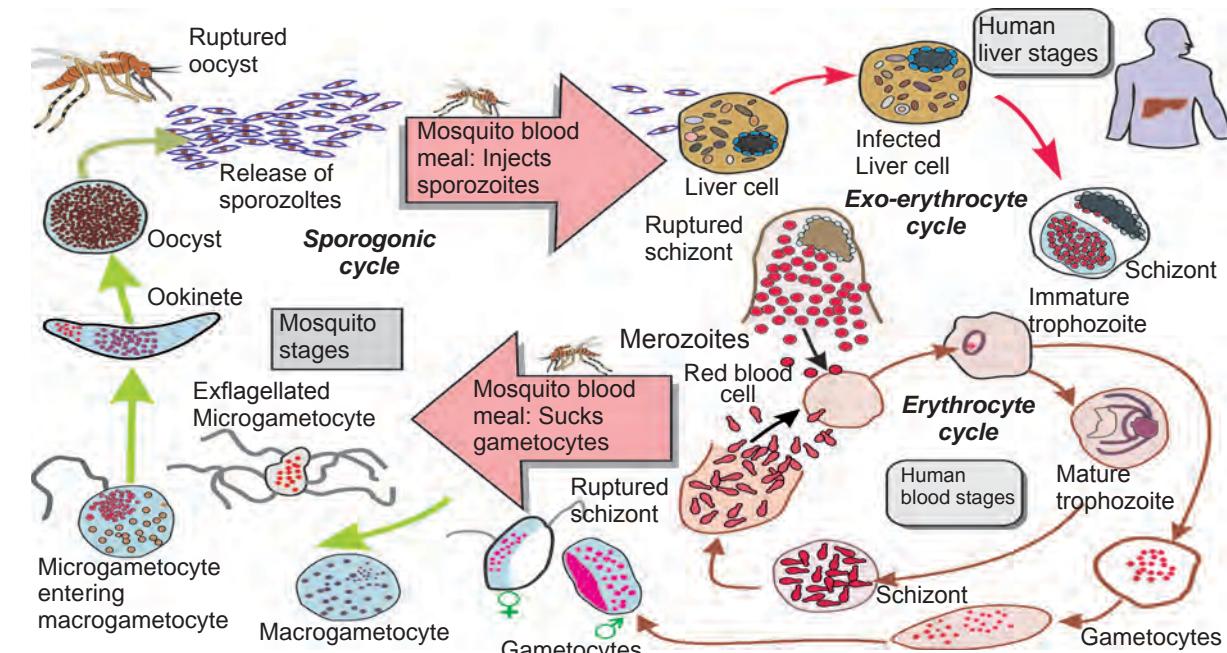


Fig. 2.12 Life cycle of malarial parasite

Life cycle of malarial parasite – Plasmodium: The sexual stage of Plasmodium takes place in female Anopheles mosquito whereas the asexual stage occurs in man. When a female Anopheles mosquito bites an infected person, these parasites enter the mosquito and undergo further development in the body of the mosquito. The parasites multiply within the body of the mosquito to form sporozoites that are stored in the salivary glands of the mosquito. When these mosquitoes bite a healthy person, the sporozoites (the infectious stage) are introduced into his body. They multiply within the liver cells first and enter the Red Blood Cells(RBC) of man, resulting in the rupture of RBC. This results in the release of toxic substance called haemoglobin which is responsible for the chill and high fever, recurring every three to four days.

Sir. Ronald Ross (1857-1932)

Sir. Ronald Ross, a British – Indian physician was born in Almora, India. He had his school education and higher studies in medicine in England. Later he was posted at the Presidency General Hospital, Calcutta. Ross did a research study about malaria between 1882 and 1899. When he was working in Bangalore, he observed the connection between water as the breeding ground of mosquitoes and the spread of malaria. He discovered the presence of malarial parasites in the female Anopheles mosquito, when he was working on malaria at Secunderabad. He demonstrated that malaria is transmitted from an infected individual to a healthy person by the bite of mosquito. In 1902, he was awarded the Nobel Prize for his work on malaria.



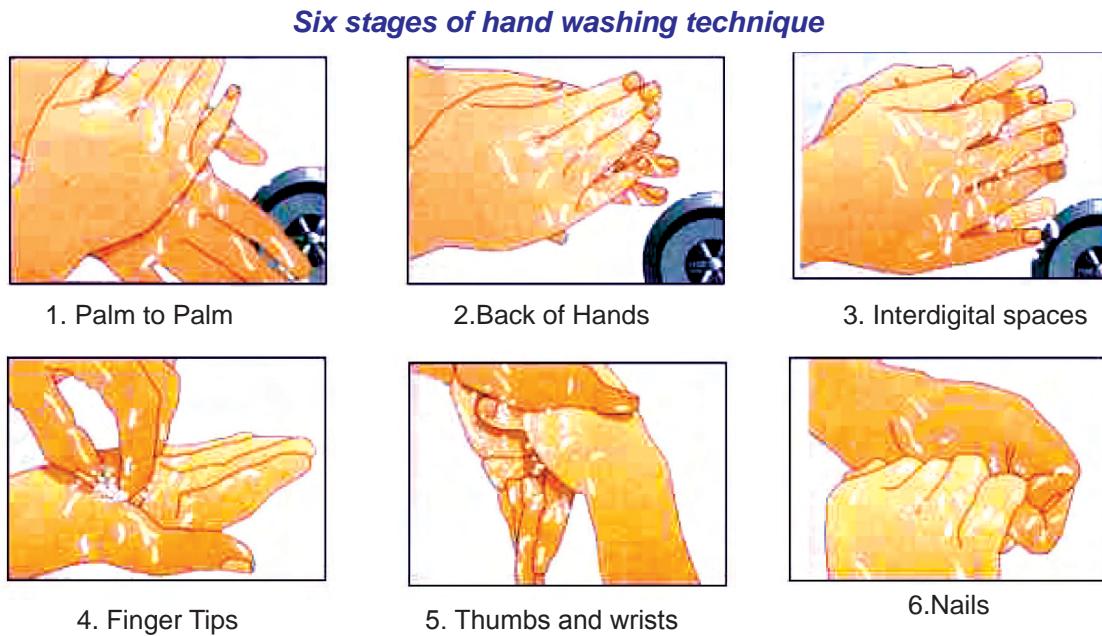


Fig. 2.13 Clean habits

Transmission

It is a water-borne and food-borne disease. Houseflies act as mechanical carriers and they transmit the parasite from the faeces of infected persons to the food and water, thereby contaminating them.

Prevention and control: Precautions include drinking filtered or boiled water, eating hygienic food and maintaining proper sanitation.

2.3.4. Fungal diseases in man

Some of the fungi are parasites and cause diseases in both human beings and animals.

Ringworm

Three different genera of fungi namely, *Epidermophyton*, *Microsporum* and *Trichophyton* cause ringworm.

Symptoms

Fungi can live on the dead cells of epidermis. They can cause superficial

infections in skin, hair, nail, etc. form patches and cause itching.

Transmission

It is transmitted by direct contact or through fomites such as towels, combs, etc.

Control and prevention: Avoid contact with infected persons and things used by them.



Fig. 2.14 Ringworm

2.4. MODES OF TRANSMISSION OF INFECTIOUS GERMS

The transfer of a disease-causing germ from an infected person to a healthy person through certain agents or direct contact

is called transmission of the disease. The transmission can take place in one of the following ways;

Direct Transmission : By direct transfer of germs from a patient to a healthy person through close contact. Diseases like diphtheria, pneumonia, cholera, typhoid, measles, mumps, etc., are transmitted this way.

During sneezing, coughing and talking, the oral and nasal discharge is sprayed in the form of small droplets and gets mixed in the air. When a healthy person inhales the air laden with germs, he gets infected.

Through the umbilical cord, the germs are transferred from the infected mother to the child during pregnancy.

Indirect transmission through fomites: Some germs may remain viable outside the body of the hosts and may be transferred indirectly through personal objects used by patients like clothing, bedding, handkerchiefs, towels, toilet articles, utensils and plates. Such contaminated objects are called **fomites**.



Fig. 2.15 Cover the mouth while coughing and sneezing

Transmission by animals: Ticks, mites, birds, insects and mammals transmit diseases like cholera, malaria, rabies, etc;

2.5. IMMUNIZATION

Immunity: Immunity is the body's defence against or the specific resistance exhibited towards infectious organisms.

Infectious organisms that invade the body, the toxins produced by them and the foreign proteins that enter the body are called **antigens**.

The immune system which includes blood plasma, lymph and lymphocytes analyze the chemical nature of the antigens and produce suitable proteinaceous substances called **antibodies** to detoxify the antigens or to kill the antigens in order to develop immunity.

Types of Immunity

Natural or Innate Immunity: The **natural or innate immunity** enables an individual to develop resistance to the disease, to which, the particular species is immune. e.g. Plant diseases do not affect animals.

Acquired or Specific Immunity: The resistance against some infectious diseases developed by an individual during lifetime, on exposure to the infections is called **acquired or specific immunity**.

The acquired or specific immunity is of two kinds – active acquired immunity and passive acquired immunity.

Active acquired immunity: This kind of immunity is developed by our body, during the first infection of any pathogen. The antibodies produced in the blood remain for a long period and kill the similar pathogens, whenever they enter the body.

If the antibody production is stimulated naturally after recovery from a disease, it is called Naturally Active Acquired Immunity.

If the antibody synthesis is stimulated by administration of vaccines or any other man-made methods, the immunity thus gained is called Artificially Active Acquired Immunity. For example the polio drops and the triple antigen injection given to the child in the immunisation programme.

Passive Acquired Immunity: In this type of immunity, a ready-made antibody is introduced from outside, instead of stimulating the body to produce antibody with antigenic stimulus.

If the readymade antibody is taken from the mother's blood into the foetus, it is called Naturally Passive Acquired Immunity. If the readymade antibody is given to an individual artificially, (produced in some other animal

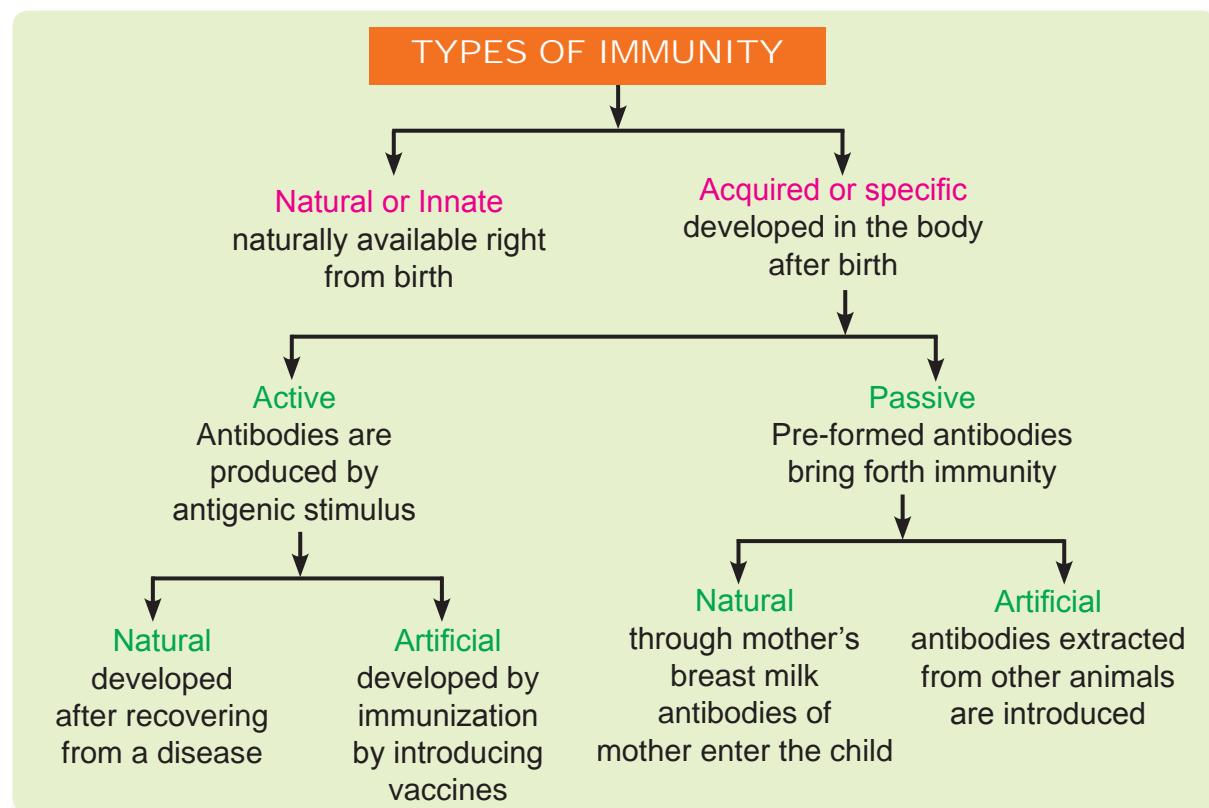


Fig. 2.16 Oral Polio Immunization

and extracted) it is called Artificial Passive Acquired Immunity. This immunity is not permanent.

Immunization: Administering vaccines to prevent the disease is called immunization. This process of Immunisation develops Artificially Active Acquired Immunity.

Immunisation through inoculation is a mass means of protecting a greater number of people against the spread of diseases.



MORE TO KNOW

What kind of Immunity does a child get when it is breast fed ? MOTHER'S MILK IS THE BEST FOOD. Antibodies or Immunoglobulins are found in breast milk. Through breast milk, antibodies are passed on to the baby. Bottle fed infants do not have the advantage of fighting the ingested pathogens on their own until the antibodies are produced in them. A mother should suckle the infant for at least six months.

Medical establishment knows that infants who are breastfed contract fewer infections than bottle fed infants. Breast milk protects the child against bacteria like Escherichia coli, Salmonella, Shigella, Streptococci, Staphylococci, Pneumococci and viruses like Polioviruses and Rotaviruses.

IMMUNIZATION SCHEDULE

The immunization schedule indicates the stages at which the vaccinations and inoculations have to be given to safeguard children against different diseases. The table given below lists the names of vaccines, the dosage and the stage at which they have to be administered.

BCG	Tuberculosis Vaccine
DPT	Diphtheria, Pertussis, Tetanus Vaccine (Triple antigen)
MMR	Mumps , Measles, Rubella
DT	Diphtheria, Tetanus (Dual antigen)
TT	Tetanus toxoid

Immunization schedule followed in India			
S.No	Age	Vaccine	Dosage
1	New born	BCG	1 st dose
2	15 days	Oral polio	1 st dose
3	6 th week	DPT & Polio	1 st dose
4	10 th week	DPT & Polio	2 nd dose
5	14 th week	DPT & Polio	3 rd dose
6	9-12 months	Measles	1 st dose
7	18-24 months	DPT & Polio	1 st booster
8	15 months - 2 years	MMR vaccine	1 st dose
9	2 – 3 years	Typhoid vaccine	2 doses at 1 month gap
10	4 – 6 years	DT & Polio	2 nd booster
11	10 th year	TT & Typhoid	1 st dose
12	16 th year	TT & Typhoid	2 nd booster

2.6. TREATMENT AND PREVENTION OF DISEASES

Treatment means the medical management of the symptoms of a disease.

Medical Management includes:

- i) Treatment involving medicine.
- ii) Treatment not involving medicine.

Treatment involving medicine: Medicines are generally used to treat infectious diseases. These medicines either reduce the effect of the disease or eliminate the cause of the disease. Antibiotics are used to block the disease without affecting the individual.

Treatment not involving medicine: For a person recovering from the effect of fracture or neurotic problem, yoga and physiotherapy can greatly help him to perform normal activities. People addicted to alcohol and drugs are given counselling to overcome the habit.



Fig. 2.17 Yoga practice

Prevention: Getting rid of disease causing germs is a means of prevention of the disease.

Prevention can be achieved in two ways:

- i. General – preventing the infectious germs by keeping away from

exposure to the germs. Hygienic life style, avoiding overcrowding, inhaling air, safe drinking water and good sanitary measures are the ways to prevent a disease causing germ, coming into contact with us.

- ii. Specific – This relates to a peculiar property of the immune system that usually fights the microbial infections. e.g. Immunisation programme.

2.7. BIO-TECHNOLOGY IN MEDICINE

A detailed account of the role of Biotechnology in health care, has been dealt with in Chapter 1.

Biotechnologically synthesized insulin has been effectively used replacing the defective insulin to treat diabetes mellitus in the field of medicine.

2.8. HIV AND PREVENTION

Acquired Immuno Deficiency Syndrome (AIDS) is a dreadful disease transmitted through sexual contact or through transfusion of blood and blood products. Robert Gallo at National Institute of Health, USA and Luc Montagnier at Pasteur Institute, Paris isolated the Human Immuno Deficiency Virus(HIV) which, causes AIDS.

HIV is a retro virus with glycoprotein envelope and the genetic material – RNA. HIV causes profound immuno suppression in humans. It is due to the depletion of one type of WBC, which, is involved in the formation of antibodies called CD4 plus T-helper cells (lymphocytes).

Symptoms: Significant weight loss, chronic diarrhoea, prolonged fever, opportunistic infections such as tuberculosis, candidiasis and recurrent herpes zoster (viral) infection.

Test for Virus:

- i. Enzyme Linked Immuno Sorbent Assay (ELISA)
- ii. Western Blot – a confirmatory test.

Prevention:

- i. Protected sexual behaviour.
- ii. Safe sex practices.
- iii. Screening of blood for HIV before blood transfusion.
- iv. Usage of disposable syringes in the hospitals.
- v. Avoid sharing the razors / blades in the salon.
- vi. Avoid tattooing using a common needle.

MODEL EVALUATION**PART - A**

1. Pick out a case of healthy state of an individual.
 - i) Mr. X is recovering from an infectious disease.
 - ii) Mr. Y takes insulin injection everyday .
 - iii) Mrs. Z is very depressed.
 - iv) Mr. K does his duty and spends time joyfully.
2. Which one of the following is not socially balanced ?
 - i) He enjoys a birthday party.
 - ii) He behaves rudely over trivial matters.
 - iii) He adjusts well to the surrounding situation.
 - iv) He attends to his ailing mother at the hospital.
3. _____ is a bacterial disease.
 - i) Meningitis
 - ii) Rabies
 - iii) Tetanus
 - iv) Small pox
4. One of the following is transmitted through air. Find it out.
 - i) Tuberculosis
 - ii) Meningitis
 - iii) Typhoid
 - iv) Cholera
5. The most serious form of malaria is caused by Plasmodium _____.
 - i) ovale
 - ii) malariae
 - iii) falciparum
 - iv) vivax
6. An example of protozoan infecting our intestine is _____.
 - i) Plasmodium vivax
 - ii) Entamoeba histolytica
 - iii) Trypanosoma gambiense
 - iv) Taenia solium
7. One of the means of indirect transmission of a disease is _____.
 - i) sneezing
 - ii) coughing
 - iii) through placenta
 - iv) using utensils of patients

8. When antibodies, extracted from other animals are injected into your body, what kind of immunity do you gain?
- i) Artificially active acquired immunity ii) Artificially passive acquired immunity
iii) Naturally active acquired immunity iv) Naturally passive acquired immunity
9. The first vaccine injected into a just born baby is _____.
- i) Oral polio ii) DPT iii) DPT and Oral polio iv) BCG
10. In order to lead a healthy life, a person should enjoy physical, mental and social well-being. If a person lacks any one of them, then that person is suffering from _____.
11. A child eats food rich in carbohydrates and avoids protein in its diet. Which type of nutritional deficiency will affect that child?
- i) Kwashiorkar ii) Nyctalopia iii) Diabetes iv) Down syndrome
12. Assertion (A) Expulsion of excess unused glucose in the blood through urine is observed in a diabetic mellitus person.
Reason (R) : insulin is not produced in sufficient quantity by pancreas.
- i) Both 'A' and 'R' are true and 'R' explains 'A'.
ii) Both 'A' and 'R' are true but 'R' doesn't explain 'A'.
iii) Only 'A' is true but 'R' is false.
iv) A is false but 'R' is true.

PART - B

- Marasmus and Kwashiorkar are both protein deficiency defects. Marasmus differs from Kwashiorkar in enlarged belly and swelling in the face. Are these symptoms for the above diseases correct? If not, correct it.
- A list of disorders are given below. Pick out the odd one out and give reasons. (Thalassemia, haemophilia, night blindness, albinism, sickle cell anaemia)
- What are the symptoms of common cold?
i) _____ ii) _____
- Differentiate between the diseases-night blindness and colour blindness.
- After observing dark patches with itching sensation on the skin of a student in a school hostel, the warden advises his room mates not to share towels, clothes and combs among themselves. Name the disease the student is suffering from and name the causative organisms.
- Name the vector host of the malarial parasite. Mention the species of malarial parasite which causes malignant and fatal malaria.
- Name the tests done for the diagnosis and confirmation of AIDS.

8. What is triple antigen? Name the three diseases which, can be prevented by using it.
9. Mention the type of immunity acquired by a baby through breast-feeding.
10. Study the following statements and state whether they are true or false.
- Colour blindness is a genetic disorder, whereas night blindness is a nutritional disorder.
 - Pernicious anaemia is a nutritional deficiency disease, whereas sickle cell anaemia is a genetic disease / disorder.
 - Administering TT injection to an injured child is related to passive artificial immunity, whereas giving BCG vaccine is active artificial immunity.
 - Malaria is a bacterial disease, whereas ring worm is a viral disease.

11. Ramya is suffering from bleeding gums and loosening teeth. On diagnosis, it was found to have been caused by vitamin deficiency.

Tell Ramya the vitamin that is lacking in her food _____, the name of deficiency disease she is suffering from _____.

12. Match B and C with A:

A	B	C
Vitamins	Deficiency diseases	Symptoms
Vitamin A	Nyctalopia	Night Blindness
Vitamin B ₁	Scurvy	Nervous disorder
Vitamin C	Rickets	Bleeding gums
Vitamin D	Haemorrhage	Defective calcification of bones
Vitamin K	Beri-beri	Profuse loss of blood

13. A health worker advises the people in a locality not to have tattooing done using common needles and to insist the barber to change the shaving razors/ blades in the salon. Name the dreadful disease, the spreading of which, can be prevented by following these measures. Also mention other preventive measures that can be taken with regard to this disease.

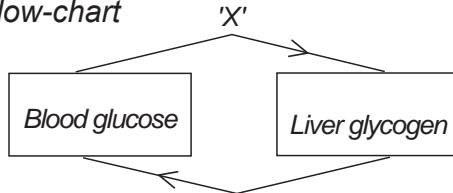
14. Match the following:

List I (Disease)	List II (Symptoms)
A. Amoebiasis	I) Chills and high fever recurring for 3 to 4 days
B. Tuberculosis	II) Patches on skin and nails with itching sensation
C. Ringworm	III) Abdominal pain with blood and mucus in stools
D. Malaria	IV) Persistent cough and loss of body weight

15. List out the diseases based on their mode of transmission (water borne, air borne, sexual contact)
- i) cholera ii) typhoid iii) tuberculosis iv) leprosy v) syphilis
vi) gonorrhoea vii) pneumonia viii) common cold ix) amoebic dysentery x) AIDS
16. i) Give any three examples for the most infectious diseases in man and their causative agents.
- ii) To discover medicine for viral infected diseases like AIDS is more difficult than other diseases. Is the statement true or false? Discuss.
17. A student had an attack of measles and recovered from the infection. His science teacher said that he will not get that disease again in his life time. Is it true? Why?
18. Name the causative organisms responsible for ring worm in humans? Mention the symptoms of the infection.
19. Pick out the odd ones:
- i) AIDS : Retro virus, lymphocytes, BCG, ELISA
ii) Bacterial disease : Rabies, cholera, common cold, influenza
iii) DPT vaccine : Diphtheria, tuberculosis, pertussis, tetanus
iv) Infective stage of Plasmodium in humans : Sporozoites, merozoites, trophozoites, gametocytes.
v) Mental dimension : brightness of skin, normal metabolism, no black rings around eyes, knows his capacity.
20. In the manufacturing of anti-venom injection against snake bite, antibodies produced in the horse are being used. Mention the type of immunity involved.
21. Say whether each of the following diseases is a metabolic disorder, a genetic disorder or a nutritional deficiency disease.
- i) thalassemia ii) beriberi iii) diabetes mellitus iv) bubble boy syndrome
v) scurvy vi) marasmus vii) obesity viii) Alzheimer's disease
ix) nyctalopia x) haemophilia
22. Find the correct statement (True / False) :
- i) Tuberculosis is caused by Mycobacterium tuberculosis bacteria.
ii) Typhoid is caused by Trichophyton fungi.
iii) Malaria is caused by Plasmodium vivax.
iv) Influenza is caused by Entamoeba histolytica protozoan.
23. Malarial fever is not caused in a person immediately after introducing the sporozoites by an infected anopheles mosquito. Why?
24. Name the stages of Plasmodium.
- i) introduced by an infected Anopheles mosquito.
ii) picked up by Anopheles mosquito from an infected human being.

25. Name two diseases that are transmitted by houseflies. Mention their causative pathogens.

26. Observe the following flow-chart



Mention the metabolic disorder 'X' and the causative factor from the options given below:

Disorder	Factors
a) Diabetes insipidus	Deficiency of ADH hormone
b) Diabetes mellitus	Deficiency of insulin hormone
c) Coronary heart disease	Blockage of arteries supplying blood to heart muscles
d) Renal failure	Failure of nephrons to filter the blood

PART - C

1. Kala has delivered a baby,

- i) Suggest the immunization schedule for the baby, in the first six months.
- ii) What are the diseases that can be cured as per the schedule?

2. There is a widespread outbreak of malaria in your area.

- i) Suggest some controlling measures to the local authorities concerned.
- ii) Pick out the right symptom for malaria.
(chills, shivering and a rise in temperature, diarrhoea)

3. 15th October is observed as ' World Handwashing Day' .

- i) Tell your friend the effects of hand washing.
- ii) How frequently do you wash your hands everyday and when?

4. What is immunity? Write a note on the various types of immunity.

5. Describe the life-cycle of plasmodium in man.

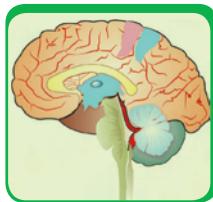
6. List out the various diseases caused due to nutritional deficiency. Add a note on their symptoms.

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STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

NERVOUS SYSTEM

When two or more people work together, each one performs the work according to his own interest and aptitude. But when the question of maintenance of order and structure enters the fray, there is a need for someone to control, coordinate and establish harmony among the workers. Our body has to work in a similar coordinated fashion. Steady state in body functioning called Homeostasis. Coordination is the process through which two or more organs interact and compliment the functions of one another. In our body, the nervous system and the endocrine system perform the task of coordinating and integrating all the activities of the organs so that the body works efficiently by synchronizing the functions.

The nervous system provides an organized network of point-to-point connections for quicker coordination. The endocrine system provides chemical integration through hormones. In this chapter, we shall learn the structure and functions of the nervous system and the endocrine system in man.

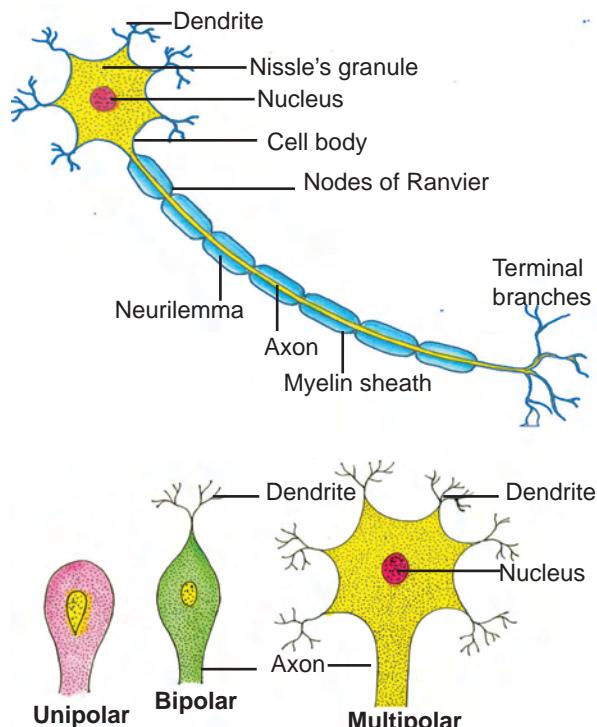


Fig. 3.1 Structure of a Neuron and its types

3.1. NERVOUS SYSTEM

The nervous system of the human is composed of:

- Specialized cells called neurons or nerve cells which can detect, receive and transmit different kinds of stimuli.

STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

- ii) Neuroglial cells are the supporting cells of neurons.
- iii) The nerve fibres are certain bundles of extended projections of nerve cells.

3.1.1. Nerve cells

Nerve cells or neurons are the structural and functional units of the nervous system.

The Human Brain is made up of about 86 billion neurons and many more neuroglial cells (more than 86 billion). A nerve cell is a microscopic structure consisting of three major parts namely, cell body, dendrites and axon.

Cell body

The cell structure is irregular in shape or polyhedral. It is also called cyton. Cell body contains cytoplasm with typical cell organelles and certain granular bodies called Nissle's granules. Nissle's granules are a group of ribosomes for protein synthesis.

Dendrites

Dendrites or Dendrons are short fibres which branch repeatedly and protrude out of the cell body. Dendrites transmit electrical impulses towards the cyton.

Axon

One of the fibres arising from the cell body is very long with a branched distal end and it is called Axon.

The distal branch of the axon terminates in bulb-like structures called synaptic knob filled with chemicals called neurotransmitters. The cytoplasm of the axon is

known as axoplasm. The axon which is covered by a myelin sheath is formed of many layers of Schwann cells. The outermost layer of Schwann cells is called Neurilemma. The gaps left by the myelin sheath are called Nodes of Ranvier. Neurilemma is discontinuous at Nodes of Ranvier. The myelin sheath ensures rapid transmission of electric impulses.

Types of nerve cell

- a) **Myelinated or Medullated or White neurons:** When the axon is enclosed by the white fatty myelin cover, it is called Myelinated or Medullated or White neurons. This forms the white matter of our brain.
- b) **Non-Myelinated or Non-Medullated or Grey neurons:** This neuron is not enclosed by the myelin sheath; so it appears greyish in colour. The axon is covered only by neurilemma and Schwann cells. This type of neuron is found in the grey matter of cerebrum.
- c) **Unipolar neurons:** The developing embryonic nervous tissue contains unipolar neurons. A unipolar neuron has a nerve cell body with a single process or fibre, which acts both as axon and dendron.
- d) **Bipolar neurons:** The sensory hair cells of the sense organs like rods and cones of retina are made up of bipolar neurons. Each bipolar neuron has a cell body and two processes at the ends, one acting as axon and the other acting as dendron.
- e) **Multipolar neuron:** The cerebral cortex contains multipolar neurons. Each multipolar neuron has a cell body with many dendrites and an axon.

Synapse: The dendrites and the synaptic knobs of the axons of neighbouring neurons are in physical contact with one another without fusing. This point is called synapse.

3.1.2. Nerve impulse

The conduction of stimuli by the nerve cells is called nerve impulse. The dendrites will receive the stimuli from the receptor (sense organ) and conduct the same as electrical impulse to the axon through the cyton. At the synapse, the synaptic knobs release chemical substances called neuro transmitters which convert the electrical impulse into chemical impulse and pass it to the neighbouring neuron.

3.1.3. Human Nervous System

The human nervous system is divided into:

- a) The Central Nervous System (CNS)
- b) The Peripheral Nervous System (PNS)
- c) The Autonomic Nervous System (ANS)

The CNS includes the brain and the spinal cord and it is the centre of information processing and control.

The PNS consists of the nerves of the body associated with the central nervous system.

Central Nervous System

It comprises two organs namely the brain and the spinal cord. The CNS is accommodated in the protective bony structures namely skull and vertebral column.

MENINGES: The central nervous system is covered by three protective coverings or envelopes collectively called meninges.

The outermost cover lying below the skull and vertebral column is doubly thick and is called **Duramater**. The middle covering is thin and vascularised and is called **Arachnoid membrane**. The innermost cover is a very thin delicate membrane and is closely applied on the outer surface of brain and spinal cord and it is called **Piamater**.

The Brain

The brain is the central information processing organ and acts as the command and control system.

The human brain as in the case of other vertebrates, is divided into three major parts:

- a) Forebrain
- b) Midbrain
- c) Hindbrain

Forebrain

The forebrain consists of cerebrum, thalamus and hypothalamus.

Cerebrum

This forms the major portion of the human brain. Nearly two-thirds of the brain is cerebrum. A deep cleft called **median cleft** divides the cerebrum longitudinally into two halves as right and left cerebral hemispheres, which are united at the base by a sheet of nervous tissue called **corpus callosum**. The outer region of the cerebrum is distinguished as the grey matter or cerebral cortex and the inner region is called the white matter.

Cerebral cortex

It consists of the nerve cell bodies of several layers of greyish nerve cells giving

STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

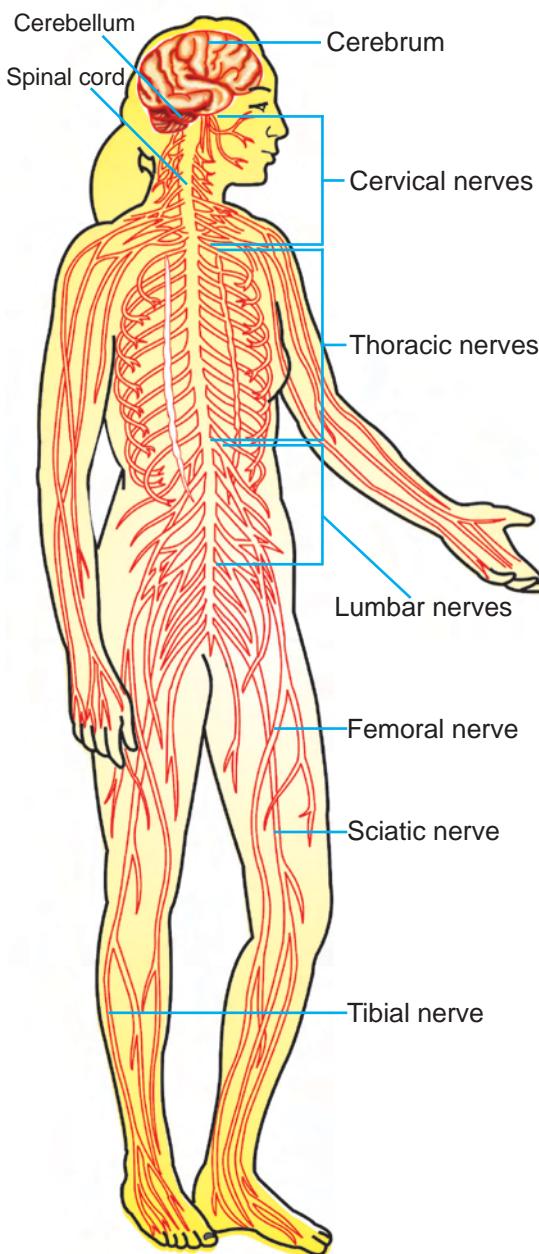


Fig. 3.2 Human Nervous System

it a grey colour and so called as the grey matter. The increased surface area of the cerebral cortex in man is folded and thrown into a pattern of convolutions consisting of ridges (gyri) and furrows (sulci).

Cerebral cortex contains

- motor areas
- sensory areas
- association areas (a region that is neither sensory nor motor).

Motor areas

Motor areas are the sites of order or command of the cerebrum, from where the order to control the activities of the various organs of our body originates. Initiation of voluntary activities takes place here.

Sensory areas

These are the sites where the sensory functions of the various sense organs are received through the sensory nerves.

Association areas

These are responsible for complex functions like intersensory associations, memory and communication.

White matter of cerebrum: The inner part of the cerebrum lying below the cerebral cortex is called white matter and it consists of bundles of nerve fibres with myelin sheath giving it the white colour. Some of these bundles of nerve fibres connect the different parts of the cerebrum, while others connect the cerebrum with the rest of the brain and spinal cord.

Within the cerebral hemispheres are present cavities called ventricles, filled with a nutritive fluid called cerebro spinal fluid.

Functions of cerebrum: Cerebrum is the seat of consciousness, intelligence, memory, imagination and reasoning. It receives impulses from different parts of the body and initiates voluntary activities.

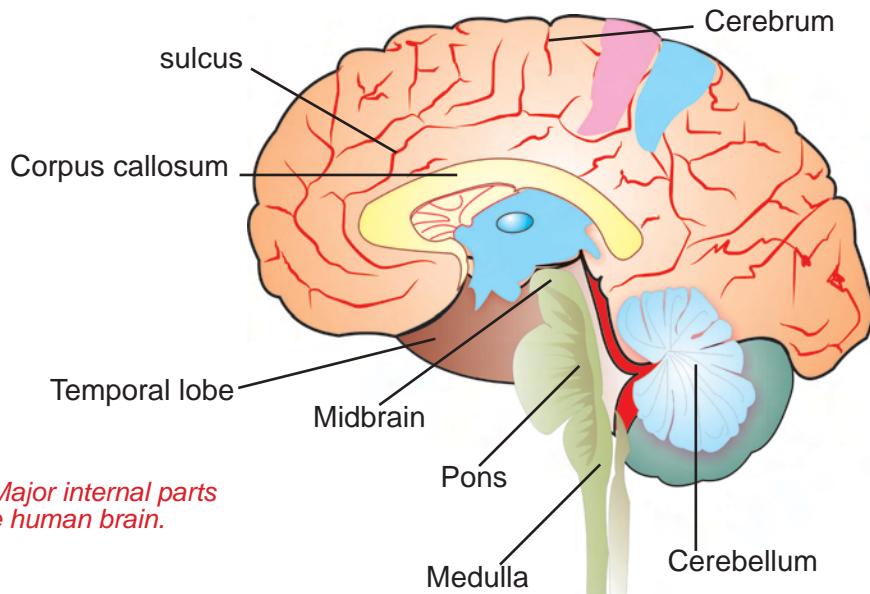


Fig. 3.3 Major internal parts of the human brain.

Specific areas of cerebrum are associated with specific functions. Thus there is a respective centre for hearing, seeing, tasting, smelling, speaking and so on. A damage in a specific centre of the cerebrum will deprive the particular part from carrying out its functions.

Thalamus

The cerebrum wraps around a structure called thalamus – a major conducting centre for sensory and motor signalling.

Hypothalamus

It lies at the base of the thalamus. It controls body temperature, urge to eat and drink, the regulation of sexual behaviour and expresses emotional reactions like excitement, anger, fear, pleasure and motivation.

Midbrain

The midbrain is located between the thalamus and the hindbrain. A canal called **cerebral aqueduct** passes through the midbrain. The dorsal portion of the midbrain consists of four hemispherical bodies called

corpora quadrigemina which controls and regulates various visual reflexes and optical orientation.

The midbrain together with the hind brain, forms the brain stem.

Hindbrain

The hindbrain comprises pons, cerebellum and medulla oblongata.

Cerebellum

It lies below the cerebrum and consists of a median portion and two lateral lobes.

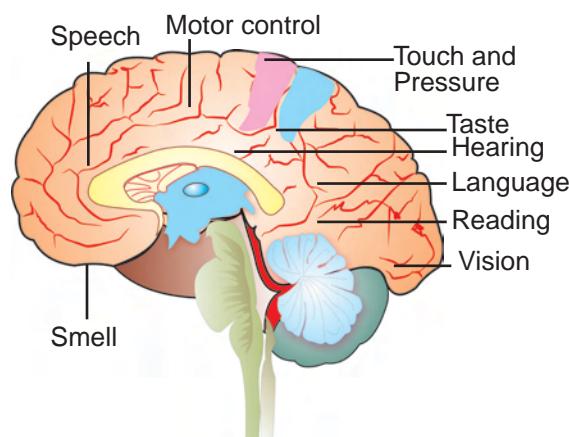


Fig. 3.4 Functional areas of human brain.

STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

Cerebellum regulates and coordinates the group movements of voluntary muscles as in walking or running.

Pons

It is the bridge of nerve fibres that connects the lobes of the cerebellum. It relays the information from the cerebrum to the cerebellum. It also contains the sleep and respiratory centres.

Medulla oblongata

Medulla is the posterior most part of the brain where it merges with the spinal cord. It acts as a coordination pathway for both ascending and descending nerve tracts. Medulla is the centre for several reflexes involved in the regulation of heart beat, blood vessel contraction, breathing, etc.

The ventricle of the medulla remains connected with the ventricles of the cerebral hemisphere.

The Spinal Cord

This is a tubular structure, a continuation of the brain lying in the neural canal of the vertebral column. The meninges – Piamater, Arachnoid membrane and the Duramater cover the spinal cord as in the case of the brain.

The spinal cord has two enlargements – one in the neck region of the body called **cervical plexus** and another in the lumbar region of the vertebral column called **lumbar plexus**.

The spinal nerves arise from these enlargements. Below the lumbar enlargement, the spinal cord tapers to form a cone like region called the **conus medullaris**. The tip of the spinal cord is filamentous and is called **Filum terminale**. Then the spinal cord forms the horse tail

like structure called **Cauda equina**. On the mid-dorsal side of the spinal cord is found a narrow depression called **dorsal fissure** and on the mid-ventral side of the spinal cord is found a deep depression called **ventral fissure**. Running through the center of the spinal cord is the **central canal**, an extension of the ventricle filled with **cerebro spinal fluid**. The outer region of the spinal cord contains medullated white neurons and the inner region contains non-medullated grey neurons. The spinal cord conducts impulses to and from the brain and acts as a reflex centre.

Peripheral Nervous System (PNS)

The nerves arising from the brain and the spinal cord constitute the PNS.

a) **Cranial nerves:** Twelve pairs of cranial nerves arise from the brain. Some of the cranial nerves are sensory nerves (taking impulse from the sense organs to the brain e.g. optic nerves from the eyes). Some of the cranial nerves are motor nerves taking impulse from the brain to the effector organ. e.g. oculomotor nerve innervating to inferior oblique muscles of the eye ball. Some cranial nerves are mixed nerves with both sensory and motor functions. e.g. facial nerves and vagus nerve.

b) **Spinal nerves:** Thirty one pairs of spinal nerves arise from the spinal cord. Each spinal nerve has a sensory root and a motor root. Thus, all spinal nerves are mixed nerves.

The Autonomic Nervous System (ANS)

It controls the functions of the vital organs of the body through its two antagonistic divisions namely, sympathetic nerves and parasympathetic nerves.

3.2. ENDOCRINE SYSTEM

The chemical coordination of physiological processes to maintain the homeostasis is the work of the endocrine system. The endocrine system controls and coordinates the physical processes of growth, reproduction and sustenance of life.

The endocrine system consists of a number of endocrine glands and their hormones.

The endocrine glands are ductless glands (without ducts), secreting chemical substances called hormones. The hormones are carried by the blood from the site of production to the site of action.

The endocrine glands in man are distributed in the different regions of the body without interconnections. The various endocrine glands which are found in different regions of human's body are as follows:

- | | | |
|---------|---|--|
| Head | - | a) pituitary gland
b) pineal gland |
| Neck | - | a) thyroid gland
b) parathyroid gland |
| Thorax | - | thymus gland |
| Abdomen | - | a) pancreas – Islets of Langerhans
b) adrenal glands – adrenal cortex and adrenal medulla
c) gonads – testes in man and ovaries in woman |

Hormones

Chemical hormones are proteins or steroids. Though the hormones are secreted in small quantities, their performance is profound in action.

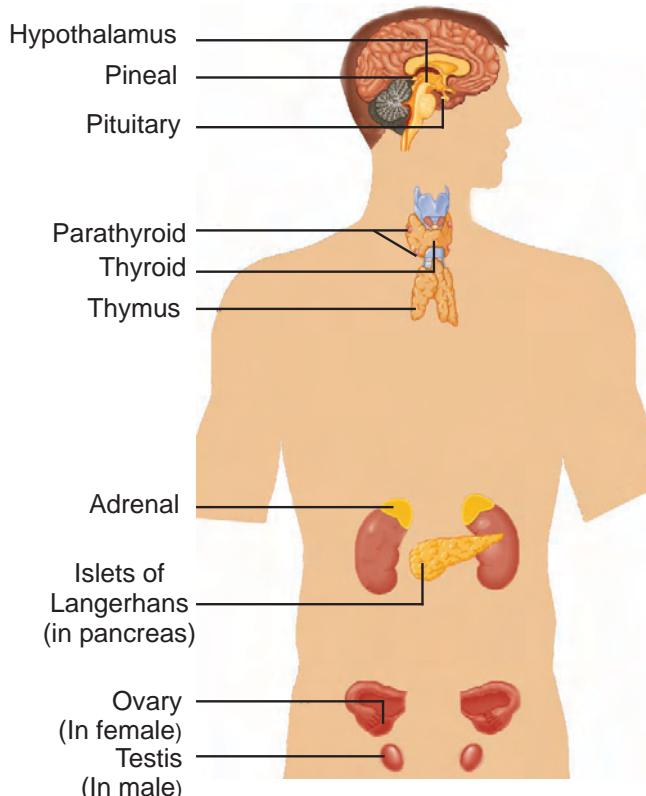


Fig. 3.5 Endocrine System in Human

Pituitary Gland

It is a tiny gland, the size of a pea, attached to the hypothalamus of the brain. The pituitary gland regulates the endocrine glands and so it is called as the conductor of the Endocrine Orchestra.

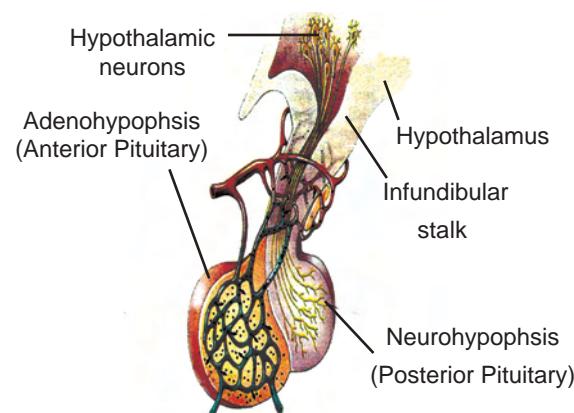


Fig. 3.6 Diagrammatic internal view of pituitary gland

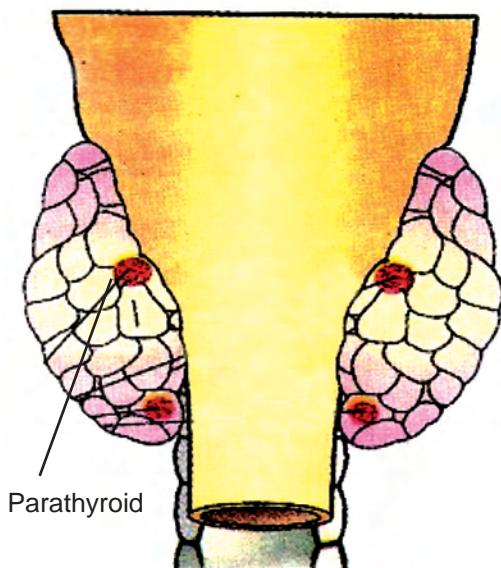
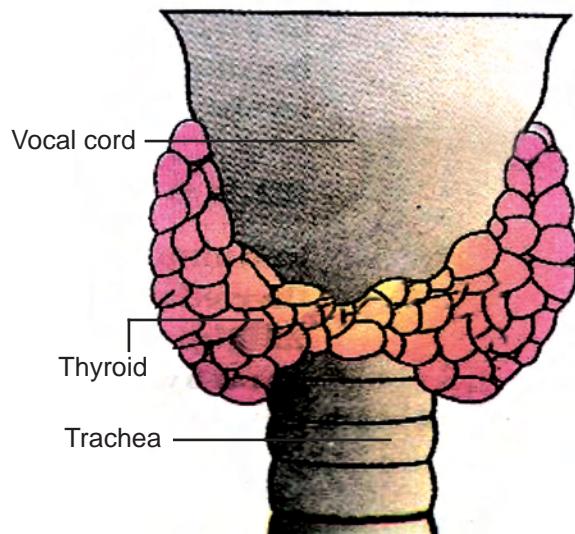
STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

Divisions of pituitary : Pituitary gland is divided into an anterior lobe called **adenohypophysis** and a posterior lobe called **neurohypophysis**.

Hormones of adenohypophysis	Functions
Somatotropic or Growth hormone (STH or GH)	<ul style="list-style-type: none"> It contributes growth in general. <p>malfunctions</p> <ul style="list-style-type: none"> Less production in children – dwarfism with retarded growth Excess production in children – gigantism with excess growth Excess production in adolescents – acromegaly with large limbs and lower jaw
Thyrotropic or Thyroid stimulating hormone (TSH)	It stimulates the growth of thyroid gland and its production – the thyroxine.
Adrenocorticotropic hormone (ACTH)	It stimulates the adrenal cortex to produce the hormones aldosterone and cortisone.
Follicle stimulating hormone (FSH)	It stimulates the maturation of graffian follicles (in the ovary) to produce eggs in females and sperm formation in males.
Lutenizing hormone (LH) in female or Interstitial cell stimulating hormone (ICSH) in male	<p>LH in a female causes discharge of eggs from graffian follicle – a process, called ovulation and production of female sex hormone-oestrogen and progesterone.</p> <p>ICSH in a male, induces the interstitial cells to produce male sex hormone – testosterone.</p>
Lactogenic hormone or prolactin	It stimulates the growth of mammary glands in females and milk production after childbirth.
Hormones of Neuro hypophysis	Functions
Oxytocin	It speeds up the childbirth process, by stimulating the contraction and relaxation of the uterus in the female.
Vasopressin or Antidiuretic hormone (ADH)	<p>It helps in the reabsorption of water, producing concentrated urine in small quantities. It constricts the blood vessels and raises the blood pressure.</p> <p>malfunctions: Less production of ADH results in diabetes insipidus, leading to excess production of dilute urine.</p>

Thyroid Gland

The bilobed thyroid gland is located in the neck, one lobe on the either side of larynx, which secretes a hormone called **thyroxine**. Thyroxine is an iodinated protein, composed of tyrosine (amino acid) and iodine.



*Fig. 3.7 Thyroid Gland a) Dorsal view
b) Ventral view*

Functions of thyroxine

- It increases the rate of metabolism.
- It stimulates a rise in body temperature.
- It promotes growth and differentiation of tissues.
- Since it indirectly affects the growth of the body, thyroxine is also called as **personality hormone**.
- It regulates iodine and sugar levels in blood.
- It controls functioning of kidneys and urine output.

Thyroid Disorders

- 1) Hypothyroidism – less secretion of thyroxine causes many abnormalities like **simple goitre**, **myxoedema** and **cretinism**.
 - a) Simple goitre – It is due to the deficiency of iodine in our diet. Thyroid gland bulges as a swelling in the neck and it is called as **goitre**.
 - b) Myxoedema – It is caused in adults. The symptoms are: low metabolic rate, loss of mental and physical



Fig. 3.8 a person with goitre

STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

- vigour, increase in weight, thickening of skin, lowered heart beat, mental dullness, etc.
- c) Cretinism – This is caused in children and the symptoms are: stunted growth, retarded mental development, defective teeth, protrusion of tongue and loose skin.
- 2) Hyperthyroidism – The excess production of thyroxine causes exophthalmic goitre or Grave's disease. The symptoms are: high metabolic rate, high blood pressure, high irritability, profuse sweating, loss of weight, fatigue and protrusion of eyeballs.

The Islets of Langerhans

Pancreas plays a dual role both as an exocrine and an endocrine gland. The an endocrine portion is called **Islets of Langerhans**. It consists of two types of cells namely, alpha cells and beta cells. **Alpha cells** produce a hormone called glucagon and **Beta cells** produce insulin.

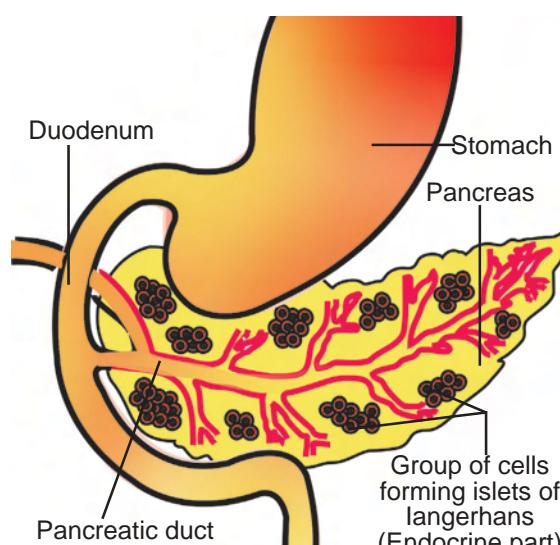


Fig. 3.9 Pancreas showing Islets of Langerhans

Insulin

- It promotes the uptake of glucose by the cells for tissue oxidation.
- It favours conversion of glucose into glycogen and its storage in the liver and the muscles.
- It prevents the formation of glucose from protein and fat.

Diabetes Mellitus

Less production of insulin causes Diabetes mellitus, in which the excess, unused glucose is excreted in the urine.

Glucagon

- It is secreted when the glucose level in the blood is low.
- It influences conversion of glycogen into glucose, thus raising the blood glucose level.
- A proper balance between insulin and glucagon is necessary to maintain proper blood glucose level of 80 – 120 mg / dl of blood.

Adrenal Gland (Supra renal gland)

On each kidney is found an adrenal gland. It is composed of two portions an outer adrenal cortex and an inner adrenal medulla.

Adrenal cortex

It secretes two hormones namely, Aldosterone and Cortisone.

Aldosterone (Mineralocorticoid)

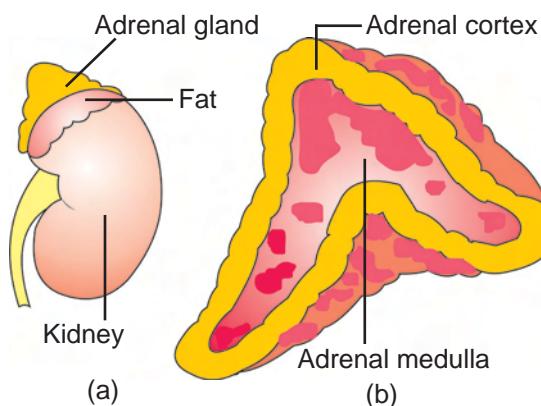
It maintains mineral metabolism by favouring reabsorption of sodium and water and excretion of potassium and phosphate ions.

It maintains electrolyte balance, body fluid volume, osmotic pressure and blood pressure.

Cortisone (glucocorticoid)

It stimulates the break down of glycogen into glucose raising the blood glucose level.

It also produces an anti-inflammatory reaction and suppresses the immune response.



*Fig. 3.10 a) Adrenal gland
b) LS of Adrenal gland*

Adrenal medulla

It is made up of modified neuroectodermal cells. It secretes two hormones, namely **adrenaline (epinephrine)** and **noradrenaline (norepinephrine)**. They are together called **emergency hormones or hormones of fight, flight and fright**, as they rapidly mobilize the body to face stress and an emergency situation.

- They increase the heart beat.
- They increase alertness.
- They increase the respiratory rate.
- They promote the conversion of glycogen into glucose.
- They cause dilation of pupils.
- They cause profuse sweating.
- They make the hair stand erect. (gooseflesh)

In short, noradrenaline and adrenaline mobilize the body to face an emergency by fighting with it or running away from it.

Testes

They are both cytogenic (producing gametes) and endocrine (producing male sex hormones) in function.

Leydig cells constitute the endocrine part of the testes. It secretes male sex hormone called **testosterone (androgen)**.

Testosterone stimulates the growth of reproductive organs and the production of male gametes- the sperm.

Testosterone determines the secondary sexual characters in male, such as growth of facial hair, hoarse voice, broadening of shoulder, etc.

Ovaries

Ovaries are both cytogenic (producing gametes) and endocrine (producing female sex hormones, such as oestrogen, progesterone and relaxin) in function.

Oestrogen is responsible for growth of female reproductive organs and the appearance of secondary sexual characters in female, such as growth of pubic hair, soft voice, feminine body,etc.

Progesterone maintains pregnancy and regulates menstrual cycle.

Relaxin relaxes the muscles of the pelvic region at the time of childbirth.

Parathyroid gland

These are found within the thyroid and produce hormones, mainly **Parathormone** and **Calcitonin** which maintain the calcium metabolism.

Thymus gland

It is a lymphoid mass, present above the heart. It secretes ***thymosin hormone*** which stimulates the differentiation of "T" lymphocytes to resist infection.

Pineal gland

It lies under the corpus callosum in the brain. It secretes ***melatonin hormone***, causing concentration of pigments in some specific areas like areola, scrotal sacs, etc.

3.3. CELL DIVISION

A matured cell divides into two daughter cells. Unicellular animalcules like amoeba, undergo binary fission without any change in the chromatin reticulum. This type of cell division is called Amitosis.

Body cells of all animals and plants undergo a cell division called ***Mitosis***, involving changes in the structure of chromosomes, but without any change in the chromosomal number.

The germinal epithelial cells of animals undergo ***Meiosis*** cell division, involving changes in the structure and number of chromosomes.

You have studied the process of mitosis. We shall study the various stages of meiosis and its significance in this unit.

Meiosis

Meiosis is a kind of cell division, which occurs in the germinal epithelial cells of the gonads to form the gametes. Meiosis takes place in the specialized diploid cells of gonads and produces four haploid gametes, each having half the number of chromosomes as compared to the parent cell. Meiosis is completed in two successive divisions – Meiosis-I and Meiosis-II.

In Meiosis-I, as the chromosomal number is reduced to half, it is called Reduction division. Meiosis-II is similar to Mitosis.

Meiosis - I

The various events of Meiosis-I are studied under four sub-stages namely Prophase-I, Metaphase-I, Anaphase-I and Telophase-I.

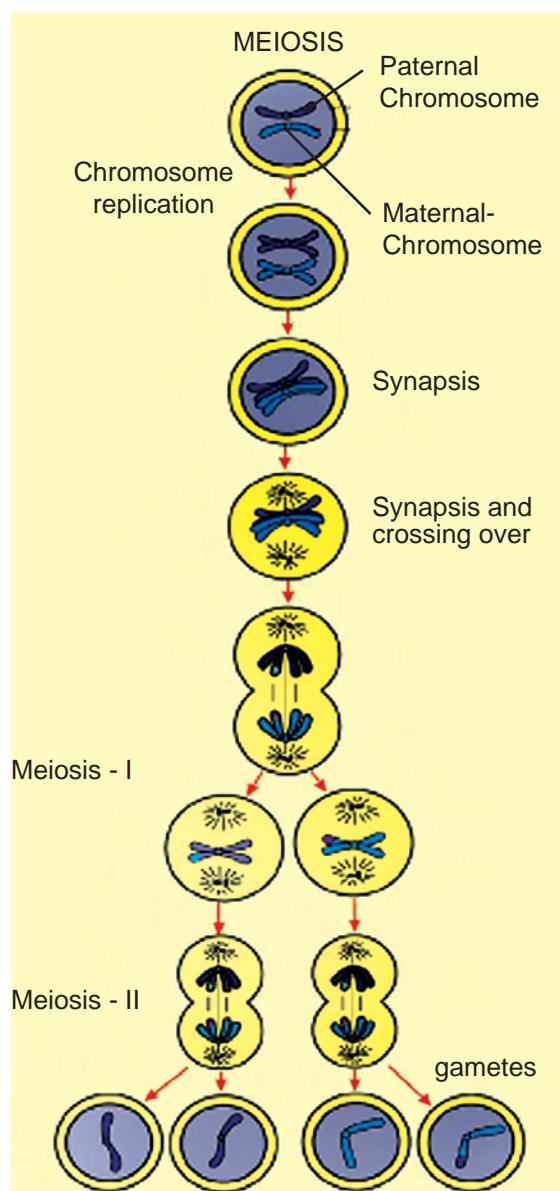


Fig. 3.11 Meiosis - stages

Prophase - I

The chromatin reticulum unwebs and individual chromosomes get liberated from one another. The nuclear membrane dissolves.

The chromosomes undergo marked differences in their shape and structure. Based on the shape of the chromosomes, this stage is studied under five sub-divisions as Leptotene, Zygote, Pachytene, Diplotene and Diakinesis.

Leptotene: The chromosomes condense and appear like threads. Each chromosome splits up longitudinally, except at the centromere.

Zygote: The homologous chromosomes come closer and start **pairing**. (a homologous pair of chromosomes consists of a paternal chromosome and a maternal chromosome with similar genes). The pairing starts from the tip or from the middle and they get attached laterally throughout the length. This pairing is called **Synapsis** and the paired chromosomes are called **Bivalents**.

Pachytene: The paired chromosomes become shorter and thicker. Each bivalent appears to have four chromatids called **tetrads** or **quadrivalents**. The point of contact between the homologous pair of chromosomes is called **Chiasmata**. At the point of chiasmata, exchange of chromosomal segment takes place, between the non-sister chromatids of the homologous pairs. This exchange of segments of chromatids between homologous chromosomes is called **crossing over**.

Diplotene: After the crossing over is completed, the homologous chromosomes

separate and this separation is called **terminalization**. Terminalization may begin in chiasmata and move to the terminal end of the chromosomes.

Diakinesis: The nuclear membrane and the nucleolus disappear. The spindle apparatus is formed in the cytoplasm.

Metaphase - I

The chromosomes get condensed. Bivalents now appear on the equator of the spindle with their chromatids pointing towards the equatorial plate and the centromere pointing towards the poles.

Anaphase - I

The spindle fibres contract pulling the chromosomes towards the opposite poles. The entire chromosome, with two chromatids move to the opposite poles. This involves a reduction in the number of chromosomes. Now two groups of chromosomes are produced, one at each pole with half the number of chromosomes.

Telophase - I

At the poles, around the group of chromosomes, a nuclear membrane develops. Thus two daughter nuclei each with half the number of chromosomes, are formed at the poles. The spindle fibres disappear.

At the end of Meiosis-I at right angle to the position of the nuclei, the cytoplasmic constriction takes place leading to the division of the cell. The cytoplasmic division is called Cytokinesis.

Meiosis - II

Meiosis-II is similar to Mitosis and so it is called Meiotic Mitosis. The events of

STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

Meiosis-II are studied in four sub-divisions as: Prophase-II, Metaphase-II, Anaphase-II and Telophase-II.

Prophase - II

The bivalent chromosomes get shortened. The centrioles form asters and move to the poles. The nucleolus and the nuclear membrane disappear.

Metaphase - II

Chromatids arrange themselves in the equator of the cell. The centromeres are attached to the spindle fibres.

Anaphase - II

The centromere divides into two and the two chromatids separate and now, they are called daughter chromosomes or new chromosomes. The daughter chromosomes move towards the opposite poles.

Telophase - II

The haploid set at the two poles coil to form chromatin material. The nuclear membrane and the nucleolus reappear. Thus two daughter nuclei are formed.

Cytokinesis

The cytoplasmic division takes place at right angles to the position of the nuclei resulting in the formation of four gametes.

Significance of Meiosis

1. Haploid sex cells are produced in order to maintain constancy in the number of chromosomes of a species.
2. Crossing over results in variation of genetic traits in the offspring.
3. Variations form the raw material for evolution.

MODEL EVALUATION

PART - A

1. Unipolar neurons are found in the _____.
i) Brain ii) Spinal Cord iii) Embryonic nervous tissue iv) Adult nervous tissue
2. The sensory organs contain _____.
i) Unipolar neuron ii) Bipolar neuron iii) Multipolar neuron iv) Medullated neuron
3. The part of brain which controls emotional reactions in our body is _____.
i) Cerebellum ii) Cerebrum iii) Thalamus iv) Hypothalamus
4. One of the following is a part of the brain stem. Pick it out.
i) Forebrain and midbrain ii) Midbrain and hindbrain
iii) Forebrain and hindbrain iv) Forebrain and spinal cord
5. Spinal nerves are _____.
i) sensory nerves ii) motor nerves iii) mixed nerves iv) innervating the brain
6. An endocrine gland found in the neck is _____.
i) adrenal gland ii) pituitary gland iii) thyroid gland iv) pancreas

7. An endocrine gland which is both exocrine and endocrine is the _____.
i) pancreas ii) pituitary iii) thyroid iv) adrenal
8. Normal blood glucose level in 1dl of blood is _____.
i) 80-100 mg/dl ii) 80-120 mg/dl iii) 80-150 mg/dl iv) 70-120 mg/dl
9. The "T" lymphocytes are differentiated to resist infection in the _____.
i) parathyroid gland ii) lymph gland iii) thymus gland iv) adrenal gland
10. In Meiosis-I, the pairing of homologous chromosomes take place during _____ stage.
i) leptotene ii) zygotene iii) pachytene iv) diplotene
11. The two systems of the human body which help in the control and co-ordination of metabolic activities are _____.
i) digestive and circulatory ii) respiratory and circulatory
iii) excretory and skeletal iv) nervous and endocrine
12. Neurotransmitters are released at the synapse by _____.
i) Tips of Dendrites ii) Synaptic Knobs
iii) Organelles of Cyton iv) Myelin sheath of Axon
13. The endocrine gland related to the immune system is _____.
i) Thyroid ii) Thymus iii) Adrenal iv) Pineal
14. The hormone administered by doctors to a pregnant woman to help in childbirth during the time of natural delivery is _____.
i) Oestrogen ii) Progesterone iii) Insulin iv) Relaxin
15. The important event of meiosis is the crossing over. It occurs during _____.
i) Leptotene ii) Pachytene iii) Diplotene iv) Zygote
16. Reduction division is the process by which gametes are produced. The cells in which reduction division take place are _____.
i) germinal epithelial cells ii) the sensory epithelial cells
iii) cuboidal epithelial cells iv) columnar epithelial cells
17. In Amoeba, the cell division takes place _____.
i) involving changes in the chromatin reticulum ii) without involving changes in the chromatin reticulum
iii) leading to reduction in the number of chromosomes
iv) without dividing the nucleus
18. Pick out the item which has sequential arrangement.
i) zygotene -> Leptotene -> Pachytene -> Diplotene -> Diakinesis
ii) Diakinesis -> zygotene -> Leptotene -> Pachytene -> Diplotene
iii) Leptotene -> zygotene -> Pachytene -> Diplotene -> Diakinesis

STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

19. Polio is a viral disease and the affected child suffers from physical disability of limbs. Which system of the body is mostly affected due to this infection?

- i) Nervous system
- ii) Digestive system
- iii) Respiratory system
- iv) Excretory system

20. Blinking when a beam of light is suddenly focussed on the eyes and sudden withdrawal of hand upon touching a hot body are some of the examples of reflex actions. Which part of the central nervous system acts as the centre these actions?

- i) Forebrain
- ii) Spinal cord
- iii) Hindbrain
- iv) Synapse

21. The following are the parts of a neuron:

- a) Axon
- b) Terminal branches
- c) Cyton
- d) Dendrites

The correct pathway of a nerve impulse through these parts are _____.

- i) badc
- ii) dcab
- iii) bdac
- iv) adbc

22. For minor surgeries in the body, doctors administer local anaesthesia to a part of the body so that the pain will not be felt by the patient. At which part, do you think, the nerve impulse is being arrested due to the effect of anaesthesia?

- i) at cyton
- ii) at axon
- iii) at synapse
- iv) in the middle of axon

23. Assertion (A) : All spinal nerves are mixed nerves.

Reason (R) : Each spinal nerve has a sensory root and a motor root.

- i) Both 'A' and 'R' are true and 'R' explains 'A'.
- ii) Both 'A' and 'R' are true but 'R' doesn't explain 'A'.
- iii) Only 'A' is true but 'R' is false.
- iv) 'A' is false but 'R' is true.

PART - B

1. Name the two systems which help in the control and co-ordination of metabolic activities. Write any one difference between them.

2. Differentiate medullated neurons from non-medullated neurons. Where are they found in the nervous system?

3. Name the part of the brain which regulates heart beat and respiration. Where is it located in the brain?

4. What is corpora quadrigemina? Name the functions associated with it.

5. What are endocrine glands? Name the secretions of these glands. How do these secretions reach the target organs?

6. Name the following endocrine glands:

- i) The master of endocrine orchestra
- ii) The dual gland

7. Which hormone(s) is/are called i) Personality hormone ii) fight, flight and fright hormones.

8. Name the male and female sex hormones. List out their functions.

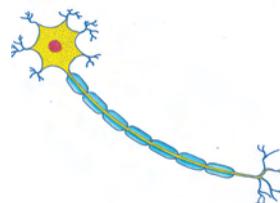
9. In which sub-stages of meiosis-I do the following events occur?

i) pairing of homologous chromosomes ii) terminalization

iii) crossing over iv) formation of spindle apparatus.

10. Copy the diagram and label any two parts in the group given:

(cyton, axon, dendron, terminal branches)



11. The diagram is of the human brain.

Shade the areas marked A and B in the parts of the brain, corresponding with the function.

A. Seat of smell

B. Seat of vision



12. On the basis of the function performed, pick out the right statements.

i) Pituitary gland secretes hormones and enzymes.

ii) Thyroid gland secretes thyroxine and insulin.

iii) Leydig cells produce testosterone hormone.

iv) Pancreas produces enzymes and hormones.

13. Correct the statements, if they are wrong.

i) Alpha cells produce insulin and beta cells produce glucagon.

ii) Cortisone suppresses the immune response.

iii) Thymus gland is a lymphoid mass.

iv) Ovary produces eggs and androgen.

14. Here are a few statements about the endocrine system in man. State whether each of them is true or false. If the statement is false write the correct statement.

i) Endocrine system controls and co-ordinates the physical process of growth, reproduction and sustenance of life.

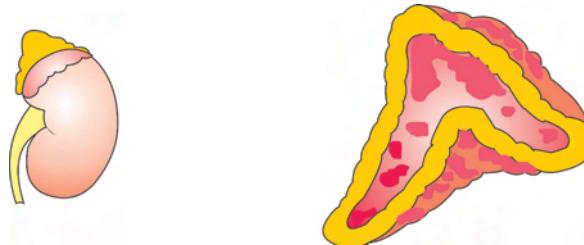
ii) Endocrine glands are duct bearing glands which secrete chemical substances called hormones.

STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

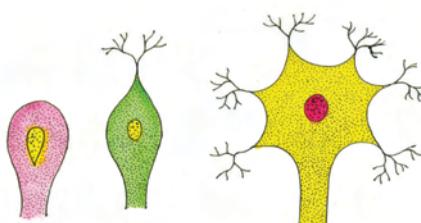
- iii) The pancreas is a dual gland.
- iv) Malfunctioning of the thymus gland causes goitre.
15. Copy and complete the following table:

	Hormones of adenohypophysis	Functions and malfunctions
1.	somatotropic or growth hormone (STH or GH)	
2.		<i>It stimulates the growth of thyroid gland and produces thyroxine</i>

16. Copy the diagram and label the parts with the help of the clues given:



- i) It is otherwise called supra renal gland.
- ii) It secretes two hormones, namely aldosterone and cortisone.
17. Copy and identify the types of neurons given below:



18. Here are some statements about meiosis. State whether each of them is true or false:
- i) It takes place in somatic cells.
- ii) Meiosis is also called reduction division.
- iii) Pairing of homologous chromosomes is called crossing over.
- iv) Meiosis leads to variations which form the raw material for evolution.
19. Match the following:

A. leptotene	I. nuclear membrane and nucleolus disappear
B. zygotene	II. terminalization
C. diplotene	III. pairing, synapsis, bivalents
D. diakinesis	IV. chromosomes condense and appear like threads

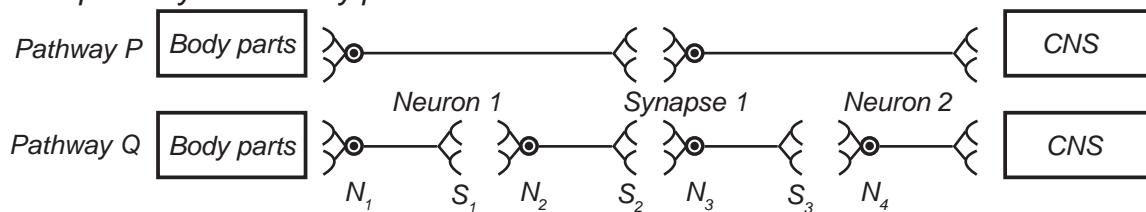
20. A person was riding a two-wheeler without wearing a helmet. He met with an accident

and sustained a head injury. He was dead before he was shifted to the hospital and it was found that his death was due to breathlessness and heart failure. Which part of his brain might have been damaged? Justify your answer.

21. Match the following:

List I	List II
A. Vasopressin	I. Resist infection
B. Insulin	II. Diabetes insipidus
C. Oxytocin	III. Diabetes mellitus
D. Thymosin	IV. contraction and relaxation of uterus

22. Observe the following diagrams that depict the transmission of nerve impulses through two pathways from body parts to CNS:



If all the nerves at both the places are similar in thickness and structure, through which pathway will the transmission of an impulse (of same threshold) be faster and why?

23. Which gland is called the 'dual gland'? Why?

24. A 16 year old boy was brought to a doctor with a complaint of non-masculine features (lack of moustache / beard / gruff voice / broadening of shoulders etc). After keen examination, the doctor found that it was a hormonal disorder and the endocrine glands responsible were not functioning properly. Mention the glands and the hormone lacking in the boy.

PART - C

1. Describe the structure of a neuron with the help of a neat, labelled diagram,
2. List out the various parts of the human brain and write a note on their functions.
3. Name the endocrine glands and their location in the human body. Describe any two of them in detail.
4. Why is meiosis called reduction division? Describe the various stages with relevant diagrams. Add a note on significance of meiosis.
5. Use words from the given list to complete the following paragraph. (The words may be used once/ more than once / not at all).
(Skull, Vertebral column, Piamater, Arachnoid membrane, Brain, Spinal cord, Meninges, Duramater)

STRUCTURE AND FUNCTIONS OF HUMAN BODY ORGAN SYSTEMS

The central nervous system is covered by three protective coverings collectively called _____. The outermost cover lying below the _____ and _____ is double thick and is called _____. The middle covering is thin and vascularised and is called _____. The innermost cover is a very thin delicate membrane and is closely stretched over the outer surface of _____ and _____ and is called _____.

6. Match these parts with their functions:-

medulla oblongata, cerebellum, forebrain, thalamus, cerebral cortex, hind brain, pons, hypothalamus

- a) Sleep centre and respiratory centre
- b) Several reflexes involved in the regulation of heart beat, blood vessel contraction, breathing etc.
- c) Consists of cerebrum, thalamus and hypothalamus
- d) Motor and sensory areas
- e) A major conducting centre for sensory and motor signalling
- f) Regulation of sexual behaviour
- g) Consists of pons, cerebellum and medulla oblongata
- h) Co-ordinates the group movements of voluntary muscles, as in walking or running

7. Observe the diagram of the human brain and identify the areas mentioned:

- i) The area responsible for consciousness, intelligence, memory, imagination and reasoning.
- ii) The area responsible for regulation and co-ordination of group movements of voluntary muscles.
- iii) The area responsible for sleeping and respiration.
- iv) The area responsible for reflexes involved in the regulation of heart beat, blood vessel contraction, breathing etc.



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REPRODUCTION IN PLANTS



REPRODUCTION IN PLANTS

Do you know that all living organisms reproduce (both plants and animals)? Reproduction is a special biological process, by which new individuals of the same species are produced. It is one of the biological processes like nutrition, respiration and excretion.

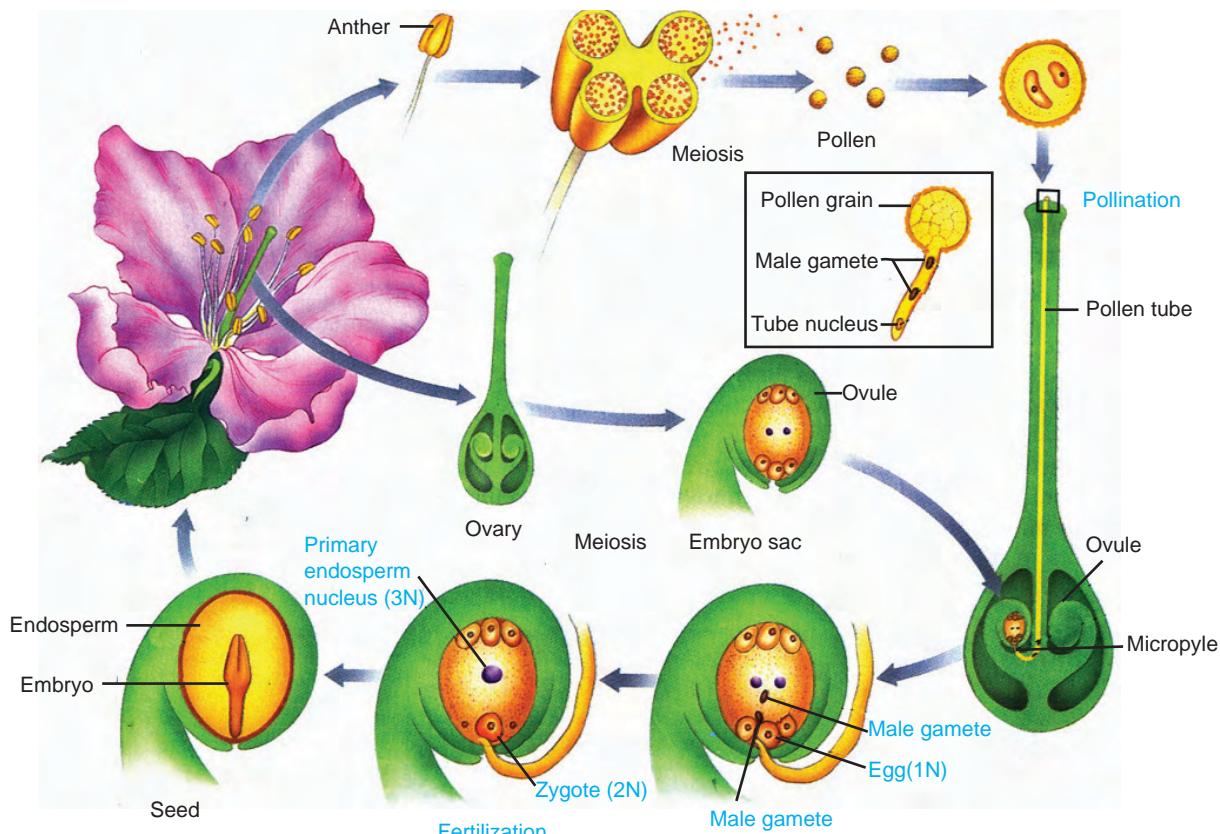


Fig. 4.1 Pollination and fertilization

Some of the methods of reproduction in organisms are:

Reproduction in animals	Reproduction in plants
Fission – Protozoan	Fission – Bacteria
Budding – Coelenterates	Budding - Yeast
Fragmentation – Flatworms	Fragmentation – Algae
	Spores – Fungi
Sexual reproduction – Mammals	Pollination and Fertilization – Flowering plants

What will happen if reproduction doesn't take place?

Questions

1. What is meant by reproduction?
2. Mention a few methods of reproduction in plants and animals.

Some Bacteria like Lactobacilli, Salmonella multiply rapidly. Others like Mycobacterium tuberculosis multiply slowly.

Activity beneficial to humans: Conversion of milk into curd by *Lactobacilli*

Activity harmful to humans : Bacteria like *Mycobacterium tuberculosis* cause tuberculosis.

ACTIVITY 4.1

- Wet a slice of bread and keep it in a cool, moist and dark place.
- Observe the surface of the slice with a magnifying glass for a week.
- Record your observations .

ACTIVITY 4.2

- Observe a permanent slide of bacteria under a microscope.
- Similarly, observe another permanent slide of bacteria showing Binary Fission.
- Now compare the observations of both the slides.

4.1. MODES OF REPRODUCTION

Modes of reproduction in single cell organism: Let us examine how different organisms actually reproduce. The methods by which organisms reproduce depend upon the body shape and structure of organisms. Unicellular organisms, like amoeba and bacteria, split into two equal halves and each half develops into new ones. This method is called binary fission.

South African fossil records show that the first formed organism in the Earth is a Bacterium, i.e, Eobacterium which came into existence approximately four billion years ago. In the past two billion years, life got diversified into multitude of varieties of organisms that exist today or existed and became extinct in the past, whereas bacteria continues to live as bacteria without much change.

Reproduction in unicellular organisms : By Fission

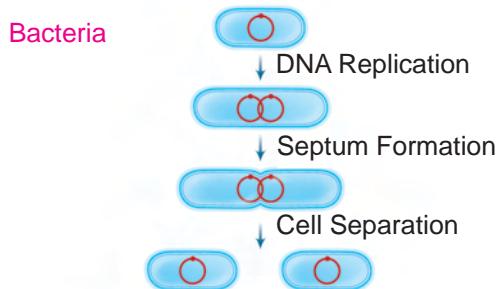
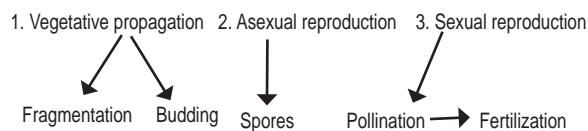


Fig. 4.2 Reproduction in unicellular organisms

Modes of reproduction in multicellular organisms:



Depending upon the body organization of multicellular organisms, there are various methods of reproduction.

Vegetative propagation:

It is the ability of plants to reproduce by bringing forth new plants from the existing

vegetative structures without sexual reproduction.

Fragmentation

In multicellular organisms with simple body organization, simple reproductive methods have been noticed.

In **Spirogyra** algae, the plant body breaks up into small fragments. Each fragment grows into a new individual.

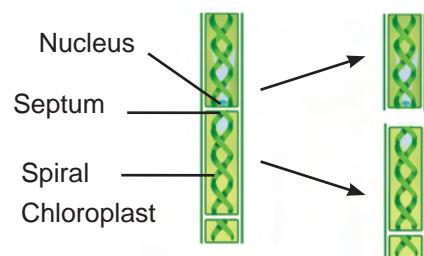


Fig. 4.3 Fragmentation in Spirogyra

ACTIVITY 4.3

- Collect some water from a lake or pond that appears dark green and contains filamentous structures.
- Place one or two filaments on a slide.
- Pour a drop of glycerin on these filaments and cover it with a cover slip.
- Observe the slide under a microscope.

Budding

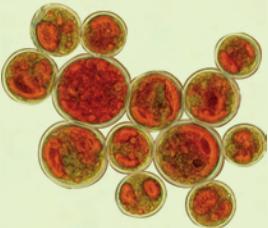
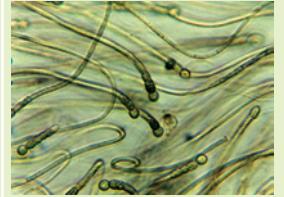
In Hydra, a bud develops into an outgrowth due to repeated cell division at one specific site. These buds develop into tiny individuals and when fully matured, get detached from the parent body to become new independent individuals.

Similarly, buds produced in the notches along the leaf margin of Bryophyllum fall on the soil and grow into new plants (in Tamil katti pottal podum).

Asexual reproduction

In lower group of plants, asexual reproduction takes place by means of **spores**. The spores are covered by thick walls that protect them until they come into contact with another moist surface and begin to grow.

Some of the spores in different algae and fungi :

APLANOSPORES	ZOOSPORES	AKINETES	CONIDIA
<p>In algae, the protoplast of the vegetative cells contract and produce ovoid bodies surrounded by a thin wall. These thin walled non-motile spores are called Aplanospores. New filaments are formed by the germination of these spores.</p>  <p><i>Aplanospores</i></p>	<p>A zoospore is a motile asexual spore that uses a flagellum for locomotion. These spores are created by some algae, bacteria and fungi to propagate themselves.</p>  <p><i>Zoospores</i></p>	<p>In algae, the vegetative cells secrete thick additional wall layers. During adverse conditions, food materials are filled up in cells. These structures are called akinetes. During favourable conditions they develop into new filaments.</p>  <p><i>Akinetes</i></p>	<p>Conidia are uninucleate, non-motile, asexual spores produced by the fungus like penicillium.</p>  <p><i>Conidia</i></p>

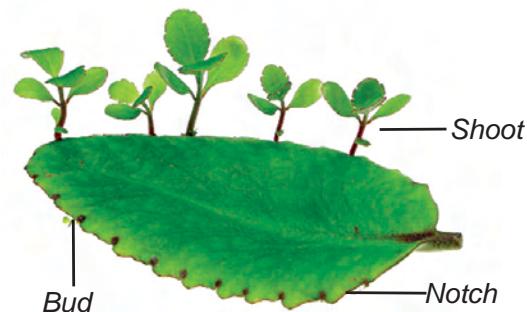


Fig. 4.4 *Bryophyllum*

Questions

- Differentiate vegetative propagation and asexual reproduction.
- Mention some of the spores of asexual reproduction.

4.2. SEXUAL REPRODUCTION IN PLANTS

Sexual reproduction is the process in which two **gametes** (male and female) are fused to produce offspring of their own kind.

A bull alone cannot produce calves. It needs a cow. A female sheep (ewe) alone cannot produce lambs. It needs a male sheep (ram).

Both the sexes, male and female, are indispensable to produce offspring.

You have already learnt that the flower is a reproductive organ of a flowering plant. To understand this further we need to first study the structure of a flower.

Parts of a typical flower

A **flower** is a modified shoot with a limited growth to carry out sexual reproduction.

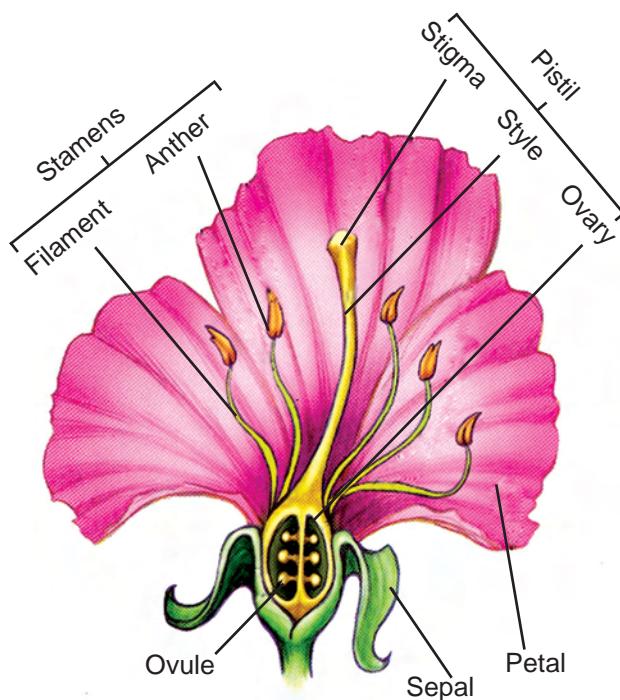
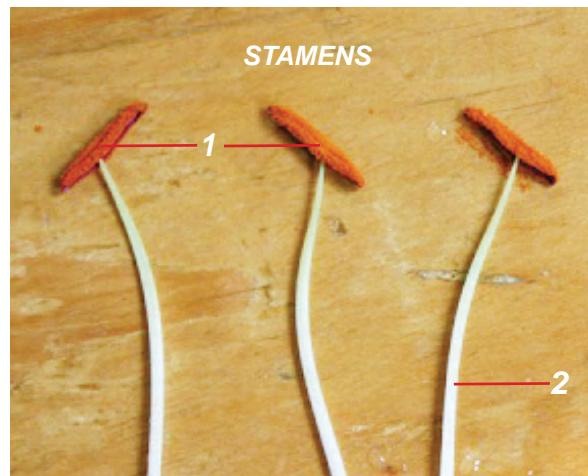


Fig. 4.5 Parts of a Flower

The main whorls of a complete flower are:

1. Calyx (Composed of sepals)
2. Corolla (Composed of petals)
3. Androecium
4. Gynoecium

Androecium is the male reproductive part of a flower and Gynoecium is the female reproductive part of a flower.



1. Anther 2. Filament

Fig. 4.6 Androecium

Androecium is composed of stamens. Each stamen consists of a stalk called the filament and a small bag like structure called the anther at the tip. The pollen grains are produced in the anther within the pollen sacs.

Gynoecium is the female part of the flower and is made of carpels. It has three parts :

1. Ovary 2. Style 3. Stigma

The ovary contains the ovules and each ovule carries within it an embryo sac, within which lies the egg cell or the female gamete.



Fig. 4.7 Gynoecium

ACTIVITY 4.4

- Take a shoe flower from a growing plant.
- Observe the floral parts Calyx, Corolla, Androecium and Gynoecium.
- Separate the stamens and carpels and observe the parts.
- Dust the pollen grains on a slide and observe under a microscope.

Pollination is the first important event in the development of a fruit and seed. Pollination is followed by fertilization.

4.2.2. Types of Pollination

Pollination is of two types. They are:

1. *Self pollination*
2. *Cross pollination*

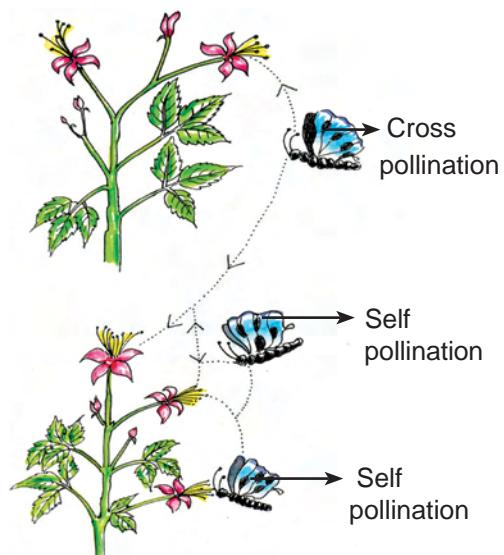


Fig. 4.8 Pollination

4.2.1. Pollination

How does sexual reproduction take place in flowering plants?

The sexual reproduction in flowering plants involves

1. Pollination
2. Fertilization

1. Pollination

The transfer of pollen grains from the anther to stigma of a flower is called pollination. Pollen grains are transferred mainly by wind, water, insects and animals. They are called pollinating agents.

Self Pollination (Autogamy)

Self pollination is also known as **autogamy**. The transfer of pollen grains from the anther of a flower to the stigma of the same flower or another flower of the same plant is known as self pollination.

Advantages of self pollination

1. Self pollination is certain in bisexual flowers.
2. Flowers do not depend on agents for pollination.
3. There is no wastage of pollen grains.

Disadvantages of self pollination

1. The seeds are less in number.
2. The endosperm is minute. Therefore, the seeds produce weak plants.
3. New varieties of plants cannot be produced, resulting in the degradation of the plant.

Cross Pollination (Allogamy)

The transfer of pollen grains of a flower to the stigma of another flower of a different plant of the same species is called cross pollination or **allogamy**.

Advantages of cross pollination

1. The seeds produced as a result of cross pollination, develop and germinate properly and grow into better plants, i.e. cross pollination leads to the production of new varieties.
2. More viable seeds are produced.

Agents of cross pollination

How is it possible to transfer pollen grains from one flower to another?

In order to bring about cross pollination, it is necessary that the pollen should be carried from one flower to another of a different plant. This takes place through the agency of animals, insects, wind and water.

- a) Pollination by animals (Zoophily)
- b) Pollination by birds (Ornithophily)
- c) Pollination by insects (Entomophily)

Entomophily

Insects like butterflies and honey bees are attracted to the bright petals of the flowers. These flowers are large in size and have a sweet smell. Some of these flowers produce nectar. This is the most

common of all types of pollination. This kind of pollination is called Entomophily. (Pollination by insects).

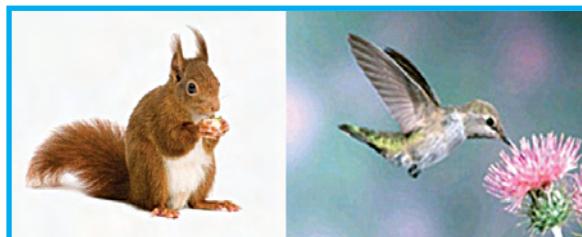


Fig. 4.9 Zoophily

ACTIVITY 4.5

Observe the flowers in a garden. Identify the insects and birds that act as pollinating agents. Maintain a record detailing the pollinating agents and the plants they pollinate.

Anemophily (Pollination by wind)

The flowers pollinated by wind are mostly small in size and do not have any attractive colour, smell and nectar. They produce a large number of pollen grains to make up for the wastage of pollen in transit.



Fig. 4.10 Anemophily

The pollen grains are non-sticky, dry, light, powdery and hence are easily carried by the wind.

Some pollen grains even have wings. Stigmas are large and protruding, even branched and feathery. e.g. maize.

Flowers pollinated by wind are called Anemophilous, e.g. grass and pine.

ACTIVITY 4.6

- Collect some zoophilous, anemophilous and hydrophilous flowers.
- Prepare a chart and make a note of their adaptations to suit the corresponding pollination.

Pollination by Water (Hydrophily)

Pollination by water is called hydrophily. It is observed in some aquatic plants like **Vallisneria, Hydrilla, Zosteria**.

The flowers of these plants are not colourful and have no nectar. Pollen grains have mucilaginous covering to protect them from getting wet.



Fig. 4.11 Hydrophily - Vallisneria

4.3. FERTILIZATION

Recall what you have studied about pollination.

Pollination is the transfer of pollen grains from the anther to the stigma. Each pollen grain has protective walls called

exine and intine. The outer wall exine is thick and it has small pores called germination pores. The inner wall is thin and elastic.

Germination of pollen grain

If a pollen grain falls on a suitable stigma, it starts germinating. A mature pollen consists of two cells. The larger one is vegetative cell and the smaller one is generative cell. The vegetative cell starts growing and emerges through the germination pore. It develops through the style as a long tube known as pollen tube. The generative cell gets into the tube and divides into two male gametes (sperms).

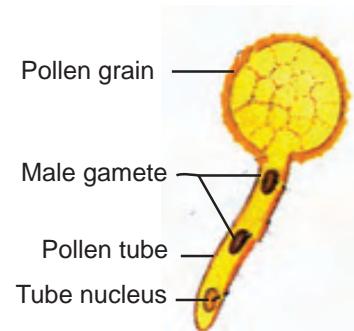


Fig. 4.12 Germination of Pollen grain

Process of fertilization

The pollen tube enters into the embryo sac through micropyle. At this time, the pollen tube bursts open, gametes are released from the pollen tube and enter into the embryo sac. One of the gametes fuses with the egg and the other fuses with the secondary nucleus. The fusion of a male gamete with a female gamete (egg) is known as fertilization. The fertilized egg is known as zygote which develops into an embryo.

Double fertilization

The other male gamete fuses with the secondary nucleus. The secondary nucleus is diploid in nature.

The fusion of this nucleus with the second male gamete is known as triple fusion. The triple fusion nucleus is called primary endosperm nucleus because it develops into an endosperm. Endosperm is a nutritive tissue meant for the development of the embryo. The process of fusion of a male gamete with an egg and the other

gamete with a secondary nucleus is known as double fertilization.

Post fertilization changes :

- i. The ovule develops into a seed.
- ii. The integuments of the ovule develop into seed coats.
- iii. The ovary enlarges and develops into a fruit.

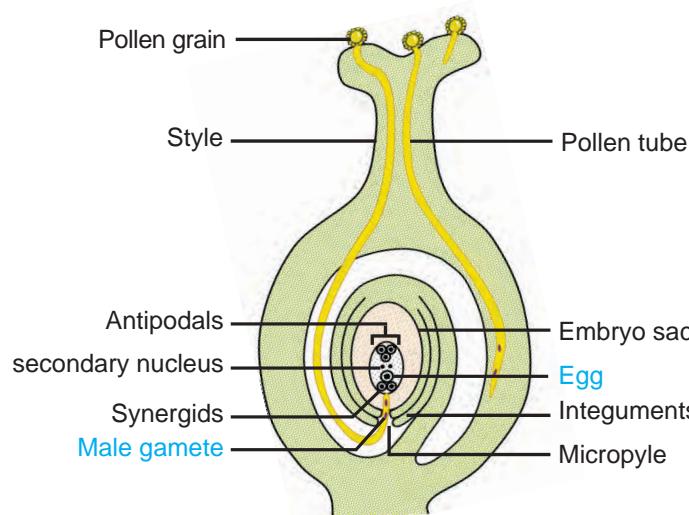


Fig. 4.13 Process of Fertilization

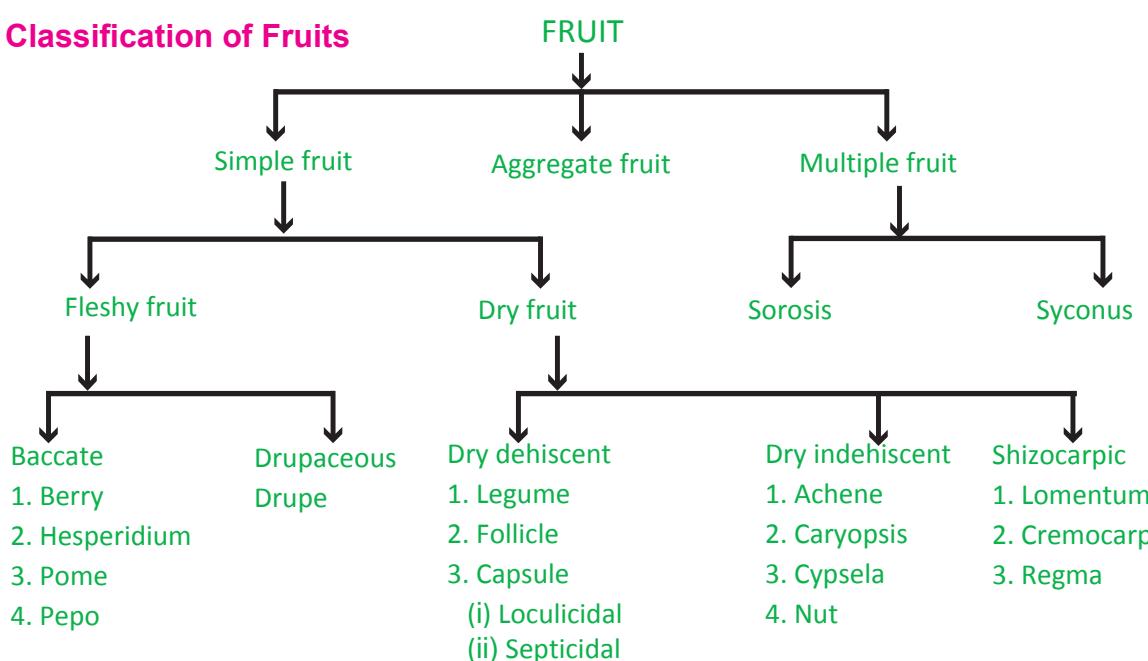
4.4. FRUIT FORMATION

Fruits form a part of our daily diet. Fruits are rich in vitamins and give us energy.

The fruit may be defined as a fertilized and ripened ovary. The ovary wall becomes the fruit wall (pericarp) and the ovule becomes the seed.

Some fruits develop without the act of fertilization. Such fruits are called Parthenocarpic fruits. e.g. seedless grapes, guava, etc.

Classification of Fruits



Simple fruits

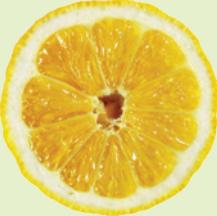
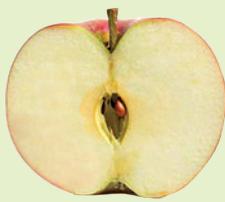
A simple fruit is developed from a single ovary with a monocarpellary or multicarpellary, syncarpous gynoecium.

Based on the nature of the pericarp, the simple fruits are classified into fleshy fruits and dry fruits.

Simple fleshy fruits

In simple fleshy fruits, the pericarp is succulent and juicy when fully ripe. The fleshy fruits are indehiscent in nature. The pericarp is made up of three layers, namely epicarp, mesocarp and endocarp. There are mainly two types of fleshy fruits – Baccate and Drupaceous. Baccate is further classified into berry, hesperidium, pome and pepo.

Baccate:

Sl. No.	Type	Description
1.	Berry - Tomato	 It is a one or many - seeded fruit. Epicarp is thin and mesocarp is fleshy. They form a pulp which is edible and the seeds are embedded in it. It develops from a bicarpellary, syncarpous, superior ovary.
2.	Hesperidium - Orange	 It develops from multicarpellary, superior ovary with axile placentation. The epicarp is thick, leathery and contains oil glands. The whitish spongy layer lining the epicarp is called mesocarp. The endocarp forms distinct chambers. Juicy hairs produced from the endocarp is the edible part.
3.	Pome - Apple	 The fruit develops from a pentacarpellary syncarpous inferior ovary with many seeds. The thalamus becomes fleshy and develops into a fruit which is edible. The true fruit containing seeds remain inside.
4.	Pepo - Cucumber	 It develops from a tricarpellary, syncarpous inferior ovary with parietal placentation. The pulp contains many seeds.

Sl. No.	Type	Description
5.	Drupaceous: Drupe - Mango 	It is a one - seeded fleshy fruit and develops from a monocarpellary ovary. The pericarp is differentiated into outer skinny epicarp, fleshy middle mesocarp and stony inner endocarp. Due to the presence of a stony endocarp, the fruit is also known as stone fruit.

Simple dry fruits

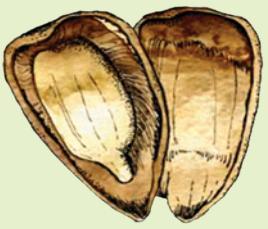
These fruits have a dry pericarp. They are classified based on mode of dehiscence as dry dehiscent, dry indehiscent and schizocarpic fruits.

Dry dehiscent fruit: These fruits split open at maturity to disperse the seeds.

Sl. No	Type	Description
1.	Legume - Peas 	It develops from a monocarpellary, unilocular, superior ovary with marginal placentation. Pericarp dehisces along both dorsal and ventral sutures e.g.pea, bean.
2.	Follicle - Calotropis 	It develops from a bicarpellary, syncarpous, superior ovary. It is like a legume fruit, but the pericarp dehisces along one suture only. e.g. Calotropis.
3.	(a) Septicidal capsule - Cotton  (b) Loculicidal capsule - Lady's finger 	This is a many - seeded fruit developing from a superior, multicarpellary syncarpous ovary. Capsules dehisce by various methods. When the fruit wall opens along the middle of each locule, it is called loculicidal capsule. When the fruit wall splits open along the line of septum, it is called septicidal capsule.

Dry indehiscent fruit

These fruits do not split open at maturity and the seeds are liberated by the decaying of pericarp.

Sl. No.	Type	Description
1.	Achene - Clematis,Mirabilis 	This is a single - seeded fruit which develops from a monocarpellary, unilocular ovary. Pericarp is hard and leathery. It remains free from the seed coat.
2.	Caryopsis - Paddy 	It is a one - seeded fruit which develops from a monocarpellary superior ovary. Pericarp is fused with the seed coat e.g. paddy, wheat, maize.
3.	Cypsela - Tridax 	This fruit develops from a bicarpellary syncarpous inferior ovary. The pericarp and the seed coat remain free e.g. Tridax.
4.	Nut - Cashew nut 	It is a dry indehiscent, one seeded fruit with hard and woody pericarp. The nut is developed from a bicarpellary or a multicarpellary superior ovary e.g. Cashew nut.

Schizocarpic fruits

At maturity, these fruits break into many one - seeded parts called mericarps. The mericarps containing the seeds remain indehiscent. Thus the schizocarpic fruits show characters of both dehiscent and indehiscent fruits.

Sl. No.	Type	Description
1.	Lomentum - <i>Acacia</i>	 <p>It resembles a legume and breaks transversely at constrictions between the seeds e.g. <i>Acacia</i>.</p>
2.	Cremocarp - <i>Coriandrum</i>	 <p>It is a two - seeded fruit which develops from a bicarpellary syncarpous, bilocular and inferior ovary. It dehisces longitudinally into two indehiscent mericarps e.g. <i>Coriandrum</i>.</p>
3.	Regma - <i>Castor</i>	 <p>It develops from a tricarpellary syncarpous superior ovary and breaks up into three one - seeded cocci e.g. <i>Castor</i>.</p>

Aggregate Fruit

It is developed from a single flower with a multicarpellary, apocarpous, superior ovary. Each free carpel develops into a fruitlet. Hence, the aggregate fruit has a cluster of fruitlets attached to a common stalk e.g. *Polyalthia*.

In *Annona squamosa* (custard apple), the margin of the matured ovaries of carpels after fertilization (fruitlets) are united and appears like a single fruit.



Fig. 4.14 *Polyalthia*



Fig. 4.15 Custard apple

Composite or Multiple fruit

Multiple or composite fruit is formed from all the flowers of whole inflorescence and gives a single fruit. There are two types of multiple fruits namely sorosis and syconus.

Sl. No.	Type	Description
1.	Sorosis - Jack fruit 	In jack fruit, the rachis (inflorescence axis) and other floral parts of the female inflorescence fuse together forming a composite fruit. It consists of a fleshy central axis. The edible part represents the perianth which is bag like and one - seeded. There are numerous, elongated, whitish flat structures in between the edible flakes. They represent the sterile or unfertilized flowers. The pines on the tough rind represent the stigma of the carpels.
2.	Syconus - Fig 	It is derived from a special type of inflorescence known as hypanthodium which has a fleshy receptacle. It has a large number of minute unisexual flowers. On ripening, the receptacle becomes fleshy and juicy and forms the edible portion e.g. banyan, fig.

ACTIVITY 4.7

Collect a variety of fruits. Identify the type of each fruit and write a note on them.

Think, read and find out :

Why are there so many varieties of fruits?

4.5. SEED FORMATION

The seed is a fertilized ovule. It possesses embryo, food materials and are protected by the seed coat. During favourable conditions, the seed germinates and gives rise to a new seedling.

Seeds vary greatly in size, shape, colour and texture. In orchids, there are many seeds which are tiny dust like particles. In coconut, there is a large sized seed. In both cases, the seed grows into a full plant.

Based on the number of cotyledons in the seed, the angiosperms have been divided into two groups.

1. Dicotyledons: Seeds with two cotyledons e.g. pea, bean and castor.

2. Monocotyledons: Seeds with one cotyledon e.g. maize, rice, wheat and onion.

1. Structure of a dicot seed (bean)

The seed is bulky, oval and slightly indented on one side. On this side, there is a short longitudinal, whitish ridge called the

raphae. At one end of the raphae, there is a minute opening known as germ pore or micropyle.

If a water-soaked seed is pressed gently, a small drop of water along with air bubbles will come out through the micropyle.

The embryo is enclosed by the seed coat. It consists of cotyledons attached to the primary axis which has a rudimentary root portion called the radicle and a rudimentary stem portion known as plumule.

The tip of the radicle projects outside, and is nearer to the micropyle. The plumule is placed between the two cotyledons and consists of a shoot axis and a small bud having two tiny folded leaves.

2. Structure of monocot seed (paddy)

In paddy, the so - called seed is actually a fruit. It is a simple indehiscent one - seeded fruit known as caryopsis (you have already studied about this in the lesson on fruits). The seed coat is very thin. The fruit wall (pericarp) is thin and fused with the seed coat. The fruit is generally covered with yellowish bract and bracteoles which are commonly known as chaff. The embryo consists of a single cotyledon called scutellum and a shoot axis. The lower part of the axis is the radicle, covered by a sheath called coleorhiza (root sheath). The upper part is known as plumule which is covered by a sheath called coleoptile. In a day or two, after the seed is placed in moist soil, the coleorhiza pierces the base of the seed. The radicle comes out next after splitting the coleorhiza.

The radicle does not form the root system. Meanwhile, roots are formed from the lower most nodes of the stem. These roots are called adventitious roots. These

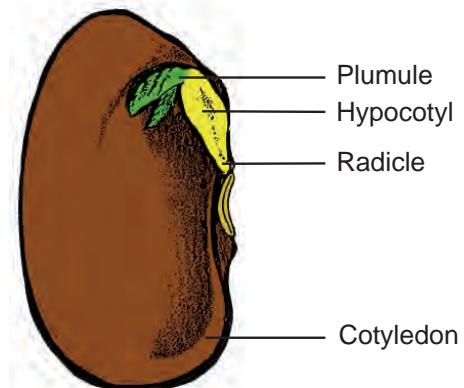


Fig. 4.16 Dicot Seed (Bean)

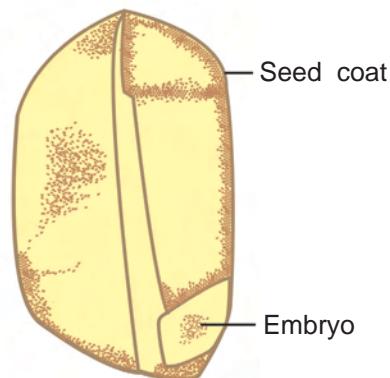


Fig. 4.17 Monocot Seed (Paddy)

adventitious roots form the fibrous root system of the matured plant.

4.6. DISPERSAL OF SEEDS

The seeds fall far away from the mother plant. Why?

The reproductive capacity of plants is so tremendous that a very large number of seeds are produced by a single plant. If all these seeds fall directly below the parent plant, the seedlings would have to compete for space, water, oxygen, minerals and sunlight. When the seedlings are grouped together in one place, they can easily be destroyed by grazing animals. Such a situation would be detrimental to the species.

ACTIVITY 4.8

- Soak a few seeds of bengal gram (*channa*) and keep them overnight in a wet cloth.
- Take care that the bengal gram does not swollen absorbing excess of water. (The bengal gram should not decay due to with excess water.)
- Drain the excess water and cover the seeds with the wet cloth and leave them for a day. Make sure that the seeds do not become dry.
- Cut open the seed carefully and observe the different parts.
- Compare your observations with the diagram and see if you can identify all the parts.

The fruits and seeds of plants have evolved various devices by which they can be distributed far and wide through various agencies.

This not only eliminates the unhealthy competitive struggle that would arise from overcrowding, but also ensures the successful spreading and establishment of a species on the earth. Most fruits and seeds have evolved adaptations for dispersal.

Agents for the Dispersal of Fruits and Seeds:

Based on the agents involved in dispersal, there are various types of dispersal mechanisms of fruits and seeds in plants.

Autochory: Autochory is an active mechanism of self dispersal of fruits and seeds. Fruits like balsam burst with a sudden jerk and disperse the seeds by wind through an explosive mechanism.

ACTIVITY 4.9

Label the jars filled with seawater and seeds. After 7 days, put the seeds in a sieve and rinse them under a tap. Then plant them in labelled pots.

Anemochory is the wind dispersal of fruits and seeds. The wind blows them away and for this they have to be light, so that their buoyancy may enable them to float on air over long distances. Some of them are provided with hairs and membranous wing-like structures, which enable them to be carried away easily. e.g. Seeds dispersed



Fig. 4.18 Anemochory (*Tridax*)



Fig. 4.19 Autochory (Balsam)

by wind are Calotropis (Erukku), Moringa (drumsticks)etc.

Fruits of Tridax carry a persistent calyx modified into a pappus (a ring of fine, feathery hair) which acts like a parachute and aids in the dispersal by wind.

Hydrochory: Hydrochory is a mechanism in which dispersal of fruits and seeds takes place by means of water. Fruits which are dispersed by water have outer coats that are modified to enable them to float. The mesocarp of coconut is fibrous and is easily carried away by water currents.

The spongy thalamus with air chamber of the Lotus floats in streams of water and after some time, the fruits get separated and the seeds germinate.

Zoochory: Zoochory is a mechanism in which dispersal of fruits and seeds is by animals. Some fruits are provided with hooks, spines, bristles, stiff hair,etc. on their outer coat. With the aid of these out growths, these fruits stick to the furry coats or skins of some animals and get carried from one place to another.

The fruits of Xanthium have sharp-pointed stiff hooks and in the

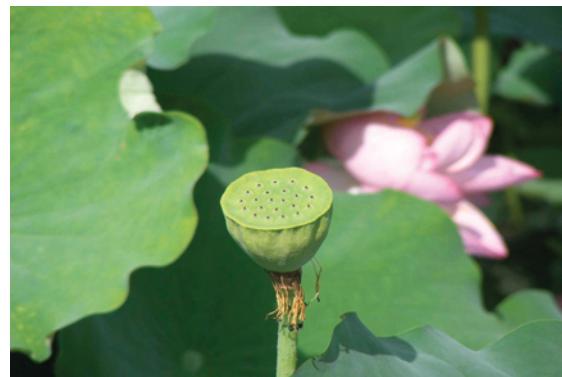


Fig. 4.20 Hydrochory(Lotus)



Fig. 4.21 Zoochory(Xanthium)

Achyranthus, the perianth and bracts are pointed. Many fleshy fruits are eaten by animals and human beings and the seeds are thrown away.

In fruits like tomato and guava, the seeds are eaten along with the edible portion and are later passed out in the excreta. These types of seeds are protected from the digestive juices by their seed coat.

Man is responsible for the dispersal of many fruits and seeds. In the pursuit of more economy, useful plants like Cinchona, Rubber and Eucalyptus have been successfully introduced by man and they have become acclimatized to the new surroundings far away from their original habitat.

MORE TO KNOW

Darwin used seeds of cress, cabbage, lettuce and onion. Darwin also studied the effect of water, temperature and sea water on germination and floating of seeds. His experiments overturned the idea that sea water kills seeds. Of the 87 species he used, Darwin found that almost three-quarters of the seeds studied could tolerate salt water for at least 28 days.



Fig. 4.22 Zochory(*Achyranthus*)

Collect some of the plants around you.
What are their local names?

Can you find out their botanical names?

ACTIVITY 4.10

- Collect a few fruits or seeds which have wings.
- Observe the fruit of *Tridax* and draw a diagram. Look at the pappus calyx.
- Why is the mesocarp of the coconut fibrous?

MODEL EVALUATION

PART - A

1. The method of reproduction in unicellular organisms like amoeba and bacteria in which they split into two equal halves and produce new ones is called _____.
 i) fragmentation ii) binary fission iii) budding iv) spore formation
2. In sexual reproduction of flowering plants, the first event involved in this is _____.
 i) fertilization ii) germination iii) regeneration iv) pollination
3. Which of the following statement is true?
 i) Thin-walled non-mobile spores are called zoospores.
 ii) A motile asexual spore produced by some algae, bacteria and fungi are Akinetes.
 iii) Uninucleate, non-motile, asexual spores produced by fungus are called conidia.
 iv) Thick-walled vegetative cells produced by algae during adverse conditions are called aplanospores.
4. The fertilized ovary is a fruit. The fruit that develops from a single flower with multi carpellary, apocarpous superior ovary is _____.
 i) Aggregate fruit ii) Composite fruit iii) Simple fruit iv) Multiple fruit

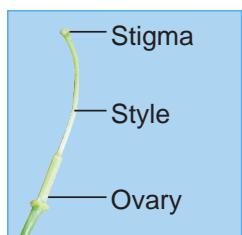
5. If a water soaked seed is pressed, a small drop of water comes out through the _____.
i) stomata ii) lenticel iii) micropyle iv) radicle
6. The mango fruit is called a stone fruit because it has _____.
i) skinny epicarp ii) stony mesocarp iii) fleshy endocarp iv) hard endocarp
7. Pick out the wrong statement.
i) In a dicot seed there is a short longitudinal whitish ridge called the raphae.
ii) The minute opening in a dicot seed is known as micropyle.
iii) The rudimentary stem portion is known as radicle.
iv) The rudimentary root portion is called radicle.
8. Consider the following statements regarding the dispersal of fruits and seeds by wind and select the correct answer.
i) Fruits and seeds are dispersed with a sudden jerk by an explosive mechanism.
ii) The fruits of tridax carry a persistent calyx modified into pappus.
iii) The fruits of xanthium have sharp pointed stiff hooks.
iv) The mesocarp of coconut is fibrous.
9. The product of triple fusion which acts as nutritive tissue for the development of an embryo is _____.
i) zygote ii) placenta iii) scutellum iv) endosperm
10. The disadvantage of self-pollination is _____.
i) There is no wastage of pollen grains. ii) The seeds are less in number.
iii) Self-pollination is sure in bisexual flowers iv) Flowers need not depend on agents of pollination.
11. The flower is important to a plant because it helps in _____.
i) attracting ii) production of nectar iii) pollination iv) sexual reproduction
12. The essential organs of the flower are _____.
i) Calyx and Corolla ii) Androecium and Gynoecium
iii) Calyx and Androecium iv) Corolla and Gynoecium
13. Cross pollination is important for producing _____.
i) new varieties of plants ii) plants with better growth
iii) More viable seeds iv) all of the above
14. Anemophily occurs in _____.
i) Vallisneria ii) Grass iii) Coconut iv) Datura

15. Which of the following structure / arrangement favours entomophily ?
 i) Pollen grains with wings and feathery stigma ii) Colourful petals and nectar secretion
 iii) A bunch of flowers with less pollen iv) Pollen grains with mucous covering.
16. Post-fertilization, the ovule changes into a/an _____ .
 i) seed ii) fruit iii) endosperm iv) pericarp.
17. Which of the following is correctly matched?
 i) False fruit – mango ii) Multiple fruit – apple
 iii) Aggregate fruit – polyalthia iv) Caryopsis – banana
18. Identify the mismatched pair.
 i) Legume – Dry dehiscent fruit ii) Cypsela – Dry indehiscent fruit
 iii) Pome – Fleshy fruit iv) Regma – Resembles legume

PART - B

1. Write any two differences between asexual and sexual modes of reproduction.
2. What is vegetative propagation? Mention the vegetative propagules in:
 i) Bryophyllum ii) Spirogyra
3. Arrange the following events of sexual reproduction in plants in the correct sequential order :
 seed formation, pollination, dispersal of seeds, fertilization.
4. Define pollination.
5. Define fertilization.
6. Name the agents of pollination in the following cases:
 i) Bright coloured flowers with scent and nectar glands.
 ii) No colour / scent/ nectar but pollen grains are dry, light weight and powdery. Stigma is feathery.
 Also mention the plants in cases (i) & (ii).
7. Name the events (i) & (ii) and mention the nature of the nuclear structures formed at the end in the following cases:
 (i) male gamete (n) + egg (n) = Zygote ($2n$)
 (ii) male gamete (n) + secondary nucleus ($2n$) = Endosperm nucleus ($3n$).
8. Differentiate dehiscent fruits and indehiscent fruits with suitable examples.
9. What are monocotyledons and dicotyledons? Give examples.
10. Give suitable terms for the following methods of seed / fruit dispersal, with one example each: (i) by wind (ii) by water (iii) by animals.
11. Give any two examples for each of the following cases where dispersal of fruits and seeds take place : (i) by birds (through excreta) (ii) by human beings

12. What is double fertilization?
13. What is triple fusion?
14. a. Identify Fig. A and B.
b. Which part of A is modified into B.



A



B

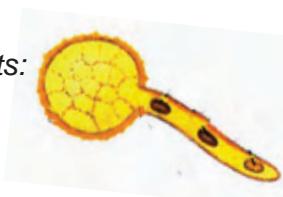
15. The methods of reproduction and the organisms are given below. Match the type of reproduction with the suitable organism.

Fission	Spirogyra	Yeast
Budding	Protozoans	Flatworms
Fragmentation	Bryophyllum	Bacteria

16. i) Composite fruits are formed by all the flowers of _____,
ii) _____ fruit is developed from a single flower with a multicarpellary apocarpous superior ovary.

17. Draw the given diagram and label the following parts:

- i) Exine ii) Tube nucleus.



18. Match the following with respect to dispersal of fruits / seeds:

a) Autochory	I) Lotus
b) Anemochory	II) Xanthium
c) Hydrochory	III) Tridax
d) Zoochory	IV) Balsam

19. Use words from the given list to complete the following paragraph. (The words may be used once / more than once / not at all).

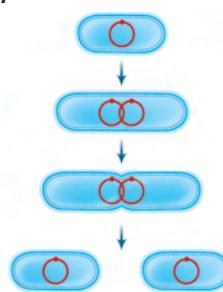
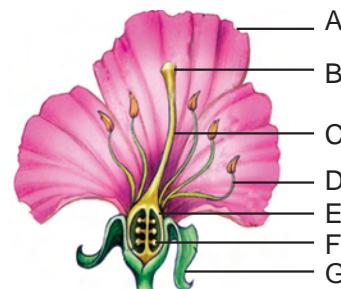
(seed, fruit, pollination, dispersal, germination, fertilization, flower, reproduction)

Ramu went to the field along with his father. He sowed mustard seeds in the soil. After a few days he observed the process of _____. The seeds grew into plants and produced _____. On maturity, these flowers produced pollen grains that were transferred to the stigma by _____. The male gametes fused with the female gametes during the process of _____.

20. Coconut seeds are dispersed by *Hydrochory* (dispersal by water). Mention the part of the fruit whose modification help in this mechanism.

PART - C

1. i) Name the process by which a fruit is developed.
ii) Explain the development process in brief.
iii) Draw a neat, labelled diagram of that process.
2. Write the two events involved in the sexual reproduction of a flowering plant.
i) Discuss the first event and write the types.
ii) Mention the advantages and the disadvantages of that event.
3. i) Fruit is the product of fertilization. Is there any fruit which is formed without the act of fertilization?
ii) Represent the classification of fruits in a diagrammatic sketch.
4. Compare aggregate fruits with multiple fruits and give suitable examples.
5. Describe the structure of a dicot seed.
6. Describe the structure of a monocot seed.
7. Observe the given diagram:
i) Draw the diagram and label the parts.
ii) What happens to the parts labelled 'E' and 'F', after the process of fertilization?
8. Look at the diagram given below:



Answer the following:

- i) Name the method of reproduction depicted here.
- ii) Name an organism in which you find this method of reproduction.
- iii) Does this method of reproduction favour variation?

9. Imagine you have a garden with the plants listed below. A swarm of bees visit your garden. Do you think the bees will visit all the flowers? Name the flowers which you think the bees will be attracted to. Give reasons to substantiate your answer.

(Jasmine, Nerium, Gulmohar, Rose, Lotus, Corn, Sugarcane, Bamboo, Chrysanthemum, Dahlia, Grass, Coconut and Peas)

10. A farmer has two fields A and B. He cultivates peas (*Pisum sativum*) in both the fields. Field A is covered with nets to keep out birds and insects. Field B is left uncovered.

i) Name the type of pollination that would occur in field 'A' and field 'B'

ii) Which of these fields will give a higher yield?

iii) To raise the next crop, from which field should the seeds be chosen by the farmer. Give reason to support your answer.

11. Mango and Coconut are both drupes. The mesocarp of mango is edible, while it is not so in coconut. Based on this fact, answer the following:

i) Which part of the coconut is edible?

ii) Why does the coconut have a fibrous mesocarp?

iii) Can you mention any other use of the fibrous mesocarp?

12. Group the following under the given heads: (a) fruit (b) seed (c) neither fruit nor seed.
tomato, cucumber, sprouted pulses, naked bean, grapes, celery, potato, sugarcane, apple, runner bean.

13. Ramu and Somu happened to observe *Calotropis* seeds floating in the air. They decided to follow a few of them till the seeds landed on the ground. They recorded their observations in a table as follows:

Distance travelled by seeds in metre	Time taken in minutes
25	6
50	15
37	10
87	17
17	2

i) Draw a graph for the above data taking Distance on 'X' axis and Time on 'Y' axis.

ii) Is there any relationship between the distance travelled and the efficiency of dispersal?

iii) State the inference you draw from the graph.

14. Given below is a list of dry fruits. Assign the fruits to their relevant types.

(Cotton, Tridax, Paddy, Castor, Coriander, Beans, Peas, Calotropis, Mirabilis, Cashew, Acacia, Lady's finger)

- | | | | |
|------------------------|---------------|--------------|---------------------------|
| i) Achene | ii) Caryopsis | iii) Cypsela | iv) Nut |
| v) Cremocarp | vi) Lomentum | vii) Regma | viii) Loculicidal capsule |
| ix) Septicidal capsule | | x) Follicle | xi) Legume |

15. Monish enters the kitchen and happens to see his mother getting the ingredients ready to prepare kadamba sambar. He sees the ingredients laid out in the kitchen. Help him sort out the ingredients into the fruit types you have studied.

(dhal, tamarind, brinjal, tomato, drumstick, coriander, mustard, lady's finger, mango)

16. Name the parts of a dicot seed based on the given clues:

- i) Rudimentary root_____.
- ii) Rudimentary shoot_____.
- iii) Fleshy structure storing food for the embryo_____.
- iv) The outer protective layer of a seed is _____.
- v) The minute opening seen in the seed coat is _____.

17. What are the types of pollination? Which among them is more advantageous? Why?

18. What is self-pollination? Mention its merits and demerits.

19. What is known as pollination? List out biotic and abiotic factors which are involved in pollination?

FURTHER REFERENCE

Book: 1. Plant Reproduction - S.R.Mishra - Discovery Publishing House Pvt. Ltd, New Delhi.

2. Complete Biology (IGCSE) - Oxford University press, New York.

Webliography: www.biologyreference.com science.howstuffworks.com

NAMES OF PLANTS IN ENGLISH AND TAMIL

S.No.	Botanical Name	Common Name in English	Tamil Name	How is it called locally?
1	<i>Abelmoscus esculentus</i>	Lady's finger	வெண்ணட்ட	
2	<i>Acacia coccina</i>	Soap acacia	சிகைக்காய்	
3	<i>Achyranthes aspera</i>		நாயுருவி	
4	<i>Anacardium occidentale</i>	Cashew	முந்திரி	
5	<i>Anona squamosa</i>	Custard apple	சீதாப்பழம்	
6	<i>Artocarpus integrifolia</i>	Jack fruit	பலா	
7	<i>Bryophyllum</i>		குட்டிப் பேஷ்டால் குட்டிப்போடும்	
8	<i>Calotropis gigantea</i>	Madar plant	எருக்கு	
9	<i>Citrus sinensis</i>	Sweet orange	சாத்துக்குடி	
10	<i>Cocos nucifera</i>	Coconut	தென்னை	
11	<i>Coriandrum sativum</i>	Coriander	கொத்துமல்லி, தனியா	
12	<i>Gossypium arboreum</i>	Cotton	பருத்தி	
13	<i>Cucumis sativus</i>	Cucumber	வெள்ளரிக்காய், தோசைக்காய்	
14	<i>Cucurbita maxima</i>	Pumpkin	பூசணிக்காய்/ பரங்கிக்காய்/ அரசாணைக்காய்	
15	<i>Cuscuta reflexa</i>	Amar bell	அம்மையார் கூந்தல்	
16	<i>Ficus glomerata</i>	Fig	அந்தி	
17	<i>Impatiens balsamia</i>	Balsam	பால்சம்/பால்செண்டு	
18	<i>Lablab purpureus</i>	Bean	அவரை	
19	<i>Lycopersicon esculentum</i>	Tomato	தக்காளி	
20	<i>Mangifera Indica</i>	Mango	மா	
21	<i>Mimosa pudica</i>	Touch-me-not plant	தொட்டால் வாடி/ தொட்டால் சுருங்கி / தொட்டால் சிறுந்கி	
22	<i>Mirabilis jalapa</i>	Four o' clock plant	அந்திமந்தாரை / அந்தி மல்லிகை	
23	<i>Nelumbo nucifera</i>	Indian lotus	தாமரை	
24	<i>Oyza sativa</i>	Paddy/ rice	நெல்	
25	<i>Pisum sativum</i>	Pea	பட்டாணி	
26	<i>Polyalthia longifolia</i>	Mast tree	நெட்டிலிங்கம்	
27	<i>Pyrus malus</i>	Apple	ஆப்பிள்	
28	<i>Ricinus communis</i>	Castor	ஆமணக்கு/முத்துக் கொட்டை	
29	<i>Tridax procumbens</i>		வெட்டுக்காயப் பூண்டுச்செடி	



A REPRESENTATIVE STUDY OF MAMMALS

Mammals are a divergent group of animals, occupying different biomes of the environment, successfully adapting to their habitats. Mammals are found almost in all habitats like oceans, freshwater bodies, hilly regions, forests, deserts, polar regions and swamps.

5.1. MORPHOLOGY

Mammalian morphology is very divergent, because mammals occupy different habitats. Sea mammals like dolphins and whales are not forms of fish and they differ in structure and behaviour. They originated (evolved) from land mammals. The nocturnal bat gliding in the sky, looks like a bird but is really a mammal.

Mammals are distinguished from other vertebrates by two fundamental characteristics that no other living vertebrate possesses. They are:

1. Epidermal Hair
2. Milk producing glands

Epidermal Hair

All mammals have hair. Even apparently hairless whales and dolphins possess hair in the embryonic stage and grow sensitive

bristles on their snouts when they turn adults. Mammalian hair is a new form of skin structure- a derivative of the skin. Hair is an insulator against heat loss. The colour and pattern of mammal's skin usually matches its background. Hair is also a sensory structure, as the whiskers of cats and dogs are sensitive to touch. Hair also acts as a defensive mechanism for porcupine and hedgehogs. Their long, sharp, stiff hair called **quills** protect them from predators.

Milk producing glands

All female mammals possess functional mammary glands that secrete milk. New-born mammals born without teeth are suckled by their mothers. Milk producing glands are modified sweat glands.

5.2. HABITAT

Habitat is the place where an organism lives. Mammals exhibit a great degree of functional adaptation to fit in the habitats in which they live. We find mammals living in high mountains, plains and forests, tundra regions, grasslands, deserts, fresh water and marine habitats. Some mammals and their habitats are listed below:

High mountains	- mountain goat, big-horned sheep, grizzly bear.
Plains and forests	- porcupine, giant squirrel, deer, elephant, tiger, leopard, rhinoceros, Hippopotamus.
Tundra	- reindeer, muskdeer, ox, rodent.
Deserts	- black buck, Indian wild ass.
Fresh water bodies	- beaver, platypus, otter.
Oceans	- whale, dolphin, dugong, porpoise, seal, walrus.



Fig. 5.1 Mammals from divergent habitats and their young

5.3. MAMMALIAN ADAPTATIONS

Mammals are the most successful group of animals adapted to various conditions of life.

- i) In marine-mammals like whales and dolphins the limbs are modified into flippers which are used as oars to swim in water. They also possess huge subcutaneous fat

deposits to conserve heat. The jaws of the whales are modified into baleen plates to sieve the water and trap minute planktonic organisms called krill, which is their food.

- ii) The skin of the camel is doubly thick and contains water-storing osmotic cells to conserve water, as they live in deserts.

A REPRESENTATIVE STUDY OF MAMMALS

- They have thick bushy eyebrows covering the eyes to protect their eyes from sand storms. Their nostrils can be closed during desert storms to prevent the entry of sand particles.
- iii) Some mammals are herbivores, eating only plants. To digest the cellulose-rich food, they have developed a mutual partnership with bacteria that have cellulose-splitting enzymes(cellulase).
- iv) Mammals such as cows, buffaloes, antelopes, goats, deer have a huge four-chambered stomach that functions as storage and fermentation vats. The stomach of cattle also helps them to ruminate or chew the cud.
- v) Mammals have heterodont dentition with different types of teeth that are highly specialized to match specific eating habits. For example, the carnivorous animals have canine teeth to tearing flesh. In elephants, the incisors are modified into tusks and are used in defence.
- vi) Bats are the only mammals that are capable of flight. The forelimbs of bat's are modified into a wing-like structure. The bats wing-patagium is a leathery membrane of skin and the muscle is stretched over the bones of the fingers. Bats prefer to hang upside down from their legs, while resting. The nocturnal bat can fly without crashing into things and still capture insects by echo location. As a bat flies, it emits a rapid series of extremely high pitched clicking sounds. The sound waves bounce off objects or flying insects and the bat hears the echo.
- vii) Marsupials, like kangaroo, have developed abdominal pouches to bear young ones.
- viii) Polar bears have thick skin and wooly fur so as to withstand cold weather in the polar regions.
- ix) Man is an intellectual social animal. The fingers and toes are adapted for extremely deft movements in holding fine objects, in writing and handling delicate instruments.

ACTIVITY 5.1

Observe the hair of dog, cat, cattle, man, horse and donkey. Look for the structural details like shape, texture and curly or straight condition and record your findings.



Fig. 5.2 Bat

5.4. BASIC PHYSIOLOGICAL FUNCTIONS

The physiological functions and processes are highly complex in mammals.

Mammals are warm-blooded or homeotherms, maintaining a constant body temperature, irrespective of the temperature in the surroundings. The body temperature in man is maintained at 98.4° F to 98.6° F. The regulation of temperature is performed as a team work, by the sweat glands of skin, kidneys, lungs and blood.

In summer, we sweat more as a cooling mechanism, to conduct the heat out through the sweating process. This is possible with increased blood supply to the sweat glands. The kidneys expel less urine, since much of water is lost in the form of sweat.

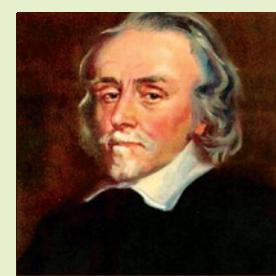
In winter, we produce little sweat as a warming mechanism to conserve heat. The sweat glands are supplied with less amount of blood, so that the amount of heat loss is lowered. Now the kidneys excrete more amount of urine.

In mammalian red blood cells (RBC) are fully packed with the respiratory red blood pigment called haemoglobin, to carry maximum amount of oxygen. The mammalian RBCs are without nucleus, as the space occupied by the nucleus is taken up by the haemoglobin molecules.

5.5. CIRCULATORY SYSTEM OF MAN

The circulatory system has evolved in order to transport substances from one part of the body to the other. In man, the circulatory system is composed of :

- i) the heart
- ii) the blood vessels namely arteries, veins and capillaries
- iii) the blood
- iv) the lymph.



William Harvey 1578-1657 was an English physician. He was the first to give details about blood circulation, properties of blood and pumping of blood by the heart.

William Harvey discovered the circulation of blood in man in 1628. Until then, it was thought that the human body is a blood-filled entity, and the blood is stagnant in it.

The Heart

The human heart is a hollow, fibromuscular organ. It is in the shape of an inverted cone. The heart is covered by a protective double layered membrane called pericardium filled with pericardial fluid. The heart is made up of a special type of muscle, called cardiac muscle. The partitions within the heart divide the heart into four chambers the auricles and the ventricles. The right half of the heart receives and pumps out deoxygenated blood and the left half of the heart receives and pumps out oxygenated blood.

Auricles

The auricles are the thin-walled upper chambers of the heart. They are divided into a right auricle and a left auricle, by a partition called inter-auricular septum. Auricles are the receiving chambers of blood. Into the right auricle, open the superior venacava and inferior venacava emptying the deoxygenated blood brought

from different parts of the body. Into the left auricle open the four pulmonary veins emptying the oxygenated blood brought from the two lungs.

Ventricles

The ventricles are the thick-walled lower chambers of the heart. A partition called inter-ventricular septum divides the ventricle into the right and the left ventricles. The ventricles pump the blood out from the heart. From the right ventricle, the deoxygenated blood is pumped into the pulmonary artery and is taken to the lungs. From the left ventricle, the oxygenated blood is pumped into the aorta to supply the oxygenated blood to various parts of the body through its branches.

Apertures of the Heart

Between the right auricle and the right ventricle is found the right auriculo-ventricular aperture. Between the left auricle and the left ventricle is found the left auriculo-ventricular aperture.

Valves of the Heart

A tricuspid valve with three flaps is found in the right auriculo-ventricular aperture to regulate the flow of blood, from right auricle to right ventricle and it prevent the back flow of blood.

A bicuspid valve or mitral valve with two flaps is found in the left auriculo ventricular aperture to regulate the flow of blood, from left auricle to left ventricle and prevents the back flow of blood.

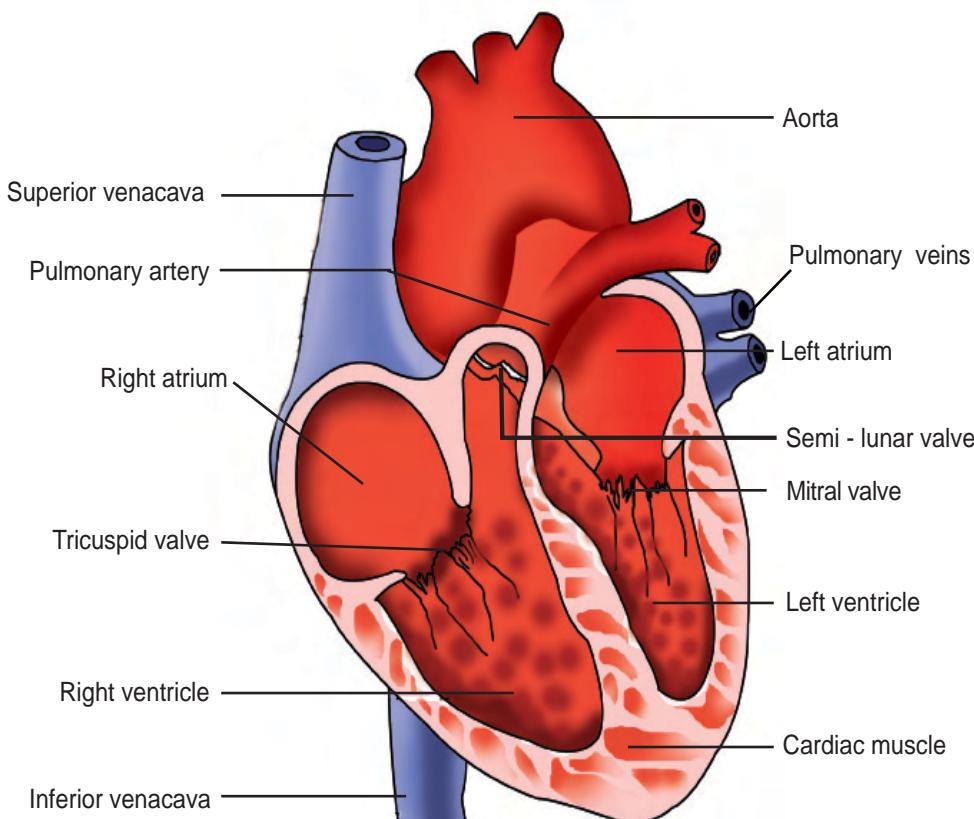


Fig. 5.3 Human Heart

ACTIVITY 5.2

Measure the body temperature of some of your classmates at 10 a.m., 1 p.m. and 4 p.m. Record the same. Do you notice any change in the temperature at different timings?

At the base of the pulmonary artery is present, the semi-lunar valve. It regulates the blood to flow from the right ventricle to the pulmonary artery.

At the base of the aorta is present the aortic valve. It regulates the flow of blood from the left ventricle into the aorta.

Heart Function

The human heart works by contraction and relaxation of the cardiac muscles. The contraction phase is called systole and relaxation phase is called diastole.

When the auricles are filled with blood, they are in relaxation phase (auricular diastole). By now, the ventricles will push the blood into the aorta and the pulmonary artery by their contraction (ventricular systole).

When the auricles contract (auricular systole) the blood is pushed into the ventricles through the bicuspid and the tricuspid valves, leading to ventricular relaxation (ventricular diastole).

Heartbeat

The closure of the valves of the heart produce two different cardiac sounds- “lubb” and “dubb”. The human heart beats 72 times a minute when the body is at rest. Heartbeat is an inherent capacity of the heart. The heartbeat begins and is conducted by the specialized muscle bundle in the heart.

Blood Vessels

There are three distinct types of blood vessels namely, arteries, veins and capillaries.

Arteries

Arteries carry the blood from the heart to different parts of the body. They are the branches of aorta, supplying oxygenated blood to the various regions of the body (except pulmonary artery which carries deoxygenated blood). The aorta branches into arteries. Arteries branch into arterioles. Arterioles branch into fine tubes called meta arterioles. The meta arterioles end up in the tiny blood vessels called capillaries.

Capillaries

Capillaries are tiny blood vessels that form a network, called capillary network around the tissues. They enable the passage of substances from the blood into the tissues.

Veins

The veins carry the blood from different parts of the body to the heart. The capillaries reunite to form venules, which carry the deoxygenated blood from the tissues. The small venules rejoin the big veins and open

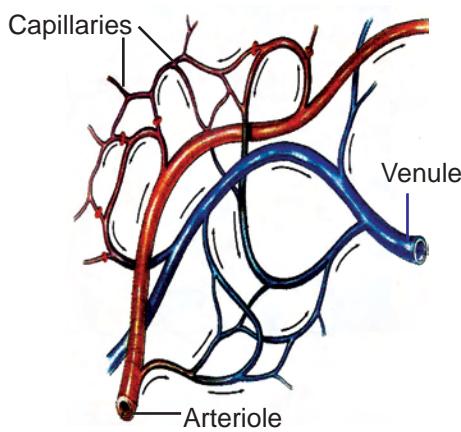


Fig. 5.4 Arteries, Capillaries and Veins

A REPRESENTATIVE STUDY OF MAMMALS

into the superior venacava and inferior venacava. Except for the pulmonary veins, all other veins carry deoxygenated blood.

Blood

Blood is the red river of life – providing the internal environment to the body. Blood is the connective tissue, consisting of the fluid part called plasma and the solid components, the blood cells.

Plasma

The liquid component of blood is the plasma. It is composed of water, organic substances, inorganic substances, etc.,. The important organic substances of plasma are the plasma proteins namely globulin (for immunity), fibrinogen (for blood clotting) and albumin (for water balance).

Blood Cells

There are three types of blood cells namely Red Blood Cells, White Blood Cells and Blood Platelets. They float freely in the plasma.

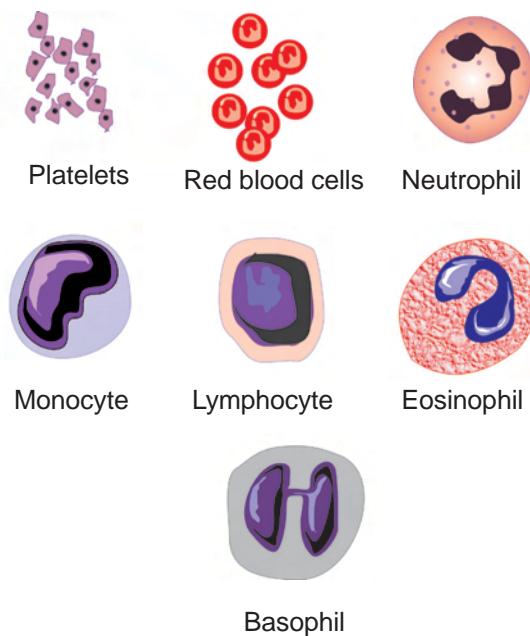


Fig. 5.5 Blood Cells

Red Blood Cells –Erythrocytes

RBCs are circular, biconcave and disc shaped. While the young RBCs have nuclei, the matured ones are without nuclei. The red blood pigment haemoglobin is fully packed in the RBCs. They are concerned with the carrying of respiratory gases.

White Blood Cells – Leucocytes

WBCs are amoeboid in shape with prominent nuclei. WBCs are involved in phagocytosis i.e engulfing the germs and producing antibodies to resist the pathogens entering the body(immunity).

Blood Platelets – Thrombocytes

Platelets are irregular broken pieces of certain giant cells of the bone marrow. They are concerned with blood clotting to prevent blood loss.

5.6. EXCRETORY SYSTEM IN MAN

Excretion is getting rid of metabolic waste products from the body.

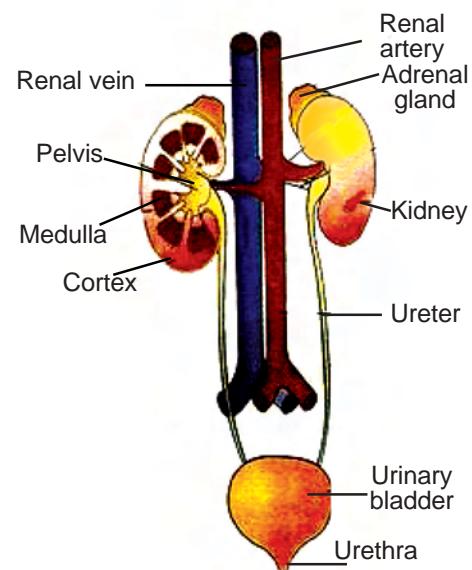


Fig. 5.6 Excretory System of Man

The principal excretory organs of our body are the kidneys. They maintain the chemical composition of the blood and so are called as the master chemists of our body.

External Structure of Kidney

A pair of kidneys are present in the upper abdominal region, one on either side of the vertebral column attached to the dorsal body wall. A thin transparent membrane called 'capsule' covers the kidney. The kidneys are bean-shaped with outer convex surface and inner concavity. The depression in the concavity is called renal hilus, from which arises the muscular tube called the ureter. The two ureters open into the distensible muscular sacs called the urinary bladder, stores urine. From the urinary bladder arises the urethra through which, urine passes out of the body.

Internal Structure of Kidney

The outer portion of the kidney is dark in colour and is called renal cortex. The inner

pale region of the kidney is called renal medulla. Renal medulla contains conical masses called renal pyramids. On the renal pyramids are found the openings called renal papillae, which open into the inner space of the kidney called renal pelvis. From the renal pelvis arises the ureter.

The kidneys are composed of millions of units called nephrons.

Structure of a Nephron

Nephrons are the structural and functional units of the kidney. Each kidney is composed of millions of nephrons. A nephron has two structural components namely, Malpighian capsule and Uriniferous tubules.

Malpighian Capsule

This consists of a network of blood capillaries called glomerulus and a double-walled cup called Bowman's Capsule. The glomerulus is a network of blood capillaries, formed by the branches of the wider afferent renal arteriole. From the glomerulus arises

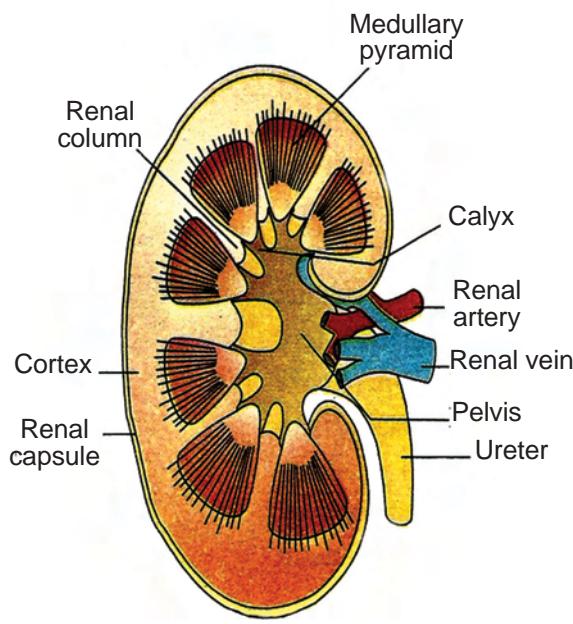


Fig. 5.7 LS of Kidney

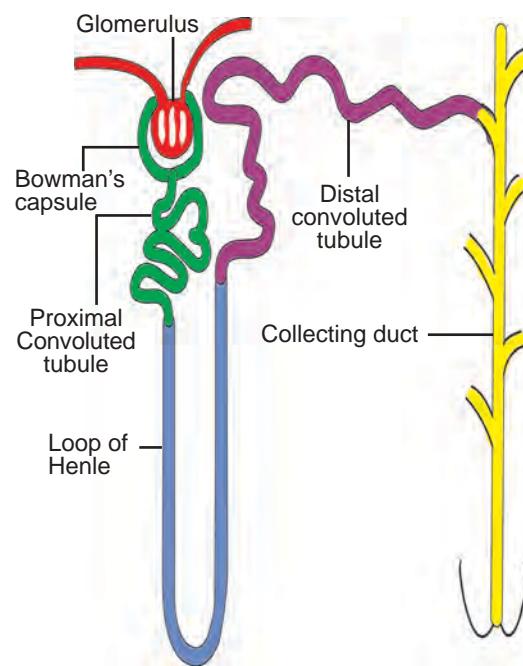


Fig. 5.8 Nephron

The important excretory organ and their excretory products

Excretory organ	Disposed as	Excretory products
Kidneys	. Urine	Nitrogenous waste products – urea, uric acid, creatinine, etc,
Lungs	Exhaled / Expired air	Carbondioxide and water-vapour
Skin	Sweat	Excess water and salt

the narrow efferent renal arteriole, which branches over the rest of the nephron as network of capillaries. The Bowman's capsule accommodates the glomerulus.

Uriniferous Tubules

From the Bowman's capsule arises the Uriniferous tubule. It is divided into three parts the initial coiled proximal convoluted tubule, the middle U-shaped Henle's loop and the later coiled distal convoluted tubule. The distal convoluted tubule straightens as the collecting ducts. The collecting ducts open on the renal pyramids as renal papillae. The nephrons filter the blood and form the urine.

5.7. RELATIONSHIP BETWEEN STRUCTURE AND FUNCTION

Based on the functional need, a particular organ or part is modified in structure. Thus a structure is well adapted to perform a specific function. So structure and function go hand-in-hand. The fore-limbs of different mammals are modified suitably to perform different functions, according to their environment. For example, all the vertebrates in general, and all mammals in particular, have a common basic pattern of construction of their forelimbs. The forelimbs of mammals consist of five parts namely upper arm, fore arm, wrist, palm and phalanges, but they are used differently in different

animals as follows:

- i) Man uses his forelimb to hold an object, write, play musical instruments and handle delicate digital devices. The thumb is deviant from other four fingers, to enable man to perform the above tasks.(opposable thumb)
- ii) A horse uses its fore-limb to gallop.
- iii) A rat or bandicoot uses its fore-limb to make holes in the ground to live in.
- iv) A giraffe uses its long and stout forelimbs to reach the vegetation, on top of plants and tall trees.
- v) A monkey leaps from one branch of the tree to another using its forelimb to hold, swing and jump.
- vi) In whales the limbs are modified into flippers which are used as oars to swim.

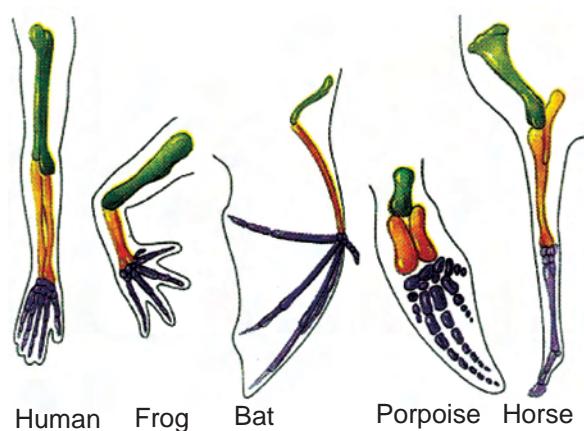


Fig. 5.9 Basic pattern of forelimbs of vertebrates



Fig. 5.10 Honey Bee

5.8. ANIMAL BEHAVIOUR

Behaviour can be defined as an organism's adaptive response to stimuli in its environment. The stimuli may be as simple as the smell of food. The Nervous System perceives and passes the information concerning environmental stimuli and triggers adaptive motor response which, we see as patterns of behaviour.

Social Behaviour

Behaviour is both an instinctive process (influenced by genes) and a learned experience (gained by experience).

Social attachment among animals is called **imprinting**. The binding or attachment between the parents and the offspring is called **filial imprinting**. At times, we find the young one of a species raised by a parent of another species (e.g. the chick of a cuckoo bird is fed by a crow in its nest). This behavioural pattern is called **cross fostering**.

Many insects, fishes, birds and mammals live in social groups, in which information is communicated among group members. For example, some individuals in mammalian societies serve as guards.

In an elephant herd, it is always the oldest she-elephant that leads the herd,

while the strong males form the periphery of the herd and the young calves and other she-elephants will be in the middle.

Sexual Behaviour

The opposite sexes coming close to each other is both by instinctive process and sexual attraction, exhibited by one or both the partners. The secondary sexual characters developed during the breeding season bring the two sexes together for sexual reproduction.

Sexual Imprinting

It is a process in which an individual animal learns to direct its sexual behaviour at a member of its own species. During the courtship, animals produce signals to communicate with potential mates and with other members of their own sex. A behaviour exhibited by one sex to attract the opposite sex is called courtship signalling. Many courtship signals are species-specific to help animals avoid making errors in mating.

Parental Care

Any investment made or any effort taken by the parent to take care of the young ones in order to increase the chance of



Fig. 5.11 Parental care in elephants

A REPRESENTATIVE STUDY OF MAMMALS

survival of the offspring and hence increase the reproductive rate of success is called parental care. The parents care for their young ones, provide good nutrition, protect them from predators and help the young ones lead a successful life.

Feeding the young one with milk secreted from its mammary glands and aggression exhibited against the predator are the best examples of parental care. Even after nutritional independency is acquired by the young one (i.e. it is able to feed itself), the parental care is extended in some species beyond this stage.

5.9. A RESEARCHER'S CASE STUDY ON ANIMAL BEHAVIOUR

The behavioural patterns in different situations are investigated in the research projects taken up by leading universities in Tamilnadu.

The abstract of case study by Arun Venkatraman, Asian Elephant Conservation Centre, Centre for Ecological Science, Indian Institute of Science – Bangalore on Dholes is given below.

(Courtesy:
Researcher – Mr.Arun Venkatraman)



Fig. 5.12 Dholes

Asiatic wild dog “Chen Nai” – in Tamil, commonly called Dholes – Cuon alpines is an endangered species living in Mudumalai Wildlife Sanctuary at Nilgiris, Tamilnadu.

The Dholes live in packs of 8-10 which consist of old females, males, females and pups. The pack members co-ordinate while attacking and killing a large prey such as an adult Sambar deer. There is a tendency to share the meat among the members of the pack. However, there prevails a squabbling among them to grab the choicest piece of meat. The young pups are allowed to take their share of meat first. The old males follow them. The other young ones and old females usually lag behind.

The Dholes also exhibit a high degree of parental care by shifting their den frequently so that the pups are kept safe from predators such as leopards and hyenas.

CASE STUDY

Conduct a case study on the behavioural aspects of your pet dogs with reference to their territorial dominance, when strangers or other dogs try to enter your locality.

ACTIVITY 5.3

- Follow an ant line and try to break its route by drawing a line with your finger without killing any ant.
- Observe the behaviour of the ants as to whether they change the path or go in disarray.
- Try to observe for a few minutes to see if they resort to any change in their route. Prepare a report of their behaviour and submit.

MODEL EVALUATION

PART - A

1. Select important characteristic features of mammals
 - i) four-chambered heart
 - ii) fore-limbs and hind limbs
 - iii) milk-producing glands
 - iv) post anal tail
2. Carnivorous animals use these teeth to tear flesh.
 - i) incisors
 - ii) canines
 - iii) premolars
 - iv) molars
3. The Henle's loop of nephron is mainly responsible for reabsorption of water in the kidney. Which of the following has a long loop of Henle in its nephrons to conserve water?
 - i) polar bear
 - ii) camel
 - iii) frog
 - iv) whale
4. Which blood cells of mammals are concerned with immunity?
 - i) Young Erythrocytes
 - ii) Leucocytes
 - iii) Thrombocytes
 - iv) Matured Erythrocytes
5. You were given two unlabelled slides with blood smears of an amphibian and a mammal. You would differentiate the blood samples by observing the _____.
 - i) colour
 - ii) nature of RBC's
 - iii) nature of WBC's
 - iv) contents of plasma
6. For the digestion of cellulose, an enzyme called cellulase is required. Some mammals lodge cellulase producing bacteria in their digestive system by offering them food and shelter. These mammals are mostly _____.
 - i) Herbivores
 - ii) Carnivores
 - iii) Omnivores
 - iv) Sanguivores
7. Forelimbs of mammals have a common basic structure or pattern, but are different in their usage/ function in different animals. They can be called _____.
 - i) Homologous organs
 - ii) Analogous organs
 - iii) Vestigial organs
 - iv) Rudimentary organs
8. Sensitive whiskers are found in _____.
 - i) Bat
 - ii) Elephant
 - iii) Deer
 - iv) Cat
9. The tusks of elephants are modified _____.
 - i) Elephant
 - ii) Dolphin
 - iii) Deer
 - iv) Kangaroo
10. Pick out an animal which has a four-chambered stomach.
 - i) Elephant
 - ii) Dolphin
 - iii) Deer
 - iv) Kangaroo
11. Normal body temperature of man is _____.
 - i) 98.4 – 98.6°F
 - ii) 96.6 – 96.8°F
 - iii) 94.4 – 98.6°F
 - iv) 98.4 – 99.6°F

A REPRESENTATIVE STUDY OF MAMMALS

12. Mitral valve is found between _____.

- i) Right auricle and right ventricle
- ii) Left auricle and left ventricle
- iii) Right ventricle and pulmonary artery
- iv) Left ventricle and aorta

13. Assertion (A) : Mammalian heart is called myogenic heart.

Reason (R) : Heartbeat is regulated by a specialized muscle bundle (pacemaker) in mammals.

- i) Both 'A' and 'R' are true and 'R' explains 'A'.
- ii) Both 'A' and 'R' are true but 'R' doesn't explain 'A'.
- iii) 'A' is true but 'R' is false.
- iv) A is false but 'R' is true.

14. One of the following groups contains a non-mammalian animal. Pick up the group.

- i) dolphin, walrus, porcupine, rabbit, bat
- ii) elephant, pig, horse, donkey, monkey
- iii) antelope, deer, cow, buffalo, black buck
- iv) dog, cat, crocodile, lion, tiger

15. The epidermis of mammals contains _____.

- i) hair, bristles, quills
- ii) hair, nails, claws
- iii) hair, bristles, horns
- iv) hair, nails, scales

16. Based on relationship, fill in:

Whale: Flippers:: Bat : _____

17. Fill in the blank.

RBC: Carrier of oxygen; WBC: _____

18. Based on modifications, make the pairs:

incisor: tusks of elephant; _____ : quills of porcupine

PART - B

1. Mention the two unique characteristics of mammals.

2. Give two examples each: (i) ruminating mammals (ii) marine mammals.

3. What type of dentition is seen in mammals? What are elephant tusks?

4. Mention any four adaptations seen in the camel so that it can live successfully in deserts.

5. What is echo location? Give an example.

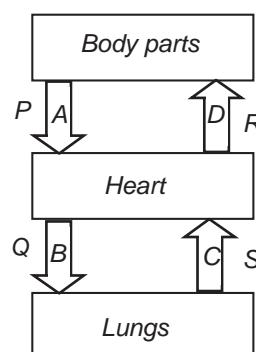
6. Mention the various valves and their location in the human heart.

7. Write any four differences between arteries and veins in mammals.

8. Name the three important blood proteins seen in plasma. Add a note on their functions.
9. Which blood cells are without nuclei? What is the advantage of this condition?
10. Name the protein and the blood-cells responsible for the clotting of blood.
11. i) What are the structural and functional units of kidney?
ii) Arrange the organs of the human excretory system in the correct order, based on the passage of urine.

Ureter, Urethra, Kidney, Urinary bladder

12. Observe the following flow-chart depicting blood-circulation in mammals.



Pick out the correct blood vessels A,B,C,D from the following:

- i) Pulmonary veins ii) Venacava iii) Pulmonary artery iv) Aorta

Among the P,Q,R and S samples, identify the correct match from the following

- a) P & Q = Oxygenated and R& S = Deoxygenated
b) P & Q = Deoxygenated and R& S = oxygenated
c) All are Oxygenated
d) All are Deoxygenated

13. Study the following passage:

Most of the vertebrates have jaws with teeth. The mode of arrangement of teeth on the jaws is called dentition.

The various types of teeth seen in mammals are incisors(I) canines (C) premolars (P) and molars (M). They are used for biting , tearing, chewing and grinding respectively. Canines, the tearing teeth are well-developed in carnivores and ill-developed or absent in herbivores.

A REPRESENTATIVE STUDY OF MAMMALS

Now answer the following questions:

- i) In frogs, all the teeth in the upper jaw look alike, whereas in human beings they are different. The type of dentition in man can be called _____.
- a) Homodont b) Isodont c) Heterodont d) Acrodont
- ii) The dental formula of a mammal is written as ICPM = 2023/1023. The teeth missing in it are _____.
- a) incisors b) canines c) premolars d) molars
14. Fill in the empty boxes with suitable answers with respect to the valves of a mammalian heart.

Valve(s)	Location	Function
Bicuspid valve or Mitral valve		Prevents the backward flow of blood from left ventricle to left auricle
	At the right auricular ventricular aperture	Regulates the flow of blood from right auricle to right ventricle
Aortic valve	At the base of Aorta	
Semilunar valve		Regulates the flow of blood from right ventricle to pulmonary artery

15. Any change in the lifestyle, the food habits and the body form of an organism in order to make it comfortable in the environment / habitat, is called adaptation. Identify the suitable adaptation given below against each mammal.

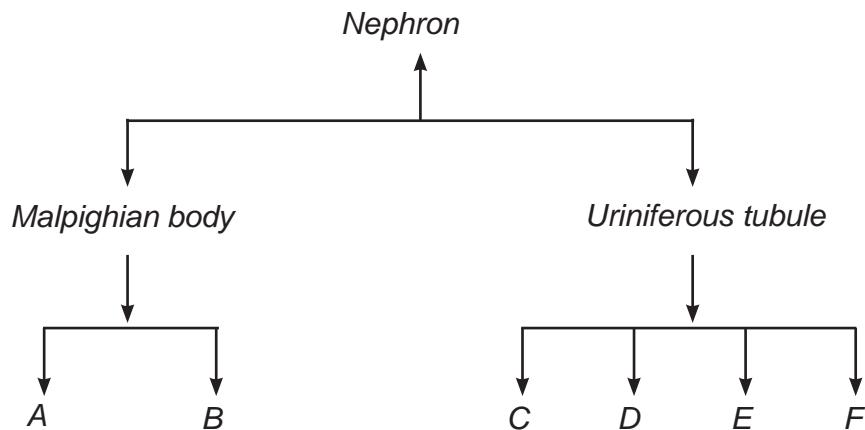
- i) conservation of body heat in large marine mammals like whale (Jaws are modified into baleen plates / Forelimbs are modified into flippers / Fat is deposited in subcutaneous tissue.)
- ii) Locating food source by bats-(Forelimbs are modified into wings / Hanging upside down using legs / Production of sounds and detection of the echo)

16. The Master chemists of our body are the kidneys. Justify.

- i) Kidneys filter all chemicals in the body.
- ii) Kidneys maintain the chemical composition of blood.
- iii) Kidneys eliminate all chemicals absorbed by the body.
- iv) Kidneys store the chemicals accumulated in the body.

PART - C

1. Observe the chart depicting the structure of a nephron.



- i) Mention the structures A to F ii) Explain the main function of a nephron.
2. With a suitable diagram, describe the structure and functions of the human heart.
3. Draw the L.S of kidney and label the parts.
4. What is adaptation? Mention the adaptations found in the following mammals.
- a) Whale b) Polar bear c) Kangaroo d) Herbivorous mammals.

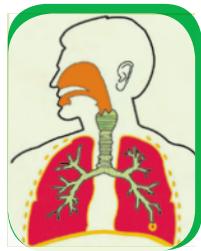
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Chapter 6



LIFE PROCESSES

How do you differentiate living things from non-living things?

If we see a dog running

(or)

a cow chewing cud

(or)

a child playing on the street,

we know that these are living beings.

What if the dog or the cow or the man are asleep?

We would still think that they are alive, but how do we know that? We see them breathing and we know that they are alive.

What about plants?

How do we know that they are alive?

We see their green leaves and some kind of movements like the folding and unfolding of leaves and stages of growth as common evidence for being alive.

What are life processes?

The maintenance of living organisms must go on even when they are not physically active. Even when we sit idle and during sleep this maintenance job, through the functioning of cells, has to go on. The life process includes the activities performed by the different organs to maintain the body.

Some of the life processes in living beings are described below:

Nutrition

Nutrition is the process of obtaining energy through consumption of food.

Respiration

The process of acquiring oxygen through breathing and making it available to cells for the process of the breaking down of organic substances into simpler compounds called respiration.

Transportation

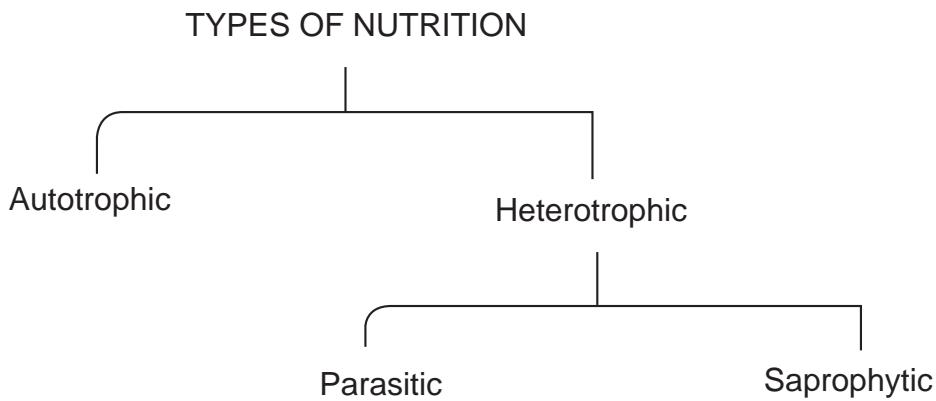
Transportation is the process by which the food and oxygen is carried from one organ to the other organs in the body.

Excretion

It is the process by which the metabolic waste by-products are removed from the different organs and released out from the body.

Questions

1. How do we understand the living nature of organisms?
2. What are the materials available from the external sources for the organism's consumption?
3. What processes are essential to maintain our body?



6.1. NUTRITION IN PLANTS

Do you know that we need energy for all activities?

Where do we get that energy from?

The source of energy is the food we eat.

Types of Nutrition

Autotrophic Nutrition

Most of the green plants can synthesize their own food materials by photosynthesis. Such mode of nutrition is described as autotrophic nutrition.

It is the process by which autotrophic plants consume substances from the external sources and convert them into stored form of energy. Materials are taken in the form of carbon dioxide and water and converted into carbohydrates in the presence of light and chlorophyll. Carbohydrates are utilized as energy rich sources to the plant, for their entire activity.

The process of photosynthesis is explained in the form of bio-chemical reaction shown below:

The raw materials and other necessary substances required for photosynthesis are



sunlight, water, CO_2 and chlorophyll.

Sunlight - energy from the sun

Water - plant absorbs water from the soil through roots.

CO_2 - assimilated from the atmosphere through leaves containing small pores called stomata.

Chlorophyll - the green pigments in the chloroplasts, an organelle of the cells of leaf.

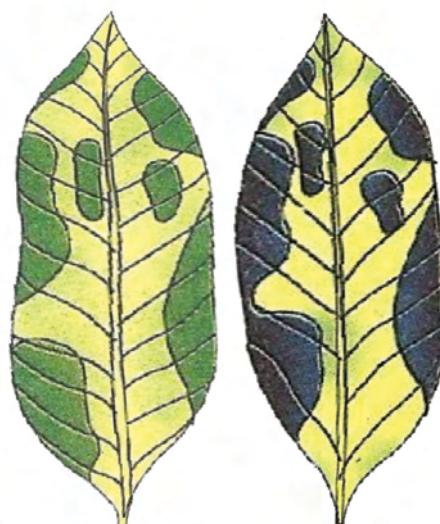


Fig. 6.1 Variegated Leaf

(a) Before starch test

(b) After starch test

Let us do an activity to demonstrate that chlorophyll is essential for photosynthesis.

ACTIVITY 6.1

1. Take a potted plant with variegated leaves – for example, money plant or crotons.
2. Keep the plant in a dark room for three days so that all the starch gets used up.
3. Now keep the plant in sunlight for about six hours.
4. Pluck a leaf from the plant. Mark the green areas in it and trace them on a sheet of paper.
5. Dip the leaf in boiling water for a few minutes.
6. After this, immerse it in a beaker containing alcohol.
7. Carefully place the beaker in a water-bath till the alcohol begins to boil.
8. What happens to the colour of the leaf? What is the colour of the solution?
9. Now dip the leaf in a dilute solution of iodine for a few minutes.
10. Take out the leaf and rinse off the iodine solution.
11. Observe the colour of the leaf and compare this with the tracing of the leaf done in the beginning.
12. What can you conclude about the presence of starch in various spots of the leaf?

Heterotrophic Nutrition

Fungal cells do not contain chloroplasts and they are of two types saprophytes and parasites. Likewise all organisms,

except the green plants, do not possess chloroplasts, as they do not perform photosynthesis. They depend upon plants or other organisms for their nutrition.

Parasites

Some organisms live on other organisms for nourishment. They are called Parasites. The plants or animals on which the parasites live for nourishment are called hosts. Parasitic plants have some special roots, which penetrate the host plant and absorb food from the phloem, water and minerals from the xylem. These roots are called haustoria. (e.g. *Cuscuta* and *Viscum*).



Fig. 6.2 *Cuscuta* - a parasitic plant



Fig. 6.3 *Viscum* - a parasitic plant

Saprophytes

Some plants obtain nutrients from non-living organic matter. They are called saprophytes. Many fungi and bacteria are saprophytes. Certain angiosperms like Monotropa lack chlorophyll and have mycorrhizal roots. The plant absorbs nutrients from the humus through their mycorrhizal roots.

Questions

1. What are the differences between autotrophic nutrition and heterotrophic nutrition?
2. What are the sources from which plants obtain materials required for photosynthesis?

6.2. DIGESTIVE SYSTEM

Intracellular Digestion

The unicellular animalcules like Amoeba also produce pseudopodia to engulf the diatoms and other minute organisms and digest them within the cell. Paramecium, another protozoan, has a cytopharynx, a cytoplasmic depression to swallow food (i.e. microorganisms in water) and digest the food within the cells. In the above mentioned examples, the food is directly taken into the cells and is digested within the cell. This sort of digestion is called intracellular digestion. Intracellular digestion is a very primitive form of digestion and does not require an organized digestive system. Even in animals like sponges and coelenterates, the digestion is intracellular, though an alimentary canal like structure has developed in them.

Extracellular Digestion

The digestive system in higher animals and human being consists of the alimentary canal and the digestive glands that produce digestive juices. Food enters into the body and passes through the alimentary canal. In the regions of digestion like mouth, stomach and duodenum, digestive juices are secreted by the digestive glands and the complex food is broken down into simpler food molecules by the action of the enzymes of the digestive juices. Since digestion takes place in the space or lumen of the alimentary canal i.e. outside the cell, it is called as extracellular digestion – an advanced form of digestion.

Digestion in Human Beings

Food contains a number of nutrient molecules needed for building up of new body tissues, repairing damaged tissues and sustaining chemical reactions.

Food must be broken down to be used as a source of energy. The process of converting the complex food into a simple chemical substance that can be absorbed and assimilated by the body is called digestion. The medical speciality that deals with the structure, function, diagnosis and treatment of diseases of the stomach and the intestine is called gastroenterology.

The digestive system is composed of two groups of organs. They are

- 1) The gastro-intestinal tract
- 2) Accessory digestive glands

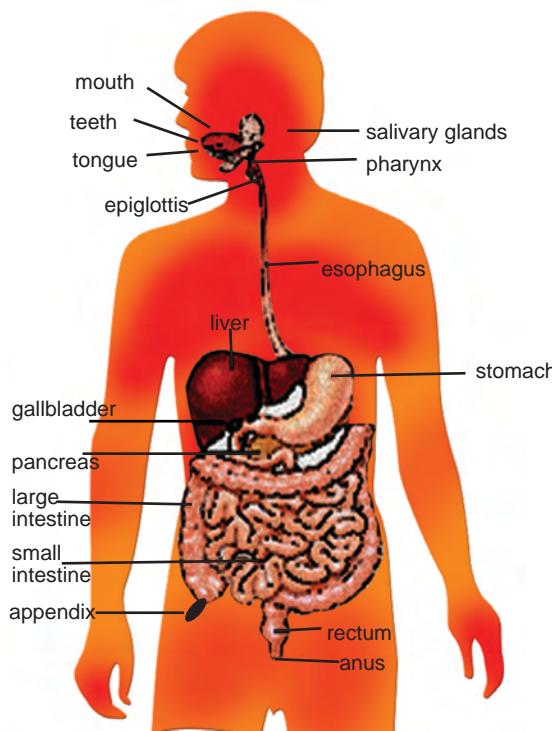


Fig. 6.4 Human Digestive System

ACTIVITY 6.2

- Take 1 ml of starch solution (1%) in two test tubes (A and B).
- Add 1 ml of saliva to test tube A and leave both the test tubes undisturbed for 20-30 minutes.
- Now add a few drops of dilute iodine to the test tubes.
- In which test tube do you observe a change in colour?
- What does this indicate about the presence or absence of starch in the two test tubes?
- What does this tell us about the action of saliva on starch?
- Is there a difference? If yes, in which case is more energy from external sources consumed?

Digestion takes place step by step with the help of enzymes which are otherwise called bio-catalysts.

The gastro-intestinal tract (alimentary canal) is a long muscular tube, about 9 mtrs in length. It starts from the mouth and ends in the anus. The mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine, large intestine, rectum and anus are parts of the alimentary canal.

6.3. RESPIRATION IN PLANTS

Why should we eat?

Why should plants synthesize food?

Plants should synthesize food for the simple reason that all living organisms, ranging from the minute bacteria to the large elephants including plants and humans, require energy for growth, movement and reproduction.

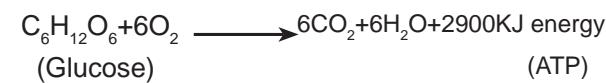
Where does this energy come from?

Starch that is synthesized by plants is the source of energy for humans.

In fact, energy is locked up in food materials. During respiration, the food materials are oxidized (degraded). During this reaction, energy is released from the food and it is stored in a special chemical (or) biological substance called ATP (Adenosine triphosphate).

The energy of ATP is utilized for the various activities of the cells.

In addition to ATP, two other substances are formed during respiration. They are CO_2 and H_2O .



The substance that is used in respiration is known as respiratory substrate. Respiratory substrates are of three kinds viz., carbohydrates, fats and proteins.

Types of Respiration

Depending on whether oxygen is used or not, respiration is classified into two types:

1. Aerobic respiration.
2. Anaerobic respiration.

1. Aerobic Respiration

In the majority of living organisms, oxygen is utilized during respiration. Respiration that uses oxygen is known as aerobic respiration.

The process of Aerobic Respiration takes place in four stages:

1. Glycolysis
2. Oxidative decarboxylation of pyruvic acid
3. Kreb's cycle
4. Electron transport chain.

During Glycolysis, glucose (a simple

carbohydrate) is split into two molecules of pyruvic acid. This takes place in the cytoplasm, through a series of reactions and a number of enzymes are involved in the process. With the formation of pyruvic acid, glycolysis comes to an end.

Further oxidation of pyruvic acid takes place in the second and third stages occurring in the mitochondria.

During the last stage, i.e. electron transport chain, the energy associated with the liberated electrons is used to synthesize the ATP energy molecules at certain stages. Finally the hydrogen, an electron, joins with oxygen to produce water as a by-product.

Complete oxidation of a glucose molecule in aerobic respiration produces 38 ATP molecules.

2. Anaerobic Respiration

In some organisms, oxygen is not utilized for respiration. This type of respiration is known as anaerobic respiration. It is also known as fermentation.

e.g. Conversion of milk into curd.

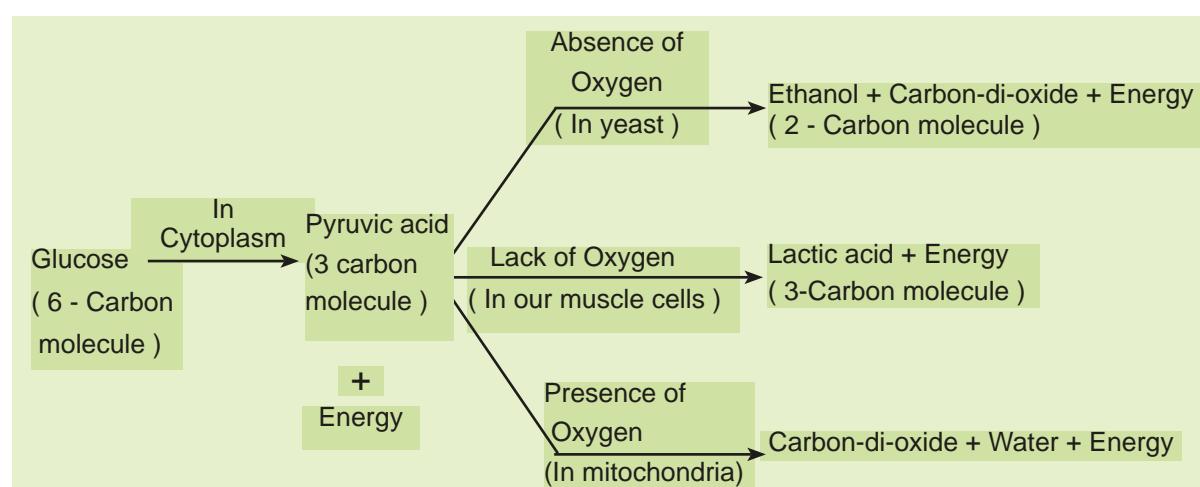


Fig. 6.5 Break-down of glucose by various pathways

ACTIVITY 6.3

- Take some fruit juice or sugar solution and add some yeast to it. Take this mixture in a conical flask fitted with a one-holed cork.
- Fit the cork with a bent glass tube. Dip the free end of the glass tube into a test tube containing freshly prepared lime water.
- What change do you observe in the lime water and how long does it take for this change to occur?
- What does this tell us about the products of fermentation?

MORE TO KNOW

- ATP is the energy currency for the most cellular processes. The energy released during the process of respiration is used to make an ATP molecule from ADP and inorganic phosphate.
- $ADP + Pi \xrightarrow{\text{Energy}} ATP$
- Think of how a battery can provide energy for many different kinds of uses. It can be used to obtain mechanical energy, light energy, electrical energy and so on. Similarly, ATP can be used in the cells for the contraction of muscles, protein synthesis, conduction of nerve impulses and many other activities.

6.4. RESPIRATION IN ANIMALS

Amoeba, Hydra, Sponge, etc. live in water. In these organisms, respiration takes place through their body surface. Dissolved oxygen in water diffuses through the cell

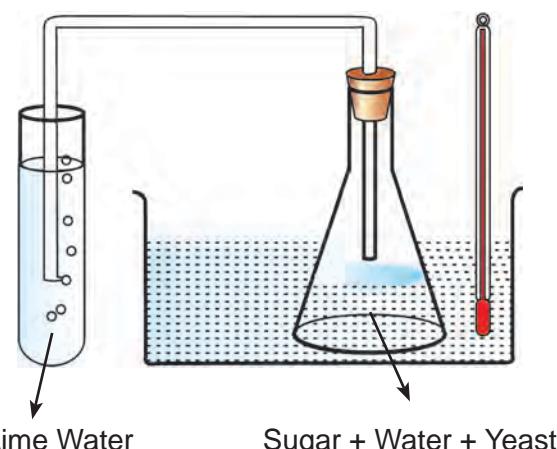


Fig 6.6 Anaerobic Respiration apparatus

membrane or body surface into the cell and after its usage, the carbon-dioxide produced is passively diffused out into water.

The respiratory organ of a fish is gills; a frog is its lungs and skin; for land vertebrates it is the lungs.

Since the amount of dissolved oxygen is fairly low compared to the amount of oxygen in the air, the rate of breathing in aquatic organisms is much faster than that of the terrestrial organisms. Fishes take in water through their mouth and force it out through their gills, where the dissolved oxygen is absorbed by the blood.

Terrestrial organisms use the oxygen in the atmosphere for respiration. Oxygen is absorbed by different respiratory organs in different animals. All these organs have a structure that has a bigger surface area, which is in contact with the oxygen-rich atmosphere. The exchange of oxygen and carbon-di-oxide has to take place across this surface, is usually within the body. So there are air passages present, that will carry atmospheric air to this area. In addition, there is a mechanism for blowing the air in and out of the area where oxygen is absorbed.

In human beings, air is taken into the body through the nostrils. The air that passes through the nostrils is filtered by fine hair that line the passage. This passage is also lined with mucus which helps in this process. From here, the air passes through the throat, to the lungs. Rings of cartilage are present in the throat to keep the air passage open and prevent it from collapsing.

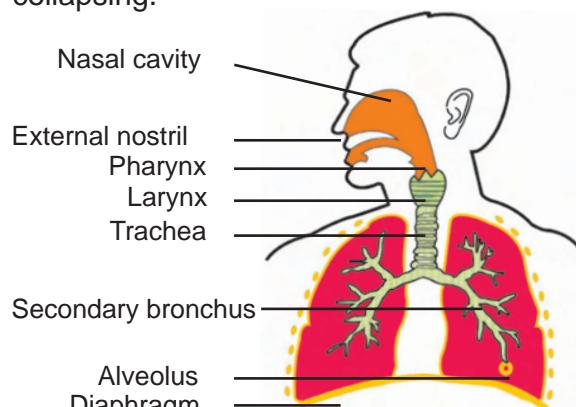


Fig. 6.7 Human Respiratory System

ACTIVITY 6.4

- Observe the fish in an aquarium, and their opening and closing of mouth and the gill slits (or the operculum which covers the gill slits) found behind their eyes. Is the timing of the opening and closing of the mouth and gill slits co-ordinated?
- Count how many times the fish opens and closes its mouth in a minute.
- Compare this with the number of times you breathe in and breathe out in a minute.

Within the lungs, the air passage branches repeatedly into smaller tubules which finally terminate in a balloon like structure called alveoli. The alveoli, surrounded by blood capillaries, provide a surface, where the exchange of gases takes place.

6.5. TRANSPORTATION IN PLANTS

We have discussed earlier, how plants prepare food by the process of photosynthesis using various raw materials like water, CO₂, sunlight and chlorophyll.

We already know that the chlorophyll pigments are present in the leaf. So the leaf is the site for photosynthesis. The food prepared in the leaf should be transported to all the other parts of the plant.

In the same manner, water is essential for photosynthesis and all other biological activities of the plants. For plants, the soil is the nearest and the richest source of water and raw materials like nitrogen, phosphorus and other minerals.

How do the absorbed water and minerals get transported from one place to all the other parts of the plant?

Which part of the plant is in contact with the soil?

For the above questions, you were getting answers already in your lower classes.

The roots are the absorbing organs of the plants.

Thus, the plant transport systems will mobilize energy stores, (food) from leaves, and raw materials from roots. These two pathways are structured as independently organized conducting tubes.

- i) Xylem transports water with dissolved minerals absorbed by the root hairs from the soil, to other parts of the plant.
- ii) Phloem transports products of photosynthesis (food) from the leaves to all other parts of the plant.

Transport of Water

In xylem, vessels and tracheids are the conducting elements of the roots, stems and leaves. They are inter-connected to form a continuous system of water conducting channels, reaching all parts of the plant. In the roots, the root hair cells are in contact with the soil and they actively take up ions.

This creates a difference in the concentration of these ions between the root and the soil. Therefore, water enters into the root from the soil to eliminate this difference.

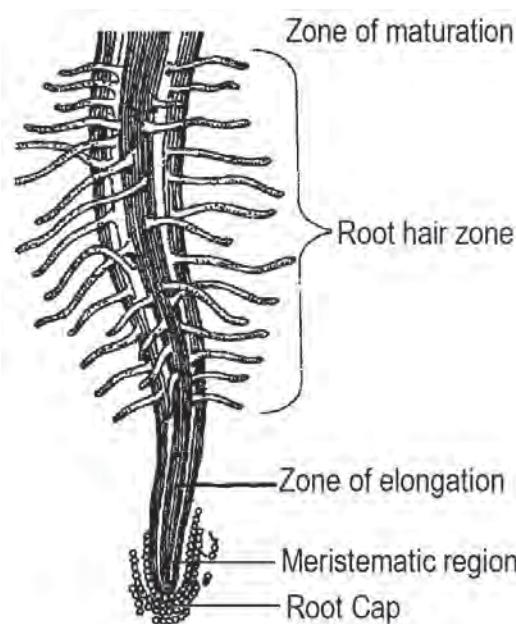


Fig. 6.8 Root hair region

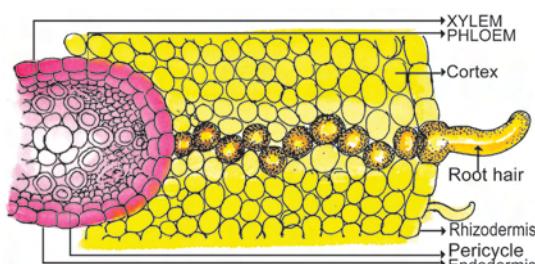


Fig. 6.9 Path of water across the root

This means that there is a steady movement of water into the root xylem, creating a column of water that is steadily pushed upwards.

Will this pressure be enough to conduct the water through the height of tall and huge trees?

Plants use another strategy to carry the water in the xylem upwards to the highest points of the plant body. This is by the process of transpiration. When the plant has an adequate supply of water, the water which is lost through the stomata is replaced by water from the xylem vessels in the leaf.

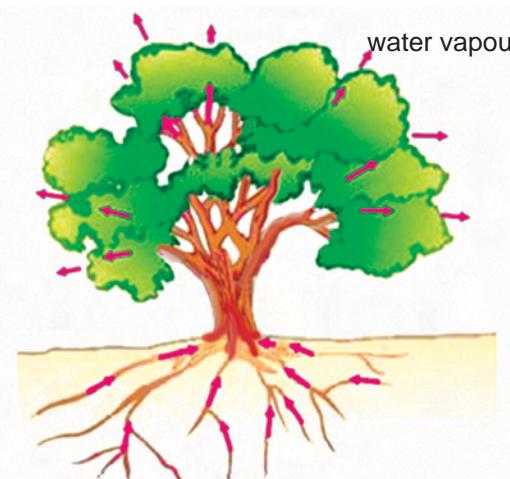


Fig. 6.10 Movement of water during transpiration in a tree

In fact, evaporation of water molecules from the cells of a leaf creates a suction which pulls water from the xylem cells of roots.

The loss of water in the form of vapour from the aerial parts of the plant is known as transpiration.

Thus, transpiration helps in the absorption and upward movement of water and the minerals dissolved in it from roots to the leaves. It also helps in temperature regulation. The effect of root pressure

in transport of water is more important at night. During the day when the stomata are open, the transpiration pull becomes the major driving force in the movement of water in the xylem.

Transport of Food and Other Substances

How are the products of photosynthesis transported from leaves to other parts of the plant?

The transport of the soluble products of photosynthesis is called translocation and it occurs in the part of the vascular tissue known as phloem. Besides the products of photosynthesis, the phloem transports amino acids and other substances. These substances are especially delivered to the storage organs of roots, fruits, seeds and to the growing organs. The translocation of food and other substances takes place in the sieve tubes (sieve tubes are one of the constituents of the phloem which act as the pipe-line from the leaves to the other parts of the plant) with the help of companion cells both in the upward and downward directions. The translocation by the phloem is achieved by utilizing energy. Materials like sucrose is transferred into phloem tissue using energy from ATP. This increases the osmotic pressure in the tissue causing water movement. This pressure moves the material in the phloem to the tissues which have less pressure. This allows the phloem to move the material according to the plant's needs. For example, in the spring, sugar stored in root or stem tissues would be transported to the buds, which need energy to grow.

Questions

1. What are the components of the

transport system in highly organized plants?

2. How are water and minerals transported to different parts in plants?
3. How is food transported in plants?

ACTIVITY 6.5

- Place a potted plant in a clear glass bell jar. Cover the pot with plastic to prevent water evaporating from the soil.
- Take a second bell jar with a potted plant with leaves removed.
- Keep the bell jars in bright light at room temperature (20°C) for 6 hours.
- No liquid condenses in the bell jar covering the plant without leaves.
- The bell jar containing the leafy plant has much more condensed liquid.
- Test the liquid. It turns a dry blue cobalt chloride paper to pink. Therefore, the liquid is water.
- Discuss with your classmates, and find the reason why water droplets are formed in the bell jar containing potted plant with leaves.

6.6. TRANSPORTATION IN ANIMALS

In microscopic organisms such as Amoeba and Paramoecium, the volume of body is so small that useful substances can be distributed by a process called diffusion. Oxygen for example, enters an amoeba through the cell membrane and spreads out i.e. diffuses, in all directions at the rate approximately equal to the rate at which oxygen is consumed in respiration. Similarly, carbon-dioxide diffuses out of an

amoeba with sufficient speed to prevent it getting accumulated within the cell to harmful levels.

In large multi-cellular organisms, however, the body volume is so great that diffusion alone is far too slow a process for adequate distribution of oxygen and food, and removal of waste.

The cells in the multi-cellular organisms relying on diffusion alone would be tightly packed. Those in the middle region would not get enough oxygen. Hence, most large organisms do not rely on diffusion for their supply of food and oxygen. They have a transport system of some kind to carry these substances to all the cells in the body.

In the human body, for example, the transport system consists of a pump called the heart, which propels the fluid called blood around a complex system of tubes called blood vessels. As it passes through these blood vessels, the blood picks up oxygen from the lungs and transports it to every cell in the body. Blood also picks up waste products such as carbon-dioxide and many other substances like salts from the cells and eliminate them from the body.

Lymph

In humans there is another type of fluid which is also involved in transportation. This is called lymph or tissue fluid. It is similar to the plasma of blood, but it is colourless and contains less protein. Lymph drains into lymphatic capillaries from the intercellular spaces, which join to form large lymph vessels that finally open into the veins. Lymph carries digested and absorbed fat, from the intestines and drains the excess fluid in extra cellular spaces back into the blood.

ACTIVITY 6.6

1. Visit a health centre in your locality and find out the normal range of haemoglobin content in human blood.
2. Is it the same for children, women and men? Discuss why does the difference exist.

6.7. EXCRETION IN PLANTS

What is excretion?

How does excretion take place in plants?

Excretion is the process by which the metabolic waste products are removed from the plant body.

In plants, there are different ways of excretion.

1. Plant waste products are stored in cellular vacuoles.
2. Waste products may be stored in leaves that fall.
3. Other waste products are stored as resins and gums, especially in old xylem tissues.
4. Plants also excrete some waste substances into the soil around them.

6.8. EXCRETION IN ANIMALS

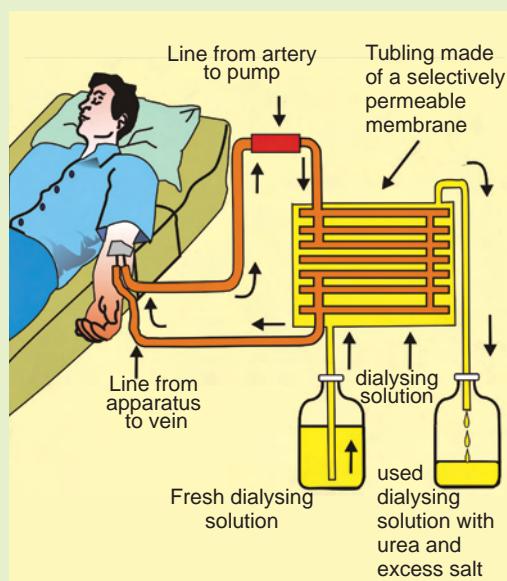
In unicellular protozoans, the excreta is discharged through the contractile vacuoles, which are formed by the absorption of water and other excreta.

In coelenterates and sponges, the excreta diffuses out through the cell membrane.

In flat worms and round worms, the excretory tubes develop, for transporting the excreta to the exterior. In annelids,

Artificial Kidney (Haemodialysis)

Kidneys are vital organs for survival. Several factors like infection, injury or restricted blood flow reduce the activity of the kidneys. This leads to accumulation of poisonous wastes in the body, which can even lead to death. In case of kidney failure, an artificial kidney can be used. An artificial kidney is a device to remove nitrogenous waste products from the blood through dialysis.



Artificial kidneys contain a number of tubes with a semi-permeable lining, suspended in a tank filled with dialysing fluid. This fluid has the same osmotic pressure as blood, except that it is devoid of nitrogenous wastes. The patient's blood is passed through these tubes. During this passage, the waste products from the blood pass into the dialysing fluid by diffusion. The purified blood is pumped back into the patient. This is similar to the function of the kidney, but it is different since there is no re-absorption involved. Normally, in a healthy adult, the initial filtrate in the kidneys is about 180 L daily. However, the volume actually excreted is only a litre or two per day, because the remaining filtrate is re-absorbed into the kidney tubules.

special kidneys called nephridia are evolved to collect excreta from the coelomic cavity.

In vertebrates, an elaborate well-defined excretory system has been developed with kidneys and excretory tubes. The kidney of vertebrates consists of nephrons which filter the blood and form the urine. Large amounts of ammonia is found in fish excreta. They are called ammonotelic animals. The birds are called uricotelic animals as their excretory substance is composed mostly of uric acids. In mammals, urea is the main excretory product. So they are called ureotelic animals.

NEPHRON

Each Nephron consists of a filtering apparatus called glomerulus and uriniferous tubules. The glomerulus filters the plasma part of the blood to form urine. The uriniferous tubules reabsorb the substances required in the body from that filtrate and the final urine product contains mostly water and nitrogenous waste products.

6.9. NERVOUS SYSTEM

The millions of cells and the scores of different tissues and organs in the body of an animal do not work independently of each other. Their activities are perfectly co-ordinated. This means that they

work together, performing various functions at certain time and at certain rates according to the needs of the body as a whole.

One of the most familiar examples of co-ordination is the way in which muscles work together during a movement. When a boy /girl runs to catch a ball, for example, he/she uses hundreds of muscles to move the joints in his arms, legs and back using information from his sense organs. The nervous system co-ordinates these muscles so that they contract in proper sequence with the perfect degree of power, and for precisely the correct length of time needed to get him/her to the spot from where he/she can catch the ball. Muscular activities like running to catch a ball, involves many other forms of co-ordination such as those which increase the rate of breathing and heart beat to adjust blood pressure, remove extra heat from body and maintain sugar and salt levels in the blood. Furthermore, all these co-ordinations occur as an unconscious process.

Worms have the simplest form of co-ordinating system, where an earthworm has dual the nerve cords. Two ganglia act as brain and the eye spots act as photo receptors.

In insects, ganglia are connected by a ventral nerve cord functioning as a brain. Well-developed sensory organ for vision and antennae for olfactory function are present.

In mammals and other well-developed vertebrates, this co-ordination is achieved by the nervous and endocrine systems.

The nervous system consists of tissues which conduct "messages", called nerve impulses, at high speed to and from all parts of the body.

6.10. CO-ORDINATION IN PLANTS

How do plants co-ordinate?

Unlike animals, plants have neither a nervous system nor muscles.

Then, how do they respond to stimuli?

When we touch the leaves of touch-me-not plant, they begin to fold up and droop.

When a seed germinates, the roots go down and the stem arises above the soil.

What happens during the above actions?

In the first instance, when the leaves of a sensitive plant is touched, the leaflets fold and the whole leaf droops down immediately. In this movement, no growth takes place.

In the second instance, the root grows towards the earth and the stem grows towards light. Here the Tropism is caused by growth. So it is a growth movement.

Therefore, plants show two different types of movements:

1. Movement independent of growth
2. Movement dependent growth

6.11. MOVEMENT- INDEPENDENT OF GROWTH

Immediate Response to Stimulus

This movement is sensitive to plants. Here, no growth is involved but the plant actually moves its leaves in response to touch. Yet there is neither nervous tissues nor muscle tissues involved.

How does the plant detect the touch and how do the leaves move in response?

If we touch the touch-me-not plant at one point, all the leaflets show the folding movement. This indicates that the stimulus



ACTIVITY 6.7

1. Go to the field and find the touch-me-not plant.
2. Touch the plant at one point.
3. Observe what happens.



Fig. 6.11 Sensitive Plant (Touch-me-not plant)

at one point is communicated. Unlike in animals, there is no specialized tissue in plants for transmitting the information. The folding effect of touch-me-not plant is

caused by a change in the turgidity of the leaflets brought about by the movement of water into and out of the parenchymatous cells of the pulvinus or swollen leaf base.

Movement Dependent on Growth:

More commonly, plants respond to stimuli slowly by growing in a particular direction. Since this growth is directional, it appears as if the plant is moving.

Let us understand this type of movement with the help of some examples.

ACTIVITY 6.8

- Fill a conical flask with water.
- Cover the neck of the flask with a wire mesh.
- Keep two or three freshly germinated bean seeds on the wire mesh.
- Take a cardboard box which is open from the side.
- Keep the flask in the box in such a manner that the open side of the box faces the light from a window.
- After two or three days, you will notice that the shoots bend towards light and roots away from light.
- Now turn the flask so that shoots are away from the light and roots towards light. Leave it undisturbed in this condition for a few days.
- Have the old parts of the shoot and root changed direction?
- Are there differences in the direction of the new growth?
- What do you understand from this activity?

1. Response of the plant in the direction of light (Phototropism).
2. Response of the plant in the direction of gravitational force (Geotropism).
3. Response in the direction of water (Hydrotropism).
4. Response in the direction of chemicals (Chemotropism).

Phototropism

Phototropism is the growth of the stem towards the direction of sunlight.

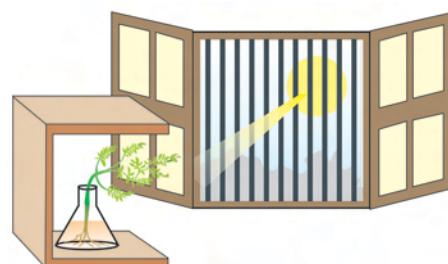


Fig. 6.12 Phototropism

Geotropism

Geotropism is the growth of roots towards the direction of gravitational force.

Roots cannot grow towards sunlight and stem cannot grow towards gravitational force.



Fig 6.13 Geotropism

Hydrotropism

The roots of very huge trees grow towards the availability of water source. e.g. The roots of the coconut tree are seen growing towards the water source.

Chemotropism

This is the movement of plant parts in the direction of chemicals. e.g. The pollen tubes grow towards the ovule.

MODEL EVALUATION

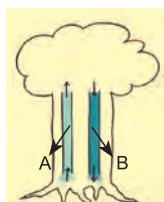
PART - A

1. In *monotropa* the special type of root which absorbs nourishment is the _____.
 - i) Haustoria ii) Mycorrhizal root iii) Clinging root iv) Adventitious root
2. The product obtained in the anaerobic respiration of yeast is _____.
 - i) Lactic acid ii) Pyruvic acid iii) Ethanol iv) Acetic acid
3. The roots of a coconut tree are seen growing far from the plant. Such a kind of movement of root for want of water is _____.
 - i) Phototropism ii) Geotropism iii) Chemotropism iv) Hydrotropism
4. The xylem in the plants is responsible for _____.
 - i) transport of water ii) transport of food
 - iii) transport of amino acids iv) transport of oxygen
5. The autotrophic nutrition requires
 - i) CO_2 and water ii) chlorophyll iii) sunlight iv) all the above
6. Leaf pores / stomata help in _____.
 - i) intake of CO_2 during photosynthesis ii) release of O_2 during photosynthesis
 - iii) release of water vapour during transpiration iv) All of these
7. _____ of green plants are called factories of food production.
 - i) Mitochondria ii) Chloroplasts iii) Endoplasmic reticulum iv) Nucleus

8. The special root-like structure of plant parasites in cuscuta and viscum are called _____ .
- Rhizoids
 - Haustoria
 - Hyphae
 - Stolons
9. Pick out the odd one : The parts of the alimentary canal are
- pharynx
 - mouth
 - buccal cavity
 - pancreas

PART - B

1. Name the types of vascular tissues in the plant stem which are labelled A and B.

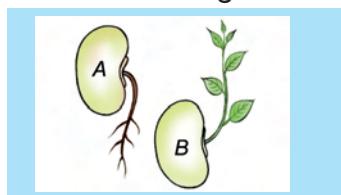


- Name A and B
- What materials are transported through A?
- What materials are transported through B?
- How do the materials in A move upwards to the leaves?

2. What is nutrition? What type of nutrition is seen in green plants and the majority of animals?
3. Match the methods of nutrition of special organs with suitable examples:

Autotrophs	Mycorrhiza	Cuscutta
Parasites	chlorophyll	Monotropa
Saprophytes	Haustoria	Hibiscus

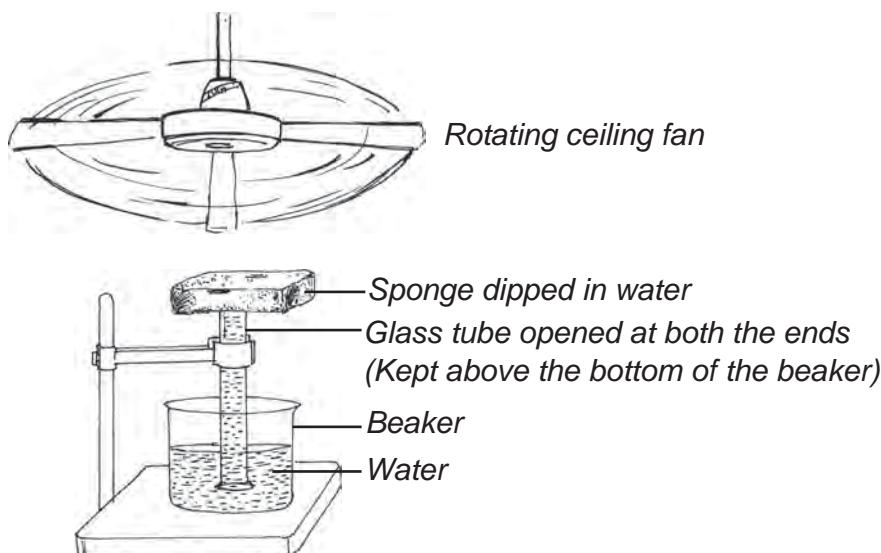
4. Observe the diagram



- Mention the type of movements shown in figure A and B.
- How does this movement differ from the movement of mimosa?

5. In the process of anaerobic respiration, _____ is a 6 carbon compound which gets converted into _____ carbon compound called lactic acid.
6. Sugar is converted into alcohol. In the above reaction what kind of process takes place? Which micro-organism is involved?
7. In human beings, air enters into the body through _____ and moves into _____. In fishes, water enters into the body through _____ and the dissolved oxygen diffuses into _____.
8. Give two examples of root parasites of plants. Mention the special structures present in them to draw the nutrients from the host plant.

9. What are saprophytes? Give two examples.
10. What is the length of the alimentary canal in human beings? List out the parts of the gastro-intestinal tract in the correct sequential order based on the passage of food.
11. What is respiration? Give a balanced equation for aerobic respiration.
12. A fish taken out of water can not survive for a long time. Why?
13. What are ammoniatelic and ureotelic animals? Give examples.
14. Describe the change that occurs in a touch-me-not plant when it is touched?
15. Study the following model with which the transpiration mechanism in plants can be demonstrated



With which structure of the plant do you compare each of the following?

- (i) Sponge (ii) Glass tube filled with water.

PART - C

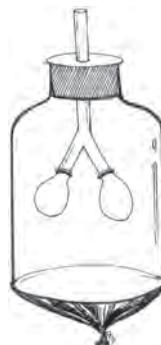
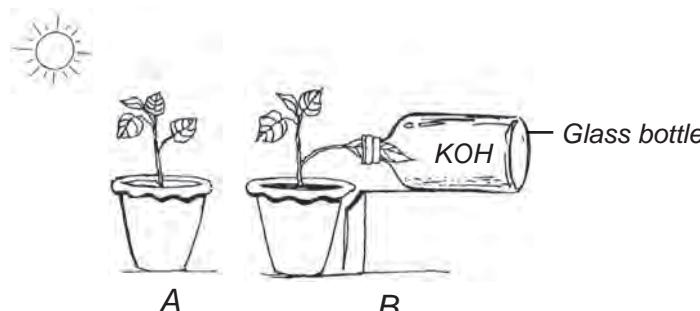
1. Describe the various movements of plants giving suitable examples.
2. Describe the various methods of excretion in animals.
3. Compare the respiration in higher plants with the respiration in lower plants
4. In the touch - me - not plant the leaves show movements. What type of movement have you observed? Discuss.
5. Differentiate extra-cellular digestion from intra-cellular digestion. Which one is an advanced form?
6. Differentiate aerobic respiration from anaerobic respiration. Mention the event that is common to both.

7. Observe the given model that can be used to demonstrate the breathing mechanism in human beings.

Name the structures which can be compared to:

- (i) Lungs (ii) Diaphragm (iii) Trachea (iv) Nostrils (Nose)

8. Observe the following figures:



Both the plants 'A' and 'B' were kept in sunlight after watering. The part of the leaf of plant 'B' which was inserted in the glass bottle containing KOH (Potassium hydroxide) did not turn blue in the iodine test/ starch test, indicating the absence of starch. The part of the leaf outside the bottle turns blue in the said test. Photosynthesis didn't occur in that part of the leaf due to the non-availability of _____.

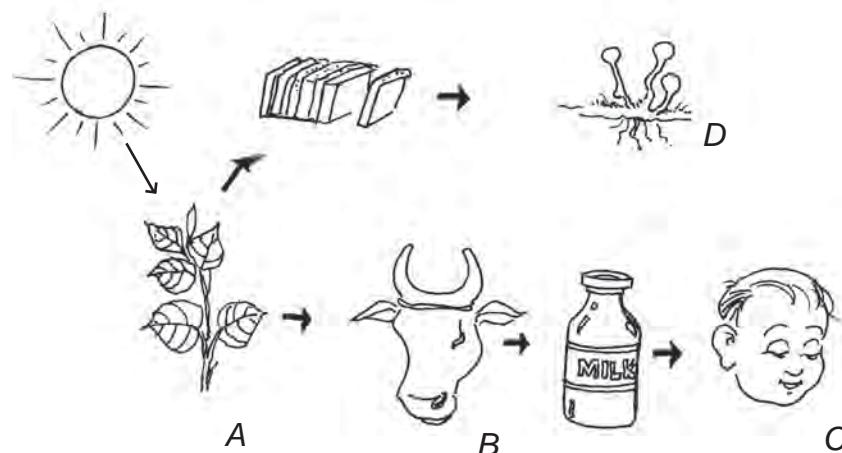
- a) Sunlight b) Chlorophyll c) CO_2 d) Water

(i) List out the factors which are available to the part of the leaf outside the bottle.

9. Look at the illustration depicting the food chain:

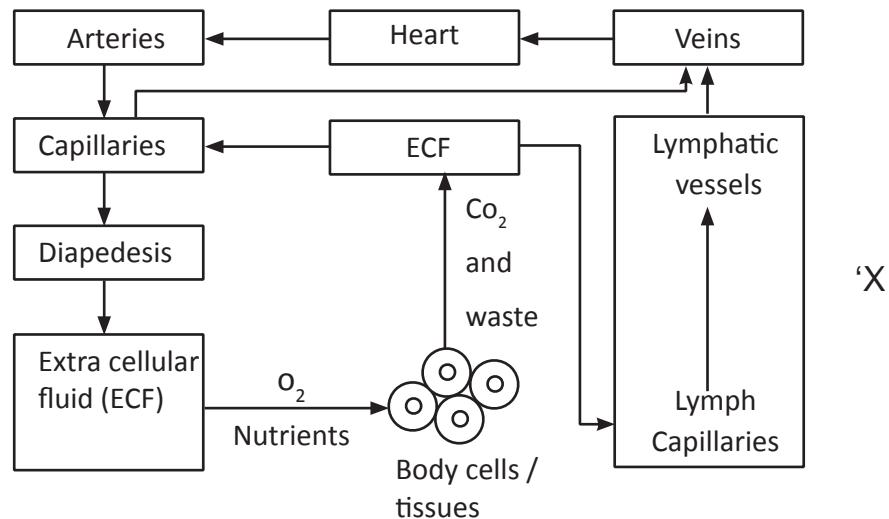
a. The correct explanation of the organisms is:

	A	B	C	D
a)	Saprophyte	Heterotrophs	Autotrophs	Heterotrophs
b)	Heterotrophs	Autotrophs	Saprophyte	Saprophyte
c)	Autotrophs	Saprophyte	Autotrophs	Heterotrophs
d)	Autotrophs	Heterotrophs	Heterotrophs	Saprophyte



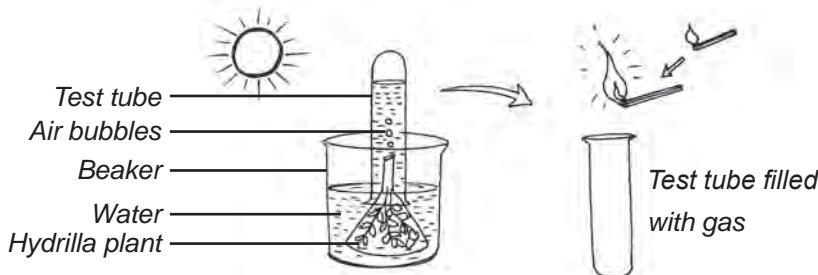
b. Why is 'A' called an autotroph?

10. Observe the following flow-chart:



- a) What is 'X' in this figure denote?
 b) In what way is it different from blood?

11. Observe the following experiment:



- i) Name the phenomenon it depicts and the gas that is released.
 a) Respiration, CO₂ b) Photosynthesis, O₂ c) Transpiration, H₂O d) Excretion, N₂
 ii) What is photosynthesis? Write a balanced equation for this bio-chemical reaction.

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Chapter 7



CONSERVATION OF ENVIRONMENT

Living organisms live in different surroundings. Some plants and animals live in water and some others live on land.

Man also leads life in different surroundings. Some live in cities, some in towns and some in villages. How do they adapt themselves to the place they live in?

Plants, animals and human beings survive the interaction between themselves and the non-living things like air, water and land. Human beings depend on the resources of nature. These resources include soil, water, coal, electricity, oil, gas, etc. These resources improve the lifestyle of human beings.

Environmental science can be defined as the study of organisms in relation to their surroundings.

In the course of development, unplanned utilization and exploitation of natural resources like water, forest produce, land and mineral resources have taken place. This has led to an imbalance in nature and release of many harmful substances into the atmosphere.

Not only is man greatly influenced by his environment, but he also affects the environment considerably. Overpopulation, environmental pollution, pest control and conservation of natural resources are some

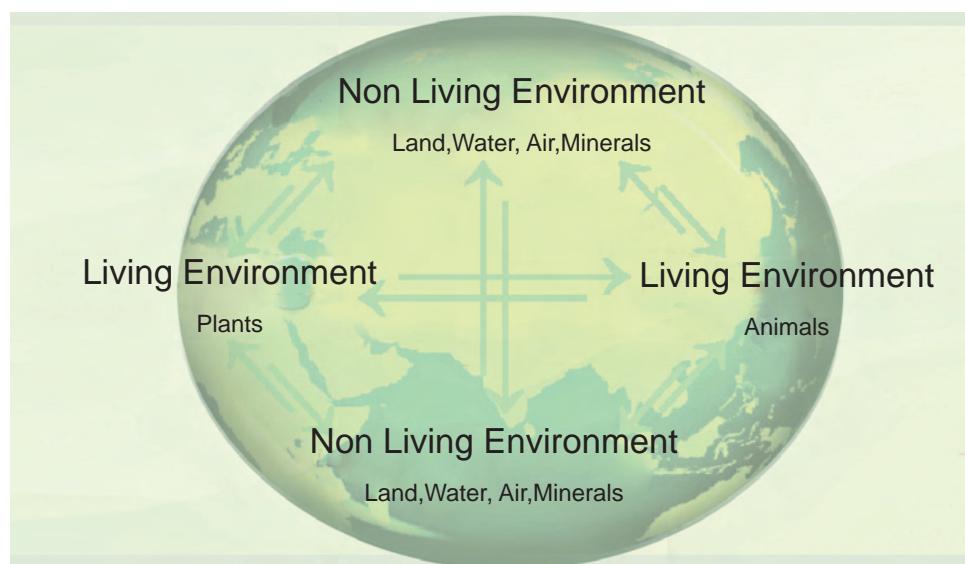


Fig. 7.1 Interaction between non-living and living components in the biosphere

of the challenges human beings face.

In our daily activities, we generate a lot of waste that we throw away.

- Name some of these waste material.
- What happens after the disposal of waste material?

Human activities related to livelihood and welfare measures generate waste. All wastes are pollutants and they create pollution in one way or the other. Air, land and water surroundings are affected due to improper disposal of wastes which create an imbalance in the environment.

- What is Pollution?
- What are Pollutants?

Pollution: Any undesirable change in the physical, chemical or biological characteristics of air, land and water that affect human life adversely is called pollution.

Pollutant: A substance released into the environment due to natural or human activity which adversely affects the environment is called pollutant. e.g. sulphur-dioxide, carbon-monoxide, lead, mercury, etc.

7.1. CLASSIFICATION OF WASTES

1. Bio-degradable wastes
2. Non bio-degradable wastes

Substances that are broken down by biological process or microbial action are called bio-degradable wastes. e.g. grass, flowers and leaves.

Substances that are not broken down by biological or microbial actions are called non-bio-degradable wastes. e.g. plastic substances and mineral wastes.

ACTIVITY 7.1

- Find out what happens to the waste generated at home. Is there a system in place to collect this waste?
- Find out how the local body (panchayat, municipal corporation or resident welfare association) deals with the waste.
- Are there mechanisms in place to treat the bio-degradable and non-bio-degradable wastes separately? Observe how much waste is generated at home in a day and how much of this waste is bio-degradable?
- Observe the amount of waste generated in the classroom in a day and how much of this waste is non bio-degradable?
- Suggest some ways on how to deal with this waste.

DISPOSABLE CUPS IN TRAINS

If you ask your parents, they will probably remember a time when tea in trains was served in plastic tumblers which had to be returned to the vendor. The introduction of disposable cups was hailed as a step forward for reasons of hygiene. No one at that time probably thought about the impact caused by the disposal of millions of these cups on a daily basis. Some time back, Kulhads, that is, disposable cups made of clay, were suggested as an alternative, but little thought was given to the fact that making these Kulhads on a large scale would result in the loss of the fertile top-soil. Now disposable paper cups are being used. What do you think are the advantages of disposable paper cups over disposable plastic cups?

How can we protect ourselves from these hazardous wastes ?

Why does the government and so many organizations conduct awareness programmes against using plastics ?

The following methods are adopted for the disposal of harmful waste materials.

1. Land fills

There are permanent storage facilities in secured lands for military related liquid and radioactive waste materials. High level radioactive wastes are stored in deep underground storage.

2. Deep Well Injection

This involves drilling a well into dry porous material below ground water. Hazardous waste liquids are pumped into the well. They soak into the porous material and remain isolated indefinitely.

3. Incineration

The burning of materials is called incineration.

Hazardous bio-medical wastes are usually disposed off by means of incineration. Human anatomical wastes, discarded medicines, toxic drugs, blood, pus, animal wastes, microbiological and bio-technological wastes etc. are called bio-medical wastes.

Management of non-hazardous wastes is called solid waste management.

Reuse and Recycling Technique

The separation of materials such as rubber, glass, paper and scrap metal from the refuse and reprocessing them for reuse is termed as reclamation of waste or recycling.

Paper (54% recovery)

Paper can be repulped and reprocessed into recycled paper, cardboard and other products.

Glass (20% recovery)

Glass can be crushed, re-melted and made into new containers or the crushed glass can be used as a substitute for gravel or sand in construction materials such as concrete and asphalt.

Food waste and yard waste (leaves, grass etc.) can be composted to produce humus soil.

7.2. WATER MANAGEMENT

Due to the increasing demand for water and reduced availability of fresh ground water resources, urgent measures have to be taken to conserve each and every drop of water that is available.

Clean and fresh water is essential for almost every human activity. Perhaps more than any other environmental factor, the availability of water determines the location and activities of human beings.

Can you list out the reasons for the increasing demand of water?

7.2.1. Sources of Water

Water is a basic natural resource and a valuable asset to all nations. Human beings depend on water for all their needs such as bathing, washing, cooking, transportation and power generation. Water in India is of two kinds-salt water and fresh water. Fresh water is obtained from rain water, surface water and ground water.

The main sources of water is rain and snow which form a part of the hydrological cycle.

Surface Water

India is blessed with a number of rivers, lakes, streams and ponds.

Ground Water

Aquifers are under ground reserves of fresh water.

In the water table, water that percolates into the ground through porous rocks is ground water. These porous rocks are saturated with water to a certain level. The ground water is important for plant growth. Man also taps this water through tubes and borewells. Scanty rainfall and unnecessary felling of trees affect the ground water level.

7.2.2. Fresh Water Management

To deal with water scarcity, we need to implement several ways to increase the water supply.

i) Seeding clouds

Seeding clouds with dry ice or potassium iodide particles sometimes can initiate rain, if water laden clouds and conditions that favour precipitation are present.

ii) Desalination: (Reverse osmosis)

Desalination of ocean water is a technology that has a great potential for increasing the supply of fresh water. Desalination is more expensive than most other methods of obtaining fresh water. In desalination, the common methods of evaporation and re-condensation are involved.

iii) Dams, Reservoirs and Canals

Dams and storage reservoirs trap run-off water in them and transfer the water from areas of excess to areas of deficit using canals and underground pipes.

iv) Water Shed Management

The management of rain water and the resultant run-off is called water shed management. Water shed is an area characterized by construction of small dams to hold back water which will provide useful wildlife habitat and stock watering facilities.

v) Rain Water Harvesting

Rain water harvesting essentially means collecting rain water from the roof of buildings or courtyards and storing it underground for later use. The main idea in harvesting rain water is to check the run-off water. The rain water that falls on the roofs of buildings or in courtyards is collected through pipes and stored in under ground tanks of the buildings fitted with motor for drawing the water for use. The process of rain water harvesting is not only simple but also economically beneficial. It helps in meeting the increased demand for water, particularly in urban areas and prevent flooding of living areas.

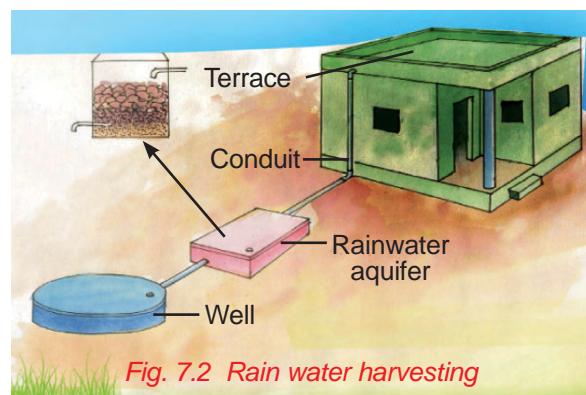


Fig. 7.2 Rain water harvesting

vi) Wetland Conservation

It preserves natural water storage and acts as aquifer recharge zones.

vii) Domestic Conservation

As an individual, everyone can reduce the water loss by using a bucket of water



Fig. 7.3 Domestic conservation of water

than by taking a shower, using low-flow taps, using recycled water for lawns, home gardens, vehicle washing and using water conserving appliances.

viii) Industrial Conservation

Cooling water can be recharged and waste water can be treated and reused.

7.3. WILDLIFE SANCTUARIES

Wildlife

All non-domesticated and non-cultivated biota found in natural habitat are termed ‘wildlife’. It includes all the natural flora and fauna of a geographic region. Wildlife is an asset to be protected and preserved to our advantage and for the benefit of future generations.

There are approximately 400 varieties of reptiles, 200 varieties of amphibians, 3000 varieties of fishes, 3000 species of birds, 20,000 species of flowering plants and 4100 species of mammals found in our country according to the latest census.

It is essential to protect and conserve wildlife because they have aesthetic, ecological, educational, historical and scientific values. A good biotic diversity is essential for ecological balance. Large scale destruction of wildlife could lead to ecological imbalance. Wildlife also adds aesthetic value and from this, eco-tourism

is being promoted in a big way by several countries. Wildlife and their products could be of great economic value if utilized properly. Plants could yield products of immense medicinal value in future. Wildlife also forms a store of vast genetic diversity which could be properly used with advances in genetic engineering. Thus wildlife has been of great value in the past and will continue to be so in the future. Protection and conservation of wildlife, therefore gains importance.

SANCTUARIES

A wildlife sanctuary is an area constituted by a competent authority where hunting or capturing of animals is prohibited except by or under control of the highest authority responsible for the management of the area.

Wildlife sanctuaries were established in India in the pursuit of conserving wildlife, which was suffering due to ecological imbalance caused by human activities. There are 89 national parks, 500 wildlife sanctuaries, 27 tiger reserves, 200 zoological parks and 13 biosphere reserves in the country covering an area of 1.6 lakh sq.km.

7.4. BALANCE IN ECO-SYSTEM

What is Eco-system?

- Fishes live in water.
- Tigers live in forests.

How can they lead their life in their respective habitats?

A community of organisms that interact with one another and exist in particular environment is called an eco-system. The eco-system is of two types, namely aquatic and terrestrial.

Important Sanctuaries in Tamilnadu

Name	Location	Animals
Indira Gandhi Wildlife Sanctuary	Western Ghats.	tiger, leopard, porcupine, nilgiris thar, civet cat, elephant, gaur, pangolin.
Kalakkadu Wildlife Sanctuary	Tirunelveli district	lion tailed macaque, sambhar, sloth bear, gaur, flying squirrel.
Srivilliputhur Grizzled Squirrel Wildlife Sanctuary	Virudhunagar district	grizzled squirrels, mouse deer, barking deer, tree shrew.
Vedanthangal Bird Sanctuary	Kancheepuram district	cormorants, egrets, grey heron, open-billed stork, white bears, shovellers, pintails, stets, sandpipers.
Mudumalai Wildlife Sanctuary	The Nilgiris	elephants, gaur, langur, tigers, leopards, sloth bear, sambhar, wildbear, jackal, porcupine, mongoose.
Viralimalai	Trichy district	wild peacocks
Gulf of Mannar Marine National Park.	Coast of Ramnad and Tuticorin district.	coral reefs, dugong, turtles, dolphins, balanoglossus,
Mundhanthurai Wildlife Sanctuary.	Tirunelvelli district	tiger, bonnet macaque, langurs, sloth bear, wild dog.
Vallanadu Blackbuck Sanctuary.	Tuticorin district	blackbuck, jungle cat, hare, mongoose.
Arignar Anna Zoological Park	Vandalur	lion, elephant, tiger, monkey.
Mukkurthi National Park	The Nilgiris	tigers.
Point Calimere Wildlife Sanctuary	Nagapattinam district	chital, wild bear, plovers, stilts, bonnet macaque.
Anaimalai Wildlife Sanctuary	Slopes of Western Ghats.	civet cat, porcupine, gaur, tiger, leopard, nilgiri tahr.

Important National Parks, Wildlife Sanctuaries and reserves

Bandipur National Park (It is also a tiger reserve)	Karnataka	Indian bison, chital, sloth bear, elephant.
Corbett National Park (India's first national park) (Also a tiger reserve)	Uttaranchal	tiger, chital, elephant, leopard, jungle cat and sloth bear.
Gir National Park	Gujarat	Asiatic lion
Kanha National Park (Tiger reserve)	Madhyapradesh	deer, tiger, wilddog, chital.
Bharathpur Bird Sanctuary	Rajasthan	374 species of birds, e.g. Indian darters, spoonbills, painted stock, open billed stork, black necked stork etc.,
Manas Wildlife Sanctuary (Tiger reserve)	Assam	Hispid hare (rere), pygmy hog, golden langur
Sunderbans National Park (Tiger reserve)	West Bengal	unique royal Bengal tigers.

What are the major components in an Ecosystem?

There are four major components, namely:

1. Abiotic factors
2. Producers
3. Consumers
4. Decomposers.

Producers, consumers and decomposers are biotic factors.

Pond Ecosystem

An example for aquatic ecosystem is a pond.

Abiotic factors

The abiotic factors includes light, temperature, hydrogen ion concentration,

inorganic substances like CO_2 , H_2 , O_2 , N, PO_4 , CO_3 and S and organic substances like carbohydrates, proteins and lipids.

Biotic factors

They include producers and consumers. Producers are the water living plants like Hydrilla, Vallisneria etc. and phytoplankton like Chlamydomonas, Volvox and Spirogyra.

Primary consumers or herbivores

Zooplanktons like insects, larvae of dragon-fly consume the phytoplanktons.

Secondary Consumers

These are certain fishes, frogs, water beetles etc. which feed on the primary consumers in the pond.

Tertiary Consumers

These are big fishes and birds that feed on small fishes.

Decomposers

Several bacteria and fungi form the decomposers in the pond.

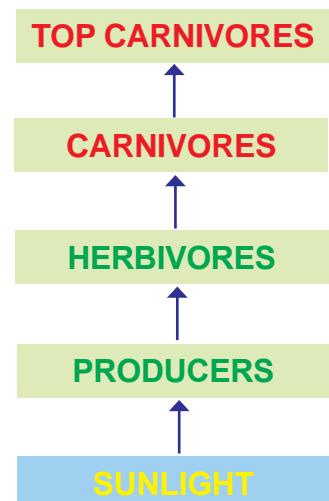


Fig. 7.4 Flow of energy in an ecosystem

BALANCE IN ECO-SYSTEM

A balanced eco-system is an ecological community, together with its environment and functioning as a complex unit.

An eco-system is maintained by the balance in nature such as the balance between hawks and mice. If the hawk population is larger than the mice population, then it is not balanced.

ACTIVITY 7.2

- In your house, have you observed lizards eating insects and a cat chasing a rat? What is the reason?
- Form groups and discuss how each of the aquatic organisms is dependent on the other.
- Make a food chain of an aquatic eco-system (atleast three steps).
- Would you consider any one group of organisms to be of primary importance? Why or why not?

There is a balance between resources like banana trees and monkeys. If banana trees stop growing, monkeys will not get bananas.

An ecosystem maintains the balance between the number of resources and the number of users or the balance between the predators and their prey.

What is Food Chain and Food Web?

Food Chain

Various organisms are linked by food chains in which the food energy is passed from one organism to another in a linear fashion.

e.g. Food chain of a grassland ecosystem.

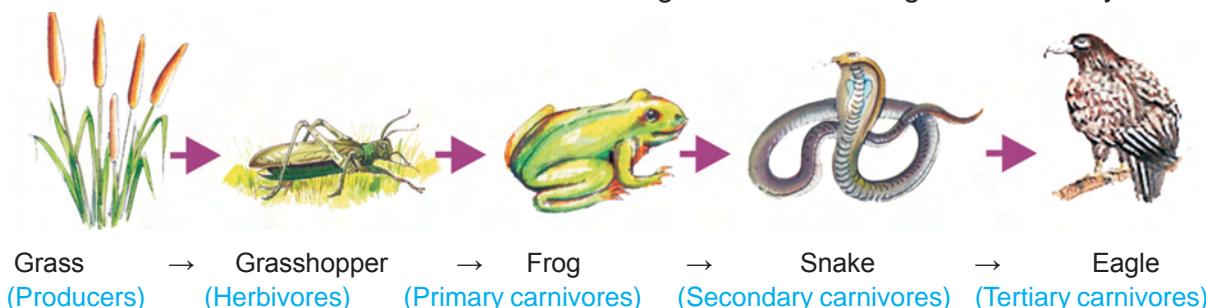


Fig. 7.5 Grassland Ecosystem

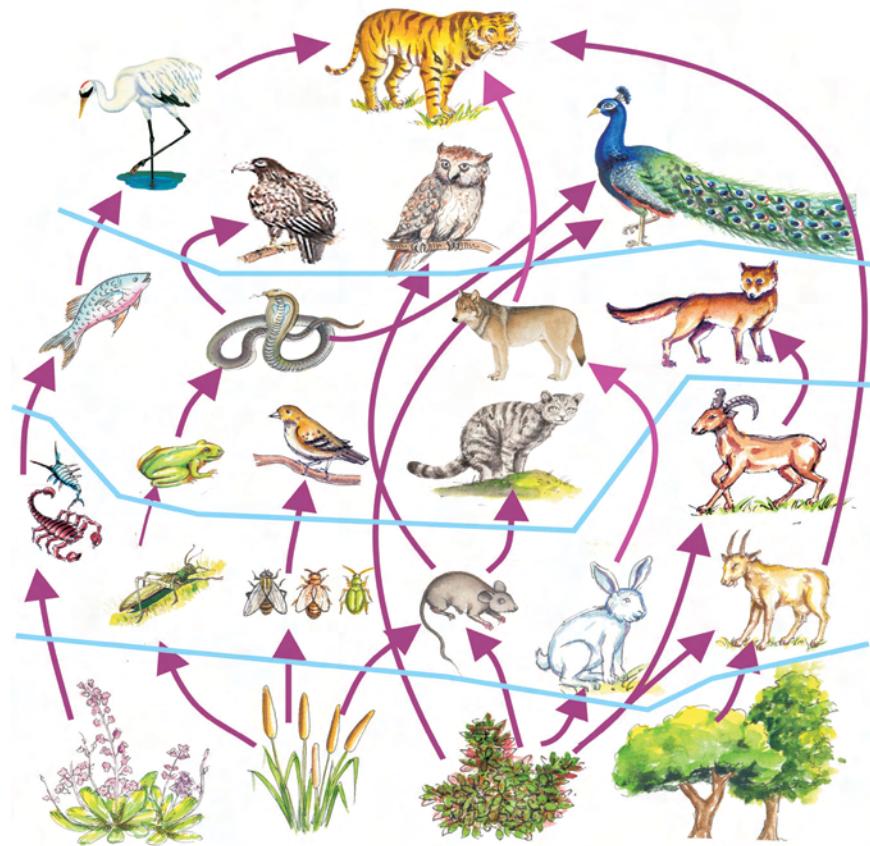


Fig. 7.6 Food web

Food Web

The food chains are interlinked to form food webs. So every component of the eco-system is connected with one another.

How is the Eco-system Maintained?

There are many factors which naturally maintain the harmony in an eco-system. Disturbing any one factor could have a drastic impact upon the living conditions of other organisms resulting in an imbalance. For example, removal of trees and vegetation would affect both land and water eco-systems, as there will be no food for organisms. Killing animals and polluting land, air and water also disturb the balance in nature.

In order to maintain the eco-balance in an ecosystem, there should be recycling

of nutrients, minerals, and water. Discreet use of natural resources will help to maintain the eco-balance. Thus eco-balance or ecological balance is the maintenance of balance between living components and the resources of an ecosystem, so that it remains a stable environment community for the better functioning of the organisms.

Bio - Geo Chemical Cycles

In an ecosystem, the energy from the sun is trapped by the plants. Then it is transferred to herbivores and carnivores, i.e. the energy flows in one direction only. But the minerals like phosphate, nitrate etc. that are required in the ecosystem are continuously absorbed by plants and transferred to animals. As the minerals are drawn from the soil, they have to be

replaced. These minerals are restored to the soil by the decomposition of dead and decaying materials by saprophytic organisms such as bacteria and fungi.

7.5. COAL AND PETROLEUM

Coal

Coal is a compost primarily of carbon along with variable quantities of other elements chiefly sulphur, hydrogen, oxygen and nitrogen.

Coal is a fossil fuel and is the largest source of energy for the generation of electricity worldwide, as well as one of the largest worldwide sources of CO_2 emission. Gross CO_2 emission from coal usage is high and more than that from petroleum and about double the amount from natural gas.



Fig. 7.7 Coal

Coal is obtained through mining or from open pits. Coal is primarily used as a solid fuel to produce electricity and heat through combustion. When coal is heated in air, coal burns and produces mainly carbon-dioxide gas. Coal is processed in industries to obtain some useful products such as coke, coal tar and coal gas.

ACTIVITY 7.3

- Visit Neyveli Lignite corporation.
- Find out the methods of coal extraction.
- Discuss with your classmates about the uses of coal.

Environmental effects of coal burning

1. Generation of waste products which contain mercury, uranium, thorium, arsenic and other heavy metals, which are harmful to human health and environment.
2. Sulphur particles present in the coal causes acid rain.
3. Interference with ground water and water table levels.
4. Contamination of land and water bodies.
5. Dust pollution.
6. Release of CO_2 , a green house gas, causing climate change and global warming.
7. Coal is the largest contributor to the man-made increase of CO_2 in the air.

Petroleum

In today's modern life, we are dependent on petrol and petroleum products. Petroleum or crude oil is a naturally occurring toxic, flammable liquid consisting of a complex mixture of hydrocarbons and other organic compounds that are found beneath the earth's surface.

Do you know how petroleum was formed?

Petroleum was formed from organisms living in the sea. After the death of those

organisms, their bodies settled at the bottom of the sea and were covered with layers of sand and clay. Over millions of years, absence of air, high temperature and high pressure transformed the dead organisms into petroleum and natural gas.

Many useful substances are obtained from petroleum and natural gas. These are used in the manufacture of detergents, fibres (polyester, nylon, acrylic etc.), polythene and other plastic substances. Hydrogen gas, obtained from natural gas, is used in the production of fertilizers (urea). Due to its great commercial importance, petroleum is also called 'Black Gold'.



Fig 7.8 Petroleum Industry

Environmental Effects

Oil Spills

1. Crude oil (refined fuel) spills from tanker ships due to accidents have damaged the natural ecosystem.
2. Oil spills at sea generally cause more damage than those on land. These can kill sea birds, mammals, shellfish and other organisms, because of their lateral spread on the surface of the water.

Tar Balls

A tar ball is a blob of oil which has been weathered after floating on the ocean. Tar balls are aquatic pollutants in most of the seas.

Alternatives to Petroleum – based Vehicle Fuels

1. Internal combustion engines (biofuel or combustion hydrogen)
2. Electricity (for e.g. all electric (or) hybrid vehicles), compressed air or fuel cells (hydrogen fuel cells).
3. Compressed natural gas used by natural gas vehicles.

7.6. GREEN CHEMISTRY

Green chemistry is the design of chemical products and the processes to reduce or eliminate the use and generation of hazardous substances.

The concept of green chemistry was introduced in 1995. The Green Chemistry Institute was recently created and the Presidential Green Chemistry Challenge Awards were established in 1999.

- Greener reaction conditions for an old synthesis. e.g. replacement of an organic solvent with water or the use of no solvent at all.

MORE TO KNOW

- Many countries are making commitments to lower green house gas emissions according to the Kyoto Protocol.
- Coal is used in thermal power stations and petroleum products like petrol and diesel are used in transportation like motor vehicles, ships and aeroplanes. We cannot really imagine a life without electrical appliances and transportation. Can you think of ways by which consumption of coal and petroleum products can be reduced?

- A greener synthesis for an old chemical. (e.g. a synthesis which uses biomass rather than petrochemical feedstock or the use of catalytic rather than stoichiometric reagents).
- The synthesis of a new compound that is less toxic but has the same desirable properties as an existing compound. (e.g. a new pesticide that is toxic only to target organisms and bio-degrades into environmentally benign substances)
- Green chemistry / technology has been developed in almost all branches of chemistry including organic, biochemistry, inorganic, polymer, toxicology, environmental, physical, industrial etc.

The Principles of Green Chemistry

- It is better to reduce waste generation than to treat or clean up waste after it is generated.
- Wherever practically feasible, synthetic methodologies should be designed to use and generate substances that possess a little or no toxicity to humans and the environment.
- Chemical products should be designed to preserve efficacy of function while reducing toxicity.

Products Produced by the Process of Green Chemistry

- Lead free solders and other products alternative to lead additives in paints and the development of cleaner batteries.
- Bio-plastics: Plastics made from plants including corn, potatoes or other agricultural products.
- Flame resistant materials.
- Halogen free flame retardants.



Fig. 7.9 Green Chemistry

(e.g. silicon based materials can be used.)

Future Products

- A raw material feedstock should be renewable rather than depleting, whenever technically and economically practical.
- Catalytic reagents are superior to stoichiometric reagents.
- Green Chemistry is applicable to all aspects of the product life cycle as well. Finally, the definition of green chemistry includes the term “hazardous”. It is important to note that green chemistry is a way of dealing with risk reduction and pollution prevention.

PVC and Lead

New lead free solders with lower heat requirements are being developed.

Beware of Green Washing

Green chemistry is not a panacea. We must be vigilant in making sure that what is called “Green Chemistry” really pushes towards a more sustainable world and not simply green washing.

7.7. SCIENCE TODAY

Towards Global Village

“Global Village” is the term used to mean that the world has shrunk into a small village by means of different types of media, especially the World Wide Web, making it easy to pass messages (like news) thereby making the world become a single village where people can easily and quickly contact each other.

What is Global Village?

A term that compares the world to a small village, where fast and modern communication allows news to reach quickly. The use of electronics for faster communication is a global village concept.

What is the global electronic village?

Global electronic village (GEV) is a term used to refer to a village without borders; it refers to connecting people around the world technologically through Information Communication Technologies (ICTS).

The term global village was coined by Marshall McLuhan. He emphasized that “this forces us to become more involved with one another from countries around the world and be more aware of our global responsibilities”. Similarly, web-connected computers enable people to link their websites together. This new reality has implications for forming new sociological structures within the context of culture.

MODEL EVALUATION

PART - A

1. Which of the following groups contain only bio-degradable items?
i) Grass, flowers and leaves ii) Grass, wood and plastic
iii) Fruit peels, cake and plastic iv) Cake, wood and glass
2. Which of the following constitutes a food chain?
i) Grass, wheat and mango ii) Grass, goat and human
iii) Goat, cow and elephant iv) Grass, fish and goat
3. Which of the following are environmental friendly practices?
i) Carrying cloth bags for shopping ii) Switching off light and fans when not in use
iii) Using public transport iv) All the above
4. What is called as ‘black gold’?
i) hydrocarbons ii) coal iii) petroleum iv) ether
5. Based on the food chain, pick the odd one out:
plants → grasshopper → frog → tiger → snake

CONSERVATION OF ENVIRONMENT

6. Example for product of green chemistry is _____.
i) plastic ii) paper iii) bio plastics iv) halogen flame retardants
7. _____ is a green house gas which causes climate change and global warming.
i) hydrogen ii) oxygen iii) nitrogen iv) carbondioxide
8. The _____ form decomposers in the pond ecosystem.
i) plants ii) bacteria iii) frogs iv) phytoplanktons
9. _____ is used in seeding clouds.
i) potassium iodide ii) calcium carbonate
iii) sulphurdioxide iv) ammonium phosphate
10. An example for fossil fuel is _____.
i) copper ii) iron iii) magnesium iv) coal
11. Air pollution is caused by transport exhaust fumes and emission of gases like SO_2 , CO_2 , NO_2 from industries. Similarly, water pollution is caused by _____.
i) sewage ii) crop cultivation iii) rain iv) soil erosion
12. If wild animals are killed, what difficulty would we face?
i) imbalance in nature ii) decrease in fog rain
iii) decrease in population iv) increase in rain
13. Water is an essential commodity for survival. What can we do to help increase water resources?
i) deforestation ii) reducing the use of vehicles
iii) the burning of the wastage iv) afforestation
14. The tiger and the lion are carnivores. Likewise the elephant and the bison are _____.
15. Assertion (A) : Coal and petroleum are called fossil fuels.
Reason (R) : Fossil fuels are formed from the remains of dead organisms after millions of years.
i) Both 'A' and 'R' are true and 'R' explains 'A'.
ii) Both 'A' and 'R' are true and but 'R' doesn't explain 'A'.
iii) Only 'A' is true but 'R' is false.
iv) 'A' is false but 'R' is true.
16. Compressed Natural Gas (CNG) is considered a better fuel than coal/ petroleum, because _____.
17. Now-a-days water bottles and lunch boxes are made from agricultural products like fruit pulp. These are called _____.

PART - B

1. Classify the following into producers, consumers, decomposers.

- | | | | |
|-----------------|-------------------|---------------|------------|
| i) butterfly | ii). grass hopper | iii) calottes | iv) snakes |
| v). shoe flower | vi) nitrobacteria | | |

2. Living organisms adapt themselves according to their habitat.

Match the following:-

a. fish	wings
b. camel	hard skin
c. frog	fins
d. birds	hind limbs with web

3. Fill in the blanks

- i) Animals give out _____ through respiration.
- ii) In the presence of sunlight, plants prepare _____.

4. Bacteria and fungi are responsible for the decay of dead plants and animals. Decaying matter is recycled to grow plants. What do we call this?

5. Fill in the blanks with suitable answers from those given in the brackets.

(harmful, heavy metals, carbon dioxide, sulphur particles)

Generation of waste products which contain Mercury, Uranium, Thorium, Arsenic, and other _____ are _____ to human health and environment. _____ present in the coal will cause acid rain and the release of _____, a green house gas, causes climate change and global warming.

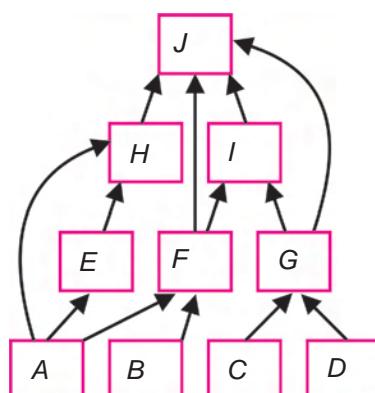
6. Depict a food chain by placing the following organisms in the correct trophic levels:

(snake, grass, eagle, frog, grasshopper)

7. Show an aquatic food chain using the following organisms.

(Small fish, Phytoplanktons, Kingfisher, Zooplanktons)

8. Observe the following food web:

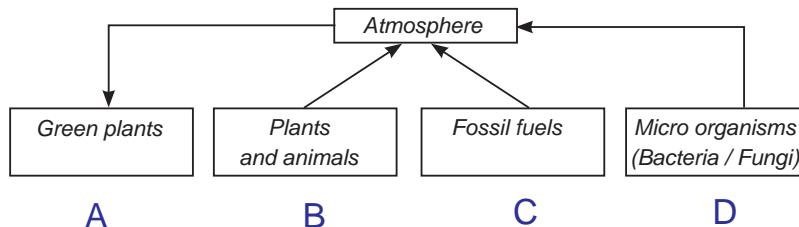


(i) Find out the wrong statement:

- a) 'A' is a producer
- b) 'F' is a herbivore
- c) 'H' is an omnivore
- d) 'I' is a climax carnivore

(ii) Find out how many food chains are present in the above food web.

9. Observe the following Bio-geo chemical cycle.



i) Mention the nutrient in the given cycle.

ii) Write the activities from 'A' to 'D'.

10. Study the food chain below, correct it and convert it into a pyramid of energy.

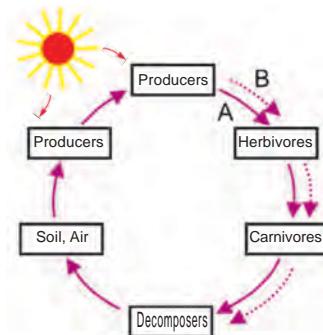
Mulberry -> Sparrow -> Caterpillar -> Kite

11. Study the illustration and answer the questions:

i) Which line (A or B) represents the flow of energy?

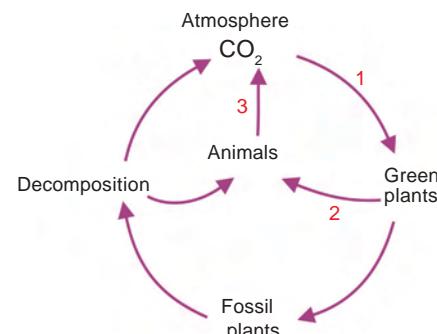
Why do you say so?

ii) Give an example of a decomposer.



12. i) Name the processes noted as No. 1 and 3.

ii) Define process 1.



PART - C

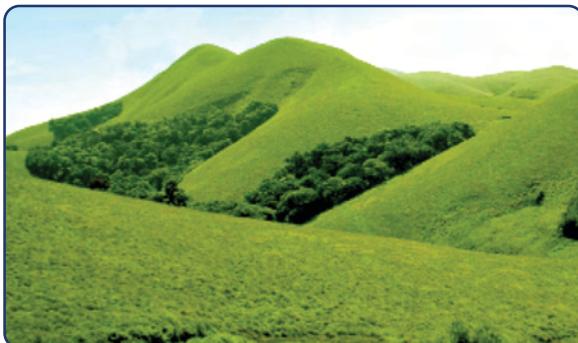
1. i) Classify the following substances – wood, paper, plastic and grass.

ii) Give a detailed account of your classification.

2. In your locality people are affected due to water scarcity. What measures will you take to deal with the problem of water scarcity?

3. We are surrounded by smoke. Is this situation good for our health. Give reason.
 4. List out the harmful effects of burning coal.

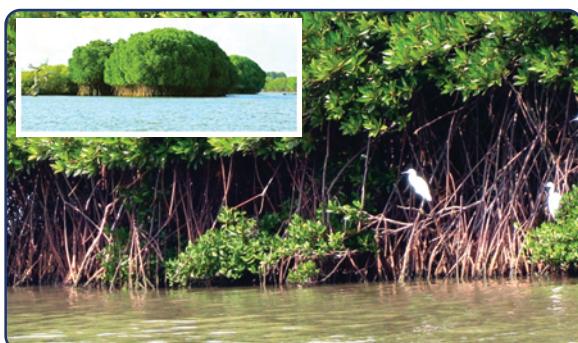
Unique Ecosystems of Tamilnadu



*Sholas and Grasslands
Western Ghats*



*Theri Kaadu
Mukuperi, Thoothukudi*



*Mangrove Forests
Pichavaram, Cuddalore*



*Neela Kurinji- Plant that blooms once in 12 years
The Nilgris*

The Sholas and grasslands of the Western Ghats are the sources of all our South Indian rivers. All the hillocks in the upper mountains have this unique ecosystem, which we cannot create.

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Chapter 8



WASTE WATER MANAGEMENT

Human beings have been abusing the water-bodies around the world by disposing all kinds of wastes into them. We tend to believe that water can wash away everything, not taking cognizance of the fact that the water bodies are our life line, as well as that of all other living organisms.

Can you list out the things we tend to wash away through our rivers and drains?

Due to such activities of human beings, the ponds, lakes, streams, rivers, estuaries and oceans are polluted in several parts of the world. So we should manage the waste water in order to prevent water pollution and its harmful effects on our life.

8.1. JOURNEY OF WATER

Water, a precious physical substance, is essential to all living organisms. All biological functions and cell metabolism require water. Without water, life cannot sustain on the earth because of this feature.

Water Cycle

A large quantity of water is present in an area of about 1400 million km³ in the entire globe. This water evaporates from moist surfaces, falls as rain or snow, passes through lakes and rivers, seeps into the ground water table and flows into the ocean, also gets fixed in glaciers and

deposited over mountains. Plants absorb water from the soil, utilize it for its metabolic activities and release it into the atmosphere mainly through transpiration.

Sources of Water

Water is widely distributed in nature and is found in various forms viz., solid, liquid and vapour. Rainfall brings the available primary source of water over the earth's surface. Oceans are the largest among all the water resources. Only a little quantity of water i.e. 2.4 percent of water is fresh and most of this fresh water is in glaciers or as ground water. Geologic layers containing water is known as **aquifers** from which water can be extracted. On some areas of the earth's crust, fresh water flows freely which is called as an **artesian well** or spring. Rivers carry a huge volume of water for discharge into the lakes and ponds. Wetlands, swamps and marshes play a vital role in this journey of water.

8.2. SEWAGE

Sewage is generated from residential, institutional, commercial and industrial establishments and includes household solid and liquid waste from toilets, baths, showers, kitchens, sinks and so forth. The sewage is disposed through sewer lines.

8.3. TREATMENT

Sewage can be treated close to where it is created (in septic tanks, biofilters or aerobic treatment systems) or collected and transported via a network of pipes and pump stations to a municipal treatment plant (see fig. 8.1 sewage pipes and infrastructure). Sewage collection and treatment is typically subject to local, state and central regulations and standards. Industrial sources of waste water often require specialized treatment process.

Conventional sewage treatment may involve three stages: 1. primary
2. secondary 3. tertiary

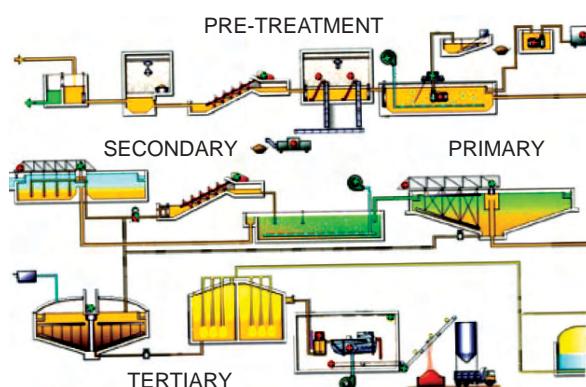


Fig. 8.1 Sewage water treatment

Primary Treatment

Primary Treatment involves temporary holding of the sewage in a quiescent basin, where heavy solids get settled at the bottom while oil, grease and lighter solids float over the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment.

Secondary Treatment

Secondary Treatment is used to remove the dissolved and the suspended biological

matter. This process is typically performed by indigenous, water borne microorganisms in a managed habitat. Secondary treatment may require a separation process to remove the microorganisms from the treated water, prior to discharge for tertiary treatment.

Tertiary Treatment

Tertiary Treatment is defined as either chemical or treatment of filtration done after the primary and the secondary treatment. Treated water is sometimes disinfected chemically or physically (for example by lagoons and microfiltration.). Before discharging the treated effluent into a stream, river, bay, lagoon or wetland, it can be used for the irrigation of a golf course a green way or a park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

Bioremediation in Sewage Treatment

Bioremediation is a technique which is used to clean up the environment using microorganisms. *Nitrosomonas europaea* can be used to treat sewage, freshwater, walls of buildings and the surface of monuments especially in polluted areas, where there are high levels of nitrogen compounds.

8.4. DOMESTIC PRACTICES

Sewage comprises of waste water i.e. waste liquid from toilets, bathrooms, kitchens and so forth, released from homes.

The process of converting household waste into grey water and black water is becoming more common in our country. Grey water is permitted to be used for watering plants or recycled for use in flushing toilets.

ACTIVITY 8.1

- Find out how the sewage in your locality is treated. Are there mechanisms to ensure that local water bodies are not polluted by untreated sewage?
- Find out how the local industries in your locality treat their wastes. Are there mechanisms in place to ensure that the soil and water are not polluted by the waste?

Waste Water

Waste water is often referred to as grey water. Any water that has been used in the households, with the exception of water in the toilet can be referred to as waste water.

This water could be reused for a multitude of purposes including,

1. Watering yards and gardens
2. Filtering septic systems
3. Irrigating fields

Benefits of household waste water recycling systems:

1. Less fresh water usage
2. Reduce stain in septic tanks
3. Recharge ground water
4. Encourage plant growth

8.5. SANITATION AND DISEASES

Water supply, sanitation and health are closely interrelated. Poor hygiene, inadequate quantity and quality of drinking water and lack of sanitation facilities cause millions of the world's poorest people to die from preventable diseases each year. Water contaminated by humans, chemicals and industrial wastes can result in a variety of

communicable diseases through ingestion or physical contact.

Waterborne diseases

Waterborne diseases are caused by the ingestion of water, contaminated by human or animal faeces or urine containing pathogenic bacteria or viruses. They include cholera, typhoid, amoebic and bacillary dysentery and other diarrhoeal diseases.

Water-washed Diseases are caused by poor personal hygiene and skin or eye contact with contaminated water. They include scabies, trachoma and flea, lice and tick-borne diseases.

Water-based Diseases are caused by parasites found in intermediate organisms living in water. They include dracunculiasis, schistosomiasis and other helminthes.

Water-related Diseases are caused by insect vectors which breed in water. They include dengue, filariasis, malaria, onchocerciasis, trypanosomiasis and yellow fever.

- Contaminated water that is consumed may result in waterborne diseases including viral hepatitis, typhoid, cholera, dysentery and other diseases that cause diarrhoea.
- Without adequate quantities of water for personal hygiene, skin and eye infections spread easily.
- Water - based diseases and water-related vector-borne diseases are a result of water supply projects. They inadvertently provide habitats for mosquitoes and snails. They are intermediate hosts for parasites that cause malaria, schistosomiasis, lymphatic filariasis and Japanese encephalitis.

ACTIVITY 8.2

- Wash your hands thoroughly before and after using the toilet.
- Clean food and water containers properly and keep them closed when they are in use.
- During floods and other natural calamities, water should be used only after boiling.
- People who live near accumulated hazardous industrial waste or polluted water areas should be very careful while using ground water.

- Drinking water supplies that contain high amounts of chemicals like arsenic and nitrates can cause serious diseases.
- Inadequate water, sanitation and hygiene, account for a large part of the burden of illness and death in developing countries.
- Lack of clean water and sanitation is the second most important risk factor in terms of the global burden of diseases, after malnutrition.
- Approximately, 4 billion cases of diarrhoea per year cause 1.5 million deaths, mostly among children under five.
- Intestinal worms infect about 10 percent of the population of the developing world, and can lead to malnutrition, anaemia and retarded growth.
- 300 million people suffer from malaria every year.

8.6. ALTERNATIVE ARRANGEMENT

FOR SEWAGE DISPOSAL

Wherever crops are grown, they always need nutrients and water. Wastewater is often used in agriculture as it contains water, minerals, nutrients and its disposal is often expensive. Where effluent is used for irrigation, good quality water can be reserved exclusively for drinking purpose. Wastewater can also be used as a fertilizer, thus minimizing the need for chemical fertilizers. This reduces the cost, energy, expenditure and industrial pollution. Waste water is also commonly used in aquaculture or fish farming.

8.7. SANITATION IN PUBLIC PLACES

Wherever population density is high such as bus station or school, especially when they eat food from the same source, there is a greater risk of the spread of diseases such as, cholera, hepatitis, typhoid and other diarrhoeal diseases.

These places vary in the number of people using them, the amount of time that people spend there and the type of activity that takes place in the area, but all public places need to have adequate sanitation and hygiene facilities.

Basic rules for sanitation in public places

1. There should be sufficient toilet facilities.
2. The toilet facilities should be arranged in separate blocks for men and women.
3. The men's toilet block should have urinals and toilet compartments. The women's block should have toilet compartments only.
4. There must be a wash basin with clean water.

- There must be a clean and reliable water supply for hand washing, personal hygiene and flushing of the toilet facilities.

8.8. ENERGY MANAGEMENT

What is Energy Management?

“Energy Management” is a term that has a number of meanings, but we are mainly concerned with the one that relates to saving energy at business, public-sector / government organizations and homes.

Energy Saving Measures

Energy Management is the process of monitoring, controlling and conserving energy in any household or organization.

8.8.1. Energy Audit

An energy audit is an inspection, survey and analysis on energy flow for energy conservation in a building, process or system. It is done with a view to reduce the amount of energy input into the system without negatively affecting the output(s).

Home Energy Audit

Home energy audit is a service where the energy efficiency of a house is evaluated using professional equipment such as blower doors and infra-red cameras, with the aim to suggest effective ways to improve energy efficiency in heating and cooling the house.

An energy audit of a home may involve recording various characteristics of the building envelope including the walls, ceilings, floors, doors, windows and skylights. The goal of this exercise is to quantify the building's overall thermal performance. The audit may also assess the efficiency and physical condition on programming of mechanical systems such

as heating, ventilation, air-conditioning equipment and thermostat.

A home energy audit may include a written report estimating energy consumption at given local climate criteria, thermostat settings, roof overhang, and solar orientation. This could show the amount of energy consumed for a given time period, say a year, and the impact of any suggested improvements per year. The accuracy of energy estimates are greatly improved when the homeowner's billing history is available showing the quantities of electricity, natural gas, fuel oil, or other energy sources consumed over a one or two-year period.

A home energy audit is often used to identify cost effective ways to improve the comfort and efficiency of buildings. In addition, homes may qualify for energy efficiency grants from the Central Government.

Energy Audit in Schools

The function of an energy audit is to expose different ways that affect energy consumption and identify numerous options for reducing energy consumption.

The money your school saves through energy audit service will be available to fund important school projects, but just as important, energy savings help the Earth by reducing resource use and environmental pollution. By improving energy efficiency in places like schools, we can obtain the same benefits as by using less energy. For example, substituting energy efficient compact fluorescent light bulbs (CFL) for standard incandescent bulbs will save on an average up to 6,000 megawatts of electricity each year.

There are many ways you can help your

school save money on water usage, such as checking for leaks in the system, reducing water usage (especially hot water), and improving the efficiency of water delivery.

ACTIVITY 8.3

- Using a thermometer, observe the room temperature of your classroom and the temperature under a Neem tree on a hot day.
- Light a tungsten lamp and a compressed fluorescent lamp and compare the energy consumption.

Another important way to conserve energy at your school is through recycling. This can be done all over the school. For example, you can save by recycling paper, milk cartons from the lunch room or printer cartridges in the copy room. By recycling paper, milk cartons and other materials, schools are able to reduce the amount of waste they generate. This can garner significant savings as well as benefit the environment.

8.8.2. Renewable sources

A natural resource is a renewable resource, if it is replaced by natural processes at a rate equal to or faster than its rate of consumption by humans. Solar radiation, hydrogen, wind and hydroelectricity are in no danger of a lack of long term availability.

Solar Energy

Solar Energy is the energy harnessed directly from the sun. Along with nuclear energy, it is the most abundant source of energy on the earth. The fastest growing type of alternative energy increasing at 50

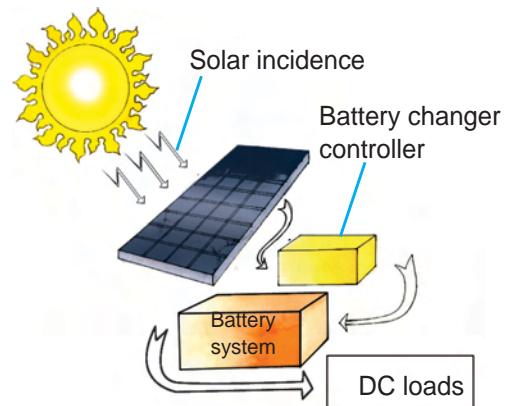


Fig. 8.2 Solar Energy

percent a year is the photovoltaic cell, which converts sunlight directly into electricity. In a year, the sun generates more than 10,000 times the energy that humans currently consume.

ACTIVITY 8.4

- Study the structure and working of a solar cooker and / or a solar water heater, particularly with regard to how it is insulated and maximum heat absorption is ensured.
- Design and build a solar cooker or water heater using low cost material available and check what temperatures are achieved in your system.
- Discuss the advantages and limitations of using solar cookers or water heaters.

Hydrogen

Hydrogen has been found to be the best choice among all the alternative fuel options. It can be produced in virtually unlimited quantities with production technologies in hand. It has been established that hydrogen can meet all the energy needs of human society including power generation, more efficiently and more economically than

petro fuels, and in total compatibility with the environment. In addition, hydrogen is non-toxic, reasonably safe to handle, distribute and to be used as a fuel. Hydrogen has the highest mass energy content. Its heat of combustion per unit weight is about 2.5 times that of hydro carbon fuel, 4.5 times that of ethanol and 6.0 times that of methanol. Its thermodynamic energy conversion efficiency (30-35 %) is greater than that of gasoline (20-25%).



Fig. 8.3 Windmills

MORE TO KNOW

Denmark is called the country of “winds”. More than 25% of their electricity needs are generated through a vast network of windmills. In terms of total output, Germany is the leader, while India is ranked 5th in harnessing wind energy for the production of electricity. It is estimated that nearly 45000MW of electrical power can be generated if India’s wind potential is fully utilized. The largest wind energy farm has been established near Kanyakumari in Tamilnadu and it generates 380MW of electricity.

Wind Power

Wind Power is derived from uneven heating of the Earth's surface from the sun and the warm core. Most modern wind power is generated in the form of electricity by converting the rotation of turbine blades into electrical current by means of an electrical generator. In wind mills, (a much older technology) wind energy is used to turn mechanical machinery to do physical work, like crushing grain or pumping water.

8.8.3. Non-renewable Sources

A non-renewable resource is a natural resource which cannot be produced, grown, generated or used on a scale which can sustain its consumption rate. These resources often exist in a fixed amount, or are consumed much faster than nature can create them. Fossil fuels (such as coal, petroleum and natural gas) and nuclear power (uranium) are examples.

Fossil Fuels

Fossil fuels which are energy rich are combustible forms of carbon or compounds of carbon formed by the decomposition of biomass buried under the earth over million of years.



Fig. 8.4 Coal Mining

Coal

Coal is a black mineral of plant origin, which is chemically a complex mixture of elemental carbon, compounds of carbon containing hydrogen, oxygen, nitrogen and sulphur.

Petroleum

Petroleum is a dark, viscous, foul smelling liquid - a mixture of solid, liquid and gaseous hydro-carbons with traces of salt, rock particles and water.

Natural Gas

The composition of natural gas is chiefly methane (> 90%) with traces of ethane and propane. It is found associated with other fossil fuels, in coal beds, as methane clathrates and it is created by methanogenic organisms in marshes, bogs, and land fills. It is an important fuel source, a major feedstock for fertilizers and a potent green house gas.

Natural gas can be used as a fuel only after it undergoes extensive processing to eliminate almost all materials other than methane. The by-products of methen processing include ethane, propane, butane, pentane and higher molecular weight hydrocarbons, elemental sulphur, carbon-dioxide, water vapour and sometimes helium and nitrogen.

Natural gas is often informally referred to as gas, especially when compared to other energy sources such as oil or coal.

Uses

Power Generation: Natural Gas is a major source of electricity generation through the use of gas turbines and steam turbines. Most grid peaking power plants and some off – grid engine generators use natural gas.

Domestic Use: Natural gas is supplied to homes where it is used for the purpose of cooking in gas stoves and ovens. Natural gas heater is used as clothes dryers. Some homes and buildings which have boilers, furnaces and water heaters use natural gas.

Natural gas is a major feedstock for the production of ammonia and fertilizers.

Other Uses: Natural gas is also used in the manufacture of fabrics, glass, steel, plastics, paint and other products. With our ever increasing need for energy, we have been using fossil fuels indiscriminately. In the process, harmful materials contributing to air pollution are produced.

8.8.4. Biofuels – Generation and Use

Biofuels are a wide range of fuels which are in some way derived from biomass. The term covers solid biomass, liquid fuels and various biogases. Biofuels are gaining increased public and scientific attention driven by factors such as oil price hikes, the need for increased energy security and concern over greenhouse gas emissions from fossil fuels.

The various liquid biofuels for transportation are :

1. Bioalcohol
2. Green diesel
3. Biodiesel
4. Vegetable oil
5. Bioethers
6. Biogas

Bioalcohol (Bioethanol)

Bioethanol is an alcohol prepared by fermenting the sugar components of plant materials and it is made mostly from sugar

and starch crops. With advanced technology being developed, cellulosic biomass, such as trees and grasses are also used as feed stocks for ethanol production. Ethanol can be used as fuel for vehicles in its pure form. Bioethanol is widely used in the USA and Brazil.

Biodiesel: Biodiesel is made from vegetable oil and animal fats. It is used as a fuel for vehicles in its pure form.

Biogas: Biogas is produced by the process of anaerobic digestion of organic material by anaerobes. It can be produced either from biodegradable waste material or by the use of energy crops fed into anaerobic digesters to supplement gas yields. The solid digestable byproduct, can be used as biofuel or fertilizer.

8.8.5. Energy Conservation

Energy Conservation

Energy Conservation refers to efforts taken to reduce energy consumption in order to preserve resources for the future and reduce environmental pollution. It can be achieved through efficient energy use or by reduced consumption of energy services. Energy conservation will lead to an increase of financial capital, environmental value, national security, personal security and human comfort. Individuals and organizations that are direct consumers of energy may want to conserve energy in order to reduce energy costs and promote economic security. Industrial and commercial users may want to increase efficiency and thus maximize profit. Electrical energy conservation is the important element of energy policy.

ACTIVITY 8.5

Debate the following two issues in class:

- *The estimated coal reserves are said to be sufficient for human use for another 200 years. Do you think we need to worry about coal getting depleted in this case? Why do you think so?*
- *It is estimated that the sun will exist for another 5 billion years. Do we have to worry about solar energy getting exhausted? Why or why not?*
- *On the basis of the debate, decide which energy sources can be considered i) exhaustible ii) inexhaustible iii) renewable iv) non-renewable. Give your reasons for each choice.*

Lighting

1. Turn off the lights when not in use.
2. De-dust lighting fixtures to maintain illumination.
3. Focus the light, where you actually need.
4. Use fluorescent bulbs.
5. Use electronic chokes in place of conventional copper chokes.

Fans

1. Replace conventional regulators with electronic regulators for ceiling fans.
2. Install exhaust fans at a higher elevation than ceiling fans.

Electric Iron Box

1. Use iron boxes with automatic temperature cut off.

2. Use appropriate regulator position for ironing.
3. Do not sprinkle more water on clothes, while ironing.
4. Do not iron wet clothes.

Gas Stove

1. When cooking on a gas burner, use moderate flame settings to conserve LPG.
2. Blue flame denotes that your gas stove is operating efficiently.
3. Yellowish flame indicates that the burner needs cleaning.
4. Use pressure cooker as much as possible.
5. Use lids to cover the pans while cooking.
6. Use solar water heater instead of an electric water heater.

Electronic Devices

1. Do not switch on the power when the TV and Audio system are not in use. i.e. idle operation leads to an energy loss of 10 watts / device.
2. Battery chargers of laptops, cell phones and digital cameras draw power, whenever they are plugged in and are very inefficient. Remove the plug and save energy.

Washing Machine

1. Always wash only with full loads.
2. Use optimal quantity of water.
3. Use timer facility to save energy.
4. Use the correct amount of detergent.
5. Use hot water to wash only very dirty clothes.
6. Always use cold water in the rinse cycle.

MODEL EVALUATION

PART - A

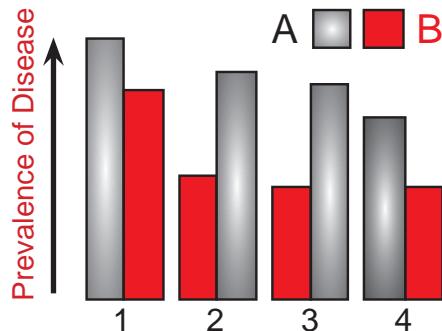
1. An example of water-borne disease is _____.
i) scabies ii) dracunculiasis iii) trachoma iv) typhoid
2. The sedimented and floating materials are removed by this treatment process.
*i) primary treatment ii) secondary treatment
iii) tertiary treatment iv) peripheral treatment*
3. Which is a non-renewable resource?
i) coal ii) petroleum iii) natural gas iv) all the above
4. _____ is the chief component of natural gas.
i) ethane ii) methane iii) propane iv) butane

PART - B

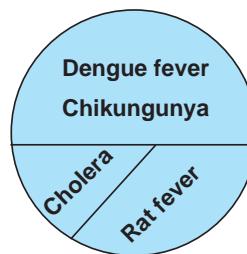
1. The bar-graph indicates the prevalence / widespread attack of infectious diseases in two cities A and B. Observe it and answer the questions given below:

1. Dengue fever 2. Rat fever 3. Cholera 4. Chikungunya

- a. What may be the reason for the disease in city A?
 b. Which city needs more effective system of waste-disposal and cleaning?
 c. How can the disease be controlled in city A?



2. The pie diagram represents a survey result of infectious diseases in a village during 2008 – 2009. Analyse it and answer the following:



- i) Which diseases affect the majority of the population?
 ii) How are these diseases transmitted?
 iii) Mention any three measures that can control the other two diseases.

3. Match the suitable renewable and non-renewable sources.

Sources	A	B	C
Renewable	Coal	Wind	Petroleum
Non- Renewable	Hydrogen	Natural gas	Solar energy

4. Find the odd one out:

- i) bioalcohol, green diesel, bioethers, petroleum
 ii) cholera, typhoid, scabies, dysentery

5. A non-renewable resource is a natural resource, if it is replaced by natural process at a rate equal to or faster than its rate of consumption by humans.

Read this statement and say whether it is correct or incorrect. If it is incorrect, give the correct statement.

6. Pick out the appliances that can conserve electric energy.

Florescent bulbs, copper choke, solar water heater, electric water heater, tungsten bulbs, electronic choke.

PART - C

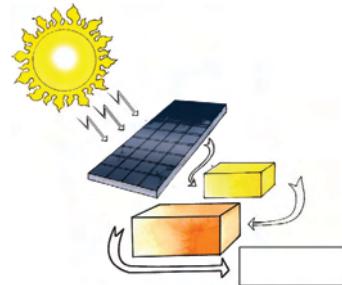
1. Observe the picture given below and find out what type of energy is produced

i) Identify whether this energy is conventional or non-conventional.

ii) Draw the given diagram and label it with the parts given below:

(battery, battery charger controller, solar incidence, DC load, battery system)

iii) In the given picture, _____ energy is transformed into _____ energy.



2. i) What type of energy is produced in this picture?

ii) What difficulties do we face in harnessing this energy? Explain.

iii) Why do we say that this energy is better than solar energy and atomic energy?



3. Fossil fuels are formed by decomposition of biomass buried under the earth over millions of years ago.

i) Name any three fossil fuels.

ii) Which fuel is used in the production of fertilizers?

iii) What is natural gas made up of ?

4. Wind power is generated from uneven heating of the earth's surface by the sun and the hot core.

i) Which country is called the country of winds?

ii) Which country leads the world in harnessing wind energy?

iii) In which district of Tamilnadu do we have wind energy farm?

iv) In which of the following land forms will you be able to harness maximum amount of wind energy?

(plains, canals, valleys)

5. Match the following:

<i>Water borne diseases</i>	<i>Water related diseases</i>	<i>Water based diseases</i>
<i>Typhoid</i>	<i>dengue</i>	<i>scabies</i>
<i>Malaria</i>	<i>amoebiasis</i>	<i>cholera</i>
<i>filariasis</i>	<i>lice</i>	<i>trachoma</i>

6. Water contaminated by human beings, chemical or industrial wastes can cause a variety of communicable diseases through ingestion or physical contact.

- i) Name any two diseases caused by polluted water.
 - ii) Why do we drink boiled water?
 - iii) How can you reuse waste water in your houses?
7. Water, a precious physical substance, is essential to all living organisms.

- i) Which is the largest water resource?
 - ii) What are the various sources of water?
 - iii) Which is the primary source of water?
 - iv) What are the ways by which you can raise the ground water level in your house?
8. An energy audit is an inspection, survey and analysis of energy flow to ensure energy conservation in a building, process or system.
- i) How will you measure consumption of electrical energy at home?
 - ii) What are the benefits of implementing this method in your school?
9. We should manage the waste water in order to prevent water pollution and its harmful effects.
- i) What are the ways by which water gets contaminated?
 - ii) How will you control water contamination in your house?

FURTHER REFERENCE

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Chapter 9



SOLUTIONS



Advantage of health drink



Health drink

Anu has got back home from the playfield after winning a match. She is received cheerfully by her mother with a glass of health drink.

Anu : Mother! What is this?

Mother: This is your health drink; it is a mixture of fruit juice and sugar. This solution will revitalise your energy.

Solutions are of great importance in **everyday** life. The process of food assimilation by man is in the form of

solution. Blood and lymph are in the form of solution to decide the physiological activity of human beings.

A solution is a homogeneous mixture of two or more substances.

All solutions exist in homogeneous form. The term **Homogeneous** refers to the state in which two or more substances are uniformly present in a given mixture. If a solution contains two components, then it is called as a **Binary Solution**.

Salt solution - common salt dissolved in water is an example for binary solution.

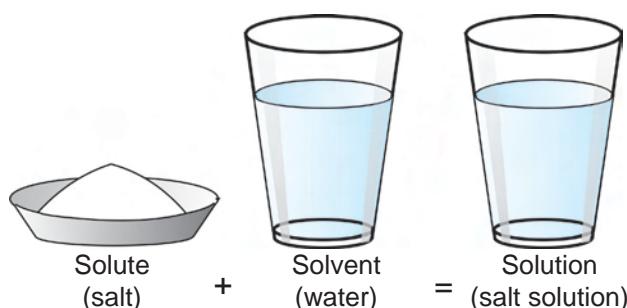


Fig. 9.1 A solution is a homogenous mixture of solute and solvent

9.1. SOLUTE AND SOLVENT

In a solution, the component present in lesser amount by weight is called **solute** and the component present in a larger amount by weight is called **solvent**. Generally a solvent is a dissolving medium. It surrounds the particles of solute to form a solution.

In short, a solution can be represented, as follows:

(Solute + Solvent → Solution)

9.2. TYPES OF SOLUTIONS

9.2.1. Based on the Particle Size

Based on the particle size of the substance, the solutions are divided into three types.

1. True Solution: It is a homogeneous mixture that contains small solute particles that are dissolved throughout the solvent eg. sugar in water.

2. Colloidal Solution: It is a heterogeneous mixture made up of two phases namely, dispersed phase and dispersion medium. The substance distributed as particles is

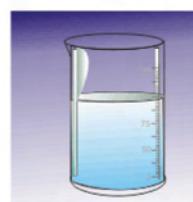
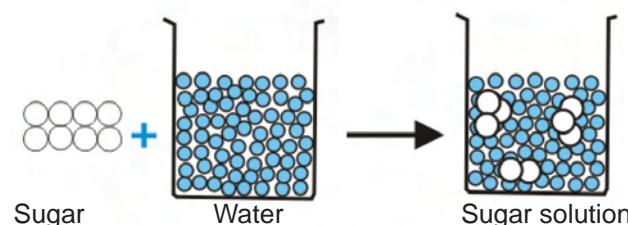


Fig. 9.2 Mixture of sugar and water forming true solution

called **dispersed phase**. The continuous phase in which the colloidal particles are dispersed is called **dispersion medium**.

(Dispersed phase + Dispersion medium → Colloidal solution)

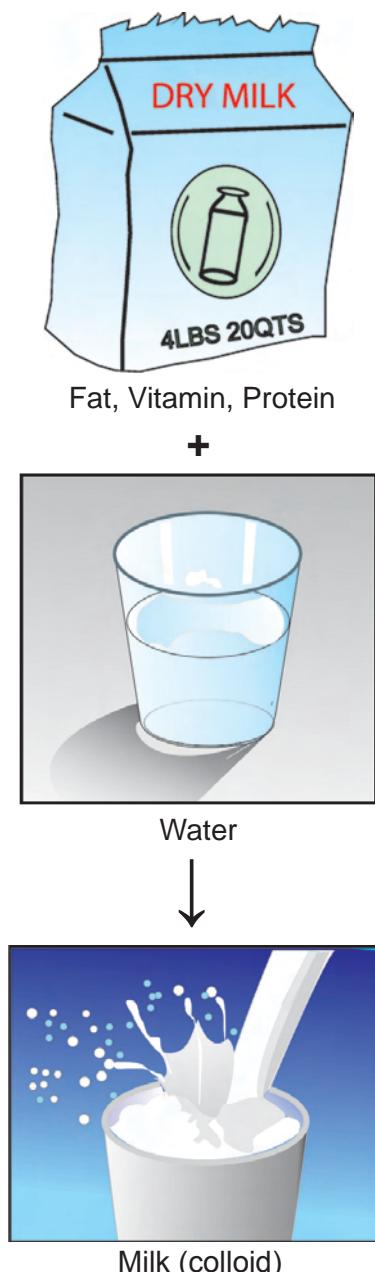


Fig. 9.3

3. Suspension: It is a heterogeneous mixture of small insoluble particles in a solvent. In a suspension, the solid particles stay in clusters that are large enough to be seen. (e.g. chalk powder in water).

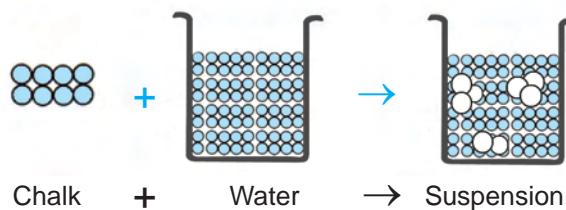


Fig. 9.4 A mixture of chalk powder and water forming suspension

MORE TO KNOW

Tyndall Effect: The phenomenon by which colloidal particles scatter light is called Tyndall Effect. If a beam of light is allowed to pass through a true solution, some of the light will be absorbed and some will be transmitted. The particles in true solution are not large enough to scatter light. However, if light is passed through a colloid, the light is scattered by the larger colloidal particles and the beam becomes visible. This effect is called TYNDALL EFFECT

ACTIVITY 9.1

Observe the scattering of light (Tyndall effect) when sunlight passes through the window of the classroom, the dust particles scatter the light, making the path of light visible.

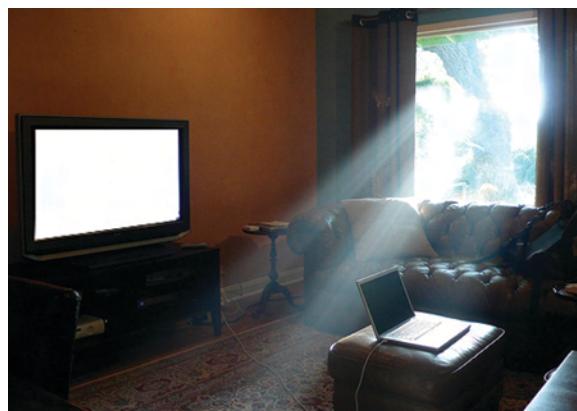


Fig. 9.5 Tyndall effect in nature

MORE TO KNOW

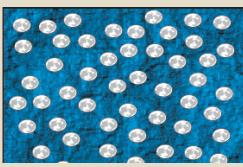
Brownian movement: The phenomenon by which the colloidal particles are in continuous random motion is called Brownian movement.

Brownian motion is named after ROBERT BROWN, a biologist. He observed the motion of the particles in suspension of pollen grains in water.



Fig. 9.6 Brownian movement

Comparing the Properties of True Solution, Colloidal Solution and Suspension:

Property	True Solution	Colloidal Solution	Suspension
Particle size in Å ($1\text{\AA} = 10^{-10}\text{m}$)	 1Å to 10 Å	 10Å to 2000 Å	 More than 2000 Å
Appearance	Transparent	Translucent	Opaque
Visibility of particles	Not visible even under ultra microscope	Visible under ultra microscope	Visible to the naked eye
Nature	Homogeneous	Heterogeneous	Heterogeneous
Diffusion of particles	Diffuses rapidly	Diffuses slowly	Diffusion does not occur
Scattering effect	Does not scatter light	Scatters light	Does not scatter light

9.2.2. Based on the type of solvent

Based on the type of solvent, solutions are classified into two types:-

1. Aqueous Solution: The solution in which water acts as a solvent, is called **aqueous solution**. (e.g. sugar solution).

2. Non-aqueous Solution: The solution in which any liquid other than water acts as a solvent is called **non-aqueous solution**. Solution of sulphur in carbon disulphide is a suitable example for non-aqueous solution. (Benzene, ether, carbon disulphide (CS_2), acetone are a few examples for non-aqueous solvents to dissolve organic compounds.)

9.2.3. Based on the Amount of Solute in the Given Solution

Based on the amount of solute in the given amount of solvent, solutions are classified into the following types.

1. Unsaturated solution
2. Saturated solution
3. Super saturated solution

1. Unsaturated Solution: Unsaturated solution is a solution in which more of the solute can be dissolved at a given temperature. In this, addition of solute is possible till the solution reaches the point of saturation.

e.g. 5g or 10g or 20g of NaCl in 100g water

2. Saturated Solution: A solution in which no more solute can be dissolved in a definite amount of solvent at a given temperature is called a saturated solution.

e.g. 36g of NaCl in 100g of water at room temperature forms a saturated solution.

3. Super Saturated Solution: A solution which has more of solute than the saturated solution at a given temperature is called **super saturated solution**.

MORE TO KNOW

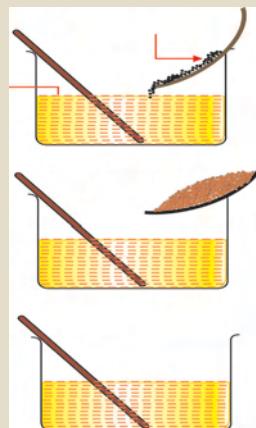
Nitrogen in soil is an example for saturated solution in nature. (Soil cannot store more N₂ than it can hold)

ACTIVITY 9.2

Test whether a solution is saturated, unsaturated or super-saturated with respect to the addition of salt to the solution at a particular temperature.

Take a glass containing 100ml of water, three packets of common salt each weighing 20g, 16g, and 1g and a table spoon (see fig 9.7).

Record your observations after the addition of each packet in the given order after stirring it at each stage.



Unsaturated

Saturated

Super Saturated

Fig. 9.7 To test Unsaturation, Saturation and Super Saturation in a given solution

9.2.4 Based on the physical state of the solute, the solvent and the solutions are of 9 types.

Solute	Solvent	Examples
Solid	Solid	Alloys
Solid	Liquid	Sugar solution
Solid	Gas	Smoke
Liquid	Solid	Cheese
Liquid	Liquid	Milk
Liquid	Gas	Cloud
Gas	Solid	Cork
Gas	Liquid	Soda water
Gas	Gas	Helium-oxygen mixture (for deep-sea diving)

9.3. SOLUBILITY

Solubility of a solute in a given solvent at a particular temperature is defined as the number of grams of solute necessary to saturate 100g of the solvent at that temperature. For example:

Solubility of CuSO_4 in H_2O is 20.7g at 20°C .

MORE TO KNOW

Dilute and Concentrated Solutions: Concentration of a solution is the amount of solute dissolved in a given amount of solvent. A solution containing less amount of solute is known as a dilute solution, whereas a solution containing a large amount of solute is known as a concentrated solution. It may be noted that dilute and concentrated are relative terms and they have only quantitative meaning.

ACTIVITY 9.3

Determine the solubility of a solid (say KCl) in water at room temperature.

- Prepare a saturated solution of KCl in about 30 ml of water at room temperature. Add more of KCl ensuring that the solution is saturated and some KCl is left undissolved.
- Filter the solution to remove the solid KCl.
- Find the temperature of the solution by immersing a thermometer in it.
- Use a low flame to avoid burning, evaporate the liquid till only the solid remains.
- Allow the dish and solid to cool to room temperature. Place the dish and solid in a dessicator containing anhydrous calcium chloride (calcium chloride is

a dehydrating agent, and it absorbs moisture).

- Take out the evaporating dish and weigh it again.
- The observations and calculations are given as follows:

Observation

Weight of the dish = $W\text{g}$

Weight of dish + saturated solution of KCl = $W_1\text{g}$

Weight of dish + dry KCl = $W_2\text{g}$

Calculation

Weight of saturated solution = $(W_1 - W)\text{g}$

Weight of KCl = $(W_2 - W)\text{g}$

Weight of water present in saturated solution

$$\begin{aligned} &= [(W_1 - W) - (W_2 - W)]\text{g} \\ &= (W_1 - W_2)\text{g} \end{aligned}$$

$$\begin{aligned} \text{Solubility of KCl} &= \frac{\text{Weight of KCl}}{\text{Weight of solvent}} \times 100 \\ &= \frac{(W_2 - W)}{(W_1 - W_2)} \times 100 \end{aligned}$$

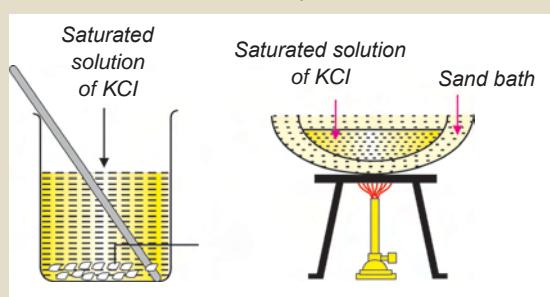


Fig. 9.8 Determination of solubility



Tit Bit

100ml of water can dissolve 36g of NaCl at 25°C to attain saturation.

Solubility of some ionic compounds at 25°C :

Ionic Compound	Solubility (g per 100g water)
NaCl	36 g
NaBr	95 g
NaI	184 g
NaNO ₃	92 g

9.4. FACTORS AFFECTING SOLUBILITY

1. Temperature
2. Nature of solute and solvent
3. Pressure

1. Effect of Temperature

In endothermic process, solubility increases with increase in temperature.

e.g. Solubility of KNO₃ increases with the increase in temperature.

In exothermic process, solubility decreases with increase in temperature.

e.g. Solubility of CaO decreases with increase in temperature.

Solubility of oxygen is more in cold water.

2. Nature of Solute and Solvent

Solubility of a solute in a solvent depends on the nature of both solute and solvent. A polar compound dissolves in a polar solvent.

e.g. Common salt dissolves in water. A polar compound is less soluble (or) insoluble in a non-polar solvent.

3. Effect of Pressure

Effect of pressure is observed only in the case of gases in liquids. An increase in pressure increases the solubility of a gas in a liquid. For e.g. CO₂ gas is filled in soft drinks using the effect of pressure.

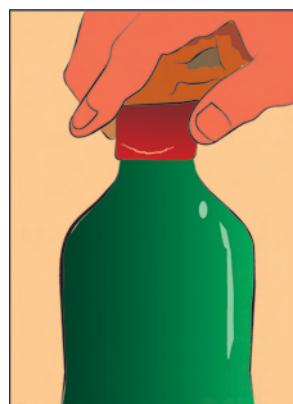


Fig. 9.9 CO₂ filled in soft drinks

MORE TO KNOW

Increase in pressure increases the solubility of gases. At a given temperature, the mass of gas dissolved in a fixed volume of liquid is directly proportional to the pressure of the gas on the surface of the liquid. This is called Henry's Law.

PROBLEM 1

Take 10g of common salt and dissolve it in 40g of water. Find the concentration of solution in terms of weight percent.

SOLUTION

Weight percent

$$\begin{aligned} & \text{Weight of the solute} \\ & = \frac{\text{Weight of the solute}}{\text{Weight of solute} + \text{Weight of solvent}} \times 100 \\ & = \frac{10}{10 + 40} \times 100 = 20\% \end{aligned}$$

PROBLEM 2

2g of potassium sulphate was dissolved in 12.5 ml of water. On cooling, the first crystals appeared at 60°C . What is the solubility of potassium sulphate in water at 60°C ?

SOLUTION

12.5 ml of water weighs 12.5g.

In 12.5g of water, the amount of potassium sulphate dissolved is 2g.

In 1g of water, the amount of potassium sulphate dissolved is $2/12.5$ g.

Hence, in 100g of water, the amount of potassium sulphate dissolved is $(2 \times 100)/12.5 = 16$ g.

The solubility of potassium sulphate in water at 60°C is 16g.

PROBLEM 3

50g of saturated solution of NaCl at 30°C is evaporated to dryness and 13.2g of dry NaCl was obtained. Find the solubility of NaCl at 30°C in water.

SOLUTION

Mass of water in solution = $50 - 13.2 = 36.8$ g

Solubility of NaCl =

$$\begin{aligned} \frac{\text{Mass of NaCl}}{\text{Mass of water}} \times 100 &= \frac{13.2}{36.8} \times 100 = 36\% \\ \text{Solubility of NaCl} &= 36\text{g (appx.)} \end{aligned}$$

PROBLEM 4

An empty evaporating dish weighs 20.0g. After adding saturated solution of NaNO_3 , the dish weighs 66.0g. When evaporated to dryness, the dish with crystals weighs 41.5g. Find the solubility of NaNO_3 at 20°C .

SOLUTION

$$\begin{aligned} \text{Weight of saturated solution of } \text{NaNO}_3 \\ &= (66.0 - 20.0) \text{ g} = 46.0 \text{ g} \end{aligned}$$

$$\begin{aligned} \text{Weight of crystals of } \text{NaNO}_3 &= (41.5 - 20.0) \text{ g} \\ &= 21.5 \text{ g} \end{aligned}$$

$$\begin{aligned} \text{Weight of water in saturated solution} \\ &= (46.0 - 21.5) \text{ g} = 24.5 \text{ g} \end{aligned}$$

Solubility of NaNO_3 =

$$\begin{aligned} & \frac{\text{Weight of } \text{NaNO}_3 \text{ Crystals}}{\text{Weight of water}} \times 100 \\ &= \frac{21.5}{24.5} \times 100 = 87.7 \text{ g} \end{aligned}$$

Solubility of NaNO_3 at 20°C is = 87.7g in 100 g H_2O .

MODEL EVALUATION

PART - A

1. A true solution is a homogeneous mixture of solute and solvent. Chalk powder in water is a heterogenous mixture. Is it a true solution?
2. A solution that contains water as the solvent is called an aqueous solution. If carbon disulphide is a solvent in a given solution, then the solution is called _____. (aqueous solution, non- aqueous solution)
3. The solubility of common salt in 100g of water is 36g. If 20g of salt is dissolved in it, how much more is required to attain saturation?
4. If two liquids are mutually soluble, they are called _____ liquids. (miscible, immiscible)
5. When sunlight passes through the window of a classroom, its path is visible. This is due to _____ of light. (reflection, scattering)
6. The particles in various forms are visible only under an ultramicroscope. A solution containing such particles is called _____. (true solution, colloidal solution)
7. The number of components in a binary solution are/is _____ (one / two)
8. The mixture of gases used by deep-sea divers is _____ (helium-oxygen, oxygen-nitrogen)
9. Soil cannot store more nitrogen than it can hold. Hence soil is said to be in a state of _____. (saturation, unsaturation)
10. In an endothermic process, solubility increases with _____ in temperature. (increase, decrease)
11. Aquatic species are more comfortable in cold water because _____
 - i). as the temperature decreases, the solubility of dissolved oxygen increases.
 - ii) as the temperature increases, the solubility of dissolved oxygen increases.
 - iii) as the temperature increases, the solubility of dissolved oxygen decreases.

PART - B

1. From the table given below, furnish your points of inference.

Substance	Solubility at 25°C
NaCl	36g
NaBr	95g
NaI	184g

2. Distinguish between the saturated and unsaturated solution at a temperature of 25°C using the data given below (Note : Solubility of NaCl is 36g)
 - i) 16g NaCl in 100g water
 - ii) 36g NaCl in 100g water

3. Differentiate true solution and colloidal solution.
4. You have prepared a saturated solution of sugar at room temperature. Is it possible to dissolve some more grams of sugar to this solution? Justify your answer.
5. Find the concentration of solution in terms of weight percent if 20g of common salt is dissolved in 50g of water.
6. Valli took some common salt, naphthalene balls, camphor, baking soda and washing soda. She attempted to dissolve these substances either in water or in acetone. Complete the table with the expected results.

SUBSTANCE	MEDIUM IN WHICH IT IS SOLUBLE	REASON
a. Common salt		
b. Naphthalene balls		
c. Camphor		
d. Baking soda		
e. Washing soda		

7.



- i) Which gas is dissolved in soft drinks?
- ii) What will you do to increase the solubility of this gas?

8. Beaker A has sugar mixed with water and Beaker B has starch dissolved in water.

- i) Which solution will scatter light?
- ii) In which beaker does the Brownian movement take place?
- iii) Name the type of solution that beaker A and beaker B contain.
- iv) Which of the two solutions is homogeneous?
- v) Identify the beaker that has particles of size $10\text{ }\text{\AA}$ to $2000\text{ }\text{\AA}$.

9. Name the type of solution formed in the following cases:

- i) 20g of NaCl in 100g of water.
- ii) 36g of NaCl in 100g of water.
- iii) 45g of NaCl in 100g of water at 80°C .
- iv) Sulphur dissolved in CS_2 .
- v) Nitrogen in soil.

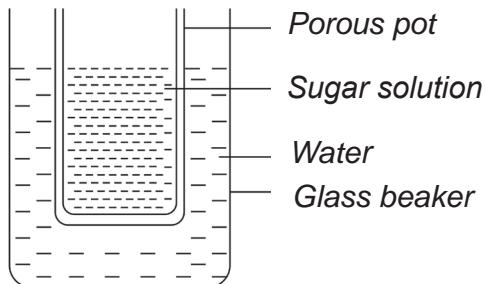
10. Give the dispersed phase and the dispersion medium in each of the following:

- a. cheese
- b. soda water
- c. smoke

11. Radha prepared a solution which could be separated by filtration.

- Name the type of solution.
- Is the solution transparent or opaque?
- Mention the nature of the solution.
- Mention the size of the solute particle.

12.



In the above case, Sekar observed that the water turned sweeter after sometime. Explain the reason for the same.

13. Beaker 'A' has chalk powder mixed with water and beaker 'B' has protein dissolved in water.

- Which solution shows Brownian movement?
- Identify the solution that has particle size greater than 2000A° .
- Which beaker contains colloidal solution?
- Mention the size of the particle present in beaker B.
- Say whether colloidal solution is homogeneous or heterogeneous.

14. Justify the following statements with an explanation:

- Solubility of calcium oxide decreases with increase in temperature.
- What happens to the solubility in exothermic process with regard to temperature?
- In endothermic process, solubility increases with increase in temperature.
- At a given temperature, increase in pressure increases the solubility of the gas.

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Chapter 10



ATOMS AND MOLECULES



Rani shows a piece of chalk to Vani and asks her to break it into minute particles. The breaking spree, goes on and on endlessly and finally they conclude that the minutest particle is a group of invisible atoms. They wish to probe further.



EXPLORING THE ATOM

The word ‘atom’ is derived from the Greek word “**Atomos**” which means indivisible. John Dalton modelled atoms as hard indivisible spheres.

His theory remained undisputed for about a century. However, towards the end the 19th and the beginning of the 20th centuries, the introduction of matter - wave concept by de Broglie, the principle of uncertainty by Heisenberg etc. paved the way for **modern atomic theory or modified atomic theory**.

10.1. MODERN ATOMIC THEORY

The findings of **modern atomic theory** are given as follows:-

- ▶ An atom is the smallest particle which takes part in chemical reaction.
- ▶ An atom is considered to be a divisible particle.
- ▶ The atoms of the same element may not be similar in all respects.

eg: Isotopes (${}_{17}Cl^{35}$, ${}_{17}Cl^{37}$)

- ▶ The atoms of different elements may be similar in some respects.
eg. Isobars (${}_{18}Ar^{40}$, ${}_{20}Ca^{40}$)
- ▶ The ratio of atoms in a molecule may be fixed and integral but may not be simple.
e.g., $C_{12}H_{22}O_{11}$ is not a simple ratio.
(Sucrose)
- ▶ The atoms of one element can be changed into the atoms of another element by transmutation.
- ▶ The mass of an atom can be converted into energy. This is in accordance with Einstein's equation $E = mc^2$.

E = Energy, m= mass, c= speed of light

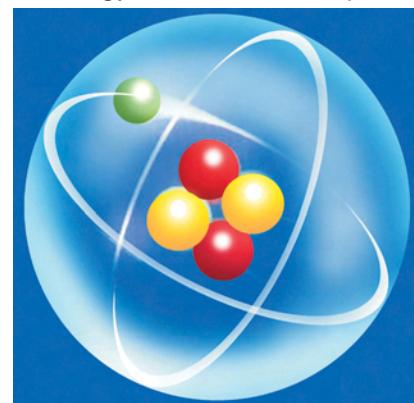
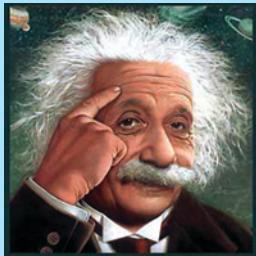


Fig. 10.1 Inner view of an Atom

ALBERT EINSTEIN



He related the mass of the substance converted into energy by an equation. When a nuclear reaction occurs, the mass of the product is found to be lesser than the mass of the reactants. The difference in mass is converted into energy in accordance with the equation $E = mc^2$, where E = energy liberated, m = mass and c = speed of light. This famous equation of Einstein caused a revolution in nuclear science.

10.2. AVOGADRO'S HYPOTHESIS

Amedeo Avogadro put forward a hypothesis based on the relation between the number of molecules and the volume of gases.

Avogadro's Law: Equal volumes of all gases under the same conditions of temperature and pressure contain an equal number of molecules.

Applications of Avogadro's Law

- It is used to determine the atomicity of gases.
- It is helpful in determining the molecular formula of gaseous compounds.
- It establishes the relationship between the vapour density and molecular mass of a gas.
- It gives the value of molar volume of gases at STP. Molar Volume of a gas at STP=22.4 lit (or) 22400 cm³.
- It explains Gay Lussac's Law effectively.

MORE TO KNOW

Isotopes ⇒ These are the atoms of same element with same atomic number (Z) but different mass number (A). Example (₁₇C³⁵, ₁₇C³⁷)

Isobars ⇒ These are the atoms of the different element with same mass number but different atomic number. Example (₁₈Ar⁴⁰, ₂₀Ca⁴⁰)

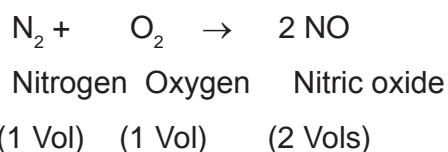
Isotones ⇒ These are the atoms of different elements with same number of neutrons. Example : (₆C¹³, ₇N¹⁴)

TO DEDUCE THE ATOMICITY OF ELEMENTARY GASES

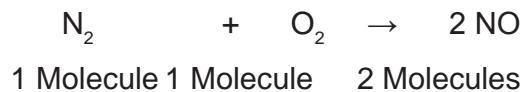
Atomicity

The number of atoms present in one molecule of an element is called the atomicity of the element.

e.g.



After applying Avogadro's Law, the equation,becomes



It is found that two molecules of nitric oxide contains 2 atoms of nitrogen and 2 atoms of oxygen.

These two atoms of nitrogen and the two atoms of oxygen should have come from 1 molecule of nitrogen and 1 molecule of oxygen, respectively.

Hence, nitrogen and oxygen are called diatomic molecules and are written as N_2 and O_2 .

This proves that, the atomicity of Nitrogen is 2 and the atomicity of oxygen is 2.

Thus Avogadro's hypothesis is used in the deduction of atomicity of elementary gases.

To establish the relationship between vapour density and relative molecular mass of a gas:

vi. Relative Molecular Mass: It is defined as the ratio of the mass of 1 molecule of the gas or vapour to the mass of 1 atom of hydrogen.

$$\text{Relative molecular mass of a gas} = \frac{\text{Mass of 1 molecule of the gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

$$V.D = \frac{\text{Mass of 1 volume of gas or vapour}}{\text{Mass of 1 volume of hydrogen}}$$

vii. Vapour Density (V.D): It is defined as the ratio of the mass of a certain volume of the gas or vapour to the mass of the same volume of hydrogen at the same temperature and pressure.

$$V.D = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 molecule of hydrogen}}$$

Applying Avogadro's Law,

$$V.D = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 molecule of hydrogen}}$$

Since hydrogen is diatomic,

$$V.D = \frac{\text{Mass of 1 molecule of gas or vapour}}{2 \times \text{Mass of 1 atom of hydrogen}}$$

MORE TO KNOW



Avogadro, an Italian Scientist

(1766 – 1856) was the one to propose that the volume of a gas at a given temperature and pressure is proportional to the number of particles.

$$2 \times V.D = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

$$2 \times V.D = \text{relative molecular mass of a gas or vapour}$$

$$2 \times \text{Vapour density} = \text{Relative molecular mass}$$

MORE TO KNOW

How to arrive at the value of GRAM MOLAR VOLUME (GMV)

$$GMV = \frac{\text{GRAM MOLAR MASS}}{\text{DENSITY OF GAS AT STP}}$$

To find the value of

$$GMV = \frac{\text{GMM of } O_2}{\text{DENSITY OF } O_2} = \frac{32/1.429}{22.4 \text{ lit}} = 22.4 \text{ litre at STP}$$

MORE TO KNOW

Gay-Lussac's Law of Combining Volumes of Gases:

Whenever gases react, they do so in volumes which bear a simple ratio to one another and to the volumes of the gaseous products, provided all the volumes are measured under the same conditions of temperature and pressure.

MORE TO KNOW

Molar Volume: Volume occupied by one mole of any gas at STP is called molar volume. Its value is 22.4 litres.

22.4 litres of any gas contains 6.023×10^{23} molecules at STP.

10.3. ATOMS AND MOLECULES

Atoms and molecules are the building blocks of matter.

10.3.1. Atom

It is the ultimate particle of an element which may or may not have independent existence. The atoms of certain elements such as hydrogen, oxygen, nitrogen, etc. do not have independent existence, whereas atoms of helium, neon, argon, etc. have independent existence. All elements are composed of atoms.

10.3.2. Molecule

A molecule is the simplest structural unit of an element or a compound which

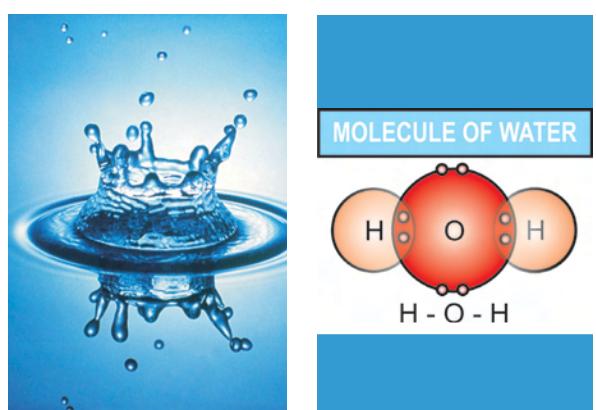


Fig 10.2 Molecule of Water

contains one or more atoms. It retains the characteristics of an element.

A molecule can exist freely and it is a combined form of bonded units, whereas an atom is the singular smallest form of a non-bonded unit.

POINT TO EXPLORE

Name the elements and find the number of atoms in one molecule of:
a) Nitrogen
b) Water
c) Ammonia
d) Sulphuric acid.

10.3.3. Difference between an Atom and a Molecule:

Atom	Molecule
The smallest particle of an element that can take part in a chemical reaction.	The smallest particle of an element or a compound that can exist freely.
An atom is a non bonded entity.	A molecule is a bonded entity.
An atom may or may not exist freely.	A molecule can exist freely.

Types of Molecules :

Molecules are of two types, namely homo atomic molecules and hetero atomic molecules.

1. Homo Atomic Molecules

These are the molecules which are made up of atoms of the same element. Most of the elementary gases consist of homo atomic molecules. For example hydrogen gas consists of two atoms of hydrogen (H_2). Similarly, oxygen gas consists of two atoms of oxygen (O_2). In accordance with the number of atoms present in these molecules, they are classified as monoatomic, diatomic, triatomic or polyatomic molecules showing that they contain one, two, three or more than three atoms respectively.

For any homo atomic molecule, atomicity can be deduced using the formula

$$\text{Atomicity} = \frac{\text{Molecular Mass}}{\text{Atomic mass}}$$

Atomicity	No. of atoms per molecule	Example
Monoatomic molecule	1	Helium (He) Neon (Ne) Metals
Diatomeric molecule	2	Hydrogen H_2 Chlorine Cl_2
Triatomic molecule	3	Ozone (O_3)
Polyatomic molecule	>3	phosphorous P_4 Sulphur S_8

TEST YOUR UNDERSTANDING SKILL

- Find the atomicity of chlorine, if its atomic mass is 35.5 and its molecular mass is 71.
- Find the atomicity of ozone if its atomic mass is 16 and its molecular mass is 48.

2. Hetero Atomic Molecules

The hetero atomic molecules are made up of atoms of different elements. They are also classified as diatomic, triatomic, or polyatomic molecules depending upon the number of atoms present. H_2O , NH_3 , CH_4 etc., are the examples for hetero atomic molecules.

10.4. RELATIVE ATOMIC MASS (RAM)

$$\text{RAM} = \frac{\text{Mass of 1 atom of an element}}{\text{Mass of 1 atom of hydrogen}}$$

10.4.1. Definition (based on hydrogen scale)

The relative atomic mass of an element is the ratio of mass of one atom of the element to the mass of one atom of hydrogen taken as standard.

10.4.2. Definition (based on carbon - 12 scale)

$$\text{RAM} = \frac{\text{Mass of 1 atom of an element}}{\frac{1}{12} \text{ th part of the mass of one atom of carbon-12}}$$

Relative atomic mass of an element is the ratio of mass of one atom of element to the $1/12^{\text{th}}$ part of mass of one atom of carbon -12.

Relative atomic mass is a pure ratio and has no unit. If the atomic mass of an element is expressed in grams, it is known as **gram atomic mass**.

e.g.

Gram atomic mass of hydrogen = 1g

Gram atomic mass of carbon = 12g

Gram atomic mass of nitrogen = 14g

Gram atomic mass of oxygen = 16g

Gram atomic mass of sodium = 23g

Atomic mass is expressed in atomic mass unit (**amu**). **One atomic mass unit is defined as 1/12th part of the mass of one atom of carbon.**

10.5. RELATIVE MOLECULAR MASS(RMM)

Definition (based on hydrogen scale)

$$\text{RMM} = \frac{\text{Mass of 1 molecule of an element / compound}}{\text{Mass of 1 atom of hydrogen}}$$

The relative molecular mass of an element or a compound is the ratio of mass of one molecule of the element or a compound to the mass of one atom of hydrogen.

Definition (based on carbon scale)

$$\text{RMM} = \frac{\text{Mass of 1 molecule of an element / compound}}{\frac{1}{12} \text{ th part of the mass of one atom of carbon}}$$

The Relative Molecular Mass of an element or a compound is the ratio of mass of one molecule of the element or a compound to the mass of 1/12th part of mass of one atom of carbon - 12 .

Relative Molecular Mass is a pure ratio and has no unit. If the molecular mass of a given substance is expressed in grams, it is known as **gram molecular mass** of that substance.

Molecular mass is the sum of the masses of all the atoms present in one molecule of the compound or an element.

Gram molecular mass calculations to test your numerical skill

1. Find the gram molecular mass of water (H_2O)

Calculations:

$$2(\text{H}) = 2 \times 1 = 2$$

$$1(\text{O}) = 1 \times 16 = \underline{\underline{16}}$$

$\therefore \text{Gram molecular mass of } \text{H}_2\text{O} = 18\text{g}$

2. Find the gram molecular mass of carbon dioxide (CO_2)

Calculations:

$$1(\text{C}) = 1 \times 12 = 12$$

$$2(\text{O}) = 2 \times 16 = \underline{\underline{32}}$$

Gram molecular mass of $\text{CO}_2 = 44\text{ g}$

10.6. MOLE CONCEPT

To know the number of atoms or molecules involved in a reaction, the **concept of mole** was introduced. The quantity of a substance is expressed in terms of mole.

$$N_A = 6.023 \times 10^{23}$$

N_A = Avogadro number = 1 Mole

Shown here in Fig.10.3 is one mole quantity of each of the following materials: (clockwise from top left) 180g of aspirin, 18.0g of water, 342g of sucrose, 201g of

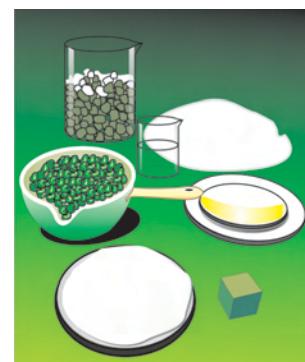


Fig. 10.3 Mole in various forms

mercury, 55.9g of iron, 58.5g of sodium chloride and 254g of iodine.

10.6.1. Definition of Mole

Mole is defined as the amount of substance that contains as many specified elementary particles as the number of atoms in 12g of carbon-12 isotope.

One mole is also defined as the amount of substance which contains Avogadro number (6.023×10^{23}) of particles.

Avogadro Number: The number of atoms or molecules or ions present in one mole of a substance is called Avogadro Number. Its value is 6.023×10^{23} .

Therefore, one mole of any substance contains Avogadro number of particles. The particles may be atoms, molecules, ions etc.

For eg. one mole of oxygen atoms represents 6.023×10^{23} atoms of oxygen and 5 moles of oxygen atoms contain $5 \times 6.023 \times 10^{23}$ atoms of oxygen.

To find the number of moles, the following formulae are used:

$$\text{Number of moles} = \frac{\text{Mass}}{\text{Atomic Mass}}$$

$$\text{Number of moles} = \frac{\text{Mass}}{\text{Molecular Mass}}$$

$$\text{Number of moles} = \frac{\text{No. of Atoms}}{6.023 \times 10^{23}}$$

$$\text{Number of moles} = \frac{\text{No. of Molecules}}{6.023 \times 10^{23}}$$

WATCH OUT !

It must be noted that while using the term mole, it is essential to specify the kind of particles involved.

10.6.2. Problems (based on mole concept)

1. When the mass of the substance is given:

$$\text{Number of moles} = \frac{\text{given mass}}{\text{atomic mass}}$$

- a. Calculate the number of moles in
 i) 81g of aluminium ii) 4.6g sodium
 iii) 5.1g of ammonia iv) 90g of water
 v) 2g of NaOH

$$\text{Number of moles} = \frac{\text{given mass}}{\text{atomic mass}} = \frac{81}{27}$$

$$= 3 \text{ moles of aluminium}$$

FOLLOW UP: Find the number of moles for the remaining problems given above.

- b. Calculate the mass of 0.5 mole of iron.

Solution:

$$\begin{aligned}\text{mass} &= \text{atomic mass} \times \text{number of moles} \\ &= 55.9 \times 0.5 = 27.95 \text{ g}\end{aligned}$$

FOLLOW UP: Find the mass of 2.5 mole of oxygen atoms

$$\text{Mass} = \text{atomic mass} \times \text{number of moles}$$

2. Calculation of number of particles when the mass of the substance is given:

Number of particles =

$$\frac{\text{Avogadro number} \times \text{given mass}}{\text{gram molecular mass}}$$

- a. Calculate the number of molecules in 11g of CO_2

Solution: gram molecular mass of $\text{CO}_2 = 44\text{g}$

$$\begin{aligned}\text{Number of molecules} &= \frac{6.023 \times 10^{23} \times 11}{44} \\ &= 1.51 \times 10^{23} \text{ molecules}\end{aligned}$$

FOLLOW UP: Calculate the number of molecules in 360g of glucose.

3. *Calculation of mass when number of particles of a substance is given:*

Mass of a substance

$$= \frac{\text{gram molecular mass} \times \text{number of particles}}{6.023 \times 10^{23}}$$

- a. Calculate the mass of 18.069×10^{23} molecules of SO_2

Sol: Gram molecular mass $\text{SO}_2 = 64\text{g}$

Mass of SO_2

$$= \frac{64 \times 18.069 \times 10^{23}}{6.023 \times 10^{23}} = 192\text{ g}$$

- b. Calculate the mass of glucose in 2×10^{24} molecules

Gram molecular mass of glucose = 180g

Mass of glucose

$$= \frac{180 \times 2 \times 10^{24}}{6.023 \times 10^{23}} = 597.7\text{g}$$

FOLLOW UP:

Calculate the number of moles in 24.092×10^{22} molecules of water.



Fig. 10.4 Illustrations of mole in various forms

FOLLOW UP: Calculate the mass of 12.046×10^{23} molecules in CaO .

4. *Calculation of number of moles when you are given number of molecules:*

- a. Calculate the number of moles for a substance containing 3.0115×10^{23} molecules in it.

$$\text{Number of moles} = \frac{\text{Number of molecules}}{\text{Avogadro Number}}$$

$$= \frac{3.0115 \times 10^{23}}{6.023 \times 10^{23}} = 0.5 \text{ moles}$$

- b. Calculate the number of moles in 12.046×10^{22} atoms of copper.

Number of moles of atoms

$$= \frac{\text{Number of atoms}}{\text{Avogadro Number}}$$

$$= \frac{12.046 \times 10^{22}}{6.023 \times 10^{23}} = 0.2 \text{ moles}$$

MODEL EVALUATION**PART - A**

- From the given examples, form the pair of isotopes and the pair of isobars:
 $^{18}\text{Ar}^{40}$, $^{17}\text{Cl}^{35}$, $^{20}\text{Ca}^{40}$, $^{17}\text{Cl}^{37}$
- Molecular mass of Nitrogen is 28. Its atomic mass is 14. Find the atomicity of Nitrogen.
- Gram molecular mass of Oxygen is 32 g. Density of Oxygen is 1.429 g/litre. Find the gram molar volume of Oxygen.
- 'Cl' represents Chlorine atom, ' Cl_2 ' represents Chlorine molecule.
 List out any two differences between atoms and molecules.
- Calculate the gram molecular mass of water from the values of gram atomic mass of Hydrogen and of Oxygen.
 Gram atomic mass of Hydrogen = 1 g
 Gram atomic mass of Oxygen = 16 g
- One mole of any substance contains 6.023×10^{23} particles.
 If 3.0115×10^{23} particles are present in CO_2 , find the number of moles.
- _____ have equal number of neutrons.
 i) Isobars ii) Isotones iii) Isotopes iv) Mass Numbers
- Classify the following based on atomicity:
 i) Chlorine ii) Neon iii) Phosphorous iv) Ozone
- Identify and correct the mistake in each of the following:
 i) The molar volume of gas at STP is 22.4 cm^3 .
 ii) $2 \times \text{R.M.M.} = \text{V.D.}$
 iii) An atom cannot exist independently.
 iv) The ratio of atoms in a molecule may be integral or simple or may not be fixed.
 v) H_2O is a homo atomic molecule.
- Give a single term substitute for each of the following:
 i) 6.023×10^{23} molecules ii) 22.4 litres of gas at STP
 iii) 1/12th part of the mass of one atom of carbon
 iv) The half of relative molecular mass
 v) Molecular mass / atomic mass

PART - B

1. Modern atomic theory takes up the wave concept, principle of uncertainty and other latest discoveries to give a clear cut picture about an atom. State the findings of modern atomic theory.
2. How will you establish the relation between vapour density and molecular mass of a gas by applying Avogadro's law?
3. Calculate the number of moles in:
 - i) 12.046×10^{23} atoms of Copper
 - ii) 27.95g of Iron
 - iii) 1.51×10^{23} molecules of CO_2
4. Find the gram molecular mass of the following from the data given:

- i) H_2O
- ii) CO_2
- iii) NaOH
- iv) NO_2
- v) H_2SO_4

ELEMENT	SYMBOL	ATOMIC No.	ATOMIC MASS
Hydrogen	H	1	1
Carbon	C	6	12
Oxygen	O	8	16
Nitrogen	N	7	14
Sodium	Na	11	23
Sulphur	S	16	32

5. Complete the table given below:

ELEMENT	ATOMIC MASS	MOLECULAR MASS	ATOMICITY
Chlorine	35.5	71	
Ozone		48	3
Sulphur	32		8

6. Calculate the number of water molecules present in one drop of water which weighs 0.18 g.

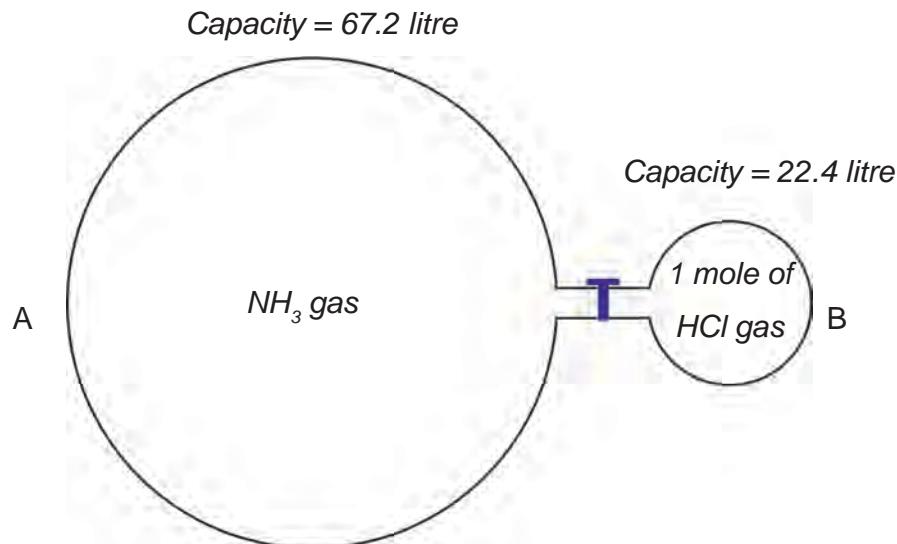
7. Fill in the blanks using the given data:

The formula of Calcium oxide is CaO . The atomic mass of Ca is 40, Oxygen is 16 and Carbon is 12.

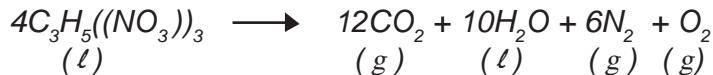
- i) 1 mole of Ca (___ g) and 1 mole of Oxygen atom (___ g) combine to form ___ mole of CaO (___ g).
- ii) 1 mole of Ca (___ g) and 1 mole of C (___ g) and 3 moles of Oxygen atom (___ g) combine to form 1 mole of CaCO_3 (___ g)
8. How many grams are there in:
 - i) 5 moles of water
 - ii) 2 moles of Ammonia
 - iii) 2 moles of Glucose

PART - C

1. When ammonia reacts with hydrogen chloride gas, it produces white fumes of ammonium chloride. The volume occupied by NH_3 in glass bulb A is three times more than the volume occupied by HCl in glass bulb B at STP.



- i) How many moles of ammonia are present in glass bulb A?
 - ii) How many grams of NH_4Cl will be formed when the stopper is opened?
(Atomic mass of N = 14, H = 1, Cl = 35.5)
 - iii) Which gas will remain after completion of the reaction?
 - iv) Write the chemical reaction involved in this process.
2. Nitro glycerine is used as an explosive. The equation for the explosive reaction is



(Atomic mass of C = 12, H = 1, N = 14, O=16)

- i) How many moles does the equation show for i) Nitroglycerine ii) gas molecules produced?
- ii) How many moles of gas molecules are obtained from 1 mole of nitroglycerine?
- iii) What is the mass of 1 mole of nitroglycerine?

3. Sodium bi carbonate breaks down on heating:



(Atomic mass of Na = 23, C = 12, H = 1, O=16)

- i) How many moles of sodium bi carbonate are there in the equation?

- ii) What is the mass of sodium bicarbonate used in this equation?
- iii) How many moles of carbon dioxide are there in this equation?
4. 40 g of calcium was extracted from 56 g of calcium oxide
(Atomic mass of Ca= 40, O=16)
- i) What mass of oxygen is there in 56 g of calcium oxide?
- ii) How many moles of oxygen atoms are there in this ?
- iii) How many moles of calcium atoms are there in 40 g of calcium?
- iv) What mass of calcium will be obtained from 1000 g of calcium oxide?
5. How many grams are there in the following?
- i) 1 mole of chlorine molecule, Cl_2 ii) 2 moles of sulphur molecules, S_8
- iii) 4 moles of ozone molecules, O_3 iv) 2 moles of nitrogen molecules, N_2
6. Find how many moles of atoms are there in:
- i) 2 g of nitrogen. ii) 23 g of sodium iii) 40 g of calcium.
- iv) 1.4 g of lithium v) 32 g of sulphur.

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2. Inorganic Chemistry : *P.L. Soni* - S.Chand publication, New Delhi.
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Webliography: www.chem4kids.com/tag/atomsandmolecules

Chapter 11



CHEMICAL REACTIONS

All living beings born in this beautiful world adopt and follow their own life styles. Have you observed and analyzed your daily life from the view point of a chemist? Chemical reactions take place around us, all the time and even in our body.

Any change can be classified as physical change or chemical change. Physical changes can be easily reversed but, it is not easy to reverse a chemical change. What is the reason? During chemical changes, new substances are formed and it is difficult to regenerate the original substances. Chemical changes are more permanent than physical changes. All chemical changes are accompanied by chemical reactions.

How do we come to know that a chemical reaction has taken place? Let us perform some activities to find out the answer to this question.

ACTIVITY 11.1

- Look at the new silver anklet of your mother or sister.
- Note the colour of the anklet.
- Observe the colour of an old anklet.
- What change do you observe?

The lustrous white colour of the silver anklet slowly changes into slightly black colour. We say, the silver anklet has got tarnished. Can you guess the reason behind it?



Fig. 11.1 Silver Anklet

It is due to the formation of silver sulphide (Ag_2S), as a result of the reaction between silver and hydrogen sulphide in the air.

ACTIVITY 11.2

- Take lead nitrate solution in a beaker
- Take potassium iodide solution in a test tube.(Both solutions are colourless)
- Add potassium iodide solution slowly to the lead nitrate solution
- What do you observe?

You observe a deep yellow precipitate, don't you?

It is lead iodide (PbI_2).

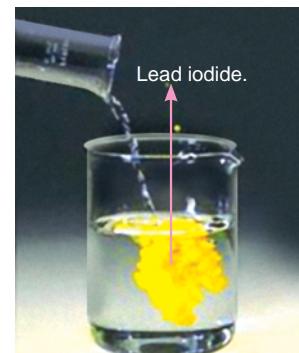


Fig. 11.2 Yellow precipitate of lead iodide.

ACTIVITY 11.3

- Take 5g of calcium oxide (quick lime) in a beaker.
- Add water to it slowly.
- Touch the beaker.
- What do you feel?

Do you feel the heat? Let us learn what happens.

Calcium oxide reacts with water to produce slaked lime (calcium hydroxide). This reaction is exothermic and is accompanied by a hissing sound and formation of bubbles, leading to the release of considerable amount of heat.

ACTIVITY 11.4

- Take a pinch of calcium carbonate powder in a test tube.
- Add dilute hydrochloric acid.
- Note the changes that take place in the test tube carefully.

Do you observe any brisk effervescence? It is due to the evolution of carbon dioxide gas.



Fig. 11.3 Reaction of calcium carbonate with dil. HCl

These are some of the common observations in a chemical reaction. From the activities that we have discussed, it is clear that chemical reactions bring about a permanent change, resulting in the formation of new product(s).

The substances taking part in the reaction are known as reactants and those formed as a result of the reaction are called products.

MORE TO KNOW

A solution of slaked lime produced in Activity 11.3 is used for white-washing. Calcium hydroxide reacts slowly with carbon dioxide in air to form a thin layer of calcium carbonate on the walls. Calcium carbonate is formed after two to three days of white-washing and gives a shiny finish to the walls. It is interesting to note that the chemical formula for marble is also CaCO_3 .

11.1. TYPES OF CHEMICAL REACTIONS

Since there are numerous chemical reactions, the study of these reactions can be made easier by classifying them. All the chemical reactions are classified under six broad categories depending on how the product is formed.

Let us see the different types of classifications of chemical reactions.

1. Combination reaction



A combines with **B** to form a new product **AB**. It is the simple representation of combination reaction.

ACTIVITY 11.5

- Take a clean piece of magnesium ribbon.
- Hold the ribbon with a pair of tongs.
- Burn it in air using a burner (keeping the Mg ribbon far away from your eyes).
- Collect the ash.



Fig. 11.4 Burning of Mg ribbon

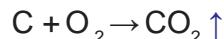
In the above activity, magnesium combines with oxygen to form a single product, the magnesium oxide. **A reaction in which a single product is formed from two or more reactants is known as combination reaction.**



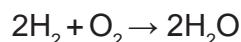
Repeat “Activity 11.3”. This reaction is also an example of COMBINATION REACTION. Now write the equation for the reaction.

Let us discuss some more examples of such combination reactions.

Combustion of coal



Combustion of hydrogen



2. Decomposition reaction



AB splits into **A** and **B**. It is the representation of decomposition reaction.

ACTIVITY 11.6

- Take about 2 g of copper carbonate powder in a dry test tube.
- Note the colour of copper carbonate.
- Heat the test tube over the flame.
- Observe the change after heating.

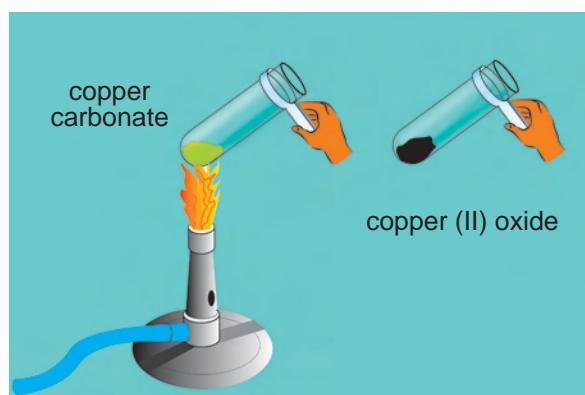


Fig. 11.5 Heating the test tube containing copper carbonate

Change of colour from green to black is observed. This is due to the decomposition of copper carbonate into copper (II) oxide.



ACTIVITY 11.7

- Take lead nitrate in a test tube.
- Heat it over the flame.
- Observe the changes.

Liberation of a reddish brown gas (NO_2) is observed. This is because of the decomposition of lead nitrate into lead oxide, nitrogen dioxide and oxygen.



From the above two activities (11.6 and 11.7), it can be noticed that a **single compound breaks down to produce two or more substances**. Such type of reaction is called **decomposition reaction**.

A few more examples for decomposition reaction are:

1. Decomposition of lime stone**2. Decomposition of ammonium dichromate****MORE TO KNOW**

At a very high temperature, ammonium dichromate decomposes immediately into green vapour, which gets released along with the steam. It will appear as if a volcano erupts and is termed as **chemical volcano**.

3. Displacement Reaction

In the reaction between **A** and **BC**, **A** displaces **B** from **BC** to form **AC**. This shows that **A** is more reactive than **B**.

ACTIVITY 11.8

- Take 20 ml of copper sulphate solution in a beaker.
- Drop an iron nail into the beaker.
- Leave it for a few days.
- Observe the colour of the copper sulphate solution and the iron nail.

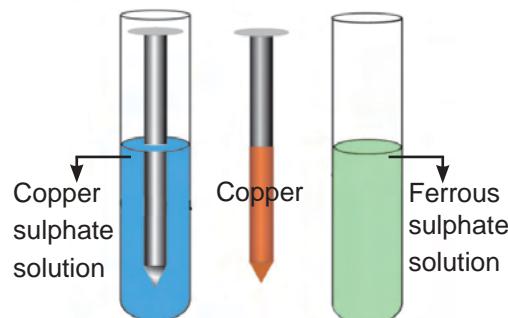
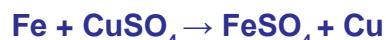


Fig. 11.6 Iron displaces copper from copper sulphate solution

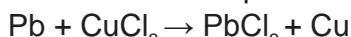
Blue colour of the copper sulphate solution changes into green colour and the iron nail acquires a brownish colour. It is a noticeable change. Is it not? This change confirms that iron is more reactive than copper. The following chemical reaction takes place in this activity.



In this reaction, iron displaces copper from CuSO_4 solution.

Repeat “**Activity 11.8**” but use a zinc rod instead of an iron nail. What colour changes do you observe on the rod and in the solution? Write the chemical equation.

Here is another example:



Lead can displace copper from its salt solution. Can copper displace zinc or lead from their salt solutions? No, because copper is less reactive than zinc and lead.

The reaction, in which, a more reactive element displaces a less reactive element from its compound is called displacement reaction.

4. Double Decomposition Reaction (Double Displacement Reaction)



In the reaction between **AB** and **CD**, both the reactants decompose to form **AD** and **CB** through the rearrangement of ions.

ACTIVITY 11.9

- Take 5ml of sodium sulphate solution in a test tube.
- In another test tube, take 5ml of barium chloride.
- Mix both the solutions.
- What do you observe?



Fig. 11.7 Formation of barium sulphate

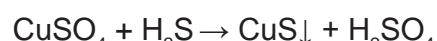
You will observe the formation of a white substance, which is insoluble in water. The insoluble substance formed is known as *precipitate*. Any reaction that produces a precipitate is called a **precipitation reaction**. The white precipitate is barium sulphate. It is formed due to the reaction of SO_4^{2-} and Ba^{2+} ions. The other product formed is sodium chloride.



Repeat "Activity 11.2" for double decomposition reaction. Observe the reaction and write the equation.

Double Decomposition Reaction is the reaction in which exchange of ions between two reactants occurs, leading to the formation of two different products.

Other example :



5. Oxidation and reduction

We are all aware of the fact that oxygen is the most essential element for sustenance of life. One can live without food or even water for a few days, but not without oxygen. In our day-to-day life, we come across various phenomena like fading of colours of clothes, burning of combustible substances like cooking gas, wood and coal, and also rusting of iron articles. All such processes fall into the category of a specific type of chemical reaction called oxidation – reduction reaction (redox reaction). A large number of industrial processes like electroplating and extraction of metals like aluminium are based on redox reaction.

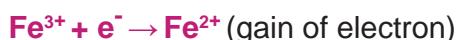
Oxidation:

A chemical reaction which involves addition of oxygen or removal of hydrogen or loss of electron(s) is called Oxidation.



Reduction:

A chemical reaction which involves addition of hydrogen or removal of oxygen or gain of electron(s) is called Reduction.



Redox Reaction:

Redox reaction is a chemical reaction in which oxidation and reduction take place simultaneously.



Write an equation of any other redox reaction.

During the conversion of copper(II) oxide to copper, the copper(II) oxide loses oxygen and is reduced. The hydrogen gains oxygen and is oxidised. In other words, one reactant gets oxidised while the other is reduced during the reaction. Such reactions are called oxidation-reduction reactions or redox reactions.

Oxidation is	Reduction is
Gain of oxygen	Loss of oxygen
Loss of hydrogen	Gain of hydrogen
Loss of electron(s)	Gain of electron(s)

Oxidation and reduction always takes place together, so the reaction is called redox reaction.

ALWAYS REMEMBER

Loss of electron is oxidation.(LEO)

Gain of electron is reduction.(GER)

The short forms in brackets will help you remember this.

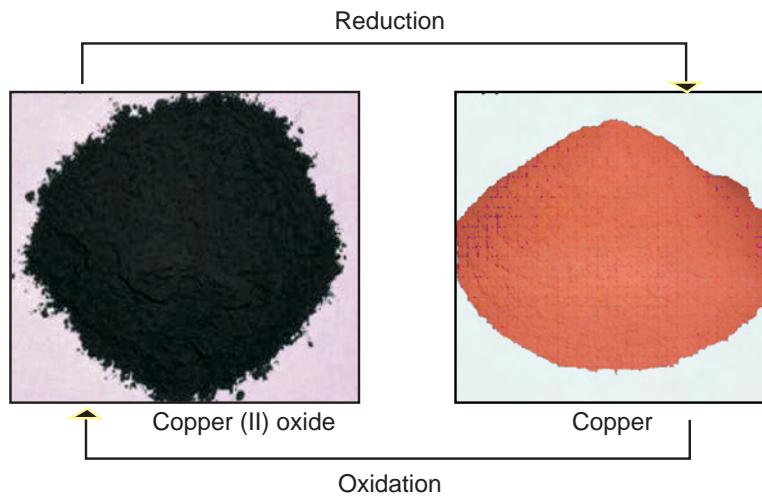


Fig. 11.8 Redox Reaction

MORE TO KNOW

Oxidation also has damaging effects on food and eatables. When food containing fat and oil is left as such for a long time, it becomes stale. The stale food develops bad taste and foul smell. This is very common in curd or cheese, particularly in summer. Oils and fats are slowly oxidised to certain foul-smelling compounds.

6. Exothermic and endothermic reactions

During chemical reactions, one of the most common changes is a change in temperature. When detergent is dissolved in water to wash clothes, heat is given out. When glucose is kept on our tongue, a cooling effect is felt. During these processes, heat is either given out to the surrounding or absorbed from the surrounding. In the same way, in most of the chemical reactions, energy is either taken in or given out.

a. Exothermic Reactions

The chemical reactions which take place with the evolution of heat energy are called exothermic reactions.



All combustion reactions are exothermic. Heat energy is liberated as the reaction proceeds.

b. Endothermic Reactions

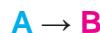
The chemical reactions which take place with the absorption of heat energy are called endothermic reactions.



11.2 THE RATE OF CHEMICAL REACTION

The rate of chemical reaction is defined as the change in concentration of any one of the reactants or product per unit time.

Consider the reaction



Rate of the reaction is given by

$$\text{Rate} = - \frac{d[\text{A}]}{dt} = + \frac{d[\text{B}]}{dt}$$

[A] - concentration of reactant A

[B] - concentration of product B

- ve sign indicates decrease in concentration of A with time.

+ve sign indicates increase in concentration of B with time.

11.2.1 Factors influencing the rate of the chemical reaction

ACTIVITY 11.10

- Take magnesium ribbon in two test tubes A and B.
- Add hydrochloric acid to test tube A.
- Add acetic acid to test tube B.
- Observe the changes in both the test tubes.

1. Nature of the reactants

Magnesium ribbon reacts with both hydrochloric acid and acetic acid but reaction is faster in hydrochloric acid than in acetic acid. Do you know why? Hydrochloric acid is more reactive than acetic acid. It shows that the nature of the reactant influences the rate of the reaction.

2. Concentration of the Reactants

ACTIVITY 11.11

- Take 3g of granulated zinc in test tubes A and B.
- Add 5 ml of 1 M hydrochloric acid in test tube A.
- Add 5 ml of 2 M hydrochloric acid in test tube B.
- Observe the changes.

Granulated zinc reacts with both 1M hydrochloric acid and 2M hydrochloric acid. The rate of evolution of hydrogen gas is more in test tube B than in test tube A. This is because 2M hydrochloric acid is more concentrated than 1M hydrochloric acid. That is, **the greater the concentration of the reactant, the greater will be the rate of the reaction.**

3. Surface Area of the Reactants

ACTIVITY 11.12

- Take powdered calcium carbonate in beaker A.
- Take marble chips (calcium carbonate) in beaker B.
- Add hydrochloric acid to both the beakers.
- Observe the changes.

Powdered calcium carbonate reacts more quickly with hydrochloric acid than marble chips. What is the reason?

Powdered calcium carbonate offers large surface area for the reaction to occur at a faster rate. **This shows that the greater the surface area, the greater is the rate of the reaction.**

4. Temperature

ACTIVITY 11.13

- Take 3g of marble chips in a beaker.
- Add 5 ml of 1M hydrochloric acid.
- Observe the changes.
- Heat the beaker.
- Observe the changes.

Calcium carbonate present in the marble chips react slowly with hydrochloric acid at room temperature and evolves carbon dioxide at a slower rate, whereas on heating, the evolution of carbon dioxide is faster. **This shows that increase in temperature increases the rate of the reaction.**

5. Catalyst

ACTIVITY 11.14

- Take potassium chlorate in a test tube.
- Heat the test tube.
- Observe what happens.
- Add manganese dioxide as a catalyst.
- Observe the changes.

When potassium chlorate is heated, oxygen is evolved very slowly, whereas after the addition of manganese dioxide to the reactant, oxygen is liberated at a faster rate. **This shows that manganese dioxide acts as a catalyst and influences the rate of the reaction.**

GROUP ACTIVITY

- From dawn to dusk observe any 10 chemical changes that take place around you and classify them.
- Prepare a table model of a volcano using ammonium dichromate (vigorous)
- Prepare a table model of a volcano using baking soda (silent).

MORE TO KNOW

A substance which alters the rate of reaction without undergoing any change in mass and composition is known as catalyst.

ACIDS, BASES AND SALTS

Nivi :	Hai Vini, you look tired. Take this fresh lime juice.
Vini :	No, it has a sour taste.
Nivi :	Do you know why it is sour?
Vini :	Sorry, I have no idea.
Nivi :	It is due to the presence of acid. Let's learn more about this.

Acids, bases and salts are used in everyday life. Let it be a fruit juice or a detergent or a medicine. They play a key role in our day-to-day activities. Our body metabolism is carried out by means of hydrochloric acid secreted in our stomach.

11.3. ACIDS

Acid is a substance which furnishes H^+ ions or H_3O^+ ions when dissolved in water. Acids have one or more replaceable

hydrogen atoms. The word 'acid' is derived from the Latin name 'acidus' which means sour taste. Substances with 'sour taste' are acids. Lemon juice, vinegar and grape juice have sour taste, so they are acidic. They change blue litmus to red. They are colourless with phenolphthalein and pink with methyl orange. Many organic acids are naturally present in food items.

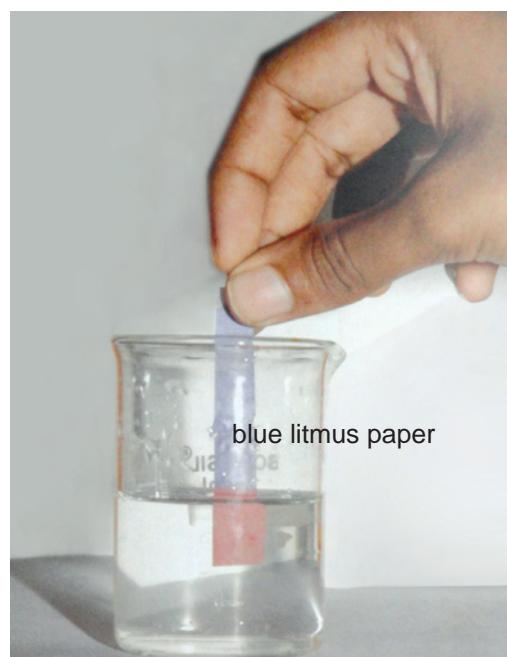


Fig. 11.9 Acid solution turns blue litmus paper red

11.3.1 Classification of Acids

1. **Based on their sources** : Acids are classified into two types, namely, organic acids and inorganic acids.

Organic Acids:- Acids present in plants and animals (living things) are **organic acids** e.g. HCOOH , CH_3COOH (Weak acids).

Inorganic Acids:- Acids in rocks and minerals are **inorganic acids** or mineral acids e.g. HCl , HNO_3 , H_2SO_4 (Strong acids).

2. Based on their Basicity

Monobasic Acid: - It is an acid which gives one hydrogen ion per molecule of the acid in solution, e.g. HCl, HNO₃.

Dibasic Acid:- It is an acid which gives two hydrogen ions per molecule of the acid in solution, e.g. H₂SO₄, H₂CO₃.

Tribasic Acid:- It is an acid which gives three hydrogen ions per molecule of the acid in solution, e.g. H₃PO₄

Source	Acid present
Apple	Malic acid
Lemon	Citric acid
Grape	Tartaric acid
Tomato	Oxalic acid
Vinegar (food preservative)	Acetic acid
Curd	Lactic acid



MORE TO KNOW

For acids, we use the term basicity which refers to the number of replaceable hydrogen atoms present in one molecule of an acid. For example, acetic acid has four hydrogen atoms but only one can be replaced. Hence it is monobasic.

3. Based on Ionisation

Acids are classified into two types based on ionisation.

Strong Acids:- These are acids which ionise completely in water, e.g.HCl.

Weak Acids:-These are acids which ionise partially in water, e.g. CH₃COOH.

4. Based on Concentration:- Based on the percentage or amount of acid dissolved in water, acids are classified into concentrated acids and dilute acids.

Concentrated Acid:- It is an acid having a relatively high percentage of acid in its aqueous solution.

Dilute Acid:- It is an acid having a relatively low percentage of acid in its aqueous solution.

MORE TO KNOW

Care must be taken while mixing any concentrated mineral acid with water. The acid must always be added slowly to water with constant stirring. If water is added to a concentrated acid, a large amount of heat is generated. The mixture splashes out of the container and it may cause burns.

11.3.2 Chemical Properties of Acids

1. Reaction of Metals with Acid

Note that zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen gas.



When a burning candle is brought near a bubble containing hydrogen gas, the

ACTIVITY 11.15

- Take 5 g of zinc granules in a test tube.
- Add 10 ml of dilute hydrochloric acid through a thistle funnel.
- During the course of addition, what do you observe?

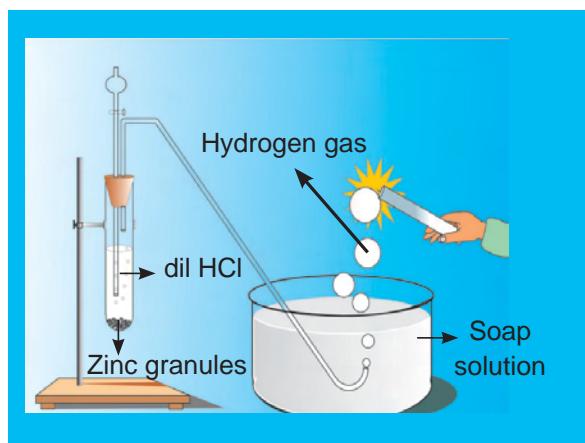


Fig. 11.10 Reaction of Zn granules with dilute HCl

flame goes off with a ‘popping’ sound. This confirms that metal displaces hydrogen from the dilute acid. (Hydrogen gas burns with a ‘popping’ sound)



Another example:

**MORE TO KNOW**

Few metals do not liberate hydrogen gas on reaction with acids. eg. Ag, Cu.

Lime stone, chalk and marble are different physical forms of calcium carbonate. They react with acids giving the corresponding salt, carbon dioxide and water.

2. Reaction of Metal carbonate and Metal bicarbonate with Acids**ACTIVITY 11.16**

- Take two test tubes. Label them I and II.
- Take a small amount of washing soda (Na_2CO_3) in test tube-I and a small amount of baking soda (NaHCO_3) in test tube-II.
- Add dilute hydrochloric acid to both the test tubes.
- What do you observe?
- Pass the gas produced in each case, through lime water $\text{Ca}(\text{OH})_2$ solution and record your observations.

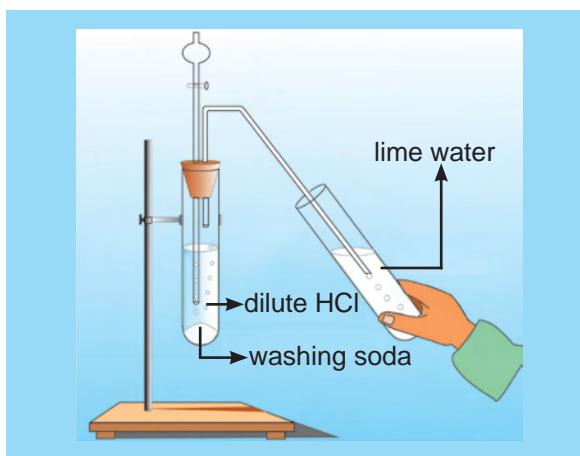
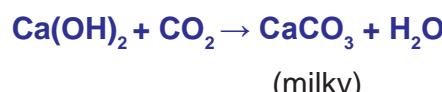


Fig. 11.11 Testing of carbon dioxide

Test tube I**Test tube II**

When carbon dioxide is passed through lime water, it turns milky.



From the activity 11.16 the reaction can be summarized as:

Metal carbonate or metal bicarbonate + acid → salt + water + carbon dioxide.

Some other examples:



MORE TO KNOW

Since metal carbonates and metal bicarbonates are basic, they react with acids to give salt and water with the liberation of carbon dioxide.

3. Reaction of Metallic oxides with Acids

ACTIVITY 11.17

- Take about 2g copper (II) oxide in a watch glass and slowly add dilute hydrochloric acid to it.
- Note the colour of the salt.
- What has happened to the copper (II) oxide?

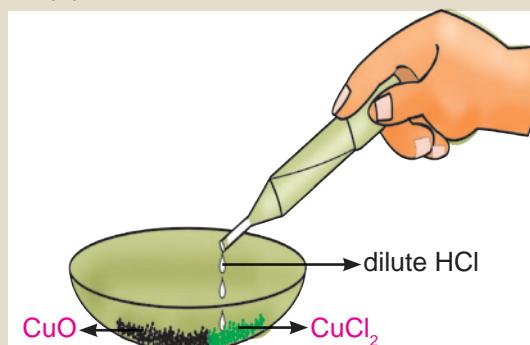


Fig. 11.12 Reaction of copper(II) oxide with dilute hydrochloric acid

The colour changes from **black to green**. This is due to the formation of copper (II) chloride in the reaction. Since metal oxides are basic, they react with acid to form salt and water.



From the above activity, we conclude that



Another example is



4 . Action of Acids with Water

An acid produces hydrogen ions in water.



Hydrogen ions cannot exist alone, but they exist in the form of hydronium (H_3O^+) ions. When water is absent, the separation of hydrogen ions from an acid does not occur.

11.3.3. Uses of Acids

- Sulphuric acid (King of chemicals) is used in car batteries and in the preparation of many other compounds.
- Nitric acid is used in the production of ammonium nitrate which is used as a fertilizer in agriculture.
- Hydrochloric acid is used as a cleansing agent in toilets.
- Tartaric acid is a constituent of baking powder.
- Salt of benzoic acid (sodium benzoate) is used in food preservation.
- Carbonic acid is used in aerated drinks.

MORE TO KNOW

The atmosphere of Venus is made up of thick white and yellowish clouds of sulphuric acid. Do you think, life can exist on this planet?

11.4. BASES

Base is a substance which releases hydroxide ions(OH⁻) when dissolved in water. It is bitter in taste and soapy to touch (e.g. washing soda, caustic soda and caustic potash). They change red litmus to blue. They are pink with phenolphthalein and yellow with methyl orange.

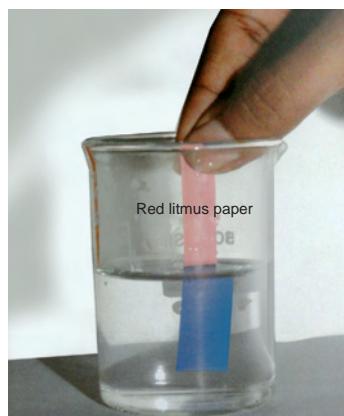


Fig. 11.13 Bases turns red litmus paper blue

11.4.1. Classification of Bases

1. Based on Ionisation

Strong Bases:- These are bases which ionise completely in aqueous solution e.g.NaOH, KOH.

Weak Bases:- These are bases which ionise partially in aqueous solution. e.g. NH₄OH, Ca(OH)₂.

2. Based on their Acidity

Monoacidic Base:- It is a base which ionises in water to give one hydroxide ion per molecule. e.g.NaOH, KOH.

Diacidic Base:- It is a base which ionises in water to give two hydroxide ions per molecule. e.g. Ca(OH)₂, Mg(OH)₂.

Triacidic Base:- It is a base which ionises in water to give three hydroxide ions per molecule. e.g. Al(OH)₃, Fe(OH)₃.

MORE TO KNOW

The term acidity is used for base, which means the number of replaceable hydroxyl groups present in one molecule of a base.

3. Based on Concentration:

Depending on the percentage or amount of base dissolved in water, bases are classified as concentrated alkali and dilute alkali.

Concentrated Alkali:- It is an alkali having a relatively high percentage of alkali in its aqueous solution.

Dilute Alkali:- It is an alkali having a relatively low percentage of alkali in its aqueous solution.

MORE TO KNOW

Bases which dissolve in water are called alkalies. All alkalies are bases, but not all bases are alkalies. NaOH and KOH are alkalies, whereas Al(OH)₃ and Zn(OH)₂ are bases.

11.4.2. Chemical Properties Of Bases

1. Reaction of Base with Metals

Zinc reacts with sodium hydroxide to form sodium zincate with the liberation of hydrogen gas.



MORE TO KNOW

Few metals do not react with sodium hydroxide, e.g. Cu, Ag, Cr.

Another example is



2. Reaction of Non-metallic oxides with Bases

Sodium hydroxide reacts with carbon dioxide and gives sodium carbonate and water.



The above reaction indicates that



Another example is



3. Action of Bases with Water

Bases generate hydroxide (OH^-) ions when dissolved in water.



4. Reaction of acids with bases

In the activity 11.18, the effect of a base is nullified by an acid.

**ACTIVITY 11.18**

- Take 20 ml of 0.1N sodium hydroxide solution in a conical flask and add a few drops of phenolphthalein.
- What colour do you observe?
- Add 20 ml of 0.1N hydrochloric acid solution to the conical flask drop by drop.
- Do you observe any colour change in the reaction mixture?

The above reaction between an acid and a base is known as neutralisation reaction.



11.4.3 Uses of Bases

- Sodium hydroxide is used in the manufacture of soap.
- Calcium hydroxide is used in white-washing buildings.
- Magnesium hydroxide is used as a medicine for stomach disorder.
- Ammonium hydroxide is used to remove grease stains from clothes.

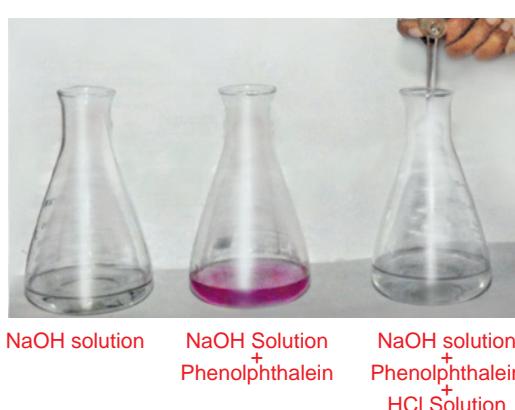


Fig. 11.14 Reaction of sodium hydroxide with hydrochloric acid

11.5. IDENTIFICATION OF ACIDS AND BASES

ACTIVITY 11.19

- Collect lemon juice, washing soda solution, soap solution and soft drinks.
- Take 2 ml of each solution in a test tube and test with a litmus paper or indicator.
- What change in colour do you observe with red litmus, blue litmus, phenolphthalein and methyl orange?
- Tabulate your observations.

Sample solution	Red litmus	Blue litmus	Phenolphthalein	Methyl orange
Lemon juice				
Washing soda solution				
Soap solution				
Soft drinks				

The same activity can be repeated for dilute hydrochloric acid, dilute sulphuric acid, sodium hydroxide solution and potassium hydroxide solution with the help of your teacher.

INDICATOR	COLOUR IN ACID	COLOUR IN BASE
Litmus	red	blue
Phenolphthalein	colourless	pink
Methyl orange	pink	yellow

11.6. P^H SCALE

p^H stands for the power of hydrogen ion concentration in a solution. p^H values decide whether a solution is acidic or basic or neutral. p^H scale was introduced by S.P.L. Sorenson. It is mathematically expressed as

$$p^H = -\log_{10} [H^+]$$

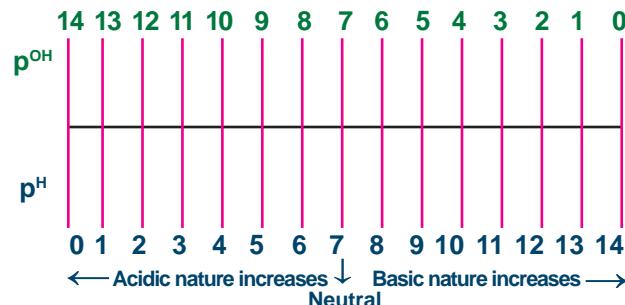
For neutral solution $[H^+] = 10^{-7}M$; $p^H = 7$

For acidic solution $[H^+] > 10^{-7}M$; $p^H < 7$

For basic solution $[H^+] < 10^{-7}M$; $p^H > 7$

When OH⁻ ions are taken into account, the p^H expression is replaced by p^{OH}

$$p^{OH} = -\log_{10} [OH^-]$$



Problems

- The hydrogen ion concentration of a solution is 0.001M. What is the p^H of the solution?

Solution

$$p^H = -\log_{10} [H^+]$$

$$p^H = -\log_{10} (0.001)$$

$$p^H = -\log_{10} (10^{-3})$$

$$= -(-3) \log_{10} 10 \quad [\log 10 = 1]$$

$$p^H = 3$$

2. The hydrogen ion concentration of a solution is 1.0×10^{-9} M. What is the p^H of the solution? Find out whether the given solution is acidic, basic or neutral.

Solution

$$p^H = -\log_{10} [H^+]$$

$$p^H = -\log_{10} (1.0 \times 10^{-9})$$

$$p^H = -(\log_{10} 1.0 + \log_{10} 10^{-9}) \quad [\log_{10} 1 = 0]$$

$$= -(0 - 9 \log_{10} 10)$$

$$p^H = -(0 - 9) = 9$$

$$p^H = 9 \text{ ie } p^H > 7$$

Therefore, the given solution is **basic**.

3. The hydroxide ion concentration of a solution is 0.001M. What is the p^H of the solution?

Solution

$$p^{OH} = -\log_{10} [OH^-]$$

$$p^{OH} = -\log_{10} (10^{-3})$$

$$p^{OH} = 3$$

$$p^H = 14 - p^{OH}$$

$$p^H = 14 - 3 = 11$$

$$p^H + p^{OH} = 14$$

$$p^H = 14 - p^{OH}$$

4. The hydroxide ion concentration of a solution is 1.0×10^{-9} M. What is the p^H of the solution?

Solution

$$p^{OH} = -\log_{10} [OH^-]$$

$$p^{OH} = -\log_{10} (1.0 \times 10^{-9})$$

$$p^{OH} = 9$$

$$p^H = 14 - p^{OH}$$

$$p^H = 14 - 9 = 5$$

11. 6.1. p^H Paper

a more common method of measuring p^H in a school laboratory is by using p^H paper. p^H paper contains a mixture of indicators, which gives different colours across the entire p^H range. p^H value of the various solutions are given in the table.

$$p^H = -\log_{10} [H^+]$$

$$p^H = \log_{10} \left[\frac{1}{[H^+]} \right]$$

$$[H^+] = 10^{-p^H}$$

$$[H^+] = 1 \times 10^{-7}; p^H = 7$$

$$[H^+] = 1 \times 10^{-2}; p^H = 2$$

$$[H^+] = 1 \times 10^{-14}; p^H = 14$$

Solution	Approximate p^H
Lemon juice	2.2 – 2.4
Tomato juice	4.1
Coffee	4.4 - 5.5
Human saliva	6.5 - 7.5
Household ammonia	12.0



Fig. 11.15 p^H paper

ACTIVITY 11.20

- Take lemon juice, orange juice, 1M NaOH, 1M HCl, pure water and vinegar.
- Dip pH paper into these solutions.
- Observe the changes.

Sl. No.	Sample	Colour of pH paper	Approximate pH	Nature of substance
1.	Lemon juice			
2.	Orange juice			
3.	1M NaOH			
4.	1M HCl			
5.	Pure H_2O			
6.	Vinegar			

11.6.2. Importance of pH in Everyday Life**1. pH in Human Body**

- (i) Using pH factor, the general health condition of our body can be examined. At pH level 6.9, the body becomes prone to viral infections like cold, cough and flu. Cancer cells thrive inside the body at a pH of 5.5.
- (ii) The pH of a normal, healthy human skin is 4.5 to 6. Proper skin pH is essential for a healthy complexion.
- (iii) pH of stomach fluid is approximately 2.0. This fluid is essential for the digestion of food.
- (iv) Human blood pH range is 7.35 to 7.45. Any increase or decrease in this value, leads to diseases. The ideal pH for blood is 7.4.
- (v) pH of saliva normally ranges between 6.5 to 7.5.

(vi) White enamel coating of our teeth is calcium phosphate, the hardest substance in our body. It does not dissolve in water. If pH of mouth falls below 5.5, the enamel gets corroded. Toothpastes which are generally basic and used for cleaning the teeth can neutralize the excess acid and prevent tooth decay.

2. pH of Soil

In agriculture, the pH of soil is very important. Citrus fruits require slightly alkaline soil, while rice requires acidic soil and sugarcane requires neutral soil.

3. pH of Rain Water

pH of rain water is approximately 7 showing the high level of its purity and neutrality. If rain water is polluted by SO_2 and NO_2 , acid rain occurs, bringing the pH value less than 7.

11.7. SALT

When you say salt, you may think of the white stuff sprinkled on chips, but that is just one kind of salt called common salt. There are many other salts used in other fields. Salts are the products of the reaction between acids and bases (see reaction of acids and bases). Salts produce positive ions and negative ions when dissolved in water.

11.7.1. Classification of Salts

1. Normal Salts

A normal salt is obtained by complete neutralization of an acid by a base.



2. Acid Salts

Acid salts are derived from the partial replacement of hydrogen ions of an acid by a metal. When a calculated amount of a base is added to a polybasic acid, acid salt is obtained, as follows:



3. Basic Salts

Basic salts are formed by the partial replacement of hydroxide ions of a diacidic or triacidic base with an acid radical.



(Diacidic base) Basic salt

A basic salt may further react with an acid to give a normal salt.

4. Double Salts

Double salts are formed by the combination of the saturated solution of two

simple salts in equimolar ratio followed by crystallization. e.g. potash alum

11.7.2. Uses of Salts

Common Salt (NaCl)

It is used in our daily food and also as a preservative.

Washing Soda (Na_2CO_3)

1. It is used in softening hard water.
2. It is used as a cleaning agent for domestic purposes.

Baking Soda (NaHCO_3)

1. It is used in making of baking powder, which is a mixture of baking soda and tartaric acid. Baking powder is used to make cakes and bread, soft and spongy
2. It is an ingredient in antacid. Being alkaline, it neutralises excess of acidity in the stomach.

Bleaching Powder (CaOCl_2)

1. It is used for disinfecting drinking water to make it free from micro-organisms.
2. It is used for bleaching cotton and linen in the textile industry.

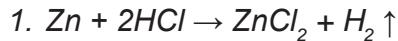
Plaster of Paris ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$)

It is used for plastering fractured bones and in making casts for statues.

GROUP ACTIVITY

Prepare the following salts in the laboratory:

1. Sodium chloride
2. Potash alum

MODEL EVALUATION**PART - A**

The above reaction is an example of _____.

- i) Combination reaction
 - ii) Double displacement reaction
 - iii) Displacement reaction
 - iv) Decomposition reaction.
2. A reddish brown coloured element 'X' on heating in air, becomes a black coloured compound 'Y'. X and Y are _____ and _____ ($Cu, CuO / Pb, PbO$).
3. A student tests the p^H of pure water using a p^H paper. It shows green colour. If a p^H paper is used after adding lemon juice to water, what colour will he observe? (Green / Red / Yellow)
4. Chemical volcano is an example of _____.
(combination reaction / decomposition reaction)
5. When crystals of lead nitrate on heating strongly produces _____ gas and the colour of the gas is _____.
6. When aqueous solution of silver nitrate and sodium chloride are mixed, _____ precipitate is immediately formed (white / yellow / red).
7. Aluminium can displace Zinc metal from aqueous solution of Zinc sulphate because _____ (zinc is more reactive than aluminium / aluminium is more reactive than zinc).
8. To protect tooth decay, we are advised to brush our teeth regularly. The nature of the tooth paste commonly used is _____ in nature.
9. Vinegar is present in acetic acid. Curd contains _____ acid.
(Lactic acid / Tartaric acid).
10. $p^H = -\log_{10} [H^+]$. The p^H of a solution containing hydrogen ion concentration of $0.001M$ solution is _____ (3 / 11 / 14)

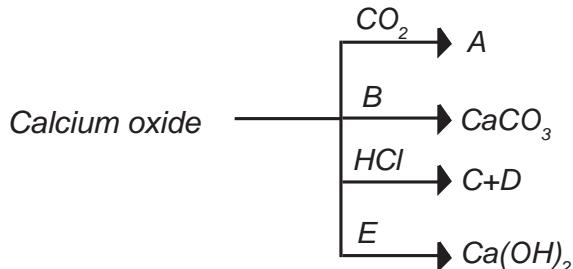
PART - B

1. What type of chemical reaction takes place when i) limestone is heated?
ii) a magnesium ribbon is burnt in air?
2. The p^H values of certain familiar substances are given below:

Substance	p^H value
Blood	7.4
Baking soda	8.2
Vinegar	2.5
Household ammonia	12

Analyse the data in the table and answer the following questions:

- i) Which substances are acidic in nature?
- ii) Which substances are basic in nature?
3. Why does the colour of copper sulphate change when an iron nail is kept in it? Justify your answer.
4. The hydroxide ion concentration of a solution is $1.0 \times 10^{-8} M$. What is the pH of the solution?
5. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid is added to test tube A, while acetic acid is added to test tube B. The amount and concentration taken for both the acids are same. In which test tube does the reaction occur more vigorously and why?
6. Two acids 'A' and 'B' were kept in beakers. Acid 'A' undergoes partial dissociation in water, whereas acid 'B' undergoes complete dissociation in water.
 - i) Of the two acids 'A' and 'B', which is weak acid and which is strong acid?
 - ii) What is a weak acid?
 - iii) What is a strong acid?
 - iv) Give one example each.
7. Observe the given chemical change and answer the following:



- i) Identify 'A' and 'B'.
- ii) Write the commercial name of calcium hydroxide.
- iii) Identify products 'C' and 'D', when HCl is allowed to react with calcium oxide.
- iv) Say whether calcium oxide is acidic or basic.
8. Take copper nitrate in a test tube and heat it over the flame.
 - i) What is the colour of cupric nitrate?
 - ii) What do you observe?
 - iii) Name the type of reaction that takes place.
 - iv) Write the balanced equation.

9. Identify the wrong statements and correct them.

- i) Sodium benzoate is used in food preservative.
- ii) Nitric acid is not used as fertilizer in agriculture.
- iii) Sulphuric acid is called the king of chemicals.
- iv) The P^H of acid is greater than 7.
- v) Acetic acid is used in aerated drinks.

10. Redox reactions are reactions during which electron transfer takes place. Here magnesium atom transfers two electrons one each to the two chlorine atoms.

- i) What are the products of this reaction?
- ii) Write the balanced equation for the complete reaction.
- iii) Which element is being oxidized?
- iv) Which element is being reduced?
- v) Write the reduction part of the reaction.

11. Suggest a reason for each observation given below.

- i) In fireworks, powdered magnesium is used rather than magnesium ribbon.
- ii) Zinc and dilute H_2SO_4 react much more quickly when a few drops of copper sulphate solutions are added.
- iii) The reaction between magnesium carbonate and dilute hydrochloric acid speeds up when some concentrated HCl is added.

12. Sodium hydroxide and hydrochloric acid react as shown in this equation.



- i) Which type of chemical reaction is this?
- ii) The reaction is exothermic. Explain what that means.
- iii) Differentiate exothermic reaction and endothermic reaction.
- iv) What happens to the temperature of the solution as the chemicals react?

13. Take two conical flasks. Label them as I and II. Take a small amount of copper sulphate solution in the first conical flask. Take a small amount of granulated zinc in the second conical flask. Allow the copper sulphate solution to react with the zinc.

- i) Name the type of reaction.
- ii) Say whether the metal zinc is more reactive or less reactive.
- iii) Write the complete and balanced reaction.
- iv) Say whether this change is reversible or irreversible.

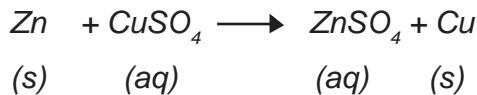
14. Relate the information given in all the four columns of the table.

Compound	Chemical formula	Chemical name	Use
1. Washing soda	CaOCl_2	calcium sulphate hemihydrate	for making statues
2. Baking soda	Na_2CO_3	sodium bicarbonate	softening of hard water
3. Bleaching powder	$\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$	sodium carbonate	for making cake
4. Plaster of paris	NaHCO_3	calcium oxy chloride	bleaching

15. When lead powder is added to copper chloride solution, a displacement reaction occurs and solid copper is formed.

- i) Write the equation for the reaction.
- ii) Why does the displacement reaction occur?

16. When zinc and copper (II) sulphate are heated together, the following redox reaction occurs:



- i) What does the word redox stand for?
- ii) Show how electrons are transferred in the reaction.
- iii) Write the ionic equation for the redox reaction.

17. If a substance gains oxygen during a reaction, it is being oxidized. If it loses oxygen, it is being reduced. Oxidation and Reduction always take place together, so that if one substance is oxidized, another is reduced. Using this idea, say which substance is oxidised and which substance is reduced in each reaction.

- i) $\text{Mg} + \text{O}_2 \longrightarrow 2\text{MgO}$
 $(\text{s}) \quad (\text{g}) \quad (\text{s})$
- ii) $\text{ZnO} + \text{C} \longrightarrow \text{Zn} + \text{CO}$
- iii) $\text{Fe}_2\text{O}_3 + 3\text{CO} \longrightarrow 2\text{Fe} + 3\text{CO}_2$
- iv) $\text{Cr}_2\text{O}_3 + 2\text{Al} \longrightarrow 2\text{Cr} + \text{Al}_2\text{O}_3$

18. The hydrogen ion concentration of a solution is $1 \times 10^{-8} M$

- i) What is the P^H of the solution?
- ii) What is the P^{OH} of the solution?
- iii) Is the given solution, acidic or basic?.

Discuss in Groups:

1. When solutions of silver nitrate and potassium bromide are mixed, a pale yellow precipitate is formed.

The ionic equation for the reaction is $\text{Ag}^+ + \text{Br}^- \longrightarrow \text{AgBr}$

- i) a) What is the name of the pale yellow precipitate?
- b) Is it soluble or insoluble?
- ii) Is the formation of silver bromide precipitate, a result of redox reaction or not ? Justify your answer.
- iii) What is this type of reaction called?

FURTHER REFERENCE

- Books:**
1. Text book of Inorganic Chemistry—P.L. Soni- S.Chand & sons publishers, New Delhi.
 2. Principles of Physical Chemistry—B.R.Puri, L.R.Sharma, Vishal Publishing Co, Punjab.
 3. Complete Chemistry(IGCSE) - Oxford University press, New York

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PERIODIC CLASSIFICATION OF ELEMENTS

Have you ever visited a library? There are thousands of books in a large library. If you ask for a book in general, it is very difficult to trace, whereas if you ask for a particular book, the library staff can locate it very easily. How is it possible? In a library, the books are classified into various categories and sub categories. They are arranged on the shelves accordingly. Therefore locating a book becomes very easy.

As on date, one hundred and eighteen elements are known. It is difficult to identify each and every element individually and to know its properties and uses. Therefore, they have been classified on the basis of their similarities in properties. One of the important instincts of mankind is to be systematic. Scientists felt the necessity to group elements of similar characteristics together so that if the properties of one of them are known, those of the others could be guessed and related.



Henry Gwyn-Jeffreys Moseley, an English Physicist (1887–1915), used X-rays to determine the atomic numbers of the elements.

When a large number of elements were discovered, several attempts were made to arrange them on the basis of their properties, nature, character, valency, etc.

(Real credit for preparing the periodic table goes to Mendeleev).

12.1. MODERN PERIODIC LAW

A large number of scientists made attempts to eliminate the drawbacks of Mendeleev's periodic table. In 1912, Moseley, an English physicist measured the frequency of X-rays emitted by a metal, when the metal was bombarded with high speed electrons. He plotted square roots of the frequencies against atomic numbers. The plot obtained was a straight line. He found that the square root of the frequency of the prominent X-rays emitted by a metal was proportional to the

MORE TO KNOW

Atomic number is number of protons in the nucleus or number of electrons revolving around the nucleus in an atom.

atomic number and not to the atomic weight of the atom of that metal.

Moseley suggested that atomic number (Z) should be the basis of the classification of elements. Thus, he gave the modern periodic law as follows:

Modern periodic law states that “**the physical and chemical properties of elements are the periodic function of their atomic numbers.**”

Thus, according to the modern periodic law, if elements are arranged in the increasing order of their atomic numbers,

the elements with similar properties are repeated after certain regular intervals.

12.2. MODERN PERIODIC TABLE

Based on the modern periodic law, a number of forms of the periodic table have been proposed from time to time, but the general plan of the table remained the same as proposed by Mendeleev. The table which is most commonly used and which is based upon the **electronic configuration of elements** is called the **long form of the periodic table**. This is called the **modern periodic table**.

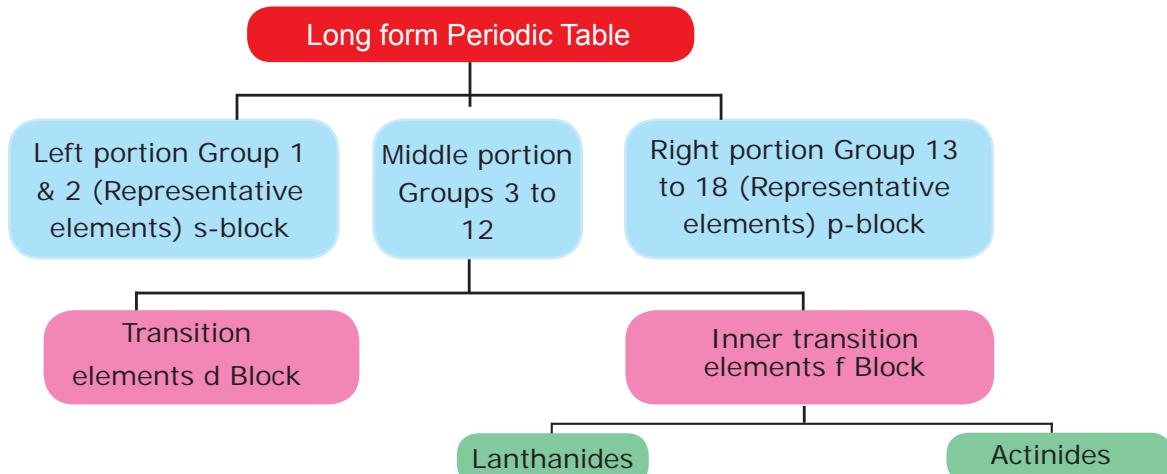
12.2.1. Description of Modern or Long Form of the Periodic Table

Long form of the periodic table is a chart of elements in which the elements have been arranged in the increasing order of their atomic numbers. This table consists of **horizontal rows called periods** and **vertical columns called groups**.

MORE TO KNOW

The modern periodic table has also been divided into four blocks known as s,p,d and f blocks.

12.2.2. Different portions of long form of periodic table



- **Sixth period** (Atomic number 55 to 86): This is the longest period. It contains 32 elements (Cesium to Radon). This includes 8 normal elements, 10 transition elements and 14 inner transition elements (Lanthanides).
- **Seventh period** (Atomic number 87 to 118): Like the sixth period, this period also accommodates 32 elements. Till now, only 26 elements have been authenticated by IUPAC.

12.2.4. Study of Groups

- Vertical columns in the periodic table starting from top to bottom are called groups. There are 18 groups in the periodic table.
- First group elements are called alkali metals.
- Second group elements are called alkaline earth metals.
- Groups three to twelve are called transition elements .
- Group 1, 2 and 13 - 18 are called **normal elements or main group elements or representative elements** .
- Group 13 - Boron family.
- Group 14 - Carbon family.
- Group 15 - Nitrogen family.
- Group 16 elements - chalcogen family (except polonium).
- Group 17 elements - halogen family.
- Group 18 elements - noble gases or inert gases.
- The Lanthanides and Actinides which form part of Group 3 are called inner transition elements.

12.3. CHARACTERISTICS OF MODERN PERIODIC TABLE

12.3.1. Characteristics of Periods

- In a period, the electrons are filled in the same valence shell of all elements.
- As the electronic configuration changes along the period, the chemical properties of the elements also change.
- The atomic size of the elements in a period decreases from left to right.
- In a period, the metallic character of the element decreases, while their non-metallic character increases.

12.3.2. Characteristics of Groups

- The elements present in 2 and 18 Groups differ in atomic number by 8,8,18,18,32.
- The elements present in 13 - 17 Groups differ in atomic number by 8,18,18,32.
- The elements present in 4 - 12 Groups differ in atomic number by 18,32,32.
- The elements present in a group have the same number of electrons in the valence shell of their atoms.
- The elements present in a group have the same valency.
- The elements present in a group have identical chemical properties.
- The physical properties of the elements in a group such as melting point, boiling point and density vary gradually.
- The atomic radii of the elements present in a group increases downwards.

12.3.3. Advantages of the Modern Periodic Table

- The table is based on a more fundamental property ie., atomic number.
- It correlates the position of the element with its electronic configuration more clearly.
- The completion of each period is more logical. In a period, as the atomic number increases, the energy shells are gradually filled up until an inert gas configuration is reached.
- It is easy to remember and reproduce.
- Each group is an independent group and the idea of sub-groups has been discarded.
- One position for all isotopes of an element is justified, since the isotopes have the same atomic number.
- The position of the eighth group (in Mendeleev's table) is also justified in this table. All transition elements have been brought in the middle as the properties of transition elements are intermediate between left portion and right portion elements of the periodic table.
- The table completely separates metals from non-metals. The non-metals are present in upper right corners of the periodic table.
- The positions of certain elements which were earlier misfit (interchanged) in the Mendeleev's periodic table are now justified because it is based on atomic number of the elements.
- Justification has been offered for placing lanthanides and actinides at the bottom of the periodic table.

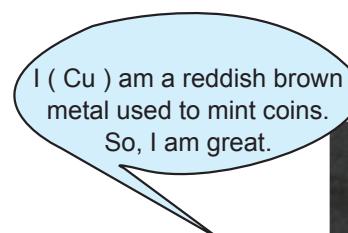
12.3.4. Defects in the Modern Periodic Table

- Position of hydrogen is not fixed till now.
- Position of Lanthanides and Actinides has not been given inside the main body of periodic table.
- It does not reflect the exact distribution of electrons of some of the transition and the inner transition elements.

MORE TO KNOW

The last element authenticated by IUPAC is Cn112 [Copernicium]. However, the number of elements discovered so far is 118.

12.4. METALLURGY





I (Fe) am a lustrous steel metal used to build machinery and bridges. So, I am great.



Individually you are great in your own way. You will become the GREATEST IF YOU ARE ALLOYED TOGETHER.
Unity is strength.

MORE TO KNOW

Purity of gold is expressed in carats.

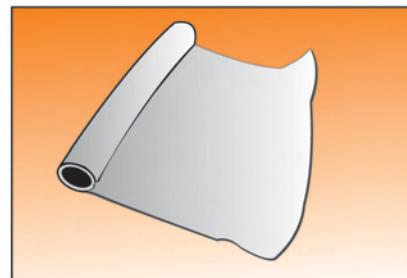
24 carat gold = pure gold.

For making ornaments 22 carat gold is used which contains 22 parts of gold by weight and 2 parts of copper by weight. The percentage of purity is $\frac{22}{24} \times 100 = 91.6\% \text{ (916 Make gold)}$

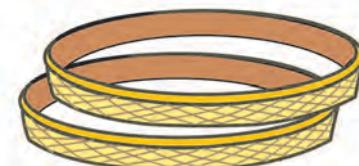
From one gram of gold, nearly 2km of filament can be drawn. It is an amazing fact indeed!



Vietnamese Craftwork in silver



Aluminium foil



Gold Bangles

MORE TO KNOW

The vitality of metals for the totality of life

Metals in minute amounts are essential for various biological purposes.

Fe – a constituent of blood pigment (haemoglobin).

Ca - a constituent of bone and teeth.

Co - a constituent of vitamin B-12 .

Mg - constituent of chlorophyll.



METALS AROUND US



12.4.1. Terminology in Metallurgy

Minerals: A mineral may be a single compound or a complex mixture of various compounds of metals found in the earth.

Ores: The mineral from which a metal can be readily and economically extracted on a large scale is said to be an ore.

For example, clay ($\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$) and bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$) are the two minerals of aluminium, but aluminium can be profitably

extracted only from bauxite. Hence **bauxite** is an **ore of aluminium** and **clay** is its mineral.

12.4.2. Differences between minerals and ores

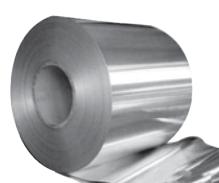
- Minerals contain a low percentage of metal, while ores contain a large percentage of metal.
- Metals cannot be extracted easily from minerals. On the other hand, ores can



Gold



Silver



Aluminium

- be used for the extraction of metals.
- All minerals cannot be called as ores, but all ores are minerals.**
- Mining:** The process of extracting the ores from the earth's crust is called mining.
- Metallurgy:** The various steps involved in the extraction of metals from their ores as well as refining of crude metals are collectively known as metallurgy.
- Gangue or Matrix:** The rocky impurity, associated with the ore is called gangue or matrix.
- Flux:** It is the substance added to the ore to reduce the fusion temperature and to remove impurities. e.g. Calcium oxide, Silica.
- Slag:** It is the fusible product formed when flux reacts with gangue during the extraction of metals.

Flux + Gangue → Slag

Smelting: Smelting is the process of reducing the roasted metallic oxide to metal in molten condition. In this process, impurities are removed by the addition of flux as slag.

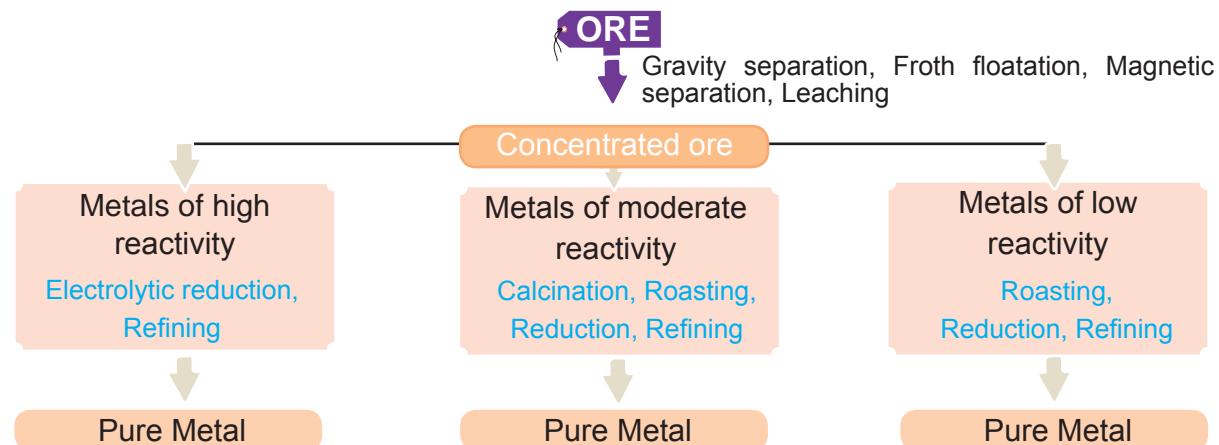
12.5. OCCURRENCE OF METALS

Nearly 80 metallic elements are obtained from mineral deposits on or beneath the surface of the earth. Metals which have low chemical reactivity are found in **free state or in native state**.

Gold, silver and platinum are examples of metals that are partly found in a free state. Most of the other metals are found in a combined state in the form of their oxide ores, carbonate ores, halide ores, sulphide ores, sulphate ores and so on.

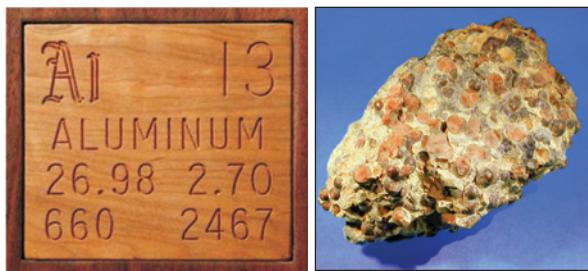
Oxide Ores	Carbonate Ores	Halide Ores	Sulphide Ores
Bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$)	Marble (CaCO_3)	Cryolite (Na_3AlF_6)	Galena (PbS)
Cuprite (Cu_2O)	Magnesite (MgCO_3)	Fluorspar (CaF_2)	Iron pyrite (FeS_2)
Haematite (Fe_2O_3)	Siderite (FeCO_3)	Rock salt (NaCl)	Zinc blende (ZnS)
Zincite (ZnO)	Calamine (ZnCO_3)	Hornsilver (AgCl)	Cinnabar (HgS)

Extraction of Metal from its Ore



12.6. METALLURGY OF ALUMINIUM, COPPER AND IRON

12.6.1. Metallurgy of Aluminium



Symbol : Al

Colour : Silvery white

Atomic number : 13

Electronic configuration:2, 8, 3

Valency : 3

Atomic mass : 27

Position in the periodic table: period=3, group=13

Aluminium is the metal found most abundantly in the earth's crust. Since it is a reactive metal, it occurs in the combined state. The important ores of aluminium are as follows:

Name of the ore	Formula
Bauxite	$\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
Cryolite	Na_3AlF_6
Corundum	Al_2O_3

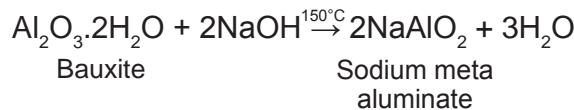
The chief ore of aluminium is bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$).

Extraction of aluminium from bauxite involves two stages:

I. Conversion of Bauxite into Alumina by Baeyer's Process

The conversion of Bauxite into Alumina involves the following steps:

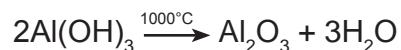
- Bauxite ore is finely ground and heated under pressure with concentrated caustic soda solution at 150°C to obtain sodium meta aluminate.



- On diluting sodium meta aluminate with water, aluminium hydroxide precipitate is obtained.



- The precipitate is filtered, washed, dried and ignited at 1000°C to get alumina.



2.Electrolytic reduction of Alumina by Hall's process

Aluminium is produced by the electrolytic reduction of fused alumina (Al_2O_3) in the electrolytic cell.

Cathode : Iron tank lined with graphite.

Anode : A bunch of graphite rods suspended in molten electrolyte.

Electrolyte : Pure alumina + molten cryolite + fluorspar (fluorspar lowers the fusion temperature of electrolyte)

Temperature : $900\text{-}950^\circ\text{C}$

Voltage used : 5-6V

The overall equation for aluminium extraction is

$$2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2 \uparrow$$

Aluminium is deposited at the cathode and oxygen gas is liberated at the anode. Oxygen combines with graphite to form CO_2 .

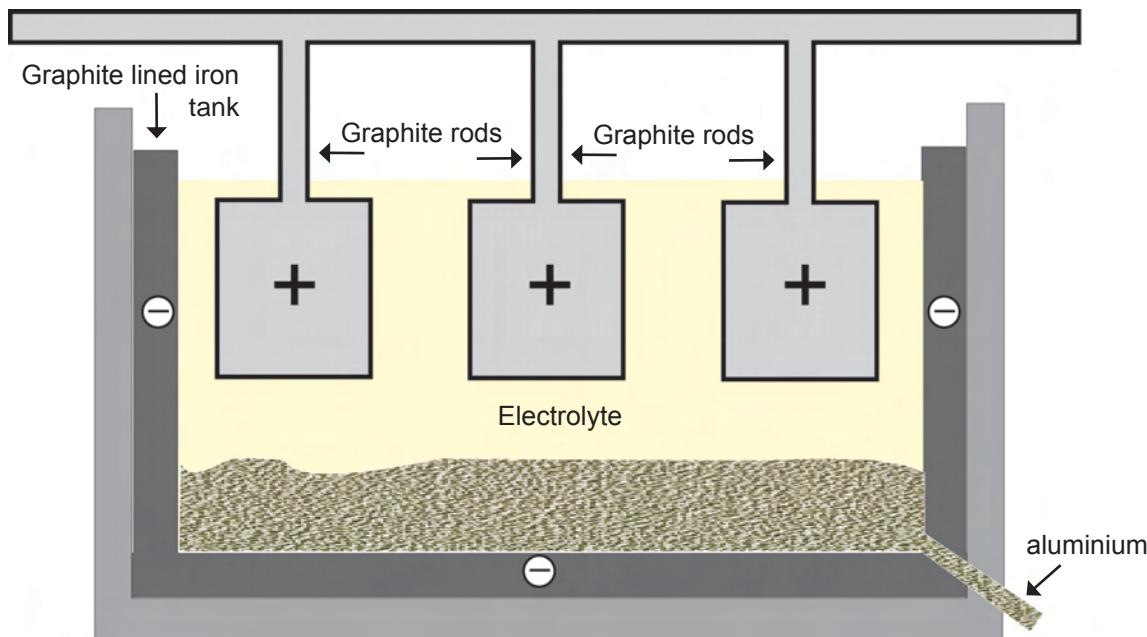


Fig 12.1 Electrolytic reduction of alumina

Properties of Aluminium

Physical properties:

- It is a silvery white metal.
- It has low density and it is light.
- It is malleable and ductile.
- It is a good conductor of heat and electricity.

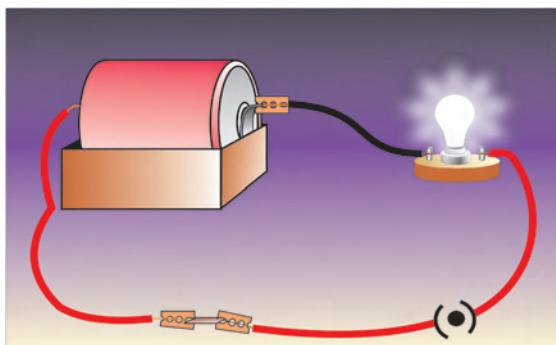


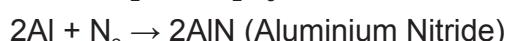
Fig. 12.2 Electric conductivity of metal

- Melting point: 660°C
- It can be polished to produce a shiny attractive appearance.

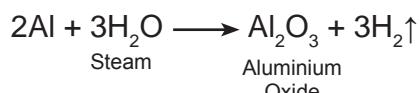
Chemical properties:

- Reaction with air:** It is not affected by dry air. On heating at 800°C , aluminium burns

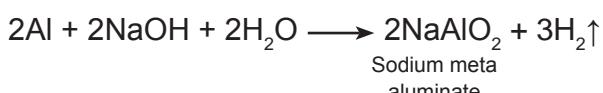
very brightly forming its oxide and nitride.



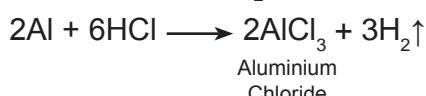
- Reaction with water:** Water does not react on aluminium due to the layer of oxide on it. When steam is passed over red hot aluminium, hydrogen is produced.



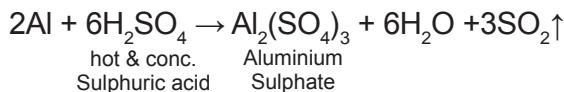
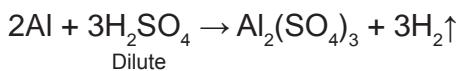
- Reaction with alkalis:** It reacts with strong caustic alkalis forming aluminates.



- Reaction with acids:** With dilute and conc. HCl it liberates H_2 gas.



Aluminium liberates hydrogen on reaction with dilute sulphuric acid. Sulphur dioxide is liberated with hot concentrated sulphuric acid.



MORE TO KNOW

Dilute or concentrated nitric acid does not attack aluminium, but it renders aluminium passive due to the formation of an oxide film on its surface.

5. Reducing action : Aluminium is a powerful reducing agent. When a mixture of aluminium powder and iron oxide is ignited, the latter is reduced to metal. This process is known as **aluminothermic process**.



Uses of Aluminium

USES	FORM	REASON
1. Household utensils	Aluminium metal	It is light, cheap, corrosion resistant, and a good conductor of heat.
2. Electrical cable industry	Aluminium wires	It is a good conductor of electricity.
3. Aeroplanes and other industrial parts	Duralumin Al,Cu,Mg,Mn Magnalium Al,Mg	Its alloys are light, have high tensile strength and corrosion resistant.
4. Thermite welding	Al powder and Fe_2O_3	Its powder is a strong reducing agent and reduces Fe_2O_3 to iron.



Aircraft - An alloy of aluminium

INDUSTRIAL VISIT

Make an industrial visit to the place where Thermite welding is actually done and record your observations on joining the gap between the broken rails.



Fig 12.3

12.6.2 Metallurgy of Copper



Symbol : Cu

Atomic mass : 63.55

Atomic number : 29

Electronic configuration : 2, 8, 18, 1

Valency : 1 and 2

Occurrence: It was named as cuprum by the Romans because they got it from the Island of Cyprus. Copper is found in the **native state** as well as in the combined state.

Ores of copper	Formula
i. Copper pyrites	CuFeS_2
ii. Cuprite or ruby copper	Cu_2O
iii. Copper glance	Cu_2S

The chief ore of copper is copper pyrite. It yields nearly 76% of the world production of copper.

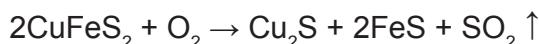
Extraction from Copper Pyrites:

Extraction of copper from copper pyrites involves the following steps:

1. Crushing and concentration: The ore is crushed and then concentrated by froth-floatation process.

2. Roasting: The concentrated ore is roasted in excess of air. During the process of roasting,

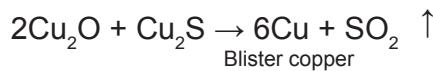
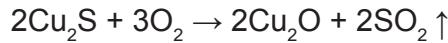
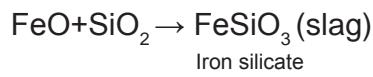
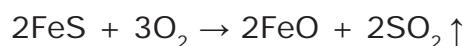
- i. moisture and volatile impurities are removed.
- ii. sulphur, phosphorus, arsenic and antimony are removed as oxides. Copper pyrite is partly converted into sulphides of copper and iron.



3. Smelting: The roasted ore is mixed with powdered coke and sand and is heated in a blast furnace to obtain matte and slag.

(Matte = $\text{Cu}_2\text{S} + \text{FeS}$) The slag is removed as waste.

4. Bessemerisation: The molten matte is transferred to Bessemer converter in order to obtain **blister copper**. Ferrous sulphide from matte is oxidised to ferrous oxide, which is removed as slag using silica.



5. Refining: Blister copper contains 98% of pure copper and 2% of impurities and is purified by electrolytic refining.

Electrolytic Refining

This method is used to get metal of a high degree of purity. For electrolytic refining of copper, we use:

Cathode: A thin plate of pure copper metal.

Anode: A block of impure copper metal.

Electrolyte: Copper sulphate solution acidified with sulphuric acid.

When electric current is passed through

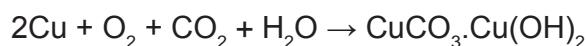
the electrolytic solution, pure copper gets deposited at the cathode and the impurities settle at the bottom of the anode in the form of sludge called **anode mud**.

Properties

Physical properties: Copper is a reddish brown metal, with high lustre, high density and high melting point (1356°C).

Chemical properties:

i. **Action of Air and Moisture:** Copper gets covered with a green layer of basic copper carbonate in the presence of CO_2 and moisture.



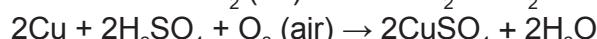
ii. **Action of Heat:** On heating at different temperatures in the presence of oxygen, copper forms two types of oxides CuO , Cu_2O .



iii. Action of Acids:

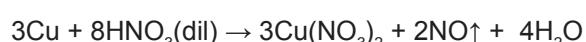
a) With dil. HCl and dil. H_2SO_4 :

Dilute acids such as HCl and H_2SO_4 have no action on these metals in the absence of air. Copper dissolves in these acids in the presence of air.



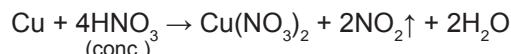
b) With dil. HNO_3 :

Copper reacts with dil. HNO_3 with the liberation of Nitric Oxide gas.



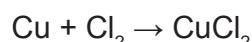
c) With con. HNO_3 and con. H_2SO_4 :

Copper reacts with con. HNO_3 and con. H_2SO_4 with the liberation of nitrogen dioxide and sulphur dioxide respectively.





iv. Action of Chlorine: Chlorine reacts with copper, resulting in the formation of copper (II) chloride.



v. Action of Alkalies: Copper is not attacked by alkalis.

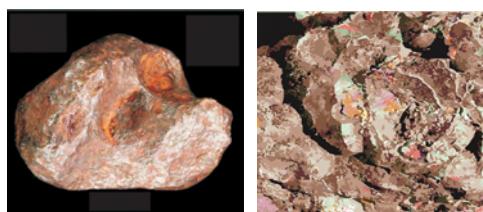
Uses of Copper:

- It is extensively used in manufacturing electric cables and other electric appliances.
- It is used for making utensils, containers, calorimeters and coins.
- It is used in electroplating.
- It is alloyed with gold and silver for making coins and jewels.

PROJECT

Submit a project report on the important applications of copper in everyday life along with samples.

12.6.3. Metallurgy of Iron



Symbol: Fe

Colour: Greyish white

Atomic mass: 55.9

Atomic number: 26

Electronic configuration: 2, 8, 14, 2

Valency: 2 & 3

Occurrence:

Iron is the **second** most abundant metal available next to aluminium. It occurs in

nature as oxides, sulphides and carbonates. The ores of iron are given in the following table:

Ores of iron	Formula
i.Haematite	Fe_2O_3
ii.Magnetite	Fe_3O_4
iii.Iron pyrite	FeS_2

Extraction of Iron from Haematite Ore (Fe_2O_3)

1. Concentration by Gravity Separation

The powdered ore is washed with a stream of water. As a result, the lighter sand particles and other impurities are washed away and the heavier ore particles settle down.

2. Roasting and Calcination

The concentrated ore is strongly heated in a limited supply of air in a reverberatory furnace. As a result, moisture is driven out and sulphur, arsenic and phosphorus impurities are oxidised off.

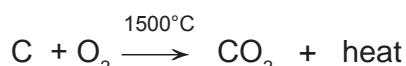
3. Smelting (in a Blast Furnace)

The **charge** consisting of roasted ore, coke and limestone in the ratio 8 : 4 : 1 is smelted in a blast furnace by introducing it through the **cup and cone** arrangement at the top. There are three important regions in the furnace.

i. The Lower Region (Combustion Zone)-

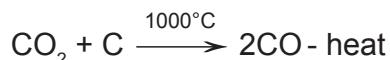
the temperature is at 1500°C .

In this region, coke burns with oxygen to form CO_2 when the charge comes in contact with a hot blast of air.



It is an exothermic reaction since heat is liberated.

ii. The Middle Region (Fusion Zone) - The temperature prevails at 1000°C . In this region, CO_2 is reduced to CO .



Limestone decomposes to calcium oxide and CO_2 .



These two reactions are endothermic due to the absorption of heat. Calcium oxide combines with silica to form calcium silicate slag.



iii. The Upper Region (Reduction Zone) -

The temperature prevails at 400°C . In this region carbon monoxide reduces ferric oxide to form a fairly pure spongy iron.



The molten iron is collected at the bottom of the furnace after removing the slag.

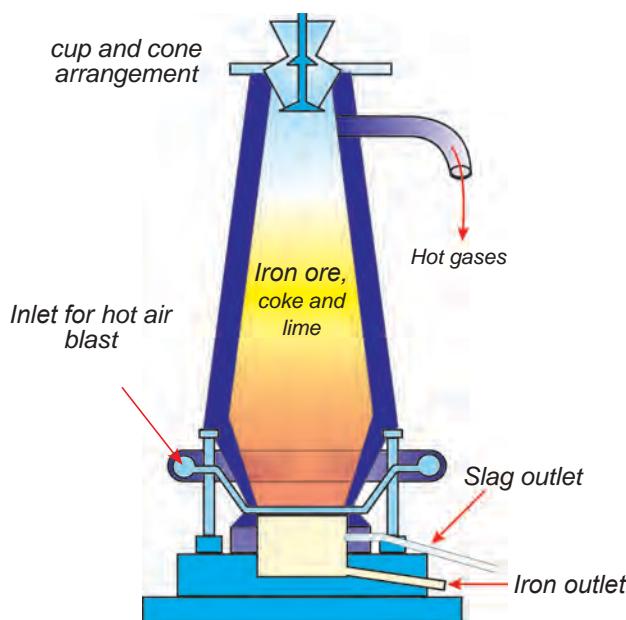


Fig. 12.4 Blast Furnace

The iron thus formed is called **pig iron**. It is remelted and cast into different moulds. This iron is called **cast iron**.

MORE TO KNOW

CALCINATION: *It is a process in which ore is heated in the absence of air. As a result of calcination, the carbonate ore is converted into its oxide.*

ROASTING: *It is a process in which ore is heated in the presence of excess of air. As a result of roasting, the sulphide ore is converted into its oxide.*

MORE TO KNOW

Depending on the carbon content, iron is classified into 3 types:

Pig iron with carbon content of 2- 4.5%

Wrought iron with carbon content of <0.25%

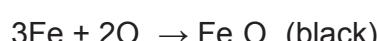
Steel with carbon content of 0.25-2%.

Physical Properties

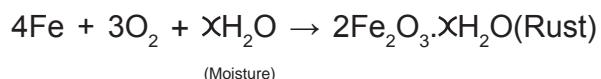
- It is a heavy metal of density 7.9 g/cc.
- It is a lustrous metal, greyish white in colour.
- It has high tensility, malleability and ductility.
- It is a good conductor of heat and electricity.
- It can be magnetised.

Chemical properties

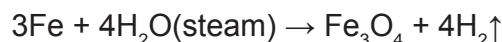
1. Reaction with air or oxygen: Only on heating in air, iron forms magnetic oxide.



2. Reaction with moist air: When iron is exposed to moist air, it forms a layer of brown hydrated ferric oxide on its surface. This compound is known as rust and the phenomenon of formation of rust is known as rusting.



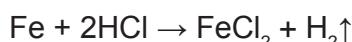
3. Reaction with steam: When steam is passed over red hot iron, magnetic oxide is formed.



4. Reaction with chlorine: Iron combines with chlorine to form ferric chloride.



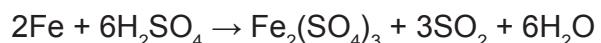
5. Reaction with acids: With dilute HCl and dilute H_2SO_4 it liberates H_2 gas.



With dilute HNO_3 in cold condition it gives ferrous nitrate.



With conc. H_2SO_4 it forms ferric sulphate.



When iron is dipped in conc. HNO_3 it becomes chemically **inert or passive** due to the formation of a layer of iron oxide (Fe_3O_4) on its surface.

Uses of Iron

- Pig iron** is used in making pipes, stoves, radiators, railings, manhole covers and drain pipes.
- Steel** is used in the construction of buildings, machinery, transmission cables and T.V. towers and in making alloys.

iii. Wrought iron is used in making springs, anchors and electromagnets.

12.7 ALLOYS

An alloy is a homogeneous mixture of a metal with other metals or with non-metals that are fused together.

Alloys are solid solutions. Alloys can be considered as solid solutions in which the metal with high concentration is the **solvent** and the metal with low concentration is the **solute**. For example, brass is an alloy of zinc(solute) in copper(solvent).

12.7.1 Methods of making Alloys

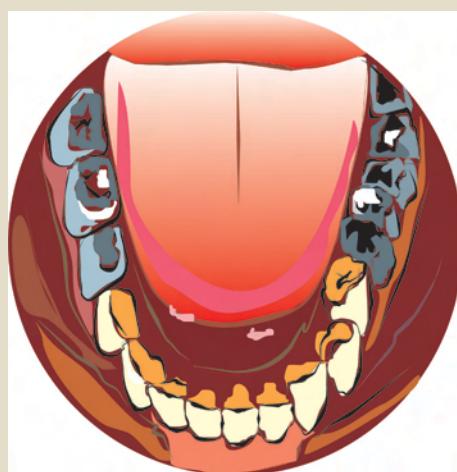
- By fusing the metals together.
- By compressing finely divided metals one over the other.

Amalgam: An amalgam is an alloy of mercury with metals such as sodium, gold, silver, etc.

MORE TO KNOW

DENTAL AMALGAMS

It is an alloy of mercury with silver and tin metals. It is used in dental filling.



Dental amalgam

12.7.2. Copper Alloys

Name of the alloy	Reason for alloying	Uses
i.Brass(Cu,Zn)	Lustrous,easily cast,malleable, ductile,harder than Cu.	Electrical fittings, medals, hardware, decorative items.
ii.Bronze(Cu,Sn)	Hard, brittle and polishable.	Statues, coins, bells, gongs.

12.7.3. Aluminium Alloys

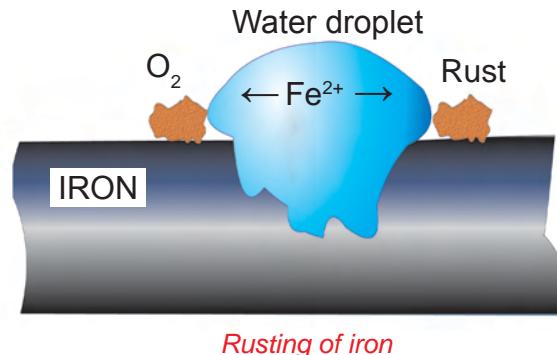
Name of the alloy	Reason for alloying	Uses
i.Duralumin (Al,Mg,Mn,Cu)	Light,strong,resistant to corrosion, stronger than aluminium.	Aircraft,tools, pressure cookers
ii.Magnalium(Al,Mg)	Light, hard, tough, corrosion resistant.	Aircraft, scientific instruments

12.7.4. Iron Alloys

Name of the alloy	Reason for alloying	Uses
i.Stainless steel (Fe,C,Ni,Cr)	Lustrous,corrosion resistant,high tensile strength.	Utensils,cutlery,automobile parts.
ii.Nickel steel (Fe,C,Ni)	Hard, corrosion resistant,elastic.	Cables,aircraft parts,propeller.

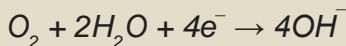
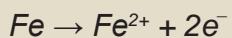
12.8. CORROSION

Corrosion is defined as the slow and steady destruction of a metal by the environment. It results in the deterioration of the metal to form metal compounds by means of chemical reactions with the environment.



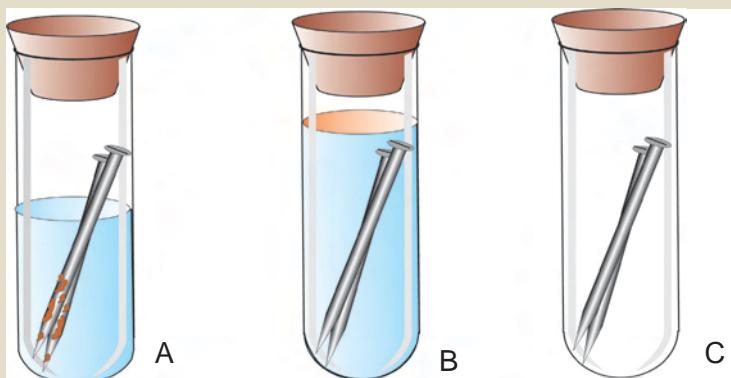
MORE TO KNOW

When the surface of iron is exposed to moisture and other gases present in the atmosphere, chemical reaction takes place.



The Fe^{2+} ions are oxidised to Fe^{3+} ions. The Fe^{3+} ions combine with OH^- ions to form $Fe(OH)_3$. This becomes rust ($Fe_2O_3 \cdot xH_2O$) which is hydrated ferric oxide.

ACTIVITY 12.1



The conditions for rusting

Take three test tubes provided with rubber corks and label them as A, B and C. Place a few iron nails of the same size in these tubes. Pour some water in test tube A, some boiled water along with turpentine oil in test tube B and anhydrous CaCl_2 in test tube C. Observe them for a few days. Notice the changes.

The nails in A get rusted, while the nails in B and C remain unaffected.

The rusting of the nails in test tube A is due to air and water. In B, the oily layer above the water does not allow air to come in contact with the nails. In C, the substance anhydrous CaCl_2 has absorbed the moisture completely. This activity shows that rusting of iron requires air and water.

Methods of preventing corrosion:

Corrosion of metals is prevented by not allowing them to come in contact with moisture CO_2 and O_2 . This is achieved by the following methods:

- **By coating with paints:** Paint coated metal surfaces keep out air and moisture.
- **By coating with oil and grease:** Application of oil and grease on the surface of iron tools prevent them from being acted upon by moisture and air.
- **By alloying with other metals:** Alloyed metals are more resistant to corrosion.
Example: stainless steel.
- **By the process of galvanization:** This is a process of coating zinc on iron sheets by using electric current. In this, zinc forms a protective layer of zinc carbonate on the surface of iron. This prevents corrosion.
- **Electroplating:** It is a method of coating one metal with another by passing electric current. Example: silver plating, nickel plating. This method not only protects but also enhances the metallic appearance.
- **Sacrificial protection:** Magnesium is more reactive than iron. When it is coated on the articles made of steel it sacrifices itself to protect steel.

MODEL EVALUATION**PART - A**

- In the modern periodic table, periods and groups are given. Periods and Groups indicate _____ i) Rows and Columns ii) Columns and Rows*
- The third period contains elements. Out of these elements, how many elements are non-metals? (8,5)*
- An element which is an essential constituent of all organic compounds belongs to the _____ group. (14th group / 15th group)*
- Ore is used for the extraction of metals profitably. Bauxite is used to extract aluminium, it can be termed as _____. (ore / mineral)*
- Gold does not occur in the combined form. It does not react with air or water. It is in the _____ state. (native / combined)*

PART - B

- Assertion:** A greenish layer appears on copper vessels, if left uncleansed.*

***Reason:** It is due to the formation of a layer of basic copper carbonate*

Give the correct option:

- Assertion and reason are correct and relevant to each other.*
 - Assertion is true but reason is not relevant to the assertion.*
- A process employed for the concentration of sulphide ore is _____. (froth floatation / gravity separation)*
 - Coating the surface of iron with other metal prevents it from rusting. If it is coated with a thin layer of zinc, it is called _____. (galvanization / painting / cathodic protection)*
 - Any metal mixed with mercury is called an amalgam. The amalgam used for dental filling is _____. (Ag – Sn amalgam / Cu – Sn amalgam)*
 - Assertion:** In thermite welding, aluminium powder and Fe_2O_3 are used.*
***Reason:** Aluminium powder is a strong reducing agent. Does the reason satisfy the assertion?*
 - Can the rusting of iron nails occur in distilled water? Justify your answer.*
 - Iron reacts with con. HCl and con. H_2SO_4 , but it does not react with con. HNO_3 . Justify your answer with proper reasons.*
 - To design the body of an aircraft, aluminium alloys are used. Give reasons.*
 - X is a silvery white metal. X reacts with oxygen to form Y. The same compound is obtained from the metal on reaction with steam with the liberation of hydrogen gas. Identify X and Y.*

10. Solve the crossword puzzle:

A	L	K	A	L	I	G	V	K	L
L	G	M	N	P	E	R	I	O	D
K	O	P	H	A	L	O	G	E	N
A	L	P	Q	R	S	U	T	U	E
L	D	A	Z	Y	X	P	W	V	O
I	O	D	I	N	E	B	C	D	N
N	O	B	L	E	G	A	S	E	S
E	A	C	T	I	N	I	D	E	S

CLUES:

DOWN	ACROSS
a. vertical columns are called _____	a. horizontal rows are called _____
b. second group elements are named as _____ earth metals.	b. first group elements are called _____
c. an inert gas used in advertisement bulbs.	c. group 17 elements are called _____
d. a yellowish shining metal weighed in carats.	d. group 18 elements are called _____
	e. belongs to halogen family and helps in thyroid treatment
	f. inner transition elements present in 7 th period

11. Give a single term for each of the following:

- The process of extracting ores from the earth's crust.
- The rocky impurities associated with the ores.
- The substance added to the ore to reduce fusion temperature.
- The process of reducing the roasted oxide ore to metal under molten condition.
- Noble metals occur in this state.

12. Connect the following metallurgical steps with the extraction of metals in the correct order:

(roasting, bessemerisation, Hall's process, smelting (reduction), Baeyer's process, electrolytic refining, blast furnace, calcination, gravity separation, froth floatation process)

Metal	Step 1	Step 2	Step 3	Step 4	Step 5
Al			—	—	—
Cu					
Fe					—

PERIODIC CLASSIFICATION OF ELEMENTS

13. Relate all the four columns of the table with unique properties:

Metal	Ore	Chemical formula	Reduction process
Al	haemetite	PbS	blast furnace
Cu	bauxite	Fe ₂ O ₃	bessemerisation
Fe	copper pyrite	Al ₂ O ₃ . 2H ₂ O	froth floatation
Pb	galena	CuFeS ₂	Hall's process

14. Here are a few statements related to alloys. Identify the incorrect ones and correct them.

- i) It is a homogenous mixture of metals.
- ii) Zinc amalgam is used in dental filling.
- iii) Duralumin is used for making statues, coins, bells and gongs.
- iv) Alloys are produced by compressing finely divided metals one over the other.
- v) Zinc is the solvent of brass.

15. Complete the following table:

Zone	Temperature	Chemical Process
Combustion zone		
		CaCO ₃ → CaO+CO ₂
	400°C	CaO+SiO ₂ → CaSiO ₃

16. Guess who I am?

- i) I am a cheap metal but highly reactive. Therefore, I sacrifice myself to save objects made of iron.
- ii) I am a solid solution. Dentists use me to fill cavities.
- iii) I am a constituent of blood pigment. When I am less in quantity, the person is anaemic.
- iv) I am formed when matrix and flux react.

17. Answer the following questions in one or two sentences:

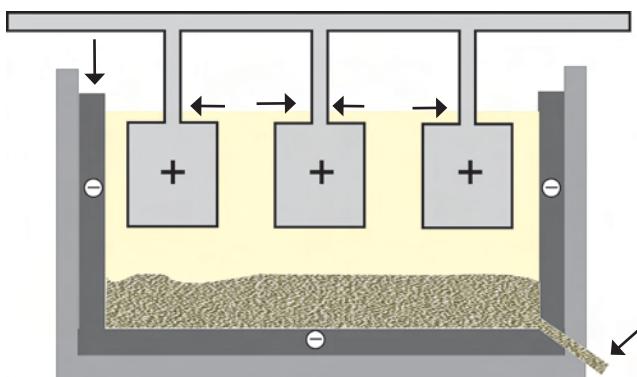
- i) What is the percentage of gold present in 'Hallmark' gold?
- ii) What is the meaning of 'chalcogens'?
- iii) What are the metals used in manufacture of science equipment?
- iv) Name the metal present in chlorophyll which is used in photosynthesis.
- v) When iron is exposed to moist air, a reddish brown substance is deposited on it. What is it? Give its composition.

18. Match the following:

Type of iron	Percentage of Carbon	Uses
steel	2 – 4.5 %	making man-hole covers and drain pipes
wrought iron	0.25 – 2 %	construction of buildings and machinery
pig iron	< 0.25%	making electromagnets

PART - C

1. Redraw and label the diagram. Then answer the following questions.



- i) What process does the diagram represent?
 - ii) Why does the graphite rod need to be replaced often?
 - iii) Give reason for the addition of cryolite to electrolyte.
 - iv) Write the overall equation of this process.
2. A reddish brown metal A when exposed to moist air forms a green layer B. When A is heated at different temperatures in the presence of O_2 , it forms two types of oxides - C (black) and D (red). Identify A, B, C, D and write the balanced equation.
3. A silvery white metal on treatment with NaOH and HCl liberates H_2 gas to form B and C respectively. The metal A will not react with acid D due to the formation of a passive film on the surface. Hence it is used for transporting acid D. Identify A, B, C, D and support your answer with balanced equations.

Discuss in groups:

1. Why cannot aluminium metal be obtained by the reduction of aluminium oxide with coke?

FURTHER REFERENCE

Books: 1. Text Book of Inorganic chemistry – P.L. Soni S.Chand Publishers, New Delhi
2. Complete Chemistry(IGCSE) - Oxford University press, New York

Webliography: www.tutorvista.com science.howstuffworks.com



CARBON AND ITS COMPOUNDS

Symbol	:	C
Atomic Number	:	6
Atomic Mass	:	12
Valency	:	4
Group	:	14

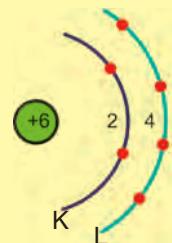


Fig. 13.1 electronic configuration of carbon

INTRODUCTION

Without carbon, no living thing could survive. Human beings are made up of carbon compounds. Carbon is a non-metal. In nature, it occurs in its pure form as **diamond and graphite**. When fuels burn, the carbon in them reacts with oxygen to form carbon dioxide.

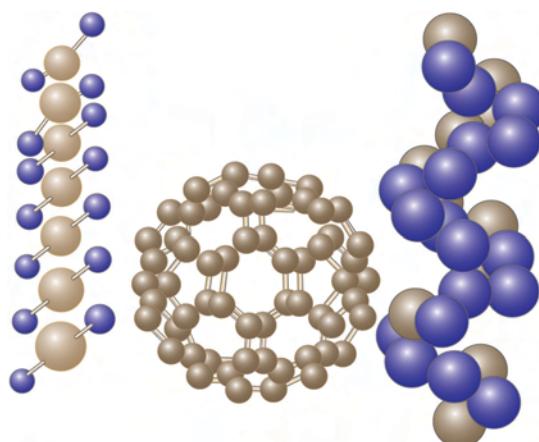


Fig. 13.2 An arrangement depicting carbon and its compounds.

Carbon compounds hold the key to plant and animal life on the earth. Carbon circulates through air, plants, animals and soil by means of complex reactions. This is called **carbon cycle**.

13.1. COMPOUNDS OF CARBON

In the beginning of the 19th century, scientists classified the compounds of carbon into two types, based on their source of occurrence. They are:

- i) Inorganic compounds (obtained from non living matter)
- ii) Organic compounds (obtained from living matter, such as plant and animal sources)

However, the basis of classification was subjected to alteration after Wohler synthesis.

LIVING CHEMISTRY

All living organisms are made of carbon atoms. This means that, carbon atoms form the building blocks of living organisms. These carbon atoms, in combination with other atoms decide life on earth. Hence **carbon chemistry** is also called as **living chemistry**.



Fig. 13.3



Fig. 13.4

FRIEDRICH WOHLER

A creator of revolution in **ORGANIC CHEMISTRY**

MORE TO KNOW

ORGANIC CHEMISTRY:

The word ‘organic’ signifies life. The term organic chemistry was used by the Swedish chemist Berzelius. This refers to the chemistry of living things. However, the German chemist Wohler succeeded in the synthesis of an organic compound (urea) from an inorganic compound (ammonium cyanate) in his laboratory. This has dealt a severe blow to the Vital Force Theory (a theory of life process).



FRIEDRICH WOHLER
A German Chemist

13.2. MODERN DEFINITION OF ORGANIC CHEMISTRY

Organic Chemistry is defined as the branch of chemistry that deals with organic compounds which are made up of hydrocarbons and their derivatives. It gives a thorough insight into the nature of bonding, synthesis, characteristics and their usefulness in various fields.

MORE TO KNOW



A polished diamond



The most precious diamond is a crystalline allotrope of carbon. KOHINOOR DIAMOND is a 105 carat diamond (21.68g). It was seized by the EAST INDIA COMPANY and became the part of British Crown Jewels. May it be an ordinary coal or the most precious Kohinoor diamond, it is an allotropic modification of carbon indeed!

13.3. BONDING IN CARBON AND ITS COMPOUNDS

The atomic number of carbon is 6 and its ground state electronic configuration is $1s^2\ 2s^2\ 2p^2$. Since it has four electrons in its outermost shell, **its valency is four**. To achieve noble gas configuration, carbon atom has to lose or gain four electrons to form C^{4+} and C^{4-} ions.

1. It could gain four electrons forming C^{4-} anions, but it would be difficult for the nucleus with six protons to hold on to ten electrons i.e. four extra electrons.
2. It could lose four electrons to form C^{4+} cations, but it would require a large amount of energy to remove four electrons leaving behind the carbon cations with six protons in its nucleus holding on to just two electrons.

Carbon overcomes this problem by sharing its valence electrons with other atoms of carbon or with atoms of other elements. *This characteristic of carbon atom by virtue of which it forms four covalent bonds is generally referred to as tetra valency of carbon.*

A molecule of methane (CH_4) is formed when four electrons of carbon are shared with four hydrogen atoms.

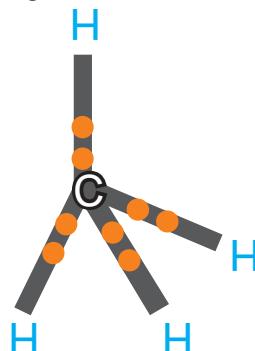


Fig. 13.5 Structure of Methane

●● Represents shared pair of electrons

13.4. ALLOTROPY

Allotropy is defined as the property by which an element can exist in more than one form that are physically different but chemically similar.

Allotropes of carbon

- Carbon exists in three allotropic forms. They are: crystalline form (diamond and graphite), amorphous form (coke, charcoal) and fullerene.

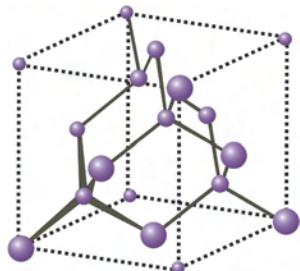


Fig. 13.6 Structure of diamond

- Diamond and graphite are crystalline allotropic forms. They differ in nature of the bond.
- In diamond, each carbon atom is bonded to four other carbon atoms in a tetrahedral fashion leading to a rigid three dimensional structure, accounting for its hardness and rigidity.
- In graphite, each carbon atom is bonded to three other carbon atoms in the same plane giving hexagonal layers held together by weak **Vander Waals forces** accounting for softness.

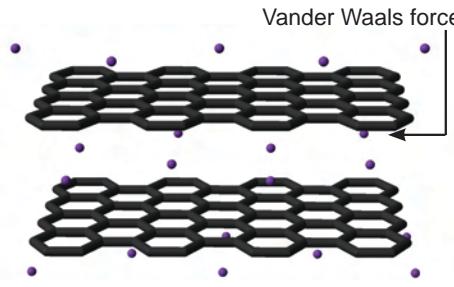


Fig. 13.7 Structure of Graphite

- Graphite is a good conductor of electricity unlike other non-metals since it has free electrons in it.
- Fullerenes form another type of carbon allotropes. The first one was identified to contain 60 carbon atoms in the shape of a football. (C-60). Since this looks like the geodesic dome designed by the US architect Buckminster Fuller, it is named as Buckminsterfullerene.

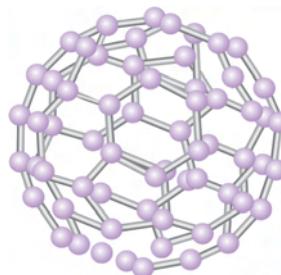


Fig. 13.8 Fullerene



Fig. 13.9 Football

13.5. PHYSICAL NATURE OF CARBON AND ITS COMPOUNDS :

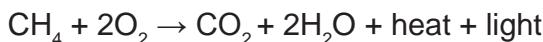
- Carbon has the ability to form covalent bonds with other atoms of carbon giving rise to a large number of molecules through self linking property. This property is called **catenation**. Since the valency of carbon is four, it is capable of bonding with four other atoms.
- Carbon combines with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements to form various stable compounds.
- The stability of carbon compounds is due to the small size of carbon which enables the nucleus to hold on to the shared pair of electrons strongly.

- Carbon compounds show **isomerism**, the phenomenon by which two or more compounds have same molecular formula but different structural formula with difference in properties. i.e. the formula C_2H_6O represents two different compounds namely ethyl alcohol (C_2H_5OH) and dimethyl ether (CH_3OCH_3).
- Carbon compounds have low melting and boiling points because of their covalent nature.
- The reactions shown by carbon compounds involve breaking of old bonds in the reacting molecules and the formation of new bonds in the product molecules.
- Carbon compounds are easily combustible.

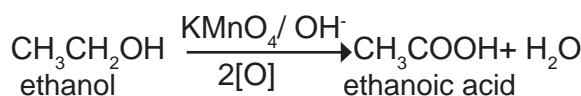
13.6. CHEMICAL PROPERTIES

- Carbon and its compounds burn in oxygen to give carbon dioxide along with heat and light.

e.g.

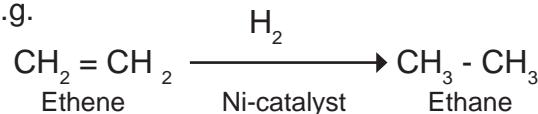


- Carbon compounds can be easily oxidized using suitable oxidizing agent like alkaline potassium permanganate to form carboxylic acids.



- Unsaturated carbon compounds undergo addition reactions with hydrogen in the presence of palladium or nickel catalyst.

e.g.



- Saturated carbon compounds undergo substitution reactions in the presence of sunlight. e.g., methane undergoes substitution reaction to form different types of products.
- Carbon compounds such as alcohols react with sodium to liberate hydrogen gas.



13.7. HOMOLOGOUS SERIES

A homologous series is a group or a class of organic compounds having same general molecular formula and similar chemical properties in which the successive members differ by a CH_2 group.

13.7.1. Characteristics of Homologous series

- Each member of the series differs from the preceding or succeeding member by a common difference of CH_2 and by a molecular mass of 14 amu (amu = atomic mass unit).
- All members of each homologous series contain same elements and same functional groups.
- All members of each homologous series have same general molecular formula.

e.g. **Alkane** = C_nH_{2n+2}

Alkene = C_nH_{2n}

Alkyne = C_nH_{2n-2}

- The members in each homologous series show a regular gradation in their physical properties with respect to increase in molecular mass.
- The chemical properties of the members of each homologous series are similar.
- All members of each homologous series can be prepared by using same general method.

to IUPAC system, these are named as **alkanes** (-ane is suffix with root word).

Formula	Common name	IUPAC name
CH_4	Methane	Methane
CH_3CH_3	Ethane	Ethane
$\text{CH}_3\text{CH}_2\text{CH}_3$	Propane	Propane
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	n-Butane	Butane

13.8. IMPORTANCE OF HOMOLOGOUS SERIES

- It helps to predict the properties of the members of the series that are yet to be prepared.
- Knowledge of homologous series gives a systematic study of the members.
- The nature of any member of the family can be ascertained if the properties of the first member are known.

13.9. HYDROCARBONS

The organic compounds containing only carbon and hydrogen are called **Hydrocarbons**. These are regarded as the **parent organic compounds** and all other compounds are considered to be derived from them by the replacement of one or more hydrogen atoms by other atoms or groups of atoms.

Hydrocarbons are classified into two types: *saturated* and *unsaturated hydrocarbons*.

13.9.1. Saturated Hydrocarbons – Alkanes

General formula = $\text{C}_n\text{H}_{2n+2}$ Suffix : -ane

These are the organic compounds which contain carbon–carbon single bond. These were earlier named as **paraffins** (Latin : meaning little affinity) due to their least chemical reactivity. According

13.9.2. Unsaturated Hydrocarbons

These are hydrocarbons which contain carbon to carbon double bonds ($-\text{C}=\text{C}-$) or carbon to carbon triple bonds $-\text{C}\equiv\text{C}-$ in their molecules. These are further classified into two types: **alkenes and alkynes**.

i) **Alkenes:** General formula: C_nH_{2n} Suffix: -ene

The hydrocarbons containing atleast one carbon to carbon double bond are called **alkenes**. They have the general formula C_nH_{2n} . These were previously called **olefins** (Greek : oleifiant – oil forming) because the lower gaseous members of the family form oily products when treated with chlorine.

In IUPAC system, the name of alkene is derived by replacing suffix -ane of the corresponding alkane by -ene. For example,

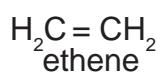
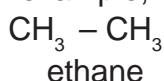


Fig. 13.10 Bromine Test

(Left) No change in colour - saturated
(Right) Decolouration occurs - unsaturated

In higher alkenes, the position of the double bond, can be indicated by assigning numbers 1, 2, 3, 4,to the carbon atoms present in the molecule.

Alkene	Common Name	IUPAC Name
$\text{CH}_2 = \text{CH}_2$	Ethylene	Ethene
$\text{CH}_3\text{CH} = \text{CH}_2$	Propylene	Propene
$\text{CH}_3\text{CH}_2-\text{CH}=\text{CH}_2$	α -Butylene	But-1-ene
$\text{CH}_3\text{CH} = \text{CHCH}_3$	β -Butylene	But-2-ene

ii) Alkynes: General formula: $\text{C}_n\text{H}_{2n-2}$
Suffix : -yne

The hydrocarbons containing carbon to carbon triple bond are called **alkynes**. Alkynes are named in the same way as alkenes i.e., by replacing suffix **-ane** of alkane with **-yne**. In higher members, the position of triple bond is indicated by giving numbers 1, 2, 3, 4,to the carbon atom in the molecule.

Alkyne	Common Name	IUPAC Name
$\text{HC} \equiv \text{CH}$	Acetylene	Ethyne
$\text{H}_3\text{C}-\text{C} \equiv \text{CH}$	Methyl acetylene	Propyne
$\text{H}_3\text{C}-\text{C} \equiv \text{C}-\text{CH}_3$	Dimethyl acetylene	2-Butyne
$\text{H}_3\text{C}-\text{CH}_2-\text{C} \equiv \text{CH}$	Ethyl acetylene	1-Butyne

13.10. FUNCTIONAL GROUP

Functional group may be defined as an atom or group of atoms or reactive part which is responsible for the characteristic properties of the compounds. The chemical properties of organic compounds are determined by the functional groups while their physical properties are determined by the remaining part of the molecule.

Example: -OH => Alcohol

- CHO => Aldehyde
- >C=O => Ketone
- COOH => Carboxylic acid

13.10.1. Classification of organic compounds based on functional group

1. Alcohols

Alcohols are carbon compounds containing **-OH** group attached to alkyl group. The general formula of alcohol is **R-OH** where '**R**' is an **alkyl group** and **-OH** is the **functional group**. The IUPAC name of alcohol is derived by replacing **-e**, in the word **alkane**, with the suffix **-ol**. Hence we get the name **alkanol**.

Molecular Formula	Common Name	IUPAC Name
CH_3OH	Methyl alcohol	Methanol
$\text{CH}_3\text{-CH}_2\text{-OH}$	Ethyl alcohol	Ethanol
$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH}$	n-Propyl alcohol	1-Propanol
$\text{CH}_3\text{-CH}(\text{CH}_3)\text{-OH}$	Isopropyl alcohol(or) secondary propyl alcohol	2-Propanol
$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-OH}$	n-Butyl alcohol	1-Butanol
$\text{CH}_3\text{-CH}(\text{CH}_3)\text{-CH}_2\text{-OH}$	Isobutyl alcohol	2-Methyl-1-propanol

2. Aldehydes

Aldehydes are carbon compounds containing **-CHO** group attached to alkyl group or hydrogen atom. The general formula of aldehydes is **R - CHO** where '**R**' is an **alkyl group or hydrogen atom** and **-CHO** is the **functional group**. The IUPAC name of aldehyde is derived by replacing **-e**, in the word alkane, with the suffix **-al**. Hence we get the name "**alkanal**".

Molecular Formula	Common Name	IUPAC Name
HCHO	Formaldehyde	Methanal
$\text{CH}_3\text{-CHO}$	Acetaldehyde	Ethanal
$\text{CH}_3\text{-CH}_2\text{-CHO}$	Propionaldehyde	Propanal
$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CHO}$	n-Butyraldehyde	Butanal

3. Ketones

Ketones are carbon compounds containing carbonyl – **CO** – group attached to two alkyl groups. The general formula of ketone is **R-CO-R'** where **R** and **R'** are **alkyl groups** and – **CO** – is the **functional group**. The IUPAC name of ketone is derived by replacing –**e**, in the word alkane, with the suffix **-one**. Hence we get the name “**alkanone**”.

Molecular Formula	Common Name	IUPAC Name
CH_3COCH_3	Dimethyl ketone (Acetone)	Propanone
$\text{CH}_3\text{COCH}_2\text{CH}_3$	Ethyl methyl ketone	Butanone
$\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$	Diethyl ketone	3-Pentanone

4. Carboxylic Acids

Carboxylic acids are carbon compounds containing **-COOH** group attached to a hydrogen atom or an alkyl group. The general formula of acid is **R-COOH** where ‘**R**’ is a **hydrogen atom** or an **alkyl group** and **-COOH** is the **functional group**. The IUPAC name of acid is derived by replacing – e, in the word alkane, with the suffix –oic acid. Hence we get the name “**alkanoic acid**”.

Molecular Formula	Common Name	IUPAC Name
HCOOH	Formic acid	Methanoic acid
$\text{CH}_3\text{-COOH}$	Acetic acid	Ethanoic acid
$\text{CH}_3\text{-CH}_2\text{-COOH}$	Propionic acid	Propanoic acid
$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-COOH}$	n-Butyric acid	Butanoic acid

Some important Organic Compounds

Almost all the compounds are useful to us in a number of ways. Most of the fuels, medicines, paints, explosives, synthetic polymers, perfumes and detergents are basically organic compounds. In fact, organic chemistry has made our life colourful and also comfortable. Two commercially important compounds, ethanol and ethanoic acid are briefly discussed here.

13.11 ETHANOL ($\text{C}_2\text{H}_5\text{OH}$)

Ethanol or ethyl alcohol or simply alcohol is one of the most important members of the family of alcohols.

(1) Manufacture of Ethanol from Molasses

Molasses is a dark coloured syrupy liquid left after the crystallization of sugar from the concentrated sugarcane juice. Molasses still contain about 30% of sucrose which cannot be separated by crystallization. It is converted into ethanol by the following steps:

(i) Dilution

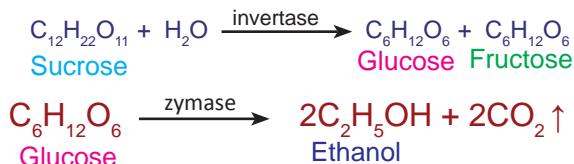
Molasses is first diluted with water to bring down the concentration of sugar to about 8 to 10 percent.

(ii) Addition of Ammonium Salts

Molasses usually contains enough nitrogenous matter to act as food for yeast during fermentation. If the nitrogen content of the molasses is poor, it may be fortified by the addition of **ammonium sulphate or ammonium phosphate**.

(iii) Addition of Yeast

The solution from step (ii) is collected in large 'fermentation tanks' and yeast is added to it. The mixture is kept at about 303K for a few days. During this period, the enzymes invertase and zymase present in yeast, bring about the conversion of sucrose into ethanol.



The fermented liquid is technically called wash.

(iv) Distillation of Wash

The fermented liquid containing 15 to 18 percent alcohol and the rest of the water, is now subjected to fractional distillation. The main fraction drawn, is an aqueous solution of ethanol which contains 95.5% of ethanol and 4.5% of water. This is called **rectified spirit**. This mixture is then heated under reflux over quicklime for about 5 to 6 hours and then allowed to stand for 12 hours. On distillation of this mixture, pure alcohol (100%) is obtained. This is called absolute alcohol.

2. Physical Properties

(i) Ethanol is a clear liquid with a burning taste.

MORE TO KNOW**FERMENTATION :**

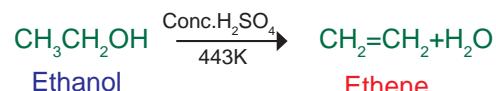
The slow chemical change that takes place in complex organic compounds by the action of enzymes leading to the formation of simple molecules is called fermentation.

(ii) Its boiling point is 351.5 K which is higher than the corresponding alkane.

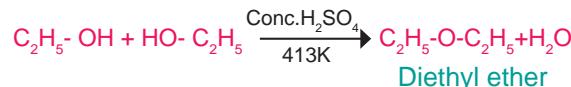
(iii) It is completely miscible with water in all proportions.

3. Chemical Properties**(i) Dehydration**

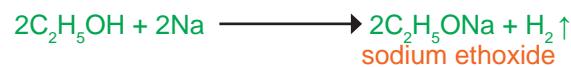
(a) Intra molecular dehydration : Ethanol, when heated with excess conc. H_2SO_4 at 443K undergoes intra molecular dehydration (i.e. removal of water within a molecule of ethanol) to give ethene.



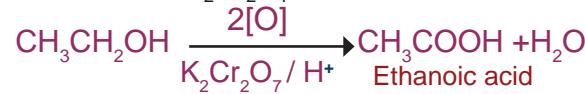
(b) Inter molecular dehydration : When excess of ethanol is heated with conc. H_2SO_4 at 413K, it undergoes inter molecular dehydration. (i.e. removal of water from two molecules of ethanol) to give diethyl ether.



(ii) Reaction with sodium : Ethanol reacts with sodium metal to form sodium ethoxide and hydrogen gas.

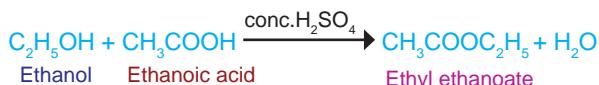


(iii) Oxidation : Ethanol is oxidized to ethanoic acid with alkaline KMnO_4 or acidified $\text{K}_2\text{Cr}_2\text{O}_7$

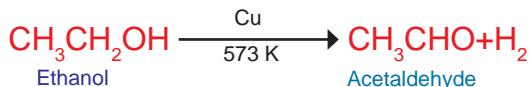


During this reaction, the orange colour of $\text{K}_2\text{Cr}_2\text{O}_7$ changes to green. Therefore, this reaction can be used for the identification of alcohols.

(iv) Esterification : Ethanol reacts with ethanoic acid in the presence of conc. H_2SO_4 to form ethyl ethanoate and water. The compound formed by the reaction of an alcohol with carboxylic acid is known as ester (a fruity smelling compound) and the reaction is called esterification.



(v). Dehydrogenation : When the vapour of ethanol is passed over heated copper catalyst at 573 K, it is dehydrogenated to acetaldehyde.



4. Uses

Ethanol is used

- as an anti-freeze in automobile radiators.
- as a preservative for biological specimen.
- as an antiseptic to sterilize wounds, in hospitals.
- as a solvent for drugs, oils, fats, perfumes, dyes, etc.
- in the preparation of methylated spirit (mixture of 95% of ethanol and 5% of methanol), rectified spirit (mixture of 95.5% of ethanol and 4.5% of water), power alcohol (mixture of petrol and ethanol) and denatured spirit (ethanol mixed with pyridine).
- in cough and digestive syrups.

Evil effects of consuming alcohol

- If ethanol is consumed, it tends to slow down the metabolism of our body and depresses the central nervous system.

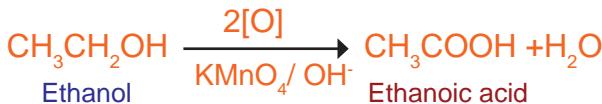
- It causes mental depression and emotional disorder.
- It affects our health by causing ulcer, high blood pressure, cancer, brain and liver damage.
- Nearly 40% accidents occur due to drunken driving.
- Unlike ethanol, intake of methanol in very small quantities can cause death.
- Methanol is oxidized to methanal (formaldehyde) in the liver and methanal reacts rapidly with the components of cells.
- Methanal causes the protoplasm to get coagulated, in the same way an egg coagulates while cooking. Methanol also affects the optic nerve, causing blindness.

13.12. ETHANOIC ACID (CH_3COOH)

Ethanoic acid is most commonly known as acetic acid and belongs to a group of acids called carboxylic acids. Acetic acid is present in many fruits and it renders a sour taste to those fruits.

1. Preparation of Ethanoic acid

Ethanol on oxidation in the presence of alkaline potassium permanganate or acidified potassium dichromate gives ethanoic acid.



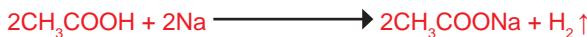
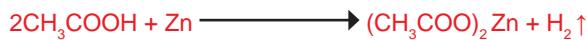
2. Physical Properties

- Ethanoic acid is a colourless liquid and has a sour taste.
- It is miscible with water in all proportions.

- (iii) Boiling point (391 K) is higher than the corresponding alcohols, aldehydes and ketones.
- (iv) On cooling, pure ethanoic acid is frozen to form ice like flakes. They look like glaciers, so it is called **glacial acetic acid**.

3. Chemical Properties

- (i) Ethanoic acid is a weak acid but it turns blue litmus to red.
- (ii) Reaction with metal: Ethanoic acid reacts with metals like Na, K, Zn, etc. to form metal ethanoate and hydrogen gas.



- (iii) Reaction with carbonates and bicarbonates.



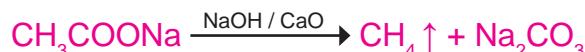
Ethanoic acid reacts with carbonates and bicarbonates and produces brisk

effervescence due to the evolution of carbon dioxide.

- (iv) Reaction with base: Ethanoic acid reacts with sodium hydroxide to form sodium ethanoate and water.



- (v) Decarboxylation (Removal of CO₂) : When sodium salt of ethanoic acid is heated with soda lime (solid mixture of 3 parts of NaOH and 1 part of CaO) methane gas is formed.



4. USES

Ethanoic acid is used

1. For making vinegar which is used as a preservative in food and fruit juices.
2. As a laboratory reagent.
3. For coagulating rubber from latex.
4. In the preparation of dyes, perfumes and medicines.

MODEL EVALUATION

PART - A

1. **Assertion:** Chemical bonds in organic compounds are covalent in nature.
Reason: Covalent bond is formed by the sharing of electrons in the bonding atoms.
Does the reason satisfy the given assertion?
2. **Assertion:** Diamond is the hardest crystalline form of carbon.
Reason: Carbon atoms in diamond are tetrahedral in nature (Verify the suitability of reason to the given Assertion mentioned above)
3. **Assertion:** Due to catenation a large number of carbon compounds are formed.
Reason: Carbon compounds show the property of allotropy.

Does the reason hold good for the given Assertion?

4. Buckminster fullerene is the allotropic form of _____. (Nitrogen / Carbon / Sulphur)
 5. Even though it is a non-metal, graphite conducts electricity. It is due to the presence of _____. (free electrons / bonded electrons)
 6. The formula of methane is CH_4 and its succeeding member ethane is expressed as C_2H_6 . The common difference of succession between them is _____. (CH_2 / C_2H_2)
 7. IUPAC name of the first member of alkyne is _____. (ethene / ethyne)
 8. Out of ketonic and aldehydic group, which is the terminal functional group?
 9. Acetic acid is heated with Na_2CO_3 in a test tube. A colourless and odourless gas (X) is evolved. The gas turns lime water milky. Identify X.
 10. **Assertion:** Denaturation of ethyl alcohol makes it unfit for drinking purpose.
Reason: Denaturation of ethyl alcohol is carried out by pyridine.
 Check whether the reason is correct for assertion.
- PART - B**
1. Write down the possible isomers and give their IUPAC names using the formula C_4H_{10} .
 2. Diamond is the hardest allotrope of Carbon. Give reason for its hardness.
 3. An organic compound (A) is widely used as a preservative in pickle and has a molecular formula $\text{C}_2\text{H}_4\text{O}_2$. This compound reacts with ethanol to form a sweet smelling compound (B).
 (i) Identify the compounds A and B.
 (ii) Name the process and write the corresponding chemical equation.
 4. An organic compound (A) of molecular formula $\text{C}_2\text{H}_6\text{O}$ on oxidation with alkaline KMnO_4 solution gives an acid (B) with the same number of carbon atoms. Compound A is used as an antiseptic to sterilize wounds, in hospitals. Identify A and B. Write the chemical equation involved in the formation of B from A.
 5. $\text{C}_2\text{H}_6\text{O}$ is the molecular formula for two compounds A and B. They have different structural formulae.
 i) What is this phenomenon known as?
 ii) Give the structural formula of A and B.
 iii) Write down their common and IUPAC names.
 iv) Mention the functional groups of A and B.
 6. Rewrite the following choosing the correct word from each pair given in brackets:
 The hydrocarbons containing at least one carbon to carbon _____ (double/triple) bond are called _____ (alkenes/alkynes). They have the general formula

C_nH_{2n} . These were previously called _____ (olefins/paraffins). When this compound is treated with _____ (bromine/lime) water, decolourisation occurs because it is _____ (saturated/unsaturated).

7. Identify the compounds using the clues given below:

- This is a dark coloured syrupy liquid containing 30% of sucrose.
- During manufacture of ethanol this is added as food for yeast.
- This enzyme converts sucrose into glucose and fructose.
- This compound contains 95.5% ethanol and 4.5% water.
- This compound contains 100% pure alcohol.

8. Read each description given below and say whether it fits for ethanol or ethanoic acid.

- It is a clear liquid with a burning taste.
- It is used to preserve biological specimens in laboratories.
- It is used to preserve food and fruit juices.
- On cooling, it is frozen to form ice flakes which look like a glacier.

9. Match these words /sentences with appropriate statements given below:

(methanol, fermentation, catenation, homologous series, hydrogen gas)

- The ability of carbon to form large number of compounds through self linking property.
- Alcohols react with sodium to give this element.
- This series helps in giving knowledge and enables systematic study of members.
- Formation of simple molecules from complex organic compounds using enzymes.
- Unlike ethanol, the intake of this compound in very small quantities can cause death.

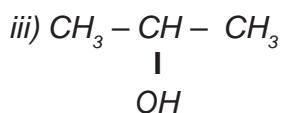
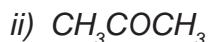
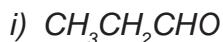
PART - C

1. Fill the blanks in the given table using suitable formulae.

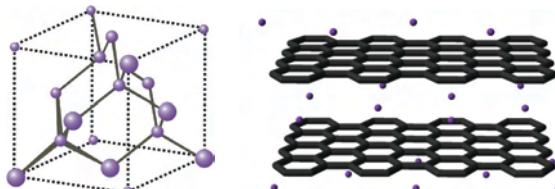
No.	Alkane	Alkene	Alkyne
1.	C_2H_6 ethane	_____ ethene	C_2H_2 ethyne
2.	_____ Propane	C_3H_6 Propene	_____ propyne
3.	C_4H_{10} Butane	_____ Butene	_____ Butyne

2. Homologous series predict the properties of the members of the series. Justify this statement through its characteristics.

3. Write the common name and IUPAC name of the following:



4.



Look at the diagram and answer the following questions:

- i) What type of structure do diamond and graphite have?
- ii) Why are diamonds used in cutting tools?
- iii) Why is graphite used in electrical circuits?
- iv) Name the force that accounts for the softness of graphite.
- v) Name the precious diamond you know and give its weight in grams.

5. C_nH_{2n+2} is the general formula of a homologous series of hydrocarbons.

- i) Is this series saturated or unsaturated?
- ii) Name the series described above. Give the formula and name of the member with two carbon atoms.
- iii) Draw the structural formula of the first member of this series.
- iv) Define the homologous series and find the common difference between the successive members of this family.
- v) Write the formula of n-butane and n-pentane.

6. Ethanol is heated with excess concentrated H_2SO_4 at 443K.

- i) Name the reaction that occurs and explain it.
- ii) Write the equation for the above reaction.
- iii) What is the product formed? What happens when this gas is passed through bromine water?
- iv) When ethanol vapour is passed through bromine water, why does no change occur?

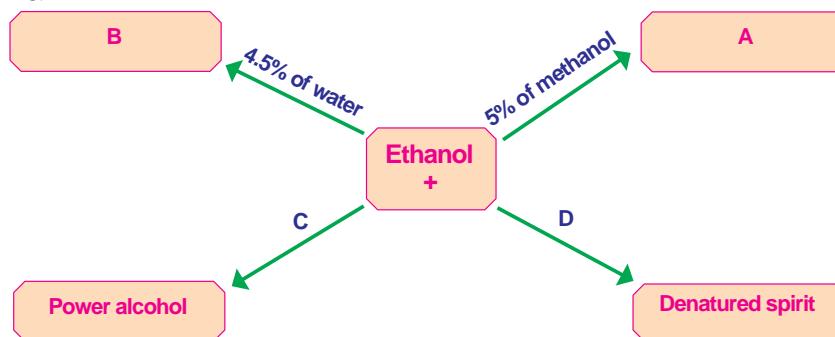
7. Complete the following table:

Molecular Formula	Common Name	IUPAC Name
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$		
	<i>Dimethyl ketone</i>	
		<i>Propanal</i>
HCOOH		
		<i>Butanone</i>

8. Ethanoic acid is a member of Homologous series with general formula $\text{C}_n\text{H}_{2n+1}\text{COOH}$.

- Name the series and give its functional group.
- Give the molecular formula and the common name of ethanoic acid.
- If this compound is mixed with ethanol in the presence of Conc. H_2SO_4 , a sweet smelling compound is formed. Give the equation and name the compound.
- Ethanoic acid reacts with carbonates. Which gas is liberated during this reaction?
- Write the balanced equation for the reaction of ethanoic acid with carbonate.
- Your grandmother has prepared mango pickle. What has she added to preserve it for a long time?

9. i) Identify A & B.



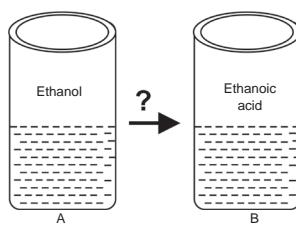
- Convert ethanol into power alcohol. Mention one of its uses.
- What should be added to obtain denatured spirit?
- Give one use of denatured spirit.

10. Write a balanced equation using the correct symbols for these chemical reactions:

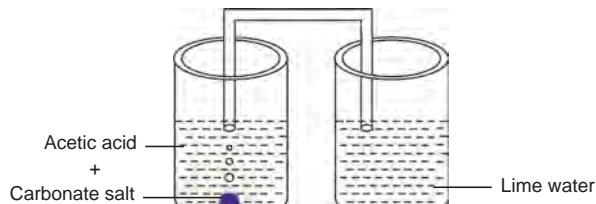
- Action of hydrogen on ethene in the presence of nickel catalyst.
- Combustion of methane evolving carbondioxide and water.
- Dehydrogenation of ethanol.
- Decarboxylation of Sodium salt of ethanoic acid.

11. Look at the picture and identify what happens. Support your answer with equations .

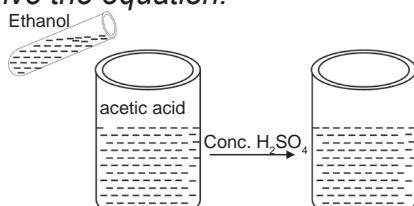
i) How is B formed from A ?



ii) What happens when acetic acid is treated with carbonate salt. Name the gas produced. What happens when this gas is treated with lime water?



iii) What happens when acetic acid is treated with ethanol in the presence of concentrated H_2SO_4 ? Give the equation.



12. Organic compounds 'A' and 'B' are the isomers with the molecular formula C_2H_6O . Compound 'A' produces hydrogen gas with sodium metal, whereas compound 'B' does not. Compound 'A' reacts with acetic acid in the presence of concentrated H_2SO_4 to form compound 'C' with a fruity flavour. What are the isomers 'A', 'B' and the compound 'C'?

13. Organic compound 'A' of molecular formula C_2H_6O liberates hydrogen gas with sodium metal. 'A' gives 'B' of formula $C_4H_{10}O$, when it reacts with concentrated H_2SO_4 at 413K. At 443K with concentrated H_2SO_4 'A' gives compound 'C' of formula C_2H_4 . This compound 'C' decolourises bromine water. What are 'A', 'B' and 'C'?

14. Organic compound 'A' of molecular formula $C_2H_4O_2$ gives brisk effervescence with sodium bicarbonate solution. Sodium salt of A on treatment with soda lime gives a hydrocarbon 'B' of molecular mass 16. It belongs to the first member of the alkane family. What are 'A' and 'B' and how will you prepare 'A' from ethanol?

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 2. Organic chemistry - **R.T. Morrison & R.N. Boyd** - Prentice Hall Publishers, New Delhi.

3. Complete Chemistry(IGCSE) - **Oxford University press, New York**

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MEASURING INSTRUMENTS

Physics is the most basic science, which deals with the study of nature and natural phenomena. It is a science of measurement. The ultimate test of any physical quantity is its agreement with observations and measurement of physical phenomena. One of the major contributions of physics to other sciences and society are the various measuring instruments and techniques that physics has developed. One such instrument is the screw gauge.

14.1. SCREW GAUGE

The Screw Gauge is an instrument to measure the dimensions of very small objects upto 0.01 mm.

The Screw Gauge consists of a 'U' shaped metal frame (Fig. 14.1.).

A hollow cylinder is attached to one end of the frame.

Grooves are cut on the inner surface of

the cylinder through which a screw passes.

On the cylinder parallel to the axis of the screw a scale is graduated in millimeter called Pitch Scale.

One end of the screw is attached to a sleeve. The head of the sleeve is divided into 100 divisions called the Head Scale.

The other end of the screw has a plane surface (S_1). A stud (S_2) is attached to the other end of the frame, just opposite the tip of the screw.

The screw head is provided with a Ratchet arrangement (safety device) to prevent the user from exerting undue pressure.

Principle of the Screw Gauge

The screw gauge works under the principle of the screw. When a screw is rotated in a nut, the distance moved by the tip of the screw is directly proportional to the number of rotations.

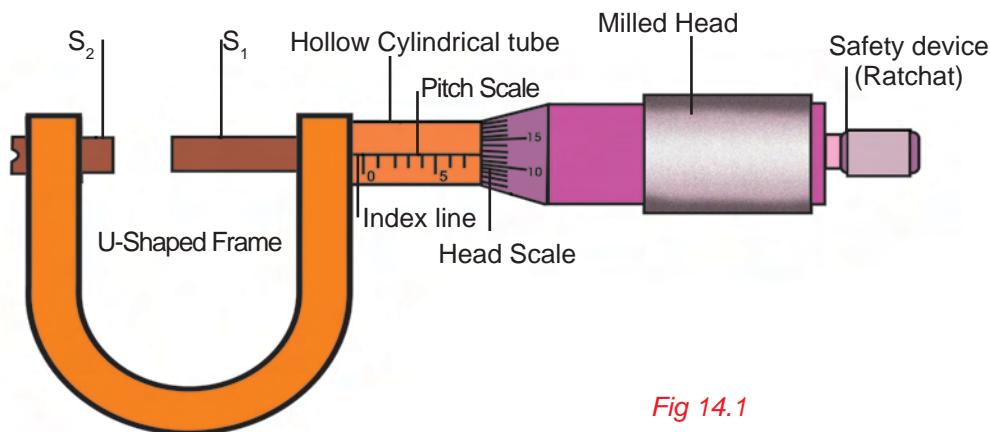


Fig 14.1

Pitch of the Screw

The pitch of the screw is the distance between two successive screw threads. It is also equal to the distance travelled by the tip of the screw for one complete rotation of the head.

$$\text{Pitch} = \frac{\text{Distance travelled on the pitch scale}}{\text{No.of rotations of the head scale}}$$

Least Count of a Screw Gauge

The distance moved by the tip of the screw for a rotation of one division on the head scale is called the least count of the Screw Gauge.

$$\text{L.C.} = \frac{\text{Pitch}}{\text{No.of divisions on the head scale}}$$

Zero Error of a Screw Gauge

When the plane surface of the screw and the opposite plane stud on the frame are brought into contact, if the zero of the head scale coincides with the pitch scale axis, there is no zero error (Fig. 14.2).

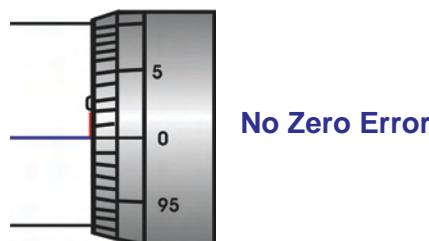


Fig. 14.2

Positive Zero Error

When the plane surface of the screw and the opposite plane stud on the frame are brought into contact, if the zero of the head scale lies below the pitch scale axis, the zero error is positive.

For example the 5th division of the head scale coincides with the pitch scale axis. then the zero error is positive.(Fig.14.3) and is given by,

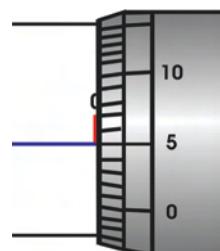


Fig. 14.3

$$\text{Z.E.} = + (n \times \text{L.C.}),$$

$$= + (5 \times \text{L.C.}),$$

and the Zero Correction

$$\text{Z.C.} = - (5 \times \text{L.C.})$$

Negative Zero Error

When the plane surface of the screw and the opposite plane stud on the frame are brought into contact, if the Zero of the head scale lies above the pitch scale axis, the zero error is negative.

For example the 5th division coincides with the pitch scale axis, then the zero error is negative (Fig. 14.4). and is given by,

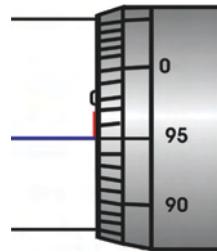


Fig 14.4

$$\text{Z.E.} = - (100 - 5) \times \text{L.C.},$$

and the Zero Correction

$$\text{Z.C.} = + (100 - 5) \times \text{L.C}$$

To measure the diameter of a thin wire using Screw Gauge

- Determine the Pitch, the Least Count and the Zero Error of the Screw Gauge.
- Place the wire between the two studs.
- Rotate the head until the wire is held firmly but not tightly, with the help of ratchet.
- Note the reading on the pitch scale crossed by the head scale (PSR) and the head scale division that coincides with the pitch scale axis (H.S.C.).
- The diameter of the wire is given by $P.S.R + (H.S.C \times L.C) \pm Z.C$
- Repeat the experiment for different portions of the wire.
- Tabulate the readings.
- The average of the last column reading gives the diameter of the wire.

S. No.	P.S.R (mm)	H.S.C (division)	H.S.C \times L.C (mm)	Total Reading P.S.R + (H.S.C \times L.C) \pm Z.C (mm)
1				
2				
3				

We now have digital Screw Gauge which give the reading immediately.

14.2 Measuring Long Distances

For measuring long distances such as distance of the moon or a planet from the earth, special methods are adopted. Radio echo method, laser pulse method and parallax method are used to determine very long distances. Units such as astronomical unit and light year are used to measure distance in space.

Astronomical Unit

Astronomical Unit is the mean distance of the centre of the sun from the centre of the earth.

$$1 \text{ Astronomical Unit (AU)} = 1.496 \times 10^{11} \text{ m}$$

Light year

Light year is the distance travelled by light in one year in vacuum.

Distance travelled by light in one year in vacuum = Velocity of light \times 1 year (in seconds)

$$= 3 \times 10^8 \times 365.25 \times 24 \times 60 \times 60$$

$$= 9.467 \times 10^{15} \text{ m}$$

$$\text{Therefore , } 1 \text{ light year} = 9.467 \times 10^{15} \text{ m}$$

MODEL EVALUATION

PART - A

- Screw Gauge is an instrument used to measure the dimensions of very small objects upto _____ ($0.1 \text{ cm}, 0.01 \text{ cm}, 0.1 \text{ mm}, 0.01 \text{ mm}$)
- In a Screw Gauge, if the zero of the head scale lies below the pitch scale axis, the zero error is _____ .(positive, negative, nil)
- The Screw Gauge is used to measure the diameter of a _____. (crowbar, thin wire, cricket ball)

4. One light year is equal to _____ .

- i) $365.25 \times 24 \times 60 \times 60 \times 3 \times 10^8 \text{ m}$
- ii) $1 \times 24 \times 60 \times 60 \times 3 \times 10^8 \text{ m}$
- iii) $360 \times 24 \times 60 \times 60 \times 3 \times 10^8 \text{ m}$

5. One astronomical unit is the mean distance between the centre of the Earth and centre of the _____ i) Moon ii) Sun iii) Mars

PART - B

1. Correct the mistakes if any, in the following statements:

- i) Astronomical unit is the mean distance of the surface of the sun from the surface of the earth.
- ii) Light year is the distance travelled by light in one year in vacuum at a speed of $3 \times 10^8 \text{ m per minute}$.

2. Match the items in group A with the items in group B:

Sl.No.	Group – A	Group – B
1.	Small dimensions	Kilometre
2.	Large dimensions	Screw gauge
3.	Long distance	Scale
4.	Small distance	Light year
		Altimeter

3. Fill in the blanks:

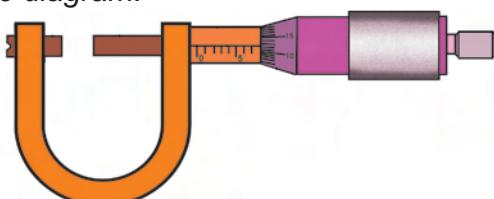
The special methods adopted to determine very large distances are _____ and _____.

(Laser pulse method, Light year method, Radio echo method, Astronomical method)

4. Least count of a screw gauge is an important concept related to screw gauge. What do you mean by the term least count of a screw gauge?

5. Label the following parts in the given screw gauge diagram.

- i) Head scale
- ii) Pitch scale
- iii) Index line
- iv) Ratchet



FURTHER REFERENCE

- Books:**
- 1. Complete physics(IGCSE) - Oxford University press, New York
 - 2. Practical physics – Jerry. D. Wilson – Saunders college publishing, USA

Webliography: www.tutorvista.com science.howstuffworks.com



LAWS OF MOTION AND GRAVITATION

In our day-to-day life, we observe that some effort is required to put a stationary object into motion or to bring a moving object to a stop. Normally, we have to push or pull or hit an object to change its state.

The concept of force is based on this push, pull or hit. No one has seen, tasted, or felt force. However, we always see or feel the effect of a force. It can only be explained by describing what happens, when a force is applied to an object. Push, pull or hit may bring objects into motion, because we apply force to act on them. Therefore, **force is one which changes or tends to change the state of rest or of uniform motion of a body**. Force is a vector quantity. Its SI unit is **newton**.

15.1. BALANCED AND UNBALANCED FORCES

Fig.15.1 shows a wooden block on a horizontal table. Two strings X and Y are tied to the two opposite faces of the block as shown.

If we apply a force by pulling the string 'X', the block begins to move to the right.

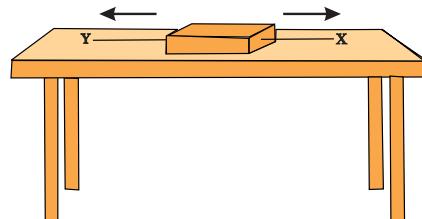


Fig. 15.1

Similarly, if we pull the string Y, the block moves to the left. If the block is pulled from both the sides with equal force, the block does not move and remains stationary. Forces acting on an object which do not change the state of rest or of uniform motion of it are called **balanced forces**.

Now let us consider a situation in which two opposite forces of different magnitudes act on the block. The block moves in the direction of the greater force. The resultant of two opposite forces acts on an object and brings it to motion. These opposite forces are called **unbalanced forces**.

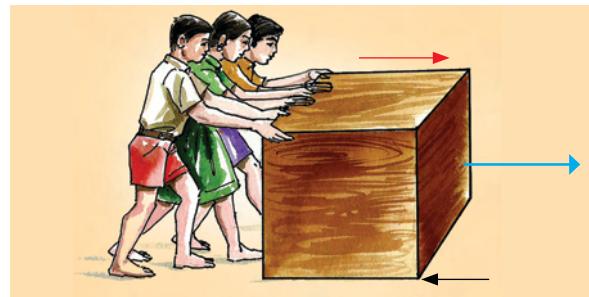
The following illustration clearly explains the concept of balanced and unbalanced forces. Some children try to push a box on a rough floor.



(a)



(b)



(c)

Fig. 15.2

If one child pushes the box with a smaller force, the box does not move because of friction acting in a direction opposite to the push [Fig. 15.2(a)]. This frictional force arises between two surfaces in contact. In this case, the frictional force between the bottom of the box and the floor balances the pushing force and therefore, the box does not move. In Figure 15.2(b) two children push the box harder but the box still does not move. This is because the frictional force still balances the pushing force. If the children push the box still harder, the pushing force becomes greater than the

frictional force [Fig. 15.2. (c)]. When an unbalanced force is applied, the box starts moving in the direction of the resultant force.

15.2. FIRST LAW OF MOTION

Galileo observed the motion of objects on an inclined plane. He deduced that objects move with a constant speed when no force acts on them.



Name	:	Galileo
Born	:	15 th February 1564
Birth place	:	Grand Duchy of Tuscany, Italy
Died	:	8 th January 1642
Best known for	:	Astronomy, Physics and Mathematics

Newton studied Galileo's ideas on force and motion and presented three fundamental laws that govern the motion of objects. These three laws are known as Newton's Laws of Motion.

The first law of motion is stated as: **An object remains in the state of rest or of uniform motion in a straight line unless compelled to change that state by an applied unbalanced force.** In other words, all objects resist a change in their state of motion. The tendency of objects to stay at rest or to keep moving with the same velocity, unless it is acted by an external force is called inertia. Hence the first law of motion is also known as the law of inertia.

Certain experiences that we come across while travelling in a motor car can be explained on the basis of the law of inertia. We tend to remain at rest with respect to the seat, until the driver applies brake to stop the motor car. With the application of brake, the car slows down but our body tends to continue in the same state of motion because of inertia. A sudden application of brake may cause injury to us by collision with the panels in front.

An opposite experience is encountered when we travel standing in a bus which begins to move suddenly. Now we tend to fall backwards. This is because a sudden start of the bus brings motion to the bus as well as to our feet in contact with the floor of the bus. But the rest of our body opposes this motion because of its inertia.

When a motor car makes a sharp turn at a high speed, we tend to get thrown to one side. This can again be explained on the basis of the law of inertia. We tend to continue in our straight line motion. When an unbalanced force is applied by the engine to change the direction of motion of the motor car, we move to one side of the seat due to the inertia of our body.

Inertia of a body can be illustrated through the following activity.

ACTIVITY 15.1

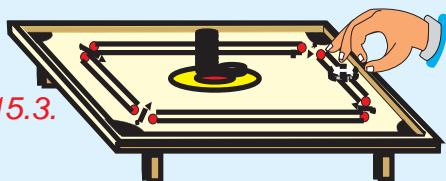


Fig. 15.3.

Make a pile of similar carrom coins on a table as shown in Fig. 15.3. Attempt a sharp horizontal hit at the bottom of the pile using another carrom coin or the striker. If the hit is strong enough, the bottom coin moves out quickly. Once the lowest coin is removed, the inertia of the other coins makes them fall vertically on the table without disturbing the pile.

15.3. INERTIA AND MASS

All the examples and activities given so far, illustrate that there is a resistance

offered by an object to change its state of motion. If it is at rest, it tends to remain at rest. If it is moving, it tends to keep moving. This property of an object is called inertia. Therefore, the **inability of a body to change its state of rest or of uniform motion by itself is called inertia.**

Inertia of a body depends mainly upon its mass. If we kick a football, it flies away. But if we kick a stone of the same size with equal force, it hardly moves. Instead we may injure our foot. A force, that is just enough to cause a small carriage to pick up a large velocity, will produce a negligible change in the motion of a train. We say that the train has more inertia than the carriage. Clearly, **more massive objects offer larger inertia.** The inertia of an object is measured by its mass.

15.4. MOMENTUM

Let us recall some observations from our day-to-day life. During the game of table tennis, if a ball hits a player, it does not hurt him. On the other hand, when a fast moving cricket ball hits a spectator, it may hurt him. A truck at rest does not require any attention when parked along a roadside. But a moving truck, even at a very low speed, may kill a person standing in its path. A small mass such as a bullet may kill a person when fired from a gun. These observations suggest that the impact produced by an object depends on its mass and velocity. In other words, there appears to exist some quantity that combines the objects' mass and velocity to produce an impact. Such a quantity of motion was called momentum by Isaac Newton. **The momentum 'p' of an object is defined as the product of its mass 'm' and velocity 'v'.**

$$p = mv$$

Momentum has both direction and magnitude. It is a vector quantity. Its direction is same as that of the velocity. The SI unit of momentum is kg ms^{-1} .

15.5. SECOND LAW OF MOTION

Let us consider a situation in which a car with a dead battery is to be pushed along a straight road to give it a speed of 1 m s^{-1} which is sufficient to start its engine. If one or two persons give a sudden push (unbalanced force) to it, it hardly starts. But a continuous push over a distance results in a gradual acceleration of the car to the required speed. It means that the change of momentum of the car is not only determined by the magnitude of the force, but also by the time during which the force is exerted. It may also be concluded that the force necessary to change the momentum of the object depends on the rate at which the momentum is changed.

The second law of motion states that the **rate of change of momentum of an object is directly proportional to the applied unbalanced force in the direction of force**. Suppose an object of mass 'm' is moving along a straight line with an initial velocity 'u', it is uniformly accelerated to velocity 'v' in time 't' by the application of constant force 'F', throughout the time 't'.

Initial momentum of the object = mu

Final momentum of the object = mv

$$\begin{aligned}\text{The change in momentum} &= mv - mu \\ &= m(v - u) \dots\dots (1)\end{aligned}$$

$$\begin{aligned}\text{Rate of change of momentum} &= \frac{\text{Change of momentum}}{\text{time}} \\ &= \frac{m(v-u)}{t} \dots\dots (2)\end{aligned}$$

According to Newton's second law of motion, this is nothing but applied force.

$$\text{Therefore the applied force, } F \propto \frac{m(v-u)}{t}$$

$$\text{But the acceleration, } a = \frac{v-u}{t}$$

(which is the rate of change of velocity).

The applied force, $F \propto ma$

$$F = k ma \dots\dots (3)$$

'k' is known as the constant of proportionality. The SI unit of mass and acceleration are kg and ms^{-2} respectively. The unit of force is so chosen that the value of the constant 'k' is equal to 1.

$$F = ma \dots\dots (4)$$

1 unit of force = $(1 \text{ kg}) \times (1 \text{ ms}^{-2}) = 1 \text{ newton}$

The unit of force is kg ms^{-2} or newton which has the symbol '**N**'.

One unit of force(1N) is defined as the amount of force that produces an acceleration of 1 ms^{-2} in an object of 1 kg mass.

The second law of motion gives us a method to measure the force acting on an object as a product of its mass and acceleration.

Example:15.1

A constant force acts on an object of mass 10 kg for a duration of 4 s. It increases the object's velocity from 2 m s^{-1} to 8 m s^{-1} . Find the magnitude of the applied force.

Solution:

Given, mass of the object $m = 10 \text{ kg}$

Initial velocity $u = 2 \text{ m s}^{-1}$

Final velocity $v = 8 \text{ m s}^{-1}$

We know, force $F = \frac{m(v - u)}{t}$

$$F = \frac{10(8-2)}{4} = \frac{10 \times 6}{4} = 15 \text{ N}$$

Example:15.2

Which would require a greater force for accelerating a 2 kg mass at 4 m s^{-2} or a 3 kg mass at 2 m s^{-2} ?

Solution

We know, force $F = ma$

$$\text{Given } m_1 = 2 \text{ kg} \quad a_1 = 4 \text{ m s}^{-2}$$

$$m_2 = 3 \text{ kg} \quad a_2 = 2 \text{ m s}^{-2}$$

$$F_1 = m_1 a_1 = 2 \times 4 = 8 \text{ N}$$

$$\text{and } F_2 = m_2 a_2 = 3 \times 2 = 6 \text{ N}$$

$$\therefore F_1 > F_2$$

Therefore, accelerating a 2 kg mass at 4 m s^{-2} would require a greater force.

15.6. THIRD LAW OF MOTION

Let us consider two spring balances connected together as shown in Fig. 15.4

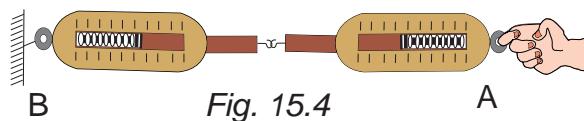


Fig. 15.4

The fixed end B of the balance is attached to a rigid support like a wall. When a force is applied through the free end of the spring balance A, it is observed that both the spring balances show the same readings on their scales. It means that the force exerted by spring balance A on balance B is equal but opposite in direction to the force exerted by the balance B on balance A. The force which balance A exerts on balance B is called action and the force of balance B on balance A is called the reaction.

Newton's third law of motion states that **for every action there is an equal and opposite reaction**. It must be remembered that the action and reaction always act on two different objects.

When a gun is fired, it exerts a forward force on the bullet. The bullet exerts an equal and opposite reaction force on the gun. This results in the recoil of the gun (Fig. 15.5)

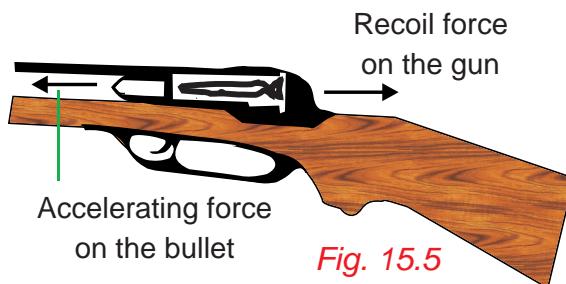


Fig. 15.5

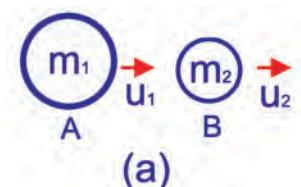
Since the gun has a much greater mass than the bullet, the acceleration of the gun is much lesser than the acceleration of the bullet.

15.7. CONSERVATION OF MOMENTUM

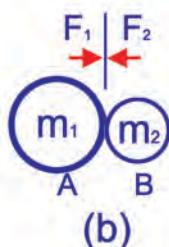
The law of conservation of momentum states that, in the absence of external unbalanced force, the total momentum of a system of objects remains unchanged.

Proof:

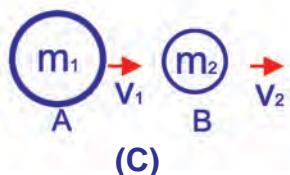
Consider two objects (two balls) A and B of masses ' m_1 ' and ' m_2 ' travelling in the same direction along a straight line at different velocities ' u_1 ' and ' u_2 ' respectively. Fig.15.6(a). There are no other external unbalanced forces acting on them. Let $u_1 > u_2$ and the two balls collide with each other as shown in Fig. 15.6(b). During collision which last for time 't', the ball A exerts a force F_1 on ball B, and the ball B exerts a force F_2 on ball A. Let v_1 and v_2 be the velocities of two balls A and B after collision respectively in the same direction as before collision. [Fig 15.6(c).]



Before collision



During collision



After collision

Fig. 15.6

According to Newton's second law of motion,

The force acting

on B (action) $F_1 = \text{mass of B} \times \text{acceleration on B}$

$$F_1 = \frac{m_2(v_2 - u_2)}{t} \dots\dots (1)$$

The force acting

on A (reaction) $F_2 = \text{mass of A} \times \text{acceleration on A}$

$$F_2 = \frac{m_1(v_1 - u_1)}{t} \dots\dots (2)$$

According to Newton's third law of motion,

$$F_1 = -F_2$$

From equation (1) and (2)

$$\frac{m_2(v_2 - u_2)}{t} = -\frac{m_1(v_1 - u_1)}{t}$$

$$m_2(v_2 - u_2) = -m_1(v_1 - u_1)$$

$$m_2v_2 - m_2u_2 = -m_1v_1 + m_1u_1$$

$$m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2$$

Therefore,

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

The total momentum before collision is equal to the total momentum after collision. The total momentum of two objects remain unchanged due to collision in the absence of external force. This law holds good for any number of objects.

ACTIVITY 15.2

- Take a big rubber balloon and inflate it fully. Tie its neck using a thread. Also, fix a straw on the surface of this balloon using adhesive tape.
- Pass a thread through the straw and hold one end of the thread in your hand or fix it on the wall.
- Ask your friend to hold the other end of the thread or fix it on a wall at some distance.
- This arrangement is shown in Fig. 15.7
- Now, remove the thread tied on the neck of the balloon. Let the air escape through the mouth of the balloon.
- Observe the direction in which the straw moves.

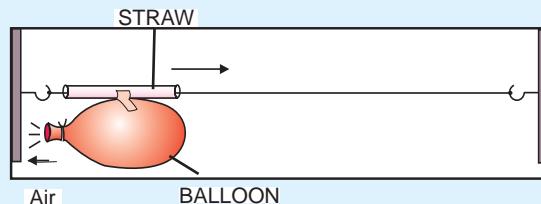


Fig. 15.7

Example:15.3

A bullet of mass 15 g is horizontally fired with a velocity 100 m s^{-1} from a pistol of mass 2 kg. What is the recoil velocity of the pistol?

Solution:

Mass of the bullet, $m_1 = 15 \text{ g} = 0.015 \text{ kg}$

Mass of the pistol, $m_2 = 2 \text{ kg}$

Initial velocity of the bullet, $u_1 = 0$

Initial velocity of the pistol, $u_2 = 0$

Final velocity of the bullet, $v_1 = +100 \text{ m s}^{-1}$

(The direction of the bullet is taken from left to right-positive, by convention)

Recoil velocity of the pistol, $= v_2$

$$\begin{aligned}\text{Total momentum of the pistol and the bullet before firing} &= m_1 u_1 + m_2 u_2 \\ &= (0.015 \times 0) + (2 \times 0) = 0\end{aligned}$$

$$\begin{aligned}\text{Total momentum of the pistol and the bullet after firing} &= m_1 v_1 + m_2 v_2 \\ &= (0.015 \times 100) + (2 \times v_2) \\ &= 1.5 + 2v_2\end{aligned}$$

According to the law of conservation of momentum,

Total momentum after firing = Total momentum before firing

$$1.5 + 2v_2 = 0$$

$$2v_2 = -1.5$$

$$v_2 = -0.75 \text{ m s}^{-1}$$

Negative sign indicates that the direction in which the pistol would recoil is opposite to that of the bullet, that is, right to left.

15.8. MOMENT OF FORCE AND COUPLE

Moment of a Force

A force applied by a wrench can rotate a nut or can open a door, while the door

rotates on its hinges. In addition to the tendency to move a body in the direction of the application of a force, a force also tends to rotate the body about any axis which does not intersect the line of action of the force and also not parallel to it. This tendency of rotation is called the turning effect of a force or moment of the force about the given axis. **The magnitude of the moment of force about a point is defined as the product of the magnitude of force and the perpendicular distance of the point from the line of action of the force.**

Let us consider a force F acting at the point P on the body as shown in Fig. 15.8.

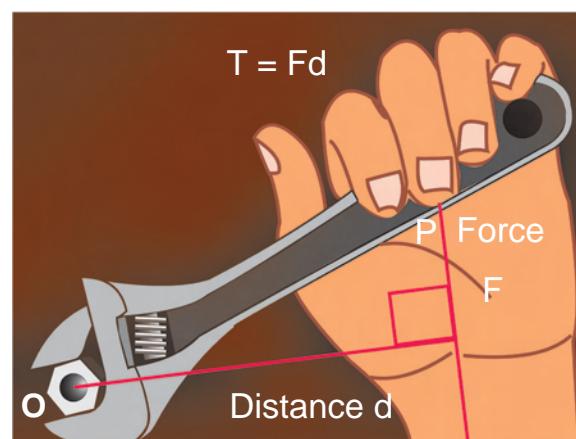


Fig. 15.8

Then, the moment of force = force x perpendicular distance

Moment of force = $F \times d$.

If the force acting on a body rotates the body in anticlockwise direction with respect to 'O', then the moment is called anticlockwise moment. On the other hand, if the force rotates the body in clockwise direction then the moment is said to be clockwise moment. **The unit of moment of force is N m.**

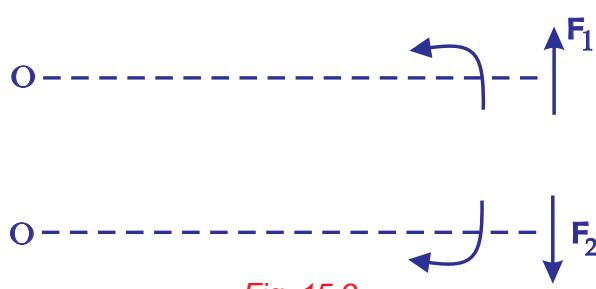


Fig. 15.9.

As a matter of convention, an anticlockwise moment is taken as positive and a clockwise moment as negative.

Couple

There are many examples in practice where two forces, acting together, exert a moment or turning effect on some object. As a very simple case, two strings are tied to a wheel at the points X and Y, and two equal and opposite forces, 'F' are exerted tangentially to the wheels (Fig. 15.10). If the wheel is pivoted at its centre O it begins to rotate about O in an anti-clockwise direction.

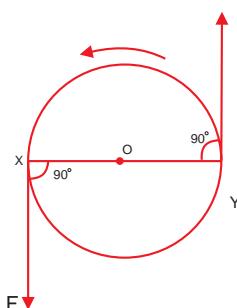


Fig. 15.10

Two equal and opposite forces whose lines of action do not coincide are said to constitute a couple.

15.9. GRAVITATION

We always observe that an object dropped from a height falls towards the ground. It is said that Newton was sitting under an apple tree and an apple fell on him. The fall of the apple made Newton

contemplate about falling bodies. It is seen that a falling apple is always attracted towards the ground. Does the apple attract the earth? If so we do not see earth moving towards an apple. Why?

According to Newton's Third Law of Motion, the apple does attract the earth. But according to the Second Law of Motion, for a given force, acceleration is inversely proportional to the mass of the object. The mass of an apple is negligibly small when compared to that of the earth. So we do not see the earth moving towards the apple. We know that all planets go around the sun. Extending the above argument for all the planets in our solar system, there exists a force between the sun and the planets. Newton concluded that all objects in the universe attract each other. This force of attraction between objects is called the gravitational force.



Name	:	Isaac Newton
Born	:	4 th January 1643
Birth place	:	Woolsthorpe, England
Died	:	20 th March 1727
Best known as	:	The genius who explained gravity.

15.9.1. Newton's law of Gravitation

Every object in the universe attracts every other object with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. The force acts along the line joining the centres of two objects.

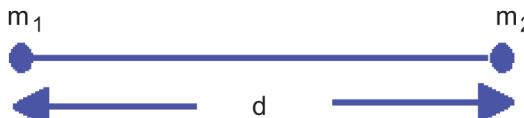


Fig. 15.11

Let two objects A and B of masses m_1 , m_2 respectively lie at a distance 'd' from each other as shown in Fig.15.11. Let the force of attraction between two objects is 'F'. According to the above law,

$$F \propto m_1 m_2 \quad \dots \dots \dots (1)$$

$$F \propto \frac{1}{d^2} \quad \dots \dots \dots (2)$$

Combining (1) and (2)

$$F \propto \frac{m_1 m_2}{d^2} \quad \dots \dots \dots (3) \quad (\text{or})$$

$$F = \frac{G m_1 m_2}{d^2} \quad \dots \dots \dots (4)$$

where G is the constant of proportionality and is called the universal gravitational constant. From equation (4)

$$G = \frac{F d^2}{m_1 m_2}$$

Substituting the S.I units in this equation, the unit of G is found to be $N \text{ m}^2 \text{ kg}^{-2}$. The value of G is $6.673 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

15.9.2. Mass

Mass is the quantity of matter contained in a body.

15.9.3. Weight

Weight is the gravitational force acting on a body. It is a measure of how strongly gravity pulls on that body.

If you were to travel to the moon, your weight would change because the pull of gravity is weaker there than that on the earth, but your mass would stay the same because you are still made up of the same amount of matter.

Example: 15.4

The mass of an object is 5 kg. What is its weight on the earth?

Solution:

Mass, $m = 5 \text{ kg}$

Acceleration due to gravity, $g = 9.8 \text{ m s}^{-2}$

Weight, $W = m \times g$

$$W = 5 \times 9.8 = 49 \text{ N}$$

Therefore the weight of the object is **49 N**

Difference between mass and weight

Mass	Weight
1. Fundamental quantity.	Derived quantity.
2. It is the amount of matter contained in a body.	It is the gravitational pull acting on the body.
3. Its unit is kilogram.	Its unit is newton.
4. Remains the same.	Varies from place to place.
5. It is measured using physical balance.	It is measured using spring balance.

15.9.4. Acceleration due to gravity

Galileo was the first to make a systematic study of the motion of a body under the gravity of the Earth. He dropped various objects from the leaning tower of Pisa and made analysis of their motion under gravity. He came to the conclusion that "in the absence of air, all bodies will fall at the same rate".

It is the air resistance that slows down a piece of paper or a parachute falling under gravity. If a heavy stone and a parachute are dropped, where there is no air, both will fall together at the same rate.

Experiments showed that the velocity of a freely falling body under gravity increases at a constant rate.(i.e.) with a constant acceleration. **The acceleration produced in a body on account of the force of gravity is called acceleration due to gravity.** It is denoted by **g**. At a given place, the value of **g** is the same for all bodies irrespective of their masses. It differs from place to place on the surface of the Earth. It also varies with altitude and depth.

The value of **g** at sea-level and at a latitude of 45° is taken as the standard free-fall acceleration (i.e.) **$g = 9.8 \text{ m s}^{-2}$**

Acceleration due to gravity at the surface of the earth

Consider a body of mass 'm' on the surface of the earth as shown in Fig. 15.12.

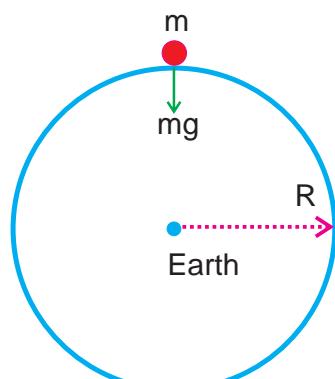


Fig. 15.12

Its distance from the centre of the Earth is R (radius of the Earth).

The gravitational force experienced by the body is $F = \frac{GMm}{R^2}$

where M is the mass of the earth.

From Newton's second law of motion,

$$\text{Force, } F = mg$$

Equating the above two forces,

$$\frac{GMm}{R^2} = mg$$

Therefore,

$$g = \frac{GM}{R^2}$$

This equation shows that 'g' is independent of the mass of the body 'm' but, it varies with the distance from the centre of the Earth. If the Earth is assumed to be a sphere of radius R, the value of 'g' on the surface of the Earth is a constant.

15.9.5. Mass of Earth

From the expression $g = GM/R^2$, the mass of the Earth can be calculated as follows:

$$M = \frac{gR^2}{G}$$

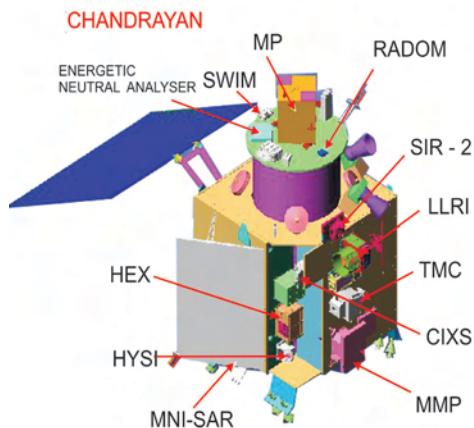
$$M = \frac{9.8 \times (6.38 \times 10^6)^2}{6.67 \times 10^{-11}}$$

$$M = 5.98 \times 10^{24} \text{ kg.}$$

Science Today

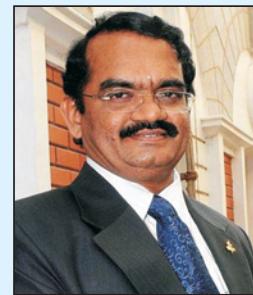
Chandrayaan

Chandrayaan-1 is a moon-traveller or moon vehicle. It was India's first unmanned lunar probe. It was launched by the Indian Space Research Organization (ISRO) in October 2008 from Sriharikota in Andhra Pradesh and operated until August 2009. The mission included a lunar orbiter and an impactor. It carried five ISRO payloads and six payloads from other space agencies including National Aeronautics and Space Administration (NASA), European Space Agency (ESA), and the Bulgarian Aerospace Agency (BAA), which were carried free of cost.



Chandrayaan operated for 312 days and achieved 95% of its planned objectives. The following are its achievements:

- The discovery of wide-spread presence of water molecules in lunar soil.
- Chandrayaan's Moon Mineralogy Mapper has confirmed that moon was once completely molten.
- European Space Agency payload Chandrayaan-1 imaging X-ray spectrometer (CIXS) detected more than two dozen weak solar flares during the mission.
- The terrain mapping camera on board Chandrayaan-1 has recorded images of the landing site of the US space-craft Apollo-15, Apollo-11.
- It has provided high-resolution spectral data on the mineralogy of the moon.
- Lunar Laser Ranging Instrument (LLRI) covered both the Lunar Poles and additional lunar region of interest.
- The X-ray signatures of aluminium, magnesium and silicon were picked up by the CIXS X-ray camera.
- The Bulgarian payload called Radiation Dose Monitor (RADOM) was activated



Mylsamy Annadurai was born on 2nd July 1958 at Kothavadi, a hamlet near Pollachi in Coimbatore District. Mylsamy and Balasaraswathy are his parents. His father served as a teacher in an Elementary School. Panchayat Union Elementary School in Kothavadi was Mylsamy Annadurai's first School, where he studied from class I to V. He then moved to Government and Aided schools in and around his native place for continuing and completing his school education upto class XI. His educational journey continued. He pursued his PUC in NGM College, Pollachi and B.E degree at Government College of Technology, Coimbatore. In 1982, he pursued his Higher Education and acquired an M.E degree in PSG College of Technology, Coimbatore and the same year he joined the ISRO as a scientist. And later, he got a Doctorate from Anna University of Technology, Coimbatore.

Annadurai is a leading technologist in the field of satellite system. Annadurai served as the Project Director of Chandrayaan-1, Chandrayaan-2 and Mangalyaan. He has made significant contribution to the cost effective design of Chandrayaan. Currently, he serves as the Director of ISRO Satellite Centre (ISAC) Bengaluru. Through his inspiring speeches, he has become a motivating force among Indian students.

on the very same day of its launch and worked till the mission ended.

- More than 40,000 images have been transmitted by Chandrayaan camera in 75 days.
- The Terrain Mapping Camera acquired images of peaks and craters. The moon consists mostly of craters.
- Chandrayaan beamed back its first images of the Earth in its entirety.
- Chandrayaan-1 has discovered large caves on the lunar surface that can act as human shelter on the moon.

Cryogenic Techniques

The term Cryogenics is from Greek and means “the production of freezing cold”.

In physics, Cryogenics is the study of the production of very low temperature (below 123K); and the behaviour of materials at those temperatures. A person who studies elements under extremely cold temperature is called a Cryogenicist. Cryogenics uses the Kelvin scale of temperature. Liquefied gases such as liquid nitrogen and liquid helium are used in many cryogenic applications. Liquid nitrogen is the most commonly used element in cryogenics and can be legally purchased around the world. Liquid helium is also commonly used and allows for the lowest attainable temperature to be reached. These liquids are held in special containers called Dewar flasks, which are generally about six feet in height and three feet in diameter.

The field of cryogenics advances during Second World War. Scientists found that metals frozen to low temperature showed

more resistance to wear and tear. This is known as cryogenic hardening. The commercial cryogenic processing industry was founded in 1966 by Ed Busch; and was merged with several small companies later, and became the oldest commercial cryogenic company in the world. They originally experimented with the possibility of increasing the life of metal tools.

Cryogens like liquid nitrogen are further used especially for chilling and freezing applications.

(i) Rocket

The important use of cryogenics is cryogenic fuels. Cryogenic fuel (mainly liquid hydrogen) is used as rocket fuel.

(ii) Magnetic Resonance Imaging (MRI)

MRI is used to scan the inner organs of human body by penetrating very intense magnetic field. The magnetic field is generated by super conducting coils with the help of liquid helium. It can reduce the temperature of the coil to around 4K. At this low temperature, very high resolution images can be obtained.

(iii) Power Transmission in big cities:

It is difficult to transmit power by overhead cables in cities. So underground cables are used. But underground cables get heated up and the resistance of the wire increases leading to wastage of power. This can be solved by cryogenics. Liquefied gases are sprayed on the cables to keep them cool and reduce their resistance.

(iv) Food Freezing:

Cryogenic gases are used in transportation of large masses of frozen

food, when a huge quantity of food is transported to war zones, earthquake, flood hit regions etc., where they must be stored.

(v) Vaccines:

The freezing of biotechnology products like vaccines require nitrogen freezing system.

Space Station:

A space station is an artificial structure designed for humans to live and work in the outer space for a certain period of time.

Modern and recent-history space stations are designed to enable stay in the orbit, for a span of few weeks, months or even years. The only space stations launched for this specific purpose are Almaz and Salyut Series, Sky lab and Mir.



Space stations are used to study the effects of long duration space flight on the human body. It provides a platform for greater number and length of scientific studies than it is available on other space vehicles. Space stations are used both for military and civilian purposes. The last military-used space station was Salyut 5, which was used by the Almaz program of the Soviet Union in 1976 and 1977.

The space stations so far launched are broadly classified into two types. Salyut and Skylab were "monolithic." They were constructed and launched as a single piece,

and was manned by a crew later. As such, they generally carried all their supplies and experimental equipment during launch, and were considered "expended", and then abandoned, when these were used up.

With Salyut 6 and Salyut 7, a change was introduced. These were built with two docking ports. They allowed a second crew to visit, carrying a new space-craft with them.

These space stations allowed the crew to man the station continually. Sky lab was also equipped with two docking ports, but the extra port was never utilized. The presence of the second port on the new space station allowed the progress supply vehicle to be docked on the station. Fresh supplies could thus be transported to aid, long-duration missions.

The second group, the Mir and the International Space Station (ISS), have been modular; a core unit was launched, and additional modules, generally with a specific role, were later added to that. (on the Mir they were mostly launched independently, whereas on the ISS, most of them were carried by the Space Shuttle). This method allows for greater flexibility in operation. It put an end to the need of a single immensely powerful launch vehicle. These stations were designed at the outset, to have their supplies provided by logistic support, and to sustain a longer lifetime at the cost of regular support launches.

These stations have various drawbacks that limit the long-term habitability of the astronauts. They are very low recycling rates, relatively high radiation levels and lack of gravity. These problems cause discomfort and long-term health problems.

In future the space, as human habitat, is expected to address these issues, and made suitable for long-term occupation. Some designs might even accommodate a large number of people, essentially “cities in space” where people would make their homes. No such design has yet been constructed, even for a small station. The cost of the latest(2010) launch is not economically or politically viable.

The People's Republic of China launched its space station named Tiangong 1, in the first half of 2011. This declared China the third country to launch a space station.

MODEL EVALUATION

PART – A

1. The acceleration in a body is due to _____.
i) balanced force ii) unbalanced force iii) electro static force
2. The physical quantity which is equal to the rate of change of momentum is
i) displacement ii) acceleration iii) force iv) impulse
3. The momentum of a massive object at rest is _____.
i) very large ii) very small iii) zero iv) infinity
4. The mass of a person is 50 kg. The weight of that person on the surface of the earth will be _____. i) 50 N ii) 35 N iii) 380 N iv) 490 N
5. The freezing of biotechnology products like vaccines require _____ freezing system.
i) Helium ii) Nitrogen iii) Ammonia iv) Chlorine
6. Two objects of same mass, namely A and B hit a man with a speed of 20 km/hr and 50 km/hr respectively and comes to rest instantaneously. Which object will exert more force on that man? Justify your answer.
7. An object is moving with a velocity of 20 m/s. A force of 10 N is acting in a direction perpendicular to its velocity. What will be the speed of the object after 10 seconds?
8. Assertion(A) : Liquefied cryogenic gases are sprayed on electric cables in big cities.
Reason(R): Liquefied cryogenic gases prevent wastage of power.
i) A is incorrect and R is correct. ii) A is correct and R is incorrect
iii) Both A and R are incorrect. iv) A is correct and R supports A.
9. The acceleration due to gravity on the surface of the earth will be maximum at _____ and minimum at _____
10. If the radius of the earth is reduced to half of its present value, with no change in the mass, how will the acceleration due to gravity, be affected?
11. Selvi placed her purse on the passenger's seat of her car when she drove to work. By the time she reached her office, her purse had fallen on the floor in front of the passenger's seat. Why did this happen? Explain.

12. Why does a fielder in the game of cricket pull his hands back when he catches a ball?
13. From the following statements, choose that which is not applicable to the mass of an object
 - i) It is a fundamental quantity.
 - ii) It is measured using physical balance.
 - iii) It is measured using spring balance.
14. List out the names of the organisations which are not associated with Chandrayaan-I mission from the following: i) ISRO ii) BARC iii) NASA iv) ESA v) WHO vi) ONGC

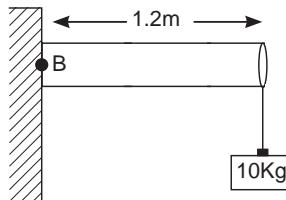
PART – B

1. Fill in the blanks.

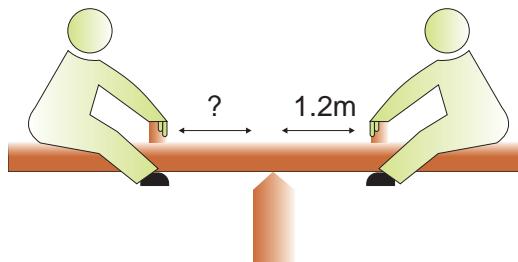
- i) If force = mass \times acceleration, then momentum = _____.
- ii) If liquid hydrogen is for rocket, then _____ is for MRI.

2. Correct the mistakes, if any, in the following statements.

- i) One newton is the force that produces an acceleration of 1 ms^{-2} in an object of 1 gram mass.
- ii) Action and reaction always act on the same body.
3. The important use of cryogenics is cryogenic fuels. What do you mean by cryogenic fuels?
4. As a matter of convention, an anticlockwise moment is taken as _____ and a clockwise moment is taken as _____.
5. A bullet of mass 20 g moving with a speed of 75 ms^{-1} hits a fixed wooden plank and comes to rest after penetrating a distance of 5 cm. What is the average resistive force exerted by the wooden plank on the bullet?
6. A shopping cart has a mass of 65 kg. In order to accelerate the cart by 0.3 ms^{-2} what force would you exert on it?
7. Why does a spanner have a long handle?
8. Why does a boxer always move along the direction of the punch of the opponent?
9. The mats used in gyms and the padding used in sports uniforms are made up of soft substances. Why are rigid materials not used?
10. Write two principles that are used in rocket propulsion.
11. A 10 Kg mass is suspended from a beam 1.2 m long. The beam is fixed to a wall. Find the magnitude and direction (clockwise or anti-clockwise) of the resulting moment at point B.



12. If the force experienced by a body of unit mass is gravitational field strength, find the gravitational field strength on the surface of the earth.
13. If the density of the earth is doubled to that of its original value, the radius remaining the same, what will be the change in acceleration due to gravity?
14. Renu is standing in a dining line 6.38×10^3 km from the centre of the earth. The mass of the earth is 6×10^{24} kg.
- Find the acceleration due to gravity.
 - Will the value change after she finishes her lunch?
15. If an angel visits an asteroid called B 612 which has a radius of 20 m and mass of 104 kg, what will be the acceleration due to gravity in B 612 ?.
16. A man of mass 'm' standing on a plank of mass 'M' which is placed on a smooth horizontal surface, is initially at rest. The man suddenly starts running on the plank with a speed of 'v' m/s with respect to the ground. Find the speed of the plank with respect to the ground.
17. Two balls of masses in ratio 2:1 are dropped from the same height. Neglecting air resistance, find the ratio of
- the time taken for them to reach the ground.
 - the forces acting on them during motion.
 - their velocities when they strike the ground.
 - their acceleration when they strike the ground.
18. An object of mass 1 kg is dropped from a height of 20 m. It hits the ground and rebounds with the same speed. Find the change in momentum. (Take $g=10 \text{ m/s}^2$)
19. What will be the acceleration due to gravity on the surface of the moon, if its radius is $1/4^{\text{th}}$ the radius of the earth and its mass is $1/80$ times the mass of the earth.
20. A boy weighing 20 kg is sitting at one end of a see-saw at a distance of 1.2 m from the centre. Where should a man weighing 60 kg sit on the see-saw, so that it stands balanced?

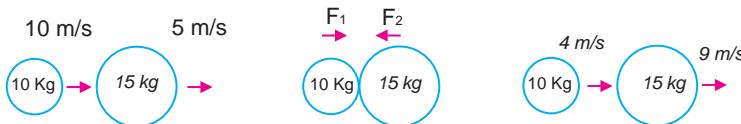


21. A cart driver prods his horse to move forward. The horse refuses to budge and explains:
 "According to Newton's III Law, I am pulling the cart, with a certain force and the cart, in turn pulls me back with an equal amount of force. As they are equal in magnitude and act in opposite directions, they cancel each other."

Do you agree with the explanation given by the horse? Support your answer with proper reasons.

PART -C

1. i) Space Stations are used to study the effects of long-space flight on the human body. Justify.
- ii) $F = G \frac{m_1 m_2}{d^2}$ is the mathematical form of Newton's law of gravitation, G - gravitational constant, m_1, m_2 , are the masses of two bodies separated by a distance d , then give the statement of Newton's law of gravitation.
2. i) Newton's first law of motion gives a qualitative definition of force. Justify.
- ii) The figure represents two bodies of masses 10 kg and 15 kg, moving with an initial velocity of 10 ms^{-1} and 5 ms^{-1} respectively. They collide with each other. After collision, they move with velocities 4 ms^{-1} and 9 ms^{-1} respectively. The time of collision is 2 s. Now calculate F_1 and F_2 .



3. A 5 N force acts on a 2.5 kg mass at rest, making it accelerate in a straight line.
 - i) What is the acceleration of the mass?
 - ii) How long will it take to move the mass through 20m?
 - iii) Find its velocity after 3 seconds.
4. State the law of conservation of momentum. Two billion people jump above the earth's surface with a speed of 4m/s from the same spot. The mass of the earth is 6×10^{24} kg. The average mass of one person is 60 kg.
 - i) What is the total momentum of all the people?
 - ii) What will be the effect of this action on the earth?
5. State Newton's law of gravitation. Write an expression for acceleration due to gravity on the surface of the earth. If the ratio of acceleration due to gravity of two heavenly bodies is 1:4 and the ratio of their radii is 1:3, what will be the ratio of their masses?
6. A bomb of mass 3 kg, initially at rest, explodes into two parts of 2 kg and 1 kg. The 2 kg mass travels with a velocity of 3 m/s. At what velocity will the 1 kg mass travel?
7. Two ice skaters of weight 60 kg and 50 kg are holding the two ends of a rope. The rope is taut. The 60 kg man pulls the rope with 20 N force. What will be the force exerted by the rope on the other person? What will be their respective acceleration?

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 3. Principles of Physics(Extended) - *Halliday, Resnick & Walker*, Wiley publication, New Delhi.

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ELECTRICITY AND ENERGY

Name : Michael Faraday
Born : 22nd September 1791
Birth-place : Newington, England
Died : 25th August 1867
Best known as : Inventor of the first dynamo



Electricity has an important place in modern society. It is a controllable and convenient form of energy for a variety of uses in homes, schools, hospitals, industries and so on.

What constitutes electricity? How does it flow in an electric circuit? What are the factors that regulate electricity through an electric circuit?. In this chapter, we shall answer such questions.

16.1. ELECTRIC CURRENT AND CIRCUIT

We are familiar with air current and water current. We know that flowing water constitutes water current in rivers. Similarly if the electric charge flows through a conductor (metallic wire), we say that there is an electric current in the conductor. In a torch we know that a battery provide flow of charges or an electric current through a torch bulb to make it glow. We have also seen that it gives light only when it is switched on. What does a switch do? A switch creates

a conducting link between the cell and the bulb. **A continuous and closed path of an electric current is called an electric circuit.** Now if the circuit is broken anywhere, the current stops flowing and the bulb does not glow.

How do we express electric current? **Electric current is expressed by the amount of charge flowing through a particular area of cross section of a conductor in unit time.** In other words it is the rate of flow of electric charges. In a circuit using metallic wires, electrons constitute flow of charges. The conventional direction of electric current is taken as opposite to the direction of the flow of electrons.

If a net charge Q , flows across any cross-section of a conductor in time t , then the current I through the cross-section is

$$I = \frac{Q}{t}$$

The SI unit of electric charge is **coulomb**. One coulomb is equal to the charge contained in 6.25×10^{18} electrons. The electric current is expressed by a unit called **ampere (A)**, named after the French Scientist **Andre- Marie Ampere**.

From the above equation,

If, $Q = 1 \text{ C}$, $t = 1\text{s}$, then $I = 1\text{A}$.

When one coulomb of charge flows in one second across any cross section of a conductor, the current in it is one ampere. An instrument called ammeter is used to measure current in a circuit.

Example 16.1

A current of 0.75 A is drawn by the filament of an electric bulb for 10 minutes . Find the amount of electric charge that flows through the circuit.

Solution:

$$\text{Given, } I = 0.75 \text{ A}, \\ t = 10 \text{ minutes} = 600 \text{ s}$$

$$\begin{aligned} \text{We know, } Q &= I \times t \\ &= 0.75 \times 600 \\ &\mathbf{Q = 450 \text{ C}} \end{aligned}$$

The Fig.16.1 shows a schematic diagram of an electric circuit comprising battery, bulb, ammeter and a plug key.

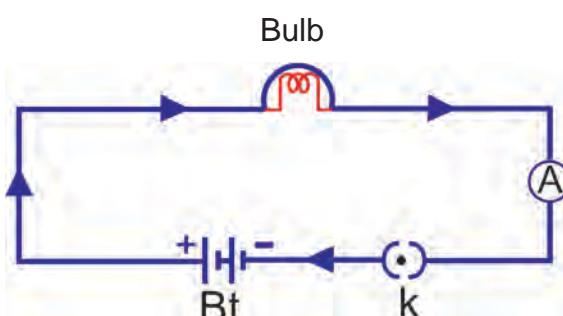


Fig. 16.1 Electric circuit

16.2. ELECTRIC POTENTIAL AND POTENTIAL DIFFERENCE

What makes the electric charge to flow? Charges do not flow in a copper wire by themselves, just as water in a perfectly horizontal tube does not flow. One end of the tube is connected to a tank of water. Now

there is a pressure difference between the two ends of the tube. Water flows out of the other end of the tube. For flow of charges in a conducting metallic wire, the electrons move only if there is a difference of electric pressure called potential difference, along the conductor.

This difference of potential may be produced by a battery, consisting of one or more electric cells. When the cell is connected to a conducting circuit element, the potential difference sets the charges in motion in the conductor and produces an electric current.

The electric potential difference between two points in an electric circuit is the work done in moving a unit positive charge from one point to the other.

$$\text{Potential difference (V)} = \frac{\text{Work done}}{\text{Charge}} \\ V = \frac{W}{Q}$$

The S.I Unit of potential difference is volt (V).

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$

One volt is the potential difference between two points in a current carrying conductor when 1 joule of work is done to move a charge of 1 coulomb from one point to the other.

The potential difference is measured by an instrument called voltmeter.

16.3. CIRCUIT DIAGRAM

The schematic diagram, in which different components of the circuit are represented by the symbols conveniently used, is called a circuit diagram. Conventional symbols used to represent some of the most commonly used electrical

components are given in table 16.1.

COMPONENTS	SYMBOLS
An electric cell	
A battery or a combination of cells	
Plug key or switch (open)	
Plug key or switch (closed)	
A wire joint	
Wires crossing without joining	
Electric bulb	
A resistor of resistance R	
Variable resistance or rheostat	
Ammeter	
Voltmeter	
Light Emitting Diode	

Table 16.1.

Example 16.2.

How much work is done in moving a charge of 5 C across two points having a potential difference 10 V?

Solution:

$$\text{Given charge } Q = 5 \text{ C}$$

$$\text{Potential difference } V = 10 \text{ V}$$

The amount of work done in moving the charge,

$$W = V \times Q$$

$$W = 10 \times 5$$

$$W = 50 \text{ J}$$

16.4. OHM'S LAW

Name : George Simon Ohm

Born : 16th March 1789

Birth place : Erlangen, Germany

Died : 6th July 1854

Best known for : Ohm's law

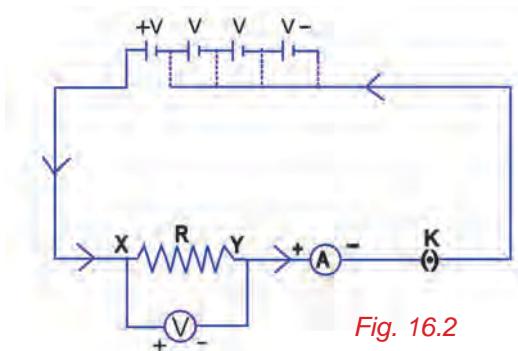


Is there any relationship between the potential difference across a conductor and the current flowing through it? Let us explore this with an activity.

ACTIVITY 16.1

- Set up a circuit as shown in Fig. 16.2. consisting of a nichrome wire XY of length 0.5m, an ammeter, a Voltmeter and four cells of 1.5V each. (Nichrome is an alloy of Nickel and Chromium).
- First use only one cell as the source in the circuit.
- Note the reading in the ammeter I for the current and reading of the voltmeter V for the potential difference across the nichrome wire XY in the circuit.
- Tabulate them in the table given.
- Repeat the above steps using two, three cells and then four cells in the circuit separately.
- Calculate the ratio of V to I for each pair of potential difference V and current I .

S. No.	Number of cells used in the circuit	Current through the nichrome wire I (ampere)	Potential difference across the nichrome wire. V (volt)	$R=V/I$ (volt/ampere) Ω (ohm)
1.				
2.				
3.				
4.				
5.				
6.				



In this activity you will find the ratio V/I is a constant.

In 1827, a German Physicist George Simon Ohm found out the relationship between the current I flowing in a metallic wire and the potential difference across its terminals.

Ohm's law states that at constant temperature the steady current (I) flowing through a conductor is directly proportional to the potential difference (V) between its ends.

$$I \propto V \text{ (or)} \quad \frac{V}{I} = \text{constant.}$$

16.5. RESISTANCE OF A CONDUCTOR

From Ohm's law,

$$V = IR$$

R is a constant for a given metallic wire at a given temperature and is called its

resistance. It is the property of a conductor to resist the flow of charges through it. Its SI unit is ohm. It is represented by the symbol Ω .

$$R = \frac{V}{I}$$

1 volt
1 ohm = $\frac{1 \text{ volt}}{1 \text{ ampere}}$

If the potential difference across the two ends of a conductor is 1 volt and the current through it is 1 ampere, then the resistance of the conductor is 1 ohm.

Example 16.3

The potential difference between the terminals of an electric heater is 60 V when it draws a current of 5 A from the source. What current will the heater draw if the potential difference is increased to 120 V ?

Solution:

$$\text{Potential difference, } V = 60 \text{ V}$$

$$\text{Current, } I = 5 \text{ A}$$

According to Ohm's law,

$$R = \frac{V}{I} = \frac{60}{5} = 12 \Omega$$

When the potential difference is increased to 120 V, the current

$$I = V / R = 120 / 12 = 10 \text{ A}$$

The current drawn by the heater = 10 A

ACTIVITY 16.2

- Set up the circuit by connecting four dry cells of 1.5 V each in series with the ammeter leaving a gap XY in the circuit, as shown in Fig. 16.3.
- Complete the circuit by connecting the nichrome wire in the gap XY. Plug the key. Note down the ammeter reading. Take out the key from the plug.
- Replace the nichrome wire with the torch bulb in the circuit and find the current through it by measuring the reading of the ammeter.
- Now repeat the above steps with the LED bulb in the gap XY.
- Do the ammeter readings differ for various components connected in the gap XY? What do the above observations indicate?

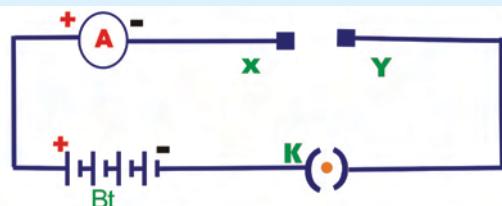


Fig. 16.3

16.6. SYSTEM OF RESISTORS

In various electrical circuits we often use resistors in various combinations. There are two methods of joining the resistors together. Resistors can be connected in

- (a) series (b) parallel.

Resistors in Series

Consider three resistors of resistances R_1 ,

R_2 , R_3 in series with a battery and a plug key as shown in Fig. 16.4.

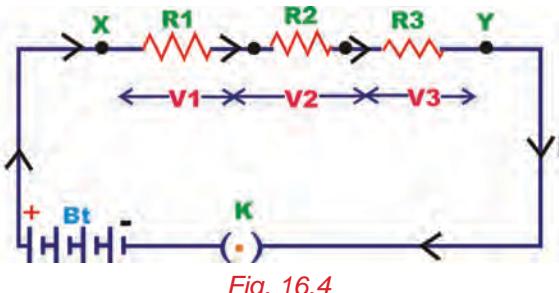


Fig. 16.4

The current (I) through each resistor is the same.

The total potential difference across the combination of resistors in series is equal to the sum of potential difference across individual resistors. That is,

$$V = V_1 + V_2 + V_3 \quad (1)$$

According to Ohm's law ,

$$V_1 = IR_1, \quad V_2 = IR_2, \quad V_3 = IR_3$$

Substituting these values in equation (1)

$$V = IR_1 + IR_2 + IR_3$$

Let R_s be the equivalent resistance, then

$$V = IR_s$$

$$IR_s = IR_1 + IR_2 + IR_3$$

$$R_s = R_1 + R_2 + R_3$$

When several resistors are connected in series, the equivalent resistance (R_s) is equal to the sum of their individual resistances.

Equivalent resistance (R_s) is always greater than any individual resistance.

Example 16.4

Two resistances 18Ω and 6Ω are connected to a 6 V battery in series. Calculate (a) the total resistance of the circuit, (b) the current through the circuit.

Solution:

(a) $R_1 = 18 \Omega$ $R_2 = 6 \Omega$

$R_s = R_1 + R_2$

$R_s = 18 + 6 = 24 \Omega$

(b) The potential difference $V = 6 V$

$$I = \frac{V}{R_s} = \frac{6}{24}$$

I = 0.25 A

Resistors in Parallel

Consider three resistors having resistances R_1 , R_2 , R_3 connected in parallel. This combination is connected with a battery and plug key as shown in Fig. 16.5

In parallel combination the potential difference (V) across each resistor is the same.

The total current I is equal to the sum of the current through each resistor.

$$I = I_1 + I_2 + I_3 \quad (1)$$

According to Ohm's law

$$I_1 = \frac{V}{R_1} \quad I_2 = \frac{V}{R_2} \quad I_3 = \frac{V}{R_3}$$

Substituting these values in equation (1)

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

Let R_p be the equivalent resistance.

$$I = V/R_p$$

$$\frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

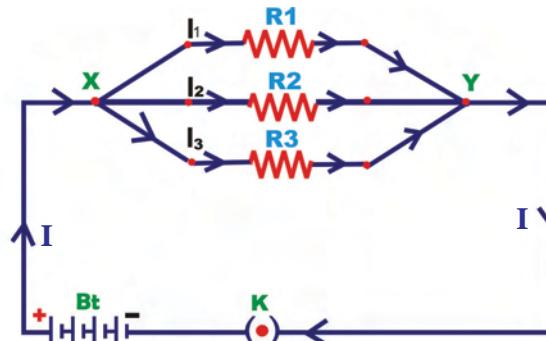


Fig. 16.5

Thus the reciprocal of the equivalent resistance ($1/R_p$) in parallel is equal to the sum of the reciprocals of the individual resistance.

Equivalent resistance (R_p) is always less than the least of the combination.

Example 16.5

Three resistances having the values 5Ω , 10Ω , 30Ω are connected parallel to each other. Calculate the equivalent resistance.

Solution:

Given, $R_1 = 5 \Omega$, $R_2 = 10 \Omega$, $R_3 = 30 \Omega$

These resistances are connected parallel

Therefore, $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$$\frac{1}{R_p} = \frac{1}{5} + \frac{1}{10} + \frac{1}{30} = \frac{10}{30}$$

$$R_p = \frac{30}{10} = 3 \Omega$$

16.7. HEATING EFFECT OF ELECTRIC CURRENT

We know that a battery is a source of electrical energy. Its potential difference between the two terminals sets the electrons in motion for the current to flow through the resistor.

For the current, to flow the source has to keep spending its energy. Where does this energy go? What happens when an electric fan is used continuously for a long period of time?

ACTIVITY 16.3

- Take an electric cell, a bulb, a switch and connecting wires. Make an electric circuit as shown in Fig. 16.6. By pressing the key allow the current to pass through the bulb.
- The bulb gets heated when current flows continuously for a long time (when the key is on).

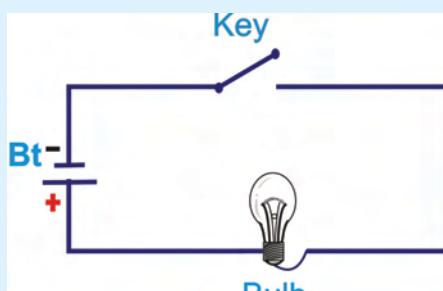


Fig. 16.6

A part of the energy may be consumed in useful work (like in rotating the blades of the fan). The rest of the energy may be expended in heat to raise the temperature of the gadget. If the electric circuit is purely resistive, the energy of the source continuously gets dissipated entirely in the form of heat. This is known as heating effect of electric current. Heating effect of electric current is used in many appliances. The electric iron, electric toaster, electric oven and electric heater are some of the familiar devices which uses this effect.

16.8. JOULE'S LAW OF HEATING

Consider a current I flowing through a resistor of resistance R . Let the

potential difference across it be V . Let t be the time during which a charge Q flows across. The work done (W) in moving the charge Q through the potential difference V is VQ . Therefore the source must supply energy equal to VQ in time t .

What happens to this energy expended by the source? This energy gets dissipated in the resistor as heat. Thus for a steady current I , the amount of heat H produced in time t is

$$H = W = VQ$$

$$\text{since, } Q = It$$

$$H = VIt$$

Applying Ohm's law we get $H = I^2 Rt$.

This is known as Joule's law of heating. **The law implies that heat produced in a resistor is**

- (1) directly proportional to the square of current (I^2) for a given resistance,
- (2) directly proportional to the resistance (R) for a given current,
- (3) directly proportional to the time(t) for which the current flows through the resistor.

Example 16.6

A potential difference 20 V is applied across a 4Ω resistor. Find the amount of heat produced in one second.

Solution:

Given potential difference, $V = 20 \text{ V}$

The resistance, $R = 4 \Omega$

The time, $t = 1 \text{ s}$

According to Ohm's law, $I = \frac{V}{R}$

$$I = \frac{20}{4} = 5 \text{ A}$$

The amount of heat produced,

$$H = I^2Rt$$

$$H = 5^2 \times 4 \times 1 = 100 \text{ J}$$

16.9. ROLE OF FUSE

A common application of Joule's heating is the fuse used in electric circuits. It consists of a piece of wire made up of an alloy (37% Lead, 63% Tin). It has high resistance and low melting point. The fuse is connected in series with the device. During the flow of high current, the fuse wire melts and protects the circuits and the appliances.

16.10. DOMESTIC ELECTRIC CIRCUITS

In our homes, we receive supply of electric power through a main supply (also called mains), either supported through overhead electric poles or by underground cables. One of the wires in the supply, usually with **red** insulation, is called **live wire**. Another wire, with **black** insulation, is called **neutral wire**. In our country, the potential difference between the two are 220 V. Another wire in **green** insulation is called **earth wire**.

At the meter-board in the house, these wires pass into an Wattmeter through a main fuse. Through the main switch they are connected to the line wires in the house. These wires supply electricity to separate circuits within the house. Often, two separate circuits are used, one of 15 A current rating for appliances with higher power ratings such as geysers, air coolers, etc. The other circuit is of 5 A current rating for bulbs, fans, etc.

The earth wire which has insulation of green colour is usually connected to a metal plate buried deep in the earth near the

house. This is used as a safety measure, especially for those appliances that have a metallic body, for example electric press, toaster, table fan, refrigerator, etc. The metallic body is connected to the earth wire, which provides a low-resistance conducting path for the current. Thus, it ensures that any leakage of current to the metallic body of the appliance keep its potential to that of the earth, and the user may not get a severe electric shock.

Fig.16.7 gives a schematic diagram of one of the common domestic circuits. In each separate circuit, different appliances can be connected across the

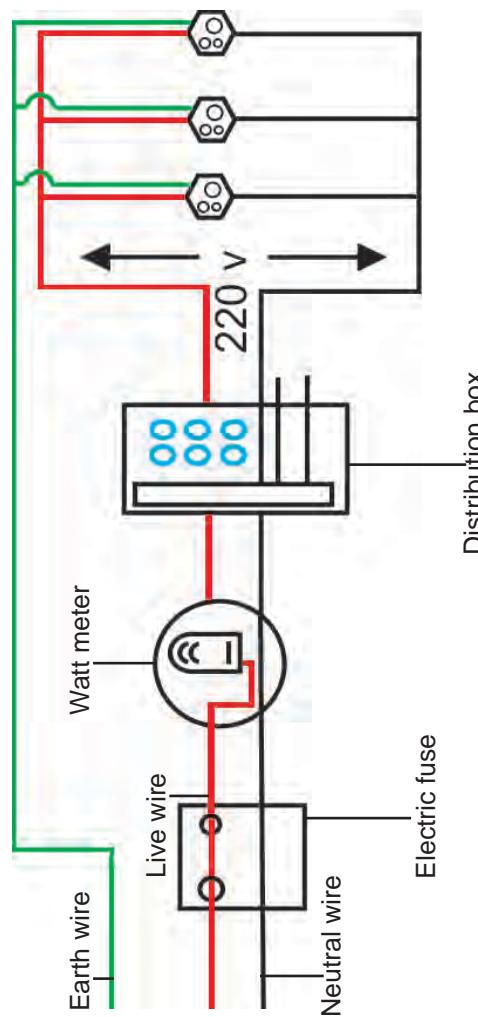


Fig. 16.7

live and neutral wires. Each appliance has a separate switch to switch ON or OFF the flow of current through it. In order that each appliance has equal potential difference, they are connected parallel to each other.

The electric fuse is an important component of all domestic circuits. Overloading can occur when the live and the neutral wire come into direct contact. In such a situation, the current in the circuit abruptly increases. This is called short circuiting. The use of an electric fuse prevents the electric circuit and appliance from a possible damage by stopping the flow of high electric current.

16.11. ELECTRIC POWER

We know already that the rate of doing work is power. The rate of consumption of electric energy is termed as electric power.

The power P is given by

$$P = \frac{W}{t} = VI$$

$$(or) \quad P = I^2R = \frac{V^2}{R}$$

The SI unit of electric power is watt (W). 1 watt is the power consumed by a device that carries 1 A of current when operated at a potential difference of 1 V. Thus,

$$1 \text{ W} = 1 \text{ volt} \times 1 \text{ ampere} = 1 \text{ VA}$$

The unit watt is very small. Therefore, in actual practice we use a much larger unit called kilowatt. It is equal to 1000 watt. Since electric energy is the product of power and time, the unit of electric energy is, therefore, watt hour (Wh). One watt hour is the energy consumed when one watt of power is used for one hour. The commercial unit of electric energy is **kilowatt hour** (KWh), commonly known as unit.

$$\begin{aligned} 1 \text{ KWh} &= 1000 \text{ watt} \times 3600 \text{ second} \\ &= 3.6 \times 10^6 \text{ watt second} \\ &= 3.6 \times 10^6 \text{ joule} \end{aligned}$$

Example 16.7

An electric bulb is connected to a 220 V generator. The current is 0.50 A. What is the power of the bulb?

Solution:

$$V = 220 \text{ V}, \quad I = 0.50 \text{ A}$$

The power of the bulb,

$$P = VI = 220 \times 0.50 = 110 \text{ W}$$

16.12. CHEMICAL EFFECT OF ELECTRIC CURRENT

ACTIVITY 16.4

- Carefully take out the carbon rods from two discarded cells.
- Clean their metal caps with sand paper.
- Wrap copper wire around the metal caps of the carbon rods.
- Connect these copper wires in series with a battery and an LED.
- Dip the carbon rods into lemon juice taken in a plastic or rubber bowl.
- Does the bulb glow?
- Does lemon juice conduct electricity?

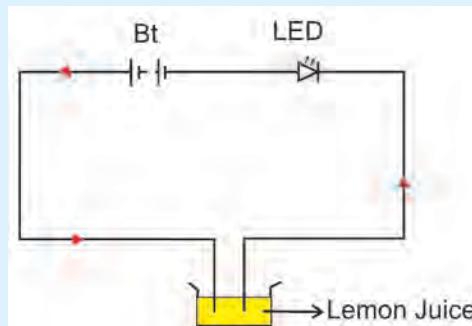


Fig. 16.8

It is observed that lemon juice conducts electricity.

16.13. ELECTROLYSIS- ELECTRO CHEMICAL CELLS

When the current is passed through aqueous or molten solutions of inorganic acids, bases and salts, the conduction of electricity is always accompanied by chemical decomposition of the solutions. Such solutions are called electrolytes and the phenomenon of the conduction of electricity through electrolytes by chemical decomposition is called electrolysis.

Name	:	Alessandro Volta
Born	:	18 th February 1745
Birth place	:	Como, Italy
Died	:	5 th March 1827
Best known for	:	The Italian who built the first battery



Electrochemical cell

The cells in which the electrical energy is derived from the chemical action are called electrochemical cells.

Voltaic cell consists of two electrodes, one of copper and the other of zinc dipped in a solution of dilute sulphuric acid in a glass vessel. This is shown in Fig. 16.9.

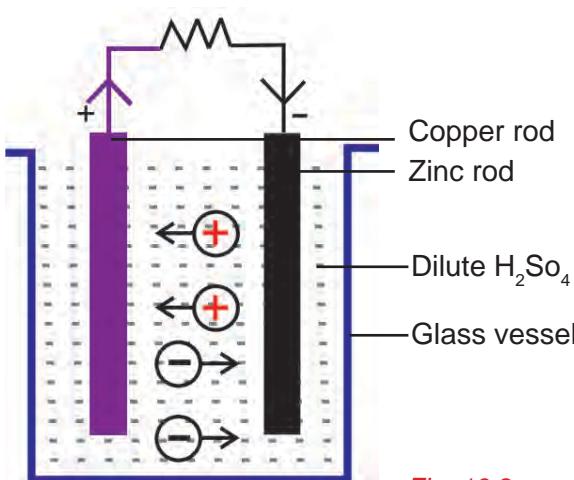


Fig. 16.9

On connecting the two electrodes externally, with a piece of wire, current flows from copper to zinc outside the cell and from zinc to copper inside it. The copper and zinc rods act as positive and negative electrodes respectively. The electrolyte is dilute sulphuric acid.

The action of the cell is explained in terms of the motion of the charged ions. At the zinc rod, the zinc atoms get ionized and pass into solution as Zn^{++} ions. This leaves the zinc rod with two electrons more, making it negative. At the same time, two hydrogen ions (2H^{+}) are discharged at the copper rod, by taking these two electrons. This makes the copper rod positive. As long as excess electrons are available on the zinc electrode, this process goes on and a current flows continuously in external circuit. This simple cell is thus seen as a device which converts chemical energy into electrical energy.

Due to opposite charges on the two plates, a potential difference is set up between copper and zinc. Copper being at a higher potential than zinc, the difference of potential between the two electrodes is 1.08 V.

16.14. PRIMARY AND SECONDARY CELLS

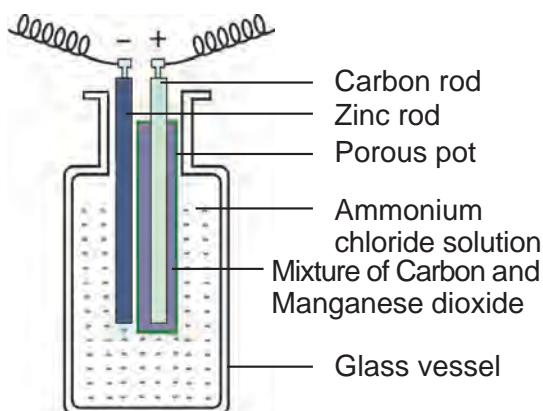
Primary Cell

The cells from which the electric energy is derived by irreversible chemical reaction are called primary cells. The primary cell is capable of giving an **electromotive force(emf)**, when its constituents, two electrodes and a suitable electrolyte, are assembled together. The main primary cells are Daniel cell and Leclanche cell. These cells **cannot be recharged**.

Leclanche cell

A Leclanche cell consists of a glass vessel which is filled with ammonium chloride solution. Ammonium chloride solution acts as an electrolyte. In it there stands a zinc rod and porous pot containing a carbon rod which is packed round with a mixture of manganese dioxide and powdered carbon. The carbon and zinc rods act as positive and negative electrodes respectively.

At the zinc rod, the atoms get ionised and pass into the solution as Zn^{++} ions. This leaves the zinc rod with two electrons more making it negatively charged. At the same time, Ammonium chloride splits into ammonia gas, two Hydrogen ions ($2H^+$) and two chloride ions ($2Cl^-$). Zn^{++} ions and $2Cl^-$ ions recombine to form zinc chloride. The $2H^+$ ions migrate to the carbon rod and make it positively charged. When the carbon rod and zinc rod are connected by a wire, the current flows from carbon to zinc through the wire. The e.m.f of the cell is about 1.5V.



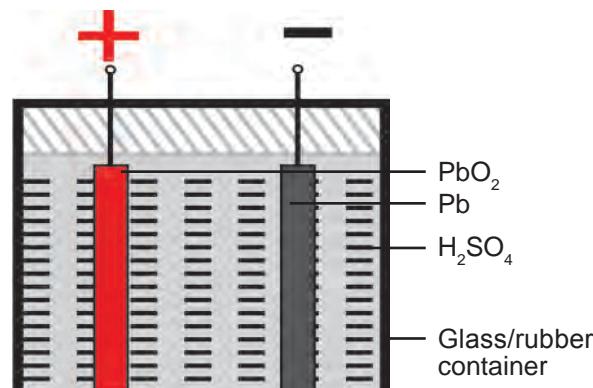
Secondary Cells

The advantage of secondary cells is that they are **rechargeable**. The chemical reactions that take place in secondary cells are **reversible**. The active materials that

are used up when the cell delivers current can be reproduced by passing current through the cell in opposite direction. The chemical process of obtaining current from a secondary cell is called discharge. The process of reproducing active materials is called charging. One of the most commonly used secondary cell is lead acid accumulator.

Lead-acid Accumulator

In a lead-acid accumulator, the anode and cathode are made of lead dioxide and lead respectively. The electrolyte is dilute sulphuric acid. As power is discharged from the accumulator, both the anode and cathode undergoes a chemical reaction that progressively changes them into lead sulphate. When the anode and cathode are connected by a wire, the current flows from anode to cathode through the wire.



When current is applied to a lead-acid accumulator, the electrochemical reaction is reversed. This is known as recharging of the accumulator. The e.m.f of freshly charged cell is 2.2V.

16.15. SOURCES OF ENERGY

Energy comes in different forms and one can be converted to another. If energy can neither be created nor destroyed, we should be able to perform endless activities without thinking about energy resources. Then why do we hear so much about the energy crises?

If we drop a plate from a height, the potential energy of the plate is converted mostly to sound energy when it hits the ground. If we light a candle, the chemical energy in the wax is converted to heat energy and light energy on burning.

In these examples we see that energy, in the usable form, is dissipated into the surroundings in less usable forms. Hence any source of energy we use to do work is consumed and cannot be used again. We use muscular energy for carrying out physical work, electrical energy for running various appliances, chemical energy for cooking food or running a vehicle. They all come from a source. We should know how to select the source needed for obtaining energy in its usable form, and only then will it be a useful source.

A good source of energy would be one

- which would do a large amount of work per unit volume of mass
- be easily accessible
- be easy to store and transport
- most importantly be economical.

16.15.1. Conventional Sources of Energy

1. Fossil Fuels

In ancient time's wood was the most common source of energy. The energy of flowing water and wind was also used for limited activities. Can you think of some of these uses? The exploitation of coal as a source of energy made the industrial revolution possible. Industrialisation has caused the global demand for energy to grow at a tremendous rate. The growing demand for energy was largely met by fossil fuels like coal and petroleum. These fuels were formed over millions of years ago and there are only limited reserves. Fossil fuels are a non-renewable source of energy. So we need to conserve them. If we were to continue consuming these sources at such alarming rates, we would soon run out of energy. In order to avoid this, alternate source of energy have to be explored.

Burning fossil fuels has other disadvantages like air pollution, acid rain and production of green house gases.

2. Thermal Power Plant

Large amount of fossil fuels are burnt everyday in power stations to heat up water to produce steam which further runs the turbine to generate electricity. The transmission of electricity is more efficient than transporting coal or petroleum over the same distance. Therefore, many thermal power plants are set up near coal or oil fields. The term thermal power plant is used since fuel is burnt to produce heat energy which is converted into electrical energy.

3. Hydro Power Plants

Another traditional source of energy is the kinetic energy of flowing water or the potential energy of water falling from a height. Hydro power plants convert the potential energy of falling water into electricity. Since there are very few waterfalls which could be used as a source of potential energy, hydro power plants are associated with dams. In the last century, a large number of dams were built all over the world. As we can see, a quarter of our energy requirements in India is met by hydro power plants. In order to produce hydro electricity, high-rise dams are constructed on the river to obstruct the flow of water and thereby water is collected in larger reservoirs. The water level rises and in this process the kinetic energy of flowing water gets transformed into potential energy. The water from the high level in the dam is carried through the pipes, to the turbine, at the bottom of

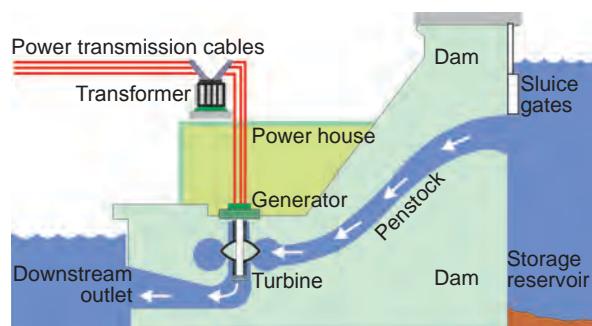


Fig. 16.12

the dam (Fig. 16.12). Since the water in the reservoir is refilled each time it rains, (hydro power is a renewable source of energy) we do not have to worry about hydro electricity sources getting used up like fossil fuels.

4. Biomass

We mentioned earlier that wood has been used as a fuel for a long time. If we

can ensure that enough trees are planted, a continuous supply of firewood can be assured. You must also be familiar with the use of cowdung cakes as a fuel. Given the large amount of live stock in India, this can also assure us a steady source of fuel. Since these fuels are plant and animal products, the source of these fuels is said to be biomass. These fuels, however, do not produce much heat on burning and a lot of smoke is given out when they are burnt. Therefore, technological inputs to improve the efficiency of these fuels are necessary. When wood is burnt in a limited supply of oxygen, water and volatile materials present in it get removed and charcoal is left behind as the residue. Charcoal burns without flames, is comparatively smokeless and has higher heat generation efficiency.

Similarly, cowdung, various plant materials like the residue after harvesting the crops, vegetable wastes and sewage are decomposed in the absence of oxygen to give biogas. Since the starting material is mainly cowdung, it is popularly known as gobar gas. The gobar gas plant structure is shown in Fig. 16.13.

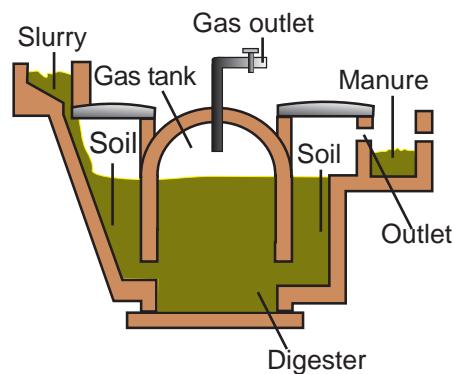


Fig. 16.13

16.15.2. Non-conventional Sources of Energy

Our life styles are changing. We use machines to do more and more of our

tasks. Therefore our demand for energy increases. We need to look for more and more sources of energy. We could develop technology to use the available sources of energy more efficiently and also look to new sources of energy. We shall now look at some of the latest sources of energy.

1. Solar Energy

The sun has been radiating an enormous amount of energy at the present rate for nearly 5 billion years and will continue radiating at that rate for about 5 billion years more. Only a small part of solar energy reaches the outer layer of the earth's atmosphere. Nearly half of it is absorbed while passing through the atmosphere and the rest reaches the earth's surface.

A black surface absorbs more heat than any other surface under identical conditions. Solar cookers and solar water heaters use this property in their working. Some solar cookers achieve a higher temperature by using mirrors to focus the rays of the sun. Solar cookers are covered with a glass plate.

ACTIVITY 16.5

- Take two conical flasks and paint one white and the other black. Fill both with water.
- Place the conical flask in direct sunlight for half an hour to one hour.
- Touch the conical flasks. Which one is hotter? You could also measure the temperature of the water in the two conical flasks with a thermometer.
- Can you think of ways in which this finding could be used in your day to day life?

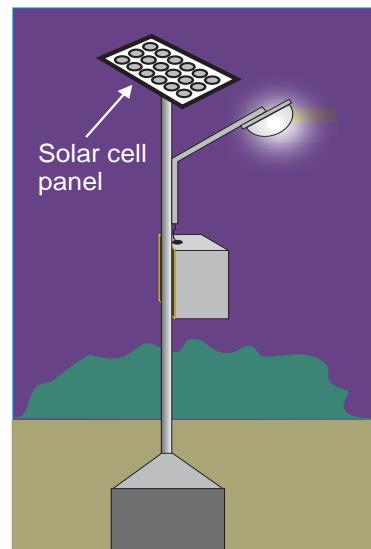


Fig. 16.14

These devices are useful only at certain times during the day. This limitation of using solar energy is overcome by using solar cells that convert solar energy into electricity. A large number of solar cells are combined in an arrangement called solar cell panel that can deliver enough electricity for practical use (Fig. 16.14.) The principal advantages associated with solar cells are that they have no moving parts and require little maintenance. Another advantage is that they can be set up in remote areas in which laying of power transmission line may be expensive.

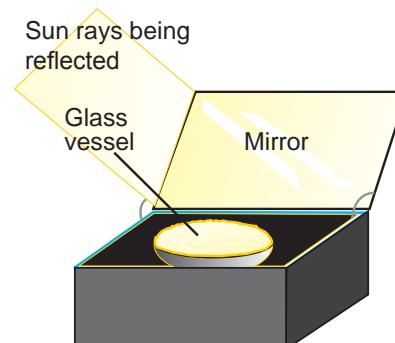


Fig. 16.15

ACTIVITY 16.6

- Study the structure and working of a solar cooker or a solar water-heater, particularly with regard to how it is insulated and maximum heat absorption is ensured.*
- Design and build a solar cooker or water-heater using low-cost material available and check the temperature achieved in your solar system.*
- Discuss what would be the advantages and limitations of using the solar cooker or water-heater.*

2. Wind Energy

The kinetic energy of the wind can be used to do work. This energy was harnessed by windmills in the past to do mechanical work. For example, in a water-lifting pump, the rotatory motion of windmill is utilized to lift water from a well. Today, wind energy is also used to generate electricity. A windmill essentially consists of a structure similar to

ACTIVITY 16.7

- Find out from your grand-parents or other elders*
- (a) How did they go to school?*
- (b) How did they get water for their daily needs when they were young?*
- (c) What means of entertainment did they use?*
- Compare the above answers with how you do these tasks now.*
- Is there a difference? If yes, in which case more energy from external sources is consumed?*

a large electric fan that is erected at some height on a rigid support.

To generate electricity, the rotatory motion of the windmill is used to turn the turbine of the electric generator. The output of a single windmill is quite small and cannot be used for commercial purposes. Therefore, a number of windmills are erected over a large area, which is known as a wind energy farm. The energy output of each windmill in a farm is coupled together to get electricity on a commercial scale.

Wind energy is an environment-friendly and efficient source of renewable energy. It requires no recurring expenses for the production of electricity. The wind speed should be higher than 15 km per hour to maintain the required speed of the turbine. (Fig. 16.16.)



Fig. 16.16

16.15.3. Nuclear Energy

How is nuclear energy generated? In a process called nuclear fission, the nucleus of a heavy atom (such as uranium, plutonium or thorium), when bombarded with low-energy neutrons, can be split apart into lighter nuclei. When this is done, a tremendous amount of energy is released if the mass of the original nucleus is just a little more than the sum of the masses of the individual products. The fission of an atom of uranium, for example, produces 10 million times the energy produced by the combustion of an atom of carbon from coal. In a nuclear reactor designed for electric power generation, sustained fission chain reaction releases energy in a controlled manner and the released energy can be used to produce steam and further generate electricity.

16.15.4. Radioactivity

The phenomenon of radioactivity was discovered by Henry Becquerel in 1896. He found that a photographic plate wrapped in a black paper was affected by certain penetrating radiations emitted by uranium salt. Rutherford later showed that the radiations from the salt were capable of ionizing a gas. The current produced due to the ions was taken as a measure of activity of the compound.

A few years later Madam Marie Curie and her husband Pierre Curie discovered the highly radioactive elements radium and

Name	: Henry Becquerel
Born	: 15 th December 1852
Birth place	: Paris, France
Died	: 25 th August 1908
Best known for : Discovery of radioactivity	



polonium. The activity of the material has been shown to be the result of the three different kinds of radiations, α , β , and γ .

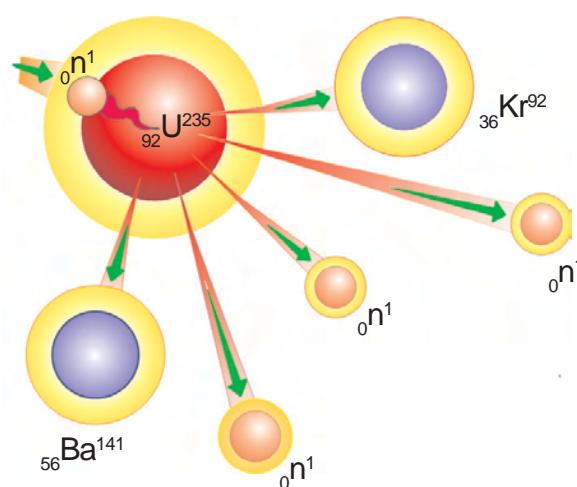
The phenomenon of spontaneous emission of highly penetrating radiations such as α , β , and γ rays by heavy elements having atomic number greater than 82 is called radioactivity and the substances which emit these radiations are called radioactive elements.

The radioactive phenomenon is spontaneous and is unaffected by any external agent like temperature, pressure, electric and magnetic fields etc.

16.15.5. Nuclear Fission and Nuclear Fusion

1. Nuclear Fission

In 1939, German scientists Otto Hahn and Strassman discovered that when uranium nucleus is bombarded with a neutron, it breaks up into two fragments of comparable masses with the release of energy.



The process of fission

Fig. 16.17

The process of breaking up of the nucleus of a heavier atom into two fragments with the release of large amount of energy is called nuclear fission. The fission is accompanied of the release of neutrons. The fission reactions with $^{92}_{\text{U}} \text{U}^{235}$ are represented as



In the above example the fission reaction is taking place with the release of 3 neutrons and 200 Million electron volt energy.

2. Nuclear Fusion

Nuclear fusion is a process in which two or more lighter nuclei combine to form a heavier nucleus. The mass of the product is always less than the sum of the masses of the individual lighter nuclei. According to Einstein's mass energy relation $E = mc^2$, the difference in mass is converted into energy. The fusion process can be carried out only at extremely high temperature of the order of 10^7 K because, only at these very high temperatures the nuclei are able to overcome their mutual repulsion. Therefore before fusion, the lighter nuclei must have their temperature raised by several million degrees. The nuclear fusion reactions are known as thermo nuclear reactions.

Hydrogen Bomb

A suitable assembly of deuteron and triton is arranged at the sight of the explosion of the atom bomb. Favourable temperature initiates the fusion of lighter nuclei in an uncontrolled manner. This releases enormous amount of heat energy.

The fusion reaction in the hydrogen bomb is ${}_{1}^1 \text{H}^2 + {}_{1}^3 \text{H}^3 \rightarrow {}_{2}^4 \text{He}^4 + {}_0^1 n + \text{Energy}$

Example: 16.8

Calculate the energy produced when 1 kg of substance is fully converted into energy.

Solution:

$$\text{Mass, } m = 1 \text{ kg}$$

$$\text{Velocity of light, } c = 3 \times 10^8 \text{ m s}^{-1}$$

$$\text{Energy produced, } E = mc^2$$

$$E = 1 \times (3 \times 10^8)^2$$

$$E = 9 \times 10^{16} \text{ J}$$

16.15.6. Nuclear Reactivity Advantages

Nuclear reactivity is a measure of the state of a reactor regarding criticality. It is a useful concept to predict how the neutron population of a reactor will change over time.

If a reactor is critical, that is, the neutron production is exactly equal to the neutron destruction, then the reactivity is zero. If the reactor is super critical (neutron production > neutron destruction) then the reactivity is positive i.e, unsafe. If the reactor is sub critical (neutron production < neutron destruction) then the reactivity is negative i.e, safe.

16.15.7. Hazards of Nuclear Energy

α , β and γ radiations are all ionizing radiations. These radiations cause a change in the structure of molecules in cells and disturbs the normal functioning of the biological system. The extent to which the human organism is damaged depends upon:

1. the dose and the rate at which the radiation is given and
2. the part of the body exposed to it.

The damage may be either pathological or genetic.

The radiation exposure is measured by the unit called roentgen(R). One roentgen is defined as the quantity of radiation which produces 1.6×10^{12} pairs of ion in 1 gram of air.

The safe limit for receiving radiation is about 250 milli roentgen per week.

The following precautions are to be taken by those, who are working in radiation laboratories.

- (i) Radioactive materials are to be kept in thick-walled lead container.
- (ii) Lead aprons and lead gloves are to be used while working in hazardous area.
- (iii) A small micro-film badge is to be always worn by the person and checked periodically for the safety limit of radiation.
- (iv) Nuclear devices can be operated using remote control system.
- (v) Clean up contamination in the work area promptly.

SCIENCE TODAY

Energy from Seas

1. Tidal Energy

Due to the gravitational pull of the moon on the earth, the level of the water in the sea rises and falls. If you live near the sea or ever travel to some place near the sea, try and observe how the sea-level changes during the day. The phenomenon is called high and low tides and the difference in sea-levels gives us tidal energy. Tidal energy is harnessed by constructing a dam across a

narrow opening to the sea. A turbine fixed at the opening of the dam converts tidal energy to electricity. (Fig. 16.18.) As you can guess, the locations where such dams can be built are limited.

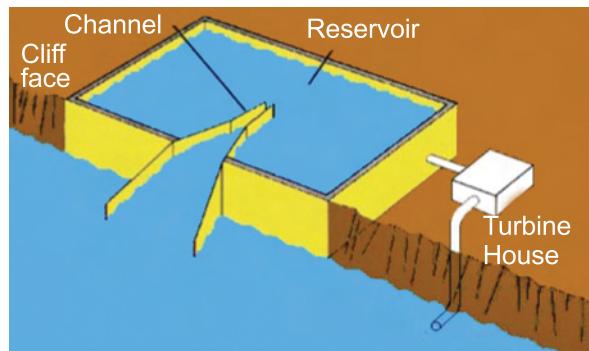


Fig. 16.18

2. Wave Energy

Similarly, the kinetic energy possessed by huge waves near the sea-shore can be trapped in a similar manner to generate electricity. The waves are generated by strong winds blowing across the sea. Wave energy would be a viable proposition only where waves are very strong.

A wide variety of devices have been developed to trap wave energy for rotation of turbine and production of electricity. (Fig. 16.19)

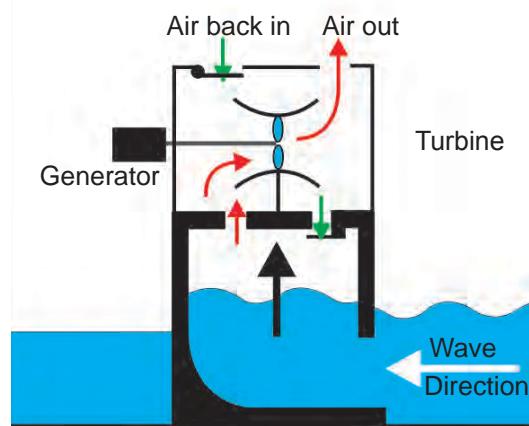


Fig. 16.19

3. Ocean Thermal Energy

The water at the surface of the sea or ocean is heated by the sun while the water in deeper sections is relatively cooler. This difference in temperature is exploited to obtain energy in ocean-thermal-energy conversion plants.

These plants can operate if the temperature difference between the water at the surface and water at depths is up to 2 kilometers is 293 K (20°C) or more. The warm surface-water is used to boil a volatile liquid like ammonia. The vapours of liquid are then used to run the turbine of a generator. The cooled water from the depth of the ocean is pumped up and condenses vapour again to liquid. (Fig. 16.20.)

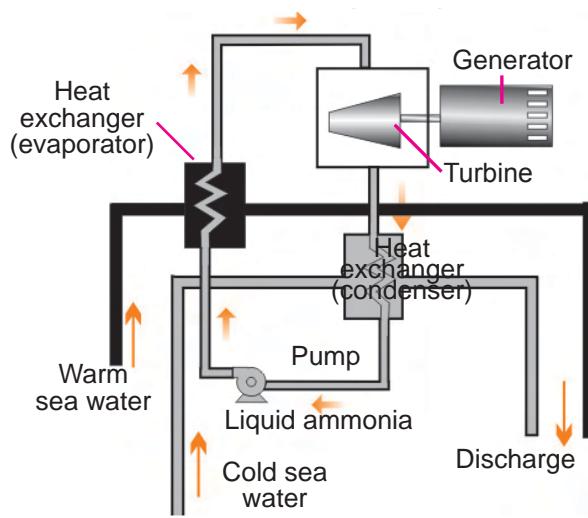


Fig. 16.20

The energy potential from the sea (tidal energy, wave energy and ocean thermal energy) is quite large, but efficient commercial exploitation is difficult.

MODEL EVALUATION

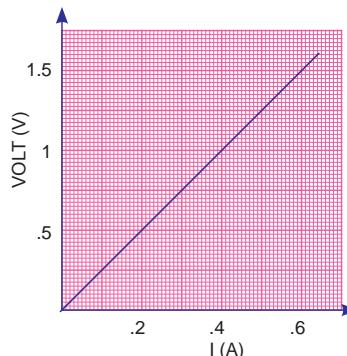
PART - A

- The potential difference required to pass a current 0.2 A in a wire of resistance 20 ohm is _____. i) 100 V ii) 4 V iii) 0.01 V iv) 40 V*
- Two electric bulbs have resistances in the ratio 1 : 2. If they are joined in series, the energy consumed in these are in the ratio _____. (1 : 2, 2 : 1, 4 : 1, 1 : 1)*
- Kilowatt-hour is the unit of _____. i) potential difference ii) electric power iii) electric energy iv) charge*
- _____ surface absorbs more heat than any other surface under identical conditions. i) White ii) Rough iii) Black iv) Yellow*
- The atomic number of natural radioactive element is _____.
i) greater than 82 ii) less than 82 iii) not defined iv) atleast 92*
- Which one of the following statements does not represent Ohm's law?
i) current / potential difference = constant
ii) potential difference / current = constant
iii) current = resistance x potential difference*
- What is the major fuel used in thermal power plants?*
- Which is the ultimate source of energy?*

9. What must be the minimum speed of wind to harness wind energy by turbines?
10. What is the main raw material used in the production of biogas?

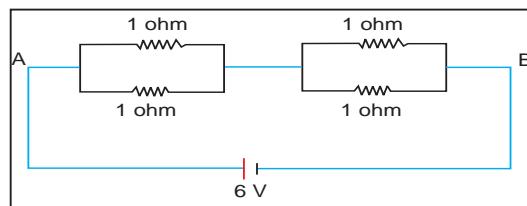
PART - B

1. Fill in the blanks
 - i) Potential difference : voltmeter; then current _____.
 - ii) Hydro power plant : Conventional source of energy; then solar energy: _____.
2. In the list of sources of energy given below, find out the odd one.
(wind energy, solar energy, hydro electric power)
3. Correct the mistakes, if any, in the following statements.
 - i) A good source of energy would be one which would do a small amount of work per unit volume of mass.
 - ii) Any source of energy we use to do work is consumed and can be used again.
4. The schematic diagram, in which different components of the circuit are represented by the symbols conveniently used, is called a circuit diagram. What do you mean by the term components?
5. The following graph was plotted between V and I values. What would be the values of V/I ratios when the potential difference is 0.5 V and 1 V?



6. We know that γ -rays are harmful radiations emitted by natural radioactive substances.
 - i) Which are other radiations from such substances?
 - ii) Tabulate the following statements as applicable to each of the above radiations
(They are electromagnetic radiation. They have high penetrating power. They are electrons. They contain neutrons)
7. Draw the schematic diagram of an electric circuit consisting of a battery of two cells of 1.5V each, three resistances of 5 ohm, 10 ohm and 15 ohm respectively and a plug key all connected in series.
8. Fuse wire is made up of an alloy of _____ which has high resistance and _____.

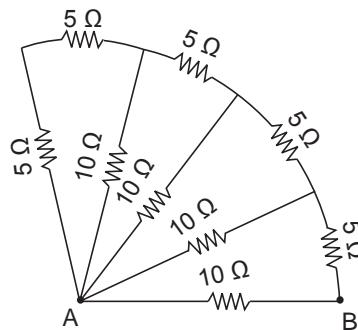
9. Observe the circuit given and find the resistance across AB.



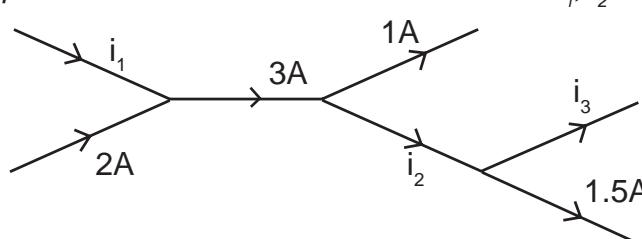
10. Complete the table choosing the right terms within the brackets.
(zinc, copper, carbon, lead, lead dioxide, aluminium.)

+ ve electrode	Lead acid accumulator	
- ve electrode	Lechlanche cell	

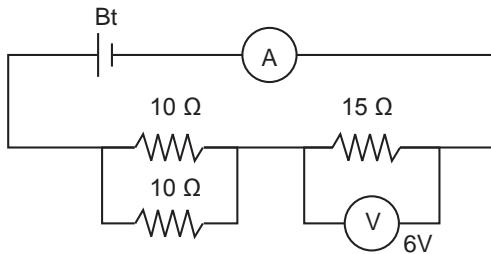
11. How many electrons flow through an electric bulb every second, if the current that passes through the bulb is 1.6 A.
12. Vani's hair dryer has a resistance of $50\ \Omega$ when it is first turned on.
- How much current does the hair dryer draw from the 230 V – line in Vani's house?
 - What happens to the resistance of the hair dryer when it runs for a long time?
(Hint : As the temperature increases the resistance of the metallic conductor increases.)
13. In the given network, find the equivalent resistance between A and B.



14. Old – fashioned serial lights were connected in a series across a 240V household line.
- If a string of these lights consists of 12 bulbs, what is the potential difference across each bulb?
 - If the bulbs were connected in parallel, what would be the potential difference across each bulb?
15. The figure is a part of a closed circuit. Find the currents i_1 , i_2 and i_3 .



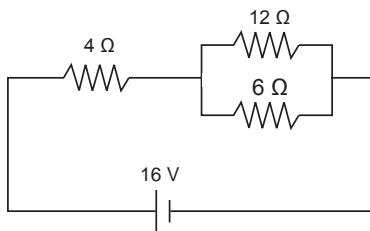
16. If the reading of the Ideal voltmeter (V) in the given circuit is 6V, then find the reading of the ammeter (A).



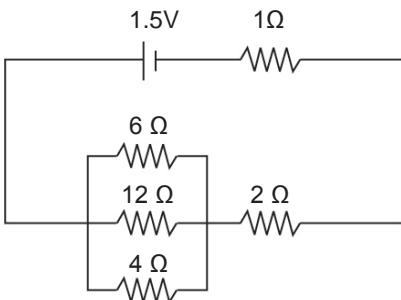
17. A wire of resistance 8Ω is bent into a circle. Find the resistance across the diameter.
18. A wire is bent into a circle. The effective resistance across the diameter is 8Ω . Find the resistance of the wire.
19. Two bulbs of 40 W and 60 W are connected in series to an external potential difference. Which bulb will glow brighter? Why?
20. Two bulbs of 70 W and 50 W are connected in parallel to an external potential difference. Which bulb will glow brighter? Why?
21. Write about ocean thermal energy?
22. In a hydroelectric power plant, more electrical power can be generated if water falls from a greater height. Give reasons.
23. What measures would you suggest to minimize environmental pollution caused by burning of fossil fuel?
24. What are the limitations in harnessing wind energy?
25. What is biomass? What can be done to obtain bioenergy using biomass?
26. Which form of energy leads to the least amount of environmental pollution in the process of harnessing and utilization? Justify your answer.

PART -C

1. Veena's car radio will run from a 12 V car battery that produces a current of 0.20 A even when the car engine is turned off. The car battery will no longer operate when it has lost $1.2 \times 10^6\text{ J}$ of energy. If Veena gets out of the car, leaving the radio on by mistake, how long will it take for the car battery to go completely dead, i.e. lose all energy? (1 day = 86400 second)
2. Find the total current that passes through the circuit. Find the heat generated across the each resistor.



3. Find the total current that passes through the circuit given in the diagram. Also find the potential difference across 1Ω resistor.

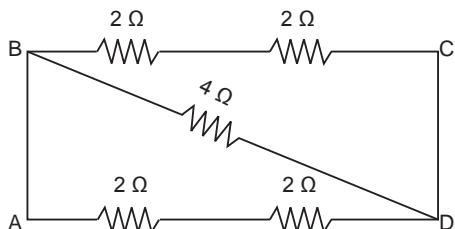


4. Raman's air-conditioner consumes 2160 W of power, when a current of 9.0 A passes through it.

- What is the voltage drop when the air-conditioner is running?
- How does this compare to the usual household voltage?
- What would happen if Raman tried connecting his air-conditioner to a 120 V line?

5. The effective resistance of three resistors connected in parallel is $60/47\text{ }\Omega$. When one wire breaks, the effective resistance becomes $15/8\text{ ohms}$. Find the resistance of the wire that is broken.

6. Find the resistance across (i) A and D (ii) B and D.



7. Explain the two different ways of harnessing energy from the ocean.

8. Five resistors of resistance ' R ' are connected such that they form a letter 'A'. Find the effective resistance across the free ends.

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3. Complete physics(IGCSE)- *Oxford University press, New York*
4. Principles of Physics(Extended) by *Halliday, Resnick & Walker, Wiley publication, New Delhi*.

Webliography: www.khanacademy.org science.howstuffworks.com
<http://arvindguptatoys.com/films.html>



MAGNETIC EFFECT OF ELECTRIC CURRENT AND LIGHT



Name	:	Oersted
Born	:	14 th August 1777
Birth place	:	Langeland Denmark
Died	:	9 th March 1851
Best known for : The study of electromagnetism		

17.1. MAGNETIC FIELD AND MAGNETIC LINES OF FORCE

We are familiar with the fact that a compass needle gets deflected when brought near a bar magnet. Why does a compass needle get deflected?

ACTIVITY 17.1

- Fix a sheet of white paper on a drawing board using some adhesive material.
- Place a bar magnet in the centre of it.
- Sprinkle some iron filings uniformly around the bar magnet (Fig 17.1).
- A salt-sprinkler may be used for this purpose.
- Now tap the board gently.
- What do you observe?

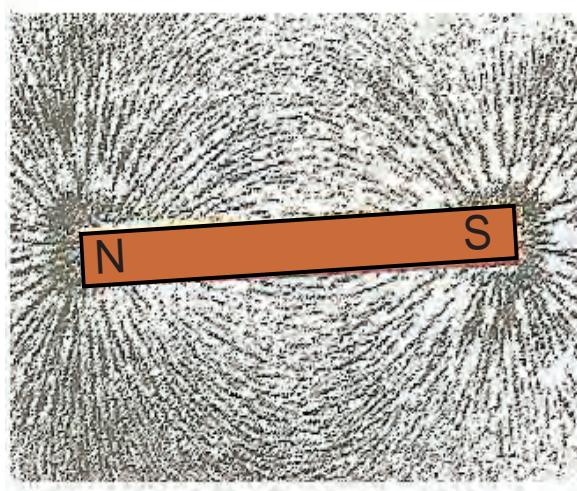


Fig. 17.1

The iron filings arrange themselves in a pattern as shown in Fig. 17.1. Why do the iron filings arrange themselves in such a pattern? What does this pattern demonstrate? The magnet exerts its influence in the region surrounding it. Therefore the iron filings experience a force. The force thus exerted makes iron filings arrange themselves in a pattern. The region surrounding the magnet, in which the force of the magnet can be experienced, is called **magnetic field**. The lines along which the iron filings align themselves represent **magnetic lines of force**.

ACTIVITY 17.2

- Take a small compass and a bar magnet.
- Place the magnet on a sheet of white paper fixed on a drawing board, using some adhesive material.
- Mark the boundary of the magnet.
- Place the compass near the north pole of the magnet. How does it behave? The south pole of the needle points towards the north pole of the magnet. The north pole of the compass is directed away from the north pole of the magnet.
- Mark the position of two ends of the needle.
- Now move the needle to a new position such that its south pole occupies the position previously occupied by its north pole.
- In this way, proceed step by step till you reach the south pole of the magnet as shown
- Join the points marked on the paper by a smooth curve. This curve represents a field line.
- Repeat the above procedure and draw as many lines as you can. You will get a pattern as shown in Fig. 17.3. These lines represent the magnetic field around the magnet. These are known as magnetic field lines.
- Observe the deflection of the compass needle as you move it along the field line. The deflection increases as the needle is moved towards the pole.

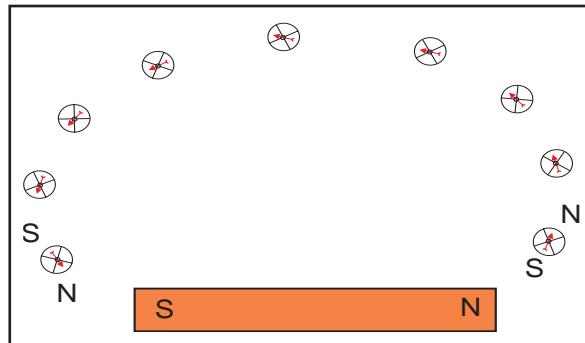


Fig 17.2

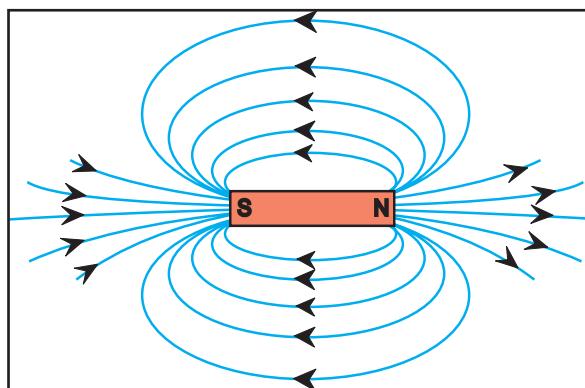


Fig 17.3

Magnetic field is a quantity that has both magnitude and direction. The direction of the magnetic field is taken to be the direction in which a north pole of the compass needle moves inside it. Therefore it is taken by convention that the field lines emerge from the north pole and merge at the south pole as shown in Fig. 17.3. Inside the magnet, the direction of field lines is from its south pole to its north pole. Thus the magnetic field lines are closed curves. The field lines never intersect each other.

17.2. MAGNETIC FIELD DUE TO CURRENT CARRYING CONDUCTOR

In the activity 17.3, the electric current through a metallic conductor produces a magnetic field around it. If the current flows in one direction (from X to Y), the north

ACTIVITY 17.3

- Take a straight thick copper wire and place it between the points X and Y in an electric circuit, as shown in Fig. 17.4. The wire XY is kept perpendicular to the plane of the paper.
- Horizontally place a small compass near this copper wire. See the position of its needle.
- Pass the current through the circuit by inserting the key into the plug.
- Observe the change in the position of the compass needle and the direction of deflection.
- Interchange the battery connection in the circuit so that the direction of the current in the copper wire changes.
- Observe the change in the direction of deflection of the needle.

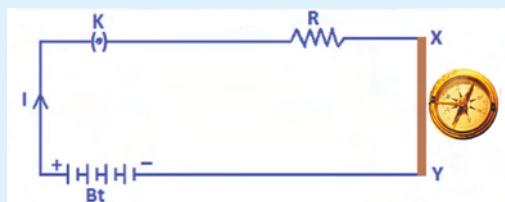


Fig 17.4

pole of the compass needle moves towards the east. If the current flows in opposite direction (from Y to X), you will see that the needle moves in the opposite direction, that is towards the west. It means that the direction of magnetic field produced by the electric current depends upon the direction of current.

17.2.1. Magnetic Field due to Current Carrying Straight Conductor

What determines the pattern of the magnetic field generated by current through a conductor? Does the pattern depend on the shape of the conductor? We shall investigate this with an activity.

ACTIVITY 17.4

- Take a battery (12 V), a variable resistance (rheostat), an ammeter (0-5A), a plug key, and a long straight thick copper wire.
- Insert the thick wire through the centre, normal to the plane of a rectangular cardboard. Take care that the cardboard is fixed and does not slide up or down.
- Connect the copper wire vertically between the points X and Y, as shown in Fig 17.5(a), in series with the battery, a plug key, ammeter and a rheostat.

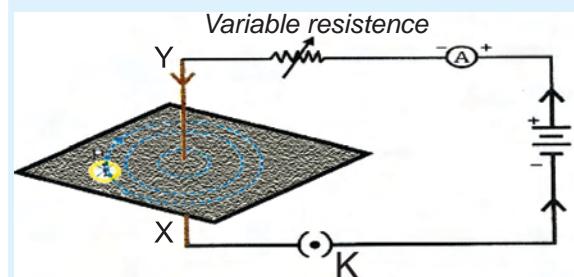


Fig. 17.5(a)

- Sprinkle some iron filings uniformly on the cardboard. (You may use a salt sprinkler for this purpose).
- Keep the rheostat at a fixed position, close the key and note the current through the ammeter.

- Gently tap the cardboard a few times. Observe the pattern of the iron filings.
- You will find that the iron filings align themselves showing a pattern of concentric circles around the copper wire, Fig 17.5(b).
- What do these concentric circles represent? They represent the magnetic field lines.
- How can the direction of the magnetic field be found? Place a compass at a point (say P) over a circle.
- Observe the direction of the needle. The direction of the north pole of the compass needle would give the direction of the field lines produced by the electric current through the straight wire at point P. Show the direction by an arrow.
- Does the direction of the magnetic field lines get reversed if the direction of current through the straight copper wire is reversed? Check it.

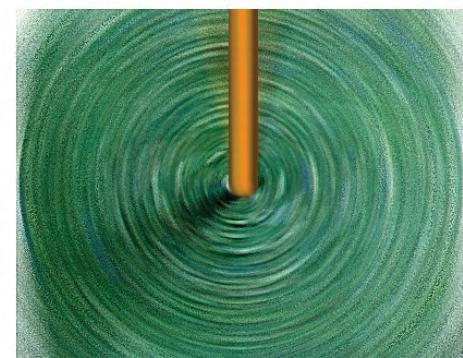


Fig. 17.5(b)

What happens to the deflection of the compass needle placed at a given point if the current in the copper wire is changed? We find that the deflection in the needle also changes. In fact, if the current is increased,

the deflection also increases. It indicates that the magnitude of the magnetic field produced at a given point increases as the current through the wire increases.

What happens to the deflection of the needle if the compass is moved away from the wire without changing the current? We see that the deflection in the needle decreases. Thus the magnetic field produced by the given current in the conductor decreases as the distance from it increases. From Fig. 17.5(b), it can be noticed that the concentric circles representing the magnetic field around a current-carrying straight wire become larger and larger as we move away from it.

17.2.2. Magnetic Field due to Current Carrying Circular Loop

We have so far observed the pattern of the magnetic field lines produced around a current-carrying straight wire. Suppose this straight wire is bent in the form of a circular loop and current is passed through it, how would the magnetic field lines look?

We know that the magnetic field produced by a current-carrying straight wire depends inversely on the distance from it. Similarly at every point of a current-carrying circular loop, the concentric circles representing the magnetic field around it becomes larger and larger as we move away from the wire (Fig. 17.6).

By the time we reach the centre of the circular loop, the arcs of these big circles would appear as straight lines. Every point on the wire carrying current would give rise to the magnetic field appearing as straight lines at the centre of the loop.

We know that the magnetic field produced by a current-carrying conductor

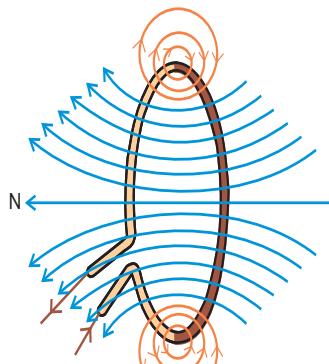


Fig. 17.6

at a given point, depends directly on the current passing through it. Therefore, if there is a circular coil having n turns, the field produced is n times as large as produced by a single turn. This is because

ACTIVITY 17.5

- Take a rectangular cardboard having two holes. Insert a circular coil having large number of turns through them, normal to the plane of the cardboard.
- Connect the ends of the coil in series with a battery, a key and rheostat, as shown in Fig. 17.7.
- Sprinkle iron filings uniformly on the cardboard.
- Plug the key.
- Tap the cardboard gently a few times. Note the pattern of the iron filings that emerges on the cardboard.

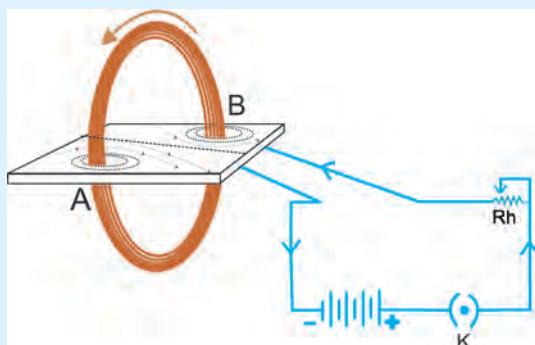


Fig. 17.7

the current in each circular turn has the same direction, and the field due to each turn then just adds up.

17.3. FORCE ON A CURRENT CARRYING CONDUCTOR IN A MAGNETIC FIELD

We know that an electric current flowing through a conductor produces a magnetic field. The field so produced exerts a force on a magnet placed in the vicinity of a conductor. French scientist Andre Marie Ampere suggested that the magnet must

ACTIVITY 17.6

- Take a small aluminium rod AB of about 5 cm. Using two connecting wires suspend it horizontally from a stand as shown in Fig. 17.8.
- Place a horse-shoe magnet in such a way that the rod lies between the two poles with the magnetic field directed upwards. For this put the North Pole of the magnet vertically below and South Pole vertically above the aluminium rod.
- Connect the aluminium rod in series with a battery, a key and a rheostat.
- Now pass a current through the aluminium rod from end B to A.
- What do you observe? It is observed that the rod is displaced towards the left.
- Reverse the direction of current flowing through the rod and observe the direction of its displacement. It is now towards the right.
- Why does the rod get displaced?

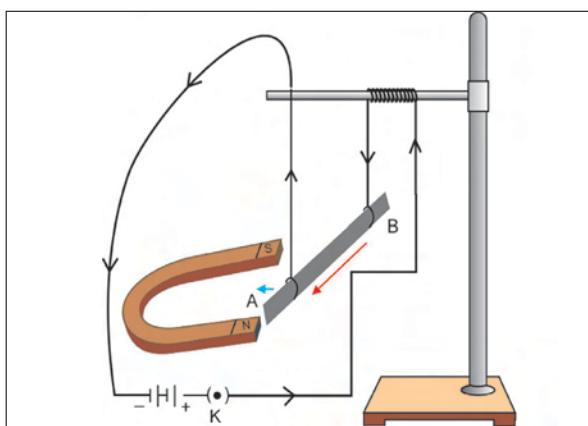


Fig. 17.8

also exert an equal and opposite force on the current-carrying conductor. The force due to a current-carrying conductor can be demonstrated through the activity 17.6.

The displacement of the rod in the above activity suggests that a force is exerted on the current-carrying aluminium rod when it is placed on a magnetic field. It also suggests that the direction of force is also reversed when the direction of current through the conductor is reversed. Now change the direction of the field to vertically downwards by interchanging the two poles of the magnet. It is once again observed that the direction of force acting on the current-carrying rod gets reversed. It shows that the direction of force on the conductor depends upon the direction of current and the direction of magnetic field. Experiments have shown that the displacement of the rod is maximum when the direction of current is at right angles to the direction of the magnetic field.

17.3.1. Fleming's Left Hand Rule

When the direction of the current and that of the magnetic field are perpendicular to each other, the force is perpendicular to both of them.

The three directions can be illustrated through a simple rule, called Fleming's left hand rule.(Fig.17.9).

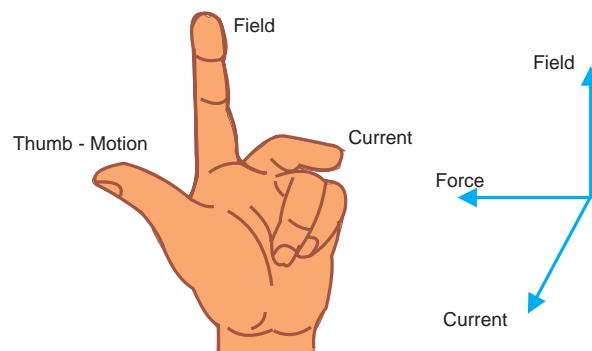


Fig. 17.9

Stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular. If the forefinger points in the direction of magnetic field and the middle finger points in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.

17.4. ELECTRIC MOTOR

An electric motor is a rotating device that converts electrical energy into mechanical energy. Do you know how an electric motor works?

An electric motor, as shown in Fig. 17.10, consists of a rectangular coil ABCD of insulated copper wire. The coil is placed between two poles of a field magnet such that the arm AB and CD are perpendicular to the direction of magnetic field. The ends of the coil are connected to the two halves S_1 and S_2 of a split ring. The inner side of these halves are insulated and attached to an axle. The external conducting edges of S_1 and S_2 touch two conducting stationary brushes B_1 and B_2 , respectively.

The current in the coil ABCD enters from the source battery through conducting brush B_1 and flows back to the battery through brush B_2 .

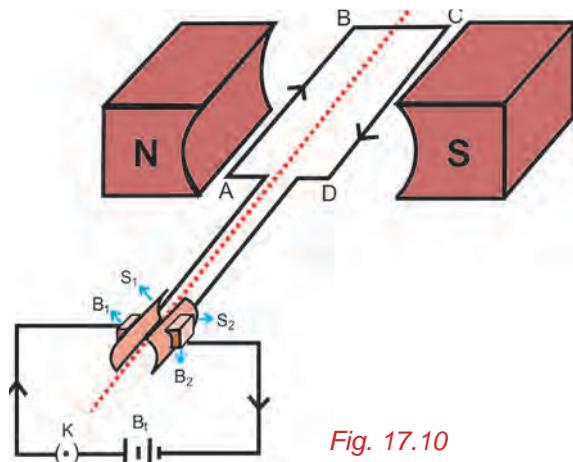


Fig. 17.10

Notice that the current in arm AB of the coil flows from A to B. In arm CD it flows from C to D, that is, opposite to the direction of current through arm AB. On applying Fleming's left hand rule for the direction of force on a current-carrying conductor in a magnetic field, we find that the force acting on arm AB pushes it downwards while the force acting on arm CD pushes it upwards.

Thus the coil and the axle, mounted free to turn about an axis, rotate anti-clockwise. At half rotation S_2 makes contact with the brush B_1 and S_1 with brush B_2 . Therefore the current in the coil gets reversed and flows along the path DCBA. A device that reverses the direction of flow of current through a circuit is called a **commutator**. In electric motors the split ring acts as a commutator. The reversal of current also reverses the direction of force acting on the two arms AB and CD.

Thus the arm AB of the coil that was earlier pushed down is now pushed up and the arm CD previously pushed up is now pushed down. Therefore the coil and the axle rotate half a turn more in the same direction. The reversing of the current is repeated at each half rotation, giving rise to a continuous rotation of the coil and to the axle.

The commercial motors use

- (i) an electro magnet in place of a permanent magnet
- (ii) a large number of turns of the conducting wire in the current-carrying coil
- (iii) a soft iron core on which the coil is wound .

The soft iron core on which the coil is wound is called an **armature**. This enhances the power of the motor.

17.5. ELECTROMAGNETIC INDUCTION

Faraday in 1831 discovered that **an electro motive force is produced in a circuit whenever the magnetic flux is linked with a coil changes**. He showed that emf is generated in a conductor whenever there is a relative motion between the conductor and a magnetic field.

The emf produced in this way is called an induced emf and the phenomenon is known as **electromagnetic induction**. The induced emf will cause a current to flow through the conductor. Such a current is known as **induced current**. Faraday made an important breakthrough by discovering how a magnet can be used to generate electric currents.

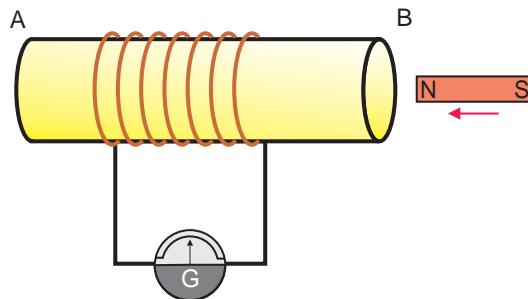
17.5.1. Faraday's Experiments

We know that **when a current-carrying conductor is placed in a magnetic field, it experiences a force. This force causes the conductor to move.**

Now let us imagine a situation in which a conductor is moving inside a magnetic field or a magnetic field is changing around a fixed conductor.

ACTIVITY 17.7

- Take a coil of wire AB having a large number of turns.
- Connect the ends of the coil to a galvanometer as shown in Fig. 17.11
- Take a strong bar magnet and move its north pole towards the end B of the coil.
- Do you find any change in the galvanometer reading?
- There is a momentary deflection in the needle of the galvanometer, say to the right. This indicates the presence of a current in the coil AB. The deflection becomes zero, the moment the motion of the magnet stops.
- Now withdraw the north pole of the magnet away from the coil. Now the galvanometer is deflected towards the left, showing that the current is now set up in the direction opposite to the first.
- Place the magnet stationary at the point near to the coil, keeping its north pole towards the end B of the coil.
- We see that the galvanometer needle deflects towards the right when the coil is moved towards the north pole of the magnet. Similarly the needle moves towards left when the coil is moved away.
- When the coil is kept stationary with respect to the magnet, the deflection of the galvanometer drops to zero. What do you conclude from this activity?

**Fig. 17.11**

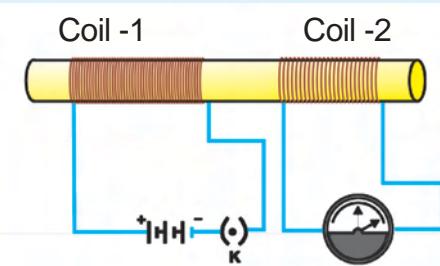
What will happen? To observe this effect, let us perform the activity 17.7.

You can also check that if you have moved the South Pole of the magnet towards the end B of the coil, the deflections in the galvanometer would just be opposite to the previous case. When the coil and the magnet are both stationary, there is no deflection in the galvanometer. It is thus clear that motion of a magnet with respect to the coil produces an induced electromotive force, which sets up an induced electric current in the circuit.

Let us now perform a different activity in which the moving magnet is replaced by a current-carrying coil and the current in the coil can be varied.

ACTIVITY 17.8

- Take two different coils of copper wire having large number of turns (say 50 and 100 turns respectively). Insert them over a non conducting cylindrical roll as shown in Fig. 17.12.

**Fig. 17.12**

- Connect the coil-1 having large number of turns, in series with a battery and a plug key. Also connect the other coil-2 with a galvanometer.
- Plug in the key. Observe the galvanometer. Is there a deflection in its needle? You will observe that the needle of the galvanometer instantly jumps to one side and just as quickly returns to zero, indicating a momentary current in coil-2.
- Disconnect coil-1 from the battery. You will observe that the needle momentarily moves, but to the opposite side. It means that now the current flows in the opposite direction in coil -2.

In this activity we observe that as soon as the current in coil-1 reaches either a steady value or zero, the galvanometer in coil-2 shows no deflection. From these observations we conclude that a potential difference is induced in coil-2, whenever the current through coil-1 is changing. Coil-1 is called the primary coil and coil-2 is called the secondary coil. As the current in the first coil changes, the magnetic field associated

with it also changes. Thus the magnetic field lines around the secondary coil also change. Hence the change in magnetic field lines associated with the secondary coil is the cause of induced electric current in it. **The direction of the induced current can be found using Fleming's right hand rule.**

Fleming's right hand rule: Stretch the thumb, forefinger and middle finger of right hand so that they are mutually perpendicular to each other. If the forefinger indicates the direction of the magnetic field and the thumb shows the direction of motion of conductor, then the middle finger will show the direction of induced current.

17.6. ELECTRIC GENERATOR

The phenomenon of electromagnetic induction is employed to produce large currents for use in homes and industry. In an electric generator, mechanical energy is used to rotate a conductor in a magnetic field to produce electricity.

An Alternating Current (AC) electric generator, as shown in Fig.17.13a, consists of a rotating rectangular coil ABCD placed between the two poles of a permanent magnet. The two ends of this coil are

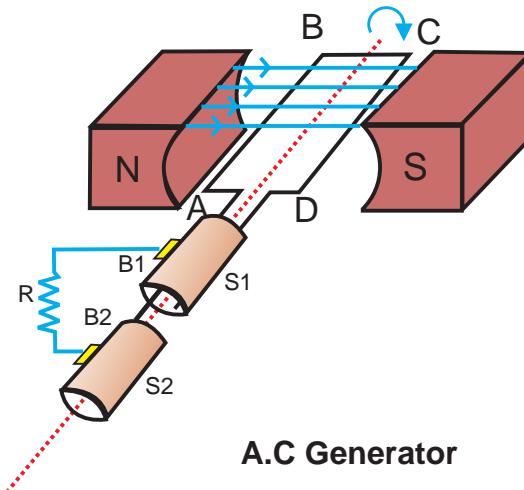


Fig 17.13(a)

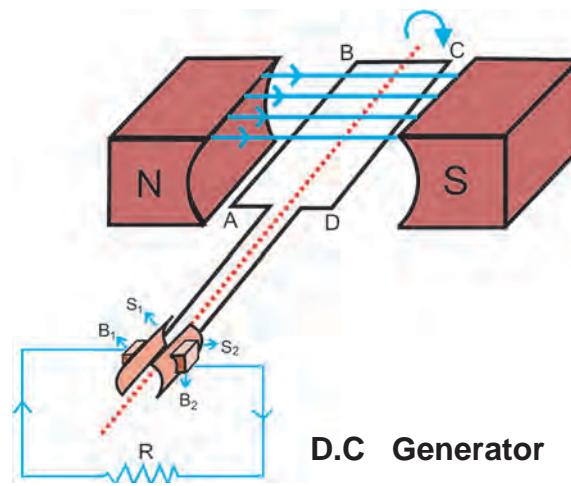


Fig 17.13(b)

connected to the two slip rings S_1 and S_2 . The inner sides of these rings are made insulated. The two conducting stationary brushes B_1 and B_2 are kept pressed separately on the rings S_1 and S_2 respectively. The two rings S_1 and S_2 are internally attached to an axle. The axle may be mechanically rotated from outside to rotate the coil inside the magnetic field. Outer ends of the two brushes are connected to the external circuit.

When the axle attached to the two rings is rotated such that the arm AB moves up, the arm CD moves down in the magnetic field produced by the permanent magnet. Let us say the coil ABCD is rotated clockwise. By applying Fleming's right-hand rule the induced currents are setup in these arms along the directions AB and CD. Thus an induced current flows in the direction ABCD. If there are large number of turns in the coil, the current generated in each turn adds up to give a large current through the coil. This means that the current in the external circuit **flows from B_1 to B_2** .

After half a rotation, arm CD starts moving up and AB moving down. As a result, the directions of the induced currents in both the arms change, giving rise to the net induced current in the direction DCBA. The current in the external circuit now **flows from B_2 to B_1** . Thus after every half rotation the polarity of the current in the respective arms changes. Such a current which changes direction after equal intervals of time, is called an alternating current (AC). This device is called an AC generator.

To get a direct current (DC), a split-ring type commutator must be used with this arrangement, Fig.17.13b, one brush is at all times in contact with the arm moving up in the field, while the other is in contact with the arm moving down. Thus a unidirectional current is produced. The generator is thus called a DC generator.

An important advantage of AC over DC is that electric power can be transmitted over long distances without much loss of energy.

17.7. LIGHT

We see a variety of objects in the world around us. However we are unable to see anything in a dark room. On lighting up the room, things become visible. What makes things visible? During the day the sunlight helps us to see objects. An object reflects light that falls on it. This reflected light when received by our eyes, enables us to see things.

There are a number of common wonderful phenomena associated with light. In this chapter, we shall study the phenomena of reflection and refraction of light using the straight-line propagation of light.

Reflection of Light

A highly polished surface, such as a mirror, reflects most of the light falling on it. You are already familiar with the laws of reflection of light. Let us recall these laws.

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

These laws of reflection are applicable to all types of reflecting surfaces including spherical surfaces.

Spherical mirrors

ACTIVITY 17.9

- Take a perfect hemispherical spoon. Try to view your face in its curved surface.
- Do you get the image? Is it larger or smaller?
- Move the spoon slowly away from your face. Observe the image. How does it change?
- Reverse the spoon and repeat the activity. How does the image look like now?
- Compare the characteristics of the images on the two surfaces.

The curved surface of a shining spoon could be considered as a curved mirror. The most commonly used type of curved mirror is the spherical mirror. The reflecting surface of a spherical mirror may be curved inwards or outwards. **A spherical mirror whose reflecting surface is curved inwards is called a concave mirror. A spherical mirror whose reflecting surface is curved outwards is called a convex mirror.** The schematic representation of these mirrors is shown in Fig. 17.14.

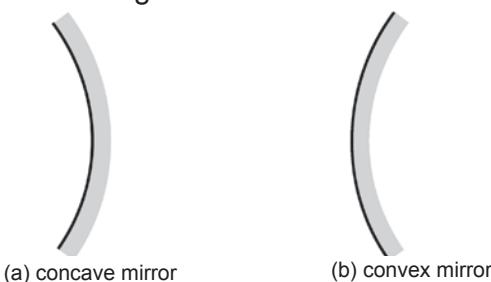


Fig 17.14

You may now understand that the surface of the spoon curved inwards can be approximated to a concave mirror and the surface of the spoon bulged outwards can be approximated to a convex mirror.

Before we move on about spherical mirrors, we need to recognise and understand the meaning of a few terms. These terms are commonly used in discussions about spherical mirrors.

The centre of the reflecting surface of a spherical mirror is a point called the **pole**. It is represented by the letter P.

The reflecting surface of a spherical mirror forms a part of a sphere. This sphere has a centre. This point is called the **centre of curvature** of the spherical mirror. It is represented by the letter C.

The radius of the sphere of which the reflecting surface of a spherical mirror forms a part, is called the **radius of curvature** of the mirror. It is represented by the letter R.

The imaginary straight line passing through the pole and the centre of curvature of a spherical mirror is called the **principal axis**.

ACTIVITY 17.10

- Hold a concave mirror in your hand and direct its reflecting surface towards the sun.
- Direct the light reflected by the mirror on to a sheet of paper held close to the mirror.
- Move the sheet of paper back and forth gradually until you find on the paper sheet a bright, sharp spot of light.
- Hold the mirror and the paper in the same position for a few minutes. What do you observe? Why?

Let us understand important terms related to mirrors, through the activity 17.10.

The paper at first begins to burn producing smoke. It may even catch fire. Why does it burn? The light from the sun is converged at a point, as a sharp, bright spot by the mirror. In fact, this spot of light is the image of the sun on the sheet of paper. This point is the focus of the concave mirror. The heat produced due to the convergence of the sunlight ignites the paper. The distance of the image from the position of the mirror gives the approximate focal length of the mirror.

Observe Fig. 17.15(a). A number of rays parallel to the principal axis are falling on a concave mirror. Observe the reflected rays. They are all meeting at a point on the principal axis of the mirror. This point is called the principal focus of the concave mirror. Similarly observe Fig. 17.15(b). How are the rays parallel to the principal axis reflected by a convex mirror? The reflected rays appear to come from a point on the principal axis. This point is called the principal focus of the convex mirror. **The principal focus is represented by the letter F.**

The distance between the pole and the principal focus of a spherical mirror is called the focal length. It is represented by the letter f.

The effective diameter of the reflecting surface of spherical mirror is called its **aperture**. In Fig. 17.15, distance MN represents the aperture. In our discussion we shall consider only such spherical mirrors whose aperture is much smaller than its radius of curvature.

Is there any relationship between the radius of curvature R, and focal length f, of a spherical mirror? For spherical mirrors of

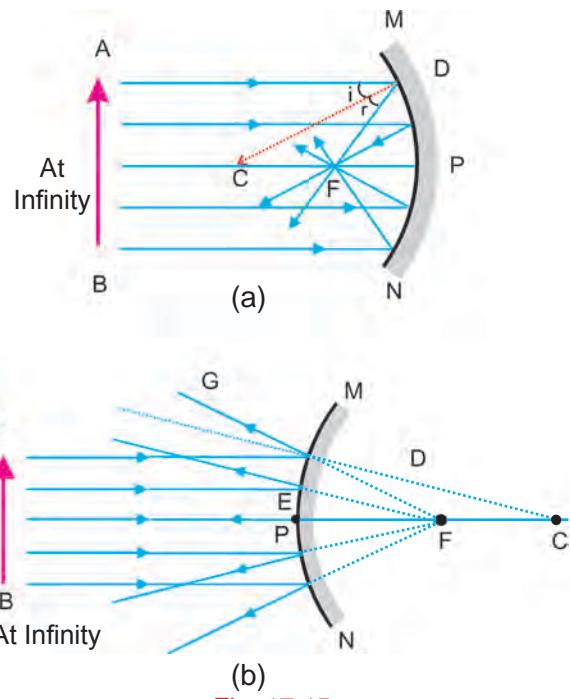


Fig. 17.15

small apertures the radius of curvature is found to be equal to twice the focal length ($R = 2f$).

17.7.1. Reflection of Light by Spherical Mirror

The reflection of light by a spherical mirror takes place according to certain definite rules as follows.

(i) A ray parallel to the principal axis, after reflection, will pass through principal focus in case of a concave mirror or appear to diverge from the principal focus in case of a convex mirror. This is illustrated in Fig. 17.16(a) and 17.16 (b).

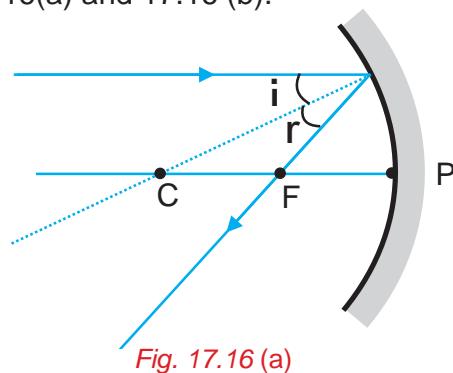


Fig. 17.16 (a)

MAGNETIC EFFECT OF ELECTRIC CURRENT AND LIGHT

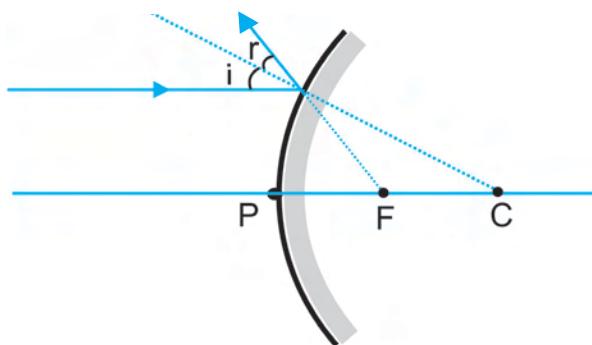


Fig. 17.16 (b)

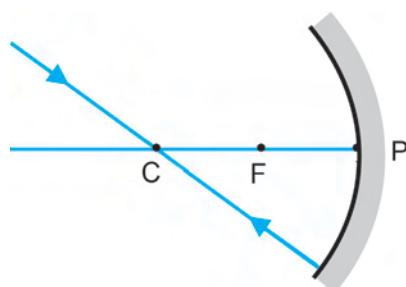


Fig 17.18 (a)

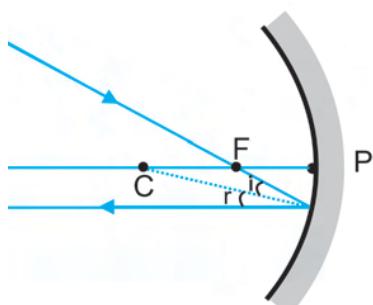


Fig. 17.17(a)

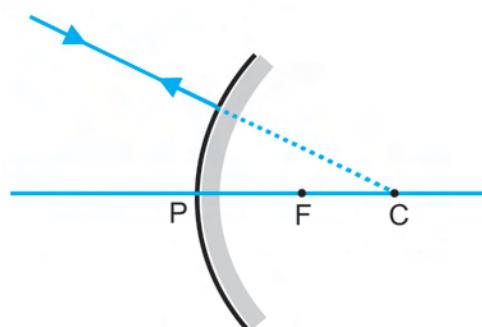


Fig 17.18 (b)

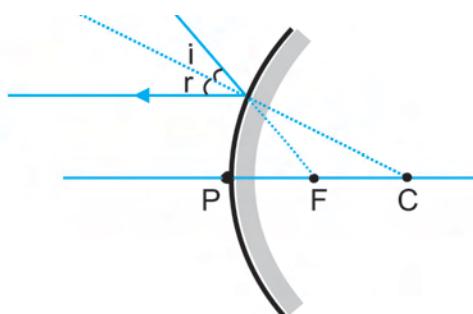


Fig. 17.17(b)

(ii) A ray passing through the principal focus of a concave mirror or a ray directed towards the principal focus of a convex mirror, after reflection, will emerge parallel to the principal axis. This is illustrated in Fig.17.17 (a) and (b).

(iii) A ray passing through the centre of curvature of a concave mirror or directed in the direction of the centre of curvature of a convex mirror, after reflection, is reflected back along the same path. This is illustrated in Fig.17.18 (a) and (b).

Image formation by concave mirror

How about the images formed by spherical mirrors? How can we locate the image formed by a concave mirror for different positions of the object? Are the images real or virtual? Are the images enlarged, diminished or have the same size?

The nature, position and size of the image formed by a concave mirror depend on the position of the object in relation to point P , F and C . The image formed is real for some positions of the object. It is found to be a virtual image for a certain other position. The image is either magnified, diminished or has the same size, depending on the position of the object.

We can study the formation of image by spherical mirrors by drawing ray diagrams. To construct the ray diagrams, it is more convenient to consider only two rays. These rays are so chosen that it is easy to know

their directions after reflection from the mirror. You may take any two of the rays mentioned in the previous section for locating the image of the point object. The intersections of the two reflected rays give the position of image of the point object. This is illustrated in the Fig. 17.19.

Uses of Concave Mirror

Concave mirrors are commonly used in torches, search-lights and vehicles head lights to get powerful parallel beams of light. They are used as shaving mirrors to see a magnified image of the face. The dentists use concave mirrors to see large images of the teeth of patients. Large concave mirrors are used to focus sun light to produce heat in solar furnaces.

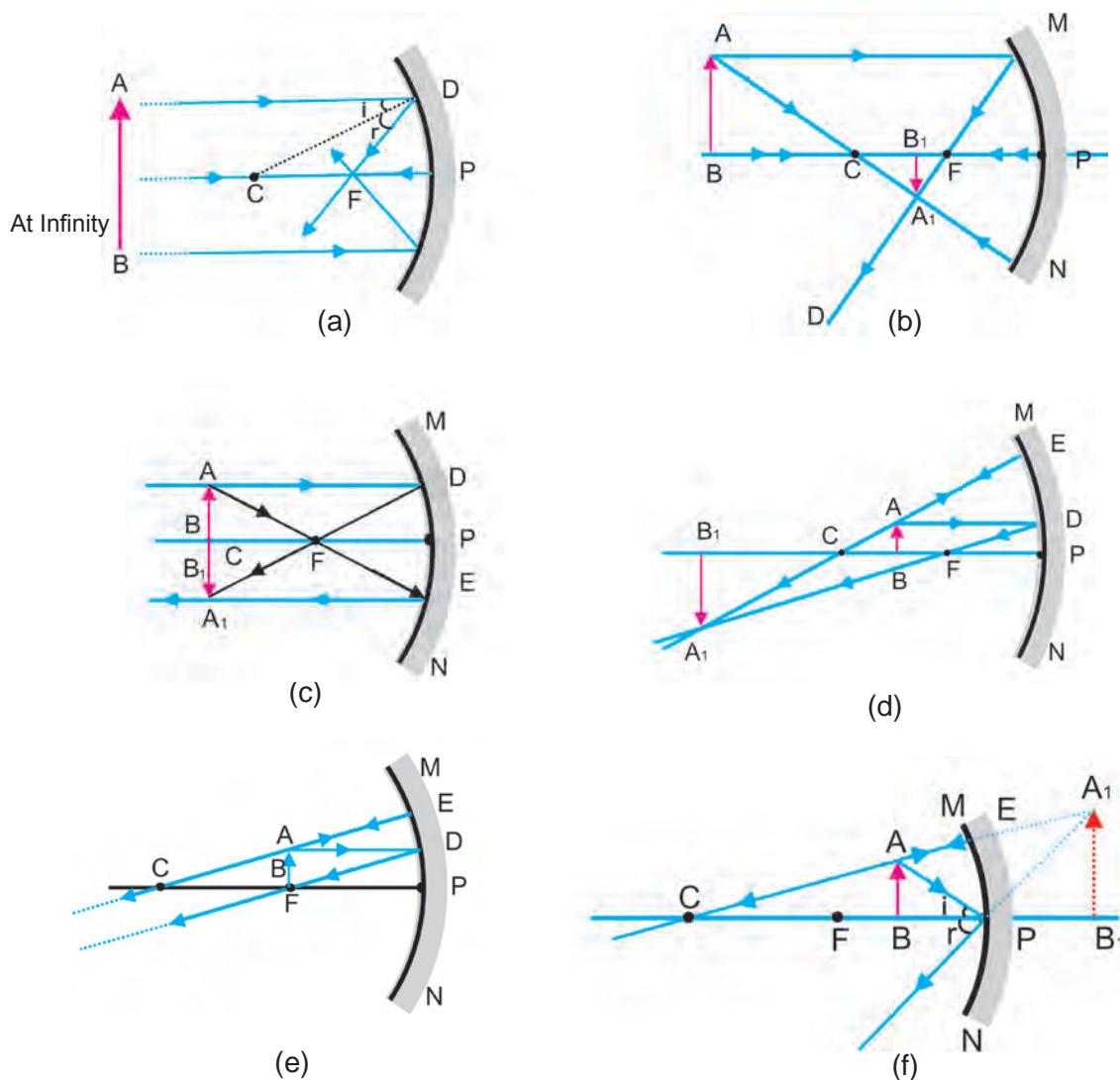


Fig 17.19

MAGNETIC EFFECT OF ELECTRIC CURRENT AND LIGHT

A summary of these observations is given in Table: 17.1.

Position of the Object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F	Highly diminished, point-sized	Real and inverted
Beyond C	Between F and C	Diminished	Real and inverted
At C	At C	Same size	Real and inverted
Between C & F	Beyond C	Enlarged	Real and inverted
At focus F	At infinity	Highly enlarged	Real and inverted
Between P and F	Behind the Mirror	Enlarged	Virtual and erect

Table 17.1

Image Formation by a Convex Mirror

We consider two positions of the object for studying the image formed by a convex mirror. First when the object is at infinity and the second position is when the object is at a finite distance from the mirror. The ray diagrams for the formation of image by a convex mirror for these two positions of the object are shown in Fig 17.20(a) and (b), respectively.

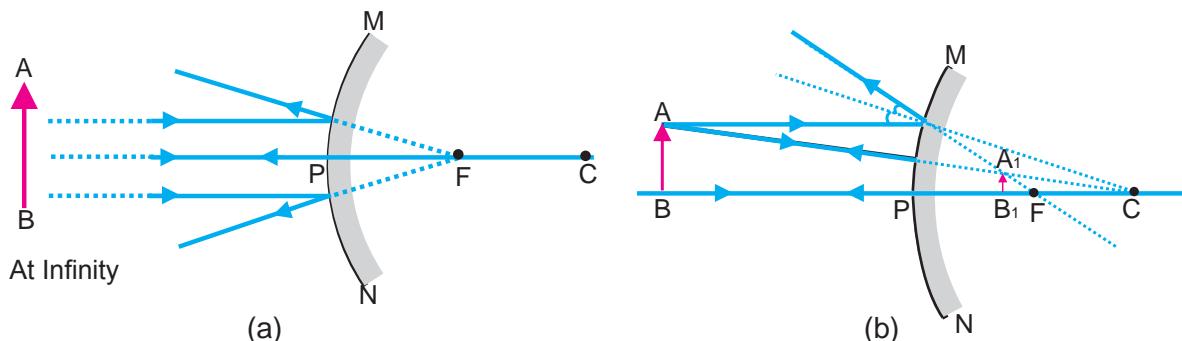


Fig. 17.20

A summary of these observations is given in Table: 17. 2

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F behind the Mirror	Highly diminished, point-sized	Virtual and erect
Between infinity and Pole P of the Mirror	Between P and F behind the Mirror	Diminished	Virtual and erect

Table 17.2

You have studied the image formation by a concave mirror and a convex mirror. Which of these mirrors will give the full image of a large object? Let us understand this through an activity.

ACTIVITY 17.11

- Observe the image of a distant tree in a concave mirror.
- Could you see a full length image?
- Repeat this activity with a convex mirror. Did the mirror show the full length image of the object?
- Explain your observations with reason.

You can see a full length image of a tree in a small convex mirror.

Uses of Convex Mirrors

Convex mirrors are commonly used as rear-view mirrors in vehicles. These mirrors are fitted on the sides of the vehicle, enabling the driver to see traffic behind him/her to facilitate safe driving. Convex mirrors are preferred because they always give an erect image. Also they have a wider field of view as they are curved outwards.

Sign Convention for Reflection by Spherical Mirrors

While dealing with the reflection of light by spherical mirrors, we shall follow a set of sign conventions called the **New Cartesian Sign Convention**. In this convention, the pole (P) of the mirror is taken as the origin. The principal axis of the mirror is taken as the X'X axis of the coordinate system. The conventions are as follows.

- The object is always placed to the left of the mirror.
- All distances parallel to the principal axis are measured from the pole of the mirror.
- All the distances measured to the right of the origin (along +X axis) are taken as positive while those measured to the left of the origin (along -X axis) are taken as negative.
- Distances measured perpendicular to and above the principal axis (along +Y axis) are taken as positive.
- Distances measured perpendicular to and below the principal axis (along -Y axis) are taken as negative.

The New Cartesian Sign Convention described above is illustrated in Fig. 17.21.

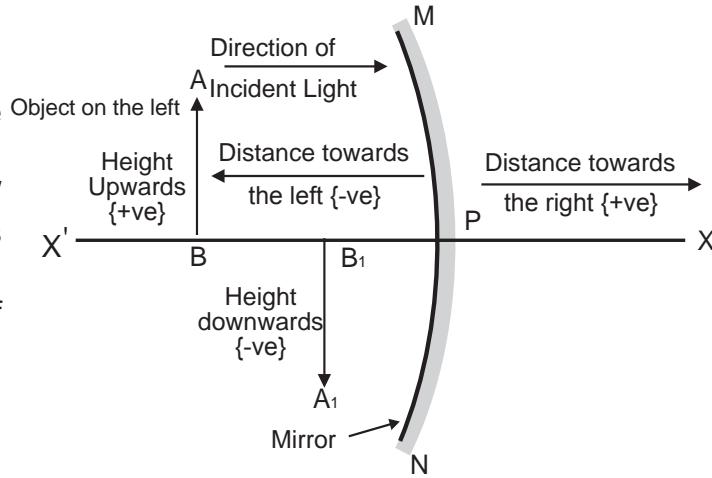


Fig. 17.21

These sign conventions are applied to obtain the mirror formula

Mirror Formula

In a spherical mirror, the distance of the object from its pole is called the **object distance (u)**. The distance of the image from the pole of the mirror is called the

image distance (v). You already know that the distance of the principal focus from the pole is called the **focal length (f)**. There is a relationship between these three quantities given by the mirror formula which is expressed as

$$1/v + 1/u = 1/f$$

This formula is valid in all situations for all spherical mirrors for all positions of the object. You must use the New Cartesian Sign convention while substituting numerical values for u , v , f , and R in the mirror formula for solving problems.

Example: 17.1

A convex mirror used as rear-view mirror in an automobile has a radius of curvature of 3 m. If a bus is located 5 m from this mirror, find the position and nature of the image.

Solution:

Radius of curvature, $R = +3.00 \text{ m}$

$$f = \frac{R}{2} = \frac{+3.00}{2} = 1.5 \text{ m}$$

Object distance $u = -5.00 \text{ m}$

Image distance $v = ?$

We know,

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

(or)

$$\begin{aligned} \frac{1}{v} &= \frac{1}{f} - \frac{1}{u} \\ &= \frac{1}{1.5} - \frac{1}{-5.00} = \frac{1}{1.5} + \frac{1}{5.00} \\ &= \frac{5.00 + 1.50}{7.50} = \frac{6.50}{7.50} \end{aligned}$$

$$v = \frac{7.50}{6.50} = 1.15 \text{ m}$$

The image is 1.15 m at the back of the mirror. The image is virtual.

17.7.2. Refraction of Light

Light seems to travel along straight-line paths in a transparent medium. What happens when light enters from one transparent medium to another? Does it still move along a straight-line path or does it change its direction? Let us recall some of our day-to-day experiences.

You might have observed that the bottom of a tank or a pond containing water appears to be raised. Similarly, when a thick glass slab is placed over some printed matter, the letters appear raised when viewed through the glass slab. Why does this happen? Have you seen a pencil partially immersed in water in a glass tumbler? It appears to be bent at the interface of air and water. You might have observed that a lemon kept in water in a glass tumbler appears to be bigger than its actual size, when viewed from the sides. How can you account such experiences?

Let us consider the case of the apparent displacement of the pencil partly immersed in water. The light reaching you from the portion of the pencil inside water seems to come from a different direction, compared to the part above water. This makes the pencil appear to be displaced at the interface. For similar reasons, the letters appear to be raised when seen through a glass slab placed over it.

Does a pencil appear to be displaced to the same extent, if instead of water, we use liquids like kerosene or turpentine? Will the letters appear to rise to the same height if we replace a glass slab with a transparent plastic slab? You will find

that the extent of the effect is different for different pair of media. These observations indicate that light does not travel in the same direction in all media. It appears that when travelling obliquely from one medium to another, the direction of propagation of light in the second medium changes. This phenomenon is known as **refraction of light**. Let us understand this phenomenon further through an activity.

ACTIVITY 17.12

- Place a coin at the bottom of a bucket filled with water.
- With your eye to one side on the surface of the water, try to pick up the coin in one go. Did you succeed in picking up the coin?
- Repeat the activity. Why did you not succeed in doing it in one go?
- Ask your friends to do this. Compare your experience with theirs.

The apparent position of the coin as seen through water differs from its actual position.

17.7.3. Laws of Refraction

Refraction of light is due to change in the speed of light as it enters from one transparent medium to another. Experiments show that the refraction of light occurs according to certain laws. The following are the laws of refraction of light.

- (i) **The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.**
- (ii) **The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.**

If i is the angle of incidence and r is the angle of refraction, then,

$$\frac{\sin i}{\sin r} = \text{constant}$$

This constant value is called the refractive index (μ) of the second medium with respect to the first.

17.7.4. Refractive Index

We know that a ray of light traveling obliquely from one transparent medium into another will change its direction in the second medium. The extent of the change in direction that takes place in a given pair of media is expressed in terms of the refractive index of the second medium with respect to the first medium.

The refractive index can be linked to the relative speed of propagation of light in different media. Light propagates with different speeds in different media. It travels the fastest in vacuum with the highest speed of $3 \times 10^8 \text{ m s}^{-1}$. Its speed reduces considerably in glass.

Consider a ray of light travelling from medium 1 into medium 2 as in Fig. 17.22.

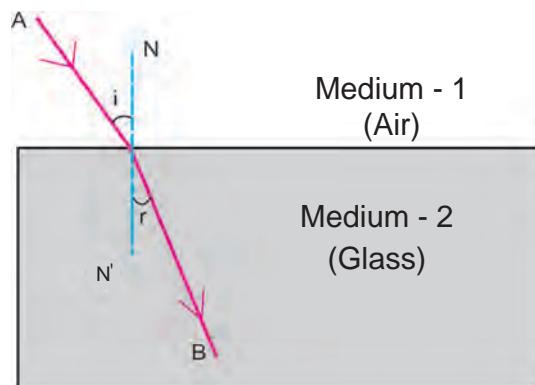


Fig. 17.22

Let i, r be the angle of incidence and angle of refraction. The refractive index of

the second medium with respect to the first is

$$\mu = \frac{\sin i}{\sin r}$$

$$\mu = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}}$$

17.7.5. Refraction by Spherical Lenses

Spherical Lenses

You might have seen people using spectacles for reading. The watchmakers use a small magnifying glass to see tiny parts. Have you ever touched the surface of a magnifying glass with your hand? Is it a plane surface or curved? Is it thicker in the middle or at the edges? The glasses used in spectacles and that by watchmaker are examples of lenses. What is a lens? How does it bend light rays?

A transparent material bound by two surfaces, of which one or both surfaces are spherical, forms a lens. This means that a lens is bound by atleast one spherical surface. In such spherical lenses, the other surface would be plane. A lens may have two spherical surfaces, bulging outwards. Such a lens is called a double convex lens. It is simply called a convex lens. It is thicker at the middle as compared to the edges. Convex lens converges light rays.

Hence it is called converging lens. Similarly, a double concave lens is bounded by two spherical surfaces, curved inwards. It is thicker at the edges than at the middle. Such lenses diverge light rays and are called diverging lenses. A double concave lens is simply called a concave lens.

Let us understand the meaning of a few terms which are commonly used in

discussions about spherical lenses.

A lens has two spherical surfaces. Each of these surfaces forms a part of a sphere. The centres of these spheres are called **centres of curvature of the lens**. The centre of curvature of a lens is usually represented by the letter C. Since there are two centres of curvature, we may represent them as C_1 and C_2 .

The imaginary straight line passing through the two centres of the curvature of a lens is called its **principal axis**.

The central point of a lens is called its **optical centre**. It is represented by the letter O. A ray of light through the optical centre of a lens passes without suffering any deviation.

The effective diameter of the circular outline of a spherical lens is called its **aperture**. Lenses whose aperture is much less than its radius of curvature are called thin lenses with small aperture. What happens when parallel rays of light are incident on a lens?

ACTIVITY 17.13

- CAUTION: Do not look at the sun directly or through a lens while doing this activity or otherwise. You may damage your eyes if you do so.
- Hold a convex lens in your hand. Direct it towards the sun.
- Focus the light from the sun on a sheet of paper. Obtain a sharp bright image of the sun.
- Hold the paper and the lens in the same position for a while. Keep observing the paper. What happens? Why?

The light from the sun constitutes parallel rays. These rays were converged by the lens as a sharp bright spot. This is the real image of the sun. The concentration of the sun light at this spot generated heat. This caused the paper to burn.

Observe Fig. 17.23(a) carefully.

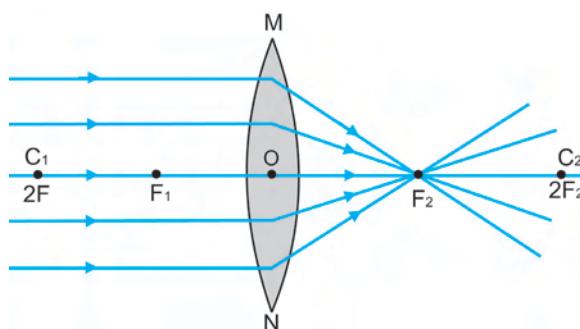


Fig. 17.23(a)

Several rays of light parallel to the principal axis are falling on a convex lens. These rays after refraction from the lens are converging to a point on the principal axis. This point is called the **principal focus** of the lens.

Observe Fig. 17.23(b) carefully,

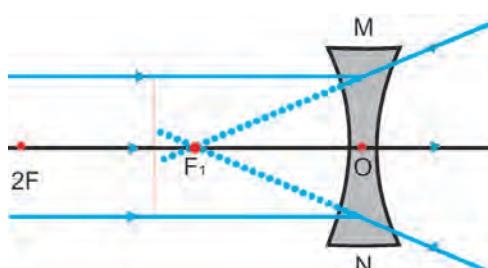


Fig. 17.23(b)

Several rays of light parallel to the principal axis are falling on a concave lens. These rays after refraction from the lens, appear to diverge from a point on the principal axis. This point is called the **principal focus** of the concave lens.

If you pass parallel rays from the opposite surface of the lens, you will get

another principal focus on the opposite side. Letter F is usually used to represent principal focus. However, a lens has two principal foci. They are represented by F_1 and F_2 .

The distance of the principal focus from the optical centre of a lens is called its **focal length**. The letter f is used to represent the focal length.

17.7.6 Image Formation by Lenses

We can represent image formation by lenses using ray diagrams. Ray diagrams will also help us to study the nature, position and relative size of the image formed by the lenses. For drawing ray diagrams in lenses, we consider any two of the following rays.

(i) A ray of light from the object, parallel to the principal axis, after refraction from a convex lens, passes through the principal focus on the other side of the lens, as shown in Fig. 17.24(a). In case of a concave lens, the ray appears to diverge from the principal focus located on the same side of the lens, as shown in Fig. 17.24(b)

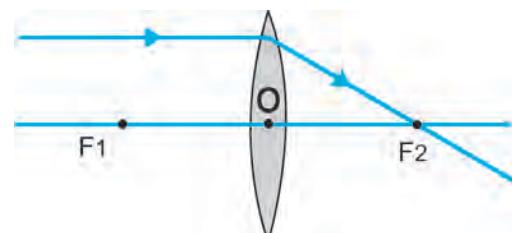


Fig. 17.24 (a)

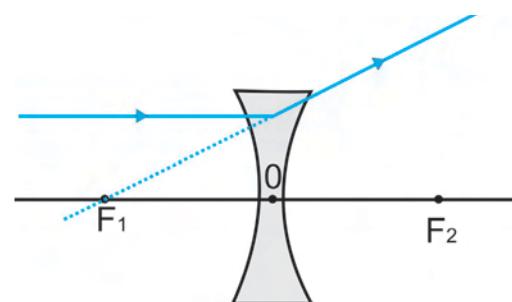


Fig. 17.24 (b)

MAGNETIC EFFECT OF ELECTRIC CURRENT AND LIGHT

(ii) A ray of light passing through a principal focus after refraction from a convex lens will emerge parallel to the principal axis. This is shown in Fig 17.25(a). A ray of light appearing to meet at the principal focus of a concave lens, after refraction, will emerge parallel to the principal axis. This is shown in Fig. 17.25(b).

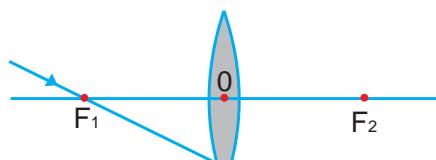


Fig. 17.25(a)

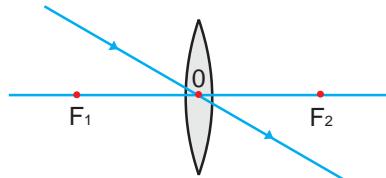


Fig. 17.26 (a)

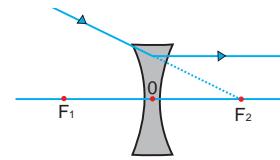


Fig. 17.25(b)

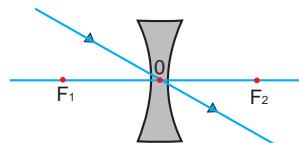
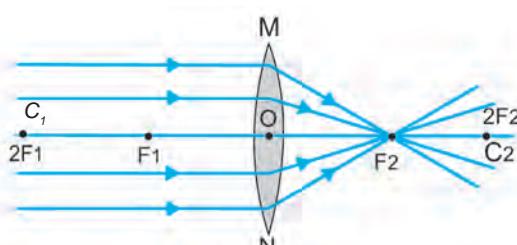
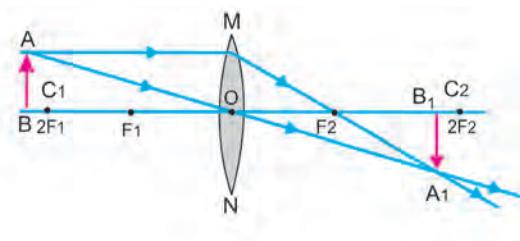


Fig. 17.26 (b)

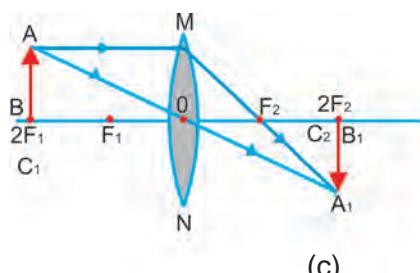
(iii) A ray of light passing through the optical centre of a lens will emerge without any deviation. This is illustrated in Fig 17.26(a) and (b). The ray diagrams for the image formation in a convex lens for a few positions of the object are shown in Fig. 17.27.



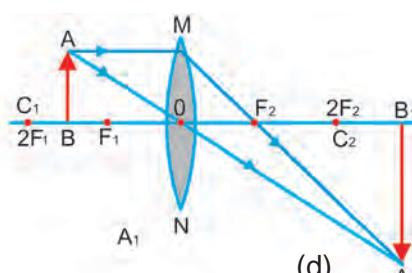
(a)



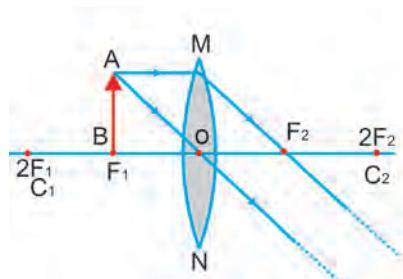
(b)



(c)



(d)



(e)

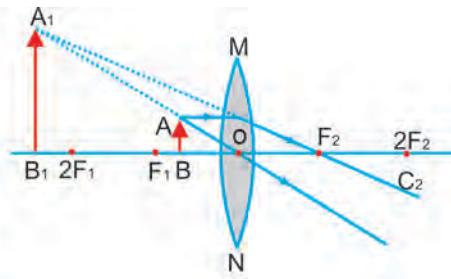


Fig. 17.27

A summary of these observations is given in Table 17.3.

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_2	Highly diminished, point-sized	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F_1 and optical centre O	On the same side of the lens as the object	Enlarged	Virtual and erect

Table 17.3

The ray diagrams for the image formation in a concave lens for various positions of the object are shown in Fig. 17.28.

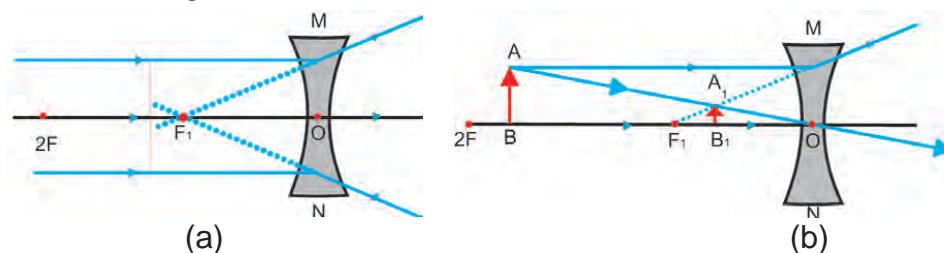


Fig. 17.28

A summary of these observations is given in Table 17.4.

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_1	Highly diminished, point-sized	Virtual and erect
Between infinity and optical centre O of the lens	Between focus F_1 and optical centre O	Diminished	Virtual and erect

Table 17.4

Sign convention for Spherical Lenses:

All measurements are taken from the optical centre of the lens. According to the convention, the focal length of a convex lens is positive and that of a concave lens is negative. We must take care to apply appropriate signs for the values of u , v , f , object height h and image height h' .

17.7.7. Lens Formula

This formula gives the relation between object-distance (u), image-distance (v) and the focal length (f). The lens formula is expressed as

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

The lens formula given above is general and is valid in all situations for any spherical lenses.

Example: 17.2

A concave lens has focal length of 15 cm. At what distance should the object from the lens be placed so that it forms an image 10 cm from the lens?

Solution:

$$v = -10 \text{ cm}, \quad f = -15 \text{ cm},$$

$$u = ?$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad \text{Or,}$$

$$\frac{1}{u} = \frac{1}{v} - \frac{1}{f}$$

$$\frac{1}{u} = \frac{1}{-10} - \frac{1}{-15}$$

$$\frac{1}{u} = \frac{-3 + 2}{30} = \frac{-1}{30}$$

$$u = -30 \text{ cm}$$

Thus, the object distance is 30 cm.

Magnification

The magnification produced by a lens is defined as the ratio of the height of the image to the height of the object

It is represented by the letter m . If h is the height of the object and h' is the height of the image given by the lens, then the magnification produced by the lens is given by,

$$m = \frac{\text{Height of the image (}h')}{\text{Height of the object (}h)} = \frac{v}{u}$$

Note:

Magnification formula for the spherical mirror differ only by sign

Example: 17.3

An object is placed at a distance of 30 cm from a concave lens of focal length 15 cm. An erect and virtual image is formed at a distance of 10 cm from the lens. Calculate the magnification.

Solution:

$$\text{Object distance, } u = -30 \text{ cm}$$

$$\text{Image distance, } v = -10 \text{ cm}$$

$$\text{Magnification, } m = v/u$$

$$m = \frac{-10}{-30} = \frac{1}{3} = +0.33$$

17.7.8. Power of lens

The degree of convergence or divergence of light rays achieved by a lens is expressed in terms of its power. **The power of a lens is defined as the reciprocal of its focal length.** It is represented by the letter P . The power P of a lens of focal length f is given by

$$P = \frac{1}{f}$$

The SI unit of power of a lens is '**dioptre**'. It is denoted by the letter D. If f is expressed in meter, then, power is expressed in dioptre. Thus 1 dioptre is the power of a lens whose focal length is 1 meter. The power of a convex lens is positive and that of a concave lens is negative.

Example: 17.4

The focal length of a concave lens is 2m. Calculate the power of the lens.

Solution:

Focal length of concave lens, $f = -2\text{ m}$

Power of the lens,

$$P = \frac{1}{f}$$

$$P = \frac{1}{-2} = -0.5 \text{ dioptre}$$

17.7.9. Refraction of Light through a Prism

Consider a triangular glass prism. It has two triangular bases and three rectangular lateral surfaces. These surfaces are inclined to each other. The angle between its lateral faces is called the angle of the prism(A). Let us now do an activity to study the refraction of light through a triangular glass prism.

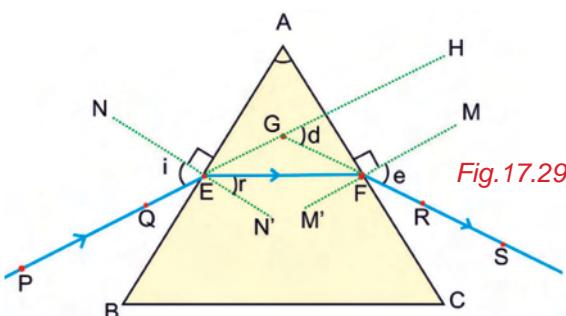


Fig. 17.29

PE - Incident ray

FS - Emergent ray

EF - Refracted ray

A - Angle of the Prism

i - Angle of incident

e - Angle of emergence

r - Angle of refraction

d - Angle of deviation

ACTIVITY 17.14

- Fix a sheet of white paper on a drawing board using drawing pins.
- Place a glass prism on it in such a way that it rests on its triangular base. Trace the outline of the prism using a pencil.
- Draw a straight line PE inclined to one of the refracting surfaces, say AB, of the prism.
- Fix two pins, say at points P and Q, on the line PE as shown in Fig 17.29. Look for the images of the pins, fixed at P and Q, through the other face AC.
- Fix two more pins, at points R and S, such that the pins at R and S lie on the same straight line.
- Remove the pins and the glass prism.
- The line PE meets the boundary of the prism at point E (see Fig 17.29). Similarly, join and produce the points R and S. Let these lines meet the boundary of the prism at E and F, respectively. Join E and F.
- Draw a perpendicular to the refracting surfaces AB and AC of the prism at points E and F, respectively.
- Mark the angle of incidence (i), the angle of refraction (r) and the angle of emergence (e) as shown in Fig 17.29.

Here PE is the incident ray. EF is the refracted ray. FS is the emergent ray. You may note that a ray of light is entering from air to glass at the first surface AB. The light ray on refraction has bent towards the normal. At the second surface AC, the light ray has entered from glass to air. Hence it has bent away from normal. Compare the angle of incidence and angle of refraction at each refracting surface of the prism. The peculiar shape of prism makes the emergent ray bent at an angle to the direction of the incident ray. This angle d is called the angle of deviation. In this case r is the angle of refraction. Mark the angle of deviation in the above activity and measure it.

17.7.10. Dispersion of White Light by a Glass Prism

You must have seen and appreciated the spectacular colours in a rainbow. How could the white light of the sun give us the various colours of the rainbow?

The prism has probably split the incident white light into a band of colours. Note the colours that appear at the two ends of the colour band. What is the sequence of colours that you see on the screen? The various colours seen are Violet, Indigo, Blue, Green, Yellow, Orange and Red. As shown in Fig.17.30.

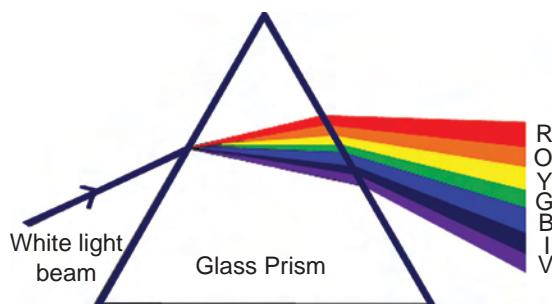


Fig. 17.30

ACTIVITY 17.15

- Take a thick sheet of cardboard and make a small hole in its middle.
- Allow sunlight to fall on the narrow slit. This gives a narrow beam of white light.
- Now, take a glass prism and allow the light from the slit to fall on one of its faces.
- Turn the prism slowly until the light that comes out of it appear on a nearby screen.
- What do you observe? You will find a beautiful band of colours.
- Why does this happen?

The acronym **VIBGYOR** will help you to remember the sequence of colours.

The band of the coloured component of a light beam is called its spectrum. You might not be able to see all the colours separately. Yet something makes each colour distinct from the other. The splitting of light into its component colours is called dispersion.

You have seen that white light is dispersed into its seven-colour components by a prism. Why do we get these colours? Different colours of light bend through different angles with respect to the incident ray as they pass through the prism. The red light bends the least while the violet the most. Thus the rays of each colour emerge along different paths and thus become distinct. It is the band of distinct colours that we see in a spectrum.

17.7.11. Atmospheric Refraction

You might have observed the apparent random wavering or flickering of objects seen through a turbulent stream of hot air

rising above a fire. The air just above the fire becomes hotter than the air further up. The hotter air is lighter (less dense) than the cooler air above it, and has a refractive index slightly less than that of the cooler air. Since the physical conditions of the refracting medium (air) are not the same, the apparent position of the object, as seen through the hot air, fluctuates. This wavering is thus an effect of atmospheric refraction (refraction of light by the earth's atmosphere) on a small scale in our local environment. The twinkling of stars is a similar phenomenon on a much larger scale.

17.7.12. Human Eye

The human eye is one of the most valuable and sensitive sense organs. It enables us to see the wonderful world and colours around us. Most people probably would say that our eyes are the most important sense organs as we use our eyes to perform most activities.

The human eye is like a camera. Its lens system forms an image on a light-sensitive screen called the **retina**. Light enters the eye through the thin membrane called the **cornea**, which forms the transparent bulge on the front surface of the eye ball as shown in Fig. 17.31.

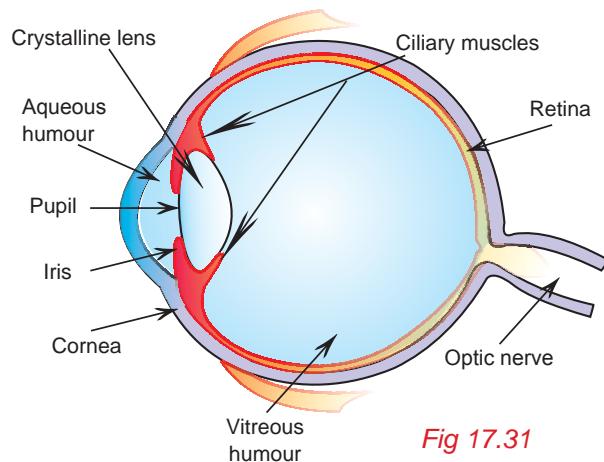


Fig 17.31

The eye ball is approximately spherical in shape with a diameter of about 2.3cm. Most of the refraction for the light rays entering the eye occurs at the outer surface of the cornea. The crystalline lens (eye lens) merely provides the finer adjustment of focal length required to focus objects at different distances on the **retina**. We find a structure called **iris** behind the cornea. The iris is a dark muscular diaphragm that controls the **pupil**. The pupil regulates and controls the amount of light entering the eye. The eye lens forms an inverted real image of the object on the retina. The retina is a delicate membrane having an enormous number of **light-sensitive cells**. The light sensitive cells get activated upon illumination and generate **electrical signals**. These signals are sent to the brain via the **optic nerves**. The brain interprets these signals, and finally, processes the information so that we perceive objects as they are.

Defects of Vision and Rectification

There are mainly three common refractive defects of vision. These are:

- (i) **Myopia** (near - sightedness)
- (ii) **Hypermetropia** (far-sightedness)
- (iii) **Presbyopia**.

These defects can be corrected by the use of suitable spherical lenses.

(a) Myopia

Myopia is also known as near-sightedness. A person with myopia can see nearby objects clearly but cannot see the distant objects distinctly. A person with this defect has the far point nearer than infinity. Such a person may see clearly up to a distance of a few metre.

MAGNETIC EFFECT OF ELECTRIC CURRENT AND LIGHT

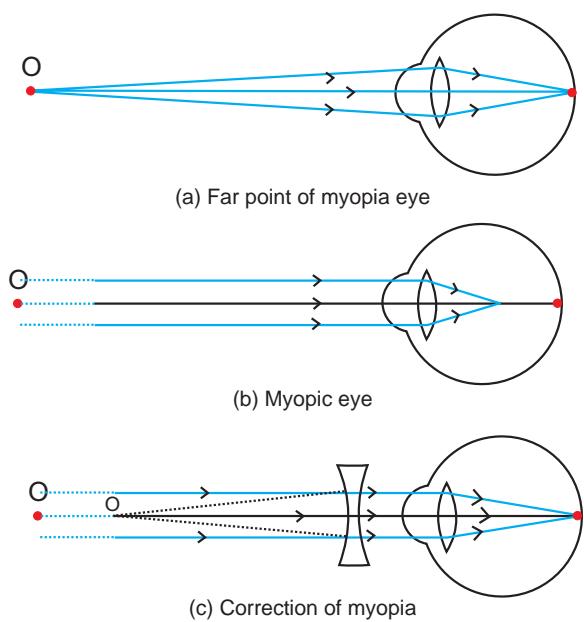


Fig. 17.32

In a myopic eye, the image of a distant object is formed in front of the retina [Fig. 17.32(a)] and not on the retina itself.

This defect may arise due to (i) excessive curvature of the eye lens, or (ii) elongation of the eyeball. This defect can be corrected by using a concave lens of suitable power. This is illustrated in Fig.17.32(c). A concave lens of suitable power will bring the image back onto the retina and thus the defect is corrected.

(b) Hypermetropia

Hypermetropia is also known as far-sightedness. A person with hypermetropia can see distant objects clearly but cannot see nearby objects distinctly. The near point, for the person, is further away from the normal near point (25 cm). Such a person has to keep reading material beyond 25cm from the eye for comfortable reading. This is because the light rays from a closeby object are focussed at a point behind the retina as shown in Fig.17.33 (b)

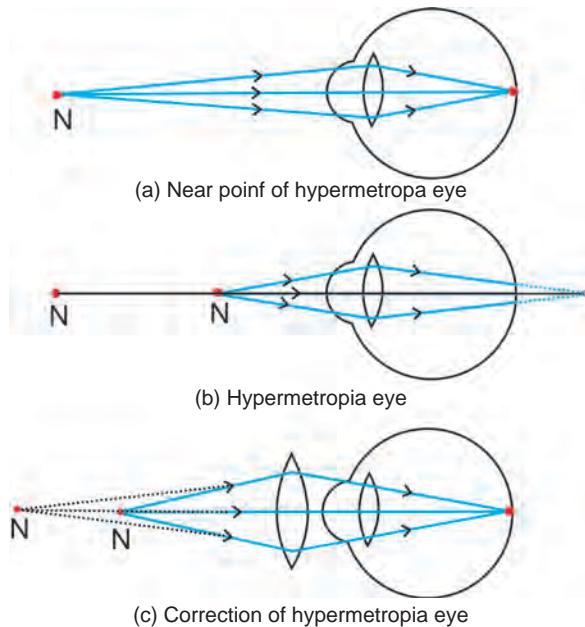


Fig. 17.33

This defect is caused either because (i) the focal length of the eye lens is too long or (ii) the eyeball has become too small. This defect can be corrected by using a convex lens of appropriate power. This is illustrated in Fig.17.33(c). Eye-glasses with converging lenses provide the additional focussing power required for forming the image on the retina.

(c) Presbyopia

The power of accommodation of the eye usually decreases with ageing. For most people, the near point gradually recedes away. They find it difficult to see nearby objects comfortably and distinctly without corrective eye - glasses. This defect is called **Presbyopia**. It arises due to the gradual weakening of the **ciliary muscles** and diminishing flexibility of the eye lens. Sometimes, a person may suffer from both myopia and hypermetropia. Such people often require bi-focal lenses. A common type of

bi-focal lenses consists of both concave and convex lenses. The upper portion consists of a concave lens. It facilitates distant vision. These days, it is possible to correct the refractive defects with contact lenses.

17.7.13. Science Today - Hubble Space Telescope (HST)

The Hubble telescope is a space telescope that was carried into orbit by a space shuttle in April 1990. It is named after the American astronomer Edwin Hubble. It has become a most popular research tool for astronomy. The HST is collaborated between NASA and the European Space Agency and is one of NASA's great observatories.

Hubble is the only telescope ever designed to be serviced in space by astronauts. The HST design with two hyperbolic mirrors is known for good imaging performance over a wide field of view. During the launch scientist found that the main mirror had been ground incorrectly, which severely affected the telescope's capabilities. After a servicing mission in 1993, the telescope was restored to its intended quality. Four servicing missions were performed from 1993-2002, and the fifth was completed in

2009. The telescope is now expected to function until at least 2014.

Hubble's orbit outside the distortion of earth's atmosphere allows it to take extremely sharp images with almost no background light. Hubble's Ultra Deep Field image is the most detailed visible-light image ever made of the universe's most distant object. Hubble Deep field and Hubble Ultra Deep Field images reveal galaxies that are billions of light years away.

Using many of the information sent by scientists have been able to accurately measure the rate at which the universe is expanding. It constrain the value of Hubble's constant and estimates the age of the Universe.

Hubble's images of planets have been crucial in studying the dynamics of the collision of a comet with Jupiter, an event believed to occur once every few centuries. Hubble's observations found that black holes are common to the centers of all galaxies. The astronomers used the telescope to observe distant supernovae.

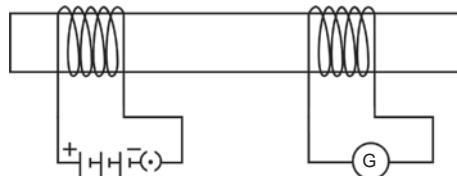


Fig. 17.34

MODEL EVALUATION

PART - A

1. The magnification produced by a mirror is $+ \frac{1}{3}$. Then the mirror is a _____ (concave mirror, convex mirror, plane mirror)
2. The phenomenon of producing an emf in a circuit whenever the magnetic flux linked with a coil changes is _____. (electromagnetic induction, inducing current, inducing voltage, change in current)
3. An electric current through a metallic conductor produces _____ around it. (magnetic field, mechanical force, induced current)
4. The field of view is maximum for _____. (plane mirror, concave mirror, convex mirror)
5. An object is placed 25 cm from a convex lens whose focal length is 10 cm. The image distance is _____. (50 cm, 16.66 cm, 6.66 cm, 10 cm)
6. From the following statement write down that which is applicable to a commutator.
 - a. A galvanometer uses a commutator for deadbeat
 - b. A transformer uses a commutator to step up voltage
 - c. A motor uses a commutator to reverse the current
7. An overhead wire carries current from east to west. Find the direction of the magnetic field 5cm below the wire.
8. In the arrangement shown in the figure, there are two coils wound on a non-conducting cylindrical rod. Initially the key is not inserted. Then the key is inserted and later removed. Then, which of the following statement is correct?
 - a. The deflection in the galvanometer remains zero throughout.
 - b. There is a momentary deflection in the galvanometer but it dies out shortly.



9. Which part of the human eye helps in changing the focal length of the eye lens?
10. A pencil partly immersed in water in a glass tumbler appears to be bent at the interface of air and water. Name the phenomenon of light responsible for it.
11. Sitting in her parlour one night, Chitra sees the reflection of her cat in the living room window. If the image of her cat makes an angle of 40° with the normal, at what angle does Chitra see the reflected image of the cat?
12. Why do the lines of the magnetic field not cross each other?

13. What is the magnetic field midway between two parallel conductors carrying same amount of current in the same direction and in the opposite direction?
14. How can an AC generator be converted into a DC generator?
15. Compute the position of the object placed in front of a concave mirror of focal length 'f' so that the image formed is of the same size of the object.

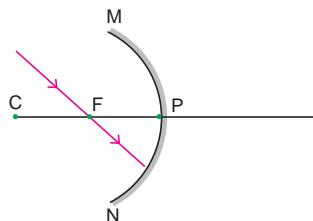
PART - B

1. Fill in the blanks

- i) For a motor : a permanent magnet, then commercial motor : _____
- ii) Focal length of a lens; metre, then for power of a lens _____

2. Correct the mistakes, if any, in the following statements.

- i) The magnetic field is a quantity that has magnitude only.
 - ii) Outside the bar magnet, the magnetic field lines emerge from the south pole and merge at the north pole.
 3. The ray diagram shown below is introduced to show how a concave mirror forms the image of an object.
- i) Identify the mistake and draw the correct ray diagram.
 ii) Write the justifications for your corrections.



4. In traffic signals _____ colour light is used to stop vehicles because it has _____ wave length. (Hint: scattering of light is inversely proportional to the fourth power of its wavelength)
5. Fill the table with the appropriate words given in bracket.

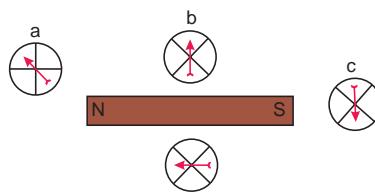
_____	the tooth's	enlarged image
_____	rear side of the vehicle	erect image

(Convex mirror, Plano convex, Concave mirror, Plane mirror, Convex lens, Concave lens)

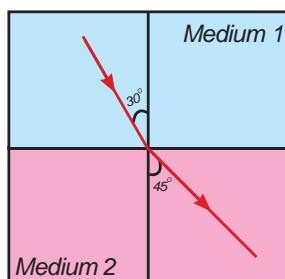
6. Write down the names of the specified parts of the human eye.
- i) Dark muscular diaphragm that controls the pupil.
 - ii) The screen where the image is formed by the eye lens.

MAGNETIC EFFECT OF ELECTRIC CURRENT AND LIGHT

7. You know that myopia is a common refractive defect of vision. A person with this defect can clearly see only objects that are near. Using concave lens of suitable power this defect is corrected.
- Mention the other two types of defects.
 - Explain how they can be corrected.
8. i) Which of the compass needle orientations in the following diagram correctly describes the magnet's field at that point?



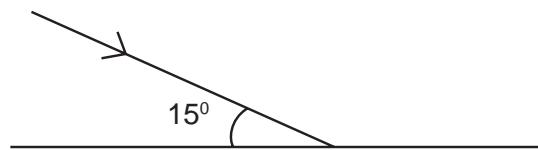
9. Does magnetic monopole exist? Give reasons.
10. A 3 cm tall bulb is placed at a distance of 20 cm from a diverging lens having a focal length of 10.5 cm. Determine the distance of the image.
11. A needle placed at 30 cm from the lens forms an image on a screen placed 60 cm on the other side of the lens. Identify the type of lens and determine the focal length.
12. A ray from medium 1 is refracted below while passing to medium 2. Find the refractive index of the second medium with respect to medium 1.



13. A real image, $1/5^{\text{th}}$ the size of the object, is formed at a distance of 18 cm from a mirror. What is the nature of the mirror? Calculate its focal length.
14. A person cannot clearly see objects farther than 12 m from the eye. Name the defect in vision he is suffering from and the lens that should be used to correct this defect.
15. Explain the use of concave mirror as solar concentrators with the help of a ray diagram.
16. Light enters from air to kerosene having refractive index of 1.47. What is the speed of light in kerosene, if the speed of light in air is 3×10^8 m/s?

17. Murugan trims his beard while looking into a concave mirror whose focal length is 18 cm. He looks into it from a distance of 12 cm.
- How far is Murugan's image from the mirror?
 - Does it matter whether or not Murugan's face is closer or farther than the focal length? Explain.
18. Light travels at 1.90×10^8 m/s in a crystal, what is the crystal's index of refraction?
19. Ranjini makes arrangements for a candle-light dinner and tops it with a dessert of gelatin filled blue berries. If a blueberry that appears at an angle of 45° to the normal in air is really located at 30° to the normal in gelatin, what is the index of refraction of the gelatin?
20. If the far point of a myopic person is 75 cm, what should be the focal length of the lens used to rectify this defect?
21. Reena and Vani find a discarded plastic lens lying on the beach. The girls discuss what they learnt in Physics and argue whether the lens is a converging or diverging one. When they look through the lens, they notice that the objects are inverted.
- If an object 25 cm in front of the lens forms an image 20 cm behind the lens, what is the focal length of the lens?
 - Is it a converging or diverging lens?
22. Light which is incident on a flat surface makes an angle of 15° with the surface.

- What is the angle of incidence?
- What is the angle of reflection?
- Find the angle of deviation.

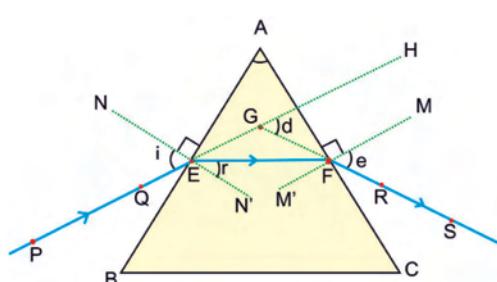


23. How can you identify the three types of mirrors without touching them?
Give reasons.
24. What will happen when the frequency of rotation in an AC dynamo is doubled?

PART - C

1. a. Draw the given diagram and label the following in the diagram.

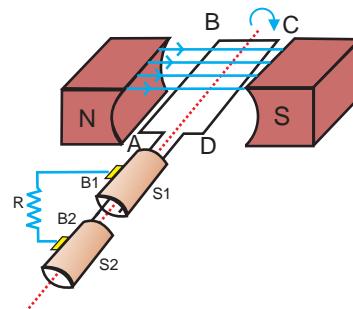
- Incident ray
- Refracted ray
- Emergent ray
- Angle of refraction
- Angle of deviation
- Angle of emergence



- b. The refractive index of diamond is 2.42. What is the meaning of this statement in relation to the speed of light?

MAGNETIC EFFECT OF ELECTRIC CURRENT AND LIGHT

2. i) Redraw the diagram.
 ii) This diagram represents _____
 iii) Label the parts of the diagram.
 iv) Mention the principle used in the device denoted by this diagram.
3. i) Find the nature, position and magnification of the image formed by a convex lens of focal length 10cm, If the object is placed at a distance of a) 15cm b) 8cm
 ii) Which of the above represents the use of convex lens in a) A film projector b) The magnifying glass used by palm reader
4. An object of 5cm tall is placed at a distance of 10cm from a concave mirror of radius of curvature 30cm
 i) Find the nature, position and size of the image
 ii) Draw the ray diagram to represent the above case.
5. The optical prescription of a pair of spectacle is
 Right eye : - 3.5 D Left eye : - 4.00 D
 i) Name the defect of the eye
 ii) Are these lenses thinner at the middle or at the edges?
 iii) Which lens has a greater focal length?



Discuss in group

1. To an astronaut sky appears dark instead of blue
2. Two wires carrying current in the same direction attract each other. Will the two beams of electrons travelling in the same direction get attracted? Reason out.
3. If a child crawls towards a mirror at the rate of 0.40 m/s, at what speed will its image move with respect to the child?

FURTHER REFERENCE

- Books:**
1. Fundamentals of optics by *D.R. Khanna and H.R. Gulati R.Chand & Co*
 2. Magnetism by *Joy Frisch* - Schnoll published by Creative Education.
 3. Advanced physics by *Keith Gibbs* Cambridge University press
 4. Principles of Physics(Extended) - *Halliday, Resnick & Walker*, Wiley publication, New Delhi.

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- | | |
|--|---|
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ANSWERS

CHEMISTRY

Chapter 9. Solutions

PART - A 3. 16 g; **PART - B** 5. 28.57%

Chapter 10. Atoms and Molecules

PART - A 2. 2; 3. 22.4 litres; 5. 18 g; 6. 0.5 mole

PART - B 3. i) 2 moles; ii) 0.5 mole; iii) 0.25 mole, 4. i) 18 g; ii) 44 g; iii) 40 g; iv) 46 g; v) 98 g;
5. 16, 256, 2; 6. 6.023×10^{21} molecules
7. i) 40 g, 16 g, 56 g; ii) 40 g, 12 g, 48 g, 100 g
8. i) 90 g; ii) 34 g; iii) 360 g

PART - C 1. i) 3; ii) 53.5 g; iii) Ammonia; iv) $\text{NH}_3 + \text{HCl} \longrightarrow \text{NH}_4\text{Cl}$

2. i) (a) 4 moles, (b) 19 moles; ii) 4.75 moles; iii) 227 g
3. i) 2 moles; ii) 168 g; iii) 1 mole
4. i) 16 g; ii) 1 mole; iii) 1 mole; iv) 714.29 g
5. i) 71 g; ii) 512 g; iii) 192 g; iv) 56 g
6. i) 0.142 mole; ii) 1 mole; iii) 1 mole; iv) 0.2 mole; v) 1 mole

Chapter 11. Chemical Reactions

PART - A 2. Cu, CuO; 10. 3

PART - B 4. 6

7. i) A is CaCO_3 ; B is CO_2 ; ii) slaked lime; iii) C is CaCl_2 ; D is H_2O , iv) basic

18. i) 8; ii) 6; iii) The given solution is basic because the P^{H} is greater than 7

PHYSICS

Chapter 15. Laws of Motion and Gravitation

PART - B 5. $F = -1125 \text{ N}$; 6. 19.5 N ; 11. 117.6 Nm ; clockwise moment

12. 9.8 N kg^{-1} ; 13. 9.8 ms^{-2}

14. i) 9.83 ms^{-2} ; ii) The acceleration due to gravity remains unchanged

15. $1.7342 \times 10^{-11} \text{ ms}^{-2}$; 18. 40 Kg ms^{-1} ; 19. $g_1 = \frac{1}{5} g$; 20. 0.4 m

PART - C 2. ii) $30 \text{ N}, -30 \text{ N}$; 3. i) 2 ms^{-2} ; ii) 4.475 s ; iii) 6 ms^{-1}

4. i) 240 kg ms^{-1} ; ii) $-8 \times 10^{-14} \text{ ms}^{-1}$; 5. 1: 36

6. -6 ms^{-1} ; 7. 0.3 m/s^2 and 0.4 m/s^2 are the respective accelerations

Chapter 16. Electricity and Energy

- PART - B**
- 5. i) 2.5Ω ; ii) 2.5Ω ; 9. 1Ω ; 11. 10^{19}
 - 12. i) $4.6A$; ii) the resistance of the conductor increases; 13. 5Ω
 - 14. i) $20V$; ii) $240V$; 15. $I_1 = 1A$, $I_2 = 2A$, $I_3 = 0.5A$; 16. $0.4A$
 - 17. 2Ω ; 18. 32Ω

PART - C 1. 5.79 days

- 2. i) Heat generated across $4\Omega = 16J$
- ii) Heat generated across $12\Omega = 5.227J$
- iii) Heat generated across $6\Omega = 10.61J$
- 3. Total current is $0.3A$, potential difference across is $0.3V$
- 4. i) $240V$, ii) $220V$, iii) AC will not operate,
- 5. 4Ω , 6. i) 1.33Ω , ii) 1.33Ω , 8. $\frac{8}{3}R$

Chapter 17. Magnetic effect of Electric current and Light

- PART - B**
- 10. $-6.88cm$, 11. $20cm$, 12. 0.707 , 13. Concave mirror; $f = -15cm$
 - 16. $2.041 \times 10^8 ms^{-1}$, 17. i) $36cm$, 18. 1.579 , 19. 1.414 , 20. $-75cm$
 - 21. i) $11.11cm$, ii) converging lens. 22. $i = 75^\circ$; $r = 75^\circ$; $d = 30^\circ$

PART - C 3. i) (a) Nature of the image : real, enlarged and inverted

Position of the image $v = 30cm$

Magnification of the image = - 2

(b) Nature of the image : virtual, enlarged and erect.

Position of the image $v = -40cm$ (same side of the object)

Magnification of the image = + 5

4. i) (a) Nature of the image : virtual, enlarged and erect.

Position of the image $v = 30cm$

Size of the image = $15cm$

SYLLABUS

1. Applied Biology	Heredity and Evolution :- Heredity –Variations-Evolution-Human evolution-Evolution tree-Genetic engineering-Bio technology and cloning-Stem cell-Organ culture-Microbial production-Biosensor – Bio chips-Science today – Gene therapy
2. Health and Hygiene	Immune System :- Health and its significance-Diseases and causes-Diseases caused by microbes and prevention-Modes of transmission-Immunization-Treatment and prevention-Biotechnology in Medicine-HIV and Prevention
3. My Body	Structure & Function of the Human Body – Organ System :- Nervous system-Endocrine system-Cell division-Stages of Meiosis.
4. World of Plants	Reproduction in Plants :-Modes of reproduction - vegetative, asexual and sexual reproduction in plants-Pollination-Fertilization-Fruits and seeds formation-Seed dispersal
5. World of Animals	A Representative Study of Mammals - Morphology-Habitats-Adaptations-Basic physiological functions.-Circulatory system in man-Excretory system in man.-Relationship of structure to functions-Animal behaviour - Behaviour (social, reproductive, parental care)-Some case studies from researchers(animals behavior)
6. Life Process	Life Processes :- Definition-Types of nutrition and human digestive system-Respiration -Transportation in plants-water and minerals and animals - blood circulation-Excretion in plants and animals-Nervous system-Coordination in plants-Movement due to growth.
7. Environmental Science - Ecology	Conservation of Environment :- Bio-degradable and non-bio-degradable wastes-Water management-Wild life sanctuaries-Balance in ecosystem-Coal and petroleum-Green chemistry-Science today – Towards a global village
8. Environmental Science – Resource Use and Management	Waste Water Management :- Journey of water-Sewage -Treatment -Domestic practices -Sanitation and diseases-Alternate arrangement for sewage disposal -Sanitation in public places-Energy management-Energy audit (home, school)- Renewable sources (solar, hydrogen, wind)- Non-renewable sources(coal, petroleum, natural gas)- Bio-fuels-generation & use-Energy conservation & how we can help.
9. Matter	Solutions :- Solute and Solvent-Types of solutions-Solubility-Factors affecting solubility-Problems
10. Atomic Structure	Atoms and Molecules :- Modern atomic theory-Avogadro Hypothesis-Atomicity-Relation between vapour density and molecular mass of a gas- Difference between-atom and Molecules-Relative atomic mass-Relative molecular mass-Mole concepts- Mole- definition-Problems based on mole concept

11. Exploring Chemical Changes and Formulation	Chemical Reactions:- Types of chemical reactions -Rate of chemical reaction-Factors influencing the rate of the chemical reaction-Acids-Classification of acids- Chemical properties of acids-Uses of acids-Bases-Classification of bases-Chemical properties of bases- Uses of bases-Identification of acids and bases-pH scale-pH paper-Importance of pH in everyday life-Salts- Classification of salts-Uses of salts
12. Exploring Chemical Families	Periodic Classification of Elements:- Modern periodic law-Modern periodic table-Characteristics of modern periodic table-Metallurgy – Introduction-Terminologies in metallurgy-Differences between minerals and ores-Occurrence of metals- Metallurgy of Al, Cu and Fe- Metallurgy of Aluminium-Metallurgy of Copper- Metallurgy of Iron- Alloys- Methods of making alloys-Copper Aluminium and Iron alloys-Corrosion -Methods of preventing corrosion
13. Exploring the World	Carbon and its Compounds:- Introduction-Compounds of carbon-Modern definition of organic chemistry-Bonding in carbon and its compounds-Allotropy- Physical nature of carbon and its compounds- Chemical properties of carbon compounds-Homologous series-Hydrocarbons and their types -Functional groups- Classification of organic compound based on functional group-Ethanol-Ethanoic acid
14. Matter and Measurement	Measuring Instruments:- Screw Gauge-Measuring long distances – Astronomical distance, light year
15. Forces and Movement	Laws of Motion and Gravitation -Balanced and imbalanced forces-First law of motion-Inertia and mass-Momentum-Second law of motion- $F=ma$ -Third law of motion-Conservation of momentum and proof-Moment of force and couple-Gravitation Newton's law of gravitation –Mass- Weight-Acceleration due to gravity-Mass of Earth-Science Today- Chandrayaan, Cryogenic techniques and Manned space station
16. Exploring Energy	Electricity and Energy:- Electric current and circuit-Electric potential and potential difference-Circuit diagram-Ohm's law-Resistance of a conductor-System of resistors -Heating effect of electric current-Joules law of heating-Role of fuse-Domestic electric circuits-Electric power-Chemical effect of electric current-Electrolysis electro chemical cells-Primary and Secondary cells-Sources of Energy-Conventional sources of energy-Non-conventional source of energy- Nuclear energy-Radioactivity-Nuclear fission and nuclear fusion-Nuclear reactivity advantages-Hazards of nuclear energy-Science today – Energy from seas.
17. Exploring Phenomena	Magnetic Effect of Electric Current and Light :- Magnetic field and magnetic lines of force-Magnetic field due to current carrying conductor-Magnetic field due to current carrying Straight conductor- Magnetic field due to current carrying Circular loop-Force on a current carrying conductor in a magnetic field-Fleming left hand rule -Electric motor-Electromagnetic induction- Faraday's experiments-Electric generator –Light-Reflection of light by spherical mirrors – Image formation and mirror formula - Refraction – Laws of refraction - Refractive index-Refraction by spherical lenses- Image formation by lenses-Lens formula and magnification-Power of lens-Refraction of light through a prism-Dispersion by a glass prism-Atmospheric refraction- Human eye –Defects and rectification-Science today –Hubble space telescope
18. Technology	Practical and Projects

Design of Question Paper – X Std Science (Theory)

Time: 2½ Hours

Max. Marks: 75

The weightage of marks allotted for the design of question paper shall be as under:

A. Weightage to Learning Outcome

Sl.No	Categories	Mark	PERCENTAGE
1	Knowledge	17	15
2	Understanding	56	45
3	Application	35	30
4	Skill	11	10
	Total	119	100

Note: (1) Total Marks is 119 inclusive of choice. (2) While preparing the question paper, there may be variations in weightage to the extent from 2 % to 5 %.

B. Weightage given to various types of question

S.No	Types of Questions	Marks for Each Question	Total No. of Questions	No. of Questions to be answered	Total Marks
1	Section A Objective Type (OT)	1	15	15	$15 \times 1 = 15$
2	Section B Short Answer (SA)	2	32*	20	$20 \times 2 = 40$
3	Section C Long Answer (LA)*	5	8	4	$4 \times 5 = 20$
	Total		55	39	75

* Each Question may be split into 2 or 3 sub-divisions carrying 1, 2 or 3 marks. But the questions shall be from each area (Botany, Zoology, Chemistry, Physics). Choices will be internal (Either - or)

*Short Answer split up

Sl.No.	Very Short Answer Type of Questions	To be asked
1	To Match	3
2	To spot the error / mistake in the given statements	3
3	Reason and assertion	3
4	To Raise questions	5
5	To label the parts in the given diagram	3
6	To copy a diagram & to identify /mark the parts	3
7	To calculate the required value(Problem solving)	3
8	To fill in the blanks (from the given pair of answers)	3
9	To interpret what happens in the given situations	3
10	To find the odd one out	3
	Total Number of Questions given	32
	Total Number of Questions to be answered	20

C. Weightage given to the higher order of questions

Sl.No	Estimated higher order of questions	% Percentage
1	Easy	20
2	Average	60
3	Difficult	20

D. Weightage to Content Unit

Units		No. of Questions			Total Marks	
		OT	SA	LA		
1. Heredity and Evolution	Botany and Zoology	1(1)	3(2)	-	27	
2. Immune System		1(1)	1(2)	1(5)		
3. Structure & Function of the Human Body Organ System		1(1)	1(2)	1(5)		
4. Reproduction in Plants		1(1)	1(2)	1(5)		
5. A representative Study of Mammals		1(1)	3(2)	-		
6. Life Processes		1(1)	3(2)	-		
7. Conservation of Environment		-	1(2)	1(5)		
8. Waste Water Management		1(1)	3(2)	-		
9. Solutions	Chemistry	1(1)	2(2)	-	14	
10. Atoms and Molecules		-	1(2)	1(5)		
11. Chemical Reaction		1(1)	2(2)	-		
12. Periodic Classification of Elements		1(1)	2(2)	-		
13. Carbon and its Compounds		1(1)	1(2)	1(5)		
14. Measurements	Physics	1(1)	-	-	14	
15. Laws of Motion and Gravitation		1(1)	2(2)	1(5)		
16. Electricity and Energy		1(1)	3(2)	-		
17. Magnetic Effect of Electric Current and Light		1(1)	3(2)	1(5)		
Total Number of Questions given		15(15)	32(64)	8(40)	55	119
Total Number of Questions to be answered		15(15)	20(40)	4(20)	39	75

() Indicates the marks

BLUE PRINT

Unit No.	Content Unit	Related Subject	Knowledge			Understanding			Application			Skill		Total No. of Questions	Total Marks
			OT	SA	LA	OT	SA	LA	OT	SA	LA	OT	SA		
1	Heredity and Evolution	Zoo	1(1)				3(2)							4	7
2	Immune System	Zoo	1(1)				1(5)		1(2)					3	8
3	Structure & Function of the Human Body	Zoo	1(1)							1(2)	1(5)			3	8
4	Reproduction in Plants	Bot	1(1)				1(5)					1(2)		3	8
5	A Representative Study of Mammals	Zoo		1(2)		1(1)	1(2)		1(2)				4	7	
6	Life Processes	Bot & Zoo		1(2)		1(1)	1(2)		1(2)				4	7	
7	Conservation of Environment	Bot								1(5)		1(2)		2	7
8	Waste Water Management	Bot	1(1)				2(2)		1(2)				4	7	
9	Solutions	Che				1(1)	1(2)		1(2)				3	5	
10	Atoms and Molecules	Che			1(5)				1(2)				2	7	
11	Chemical Reaction	Che		1(2)		1(1)	1(2)						3	5	
12	Periodic Classification of Elements	Che				1(1)	1(2)		1(2)				3	5	
13	Carbon and its Compounds	Che				1(1)		1(5)		1(2)			3	8	
14	Measurements	Phy				1(1)							1	1	
15	Laws of Motion and Gravitation	Phy			1(2)		1(2)	1(5)	1(1)				4	10	
16	Electricity and Energy	Phy			1(2)	1(1)	1(2)					1(2)	4	7	
17	Magnetic Effect of Electric Current and Light	Phy				1(1)	1(2)		1(2)	1(5)		1(2)	5	12	
			5(5)	5(10)	1(5)	9(9)	13(26)	4(20)	1(1)	10(20)	3(15)	4(8)	-	55	119

SCIENCE PRACTICALS

PART - 1

S.No.	CONTENTS
	<p style="text-align: center;">BIOLOGY</p> <p>BIO-BOTANY</p> <p>1 Dissect and display the floral parts like Calyx, Corolla, Androecium and Gynoecium of a flower</p> <p>2 Identify the given slide with help of microscope</p> <p>3 Fermentation experiment (Anaerobic Respiration)</p> <p>BIO-ZOOLOGY</p> <p>4 Test for Starch (Iodine test)</p> <p>5 Identify the given slide, draw a neatly labelled diagram and write a note on it.</p> <p>6 Calculate the Body Mass Index (BMI) of a person, by using the BMI formula and comparing the value with BMI chart.</p> <p style="text-align: center;">CHEMISTRY</p> <p>7 You are provided with a solid sample. Prepare a solution and identify the type of solution based on filtration</p> <p>8 Prepare a solution from the given salt and identify whether it is an unsaturated solution or saturated solution</p> <p>9 Identify the carboxylic or alcoholic functional group present in the given organic compound by performing the following test 1) Blue litmus paper 2) Sodium carbonate 3) Acidified potassium dichromate</p> <p style="text-align: center;">PHYSICS</p> <p>10 Screw Gauge</p> <p>11 Ohm's Law Verification</p> <p>12 Resistors in Series</p>

BIO-BOTANY

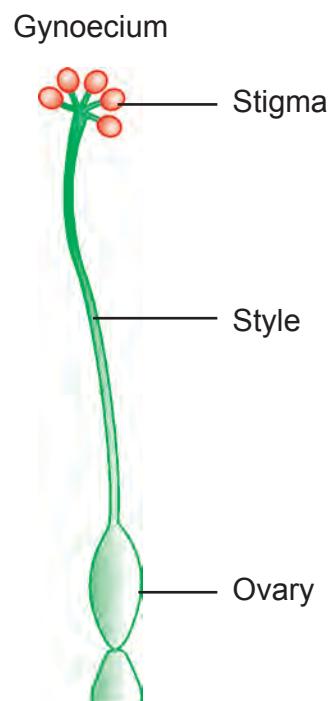
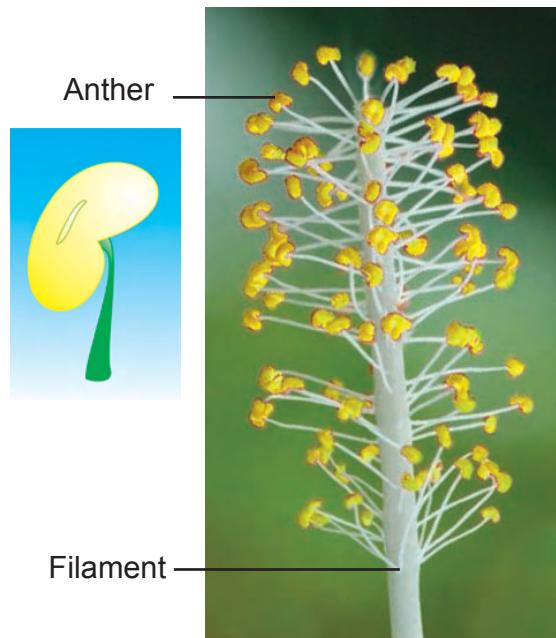
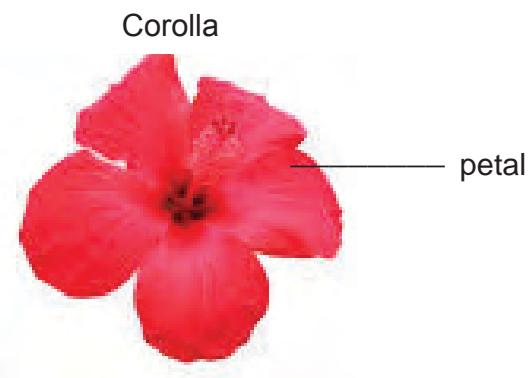
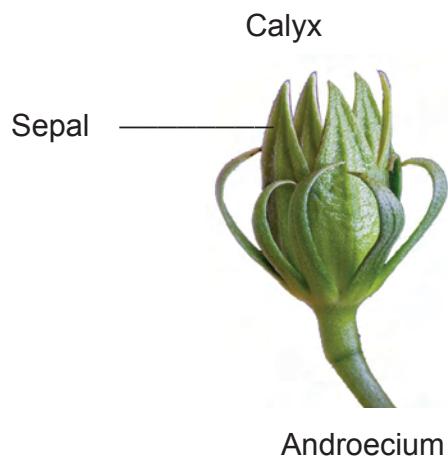
Exercise No : 1

Date :

Dissect and display the floral parts like Calyx, Corolla, Androecium and Gynoecium of a flower.

Floral parts

1. Calyx
 2. Corolla
 3. Androecium – Male parts of the flower
 4. Gynoecium – Female parts of the flower
1. Calyx 2. Corolla } Accessory Organs

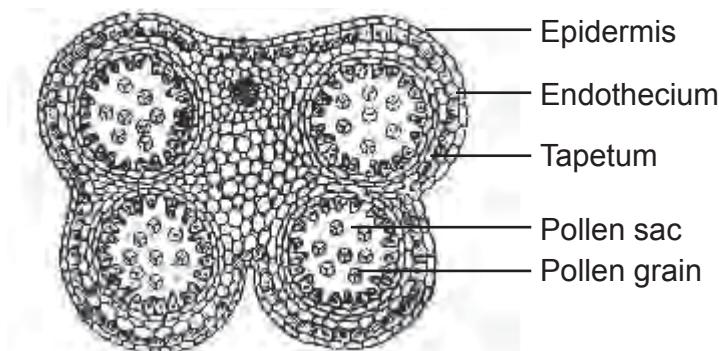


Exercise No : 2**Date :**

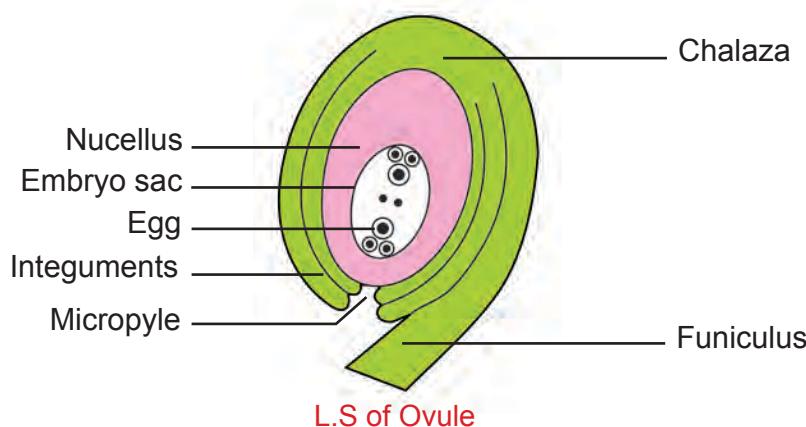
Identify the given slide with the help of microscope.

(a) T.S of Anther

- * Each anther lobe is covered by a 4 layered wall.
- * The inner most layer of the wall is called tapetum.
- * Inner side of the anther wall pollen sac (microspore) with pollen mother cell (micropore mother cell) is present.
- * The pollen mother cell divides meiotically to produce pollen grains.

**(b) L.S. of Mature Ovule**

- * The ovule consists of central nucellus surrounded by two protective coats called integuments.
- * The integuments leave a small opening at the apex of the ovule called micropyle.
- * The embryo sac is found inside the nucellus.
- * Embryo sac contains eight nuclei.



Exercise No : 3

Date :

Fermentation Experiment (Anaerobic Respiration).

Aim :

To prove the fermentation process.

Materials and apparatus required:

Sugar solution, Baker's yeast, conical flask (250ml), beaker and lime water.

Procedure:

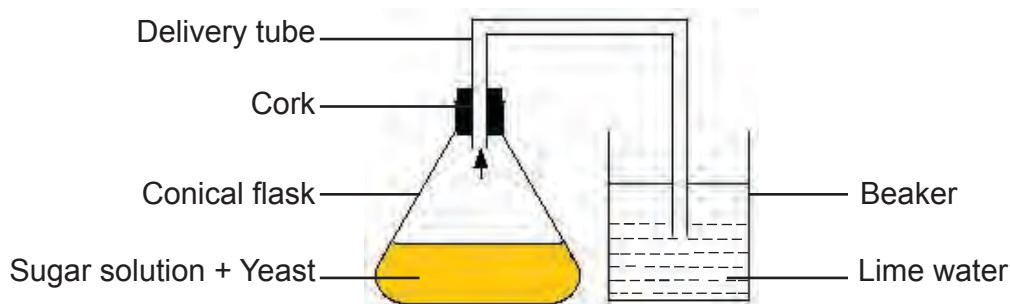
- * Take sugar solution with a small quantity of baker's yeast in a (2/3) conical flask.
- * Close the mouth of the conical flask with a one holed rubber cork and insert a delivery tube in the cork.
- * Immerse the other end of the delivery tube in a beaker containing lime water.
- * Keep the apparatus in sunlight for 2 hours.

Observation:

- * After 2 hours, it is observed that the lime water in the beaker turns milky.
- * Remove the stopper of the flask, An alcoholic smell is observed.

Inference:

- * Due to fermentation of sugar solution, CO_2 is released and ethanol is formed.
- * The CO_2 turns the lime water milky and the smell is due to the formation of ethanol.
- * Hence the process of fermentation is proved.



BIO-ZOOLOGY

Exercise No : 4

Date :

Test for Starch (Iodine test).

Aim :

To find out the presence of starch in the given food samples A, B and C by Iodine test.

Materials and apparatus required:

Food sample A, B and C, Iodine solution, test tubes, test tube holder and test tube stand.

Procedure:

- * Take 1ml of food samples A , B and C in three different test tubes.
- * Add one drop of Iodine solution each of the test tubes and mix well.
- * Note the changes that occur in the colour and tabulate the results.

Observation:

Sample A :

Sample B :

Sample C :

Table:

Sample	Observation	Inference
A		
B		
C		

Result:

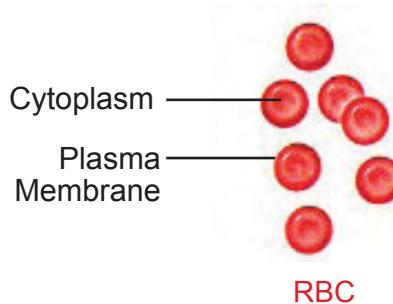
Appearance of dark blue colour in the Sample _____ indicates the presence of starch.

Exercise No : 5**Date :**

Identify the given slide, draw a neatly labelled diagram and write a note on it.

(a) Red Blood Corpuscles**Identification:**

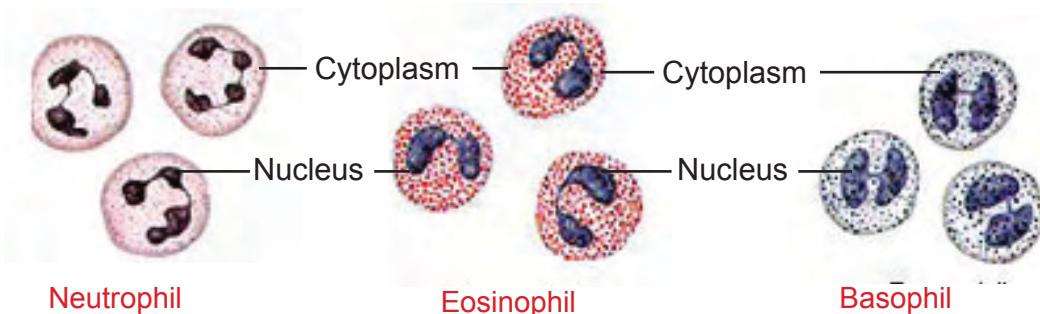
The given slide is identified as Red Blood Corpuscles - (Erythrocytes)

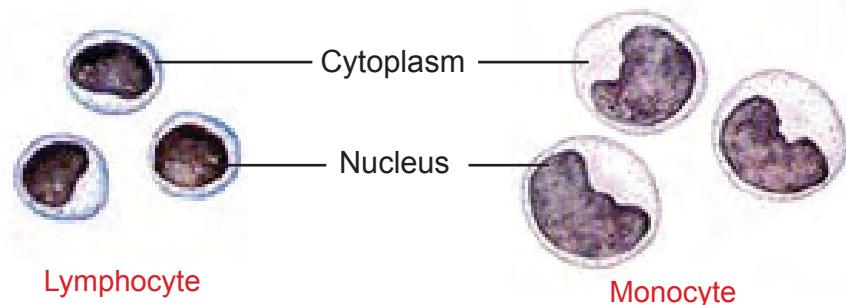
**Notes:**

- * RBCs are circular, biconcave and disc shaped.
- * The young RBCs have a nuclei but the mature RBCs do not have a nuclei.
- * RBCs are red due to the presence of a respiratory pigment called haemoglobin.
- * RBCs are concerned with the carriage of oxygen.
- * Decrease in RBCs causes Anaemia, increase in number causes Polycythaemia.

(b) White Blood Corpuscles (Leucocyte)**Identification:**

The given slide is identified as White Blood Corpuscles (Leucocyte)





Notes:

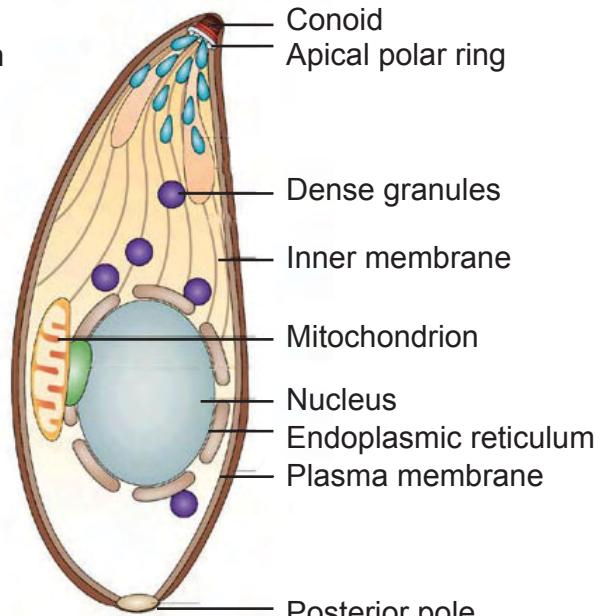
- * WBCs are amoeboid in shape.
- * WBCs have a prominent nuclei.
- * WBCs are concerned with phagocytosis of foreign germs and production of antibodies which provides immunity against infection.
- * There are five different types of WBC.
- * Increase in WBCs causes Leukemia, decrease in number causes Leukopenia.

(c) Plasmodium

Identification:

The given slide is identified as Plasmodium

Notes:



- * Plasmodium is a protozoan organism.
- * Plasmodium parasite causes Malaria.
- * Plasmodium is transmitted to man through female Anopheles mosquito.
- * Life cycle of Plasmodium requires two hosts namely man and female Anopheles mosquito.
- * The infective stage of Plasmodium is Sporozoite.

Exercise No : 6**Date :**

To calculate the Body Mass Index (BMI) of a person, by using the BMI formula and comparing the value with BMI chart.

Aim:

To calculate the BMI of any one of your classmates by using BMI formula.

Materials required :

Weighing machine, measuring tape.

Procedure:

Find out the weight in kg of your classmate by using a weighing machine.

Find out the height in meter of the same person. Convert the height into meter².

By using the formula

find out the BMI and record it.

$$\text{BMI} = \frac{\text{Weight in Kg}}{\text{Height in M}^2}$$

Note: BMI - Below 19 is Lean, 19-25 is Normal, 26 and above is Obese.

Sl.No.	Students Name	Weight in Kg	Height in Meter	Height in Meter ²	BMI
1.					
2.					

Inference:

1. BMI of my classmate Sl.No 1. _____ is _____. Hence he/she is _____.
2. BMI of my classmate Sl.No 2. _____ is _____. Hence he/she is _____.

CHEMISTRY

Exercise No: 7

Date :

You are provided with a solid sample. Prepare a solution and identify the type of solution based on filtration.

Aim:

To prepare a solution from the solid sample and identify the type of solution based on filtration.

Materials required :

Beaker, water, glass rod, filter papers, test tube, test tube stand, funnel and given solid sample.

Theory:

A true solution is a homogenous and transparent. It completely passes through filter paper.

A suspension is a heterogeneous mixture. Here solute particles settle down on standing and can be filtered by filter paper.

Procedure:

Experiment	Observation	Inference
Take 50ml of water in a beaker. Add the given solid sample, into the beaker and stir the content gently with the help of the glass rod. Filter the solution by using filter paper.	a) Solute particles do not remain in the filter paper. b) Solute particles remain in the filter paper.	a) True solution. b) Suspension.

Result:

The given solid sample forms _____ solution (true/suspension).

Exercise No : 8**Date :**

Prepare a solution from the given salt, identify whether it is an unsaturated solution or saturated solution.

Aim:

To prepare a solution from the given salt and identify whether it is an unsaturated solution or saturated solution.

Theory:

Unsaturated solution is a solution in which more of the solute can be dissolved at a given temperature.

A solution in which no more solute can be dissolved in a definite amount of solvent at a given temperature is called a saturated solution.

Materials required :

Beaker, 50 ml of water, a glass rod and given salt.

Procedure:

Experiment	Observation	Inference
Take 50 ml of water in a beaker and add the given salt slowly by constant stirring.	a) No more salt particles remain in the beaker. b) Less amount of salt remains in the beaker	a) The solution is unsaturated. b) The solution is saturated solution.

Result:

The given salt forms _____ solution (unsaturated/ saturated).

Exercise No : 9**Date :**

To identify the carboxylic or alcoholic functional group present in the given organic compound. By performing the following test 1) Blue litmus paper 2) Sodium carbonate 3) acidified potassium dichromate.

Aim : To identify the carboxylic or alcoholic functional group present in the given organic compound.

Theory : Alcohols are neutral and it will not affect the blue litmus paper and sodium carbonate. Alcohols are oxidized by acidified potassium dichromate. Carboxylic acids are the most acidic amongst the organic compound. Carboxylic acid affects the blue litmus paper and liberates carbon dioxide with sodium carbonate by forming salt.

**Materials required:**

Test tubes, blue litmus paper, glass rod, sodium carbonate, salt, phenolphthalein solution, acidified potassium dichromate solution and the given organic compound.

Procedure:

S.No.	Experiment	Observation	Inference
1.	Blue litmus paper test Put a drop of the given organic compound on the blue litmus paper.	a) No change. b) Blue litmus paper turns into red.	a) Alcoholic group may be present. b) Carboxylic group may be present.
2.	Sodium carbonate test Take a small amount of the organic compound and add a pinch of sodium carbonate.	a) No brisk effervescence. b) Brisk effervescences.	a) Alcoholic group may be present. b) Carboxylic group may be present.
3.	Acidified potassium dichromate test Take a small amount of the organic compound add acidified potassium dichromate solution drop by drop.	a) The red orange solution turns green b) No characteristic colour change	a) Presence of alcoholic group is confirmed. b) Presence of carboxylic group

Result :

The given organic compound contain _____ functional group.

PHYSICS

Exercise No : 10

Date :

Screw Gauge

Aim:

To find out the thickness of the given one rupee coin.

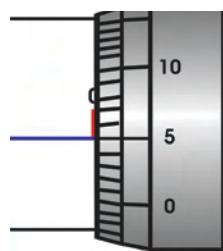
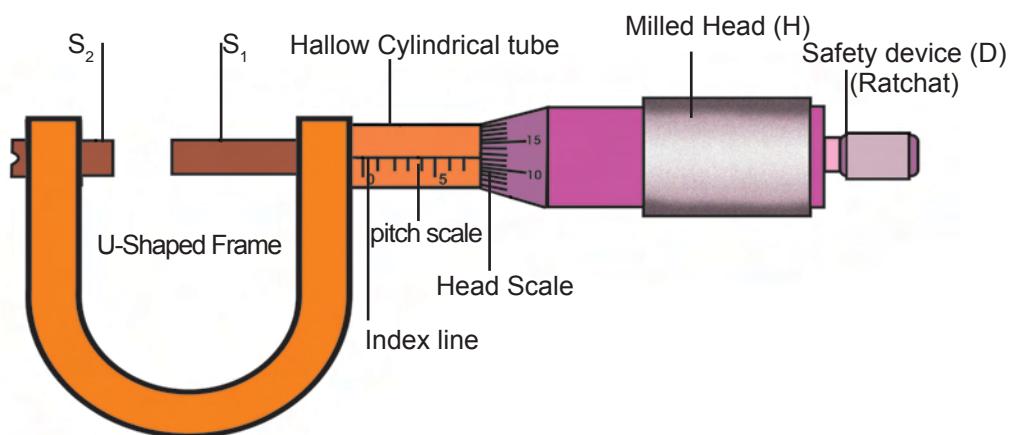
Materials required :

screw gauge, one rupee coin.

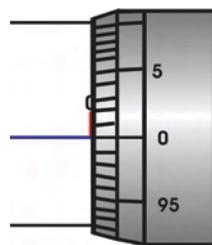
Formula :

$$\text{Least count} = \frac{\text{Pitch}}{\text{No. Of HSD}}$$

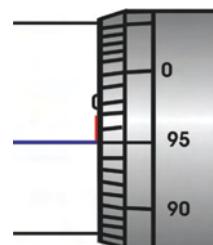
$$\text{Thickness} = \text{P.S.R} + (\text{H.S.C} \times \text{L.C}) \pm \text{Z.C} \text{ (mm)}$$



positive error



no error



negative error

Procedure:

- * The least count of the screw gauge is found by using the formula.
- * Zero error of the screw gauge is found in the following way.

The plane surface of the screw S_2 and the opposite plane stud on the frame S_1 are brought into contact. If zero of head scale coincides with the pitch scale axis, there is no zero error. If the zero of the head scale lies below the pitch scale axis, the zero error is positive. If the n^{th} division of the head scale coincides with the pitch scale axis

$$ZE = + (n \times LC)$$

Then the zero correction is $ZC = - (n \times LC)$

If the zero of the head scale lies above the pitch scale axis, the zero error is negative. If the n^{th} division of the head scale coincides with the pitch scale axis,

$$ZE = - (100 - n) \times LC$$

Then the zero correction is $ZC = + (100 - n) \times LC$

- * Place the given coin between two studs. Rotate the head until the coin is held firmly but not tightly. Note the pitch scale reading (PSR) and the head scale division which coincides with the pitch scale axis (HSC). The thickness of the wire is given by $PSR + (H.S.C \times LC) + ZC$.
- * Repeat the experiment for different positions of the coin. Tabulate the readings. The average of the readings gives the thickness of the coin.

Table:

$$\text{Pitch} = \quad L.C = \quad Z.E = \quad Z.C =$$

Trial No.	P.S.R (mm)	H.S.C (division)	H.S.C x L.C (mm)	Thickness of the coin = P.S.R + (H.S.C X L.C) \pm Z.C (mm)
1.				
2.				
3.				
4.				
5.				
Mean				

Result:

The thickness of the given coin = _____ mm

Exercise No :11

Date :

Ohm's Law Verification

Aim:

To study the dependence of the potential difference across a resistor on the current through it and to determine its resistance and to verify the Ohm's law.

Material required :

A resistor of unknown value, an ammeter (0-3 A), a voltmeter (0-10V), a battery eliminator, plug key and connecting wires.

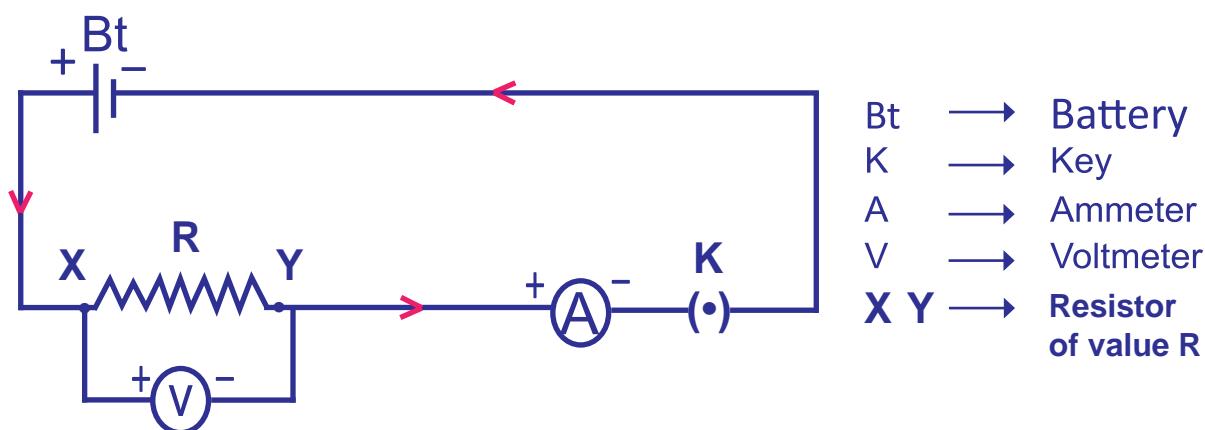
Formula :

$$\text{Resistance } (R) = V/I \Omega$$

V - Potential difference in volt

I - Current in ampere

Circuit diagram :



Procedure:

- * Note the range and least count of the given ammeter and the voltmeter.
- * Set up the circuit by connecting different components with the help of connecting wires. Keep the rating of the eliminator at the minimum (say at 2 V)
- * Make sure that the positive and negative terminals of the ammeter and voltmeter are correctly connected in the circuit as shown above.

- * Insert the key into the plug to let the current flow in the circuit. Note the readings of the ammeter and voltmeter and record them. The voltmeter measures the potential difference (V) across the two ends X and Y of the resistor, and the ammeter measures the current I through it. Remove the key from the plug.
- * Now increase the rating of the Battery Eliminator rating to 4 V. Note and record the voltmeter and ammeter readings.
- * Repeat the experiment by varying the rating of the battery eliminator to 6 V and 8V.

Observations and Calculations:

1. Range of the ammeter = _____ to _____ A
2. Least count of the ammeter = _____ A
3. Range of the voltmeter = _____ to _____ V
4. Least count of the voltmeter = _____ V

Table:

Sl. No.	Voltage applied in the circuit (in volt)	Current through the Resistor, I (in ampere)	Potential difference across the ends of the resistor, V (in volt)	Resistance of the resistor $R=V/I$ (in ohm)
1.				
2.				
3.				
4.				

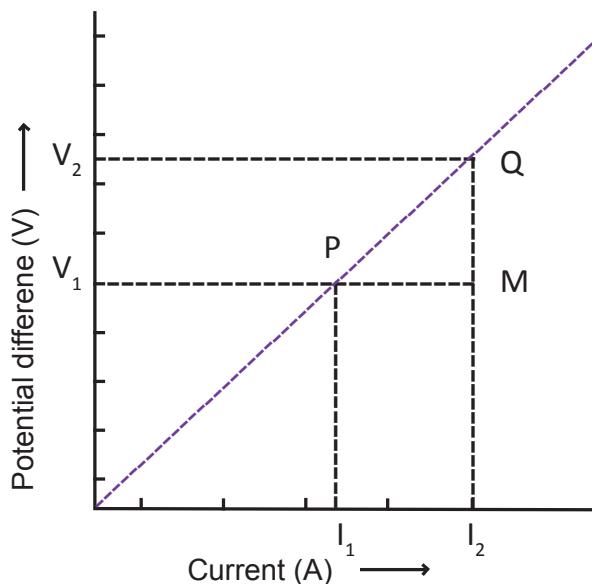
Mean value of resistance R of the resistor = _____ Ω

Graph:

Find the range of variation in the values of I and V. Choose appropriate scale for the values of I and V along the x and y-axes respectively on the graph paper. Mark the points on the graph paper for each value of current I and corresponding value of potential difference V. Join all the points by a straight line such that most of the points lie on it. Find the slope of this straight line graph by choosing two points P and Q on it. The slope is the resistance of the resistor used in the circuit.

Extend the straight line of the graph backwards to check whether it passes through the origin of the graph.

$$\begin{aligned}\text{Slope} &= \frac{QM}{MP} \\ &= \frac{V_2 - V_1}{I_2 - I_1}\end{aligned}$$



Result:

- * Resistance R of the resistor obtained from the calculations = _____ ohm.
- * Resistance R of the resistor obtained from the graph = _____ ohm.
- * The value of resistance R of resistor for all values of current through it remains the same. The graph between V and I is a straight line and passes through the origin. This verifies the Ohm's law.

Exercise No : 12**Date :****Resistors in Series****Aim:**

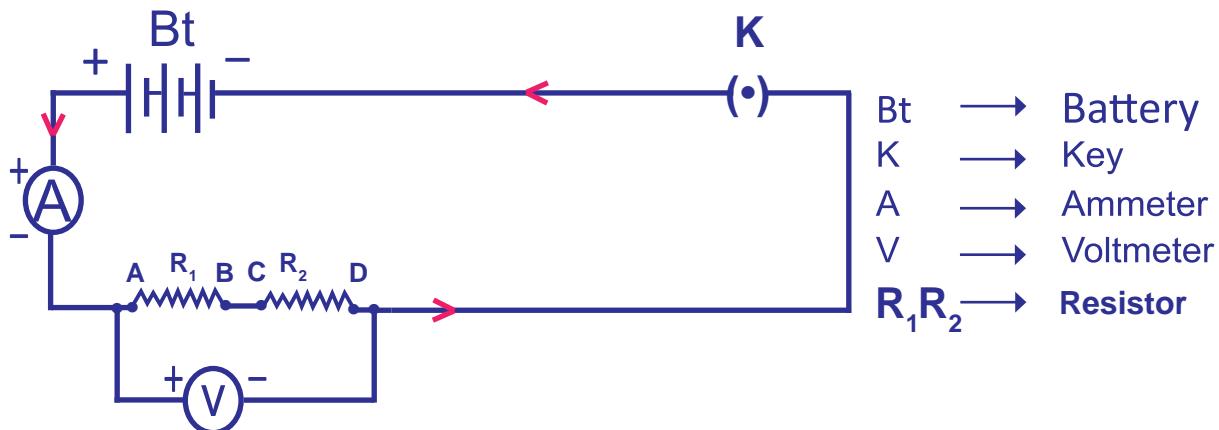
To determine the equivalent resistance of two resistors connected in series.

Materials required :

Two resistors of each $2\ \Omega$, an ammeter (range 0-5 A), a voltmeter (range 0-5 V), a battery eliminator, a plug key and connecting wires.

Formula :

$$\text{Effective Resistance of the Resistors connected in series } R_s = R_1 + R_2 \ \Omega$$

Circuit diagram :**Procedure:**

- * Note the range and least count of the given ammeter and the voltmeter.
- * The given resistors are connected in series by joining the ends labelled B and C as shown in the circuit diagram. Set up the circuit by connecting different components with the help of connecting wires.
- * Insert the key in the plug to let the current flow in the circuit. Note the readings of the ammeter and voltmeter and record them. The voltmeter measures the potential difference (V) across the two ends A and D of the series combination of two resistors. And the ammeter measures the current I through series combination.

- * Repeat the experiment with three different values of current flowing through the circuit and record the readings of the ammeter and voltmeter in each case. The current flowing through the circuit may either be decreased or increased by changing the voltage rating of the battery eliminator.

Observations and Calculations:

- Range of the ammeter = _____ to _____ A
- Least count of the ammeter = _____ A
- Range of the voltmeter = _____ to _____ V
- Least count of the voltmeter = _____ V
- Resistance of the first resistor R_1 = _____ Ω
- Resistance of the second resistor R_2 = _____ Ω

Table:

Sl. No.	Voltage applied in the circuit (in volt)	Current through the Series Combination, I_s (in ampere)	Potential difference across the series, V_s (in volt)	Equivalent Resistance of the combination $R_s = V_s / I_s$ (in ohm)	Experimental Average value of R_s (in ohm)	Theoretical Average value of $R_s = R_1 + R_2$ (in ohm)
1.						
2.						
3.						
4.						

$$R_1 = \text{_____ } \Omega \text{ and } R_2 = \text{_____ } \Omega$$

Result:

The equivalent resistance of the series combination of the two given resistors is found to be the same in the experimental and theoretical value.

BIO-BOTANY

PRACTICAL INSTRUCTIONS

1. To Dissect and display the parts of a flower (any one)

a) Hibiscus, Datura, Clitoria and Thespesia.

b) Separate out the Calyx, Corolla, Androecium and Gynoecium and display them on a separate sheet

c) Draw a labelled sketch of the floral parts.

d) Marks:

Dissection	– 1 $\frac{1}{2}$	}	= 3
Display	– 1 $\frac{1}{2}$		

Diagram + parts – 1+1 = 2

2. To identify the given slide and to draw a neatly labelled diagram with notes (any one)

a) L.S of Anther

b) L.S of Ovule

Identification – 1

Reasons – 2x1 = 2

Diagram + parts – 1+1 = 2

3. To demonstrate the fermentation process.

The physiological experiments must be demonstrated in the laboratory during practical hours.

For the examination, the experimental setup alone should be displayed.

Students should identify the experimental setup and write notes on it

Identification :

Aim – 1

Material required – 1

Procedure – 1

Observation – 1

Inference – 1

BIO-ZOOLOGY

4. To test the presence of starch by iodine test method.

Sample A & B – one sample should contain starch solution and the other should be a dummy sample.

Starch sample – potato extract, starch powder, rice water – (any one can be used)

Materials required	– 1
Procedure	– 1
Table	– 2
Result	– 1

5. To identify the given slide and to write notes with a neatly labelled diagram. (any one)

- a) Red blood corpuscles
- b) White blood corpuscles
- c) Plasmodium

Identification	– 1
Reason	– 2
Diagram + parts	– 2

6. To calculate the Body Mass Index using BMI formula.

Material required	– 1
Procedure	– 1
Table	– 2
Inference	– 1

CHEMISTRY

Scoring method:

Aim	– 1 mark
Procedure/ observations	– 2 marks
Result	– 2 marks
Total	– 5 marks

PHYSICS

1. Screw Gauge

Least count	– 1 mark
Procedure	– 1 mark
Tabulation	– 1+1 mark
Result +unit	– 1 mark

2. Ohm's Law

Formula	– 1/2 mark
Circuit diagram	– 1/2 mark
Procedure	– 1 mark
Tabulation	– 1 mark
Graph	– 1 mark
Result + unit	– 1 mark

3. Resistance in Series

Formula	– 1/2 mark
Circuit diagram	– 1/2 mark
Procedure	– 1 mark
Tabulation	– 1+1 mark
Result + unit	– 1 mark

SCIENCE PRACTICALS

PART - 2

S.No.	CONTENTS
	<p style="text-align: center;">BIOLOGY</p> <p>BIO-BOTANY</p> <p>1 Identify the given seed and classify whether it is a dicot or a monocot seed</p> <p>2 Classify the given fruit and give reasons with diagram</p> <p>3 Test tube and funnel experiment</p> <p>BIO-ZOOLOGY</p> <p>4 Test for lipids (Saponification Test)</p> <p>5 Identification of given models</p> <p>6 Identify the flagged endocrine gland and write its location, the hormones secreted and any two of its functions</p> <p style="text-align: center;">CHEMISTRY</p> <p>7 You are provided with a sample solution. Perform the following tests and identify whether the given sample is an acid or a base</p> <p>8 You are provided with samples A&B. Identify if the samples are acids/bases/neutral by using pH paper</p> <p>9 Identify the basic radical presence in the given salt using sodium hydroxide solution</p> <p style="text-align: center;">PHYSICS</p> <p>10 Focal length of convex lens</p> <p>11 Glass prism</p> <p>12 Mapping of magnetic field</p>

BIO-BOTANY

Exercise No : 1

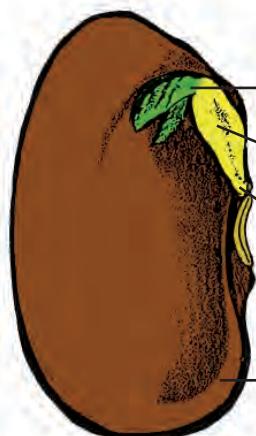
Date :

Identify the given seed and classify whether it is a dicot or a monocot seed.

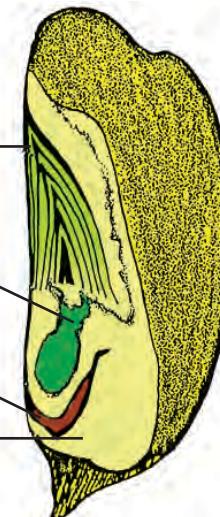
Dissect and display the seed

Entire seed

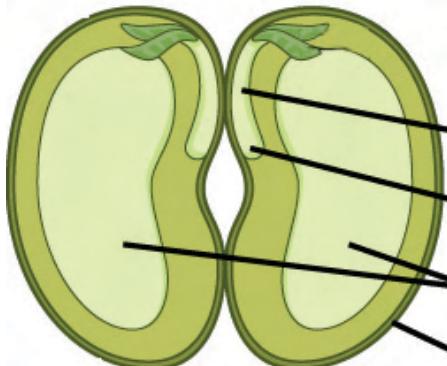
Dicot seed - bean



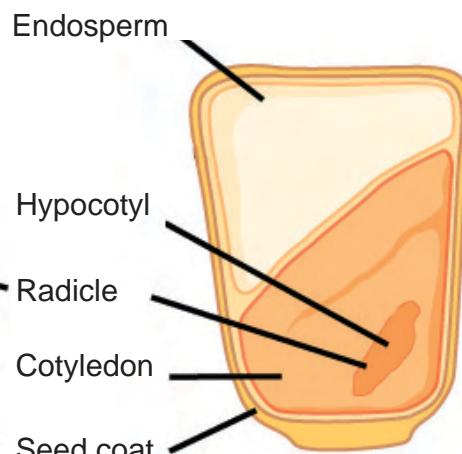
Monocot seed - corn



L.S of the bean seed



L.S of the corn seed



Exercise No : 2

Date :

Classify the given fruit and give reasons with diagram.

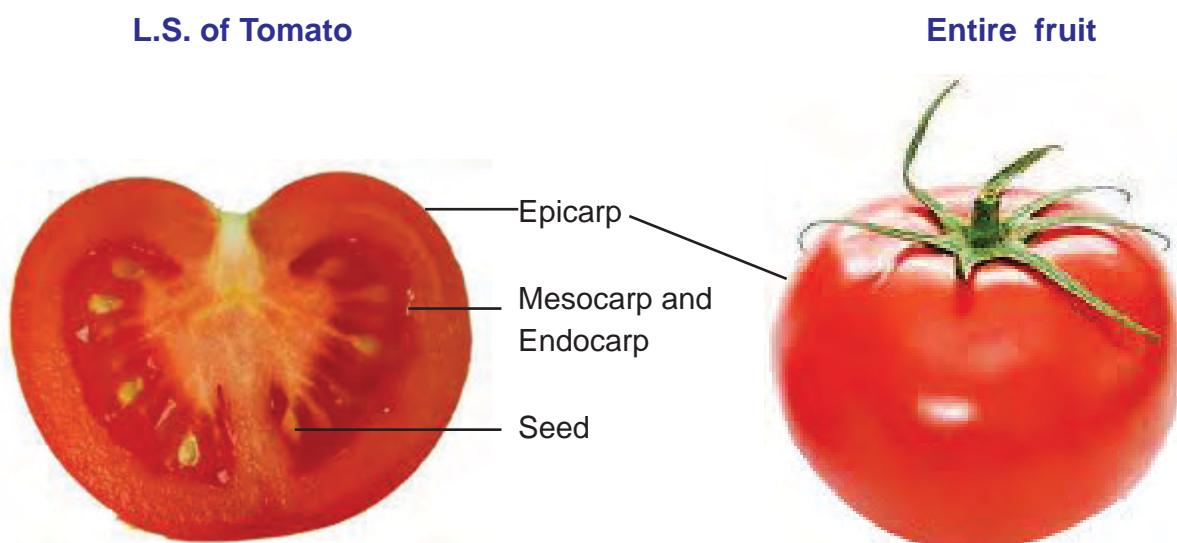
(a) Tomato

(i) Classification : Simple fleshy fruit – Berry – L.S. of Tomato

(ii) Reasons :

- * Fruit is developed from the single flower, multicarpellary, syncarpous and superior ovary.
- * The succulent pericarp is differentiated into outer epicarp and inner fleshy pulp.
- * The mesocarp and endocarp are fused to form the fleshy pulp where the seeds are embedded.
- * The entire fruit is edible.

(iii) Diagram :



(b) Polyalthia

(i) Classification : Aggregate fruit – (e.g.) Polyalthia

(ii) Reasons :

- * Polyalthia develops from a single flower with multicarpellary apocarpous ovary.
- * During fruit formation each free carpel develops into a fruitlet.
- * So, there are many fruitlets seen attached to a common stalk.

(iii) Diagram :

Entire fruit



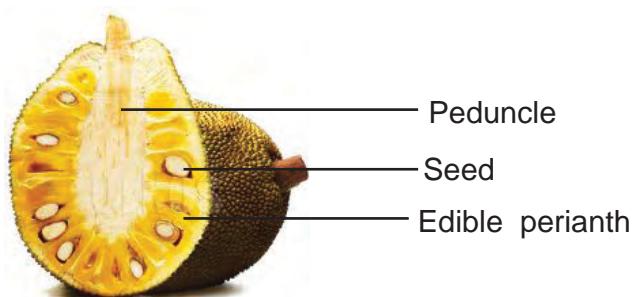
(c) Jack fruit

(i) Classification : Multiple fruit - (e.g.) Jack fruit

(ii) Reasons :

- * The entire female inflorescence develops into a single fruit.
- * The fertilized flowers develop into fruitlets.
- * The perianth develops into fleshy edible part.
- * The membranous bag around the seed is the pericarp.

(iii) Diagram :



L.S. of Jack fruit

Exercise No : 3

Date :

Test tube and funnel experiment

Aim :

To prove that Oxygen is evolved during Photosynthesis.

Materials required:

Test tube, funnel, beaker, pond water and Hydrilla plant.

Procedure:

- * Take a few twigs of Hydrilla plant in a beaker containing pond water.
- * Place an inverted funnel over the plant.
- * Invert a test tube filled with water over the stem of the funnel.
- * Keep the apparatus in the sunlight for few hours.

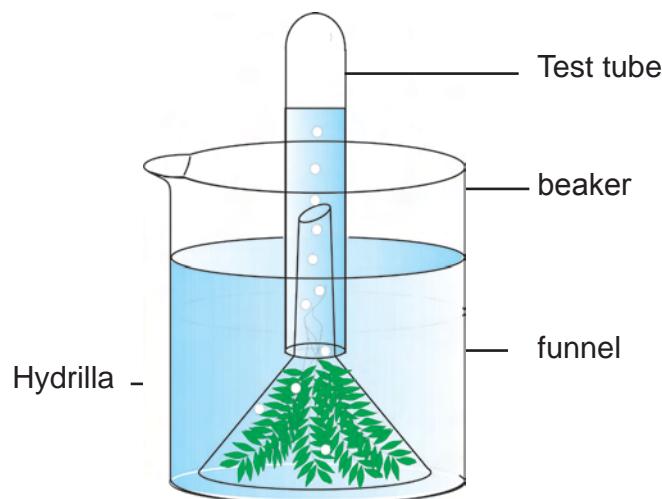
Observation:

After one hour, it is noted that water gets displaced down from the test tube.

Inference:

- * During photosynthesis, Oxygen is evolved as a by product. Gas bubbles liberated from the Hydrilla plant reach the top of the test tube and it displaces the water downwards. Take the test tube and keep the burning stick near the mouth of the test tube. Increased flame will be appeared. Hence, it is proved that Oxygen is evolved during photosynthesis.

Diagram :



BIO-ZOOLOGY

Exercise No : 4

Date :

Test for lipids (Saponification Test).

Aim :

To find the presence of Fat in the given food samples A and B by saponification test.

Materials required:

Test tubes, test tube holder and test tube stand, food samples A and B, 5% NaOH.

Procedure:

- * Take 1 ml of sample solution A and B separately in clean test tubes.
- * Add 2 ml of 5% NaOH in each test tube and shake well.
- * After noting the changes the results are tabulated.

Observation:

Sample A :

Sample B :

Table:

Sample	Observation	Inference
A		
B		

Result:

Appearance of soapy solution in Sample _____ indicates the presence of fat.

Exercise No : 5

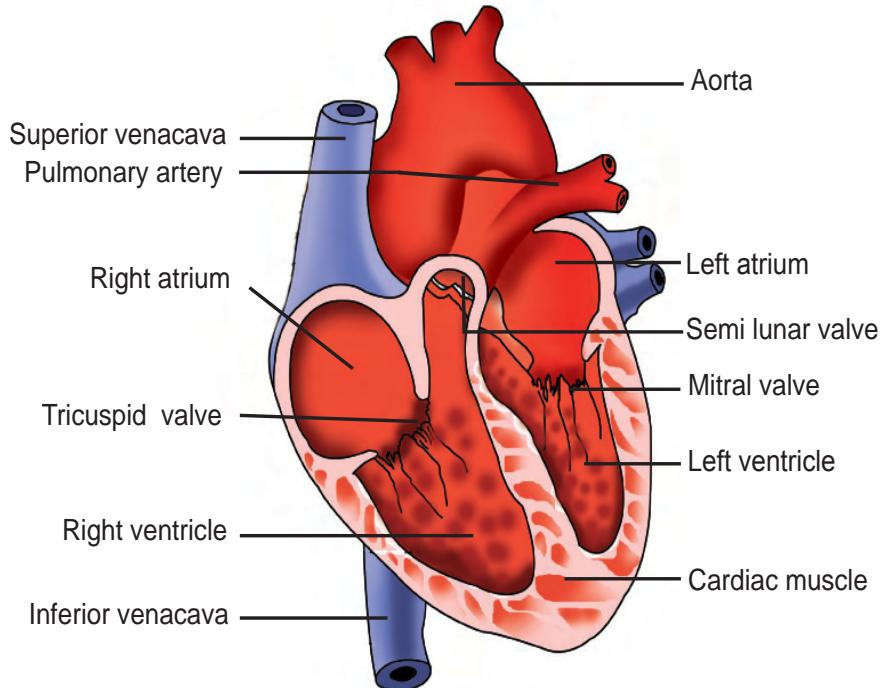
Date :

Identification of given models.

(a) L.S. of Human heart

Identification: The given model is identified as a L.S.of Human Heart

Diagram :

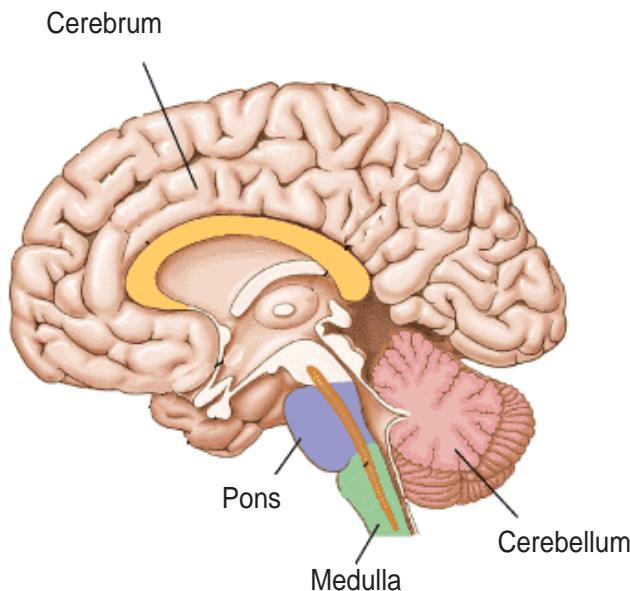


Notes:

- * The heart is a hollow fibro muscular organ, which is conical in shape.
- * The heart is covered by a protective double walled sac called pericardium.
- * The heart is made up of a special type of muscle called cardiac muscle.
- * It has four chambers namely two auricles and two ventricles.
- * The heart is a pumping organ which pumps blood to all parts of the body.

(b) L.S. of Human brain:

Identification: The given model is identified as L.S.of Human Brain.

Diagram :**Notes:**

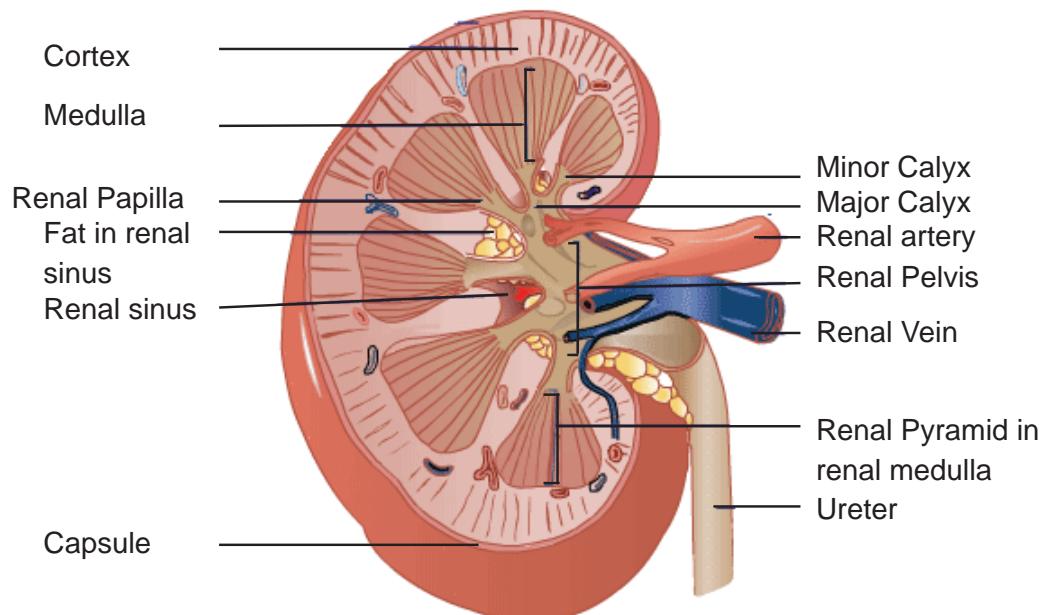
- * The human brain is placed inside the cranial cavity.
- * It is covered by three protective coverings called meninges.
- * The human brain is divided into three major parts namely forebrain, midbrain and hind brain.
- * The human brain contains millions of neurons.
- * Brain acts as a command and co-ordinating system of the human body.

(c) L.S. of Human Kidney:

Identification:

The given model is identified as L.S. of Human Kidney.

Diagram :



Notes:

- * The kidney is the principal excretory organ of our body.
- * The kidney is bean shaped paired structure and located in the upper abdominal region.
- * A thin transparent membrane called capsule covers the kidney.
- * The outer portion of the kidney is the renal cortex and the inner portion is the renal medulla.
- * A kidney has about 1.0 millions of functional units called nephrons.

Exercise No : 6**Date :**

Identify the flagged endocrine gland and write its location, the hormones secreted and any two of its functions. (No need to draw the diagram. Between two models anyone may be considered in examination).

1. Endocrine glands – (a) Thyroid gland

(b) Pancreas – Islets of Langerhans

(c) Adrenal gland

2. Any one endocrine gland should be flag labelled. For the purpose of flag labelling a model or a chart or a neat drawn diagram showing all endocrine glands should be used.

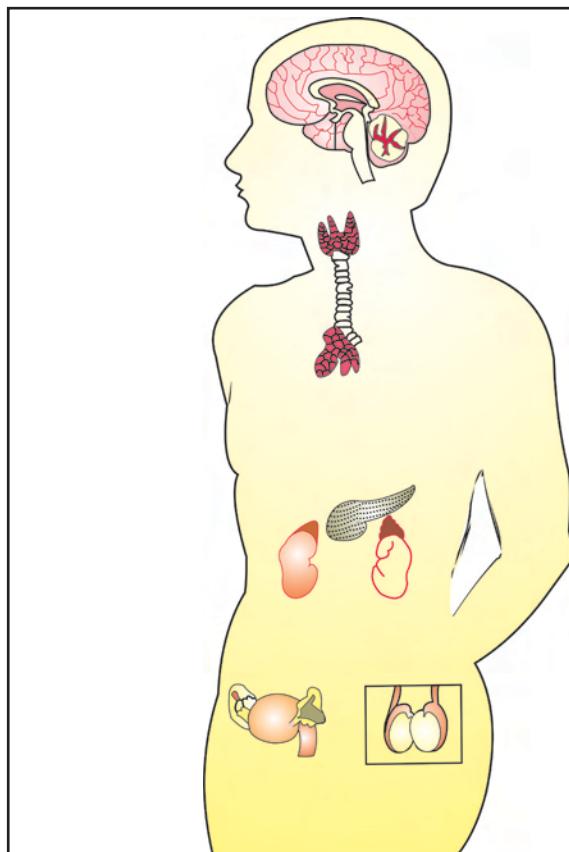


Diagram showing various Endocrine Glands
(Mark any one of the given Endocrine Glands for the practical)

(a) Thyroid gland

Identification:

The marked endocrine gland is identified as Thyroid gland

Location : Thyroid gland is a bilobed gland located in the neck region on either side of the trachea.

Hormones secreted: Thyroxine

Functions of Hormones:

- * Thyroxine increases the basal metabolic rate (BMR).
- * It increases the body temperature.
- * It is a personality hormone.
- * It regulates Iodine and sugar level in the blood.
- * Deficiency of thyroxine results in simple goiter, myxoedema and cretinism.
- * Excessive secretion causes Grave's diseases.

(b) Pancreas – islets of Langerhans

Identification:

The marked endocrine gland is identified as Islets of Langerhans in the Pancreas.

Location: Islets of Langerhans are seen embedded in the pancreas which is located in the abdominal region.

Hormones secreted:

1. α cells secrete glucagon and
2. β cells secrete insulin and amylin.

Functions of Hormones:

1. Insulin converts glucose into glycogen and deposits it in liver and muscles.
2. Glucagon converts glycogen into glucose.

Insulin and glucagon together control the blood sugar level (80 – 120 mg/1dl) by their antagonistic function.

3. Decrease in insulin level causes diabetes mellitus.

(c) Adrenal Gland**Identification:**

The marked endocrine gland is Adrenal gland.

Location: Adrenal glands are located above each kidney in the abdominal region.

Hormones secreted:

Adrenal cortex – Aldosterone and Cortisone.
Adrenal medulla – Adrenaline and Nor-Adrenaline

Functions of Hormones:

- * Aldosterone – regulates mineral metabolism.
- * Cortisone – regulates carbohydrate metabolism.
- * Adrenalin and Nor-Adrenalin – prepare the body to face stress and emergency conditions.
- * Adrenalin and Nor-Adrenalin hormones are called Emergency hormones and they increase the rate of heart beat and respiration.

CHEMISTRY

Exercise No :7

Date :

You are provided with the sample solution. Perform the following test, identify whether the given sample is an acid or a base.

- a) Phenolphthalein
- c) Sodium carbonate

- b) Methyl orange
- d) Zinc granules

Aim:

To identify the presence of an acid or a base in a given sample.

Theory:

In acid medium, phenolphthalein is colourless whereas methyl orange is pink colour. Similarly, in basic medium, phenolphthalein is pink in colour whereas methyl orange is yellow in colour. Acid gives brisk effervescence with sodium carbonate due to the liberation of carbon dioxide whereas bases do not. Zinc reacts with dilute acid to liberate hydrogen gas whereas bases will liberate hydrogen only on heating.

Materials required:

Test tubes, test tube stand, glass rod, phenolphthalein, methyl orange, sodium carbonate salt, zinc granules and the given sample.

S. No.	Experiment	Observation (Colour change)	Inference (Acid / base)
1	Take 5 ml of the test solution in a test tube and add Phenolphthalein in drops to this content	a) No change in colour. b) Turns pink in colour.	a) Presence of acid b) Presence of base
2	Take 5 ml of the test solution in a test tube and add Methyl orange in drops.	a) Turns pink in colour. b) Turns yellow in colour.	a) Presence of acid b) Presence of base
3	Take 5 ml of the test solution in a test tube and add a pinch of sodium carbonate salt.	a) Brisk effervescence occurs b) No Brisk effervescence	a) Presence of acid b) Presence of base
4	Take 5 ml of the test solution in a test tube and add a little of the zinc granules.	a) Bubbles come out. b) Bubbles do not come out.	a) Presence of acid b) Presence of base

Result: The given test solution contains _____ (acid / base)

Exercise No : 8**Date :**

You are provided with sample A&B. Find the nature of the samples as acids/bases/ neutral by using pH paper.

Aim:

To identify the nature of the given solution using pH paper.

Principle:

pH paper is the power of H⁺ ions or OH⁻ ions present in a solution. The pH scale values varies from 0 to 14. A pH less than 7 indicates acidic nature whereas pH greater than 7 indicates basic nature. pH equal to 7 indicates neutral. The pH paper is used for finding the approximate pH value. It shows different colour at different pH.

Materials required:

Sample solutions A&B, pH paper, glass rod and watch glass.

Procedure:

Take a pH paper. Place it on a watch glass. By using glass rod take a drop of each sample and place it on the pH paper. Observe the colour change that appears and note down the approximate pH value based on the reference scale given on pH paper.

Observation:

Sample	pH paper		Inference Nature of solution
	Colour produced	Approximate pH	
A			
B			

Result:

The given sample A is _____ in nature.

B is _____ in nature.

Exercise No : 9**Date :**

Identify the basic radical presence in the given salt using sodium hydroxide solution.

Aim :

To identify the basic radical present in the given salt by the action of sodium hydroxide solution.

Theory:

Most of the metals generally form the precipitate of respective metal hydroxide with sodium hydroxide solution.

**Materials required:**

Test tube, test tube stand, sodium hydroxide solution, distilled water and given salt.

Procedure:

Dissolve a few grams of the given salt in 10 ml of distilled water. This solution is called salt solution. Take a small portion of that salt solution in a test tube and perform the test given below.

S.No	Experiment	Observation (Colour change)	Inference (Acid/base)
1	Sodium hydroxide test To the salt solution, add sodium hydroxide solution drop by drop.	a) Bluish white precipitate is formed b) Dirty green precipitate is formed c) White precipitate is formed	a) Presence of cupric ion (Cu^{+2}) b) Presence of ferrous ion (Fe^{+2}) c) Presence of Aluminium ion (Al^{+3})

Result:

The given salt contains _____ basic radical.

PHYSICS

Exercise No : 10

Date :

Focal length of convex lens.

Aim:

To determine the focal length of the given convex lens by:

- I. distant object method
- II. u-v method

Materials required :

Convex lens, lens stand, white screen, metre scale, and illuminated wire gauze.

Formula :

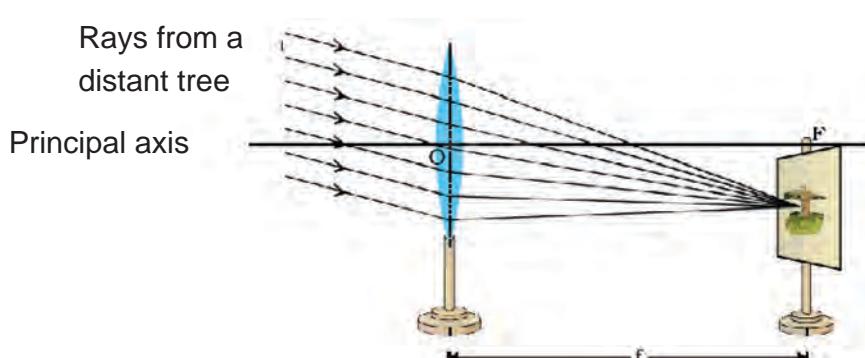
$$\text{Focal length of the convex lens by u-v method} \quad f = \frac{uv}{u+v} \text{ cm}$$

u - is the distance between the lens and the object

v - is the distance between the lens and the image.

Procedure:

Diagram :

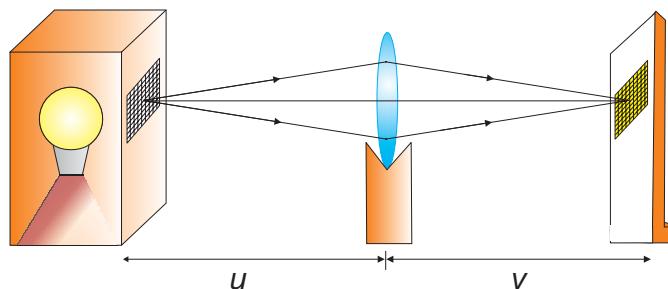


Distant object method

Distant object method:

1. The convex lens is mounted on the stand and is kept facing a distant object (may be a tree or a building).
2. The white screen is placed behind the convex lens and its position is adjusted to get a clear, diminished and inverted image of the object.
3. The distance between the convex lens and the screen is measured. This gives an approximate value of the focal length of the convex lens.

Diagram :



u-v method

u-v method

1. The convex lens is mounted on the stand and placed in front of the illuminated wire gauze at a certain distance 'u' from the wire gauze.
2. The screen is adjusted to get a clear image. Two values of 'u' are chosen between f and $2f$ of the lens and the other two values of u are chosen beyond $2f$.
3. A screen is placed on the other side of lens and its distance from the lens is adjusted to get a clear image. The value of 'u' lesser than $2f$ will produce an enlarged image and that greater than $2f$ will produce a diminished image.
4. The distance between the lens and the screen is taken as 'v' and it is measured for each experimental value of 'u' focal length of the convex lens by u-v method

Table :

u-v Method

Trial No.	Nature of image	Object distance u cm	Image distance v cm	Focal length $f = \frac{u v}{u + v} \text{ cm}$
1.	$u < 2f$			
2.	magnified			
3.	$u > 2f$			
4.	diminished			

Result:

The focal length of the given convex lens by:

- i. Distance object method $(f) = \underline{\hspace{2cm}}$ cm
- ii. u-v method $(f) = \underline{\hspace{2cm}}$ cm

Exercise No : 11

Date :

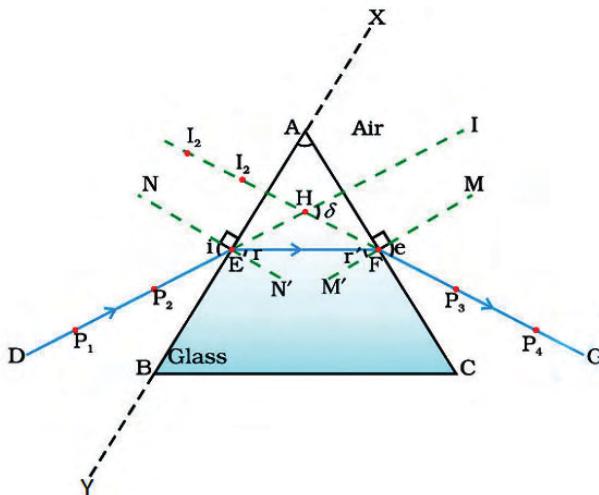
Glass Prism

Aim:

To trace the path of a ray of light through a glass prism, to identify the rays and to measure different angles.

Materials required :

A glass prism, drawing board, white paper, adhesive tape or drawing pins, pins, a measuring scale, and a protractor.



Procedure :

1. Fix a white sheet of paper on a drawing board. Draw a thin line XY in the middle of the paper.
2. Draw a thin line NEN^l normal (perpendicular) to the line XY at point of incidence E (say). Also draw a line DE making an angle, preferably between 30° and 60° .
3. Place the prism with one of its refracting surfaces (say AB) along the line XY. Mark the boundary ABC of the glass prism holding it firmly with your hand.
4. Fix two pins P_1 and P_2 vertically, by gently pressing their heads with thumb on line DE at a distance of about 6 cm from each other. View the images of pins P_1 and P_2 from the opposite face AC of the prism.
5. Fix two more pins P_3 and P_4 vertically such that the feet of pins P_3 and P_4 appear to be on the same straight line as the feet of the images of the pins P_1 and P_2 as viewed through the face AC of the prism.

- Remove the pins and the prism. Mark the position of feet of pins P_3 and P_4 on the sheet of paper. Draw a straight line to join the points that mark the position of pins P_3 and P_4 . Extend this line so that it meets the face AC of the prism at point F. The line FG represents the path of the emergent ray.
- Extend the direction of incident ray DE till it meets the face AFC. Also extend (backwards) the emergent ray FG as shown in the Figure. These two extended lines meet at point H.
- Measure $\angle DEN$ as the angle of incidence (i), $\angle GFM$ as the angle of emergence (e) and $\angle FHI$ as the angle of deviation (d). Record these angles in the observation table.

Sl. No.	Angle of incidence (i)	Angle of deviation (d)
1.		
2.		

Result :

- The path of light incident on one face of a glass prism is shown.
- The different rays and angles are identified as below

Incident ray _____ angle of incidence _____

Refracted ray _____ angle of emergence _____

Emergent ray _____ angle of deviation _____

3. The value of the angle of incidence $i = \underline{\hspace{2cm}}^0$

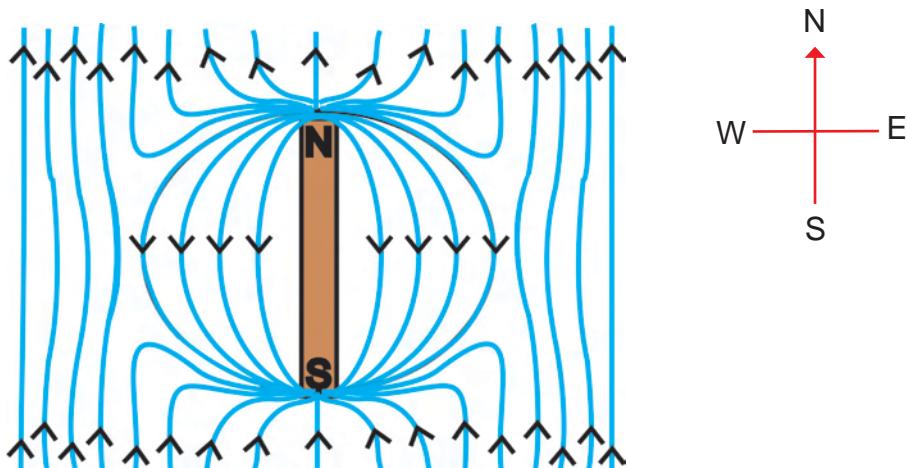
4. The value of the angle of deviation $d = \underline{\hspace{2cm}}^0$

Exercise No : 12**Date :****Mapping of magnetic field****Aim:**

To map the magnetic field of a Bar Magnet when it is placed in a Magnetic Meridian with its North-pole pointing towards North.

Apparatus required:

Drawing Board, board pin or sellotape(sticky tape), compass needle, sheets of white paper and bar magnet.

Diagram :**Procedure:**

1. A white sheet of paper is fastened to the drawing board using board pins or sellotape. (When doing this, all magnets and magnetic materials are moved far away from the drawing board).
2. A small plotting compass needle is placed near the edge of the paper and the board is rotated until the edge of the paper is parallel to the magnetic needle. This position should not be disturbed throughout the experiment.
3. The compass needle is placed at the centre of the paper, the ends of the needle i.e. the new positions of the north and South Pole are marked when the needle comes to rest. These points are joined and a straight line is obtained. This is the magnetic meridian.

4. Cardinal directions NEWS is drawn near the corner of the paper. The bar magnet is placed on the line at the centre of the paper with its north pole facing the geographic north. The outline of the bar magnet is drawn.
5. The plotting compass is placed near the North Pole; the ends of the needle are marked. Move the compass to a new position such that its south end occupies the position previously occupied by its north pole. In this way proceed step by step till the South Pole of the magnet is reached.
6. The lines of the magnetic forces are drawn by joining the plotted points around the magnet. In the same way several magnetic lines of force are drawn around the magnet as shown in the figure.
7. The curved lines represent the magnetic field of the magnet. The direction of the lines is shown by arrows heads.

Result:

The magnetic lines of force are mapped when the bar magnet is placed with its north pole facing geographic north. The mapped sheet is attached.

BIO-BOTANY

1. To identify the given seed Whether it is a Dicot or a monocot seed.

1.Bean, Bengal gram, Paddy, Maize (any one)

2.The cotyledons of the seed should be separated and displayed.

3.Labeled diagram of the structure of seed should be drawn.

Classification – 1

Dissect and Display – 2

Diagram + parts – 2

2. To identify and classify the given fruit.(any one)

1. Simple fleshy fruit - Tomato

2. Aggregate fruit - Polyalthia

3. Multiple fruit - Jack fruit

Classification – 1

Diagram + parts – 2

Reasons – 2

3. To demonstrate that oxygen is evolved during photosynthesis by test tube and funnel experiment.

The physiological experiments must be demonstrated in the laboratory during practical hours.

For the examination the experimental set up should be displayed.

Students should identify the experimental set up and write notes on it.

Identification	- ½
Aim	- ½
Material required	- 1
Procedure	- 1
Observation	- 1
Inference	- 1

BIO-ZOOLOGY

4. To test the presence of lipid by Soaponification test method - Sample A&B - One Sample should contain lipid solution and the other should be a dummy solution.

(Lipid sample – any plant oil)

Materials required	- 1
Procedure	- 1
Table	- 2
Result	- 1

5. To Identify given human models (any one)

- a) Human Heart
- b) Human brain
- c) Human Kidney

Identification	- 1
Diagram + Parts	- 2
Notes	- 2

6. Identify the flag labelled endocrine gland.

- 1. Endocrine glands – (a) Thyroid gland
- (b) Pancreas – Islets of longerhans
- (c) Adrenal gland

2. Any one endocrine gland should be flag labeled. For the purpose of flag labelling a model or a chart or a neat drawn diagram showing all endocrine glands should be used.

Identification	– 1 mark
Location	– 1 mark
Hormones secreted	– 1 mark
Any two functions	– 2 mark

CHEMISTRY

Scoring method:

Aim	– 1 mark
Procedure/ observations	– 2 mark
Result	– 2 mark

PHYSICS

1. Convex Lens

Formula	– 1 mark
Procedure	– 1 mark
Tabulation	– 1 mark
Graph	– 1 mark
Result + unit	– 1 mark

2. Glass Prism

Diagram	– 1 mark
Procedure	– 1 mark
Tabulation	– 1+ 1 mark
Result + unit	– 1 mark

3. Mapping of the Magnetic Field

Magnetic meridian	– 1 mark
Procedure	– 1 mark
Tabulation	– 1+ 1 mark
Result + unit	– 1 mark