Government of Karnataka

SCIENCE

[REVISED]

8

EIGHTH STANDARD

PART - 1

KARNATAKA TEXT BOOK SOCIETY (R)
100 Feet Ring Road, Banashankari, 3rd stage,
Bengaluru-85

PREFACE

The Textbook Society, Karnataka has been engaged in producing new textbooks according to the new syllabi prepared which in turn are designed based on NCF – 2005 since June 2010. Textbooks are prepared in 11 languages, seven of them serve as the media of instruction. From standard 1 to 4 there is the EVS and 5th to 10th there are three core subjects namely mathematics, science and social science.

NCF – 2005 has a number of special features and they are:

- Connecting knowledge to life activities
- Learning to shift from rote methods
- Enriching the curriculum beyond textbooks
- Learning experiences for the construction of knowledge
- Making examinations flexible and integrating them with classroom experiences
- Caring concerns within the democratic policy of the country
- Make education relevant to the present and future needs.
- Softening the subject boundaries integrated knowledge and the joy of learning.
- The child is the constructor of knowledge

The new books are produced based on three fundamental approaches namely.

Constructive approach, Spiral Approach and Integrated approach

The learner is encouraged to think, engage in activities, masters skills and competecies. The materials presented in these books are integrated with values. The new books are not examination oriented in their nature. On the other hand they help the learner in the total development of his/her personality, thus help him/her become a healthy member of a healthy society and a productive citizen of this great country India.

We live in an age of science and technology. During the past five decades man has achieved great things and realized his dreams and reached pinnacle of glory. He has produced everything to make life comfortable. In the same way he has given himself to pleasures and reached the stage in which he seems to have forgotten basic sciences. We hope that at least a good number of young learners take to science in higher studies and become leading scientists and contribute their share to the existing stock of knowledge in order to make life prosperous.

Ample opportunity has been given to learners to think, read, discuss and learn on their own with very little help from teachers. Learning is expected to be activity centered with the learners doing experiments, assignments and projects.

The Textbook Society expresses grateful thanks to the chairpersons, writers, scrutinisers, artists, staff of DIETs and CTEs and the members of the Editorial Board and printers in helping the Text Book Society in producing these textbooks.

Bengaluru

Prof. G S Mudambadithaya
Coordinator
Curriculum Revision and Textbook Preparation
Karnataka Textbook Society®
Bengaluru, Karnataka

Nagendra Kumar
Managing Director
Karnataka Textbook Society®
Bengaluru, Karnataka.

★★★★★

FOREWORD

The Present text book for eight standard science has been prepared according to the NCF 2005. The revised syllabus approved by the authorities concerned has been followed.

The main feature of the text book is constructive approach. The activity based development of the content may help in the formation of concepts. In some areas there is a narrative approach on account of the nature of the subject matter. Direct definitions in some areas are deliberately avoided such that the learner can draw his own but correct conclusions. *Learning to learn* principle is followed by and large.

The text book committee is presenting this text book with pleasure and with a bit of anxiety. Extreme care is taken to avoid content errors. However, lack of sufficient information or elaboration in certain units should not be construed as wrong information. This is done to avoid memorization of facts and to reduce the burden.

It should be noted that the main aim of secondary education is to lay the foundation for higher education. It is a cushion for children to jump to higher studies and to develop their personality by meeting their immediate instinctive needs. Learner at this stage, should develop minimum skills and should acquire sufficient knowledge so that he can interact with his present environment effectively.

We, the Chairpersons of text book preparation committee, express our sincere thanks to prof. G.S. Mudambadithaya, coordinator for assigning this responsibility to us. We also wish to express our thanks to writers, scrutinisers, editorial committee members, teachers and translators for their valuable contributions in improving the quality of the content. Our thanks are also due to the artist for his drawings and to the authorities of Karnataka Text book Society and DSERT for their kind cooperation.

Any further feasible suggestions to improve the text book are welcome, Humans are never perfect. But perfection is the goal towards which one should sincerely try to move.

Chairpersons

Dr. T.A. Balakrishna Adiga

A.B. Katti

Text Book Committee

Chairpersons

Dr. T.A. Balakrishna Adiga, Principal, Silicon city, P.U.College, Bengaluru.

Sri. A.B. Katti, Rtd. Head Master, Sheshadripuram High school, Bengaluru.

Members

Smt. H.V. Bhagyalakshmi, Rtd. Science Teacher, Stella Mary's High School, Bengaluru.

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Sri. G. Satish, Assistant Teacher, R.V. Girls High School, Jayanagar , Bengaluru.

Sri. Venkatesh Udupa, Assistant Teacher, Viveka P.U. College, Kota, Udupi.

Sri. M.G. Manjunatha, Assistant Teacher, S.J.S. R.R. High School, Yalavatti, Shivamogga.

Sri. Girish Kadlewad, Assistant Teacher, Govt. High School, Martoor, Kalaburagi.

Sri. Lakshminarayana, Artist, Drawing Teacher, Govt. High School, D.G. Halli, Bengaluru.

Scrutinisers

Sri. Ragavendra Patil, Rtd. Prinicipal, AST P.U. College, Malladi halli, Chitradurga.

Dr. C.R. Girija, Associate professor, SSMRV Degree College, Jayanagar, Bengaluru.

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Prof. H.S. Lakshminarayana Bhatta, Rtd. Prinicipal, V.V. Puram, Science College, Bengaluru.

Chief Co-ordinator

Prof. G.S. Mudambadithaya, Curriculum Revision and Text book preparation, Govt. of Karnataka.

Chief Advisors

Sri. Nagendra Kumar, Managing Director, Karnataka Text Book Society,Bengaluru.

Sri. Nagamani C , Deputy Director (in charge), Karnataka Text Book Society, Bengaluru.

Programme Co- ordinator

Smt. Bharathi Sreedhara Hebbalalu, Senior Asst. Director, Karnataka Text Book Society, Bengaluru.

About the Revision of Textbooks

Honourable Chief Minister Sri Siddaramaiah who is also the Finance Minister of Karnataka, in his response to the public opinion about the new textbooks from standard I to X, announced, in his 2014-15 budget speech of constituting an expert-committee, to look into the matter. He also spoke of the basic expectations there in, which the textbook experts should follow: "The textbooks should aim at inculcating social equality, moral values, development of personality, scientific temper, critical acumen, secularism and the sense of national commitment", he said.

Later, for the revision of the textbooks from class I to X, the Department of Education constituted twenty seven committees and passed an order on 24-11-2014. The committees so constituted were subject and class-wise and were in accordance with the standards prescribed. Teachers who are experts in matters of subjects and syllabi were in the committees.

There were already many complaints, and analyses about the textbooks. So, a freehand was given in the order dated 24-11-2014 to the responsible committees to examine and review text and even to prepare new text and revise if necessary. Eventually, a new order was passed on 19-9-2015 which also give freedom even to re-write the textbooks if necessary. In the same order, it was said that the completely revised textbooks could be put to force from 2017-18 instead of 2016-17.

Many self inspired individuals and institutions, listing out the wrong information and mistakes there in the text, had send them to the Education Minister and to the Textbook Society. They were rectified. Before rectification we had exchanged ideas by arranging debates. Discussions had taken place with Primary and Secondary Education Teachers' Associations. Questionnaires were administered among teachers to pool up opinions. Separate meetings were held with teachers, subject inspectors and DIET Principals. Analytical opinions had been collected. To the subject experts of science, social science, mathematics and languages, textbooks were sent in advance and later meetings were held for discussions. Women associations and science related organistation were also invited for discussions. Thus, on the basis of all inputs received from various sources, the textbooks have been revised where ever necessary.

Another very important aspect has to be shared here. We constituted three expert committees. They were constituted to make suggestions after making a comparative study of the texts of science, mathematics and social science subjects of central schools (NCERT), along with state textbooks. Thus, the state text books have been enriched based on the comparative analysis and suggestions made by the experts. The state textbooks have been guarded not to go lower in standards than the textbooks of central school. Besides, these textbooks have been examined along side with the textbooks of Andhra Pradesh, Kerala, Tamil Nadu and Maharashtra states.

Another clarification has to be given here. Whatever we have done in the committees is only revision, it is not the total preparation of the textbooks. Therefore, the structure of the already prepared textbooks have in no way been affected or distorted. They have only been revised in the background of gender equality, regional representation, national integrity, equality and social harmony. While doing so, the curriculum frames of both central and state have not been transgressed. Besides, the aspirations of the constitution are incorporated carefully. Further, the reviews of the committees were once given to higher expert committees for examination and their opinions have been inculcated into the textbooks.

Finally, we express our grateful thanks to those who strived in all those 27 committees with complete dedication and also to those who served in higher committees. At the same time, we thank all the supervising officers of the Textbook Society who sincerely worked hard in forming the committees and managed to see the task reach its logical completion. We thank all the members of the staff who co-operated in this venture. Our thanks are also due to the subject experts and to the associations who gave valuable suggestions.

Narasimhaiah
Managing Director
Karnataka Textbook Society (R)
Bengaluru.

Prof. Baraguru Ramachandrappa
Chairman-in-Chief
Textbook Revision Committees
Karnataka Textbook Society (R)
Bengaluru.

Revision Committee

Chairman-in-Chief :

Prof. Baraguru Ramachandrappa, State Textbook Revision Committees, Karnataka Textbook Society, Bengaluru.

Chairperson :

Dr I M Khazi, Professor, Department of Chemistry, Karnatak University, Dharwad.

Members:

Dr Prajwal Shastri, Scientist, Indian Institute of Astro Physics, Bengaluru.

Prof Palahalli Vishwanath, Tata Institute of Fundemental Research, Mumbai

Dr Ullas N Shetty, Asst. Professor,Govt. Arts and Science Degree College, Karawar, Uttara Kannda Dist.

Smt Bhagya Lakshmi, Rtd . Science Teacher, Stella Mary's High School, Bengaluru.

Smt Padmavathamma, Rtd . Science Teacher, Stella Mary's High School, Bengaluru.

Smt Kamalakshamma, Lecturer in Chemistry, GJ College, Narasapura, Kolar Dist.

Sri Ramachandra Bhat B. G. Asst. Teacher, Govt High School , Byatarayanapura, Bengaluru,

Sri Suresh K, Asst. Teacher - High School, Grade II, GHPS Jodikarenahalli, Ramanagara District.

Sri Laxmi Prasad Nayak, Asst. Teacher, Government High School, (RMSA-Kannada) Kengeri, Bengaluru, South-1.

Smt Sumitra M S, Asst. Teacher, Vijaya High School, Bengaluru

Artist : Sri D N Venkatesh, Drawing Teacher, GHS, Uramara Kasalgere, Mandya Dist.

High Power Review Committee:

Dr T R Anatha Ramu, Senior Scientist(Rtd), Geological Survey of India, Bengaluru

Prof V S Vatsala, Professor of Chemistry(Rtd), MES College, Bengaluru

Dr G M Nijaguna, Professor of Zoology(Rtd), Vijaya College, Bengaluru

Prof K S Nataraj, Professor of Physics(Rtd), National College, Bengaluru

Chief Advisors :

Sri Narasimhaiah, Managing Director, Karnataka Textbook Society, Bengaluru.

Smt C Nagamani, Deputy Director, Karnataka Textbook Society, Bengaluru.

Programme Co-ordinator :

Smt Bharathi Sreedhara Hebbalalu, Senior Asst. Director,
Karnataka Text Book Society, Bengaluru.

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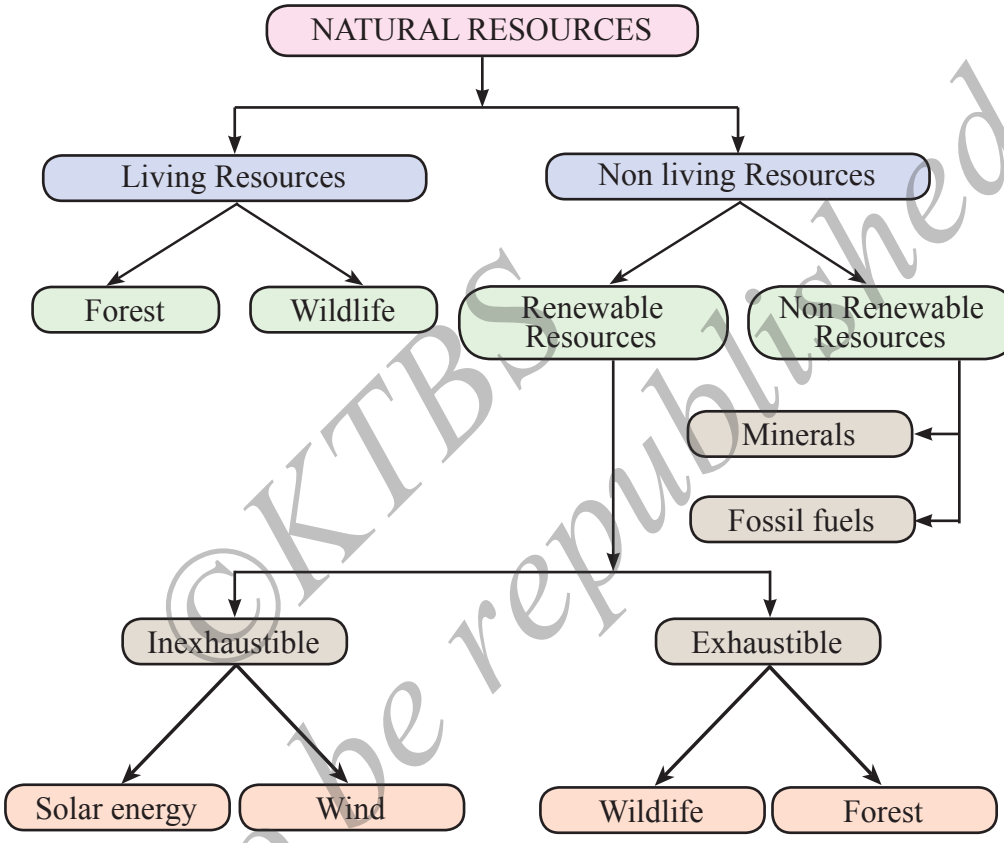
CHAPTER 1

NATURAL RESOURCES



We see various kinds of living and non-living things around us. Things that occur in nature and that are useful to us are called '**natural resources'.** Many of these natural resources are essential for our survival. Some of them are used for satisfying our needs.

A large number of these natural resources are either living or derived from living organisms. Forest and wild life are examples of **living resources.** Forest products like timber, animal products like leather are described as living resources. Fossil fuels like coal and petroleum products are derived from remains of decayed, dead organisms over long periods of time. Soil, water, air and mineral ores are examples of **non-living resources.**

Some natural resources get replenished in nature easily. Such resources are called **renewable natural resources.** Wild

life, forests etc are examples of renewable resources. Some of the resourses are continuously available for use. For eg: solar energy and wind energy. Such resources are described as **inexhaustible resources.** Resources like forests and wild life may get depleted by continuous use or interference by humans. However, they can be replenished to maintain a flow. Hence, they are called **exhaustible resources.**

Some natural resources have been formed on earth over a long period of time, even billions of years. For eg. fossil fuels and minerals. The rate of formation of such minerals is very slow compared to the rate at which they are being used by humans. Such resources which cannot be replenished once depleted are called **non renewable resources.**

Let us learn more about some of these natural resources that have a significant influence on human life.

Water

Water is a unique natural resource as it is very much essential for the existence of life. It is the most critical limiting factor for many aspects of life such as environmental stability, biodiversity conservation, fuel security and even healthcare. In most cases, there is no substitute for water. The most significant aspect of water is that, it is a largely irreplaceabale resource unlike energy which has alternatives.

In nature, water may change its form but we can always retrieve it. The Earth holds the same quantity of water as it did when it was formed.

You may be aware that nearly 71% of the earth's surface is covered by water. It is one of the most important components required for sustaining life on earth.

Nearly 97% of water on earth is held in oceans, seas and other large water bodies. 0.001% of water occurs in atmosphere as water vapour. About 2.4% of the water is found in glaciers and polar ice-caps. Remaining water is found in rivers, lakes, ponds and other water bodies. As such, a very small percentage of this valuable natural resource is available for human use.

Activity 1.1

Measure 2200 mL of water into a container. Assume that 2200ml represents the total water available on earth. Take a teaspoon and measure

out 12 spoonfuls of water into a small transparent container. This is the total amount of fresh water on the earth including the water found in lakes, rivers, ice-caps, and as ground water. The water that remains in the large container represents salty water. From the container with 12 spoonfuls of water, measure out two spoonfuls into a dish and remove half a spoon of water from the container which now has 10 spoonfuls of water. This represents the water found on the surface of the Earth in fresh water lakes. From the remaining water in the small container, remove one drop using an ink-dropper. This drop represents the amount of water found in rivers. The smaller container will now have about 9 spoonful of water left in it. This represents the amount stored in ice-caps. Compare the quantities of water in the various containers.

With even such a small quantity of water available, humans have been using water for various purposes. It is estimated that the average consumption of water by a human being ranges from 20 litres to 30 litres per day, depending on their activity and place of living.

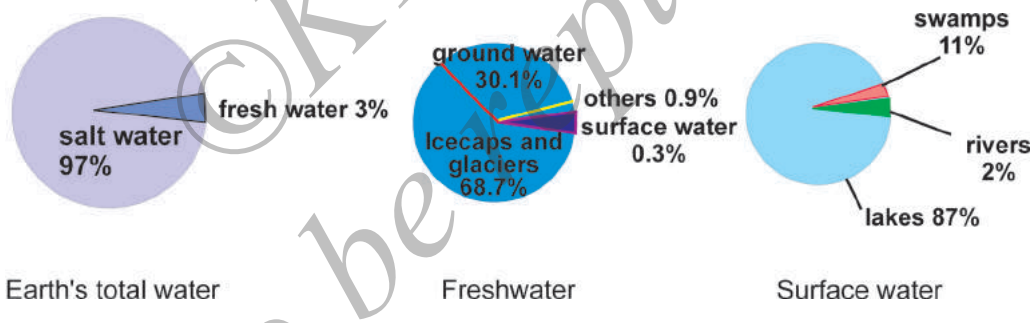


Fig. 1.1 Distribution of water on earth

Water is used for various human activities like drinking, agriculture,washing and recreation. In addition water is used in heat exchange processes, industries and fire extinguishers.

The largest use of water is in the agricultural sector. In our country, it is estimated that more than 80% of the water available for human use is employed for agricultural practices. In states like Punjab, Haryana, Uttar Pradesh and Gujarat, over 85% of irrigation is done through ground water sources.

We have been misusing and polluting water to a great extent. Some of the problems related to water in our country are scarcity, overuse

and unequal distribution. The annual rainfall in the country is about 400 million hectare metre. Another 20 million hectare metres flows in as surface water. This is considered more than sufficient to provide water for different uses in the country. However, overuse of water and lack of planning have resulted in a state of scarcity. It is necessary to increase the efforts related to conservation of water in both urban and rural areas. Importance should be given to educate people about the need for harvesting rain water resources and constructing watersheds.

Activity 1.2

Fig. 1.2 World water day

Is overuse, scarcity and quality of water an important issue of concern in your school or locality? Find out the reasons.

Do you know ?

March 22nd is observed as World Water Day. Each year, UNO chooses a specific slogan to highlight a particular theme. Do you observe such important days in your School?

Soil

Soil is a natural resource that provides minerals and water to all the land plants. It is a primary nutrient base particularly for agricultural crops. In addition, it is the place of living for a wide variety of organisms like earthworms, crabs, insects and microorganisms.

Soil absorbs rain water. The soil water is used by plants.

Human activities have influenced even the soil quality. We have deteriorated the soil quality in various ways. One such case is salinisation of soil. It is caused by rise in the water table when water enters the soil at a higher rate than the rate at which it is being used from the soil. Soil pollution decreases the fertility and in extreme cases it deteriorates the soil. Water logging and salinisation are the main causes of another serious problem in which once fertile lands are becoming barren and useless. This is called **desertification.** Today, the nutrient rich alluvial soils of Punjab suffer seriously from desertification caused by the introduction of excessive irrigation.

Apart from this, the use of chemical fertilizers has also been a serious cause of soil pollution. The use of pesticides to protect our agricultural crops has also been adding to this problem.

However, the most serious threat to soil is the process of erosion. Top soil is getting exposed due to activities like deforestation and overgrazing. As a result, soil is being subjected to the action of wind and water. This is leading to a huge loss of useful fertile top soil.

You know that formation of soil occurs by a natural process called weathering of rocks. The rate at which soil formation occurs is much less compared to the rate at which soil erosion takes place. This has led to a serious concern about soil conservation. Soil protection has now become an integral part of any conservation plan. Restoring the soil quality can be a solution for many of the environmental issues bothering human life.

Do this : Prepare an action plan to save water and soil. Implement it at your home and school.

Forests

Forests are renewable natural resources that have innumerable contributions to the environment. Forests maintain water cycle. They provide habitat for wild life. They maintain soil quality by preventing soil erosion. They provide timber and many other useful products and services. Generally, forests are indicators of the natural wealth of a nation.

However, rapid changes have been noticed in the percentage distribution of forests in the world. It is now estimated that only 20% of the world's original forests remain intact and undestroyed.

In the last 20 to 30 years, the rate of deforestation has increased to such an extent that we are today facing several environmental problems. The pattern of rainfall has changed since water cycle has been affected. The rate of soil erosion has increased as the vegetation cover on soil has been destroyed. It is now necessary to restore the forests by activities such as afforestation.

Fig. 1.3 World forest Day

Do you know? March 21st is observed as World Forest Day.

Think : Why do we have to observe World Forest Day? Will observing such days really help in the cause of environmental issues ?

Wildlife

The term wild life is used to describe the species of plants and animals found in the forest. It represents the diversity of organisms inhabiting our forests, seas and oceans. Human activities such as hunting, poaching and capturing have severely affected wild life leading to the extinction of many species. Many other species are facing a threat of extinction in the near future.

The immediate need is the measures to be taken for the conservation of wild life. It is one of the important challenges of the present and the immediate future. Efforts are being made to conserve the living resources through their maintenance in their natural habitats. National parks, wild life sanctuaries, bird sanctuaries are examples of such conservation measures. Sometimes, conservation of living resources involves measures where in sample populations are protected in zoos, botanical gardens and other man made situations. It may also involve the creation of seed banks, gene banks and similar genetic resource centres.

Fossil Fuels

Resources like coal, petroleum products and natural gas are collectively called **fossil fuels.** They are the result of the photosynthetic activity of green plants which were existing millions of years ago. They got submerged within the earth's crust and formed the fossil fuels. They are non-renewable resources. If their consumption is not reduced we foresee their total depletion in the near future.

Coal is a natural resource with high carbon content. Four types of coal deposits are normally found. **Anthracite** is one form in which carbon content is very high about 80%. **Lignite** has about 50 to 65% of carbon. While **peat** contains about 40% of carbon, **Bituminous coal** has less than 40% of carbon.

Petrol, diesel, kerosene, lubricating oils and naphtha represent various forms of petroleum products. They account for about 40% of the total energy consumed in the world.

Natural gas is formed in the same way as oil. Low sulphur content of natural gas makes it the least polluting source of fuel.

Once we discovered these fossil fuels, we began utilising them at an increasing rate. A total of about 227 billion barrels (1 barrel = 159 litres) of oil was extracted from fossil fuels between 1859 and 1969. About fifty percent of this was extracted in 100 years, while the next fifty percent was extracted in just 10 years!

Today consumption rate is more than the rate of formation of fossil fuels. In one day we consume what the earth has taken one thousand years to form! Hence, fossil fuels are called as non-renewable resources.

Mineral Resources

A mineral is a substance that is naturally found in the earth's crust and is not formed from living matter. Minerals are formed due to earth's geological processes over millions of years. Hence, minerals are also non-renewable resources. **Mining** is the process of extraction of the minerals from the earth's crust.

More than 100 minerals including metals like gold, iron, copper and aluminium and materials like stone, sand and salt are extracted and processed for human use.

Mining has become more intense and widespread in recent years causing serious environmental problems.

You have learnt

- The meaning of natural resources.
- The importance of natural resources.
- Differences between living and non-living resources.
- The need for conserving non-renewable resources.
- The biological need of water.
- The ill effects of excessive use of chemicals in agriculture.
- Classification and importance of natural resources.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements/ questions. Choose the right answer:

1. One of the following does not belong to the group

   a. water b. forests c. petrol d. soil

2. Government has banned hunting of wild animals. This helps to

   a. maintain biodiversity b. promote tourism

   c. provide food to animals d. maintain soil fertility

II. Fill in the blanks with suitable words :

1. Resources that get replenished in nature are called _____.
2. Petrol, and kerosene are _____ forms of natural resources.
3. If there is rise in water table, soil becomes _____.
4. Soil provides _____ and _____ to terrestrial plants.
5. An example for renewable resource is _____.

III. Answer the following :

1. What are natural resources?
2. Differentiate between renewable and non-renewable resources.
3. List the uses of water.
4. What is mining?
5. What happens if too much of fossil fuels are used?
6. A student argues that a nation will be rich, if its forests are conserved. Justify.

IV. Match the following :

A	B
1. high carbon content	a. lignite
2. renewable resource	b. bituminous
3. low sulphur content	c. wind
4. formation of soil	d. L.P.G.
	e. weathering of rocks
	f. anthracite
	g. natural gas

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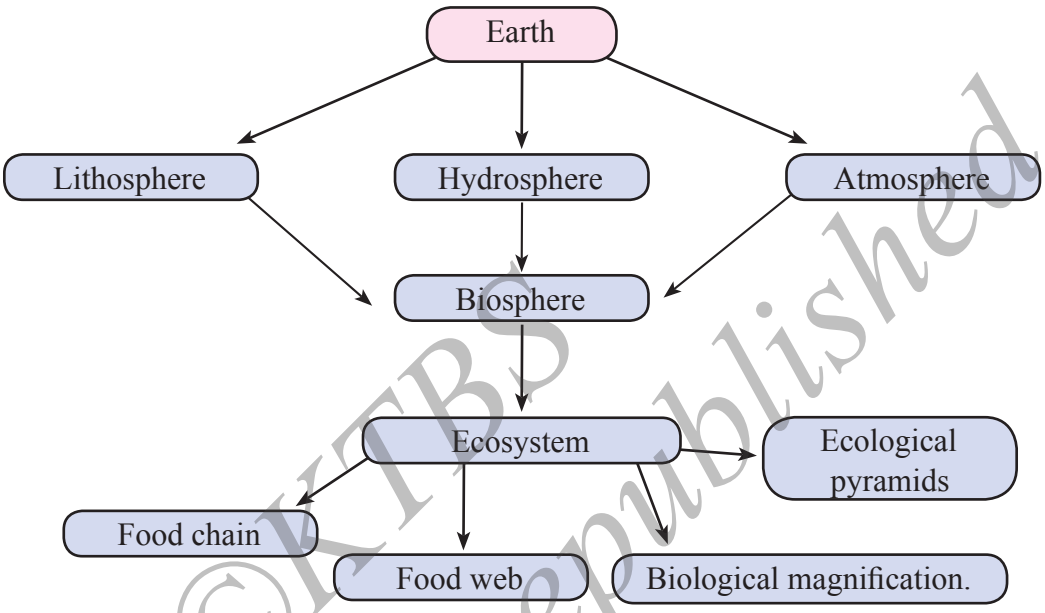
CHAPTER 2

OUR ENVIRONMENT



Earth - A Unique Planet

You are aware that earth is a unique planet in the solar system, since it is the only planet that supports life. What makes earth exhibit this feature? Is it the position of our planet in the solar system? Is it the physical and chemical composition of the earth that have resulted from innumerable processes that occurred since its formation?

The earth is said to have been formed about 4.6 billion years ago and the first sign of life is said to have appeared about 3.8 billion years ago. You will learn more about this in chapter 22. However, it was not until about 1.4 billion years ago, that the first multicellular organisms appeared. These organisms and the other forms of life which evolved from them, could survive when the conditions on earth began to stabilize gradually.

You know that nearly 71 percent of earth's surface is covered by water. This part of the earth is called **hydrosphere**. It is the only planet in the solar system with abundant liquid water and this is one of the factors responsible for making life possible on earth. Water has some unique physical and chemical properties which supports life. Water exists in all the three states:solid-ice, liquid-water and gas-water vapour.

- Water requires considerable amount of energy to get heated up and to get converted into gaseous state. On very hot days, water bodies help to reduce atmospheric temperature by absorbing heat from the sun. During night the heat absorbed is returned to the atmosphere. Such a regulation is crucial for the survival of living organisms.
- The hydrosphere comprises oceans, rivers, streams, lakes, reservoirs, tanks, ponds, pools and ice caps. A lot of water also exists as water vapour in the atmosphere. It is this which absorbs sun's heat and regulates atmospheric temperature.
- You already know that depending on the dissolved salts, water is called salt water or fresh water. The salt water in seas and oceans (marine habitat) provides living space. This is far greater than that provided by fresh water habitat and land. Being heavier than air, water provides buoyancy to aquatic life.
- water is the major constituent of protoplasm. As an universal solvent, it allows substances to dissolve in it. It acts as a bridge between outer non thing environment and body of organism. For example, nutrients enter into the roots of plants in solution. water has a direct influence on the distribution of plants and animals.

Think : Is there any other unique property of water that supported the existence of life?

Yet another unique feature of earth is its **atmosphere** which is a mixture of gases, water vapour and fine dust, surrounding the earth. You know that nearly 78% of atmosphere is nitrogen and 21% is oxygen, while carbon dioxide, argon and other gases make up the rest.

Atmosphere of the earth at its beginning was rich in carbon dioxide and the oxygen content was very less. As photosynthetic algae appeared on earth, oxygen concentration increased resulting in a shift from reducing type of atmosphere to an oxidizing type. Gradually atmosphere reached its present composition, which is ideally suited for humans and other life forms that are existing today.

The surface or crust of the earth is called **lithosphere.** It includes the mountains, the ocean floors and the plain lands.

Do you know? Surface of the earth is cool and solid. But as we move into the layer below the lithosphere, we reach the second layer called mantle which has more heat and pressure. Mantle is the store-house of metallic minerals. Below the mantle is the core, where the temperature may reach as high as 4000^0C. It is the lithosphere which allows life to flourish, unlike the barren surface of other planets in our solar system.

Concept Of Biosphere:

Biosphere is the area of earth where life exists. Hydrosphere, atmosphere and lithosphere of the earth together constitute the **biosphere.** The distribution of life varies in these areas.

Earth is truly a dynamic planet where life is influenced by its physical environment. At the same time, various factors in the environment influence living organisms. This two way process is the essence of the dynamic nature of our planet.

The scientific studies which enable us to understand the totality and pattern of the relations between organisms and their environment is called **ecology**. It is also known as **environmental science.**

You would have observed in your surroundings that there is an intricate relationship between various components of nature.

Green plants absorb mineral nutrients and water from the soil. The leaves, fruits and other parts of these plants are eaten by animals like insects, birds and deer. These animals become the food for other kinds of animals. When these plants and animals die, their dead remains are broken down by microorganisms.

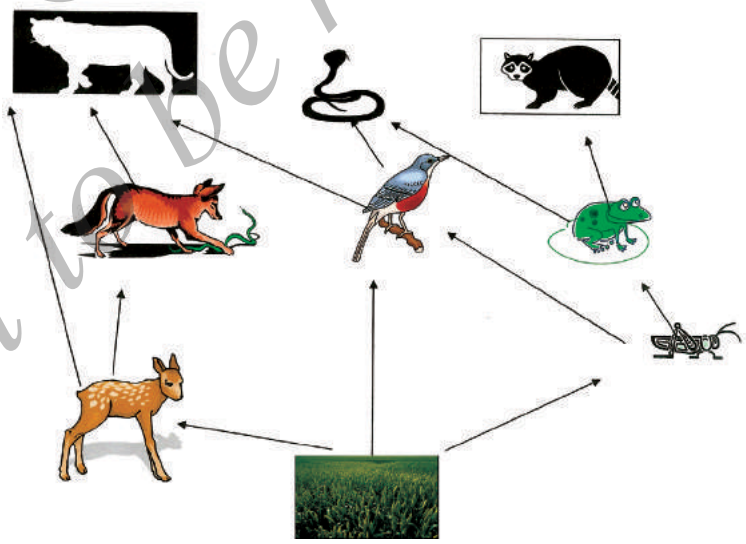


Fig. 2.1 Interactions among living organisms

A very large number of such connections exist in nature. These links are the foundations of the balance existing in the natural world. These links explain the two basic laws of ecology.

- We can never do any one thing in nature.
- In nature every thing is connected with everything else.

If one has to understand and analyse all these connections, it is necessary to categorize the natural system into smaller units.

Levels Of Organization

Let us look at the natural system from the point of view of levels (hierarchy) of organization. It provides a convenient framework for dealing with complex interrelationships. The most clearly identifiable levels are organisms, species, populations, communities and ecosystems.

You know that any form of life can be called an **organism**. A variety of organisms are found on the planet earth from a single celled amoeba to humans and from microscopic bacteria to huge banyan trees. An organism represents an individual member of the next level called **species**.

You will be able to recall that a species is a group of similar organisms sharing common genetic structure. Hence, they are capable of breeding only among themselves. Human beings belong to the species *sapiens*, dogs belong to the species *familiaris*. Pea plants belong to the species *sativum*.

A group of individuals belonging to the same species occupying a given area, at a given time is called **population.**

You would have noticed that a given area will have populations of different species of plants, animals and other organisms. All these different populations together constitute a **biotic community**. Members of a community interact with each other.

The community as a whole will be interacting with the nonliving components. Any such unit in nature where there is an interaction between living and nonliving components is known as **ecosystem.** Ecosystem forms the basic unit of environmental science.

We have now become familiar with the idea that ecosystem forms the basic unit of environmental science. It is also the functional unit in biosphere.

An ecosystem consists of different kinds of living organisms in an area interacting among themselves and with the nonliving components in that area.

Find out:- Is garden an ecosystem? why?

Earth has different kinds of living organisms in a variety of habitats. Each habitat has a set of unique features. Hence, we have variety of ecosystems on the planet earth. The different kinds of ecosystems on the earth together constitute the **biosphere**.

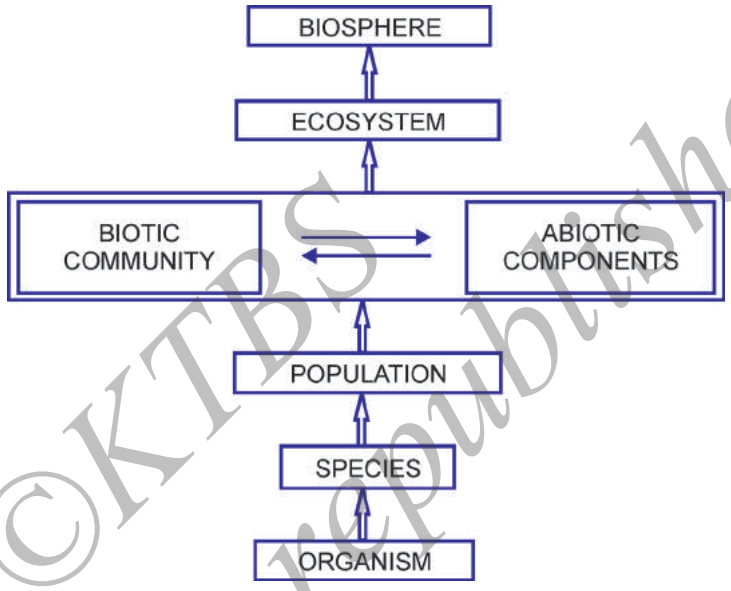


Fig. 2.2 Levels of organization in nature

Types Of Ecosystem

You have seen a variety of ecosystems in your surroundings such as a pond or a grassland. You might have visited a forest or a sea. Have you ever wondered what is common to all these? Similarly an ocean, an estuary (place where river meets sea), and a desert also represent natural ecosystems. Natural ecosystems can be broadly classified into **aquatic** ecosystems and **terrestrial** ecosystems.

Activity :2.1

List the examples of aquatic and terrestrial ecosystems.

There are also many examples of man-made ecosystems. The most familiar example is aquarium.

Activity 2.2

List a few more examples of man-made ecosystems.

Activity 2.3

With the help of your teacher and classmates set up and maintain a small aquarium in your school.

Components Of Ecosystem

You will be able to recall that any ecosystem should have two basic components, the nonliving components and the living components interacting with each other.

The nonliving components are also called **abiotic components.** They represent the physical, and chemical conditions operating in the environment. Physical factors include air, light, heat, soil, rain fall and humidity. Chemical factors are represented by various organic and inorganic substances.

The living components are also called **biotic components.** They are represented by plants, animals, bacteria and fungi.

You know that plants are described as **autotrophs** since they are capable of manufacturing their own food. Green plants in land ecosystems and algae in aquatic ecosystems are described as **producers.** Apart from green plants, algae also belong to this category. The food prepared by these organisms is used by all other organisms either directly or indirectly. Hence, it is commonly said *all flesh is grass.*

Animals are **heterotrophs** since they cannot prepare their own food. Hetrotrophs depend on producers for their food either directly or indirectly. Hence, in any ecosystem animals are described as **consumers.**

You know that animals differ in their food habits. There are animals which feed only on plants and they are called **herbivores**. In the ecosystems herbivores are described as **primary consumers,** since they obtain their food energy by feeding directly on plants. Grass hoppers, the deer the cattle are all examples of primary consumers.

There are animals which obtain their food by eating herbivores. They are described as **secondary consumers**. Grass hoppers may be consumed by frogs. Deer or cattle may become the food for lions or tigers. Examples like frogs, lions and tigers are secondary consumers.

Some animals obtain their food by feeding on secondary consumers. They represent the **tertiary consumers.** The frogs which have eaten the grass hoppers may become the food for snakes. Hence, in this example snakes represent tertiary consumers.

The producers and the different kinds of consumers-primary, secondary and tertiary are involved in a nutritional relationship involving *eating and being eaten.* They represent different levels of feeding in the ecosystem and hence are described as **trophic levels.** Each organism in an ecosystem is at a specific feeding stage that represents its trophic level. Let us go back to the same examples we studied earlier.

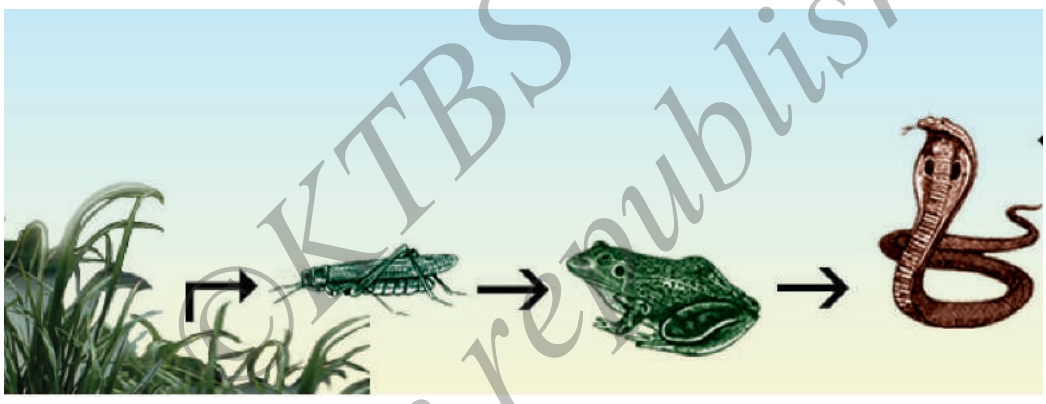


Fig. 2.3 A typical food chain

Examples

Grass land food chain :

Grass → Grass hopper → Frog → Snake

Aquatic food chain:

phytoplankton → Zooplankton → Fishes → Aquatic birds

Activity :2.4

Classify the examples in the above food chains into their respective trophic levels in the table given below.

Trophic Level-1(T_1)	*Trophic Level-2 (T_2)*	*Trophic Level-3(T_3)*	*Trophic Level-4(T_4)*

This kind of nutritional relationship where the food energy is getting transferred from one trophic level to another is called **food chain.**

In any food chain, producers represent the first trophic level and the different levels of consumers represent the successive trophic levels**.** In an ideal situation, a food chain will have a maximum of three or four trophic levels.

There can be hundreds and thousands of food chains operating in an ecosystem. It is because any given plant can be a food for a variety of primary consumers. Each primary consumer in turn can be food for many varieties of secondary consumers and so on.

Food chains can be broadly classified into the following three types.

- **Grazing or herbivorous food chains:** In this food chain' primary consumers are plant eating animals. Most of the food chains belong to this category. Such food chains are also known as **predatory food chains.**

Example : Grass → Rabbit → Wolf

- **Detritivorous food chains:** In this food chain primary consumer is a detritivore. Ants, termites, earthworms, millipedes and crabs are called **detrivores** because they feed on **detritus** (fallen leaves, parts of dead trees and similar kinds of organic matter).

Example : Detritus → Earthworms → Birds

Activity 2.5

Construct detritivorous food chain found in pond ecosystem.

- **Parasitic food chains** : In this type, either the producer or consumer is parasitized. The transfer of food energy may occur through a series of parasites.

Example : Tree → fruit eating birds → lice and bugs → fungi

Here, lice and bugs are parasitic on birds and fungi are parasitic on bird lice.

Since most organisms feed on more than one kind of food item, every organism at every trophic level becomes linked to several food chains at the same time. Thus, in every ecosystem, we have a complex network of interconnected food chains, forming a **food web.**

Energy flow in an ecosystem

How does food become energy in organisms?

Organisms need energy for all their activities. When organisms consume food, the carbohydrates in their food become the source of energy. This energy is released, as you are aware, through a process called respiration. It makes the stored energy in the carbohydrates available for biological work.

The main source of energy for all ecosystems is solar energy. As you know only green plants can trap this energy and store it in the form of carbohydrates. When primary consumers eat the producers, energy also moves up the trophic level. However, during this transfer almost 90% of the energy is lost to the environment as heat, a form in which it cannot be used again. As we move up the trophic levels, the amount of available usable energy keeps on decreasing at each level. Only about 10% of the energy reaches any given trophic level.

Know this:

If the producer has 10,000 units of energy the primary consumer receives only about 1000 units, the secondary consumer gets only about 100 units and the tertiary consumer gets only about 10 units. This is known as 10% law.

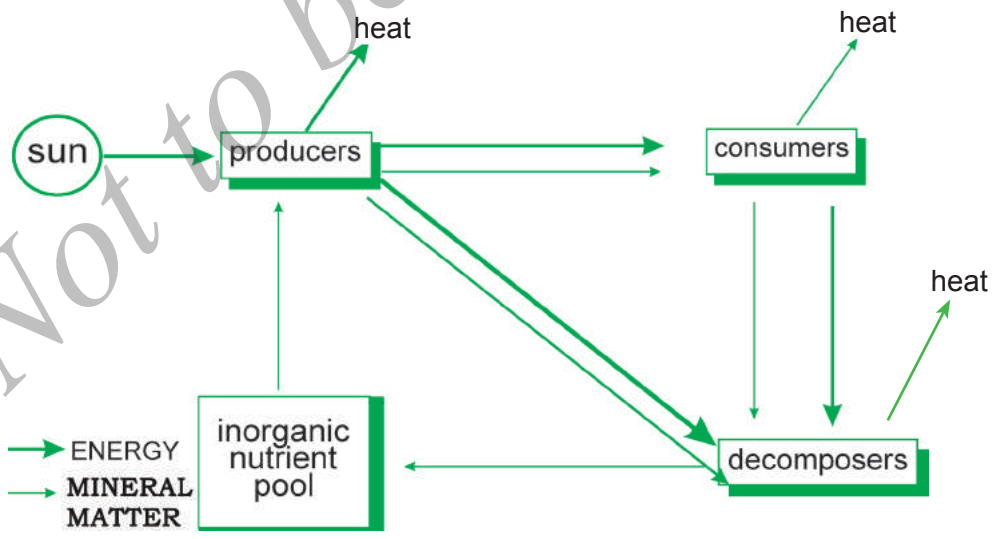


Fig. 2.4 Energy flow in an ecosystem

Energy flow is thus **unidirectional** and the loss at each stage is simply released into the environment as unusable heat.It is for this reason that a food chain will not have more than three or four trophic levels. Very rarely a fifth trophic level called **quaternary consumer** can be recognised.

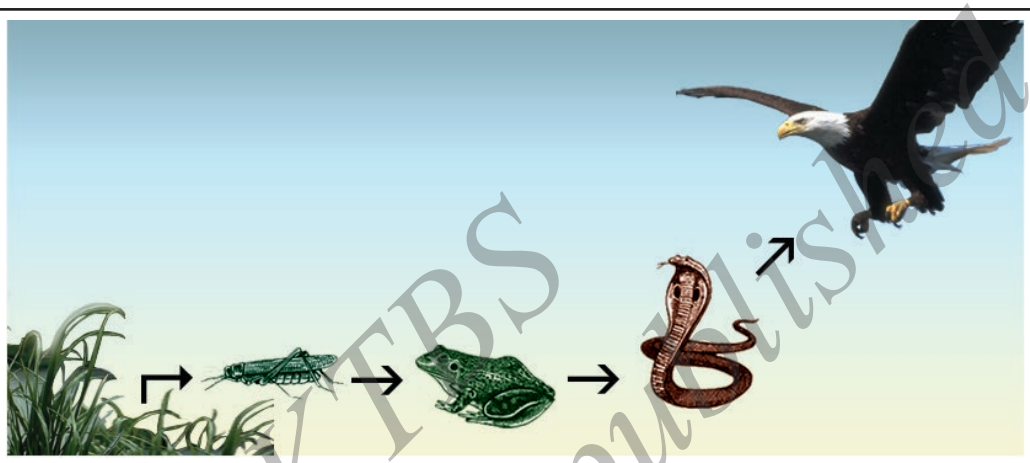


Fig. 2.5 A food chain with five trophic levels

Think : Among the examples you have studied here, is there a foodchain which has quaternary consumer?

What are ecological pyramids?

You have now understood the nutritional relationship between the organisms at different trophic levels. These relationships not only involve energy but also the number of individuals and their biomass at each trophic level. It is possible to graphically represent these relationships, which assume the shape of pyramids. Such graphical representations of organisms occupying each trophic level in an ecosystem are called **ecological pyramids.** In an ecological pyramid, producers occupy the base and the different levels of consumers occupy the successive tiers. The tertiary consumers form the apex of the pyramid.

A pyramid constructed based on the number of individuals occupying each trophic level in a given place and time in an ecosystem is called **pyramid of numbers**. In most of the ecosystems, for most of the food chains, the pyramid of number will be **upright** since the number of individuals at the successive trophic levels keeps on decreasing.

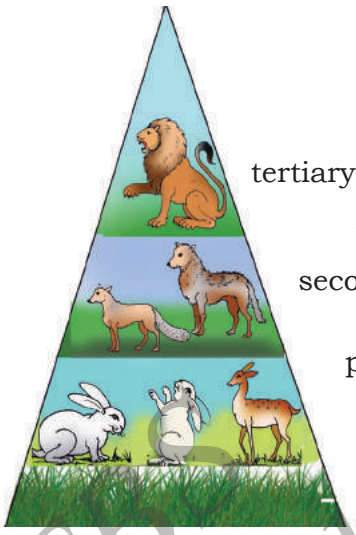


Fig. 2.6 Upright pyramid of number

Look at the parasitic food chain (fig 2.7). Here the pyramid of number is inverted!

A pyramid constructed based on the biomass (wet or dry weight of all the matter in the organisms in each trophic level) is called **pyramid of biomass.** For most of the food chains, the pyramid of biomass will be upright. In some aquatic food chains it may be inverted.

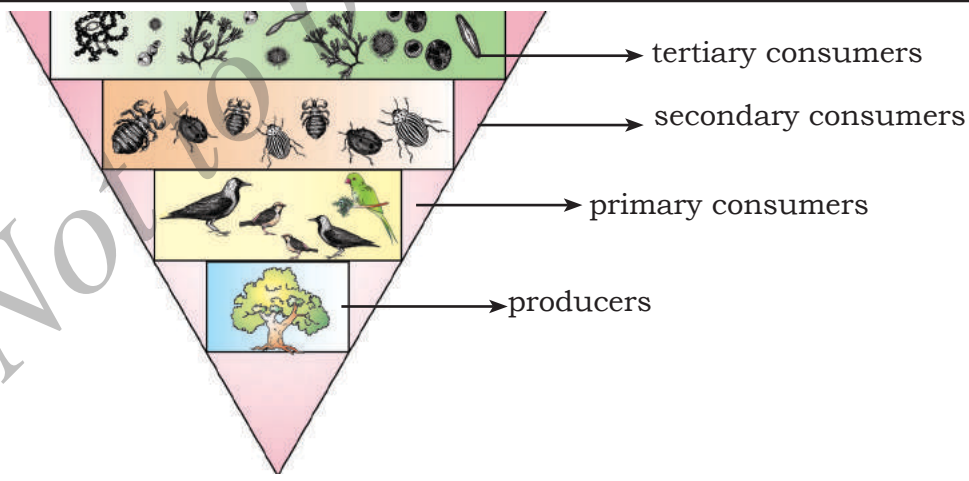


Fig. 2.7 Inverted pyramid of number

A pyramid constructed on the basis of the amount of energy fixed at each trophic level, is called **pyramid of energy**. In any ecosystem, for any food chain, the pyramid of energy will always be upright. You have already learnt that the amount of usable energy available at each trophic level is about 10% of the energy that was available at the previous trophic level.

Biomagnification

In food chains, it is not just the nutrients that get transferred. Several toxic substances may be transferred from one trophic level to another. In most of these cases, the concentration of toxic substances increases, as they pass on to the higher trophic levels.

Such an increase in the concentration of a toxic substance such as DDT, mercury, cadmium etc with every link in the food chain is called **biological magnification or biomagnification.**

The most familiar example of biomagnification is the gradual increase in the concentration of DDT in the trophic levels in several food chains. Indiscriminate use of DDT as an insecticide, especially for eradicating mosquitoes, has now resulted in DDT being detected in the tissues of small fishes and predatory birds. DDT has been detected even in human mother's milk!

Biomagnification disrupts the balance in the food chains. Particularly it affects the organisms at the higher trophic levels.

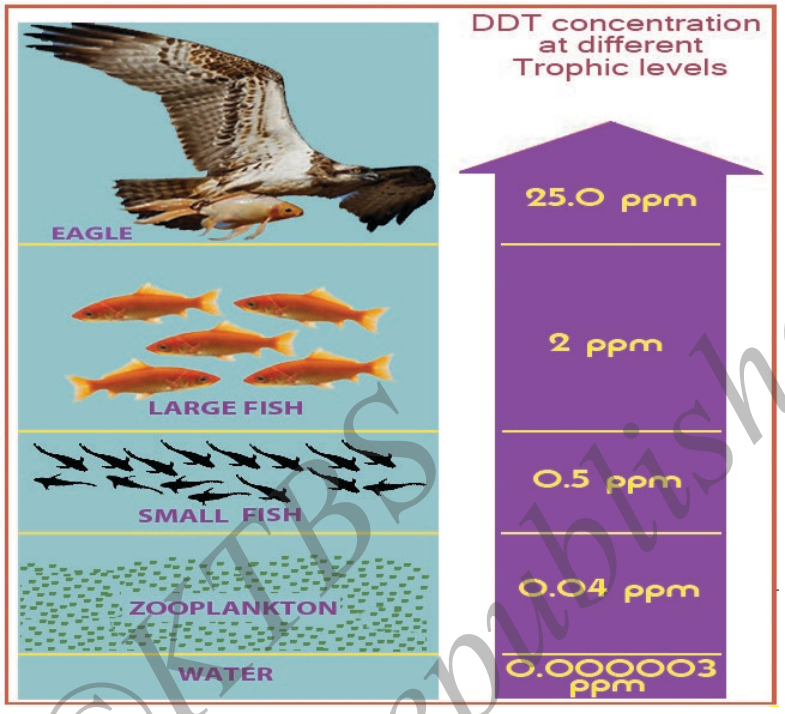


Fig. 2.8 Biomagnification of DDT

Know this : ppm = Parts per million

Activity : List more examples for biomagnification

Extended learning activity : Visit a near by pond ecosystem. List the biotic and abiotic factors. Identify the food chain and food web found in the ecosystem

You have learnt

- Importance of water for existence of life.
- Role of water bodies in maintaining ecological balance.
- Importance of photosynthetic algae in primitive earth.
- Need of interactions between living organisms.
- Energy flow in an ecosystem.

Exercises :

I. Four altertnatives are given to each of the following incomplete statements / questions. Choose the right answer :

1. Fill in the box with the name of the appropriate organism
   Grass ⟶ [ ] ⟶ Frog ⟶ Snake ⟶ Eagle
   a. deer b. lizard
   c. grass hopper d. rat
2. One of these is a decomposer
   a. fungi b. algae
   c. protozoa d. insect

II. Fill in the blanks with suitable words :

1. The crust of the earth is called _____ .
2. The basic unit of environmental study is _____ .
3. A group of individuals belonging to the same species is _____ .
4. Different kinds of ecosystems together constitute _____ .
5. In a parasitic food chain, the pyramid of number will be _____.

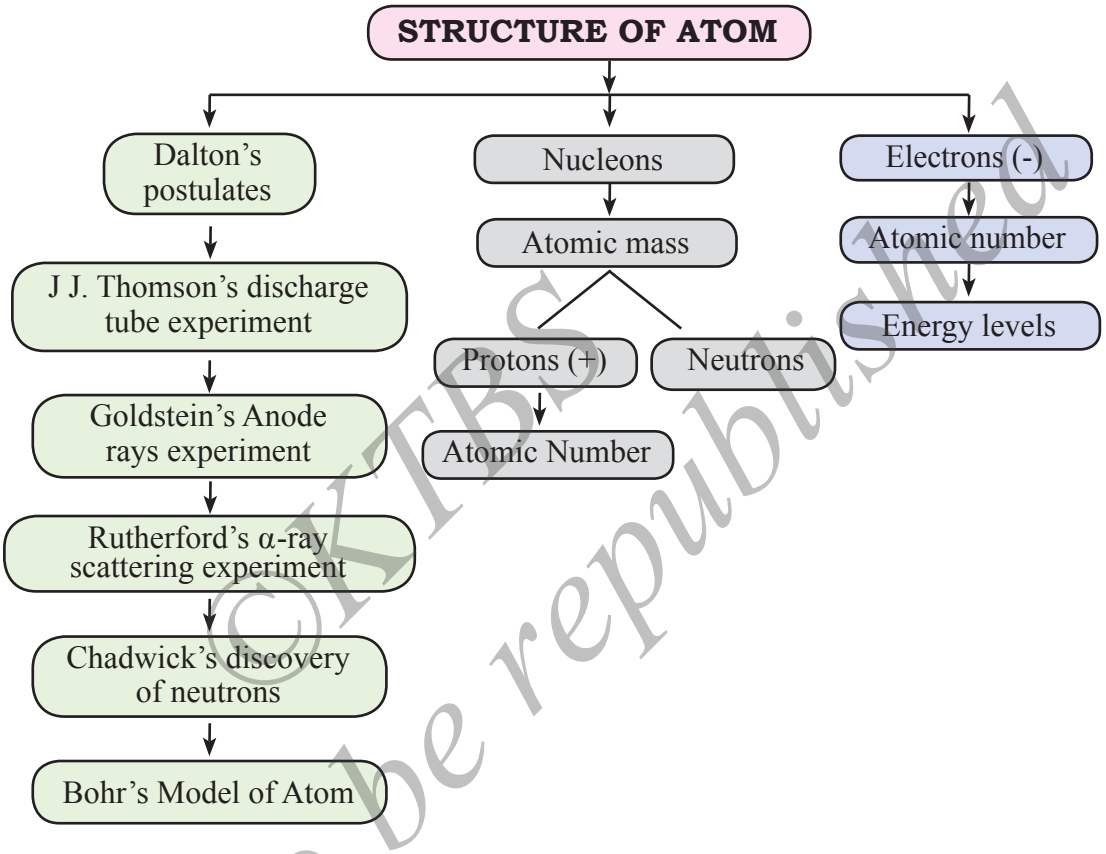
III. Answer the following:

1. List the factors which have made life exist on earth.
2. Define the following-
   a. Lithosphere b. Population
   c. Biotic community d. Food web e. Trophic level
3. What is an ecosystem?
4. Why is the use of DDT not advisable?
5. Construct a simple food chain.
6. What may happen if all herbivores are killed in a terrestrial ecosystem?
7. In any food chain trophic level-1 is occupied by green plants. Give reason.

★★★★★

CHAPTER 3

STRUCTURE OF ATOM



We know that the Indian sage **Kanāda** was the first to suggest that all matter is made up of very small particles called 'paramanu'. In Sanskrit 'parama' means final or ultimate and '*anu*' means particle.

It was he who first propounded that material universe is made up of *'Kana'*. An interesting story states that this theory flashed to Kanāda while he was walking with food in his hand. As he nibbled at the food in his hand, throwing away the small particles, it occurred to him that he could not divide the food into further parts and thus, the idea of a matter which cannot be divided further came into existence. He called that indivisible matter as *'kana'*. Indian theories about the atom are based on logic and not on experimentation. Thus, the Indian theories lacked an empirical and scientific base.

In, fifth century BC, Greek philosopher Democritus came up with a similar idea. He thought of dividing a piece of substance, ultimately to get a particle that could not be divided further. He gave the name 'atom' to this ultimate particle. All the substances are made up of atoms.

Are the atoms of all substances similar? Do they resemble one another? Let us do an activity to understand and explain it.

Activity 3.1

With the help of teacher, take a small piece each of sodium and iron. Drop them into a 500 ml beaker containing water. What do you observe? Which reacts faster in water?

Activity 3.2

With the help of teacher, take a small piece of sodium in a spatula . Ingnite it. Hold a piece of magnesium strip in tongs. Ingnite it. What do you observe? Which burns very fast? Is colour of both the flames same? Sodium and magnesium are made up of atoms. Is the nature of both the atoms same? The above activities show that atoms of different elements have different properties.

Take precautions while conducting the above activities.

Any substance made up of the same type of atoms is called an **element**. 118 elements are known to us. Out of this, 90 are found in nature and rest are made in laboratory.

> ***Know this:*** The elements Astatine and Technetium are not added to the list of 90 natural elements as they occur only in very small quantities in nature. However, Technetium can be made artificially.

Activity 3.3

Make a list of elements that you use in day-to-day life. Write their symbols and uses.

Atomic theory

In 1803 English chemist Dalton put forth his atomic theory. The main postulates of the theory are as follows:

1. Elements are made up of very small indivisible particles called atoms.
2. All atoms of a particular element are identical in shape, mass and other properties, but are different from the atoms of other elements.
3. Atoms of one element cannot be converted into those of another element.

4. Atoms of an element combine in **integral ratio** with those of other elements to form a compound.
5. An atom can neither be created nor destroyed.

Dalton's atomic theory was the first milestone in explaining the inner structure of matter. It gave a powerful initiative to the scientists in the study of matter in the 19th century.

How would an atom be like? Is it possible to divide the atom further? After conducting a number of experiments, scientists came to know what is inside an atom. Understanding the structure of an atom enabled them to resolve many mysteries concerning nature and behavior of matter.

Fundamental particles : J.J. Thomson's Experiment.

Let us look at the history of discovery of the smaller particles inside an atom. J.J.Thomson and others conducted some experiments using discharge tube apparatus.

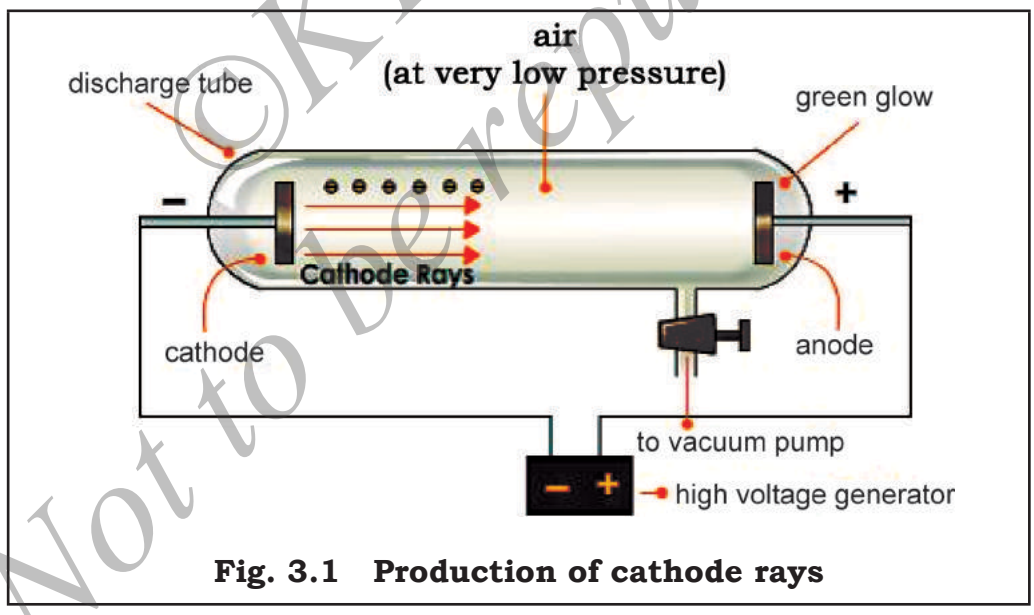


Fig. 3.1 Production of cathode rays

A discharge tube is a glass tube, about 15 cm long and 3 cm diameter, connected to a vacuum pump. Metal electrodes are fixed to the ends of the glass tube.

J.J.Thomson created a very low pressure inside the discharge tube and applied high voltage. He observed a greenish glow near the anode of the glass tube. The rays which are emitted from the cathode towards

the anode and caused the greenish glow. The streams of rays emitted from the cathode are called cathode rays. (If you connect the plate of the discharge tube to a positive source, then that plate is called **anode.** (see fig: 3.1).

J.J. Thomson placed a light paddle wheel in the path of the cathode rays. The paddle wheel started to rotate. He concluded that cathode rays are a stream of particles. (see fig. 3.2).

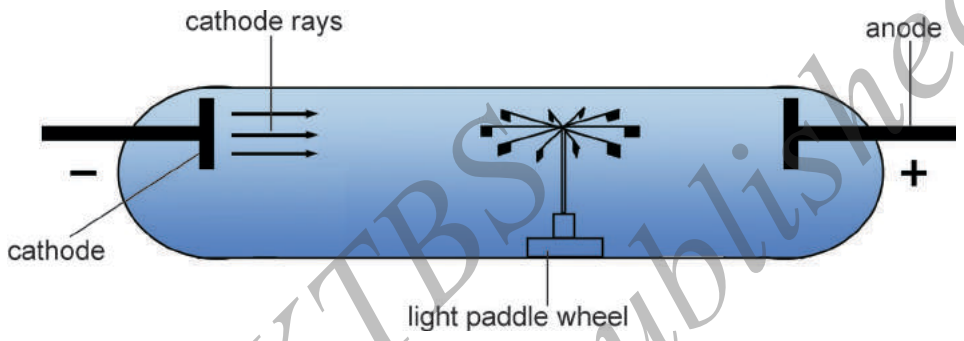


Fig. 3.2 Experiment to demonstrate particle nature of cathode rays

J.J Thomson applied an electric field parallel to the path of the rays. The cathode rays deflected towards the anode. He concluded that cathode rays are negatively charged. (See the fig. 3.3)

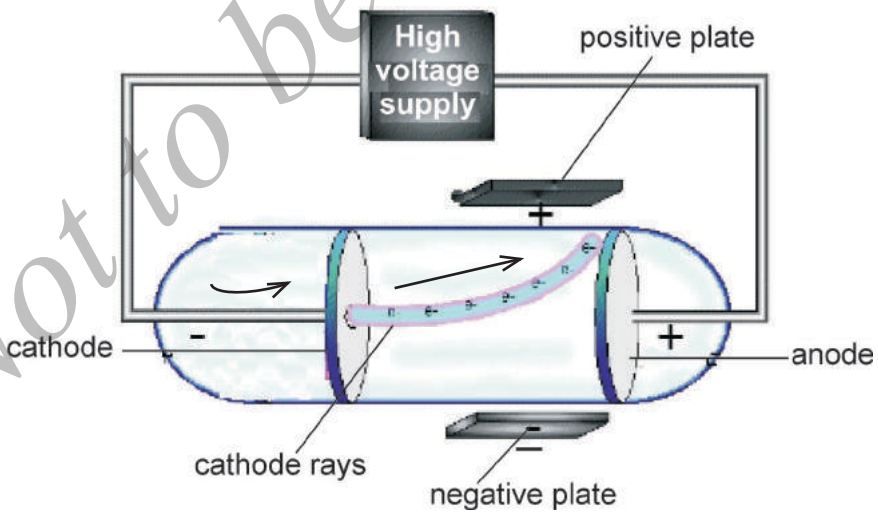


Fig. 3.3 Experiment to demonstrate negative charge of cathode rays

Though J.J Thomson conducted the above experiment with different gases, the same results were obtained. He named these particles

as electrons, and stated that these electrons are negatively charged particles. The electron is lighter than Hydrogen atom. Its mass is very small when compared to that of an atom. He showed that the atom is divisible and it is made up of very small particles. After the discovery of electron, the first postulate of Dalton had to be given up.

Presence of positive charge in an atom: If an atom is composed of only electrons, then atoms and matter should be negatively charged. The fact is that, all matter and atoms are electrically neutral. Does it mean that atoms carry positively charged particles also? To explore this, Goldstein conducted an experiment.

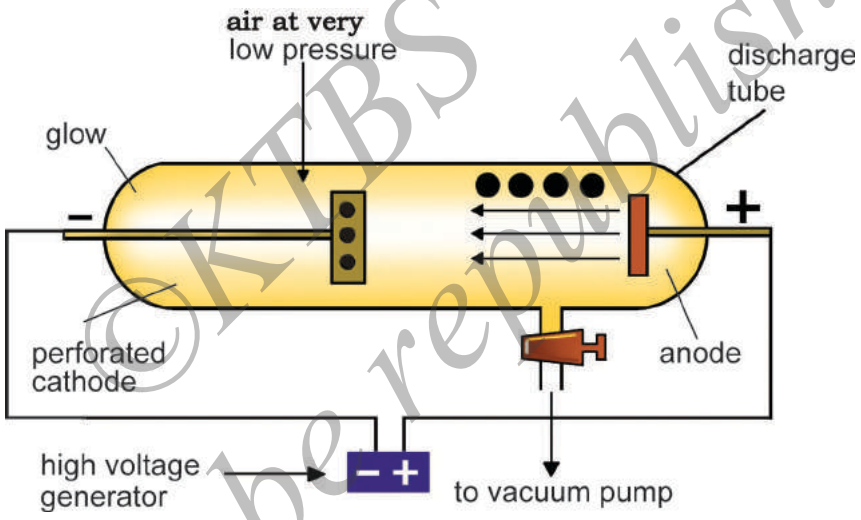


Fig. 3.4 Production of anode rays

In 1886, Goldstein used a modified type of discharge tube with a perforated cathode. He observed that certain rays travel in the direction opposite to that of the cathode rays. These rays are called anode rays. (see fig: 3.4) He applied an electric field parallel to the path of anode rays. He observed that the path of the rays deflected towards cathode.

What conclusion do you draw about the kind of charge of the anode rays? These rays contain positively charged particles and are called positive rays. The deflection of anode rays in an electric field was very little when compared to the deflection of cathode rays. Why is it so? The deflection of anode rays towards cathode depends on the type of gases taken inside the tube.

Let us list out the different characteristics of anode rays.

1. They consist of positively charged particles.
2. They are deflected by electrical and magnetic fields. The deflection is very little when compared to the deflection of cathode rays because they consist of heavy particles (nucleus).
3. The deflection of the anode rays depends on the nature of the gas in the discharge tube. Heavier the gas lower the deflection.

When hydrogen gas is taken inside the discharge tube, the deflection will be maximum. The positive particles of hydrogen atoms are found to be lightest. These particles are called protons. The mass of one proton is about the mass of 1840 electrons. The charge of proton is equal and opposite to that of electron. We take the mass of the proton as **1 atomic mass unit** and its charge is taken as +1.

How are electrons and protons arranged in an atom? Rutherford's experiment

It was initially believed that electrons and protons are uniformly distributed. Rutherford conducted an experiment which changed the entire concept of distribution of electrons and protons in an atom. He directed high speed positively charged particles called alpha particles towards a thin gold foil. He observed that most of the alpha particles passed through the foil without deflection. A few of them were deflected at very large angles from their original direction and a few were even turned back on their path.

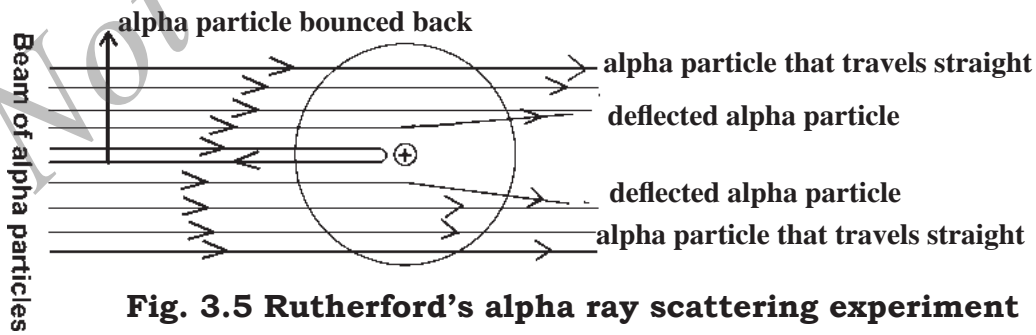


Fig. 3.5 Rutherford's alpha ray scattering experiment

This experiment raised several questions.

1. Why did most of the particles pass through the foil?
2. Why did a few of them deflect from their original path through large angles?
3. Why did a few of the alpha particles rebound?

Based on this experiment Rutherford proposed a set of assumptions. They are

1. Positively charged particles of an atom are held together in the centre of the atom. It is called **nucleus**. Nucleus is surrounded by electrons.
2. The volume of nucleus is small when compared to the volume of an atom.
3. The mass of an atom is concentrated in the nucleus.
4. The nucleus is positively charged, which is different in magnitude for different elements.
5. In a neutral atom, the number of electrons outside the nucleus is equal to the number of positively charged particles in the nucleus.

Rutherford noticed that atomic masses of different atoms could not be explained, if only protons and electrons are present in them. He predicted that a kind of neutral particle with mass equal to that of proton must be present in the atom.In 1932, James Chadwick experimentally proved the presence of such particles and called them **neutrons**. Mass of a neutron is almost equal to that of a proton. They are present in the nucleus of the atom along with the protons.

Activity 3.4

Complete the table

Atomic particle	*Discovered by*	*Type of charge*	*mass*
Proton			
neutron			
electron			

Several scientists did not agree with Rutherford's model of atom. An electron revolving around the nucleus should continuously lose energy. As a result, it should be gradually pulled towards the nucleus and end up colliding with it. If this should happen, then the atom would collapse. Rutherford's atomic model could not explain the stability of the atom. A new theory was presented to explain this.

A replica of an object constructed to a given scale retaining the internal structure: A model usually helps in understanding the object better.

In 1913 Neils Bohr presented a model of the atom which is now called the **Bohr model**. The postulates of this model are:

1. Electrons revolve around the nucleus only in certain permissible circular orbits. (orbit is some times called a **shell**. The first shell nearest to the nucleus is called **'K' shell.** The subsequent shells as we move away from the nucleus are L, M, N, O, . , respectively).
2. Electrons in each shell have been associated with a definite amount of energy. Electrons in higher shell have more energy than those nearer to the nucleus.
3. The energy of an electron remains constant so long as it revolves in its own shell. **The shells also represent energy levels.**

Neils Bohr proposed that each shell (energy level) can accommodate a maximum of $2n^2$ electrons, where 'n' is the shell number. For instance n = 3 for the third shell. This shell accommodates maximum of $2\times3^2 = 18$ electrons. This means 'M' shell contains not more than 18 electrons. Can you calculate the total number of electrons that can be present in 'N' shell?

You know that neutral chlorine atom has 17 electrons. According to Neils Bohr, out of 17 electrons, the 'K' shell accommodates 2 electrons, 'L' shell accommodates 8 electrons, and the remaining 7 electrons are accommodated in the next shell namely 'M' shell. This is represented in figure. 3.6

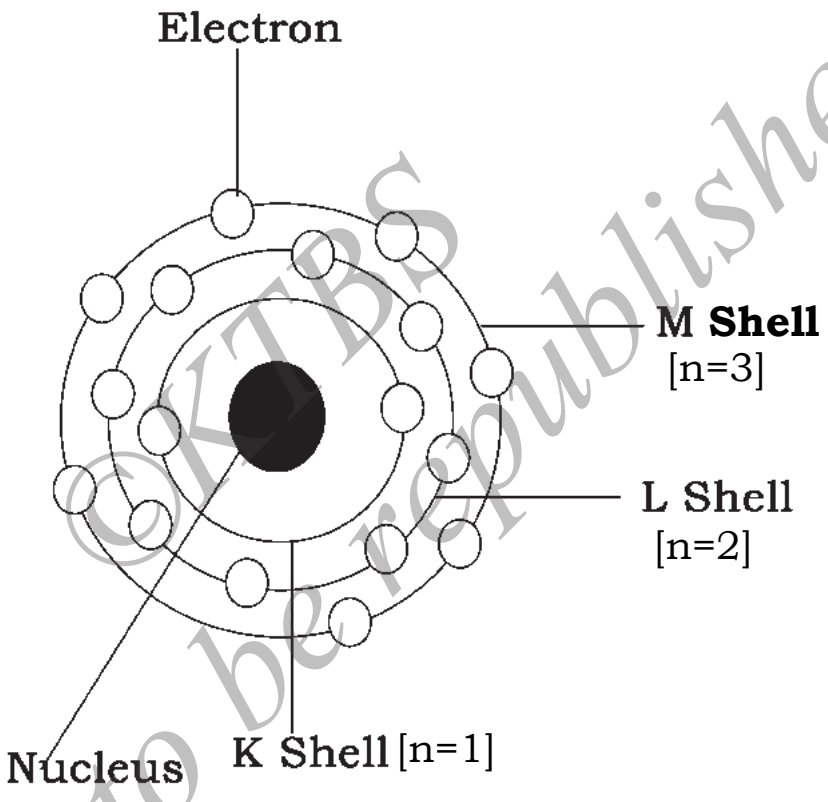


Fig. 3.6 Electron distribution in chlorine atom

Activity 3.5

Write the structure of sulphur atom, showing the distribution of electrons.

The model of the atom that emerged after Neils Bohr's proposal can be summed up as follows.

1. Every matter is made up of atoms.
2. An atom is no longer considered to be indivisible.

Atomic number and mass number

The number of protons present in the nucleus of an atom is known as atomic number. It also represents the number of electrons in the orbits. It is denoted by Z. The total number of protons and neutrons present in the nucleus of an atom is known as mass number. It is denoted by A. Generally atomic number and mass number of the atom of an element are represented by a symbol ${}_{Z}X^{A}$. 'X' is the element.

The value of Z is written on the left hand bottom corner of the symbol representing the element and the value of 'A' is written on the right hand top corner.

Activity 3.6

Fill in the blanks in the following table.

Name of the element	Number of protons	Number of electrons	Number of neutrons	Atomic number	mass number	Symbolical representation
Hydrogen H	1	1	0	1	1	${}_{1}H^{1}$
Helium He	2		2			
Neon Ne				10		
Uranium U	92				238	
Oxygen O		8				
Sodium Na	11					
Carbon C			6	6		
Radium Ra	88				226	
Aluminium Al	13				27	

The model of an atom has undergone further improvement which you will study in higher classes. You have studied that the nucleus of an atom contains protons and neutrons. It is observed that if the atomic number changes then the element also changes. For example, if an atom contains three protons, it has to be a lithium atom. If an atom contains six protons, it has to be a carbon atom. Does the element change when the mass number changes? Let us see.

Isotopes:

Observe the following figures. How many protons are present in each atom? If one proton is present in the atom, it has to be a hydrogen atom. Observe the mass number of each atom in fig 3.7. Is it the same? Atoms of an element with different mass numbers are called **Isotopes**. Hydrogen has three types of atoms. $_1H^1$ (protium/hydrogen) figure 3.7(1), $_1H^2$ (deuterium) figure 3.7(2), $_1H^3$ (tritium) figure 3.7(3). one more example - Carbon Isotopes- $_6C^{12}$,$_6C^{13}$, $_6C^{14}$

Fig. 3.7(1) Fig. 3.7(2) Fig. 3.7(3)

Fig. 3.7 Isotopes of hydrogen

After the discovery of isotopes, the second postulate of Dalton became invalid because the same element hydrogen has three different types of atoms.

You have learnt

- Postulates of Dalton's theory.
- J.J. Thomson's experiment and discovery of electrons.
- Properties of cathode and anode rays
- Rutherford's model of an atom.
- Neil's Bohr model of an atom.
- Fundamental particles and their properties.
- Atomic number and atomic mass.
- Meaning of isotopes.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer:

1. The heaviest fundamental particle is

   a. proton b. electron

   c. neutron d. hydrogen

2. In the scattering experiment the deflection of alpha particle is due to

   a. increase in kinetic energy b. force of repulsion

   c. force of attraction d. decrease in kinetic energy

3. The simplest atom that does not contain neutron is

   a. deuterium b. tritium

   c. hydrogen d. helium

4. The reason for the existence of isotopes is change in

   a. atomic number b. electron number

   c. neutron number d. proton number

II. Fill in the blanks with suitable words :

1. The total number of protons and neutrons in the nucleus of an atom is known as _____ .
2. Almost all the mass of an atom is concentrated in a small region of space called the _____.
3. The particle of an atom that has no charge is _____ .
4. The fundamental particle not present in a normal hydrogen atom is _____ .
5. The atomic mass of an atom is 23 and its atomic number is 11. the atom has _____ neutrons.

III. Answer the following:

1. State the postulates of Dalton's atomic theory.
2. Describe J.J. Thomson's experiment on the discovery of electrons.
3. List the characteristics of anode rays.
4. Describe Rutherford's model of an atom.
5. Describe Neils Bohr's atomic model.

6. Mention the properties of cathode rays.
7. Who proposed that atomic nucleus is positively charged?
8. State the conclusions drawn by alpha ray scattering experiment of Rutherford?
9. Why is an atom neutral in spite of the presence of charged particles in it?
10. List the three fundamental particles and their properties.
11. Define the terms atomic number and mass number of an element
12. Define the term 'isotope' of an atom with a suitable example.
13. From the symbol $_{19}K^{40}$. write the following

    1. mass number of Potassium 2. atomic number of Potassium

    3. Write the distribution of electrons in an atom of Potassium.

IV. Match the following :

A	B
1. proton	a. negligible mass
2. 'L' shell	b. 32 electrons
3. electrons	c. Dalton's atomic theory
4. neutrons	d. 8 electrons
	e. electrically neutral
	f. positively charged
	g. 18 electrons.

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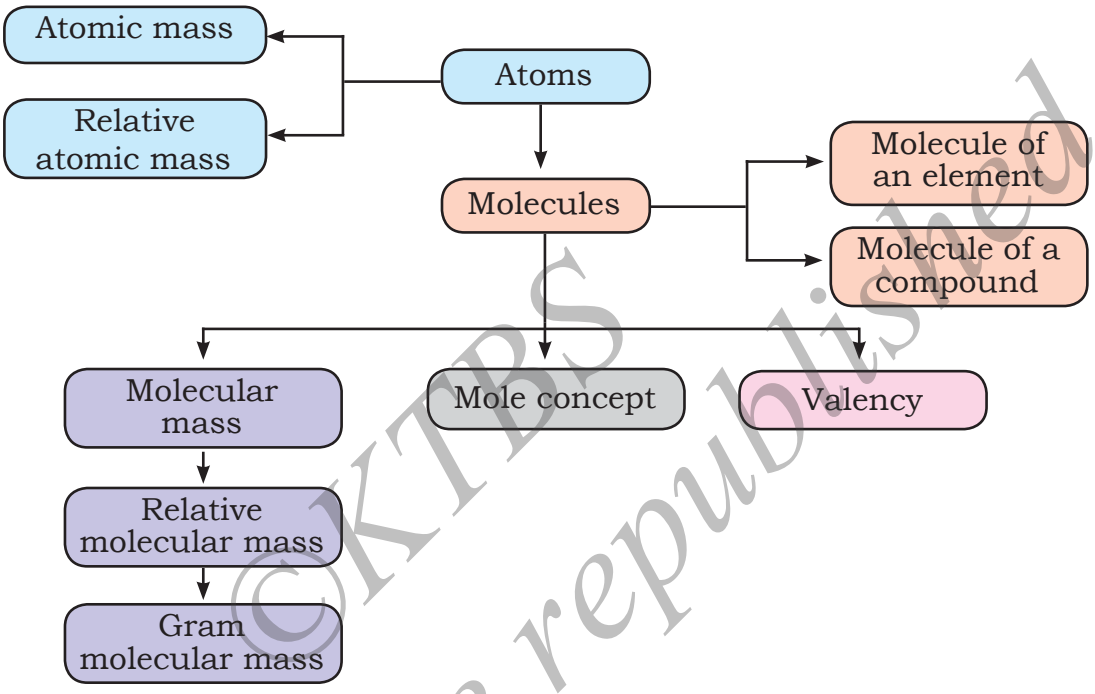
CHAPTER 4

ATOMS AND MOLECULES



You have already learnt that all substances are made up of extremely small particles called **atoms**. They are very small in size but still they occupy the whole world. We may not be able to see them but we experience their presence everywhere. Then there arises a question what is their mass? How much do they weigh? The mass of an atom is too small and cannot be expressed even in terms of units such as milligram.

Atomic Mass

Each atom has its own characteristic atomic mass. Mass of an atom is expressed interms of unit called atomic mass unit (amu) or Dalton (da) or unified mass 'u'. Atomic mass can be defined as the total mass of its nucleons (protons and neutrons together are called nucleons) present in it. Mass of one proton is 1.0078 amu and that of neutron is 1.0087 amu. In determining the mass of an atom Hydrogen, being the lightest atom, was arbitrarily assigned a mass of 1 and other elements were assigned masses relative to it.

Table 4.1 Atomic Mass of some elements

Sl. No.	Element	Mass Number	Atomic Mass (u)
1.	Hydrogen	1	1.0078
2.	Oxygen	16	15.99

In the nineteenth century scientists could only determine the mass of one atom relative to another by experimental means i.e., using law of chemical combination.

Example : 1) Atomic mass of carbon is determined by converting that into CO_2

2) Atomic mass of hydrogen is determined by converting that into H_2O

Relative Atomic Mass

The present system of atomic masses is based on carbon – 12 as the standard. The isotope of carbon namely ${}_6C^{12}$ atom has been chosen as a standard by international committee of chemists to find relative atomic mass of an element. Atomic mass of carbon is 12.01u.

$$\text{Relative atomic mass} = \frac{\text{mass of 1 atom of the element}}{\frac{1}{12} \times \text{mass of 1atom of } {}_6C^{12} \text{ isotope}}$$

Now relative atomic mass of Aluminium $({}_{13}Al^{27})$

$$= \frac{27}{\frac{1}{12} \text{ X } 12.01}$$

$$= \frac{27 \times 12}{12.01}$$

$= 26.98u$

Today we have very sophisticated techniques such as mass spectroscopy for determining the atomic masses very accurately. They are more reliable values. Listed below are atomic masses of some of the elements.

Table 4.2 Relative Atomic Mass of some elements

Element	Symbol	Relative Atomic Mass	Element	Symbol	Relative Atomic Mass
Aluminium	Al	26.98	Magnesium	Mg	24.31
Calcium	Ca	40.08	Nitrogen	N	14.01
Carbon	C	12.01	Oxygen	O	15.99
Chlorine	C1	35.45	Phosphorus	P	30.97
Hydrogen	H	1.008	Silver	Ag	107.87

Gram –Atomic Mass

Gram atomic mass of an element is its relative atomic mass expressed in grams. For example, the relative atomic mass of a hydrogen atom is 1.008, and its gram atomic mass is 1.008 g.

Average atomic Mass OR atomic weight

The atomic mass of an atom is a whole number, but the atomic weight of an element is not necessarily a whole number. This is because the atomic weight of an element represents the weighted average of all naturally occurring isotopes of the element.

Example: The atomic masses of the isotopes of Chlorine are 35 and 37. However, in any given sample of Chlorine, the two isotopes occur in the approximate ratio 3:1 (75.5% of Cl^{35} and 24.5% of Cl^{37}).

$$\text{Atomic weight of Chlorine} = \frac{3(35)+1(37)}{3+1} = \frac{142}{4}$$

$$= 35.5$$

Therefore, the Average atomic mass or atomic weight of Chlorine is 35.5

Likewise atomic masses of the isotopes of Carbon are C^{12}, C^{13} and C^{14}. Their relative abundance in percentage is 98.892%, 1.108% and $2x10^{-10}$ % respectively and their atomic mass is 12, 13.00335 and 14.00317.

The average atomic mass of carbon will be,

= (98.892%)(12u) +(1.108%)(13.00335) + ($2x10^{-10}$ %)(14.00317)

= 12.011u

Similarly, average atomic masses for other elements can be calculated.

Molecule

Atoms of most element do not exist independently. They are available in nature in a group of two or more atoms that are chemically combined together by attractive forces.

Atoms of the same element or of different elements are joined together to form a particle called molecules. 'A molecule can be defined as the smallest particle of an element or a compound that is capable of an independent existence and shows all the properties of that substance'.

Molecule of an Element

Eg : In earth's atmosphere Oxygen is available as combination of two atoms i.e., O_2 and not as O. (Of course mono atomic oxygen is found at the upper strata of exosphere layer of earth's atmosphere). In Ozone oxygen being united in 3 numbers to form O_3.

Some elements such as Helium (He), Argon(Ar) etc are made of only one atom.

Molecule of a Compound

Atoms of different elements join together in definite proportions to form molecule of compounds.

Eg: Two atoms of Hydrogen and one atom of Oxygen combine together to form Water molecule (H_2O)

One atom of Carbon and one atom of Oxygen combine of form Carbon Monoxide. [CO]

Molecular Mass

Molecular mass is the sum total of atomic masses of the elements present in a molecule.

Eg: Molecular mass of Oxygen Molecule (O_2)

= 2x (atomic mass of Oxygen)

= 2x (16.00u) =32u

Similarly Molecular mass of Carbon Dioxide CO_2

Atomic mass of Carbon = 12, Atomic mass of oxygen =16

1(atomic mass of Carbon) + 2 (atomic mass of Oxygen)

$1\times(12) + 2\times(16) = 12 + 32 = 44u$

Hence, molecular mass of Carbon dioxide is 44.

Activity 4.1

Calculate the Molecular Mass of Hydrochloric Acid(HCl)

Relative Molecular mass

The relative molecular mass of a substance is the ratio of the mass of a molecule of the substance to $\frac{1}{12}$ the mass of an atom of carbon ${}_6C^{12}$ isotope.

$$\text{Relative molecular mass} = \frac{\text{mass of 1 molecule of the substance}}{\frac{1}{12}\times \text{mass of 1atom of } {}_6C^{12} \text{ isotope}}$$

Thus, the relative molecular mass of a substance is the number that shows how many times a molecule of the substance heavier than that of $\frac{1}{12}$ of Carbon ${}_6C^{12}$ isotope.

The relative molecular mass of a substance, element or compound can be easily calculated by adding the relative atomic masses of all the individual atoms present in the molecule.

Activity 4.2

Calculate the relative molecular mass of water, molecular formula of water is H_2O

Gram Molecular Mass

Gram molecular mass of a substance is its relative molecular mass expressed in grams. The following table gives gram molecular mass of some substance.

Table 4.3 Gram Molecular Mass of Some Substances

Substance	Molecular formula	Relative molecular mass	Gram molecular mass
Hydrogen	H_2	2×1=2	2 g
Oxygen	O_2	2×16=32	32 g
Chlorine	Cl_2	2×35.5=71	71g
Water	H_2O	(2×1)+16=18	18 g
Hydrogen chloride	HCl	1+35.5=36.5	36.5 g
Carbon dioxide	CO_2	12+(2×16)=44	44 g
Sulphuric acid	H_2SO_4	(2×1)+32+(4×16)=98	98 g

Mole concept

In day-to-day life we use units like dozen, to deal with quantities. The term dozen indicates a constant number, whatever may be the items. In a similar manner to represent the number of atoms or molecules we use the word '*mole*'. A '*mole*' is equal to 6.023×10^{23} atoms or molecules. This is also called **Avagadro's number** and is represented by **N**.

Molar mass of substance	Mass in grams	Number of atoms of a substance
1mole of molecules	Molecular mass in grams	6.023×10^{23} number of molecules
1mole of carbon atoms	12g of carbon atoms	6.023×10^{23} atoms of C
1mole of hydrogen atom	1g of hydrogen atoms	6.023×10^{23} atoms of H
1mole of water molecules	18g of water molecules	6.023×10^{23} molecules of H_2O

Avagadro

Know this : "Mole" represents the number of atoms or molecules in 22.4 litres of any gas at standard temperature and pressure (STP). The volume 22.4 litres is also called gram molecular volume.

[STP: Standard temperature and pressure]

Importance of gram atomic mass

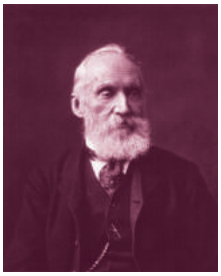
Gram atomic mass of a substance contains 6.023×10^{23} atoms. For example, gram atomic mass of oxygen is 16 g. That means 16 g of oxygen contains 6.023×10^{23} atoms. If we inhale 16 g of oxygen we will be breathing in 6.023×10^{23} oxygen atoms. Similarly, gram molecular mass of any substance contains 6.023×10^{23} molecules. Example: Gram molecular mass of water is 18 g. That means if we drink 18 g of water we will be drinking 6.023×10^{23} molecules of water.

Do you know?

Lord Kelvin inventor of the Kelvin Scale of Temperature helped in calculating Avogadro's number. This number is also referred to as mole. Mole is a huge number, 6.023×10^{23}

which is equal to,

602, 300,000,000,000,000,000,000



Lord Kelvin

Mole concept gives us a method of calculating the number of atoms present in a given mass of a substance. It helps in the calculation of the ratio of reactants consumed to products formed quantitatively.

Activity 4.3

Calculate the number of moles of water molecules in 1000 mL of water.

Problem

To prepare one gram of hydrogen molecules using hydrochloric acid, how many grams of zinc should be taken?

$Zn + 2HCl \rightarrow ZnCl_2 + H_2\uparrow$

Gram atomic mass of zinc is 65 g and that of hydrogen molecule is 2 g. From the above equation we can understand that 65 g of zinc gives 2 g of hydrogen molecules. To prepare 1 g of hydrogen molecules we need 32.5 g of zinc.

Valency Of An Element

You know that the molecular formula of sodium chloride is NaCl, and that of calcium chloride is $CaCl_2$ but not CaCl. Similarly the molecular formula of ferric chloride is $FeCl_3$ but not FeCl. These differences are due to the combining capacity of atoms. Valency can be considered as the combining capacity of an element. The knowledge of atomic structure has helped in understanding the concept of valency. The modern concept of valency in its simplest form can be defined as the number of electrons of an element that take part in chemical reactions. For example, valency of chlorine is 1, because it can accept or share one electron to form a chemical bond. The valency of calcium is 2, because it can donate two electrons. The valency of oxygen is also 2, because it can accept or share 2 electrons to form a bond. The valency of carbon is 4, because it can share 4 electrons with other atoms. You will study more about chemical bonds in higher classes.

Some elements do not have a natural tendency to react with other elements to form compounds. They are called **inert gases** or **noble gases**. For example: Helium, Neon, Argon (The element of 18th group in the periodic table). Their valency is zero. These elements have either completed shell of electrons or 8 electrons in the outermost shell (**octet structure**).

Helium atom has 1 shell (K shell). This shell can accommodate only 2 electrons. It has a completed shell. Its valency is zero or it is chemically stable.

Similarly electronic configuration of Argon (Atomic number18) is,

K	L	M
2	8	8

It has octet structure. Its valency is also zero. Thus it is stable.The electronic configuration of chlorine atom (Atomic number17) is

K	L	M
2	8	7

It has an incomplete shell. It needs 1 electron to complete the octet structure. Its valency is 1. Chlorine atom can also donate the 7 electrons of the outer most shell and get octet structure. Then its valency becomes 7

Now consider sodium atom, (Atomic number11). It has one electron in the outermost shell. It donates 1 electron and gets octet structure in the 'L' shell itself. Its valency is also 1.

K	L	M
2	8	1

Activity 4.4

Atomic number of Aluminium is 13. Find out its valency and valence electrons.

As a special case, some elements have **variable valency**. For example, iron has two valencies-ferrous (2) and ferric (3). It is because the number of electrons from the iron atoms which participate in the chemical reaction will be either 2 or 3 depending upon conditions.

Activity 4.5

Complete the following table:

Name of the element	Symbol of the element	Atomic number	Distribution of electrons				Valence electrons
			K	L	M	N	
Nitrogen	N	7	2	5			5
Oxygen	O	8	2	6			
Sodium	Na	11	2	8	1		
Magnesium	Mg	12	2	8	2		
Silicon	Si	14	2	8	4		
Sulphur	S	16	2	8	6		

Percentage composition of an element in a compound

The Percentage composition of an element in a compound is the mass of an element present in 100g of that compound. It tells us how much percentage of a particular element is present in a given compound.

Mass percentage of an element =

$$\frac{\text{Mass of that element in the compound x 100}}{\text{Mass of that compound}}$$

Eg: Percentage of each of the element in Calcium Carbonate ($CaCO_3$)

The total weight of $CaCO_3$ = 1 (Ca) +1(C) + 3(0)=1(40) + 1(12) +3(16)

=40+12+48

=100

% mass of calcium in $CaCO_3$ = $\frac{40}{100}$ X100 =40%

% mass of Carbon in $CaCO_3$ = $\frac{12}{100}$ X100=12%

% mass of Oxygen in $CaCO_3$ = $\frac{48}{100}$ X100=48%

2) What is the percentage composition of Hydrogen and Oxygen in Water:

Mass of Hydrogen Monoxide (water) =2(H) + 1(O)=2(1)+1(16)

=18

% mass of Hydrogen = $\frac{2}{18}$ X100=11.11%

% mass of Oxygen = $\frac{16}{18}$ X100=88.89%

Activity 4.6

Calculate the percentage composition of Oxygen in Potassium Chlorate ($KClO_3$) (Atomic Mass of K=39, Cl=35.5 and O=16)

You have learnt

- Atomic Mass and relative atomic mass.
- Molecules of an element & of a compound.
- Molecular mass, relative molecular mass & gram molecular mass.
- Avagadro number & mole concept.
- Calculation of number of moles in a gram mass of a substance.
- Estimation of amount of elements required for chemical reaction.
- Valence electrons & Valency.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements/questions. Choose the right answer.

1. Some elements have atomic mass in fractions. It is due to the presence of

   a. fractions of protons b. fractions of neutrons

   c. isotopes d. valence electrons

2. Plants in a garden make use of 22.4 litres of carbon dioxide at S T P (Standard temperature and Pressure) The number of molecules of carbondioxide utilised by the plants is,

   a. 6.023×10^{23} molecules b. 22.4 molecules

   c. 6.023×10^{24} atoms d. 11.2 moles of molecules

3. The atomic mass of Deuterium, isotope of hydrogen is 2. The atomic mass of oxygen is 16. Then the molecular mass of heavy water formed is

   a. 16 b. 18 c. 20 d 24

4. Some elements can have different valencies. It can happen due to the change in

   a. number of electrons that participate in a reaction

   b. number of neutrons c. number of protons

   d. atomic mass number

II. Give scientific reason for the following

a) The Valency of noble gases is zero.

b) In the atmosphere, Oxygen is available as O_2 but not as O.

III. Answer the following

1. Define:

   a) Atomic mass b) Relative atomic mass

   c) Gram molecular mass d) Mole. e) Valency of an element

2. Calculate the percentage composition of carbon and Oxygen in CO_2. (given atomic masses : Carbon =12 and oxygen =16)

3. A student has a piece of copper sulphate ($CuSO_4$) crystal. Explain the method of calculating the number of $CuSO_4$ molecules in that crystal. (Given atomic masses: Calcium =40, Sulphur = 32 and Oxygen=16)

4. $CaCO_3 \xrightarrow{\text{Heat}} CaO + CO_2 \uparrow$

From the above equation calculate the amount of carbon dioxide in grams liberated by heating 25 g of calcium carbonate.

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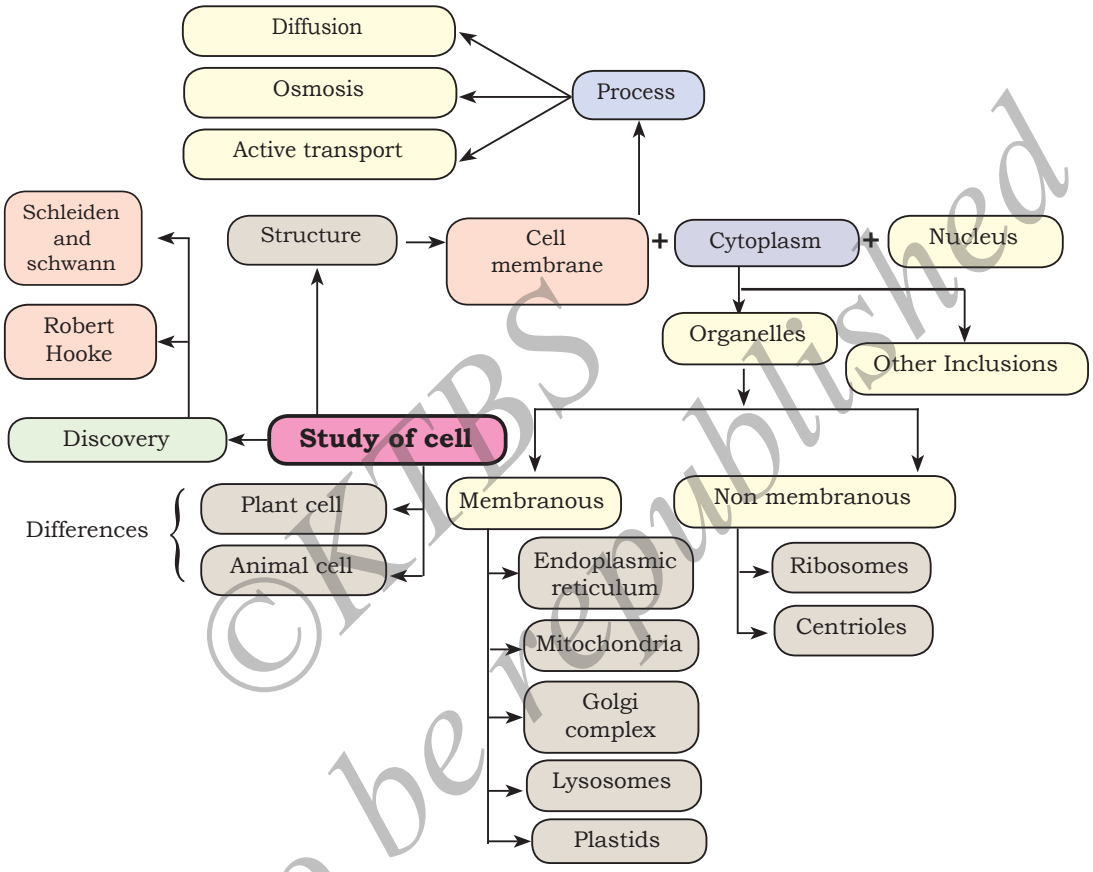
CHAPTER 5

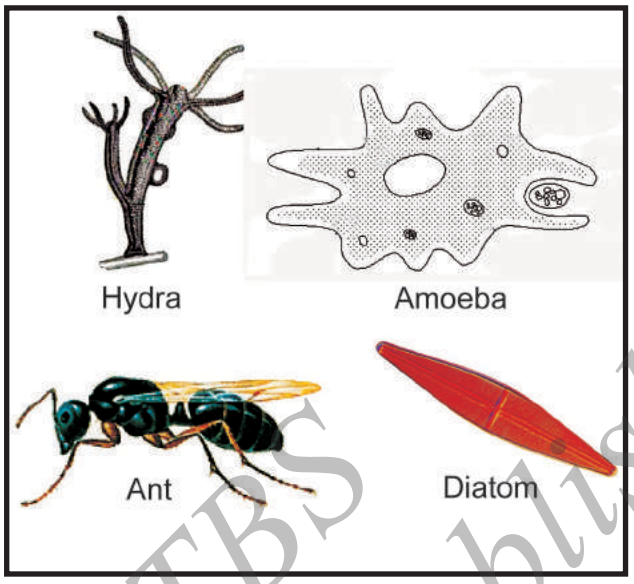
STUDY OF CELLS



You know that all organisms are made up of small units called **cells**. As are the bricks to a building, so are the cells to the body of an organism. You have already learnt that organisms may be unicellular or multicellular.

Activity 5.1

Classify the following into unicellular and multicellular organisms.



The number of cells in multicellular organisms may be from a few hundreds to billions.

Know this : An average adult human body approximately has trillions of cells.

1 million	= 10^6	(1,000,000)
1 billion	= 10^9	(1,000,000,000)
1 trillion	= 10^{12}	(1,000,000,000,000)
100 trillion	= 10^{14}	(100,000,000,000,000)

Cells perform activities such as nutrition, respiration and cell division, which contribute to the overall growth of an organism. Hence, cells are called **structural and functional units** of an organism.

Recall : An organism such as horse has a number of organ systems. One such system is the circulatory system. Name an organ of the circulatory system. Mention a tissue of this organ, and a cell of this tissue.

Fig.5.1 Cell is the basic unit of an organism

Discovery of the cell

Many scientists have contributed to the development of cytology (cell biology).

Robert Hooke
(1635-1703)

Robert Hooke

Robert Hooke was an English naturalist. He designed a microscope and examined a thin section of a piece of dried cork under it. He saw honey comb like structures in it. He called them cells. The word cell means small room.

M.J. Schleiden and Theodore Schwann

Schleiden, a German botanist and Schwann, a German zoologist, together put forth the **cell theory** in 1839.

Cell theory states

- The body of living organisms is formed of one or more cells.
- All the cells arise only from preexisting cells through cell division.

Nerve cell

Red blood cell

Fig.5.2 Types of Cells

Look at Fig.5.2 and observe the cells of various shapes. A nerve cell is long and has branched fibre like structures. A nerve cell carries messages from one part of the body to another. A red blood cell is biconcave and round in shape. It transports oxygen to different parts of the body. Thus, cells have different shapes to carry out different functions. Give some more examples of cells to show the relationship between their shape and function.

How small are the cells? Most of the cells are not visible to the naked eye. They need to be magnified by a microscope. How to express the size of a cell? As cells are very small, ordinary units are not convenient to express the size of the cells. Micron is the most commonly used unit to express the size of the cell. One micron is equal to 1/1000 of a millimetre.

Think : Is the difference in the size of an organism, due to the large size of the cells or large number of cells?

The cell and its components can be observed clearly with the help of an electron microscope. Electron microscope uses a beam of electrons to get the image of the object. Its magnification is about 200,000 times as against the compound microscope which magnifies objects up to 2000 times.

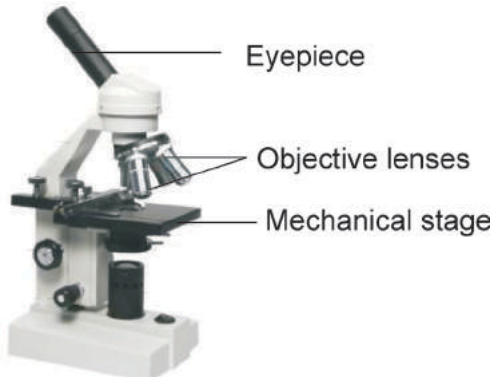


Fig. 5.3 Compound Microscope **Fig. 5.4 Electron Microscope**

Find out: *Why is electron Microscope called so?*

How to find the magnification produced by a compound microscope? Look at the compound microscope in fig. 5.3. Observe the **eye piece** in the compound microscope. An eye piece lens is the one through which we see. An **objective lens** is the one which is near the object. Find the magnification written on the eye piece lens and the objective lens. For example, in a compound microscope magnification of eye piece lens is 10x and that of objective lens is 40x. The total magnification is 400x. It means, the object appears 400 times larger than its actual size.

Activity 5.2

Find out the magnification power of a compound microscope that you use in your school.

How do you observe a cell under compound microscope?

Activity 5.3

Take a peice of a layer from an onion. Remove a thin epidermal layer from this piece. Put this on a drop of water taken on a glass slide. Put a drop of iodine or any suitable staining solution on this piece. Observe the slide under a microscope with the guidance of your teacher. Under a microscope, you will see the cells, usually as shown in the fig.5.5

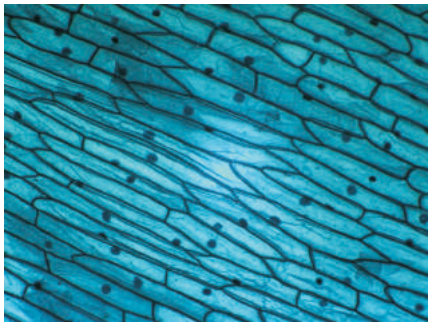


Fig. 5.5 Cells in onion peel

Observe fig. 5.6 and fig. 5.7. Any cell, when observed under a compound microscope, shows three prominent parts. They are **cell membrane**, **cytoplasm** and **nucleus**. A cell is surrounded by a **cell membrane.** It is also called **plasma membrane.** It separates the interior of the cell from outside environment. Cell membrane helps to maintain the shape of the cell. It controls the movement of selected substances into or out of the cell. Hence, cell membrane is described as a **semipermeable membrane.**

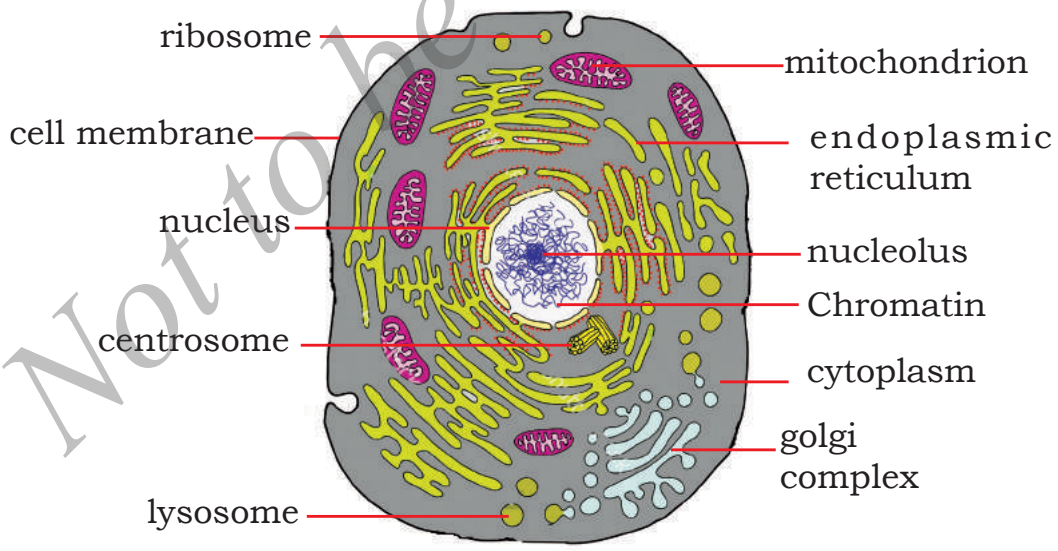


Fig. 5.6 Animal cell

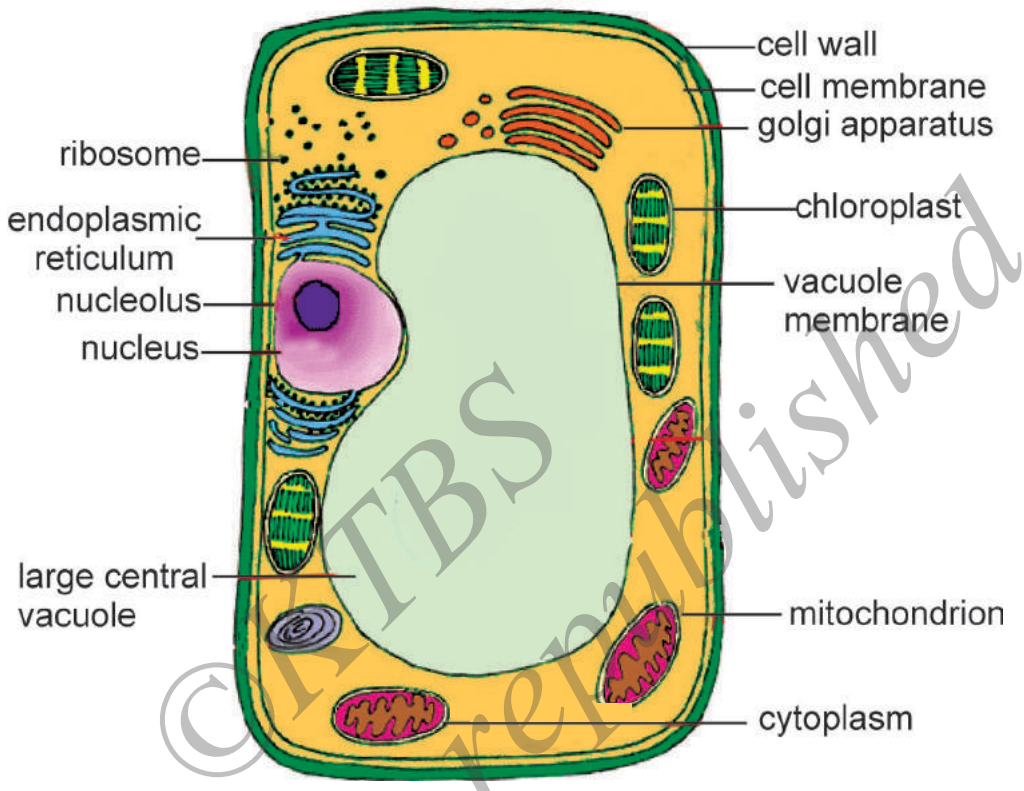


Fig. 5.7 Plant Cell

The movement of molecules across the cell membrane occurs by two processes.

How do these processes occur? Let us conduct an experiment.

Activity 5.4

Experiment to demonstrate diffusion

Take some water in a beaker. Drop a crystal of potassium permanganate into it. Observe the change in the colour of water- whether the change was gradual or immediate. The change is due to the movement of molecules. Potassium permanganate has diffused. This process of movement of molecules is called diffusion. Diffusion is a process in which, molecules of a substance move from a region of higher concentration to a region of lower concentration.

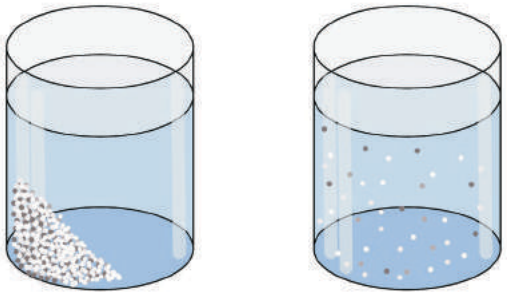


Fig. 5.8 Experiment to demonstrate diffusion

Think : How does oxygen move in and out of a cell?

Let us take another situation, in which the molecules move from a region of higher concentration to a region of lower concentration. We shall conduct another experiment.

Activity 5.5

Experiment to demonstrate osmosis

Make a cup shaped cavity in a peeled potato as shown in fig 5.9. Pour sugar solution into the cavity. Place the potato in a container with little water. Mark the level of sugar solution. Leave it for about half an hour. Note the rise in the level of sugar solution. Why did it rise? It is due to the movement of water molecules from a region of higher concentration to a region of lower concentration. However, the movement of molecules is through the semipermeable membrane of the potato cells. This process is called osmosis. Osmosis is a special kind of diffusion. It is the diffusion of water molecules through a semipermeable membrane. Hence, osmosis is the movement of water molecules from a region of higher concentration to a region of their lower concentration through a semipermeable membrane.

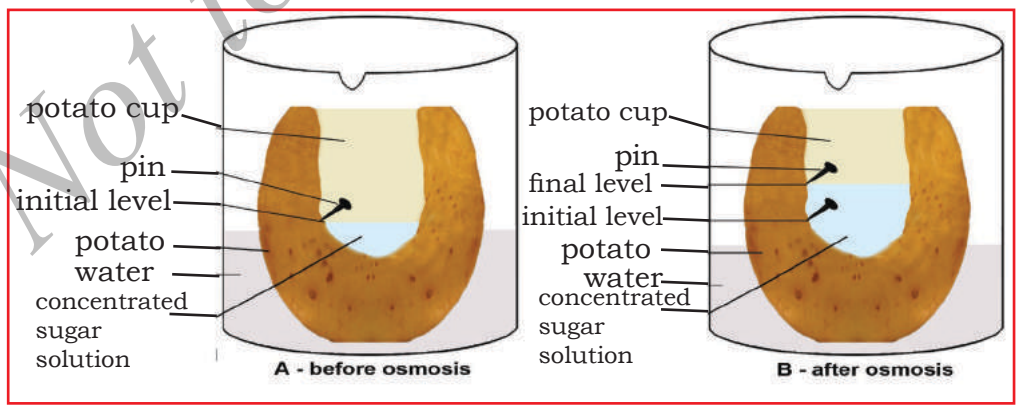


Fig. 5.9 Experiment to demonstrate osmosis

Movement of water molecules across the plasma membrane of cells is from a region of higher water concentration to a region of lower water concentration. Under certain conditions, molecules move from a region of lower concentration to a region of higher concentration with the expenditure of energy. For example, in blood, the concentration of sodium is less and it is more in a heart muscle cell. Inspite of this, sodium is absorbed into the heart muscle cell, from the blood. This process requires energy. This is called **active transport.**

Look at the fig. 5.7. In plant cells, in addition to the cell membrane, there is a **cell wall.** Cell wall is thick, rigid and surrounds the cell membrane. It is mainly composed of **cellulose,** a non living substance. Cell wall provides shape, strength, protection and rigidity to the cell. Unlike cell membrane, cell wall is a **permeable membrane.**

Cytoplasm is a jelly like substance found between the cell membrane and nucleus. Nearly 80% of cytoplasm is water. It is the site for most of the cellular activities. A number of smaller components are found in the cytoplasm. They include nonliving substances (inclusions) and living structures called **organelles**. Non-living substances include several chemicals such as starch grains, oil droplets, calcium carbonate, resin and gum. Some of them are used as reserve food, some are waste products and the others are secretions.

Organelles are specialized structures found in the cytoplasm of cell. They carry out specific functions. They are grouped under two categories. They are-

1. **Membranous organelles :** Organelles covered by membranes.

   Examples: Endoplasmic reticulum, mitochondria, golgi complex, lysosome, plastids.

2. **Non membranous organelles** : Organelles which are not covered by membranes Examples: Ribosomes, centrioles.

Look at the organelles marked in the Fig. 5.6 and 5.7.

Membranous organelles :

Endoplasmic reticulum : Observe the fig 5.10. Endoplasmic reticulum is a network of branching tubules. It extends from the cell membrane to the nuclear membrane. It also lies scattered in the cytoplasm. Endoplasmic reticulum forms the supporting framework of the cell. It transports substances from one part of the cell to the other and from one cell to another.

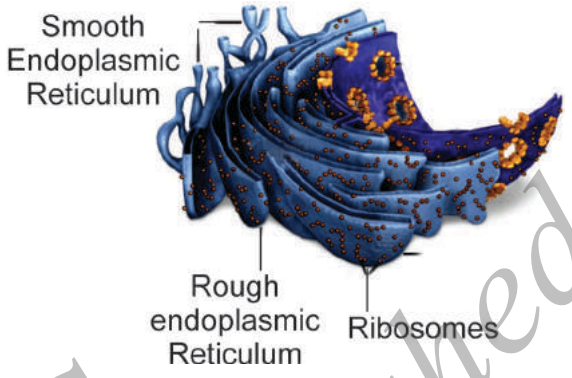


Fig. 5.10 Endoplasmic reticulum

Mitochondrion: Observe the fig 5.11. Mitochondria occur in various shapes such as-cylindrical, spherical, oval and rod shaped. Each mitochondrion is bound by a double membrane. Outer membrane is smooth but inner one is folded. Folds are called **cristae**. Inner membrane encloses a fluid known as **matrix.** Mitochondria are the sites of respiration in a cell. They use oxygen to break down glucose into carbon dioxide and water. This process releases energy which is stored in a molecule called **adenosine triphosphate (ATP).** Hence, mitochondria are called **power houses of the cell.** Normally, a cell has 30 to 40 mitochondria but the number of mitochondria in a cell varies and depends on the function of the cell.

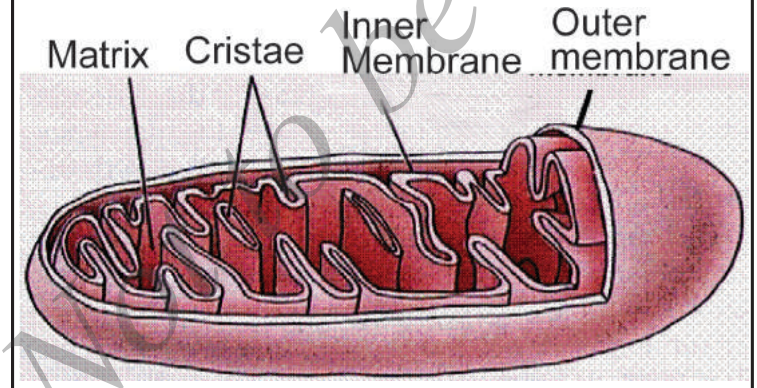


Fig. 5.11 Mitochondrion

Think: Flight muscle cells in insects contain thousands of mitochondria. Why?

Golgi complex : Observe fig 5.12. Golgi complex consists of flat discs with expanded ends (vesicles). The main function of golgi complex is to secrete chemicals required for cellular activities.

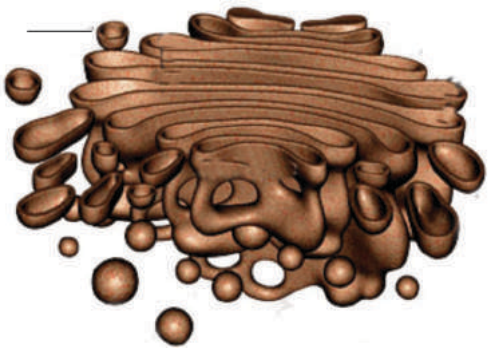


Fig 5.12 Golgi Complex

Lysosomes : Lysosomes are usually found in an animal cell. They are spherical, sac like organelles. They contain a variety of hydrolytic enzymes. These enzymes help in the digestion of organic substances present in the cell. They may also destroy their own cell when it becomes old, weak, damaged or diseased. Hence they are often called ***suicide bags of the cell.***

Know this : Lysosomes use about 40 different types of enzymes which are manufactured in the endoplasmic reticulum and modified in the golgi complex.

Plastids

Plastids are found only in plant cells. Some plastids are without colouring pigments and are called **leucoplasts.** They occur in regions of plant which are not exposed to sunlight such as tender roots. They are mainly involved in the storage of reserve food. Second type of plastids are with colouring pigments other than green. They are called **chromoplasts**. Chromoplasts contain pigments that are yellow, red, or orange in colour. The third type contain green coloured pigments and are known as **chloroplasts.** In chloroplasts, green coloured pigment, namely chlorophyll is present. They are found in the green parts of the plants such as leaves. Look at fig. 5.13 to understand the structure of chloroplast.

Activity 5.6

Find out the differences between an organ and an organelle

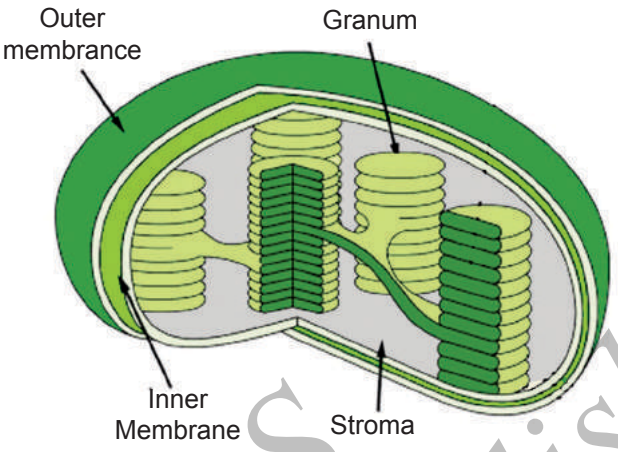


Fig. 5.13 Chloroplast in section

Chloroplast:

Each chloroplast is covered by a double membrane. The inner membrane encloses matrix - **stroma** and **grana**. Grana has chlorophyll. Chlorophyll plays an important role in preparing food. What exactly is the role of chlorophyll? You will learn more about this, in the nineteenth chapter.

Think : A tender tomato is whitish in colour. Later it becomes green. Further it turns red. Why?

Non membranous cell organelles

Ribosomes : You will find some grain like structures attached to the endoplasmic reticulum and nuclear membrane. These are ribosomes. They are also freely distributed in cytoplasm. They play an important role in the synthesis of proteins. Hence, they are known as **protein factories of the cell.**

Centriole : Look at fig. 5.6 to identify the organelle called centriole. Centrioles are found in some algae, fungi and all animal cells. Two centrioles are located usually near the nucleus. Centrioles help during cell division.

Vacuoles In the cell, we also find membrane covered cavities called **vacuoles**.They are filled with a fluid called **cell sap**. Vacuoles are structures which store food, excess water and waste products.

Know this : Most of the protozoans have vacuoles. Vacuoles, which store food and help in digestion are food vacuoles. Vacuoles which help in the removal of excess water are contractile vacuoles.

Nucleus

Nucleus is a spherical organelle found in all eukaryotes. Recall what eukaryote is. Nucleus is the largest organelle in a cell.

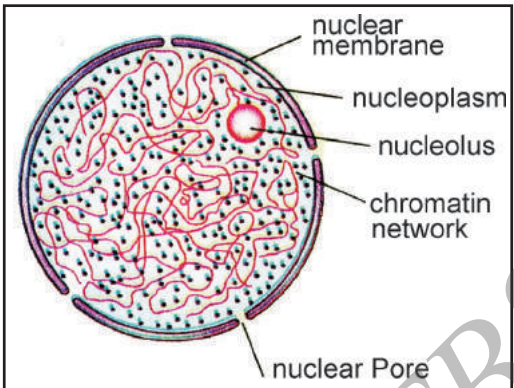


Fig. 5.14 Nucleus

Most of the eukaryotic cells usually have one nucleus. Some like slime molds have many nuclei. Some mammalian cells like red blood cells do not have nucleus at maturity.

Think : Mammalian red blood cells do not contain nucleus at maturity. Why?

Nucleus is covered by a double membrane called **nuclear membrane.** The membrane encloses a fluid called **nucleoplasm.** Nucleoplasm has a network of thread like structures called **chromatin**. During cell division chromatin undergoes coiling and super coiling and becomes short and thick to form **chromosomes**.

Chromosomes contain genetic material called **Deoxyribo nucleic acid (**DNA). DNA has **genes**. Each gene determines a particular characteristic of an organism. For example, height of a person, colour of the skin, colour of the eyes like black, blue, green or brown. Normally, every cell of an organism of a species has a definite number of chromosomes. Every human cell has 46 chromosomes. Look at the given table to know the chromosome number of some organisms.

Table 5.1 Chromosome number per cell in some organisms

Organism	Chromosome Number
Round worm	2
Onion	16
Cat	38
Mango	40
Capuchin monkey	54
Dog	78

Activity 5.7

Collect information about the number of chromosomes present in some plants.

Look at the structure other than chromatin in the nucleus. Nucleus also has a dense spherical body called **nucleolus**. Nucleolus is not covered by a membrane. Nucleolus forms ribosomes.

Nucleus co-ordinates the activities of the cell. For instance, look at the given illustrations a and b carefully in Fig. 5.15.

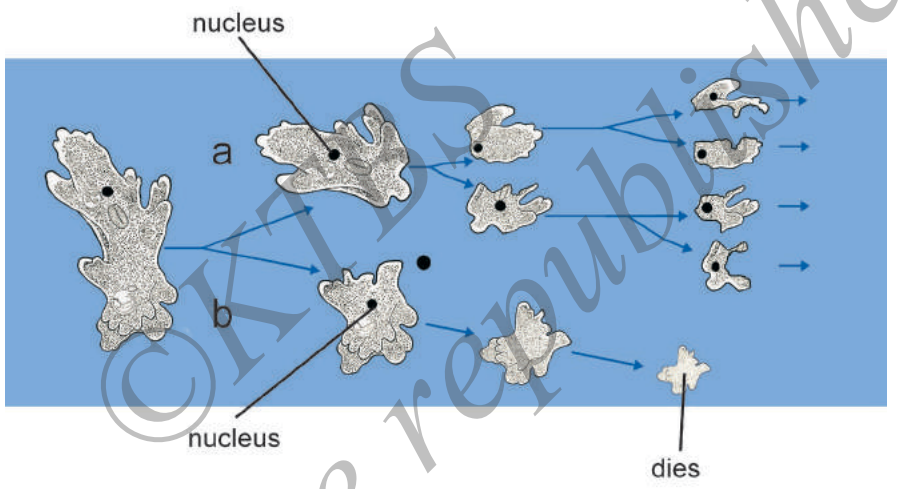


Fig. 5.15 Illustrations a and b

From the above illustrations, can you establish the importance of nucleus?

Activity 5.8

List the major differences between a plant cell and an animal cell by looking at the diagrams: 5.6 and 5.7.

		PLANT CELL	*ANIMAL CELL*
1	*Cell wall*		
2	*Plastids*		
3	*Vacuole*		
4	*Centrioles*		

You have learnt

- The major parts of a cell.
- The role of each organelle of a cell.
- The structure and function of chloroplasts and mitochondria.
- Differences between a plant cell and an animal cell.
- The role of diffusion and osmosis in the functioning of a cell.
- The skill of draw the diagrams of plant and animal cells.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer :

1. A cell lacking in nucleus, also lacks

   a. plasma membrane b. mitochondria

   c. chromosome d. vacuole

2. Cell wall is absent in the cell of this organism

   a. mushroom b.moss

   c. fern d. mosquito

3. Organelle of the cell which releases energy through respiration is

   a. Golgi complex b. Mitochondrion

   c. Lysosome d. Chloroplast

4. Which one of the following part of a cell is non-living ?

   a. cell wall b. mitochondria

   c. cell membrane d. lysosome

5. One of the following is the smallest organelle in a cell

   a. lysosome b. nucleus

   c. ribosome d. mitochondrion

II. Fill in the blanks with suitable words:

1. The instrument that led to the understanding of the cell is _____.
2. The organelle which controls the various activities of the cell is_____.
3. The organelle which is called the 'kitchen of the plant cell' is _____ .
4. The site of protein synthesis in the cell is_____ .
5. The main chemical component of the cell wall is _____ .

III. Match the following:

A	B
1. storage room of the cell	a. chloroplast
2. gateway of the cell	d. golgi complex
3. solar panels of the cell	c. vacuole
4. packages of hereditary information	d. nucleus
	e. chromoplast
	f. cell membrane
	g. chromosome

IV. Answer the following questions:

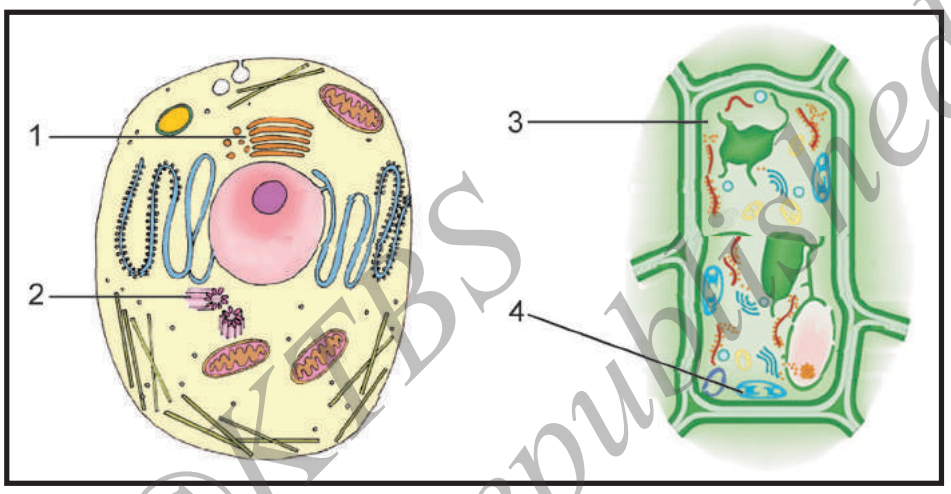
1. What are genes? Mention their importance.
2. Which organelle in an animal cell is useful during cell division?
3. What is the role of chloroplast in a plant cell?
4. Which are the organelles that are found more in number in the following cells?

   a. muscle cells b. white blood cells

   c. leaf cells d. pancreatic cells
5. List any four differences between a plant cell and an animal cell.
6. What happens when an empty potato cup is kept in a trough with water? Why?

7. 0.9% sodium chloride solution is good and balanced to RBC. A lab technician accidentally places a sample of RBC's in 1.8% sodium chloride solution. What happens? Why?

8. Diagrams of two different cells are given below. Which one of the two is a plant cell? Support your answer.



(i) Name the parts 1, 2, 3 and 4.

(ii) Write the functions of 1 and 3.

(iii) Draw a diagram to show the structure of 4 and label the parts.

(iv) Draw a diagram of a plant cell and label the parts

V. Suggested Activities

1. Put dried raisins (dry grapes) in a dish with water. What is the change in the raisins after some time? Why?

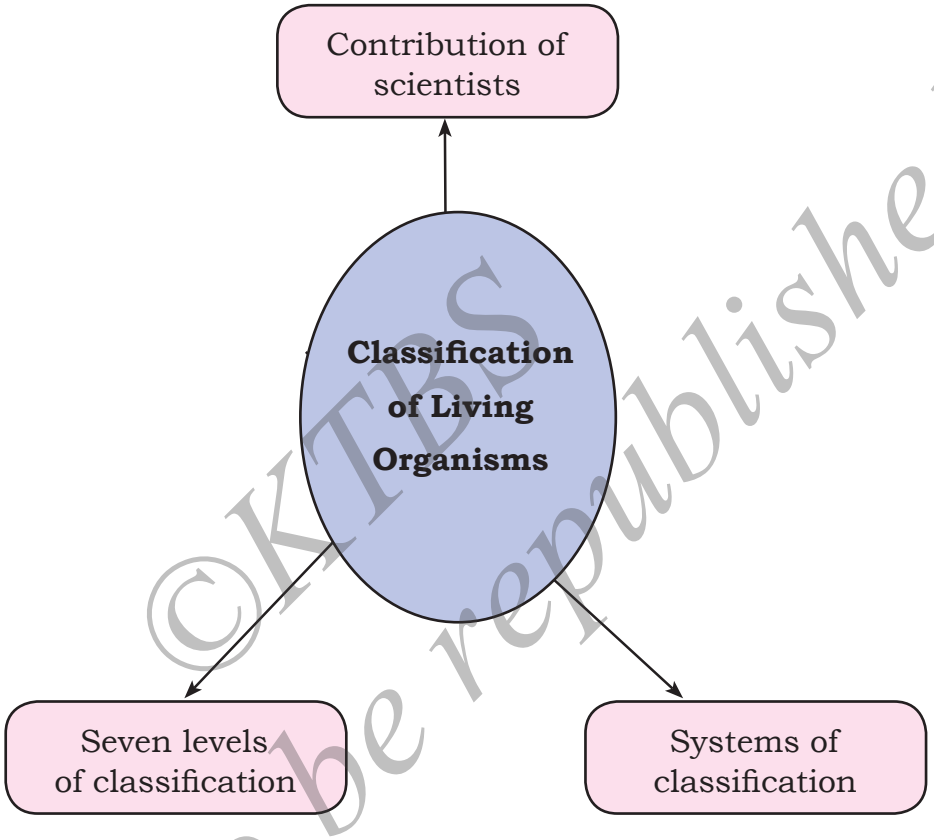
2. Remove the shell of an egg by dissolving it in dilute hydrochloric acid. A thin outer skin now encloses the egg. Put the egg in water. Observe after a few minutes. What is your inference ?

3. Place a similar de-shelled egg in a concentrated salt solution for a few minutes. Observe the changes. Record your observations giving reasons.

★★★★★

CHAPTER 6

CLASSIFICATION OF LIVING ORGANISMS



Nature is beautiful with a wide variety of plants and animals. Is it not important and interesting to know about plants, animals and other living organisms?

Classification of Livng Organisms

Earth is inhabited by innumerable organisms. Scientists have discovered and described approximately 1.9 million species on earth. In addition to this, new species are being discovered every day. There are microscopic organisms like bacteria and yeast; small plants like coriander and tulasi; large organisms such as elephant, whale and banyan tree. Some organisms live in water; some on land; a few in deserts and a few others in the polar regions. Do you know organisms living in other environments?

Diversity among the organisms is amazing and beyond our imagination! Find the reasons for the differences in shape, size, colour and mode of nutrition among animals. We know that there are many organisms on earth. It is very difficult to study each and every one of them to understand their characteristic features. For the sake of convenience of study, organisms are grouped according to their similarities or differences. A detailed study of a typical organism of the group, helps us to understand the main characteristics of the whole group. Thus, grouping makes our study easier. The method of grouping organisms, according to their similarities and differences is called **classification. Taxonomy** is the branch of biology which deals with the classification of organisms.

The purpose of classification is

- for convenience- easy to study, identify and remember.
- to show relationships among various groups of organisms.
- to show the evolution of organisms from simple to complex forms of life.

Think: How does the knowledge of classification help in your daily activities? How would you use the idea of classification to do the following?

A. arranging your book shelf. B. preparing a study timetable.

Activity: 6.1

Group the following animals into herbivores and carnivores.

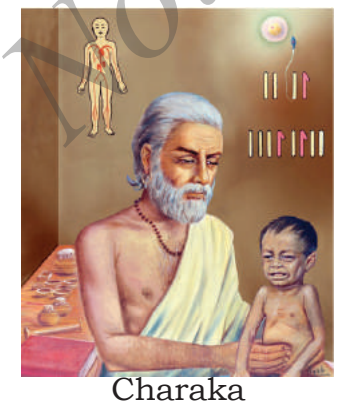
Tiger, cow, elephant, wolf, deer, crocodile, squirrel and parakeet.

Activity: 6.2

Group the following plants under the headings food, furniture and medicine:

Tulasi, ragi, honne, garlic, teak and potato.

Contributions of ancient scientists to the classification of living organisms



Charaka

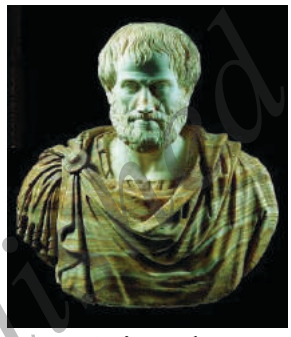
Charaka : (600 BC)

Charaka, an ancient Indian sage, was a philosopher, astronomer and physician. He had listed about 340 plant types and about 200 animal types in his book *Charaka Samhita.* Charaka Samhita is considered as the most ancient and authoritative writing on ayurveda. For his contributions, Charaka is called **Father of ayurveda.**

Know this : Charaka Samhita mentions in minute detail the gradual development of foetus within the womb. It accurately resembles the modern medical version.

Aristotle : (384-322 BC)

Aristotle was a great Greek philosopher and a biologist. His writings cover many subjects such as physics, biology, logic, music and politics. Aristotle followed specific methods of investigation like observation, description, survey, comparison and classification in studying the living organisms. He dissected many animals to study their structure.



Aristotle

Aristotle classified plants and animals into three groups each

Plants :
- Herbs with soft stems.
- Shrubs with several woody stems.
- Trees with a single woody stem.

Animals:
- Aquatic animals (found in water)
- Terrestrial animals, (found on land)
- Aerial animals (found in air)

Aristotle, because of his contributions, is popularly known as **Father of Biology.**

Parashara

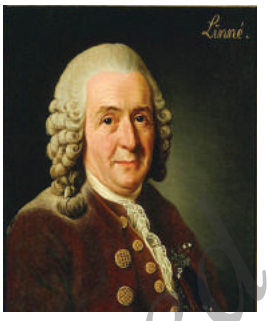
Parashara: (100 BC.)

Parashara, an ancient Indian sage, in his book **Vrikshaayurveda** had given a clear description of plants and divided the plants into several **ganas**. It was based on the characteristics of flowers.

Parashara's another book, **Krishiparashara** was written for the benefit of farmers. The book can help the farmers to plan and manage the activity of farming.

Carolus Linnaeus: (1707-1778 A.D.)

Linnaeus was a Swedish biologist. He had recorded about 6000 species of plants in his book, ***Species plantarum*** published in 1753. He had given a detailed system of his classification in another book, called *Systema naturae*.



Carolus Linnaeus

Linnaeus had proposed two kingdoms, **kingdom Plantae** and **kingdom Animalia** in his classification. He introduced four categories for grouping organisms - **class, order, genus** and **species** in each kingdom. Modern classification adds two more categories. They are-**phylum** and **family.** Hence, modern system is an extension of Linnaeus system of classification. Linnaeus also introduced the scientific method of naming the organisms. It is called, **binominal nomenclature.** For these contributions Linnaeus is considered **Father of modern taxonomy.**

Did you know?

Carolus Linnaeus was the first person to place humans in a system of biological classification. He placed humans and monkeys under the same order - **primates**.

Kingdom
↑
Phylum
↑
Class
↑
Order
↑
Family
↑
Genus
↑
Species

Modified Linnaean Hierarchy

Seven levels of classification:

The basic unit of classification is **species.** The next level is **genus** and then **family**. Later come the **order, class, phylum** and **kingdom**. Kingdom forms the highest level of classification. Classification with seven levels is the modified **Linnaean hierarchy**.

Recall : What is a species?

Binomial nomenclature

Binominal nomenclature is the scientific method of naming the living organisms. Common names often differ from one part of a country to another and certainly vary from one country to another. In contrast, scientific name can be used all over the world speaking different languages. It avoids confusion.

Activity: 6.3

What is cat called in Kannada, Tamil, Telugu, Malayalam and Hindi?

Every scientific name has two words. The first word refers to name of the **genus** and the second to the name of the **species**. Scientific names are written in Latin and Greek. In print, they are always in italics. If handwritten, both genus and species names are underlined separately. *Ficus religiosa* is the binomial nomenclature of peepul tree. *Equus caballus* is the binomial nomenclature of horse. The first letter of the first name, the genus, always begins with a capital letter and that of the second- species, is a small letter. Scientific names have a background. For example, scientific name of mango is *Mangifera indica.* Mangifera means sweet fruit; indica indicates its origin in India. Man- *Homo sapiens.* Homo means human; sapiens means wise. Dog- *Canis familiaris- Canis*-having canines; familiaris – most familiar.

Activity 6.4

Take up an activity under eco club and try to collect such information about plants and animals found in your school campus.

Think : Donkey belongs to the species 'asinus'. Both donkey and horse are included in the same genus. What is the binomial nomenclature of donkey?

Some animals have the same genus and species name. For example cobra- Naja naja.

Let us understand clearly the seven levels of classification with a few examples.

Systematic position: It is the description of an organism in terms of the various levels to which it belongs.

Systematic position of human

Activity: 6.5

Consider human as an example. You know that there are seven levels of classification. You know that human is an animal. So, human is included under animal kingdom. Give some other examples for animals. Human has a notochord in the embryonic stage. So human is placed under the phylum Chordata. Remember each subsequent level eliminates animals that could be included in the previous level. Hence, eliminate all the non chordates, if you have given such examples. Now, give examples only for vertebrates. Humans belong to the class mammalia, as they have mammary glands, which secrete a nourishing fluid called milk. Hence, remove all the other vertebrate examples which are not mammals. Like this, proceed with order, family, genus and species.

Table 6.1 Systematic position of human

Level	Human	Characteristic feature
Kingdom	Animalia	Heterotroph, movement
Phylum	Chordata	Notochord
Class	Mammalia	Mammary glands
Order	Primates	Erect posture with binocular vision.
Family	Hominidae	Fore limbs are shorter than hind limbs
Genus	*Homo*	Human- large cranium; tool making ability
Species	*sapiens*	Highly developed brain, capable of thinking and speaking.

Know this:

Table 6.2 Systematic position of mango

Level	Mango
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Sapindales
Family	Anacardiaceae
Genus	*Mangifera*
Species	*indica*

Systems of classification

Classification of living organisms is probably as old as human civilization. The earliest classification was probably on the basis of utility of organisms. Plants were classified as edible and non edible; animals were classified as useful and harmful. Discoveries of new organisms have led to the periodical revision of classification from **two kingdom system to five kingdom system**. It is likely that the number of kingdoms in future may increase, because of more and more discoveries.

Ancient system of classification

Ancient system classifies organisms on the basis of one or more superficial similarities and differences among them. For example, plants were grouped based on the nature of the stem, into herbs, shrubs and trees. Animals were grouped on the basis of habitat into aquatic animals, terrestrial animals and aerial animals. This type of classification led to the inclusion of **unrelated organisms** in one group. Let us understand clearly with the help of an example. Earthworm and tiger were included along with other animals as terrestrial animals. In spite of many other differences, earthworm differs from tiger in not having a backbone. Can you think of such other examples?

Natural system of classification

The system of classification put forth by Parashara and Aristotle were based mainly on superficial characters. Invention of microscope helped us to understand even the minute similarities and differences between the organisms. This led to a systematic and scientific approach to classification and to the development of **modern classification**. Modern classification is also called the **natural system of classification**. Modern classification has some merits. It includes the related organisms in one group and shows relationships with regard to habitat, life process and mode of reproduction.

Two kingdom classification: One of the earliest type of classifications in the modern system is the two kingdom classification introduced by **Carolus Linnaeus** in 1758. It lasted for about 100 years. Linnaeus classified the living organisms under two kingdoms. They are **kingdom plantae** and **kingdom animalia**. He included all the plants under plantae and animals under animalia. As the diversity among the living organisms became more and more evident, Linnaean classification was revised.

Know this : Linnaeus included mushroom in kingdom plantae. Mushrooms do not synthesize food like other plants.

Activity: 6.6

Observe the fig. 6.1. List the plant like and animal like parts of Euglena.

Do you include Euglena under plant kingdom or animal kingdom? Discuss.

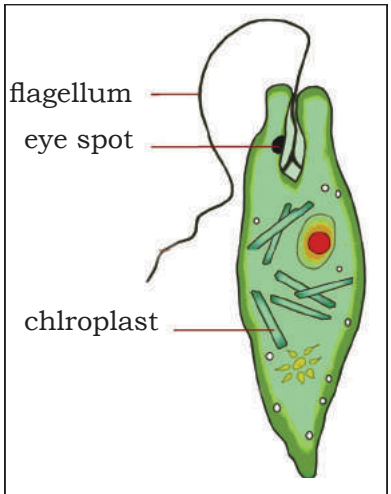


Fig. 6.1 Euglena

Three kingdom classification

In 1674, Leeuwenhoek observed primitive organisms under a microscope. Till that time, their existence was unknown. To give a right place to such organisms, **Ernst Haeckel** in 1866 proposed a third kingdom, **Protista** and included all the primitive, microscopic organisms like protozoa, bacteria, algae and fungi under it.

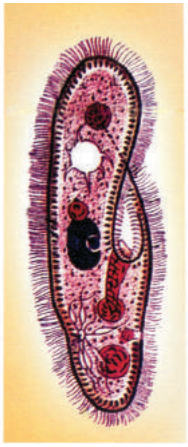


Fig. 6.2 *Paramecium* (Protozoa)

Fig. 6.3 *Agaricus* (Fungus)

Four kingdom classification

The development of microscope and electron microscope in particular, revealed an important distinction between organisms containing cells without a definite nucleus (**prokaryotes**) and organisms containing cells with a definite nucleus (**eukaryotes**). To accommodate prokaryotes, **Copeland** added another kingdom called **Monera** and proposed four kingdom classification in 1966. He included bacteria and one of the most primitive algae, called blue green algae under this kingdom because, both of them exhibit prokaryotic type of cells. Blue green algae are also known as **Cyanobacteria.** The four kingdoms introduced by Copeland are – **Monera, Protista, Plantae** and **Animalia.**

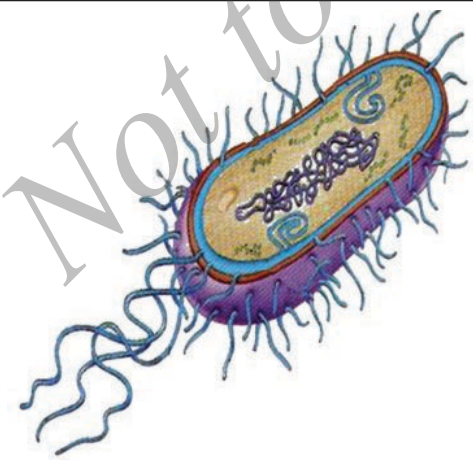


Fig. 6.4 Bacterium

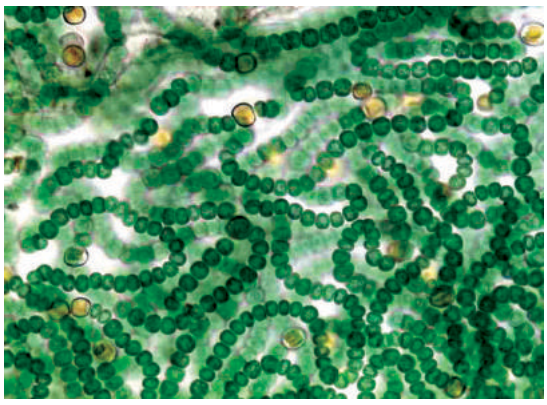


Fig. 6.5 Nostoc (blue green alga)

Five kingdom classification

Plants synthesize their own food. But fungi, unlike plants, do not synthesize their food. The difference between fungi and other plants was recognized by **Robert Whittaker**. He created another kingdom, **Mycota** in 1969 and included fungi, under it. The kingdoms introduced by Robert Whittaker are **Monera, Protista, Plantae, Animalia** and **Mycota**.

Systematic classification

Carolus Linnaeus	-	1758	-	Plant and animal kingdom (Two kingdom classification)
Ernst Haeckel	-	1866	-	Added kingdom protista (Three kingdom classification)
Copeland	-	1966	-	Added kingdom monera (Four kingdom classification)
Robert Whittaker	-	1969	-	Added kingdom fungi (Five kingdom classification)
Carl Woese	-	1977	-	Divided kingdom monera Archae bacteria and eubacteria

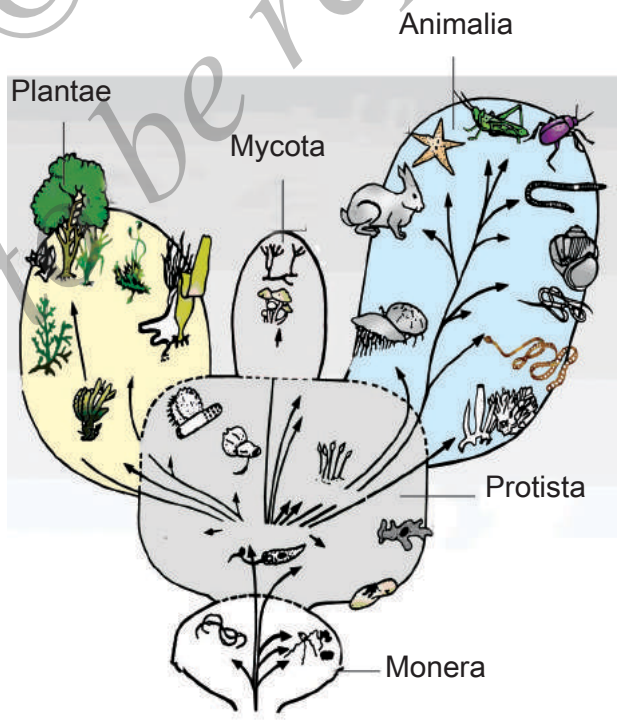


Fig. 6.6 Five kingdoms of living organisms

Have we considered all organisms? Are there groups not included in any of these kingdoms?

Yes - there are.

In whittaker's five kingdom classification, there is no mention of viruses and lichens. You will learn about them in higher classes.

Know this :

Viruses do not have a cellular structure and hence they are not considered as organisms. They have genetic material-either RNA or DNA.

Viroids : They are smaller than viruses. They have free RNA without a protein coat.

Lichens : They are the products of associations of algae and fungi. They are mutually useful.

You have learnt

- The need for the classification of living organisms.
- The efforts of scientists in developing systematic classification.
- The evolutionary basis of classification.
- The diversity in the living organisms and the fundamental similarities in the life forms.
- The skill of drawing the diagrams of organisms such as bacterium, euglena, paramecium, mushroom.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements/questions. Choose the right answer :

1. A kingdom consisting of single celled, prokaryotic organisms is

   a. mycota b. monera c. plantae d. protista

2. Which one of the following is the basic unit of classification of the living organisms ?

   a. family b. species c. genus d. kingdom

3. Most primitive organisms among the following are

   a. Monerans b. Protists c. Fungi d. Algae

4. Which one of the following should be grouped with whales, according to modern classification?

a. Shark b. Dolphin c. Snake d. Tortoise

II. Fill in the blanks with suitable words

1. Protozoa belong to the kingdom _____ .
2. Animals without a backbone are called _____ .
3. Most of the organisms depend directly or indirectly upon _____ for food.
4. Group of organisms that breed among themselves and produce fertile offsprings make a _____ .

III. Match the following

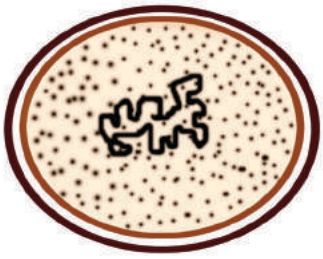
A	B
1. familiaris	a. class
2. primates	b. genus
3. anacardiaceae	c. species
4. magnoliophyta	d. order
	e. family
	f. Division
	g. kingdom

IV. Answer the following

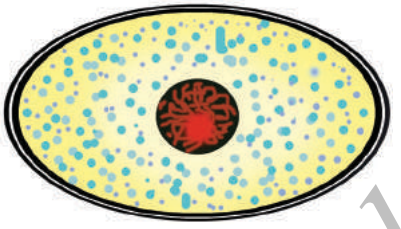
1. Why are animals included under eukaryotes?
2. In which kingdom do you include multicellular, primitive, heterotrophic eukaryotes?
3. Aristotle's classification include both fish and whale under one group. How are these unrelated?
4. What is the difference between plants and animals with regard to nutrition?
5. Place the following organisms in their respective kingdoms. Deer, paramecium, mushroom.
6. Why are bread moulds grouped under mycota?

7. Explain, the concept of binomial nomenclature.

8. Which one of the following is a prokaryote cell? Why?



A



B

V. Suggested Activities

Activity 1

Divide the class into three groups A, B, and C. Each group should collect the scientific names of five familiar organisms. 'A' group for protists, 'B' group for kingdom plantae and 'C' group for kingdom animalia.

Activity 2

Observe and list the various kinds of animals in your locality. Classify them into vertebrates and invertebrates.

Activity 3

Monkeys, apes, humans are included under the same order primates. Collect information about the similarities of humans with other primates.

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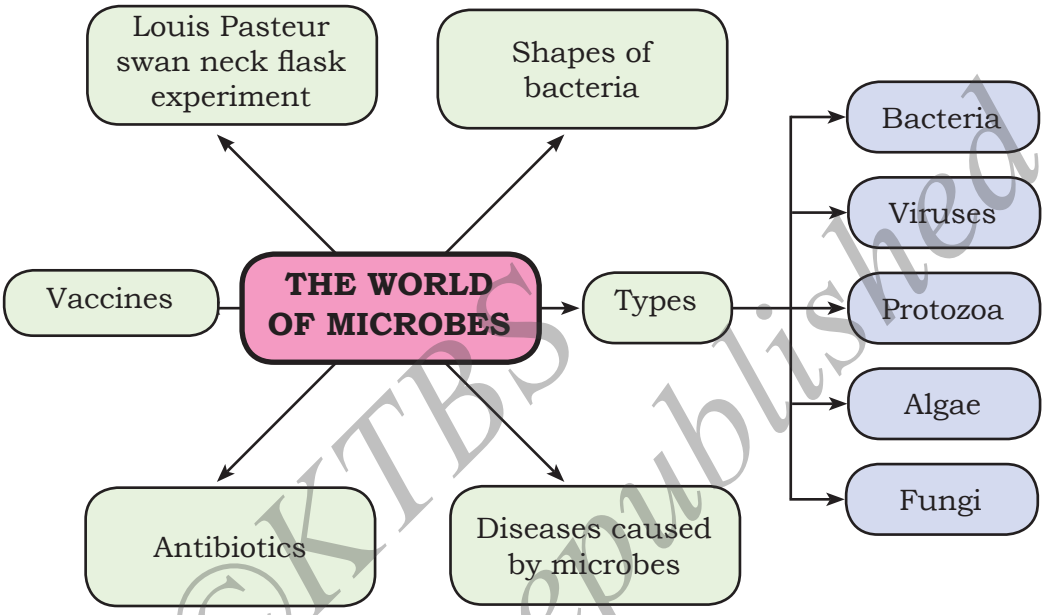
CHAPTER 7

THE WORLD OF MICROBES



You find so many things around you, some are living and others are non living. Of those living, you find varieties of plants and animals. Yet there are so many organisms which cannot be seen through our naked eyes. These organisms are called microorganisms. You have read about classification of bacteria, fungi, protozoa, algae and viruses in an earlier chapter. All these are microorganisms.

Activity 7.1

Collect pond water in a small clean glass bottle. Place a drop of water on a clean slide. Add a drop of methyl cellulose to slow down the movement of protozoa. Place a cover slip over the above suspension. Examine the slide under low power (10x) and high power (40x) objectives. Do you find tiny organisms moving around? These are microorganisms.

From the above activity it is clear that microorganisms can be seen only through microscopes.

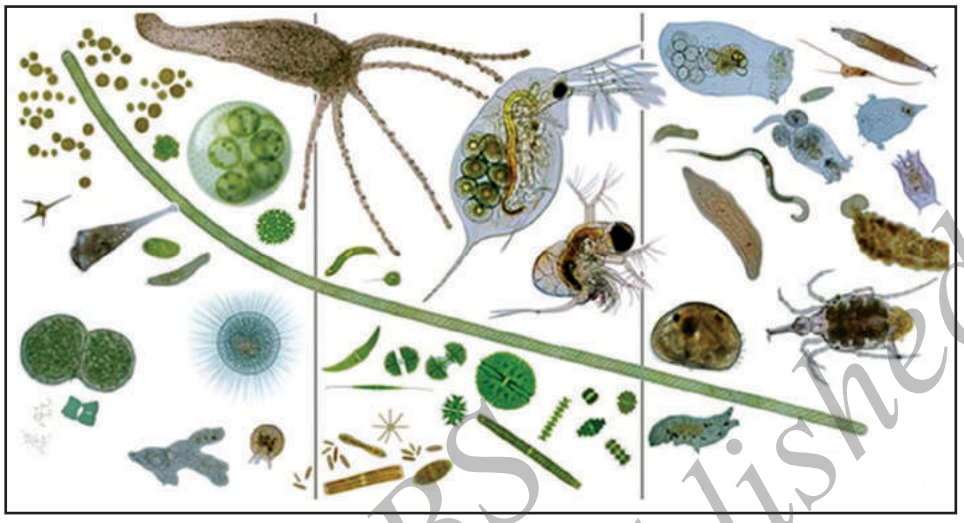


Fig.7.1 Microbes found in pond water

Know this:

Golden age of microbiology: Golden age of microbiology began with the work of Louis Pasteur of France and Robert Koch of Germany. They discovered many agents of different infectious diseases and also measures to prevent the spreading of diseases.

Louis Pasteur (1822 - 1895)

The contribution of Louis pasteur of France in the field of microbiology led to a greater understanding of human ailments and animal diseases. Much of Pasteur's work involved the growth of bacteria and yeast in liquid cultures. He developed methods of sterilization and of pasteurization. Pasteur (1857) observed different kinds of microbes associated with different kinds of fermentation. e.g. yeast cells - spheres of variable size with alcohol fermentation and rod-like Lactobacilli with lactic acid fermentation. This finding led Pasteur to state that specific microbe may cause specific disease in man.

His crowning achievements were Pasteurisation of milk, the development of techniques to reduce the virulence of infectious organisms, without eliminating their capacity to produce immunity. In this way he developed vaccines for the control of cholera and rabies in man.

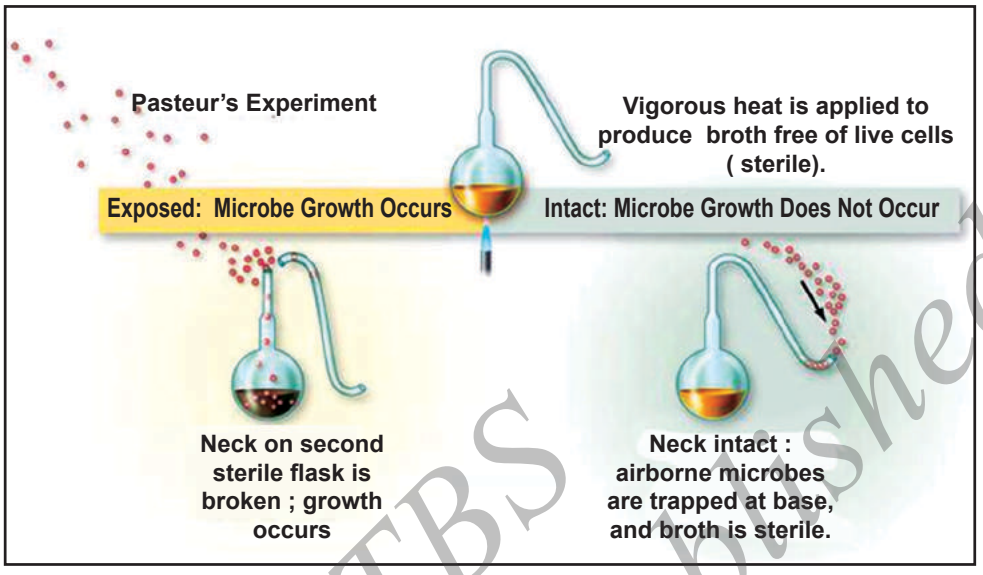


Fig.7.2 Swan neck flask experiment

Swan neck flask experiment

Pasteur had to disprove spontaneous generation to sustain his theory and he therefore designed a series of swan necked flasks. He took little broth in the flasks and boiled the broth. Then, he left the flasks open to the air, only the air free from dust particles entered the flask while dust particles and microbes got trapped in the bent portion of the neck. After few days, he broke the neck, took a sample of broth and examined under microscope. He found no microorganisms. Based on this, Pasteur concluded that living organisms do not arise from non - living matter. Thus, Pasteur's experiments disproved the theory of spontaneous generation.

Pasteur also encouraged the belief that microorganisms were in the air and could cause disease. Pasteur postulated the germ theory of disease which states that microorganisms are the causes of infectious diseases. He is considered as **"Father of microbiology".**

Know this: **Spontaneous generation means organisms (life) arising from non-living matter spontaneously. This was disproved by Pasteur through his theory of biogenesis. According to Pasteur, life arises from preexisting life.**

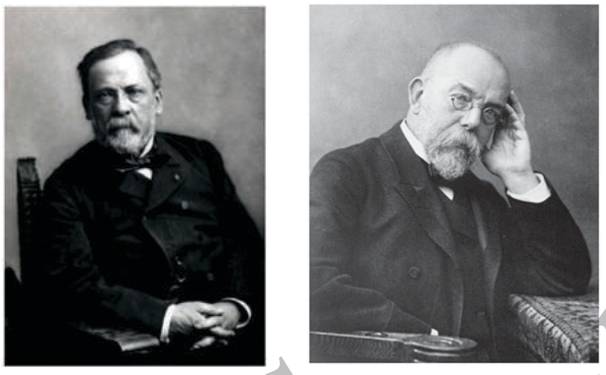


Fig.7.3 Louis Pasteur and Robert Koch

Robert Koch - (1843 - 1910)

Robert Koch, a contemporary of Pasteur, made his contributions on new procedures for staining, visualizing and growing bacteria. He solidified liquid culture media with agar. He also isolated and characterized the bacilli of anthrax and tuberculosis and demonstrated their causative role by a series of experiments. After identifying the Anthrax bacillus, Koch advocated his postulates – They are

1. The disease agent can be present in every affected case and absent in healthy individuals.
2. The agent can be isolated and cultured in vitro (i.e. cultivated in a laboratory environment).
3. Disease can be produced when a pure culture of pathogen is inoculated into susceptible host
4. The agent must be recoverable from infected host.

He was awarded the Nobel Prize in the year 1905 for his work on tuberculosis.

Where do microorganisms live?

Microorganisms are widely distributed in nature and exist as unicellular, multicellular or cell clusters. Some microorganisms are beneficial and some others are harmful. The major types of microbes are bacteria, fungi, protozoa, algae and viruses.

Bacteria:

Bacteria are unicellular organisms. The cells are described as prokaryotic because they lack a definite nucleus.

Activity 7.2

Take a small amount of curd. Put a drop of curd on a clean microscope slide. Spread the curd drop evenly and prepare a thin smear. Dry the smear by heat fixation by passing the slide 5-6 times over spirit lamp. Add methylene blue stain on the curd smear and leave it for 1 min. Remove excess of stain by washing the slide with water. Observe the slide under a compound microscope - under low power (10x) , high power (40x) and oil immersion (100x) objectives. Tiny objects you see are the bacteria which convert milk into curd. What is their shape? How do they look like? Look at fig.7.5. They are rod shaped. Rod shaped bacteria are called **bacilli** (Singular- bacillus). The bacteria that you have observed in the curd sample are **Lactobacilli.**

Fig. 7.4 Microbiologist observing lactobacilli

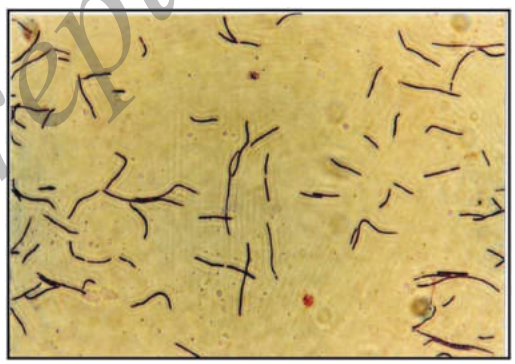


Fig. 7.5 Lactobacilli

Know this: *In light microscopy oil immersion is a technique used to increase the resolution of a microscope. This is achieved by immersing both the objective lens and the specimen in a transparent oil of high refractive index such as linseed oil.*

Are there bacteria of different shapes? Yes, they exist in different shapes: bacillus (rod shape), coccus (spherical shape), spirilla (spiral shape) and vibrio (curved shape). By observing the figure 7.6 we can know that cocci bacteria may be single, in pairs, in clusters and in chains. Comma shaped bacteria are called vibrio. spirally coiled bacteria are called spirilli.

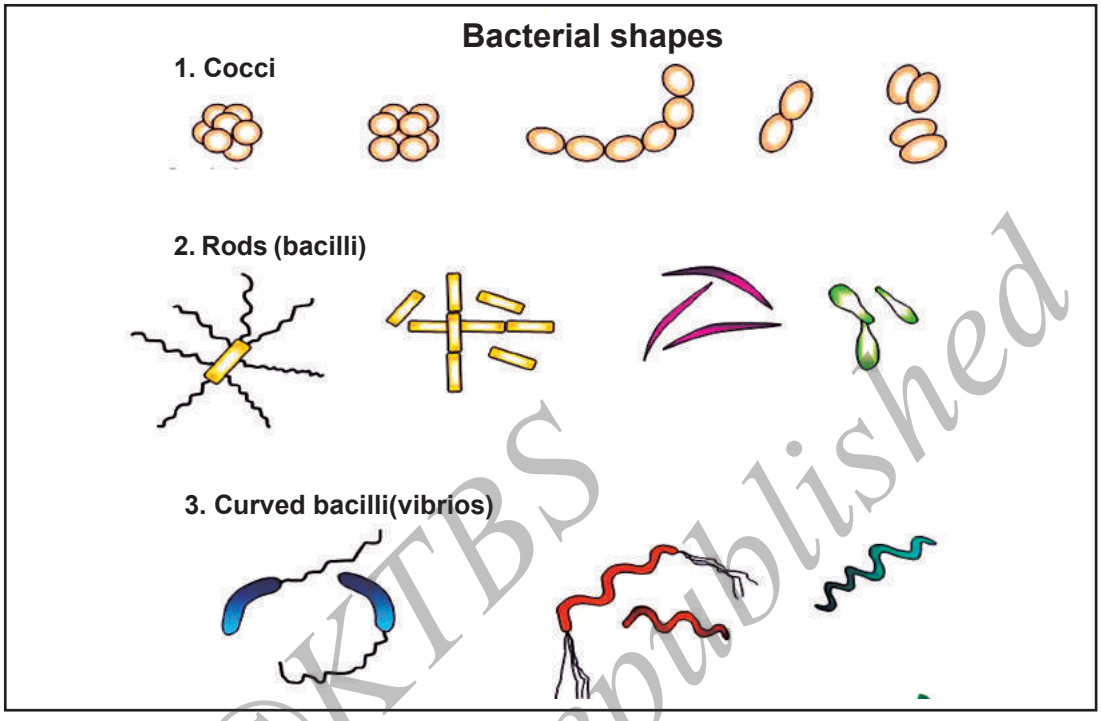


Fig. 7.6 Different shapes of bacteria

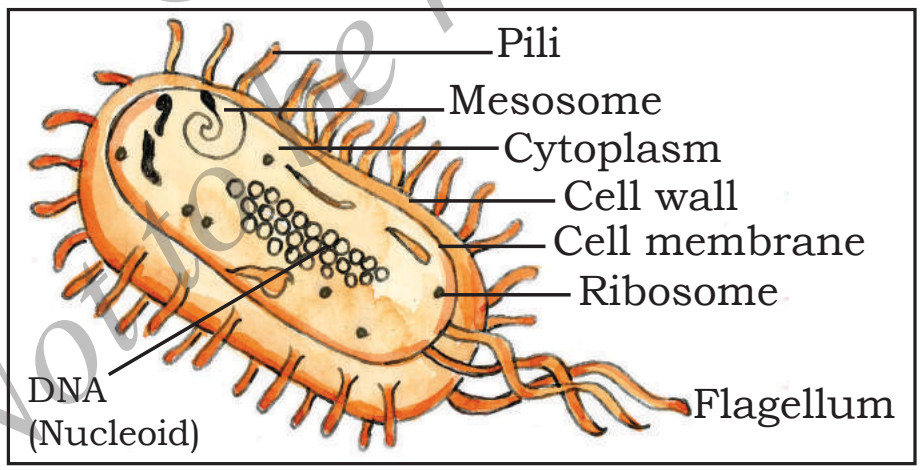


Fig. 7.7 Structure of a typical bacterium

Know This: Peptidoglycan, also known as murein, is a polymer consisting of sugars and amino acids. It forms a mesh-like layer outside the plasma membrane of most bacteria forming the cell wall which gives shape and protection to the bacteria.

Viruses

- Viruses are noncellular entities that consist of a nucleic acid core (DNA or RNA) surrounded by a protein coat called capsid. Nucleic acid and capsid together form nucleocapsid. The nucleocapsid may be naked or surrounded by a loose membrane called envelope.
- Viruses contain only one type of nucleic acid, either DNA or RNA.
- Viruses are infectious agents. They are much smaller than the bacteria. Their approximate size ranges from 20 to 300 *nm* . They can be seen only through electron microscope.
- Examples: HIV,Tobacco Mosaic Virus(TMV), Pox Viruses

[10^{-9} of a metre = 1nano metre]

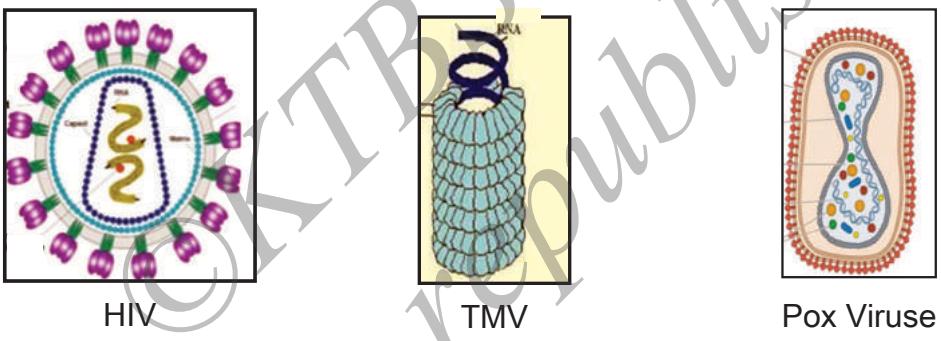


Fig. 7.8 Examples of viruses

- Viruses are incapable of independent growth in artificial media.
- They can grow only in animal or plant cells or in microorganisms. Hence they are referred to as obligate intracellular parasites.
- They lack metabolic machinery of their own to generate energy or to synthesize proteins. They depend on the host cells to carry out these vital functions.
- There is a group of viruses which infect bacteria. These are called bacteriophages. These viruses infect the bacteria and multiply inside the bacterial body and cause the lysis of bacteria.

Know This:
DNA Viruses: Hepatitis B, Pox viruses, Herpes simplex virus, varicella-zoster virus etc.
RNA Viruses : HIV, Influenza virus, Polio virus, Mumps virus etc.

Do You Know ?

- Viruses do not respond to antibiotics
- Viruses live and replicate inside a host cell.
- Viruses insert their genetic material into a host cell's DNA in order to reproduce.
- However, antiviral medicines and vaccines are specific for viruses.

Let us now study the structure of a bacteriophage.

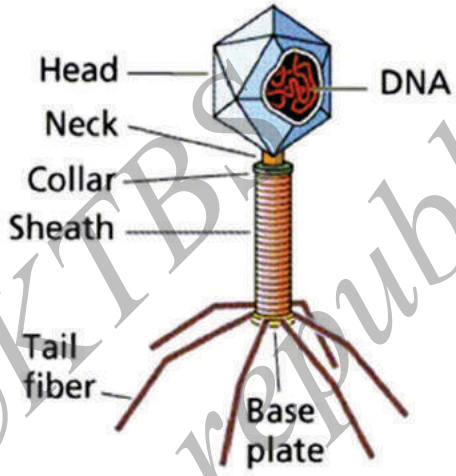


Fig. 7.9 Bacteriophage

Look at the fig 7.9 A bacteriophage has a head region containing the genetic material DNA. Collar region contains protein sheath. It has a tail which is a hollow tube through which the nucleic acid passes during infection. At the end of the tail there is a base plate and one or more tail fibres attached to it. The base plate and tail fibres are involved in the binding of the phage to the bacterial cell.

Think: *Can bacteriophages be used to kill bacteria? Can they replace antibiotics?*

Protozoa :

- Protozoa are unicellular eukaryotes.
- Protozoa are located in moist habitats. Free-living species inhabit freshwater and marine environments and terrestrial species inhabit decaying organic matter. Some species are parasites of plants and animals.

- Protozoan species are aerobic, but some anaerobic species have been found in the human intestine and animal rumen.
- They have a cell membrane.
- Many protozoan species move independently by one of the three types of locomotor organelles: flagella, cilia and pseudopodia.
- Protozoans reproduce by asexual methods, sexual reproduction has been observed in several species.

Examples: Amoeba, Euglena, Paramecium.

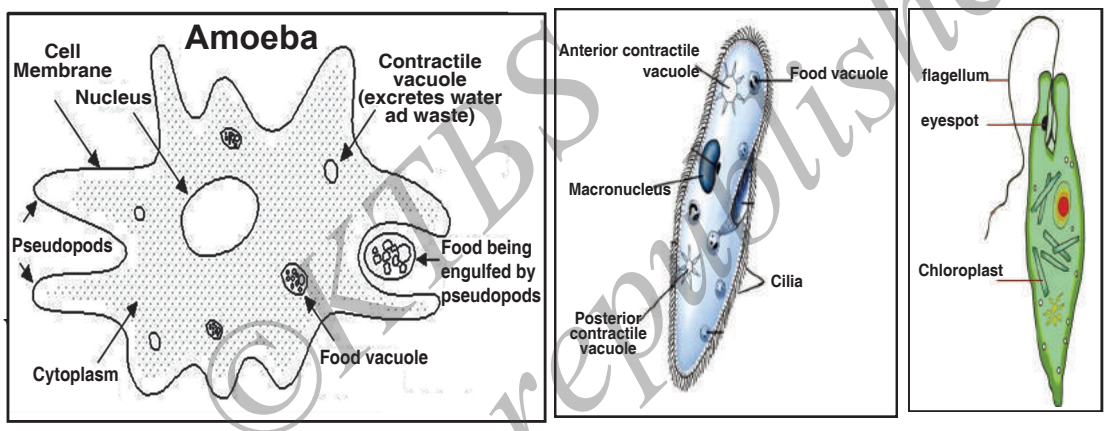


Fig.7.10 a) Amoeba b) Paramecium c) Euglena

Structure of Amoeba

Observe fig 7.10 a. Amoeba has no definite shape. It has finger like projections called pseudopodia. They help in nutrition and locomotion. An outer cell membrane encloses cytoplasm. Cytoplasm is differentiated into two parts:

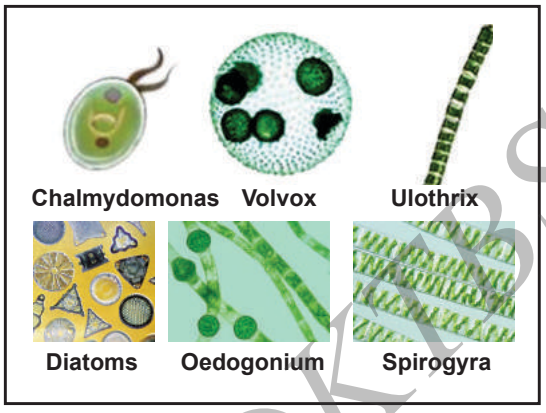
(i) Ectoplasm: outer clear and transparent portion.

(ii) Endoplasm: inner, viscous, translucent and granular part. The endoplasm appears granular and darker in colour due to the presence of reserve food materials, food vacuoles, contractile vacuoles and other cell organelles. There is nucleus in the centre which controls all the metabolic activities of the organism.

Algae

- Algae are unicellular or multicellular eukaryotes which can carry out photosynthesis.
- They live in water, damp soil and on rocks.
- Reproduction occurs both by asexual and sexual methods.

Examples: Chlamydomonas, Volvox, Spirogyra, Ulothrix.



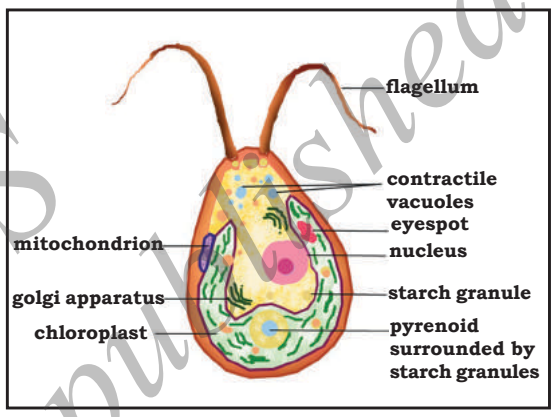


Fig.7.11 Different types of algae Fig. 7.12 Chlamydomonas

Structure of Chlamydomonas: Look at Fig.7.12. Chlamydomonas is unicellular. It is oval or spherical in shape. The cell is surrounded by cell wall made up of cellulose or pectin. Inside the cell wall is a cell membrane which encloses cytoplasm and nucleus. In the cytoplasm there is a large cup shaped chloroplast with one or more pyrenoids which store food. To the lateral side of chloroplast there is orange or reddish coloured structure called stigma/eyespot. It is photoreceptive. Flagella are thin protoplasmic thread like structures originated form basal granules. Below the basal granules, contractile vacuoles are present.

Activity 7.3

Take a thin slice of bread. Sprinkle a few drops of water on it. Cover it with a plastic bag. Observe the changes after 3 days. What do you observe? Bushy material with black,grey,white,blue,green,brown coloured colonies are found. These are fungi. Place a drop of lactophenol or cotton blue stain on a clean slide. Transfer a small tuft of fungus grown on bread into it. Gently squash the material. Place a cover slip and examine under low power (10x) and high power (40x) objectives. What do you observe? Note your observations under the guidance of teacher.

Fungi

- Fungi (mushroom, molds and yeasts) are eukaryotic cells.
- Most fungi are multicellular and cell wall is composed of chitin.
- They obtain nutrients by absorbing organic material from the dead and decaying substances. So they are called saprophytes.
- They form characteristic filamentous tubes called hyphae that help to absorb nutrients. The collection of hyphae is called mycelium.
- Fungi reproduce by spores.

Fig.7.12 (a) (b) (c) s(d)

(a) Rhizopus(Bread mold) (b) Aspergillus(Black mold)

(c) Penicilium (Blue mold) (d) Yeast (Saccharomyces)

Structure of Aspergillus : Look at Fig.7.12 b. Aspergillus occurs over a wide range of substrata. The mycelium forms dense mass on substrata. Hyphae are branched, septate with uni or multinucleate cells. Most species produce a characteristic pigment which gives colour to the fungus.

Structure of Yeast : yeasts are the oldest cultivated microorganisms commonly found in media rich in sugar or in organic matter. Look at Fig.7.12 d. It is unicellular .The cell is elliptical and eukaryotic. Outer most cell wall is made up of chitin. Inner to the cell wall, cell membrane is present. Other cell organelles are endoplasmic reticulum, ribosomes, mitochondria,vacuoles, golgi apparatus and nucleus.

Activity 7.4

Make a suspension of yeast using yeast powder and water. Take a drop of suspension and prepare a smear on a microscopic slide. Stain the smear with methylene blue or safranin stain. Observe the slide under a compound microscope and record the result.

Some of the microorganisms are beneficial to us as stated earlier. However, if we neglect hygiene, then we are prone to microbial infections. The following table keeps you informed on some of the common microbial diseases caused in humans.

Table 7.1 Some common human diseases caused by microbes

Name of the disease	Disease causing microbe	Symptoms	Mode of transmission	Preventive measure
Influenza	*Influenza Virus*	Chill, fever, sore throat, cough, muscle pains, severe headache	Air, contaminated hand kerchiefs,	Avoid being close to infected people, Do not touch the nose and eyes with contaminated hands.
Cholera	*Vibrio Cholerae*	Vomiting, diarrohea, dehydration stomach pain	Contaminated water, food	Avoid eating and drinking contaminated food and water. Vaccination.
Malaria	*Plasmodium vivax*	Recurring fever, chills, headache, muscle pain, tiredness, stomach pain, nausea, vomiting	Bite of female anopheles mosquitoes	Vaccination, controlling mosquito population, usage of mosquito curtains are advised.
Aspergillosis	*Aspergillus niger*	Cough, fever, chest pain and difficulty in breathing	spreads by inhaling spores of Aspergillus niger	Avoid dusty and unhygienic places.

Activity 7.5

List few more microbial infections and causative agents.

Cultivation of Microorganisms:

How to culture microbes? They are grown in artificial media under controlled laboratory conditions.

Know This

Artificial culture media

A culture medium is an environment which suplies the ingredients necessary for the growth of an organism. Various kinds of media are used in the laboratory to grow, isolate and identify an organism. Depending on the need to isolate and identify a particular organism from a particular sample or environment, different kinds of media are formulated.

Microorganisms	Culture media
Bacteria	Nutrient Agar(N.A), Nutrient Broth(N.B)
Fungi	MRBA (Martin Rose Bengal Agar media), Potato dextrose Agar(PDA)
Protozoans	Nutrient Broth media
Algae	Bristols Media, Beneck's Media
Virus	Animal cells, Chick embryo as sources for inoculation of sample.

Microbes cause a number of diseases. Vaccines prevent microbial infections. Vaccines are prepared from weakened or killed forms of microbes. Vaccines help us in developing immunity. Eg: Polio vaccine, DPT vaccine. They also help in producing antibiotics. Eg: Streptomycin, Penicillin.

Know This

DPT vaccine is a combination of vaccines against three infections diseases of bacteria such as Diphtheria, pertussis(whooping cough) and Tetanus.

Know This

Antibiotics: (Greek word Anti=against; Bios=life) Antibiotics are chemical substances produced by microorganisms which kill or inhibit growth of other microorganisms.

Examples:

Antibacterial: Penicillin, Cephalosphorins, streptomycin

Antifungal; Griseofulvin, Nystatin, Candicidin

Antiviral: Acyclovir, Azidothymidine, Amantadine.

You have learnt :

- The meaning of microorganisms.
- To record observations made using microscope.
- To compare the characteristics of different groups of microorganisms.
- The skill of preparing microscopic slides.
- Need for hygiene.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements /questions. Choose the right answer :

1. One of the following does not belong to the group
   a. Aspergillus niger b. Clostridium tetani
   c. Staphylococcus aureus d. Vibrio cholerae
2. The locomotory structure of amoeba is
   a. cilium b. flagellum
   c. pseudopodium d. tentacle
3. Chlorophyll is present in
   a. Chlamydomonas b. Mushroom
   c. Yeast d. Aspergillus

II. Fill in the blanks with suitable words

1. _____ was considered father of microbiology.
2. Malaria is caused by _____ .
3. Vibrio are _____ shaped bacteria.

III. Answer the following

1. What are microorganisms?
2. Explain the structure of a typical bacillus?
3. Draw a diagram of a typical bacillus and label the parts?
4. How can the transmission of cholera be prevented?
5. What are vaccines?

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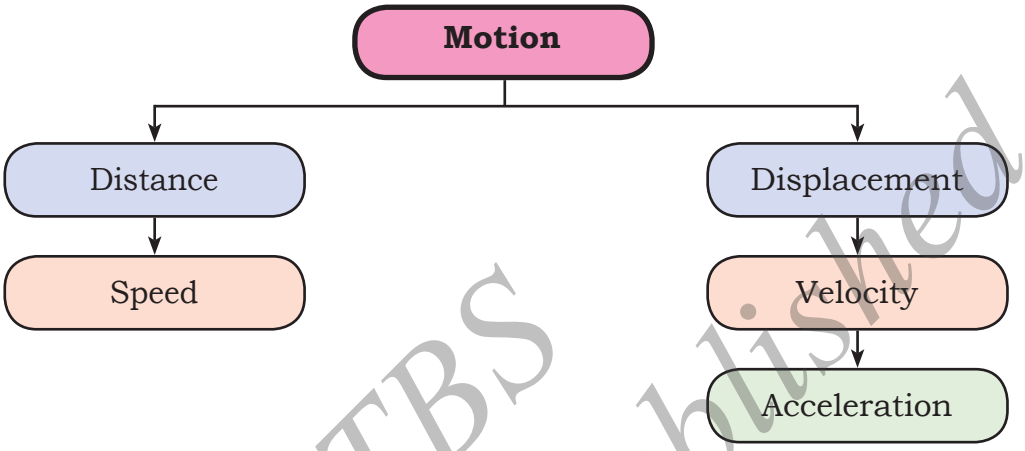
CHAPTER 8

DESCRIBING MOTION



There is a popular Kannada poem written by **N.R.Hiremath** about moon. The poem starts like this "Why is the moon running away mom ? Is he afraid of the clouds? ["Chandiranetake oduvanamma modake bedarihane. . . . . "]. You might have experienced the same. When the bright moon in the night sky is apparently covered by thin clouds and wind blowing across the clouds, the moon appears to be running. What happens when there are no clouds?

Imagine that you are sitting inside a train. When the train starts moving you feel that the people on the platform are moving backwards. You may not feel your movement. But for a person standing outside the train, the feeling will be that the train, you and the others in the compartment are all moving.

These experiences show that motion is relative. Can you recall some more experiences about relative motion? Is rest also relative?

Activity 8.1

Give more examples that you come across regarding relative motion.

An object is said to be in motion if its position changes with time, with reference to a fixed frame.

Do you Know ?

Rest and motion are relative terms. A pen kept on the table is at rest with respect to the table. But you know that earth is moving. The objects kept on earth must also be moving with earth.

In this chapter you will learn more about motion.

Know this

Scalar - Physical quantity which requires only magnitude for its description.

Vector - Physical quantity which requires both magnitude and direction for its description.

Distance and displacement

Consider two flowers 'A' and 'B' on the same tree. A honey bee flies from A to B in a curved path as shown. in Fig. 8.1

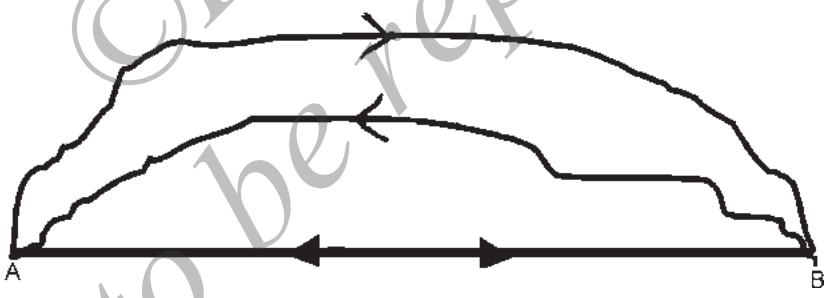


Fig. 8.1 Distance and displacement

The length of the actual path it has travelled from A to B is the *distance*. The shortest distance between A and B is *displacement*. Displacement refers to distance travelled in a given direction. If the honey bee starts from 'A' reaches 'B' and again comes back to 'A', the distance travelled will be different from displacement. However displacement is zero. When will be the distance travelled and displacement same? Displacement refers to change of position. The SI unit of both distance travelled and displacement is **metre**. If the displacement is 30 metre it is written as 30 *m*.

Distance is a scalar and displacement is a vector.

Activity 8.2

Take the railway map of India. Using a thread and scale find the displacement from Bengaluru to Delhi. Also find the distance travelled by the train from Bengaluru to Delhi. Which is shorter? Can you think why?

Activity 8.3

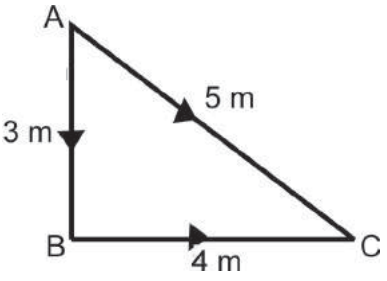


Fig. 8.2

An object travels from A to B and then from B to C as shown in the figure 8.2. What is the distance travelled? What is the displacement?

An object moves from A to B in a circularpath of radius 7 m. What is the distance travelled? What is the displacement?

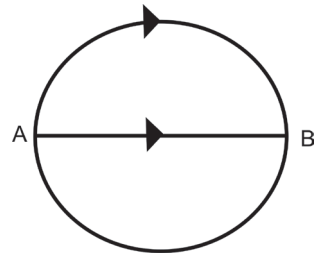


Fig. 8.3

Displacement = Diameter

$= 2 \times$ radius

$= 2 \times 7 = 14$ m

Distance travelled $= \frac{1}{2} \times$ Circumference

$= \frac{1}{2} \times 2 \times \pi \times r$

$= \frac{1}{2} \times 2 \times \frac{22}{7} \times 7$

$= 22$m

Speed and Velocity

You might have seen the sign boards, "speed limit 30 km per hour", near the school or hospital zones. You might have observed the writings inside a bus "maximum speed 60 km per hour". What do these writings indicate?

A bus may be slow or fast during its journey. What do you understand by the words fast or slow?

Speed is the distance travelled by an object in unit time.

Let us take an example. A bus covers a distance of 30 km in one hour. In the next one hour it covers a distance of 50 km. The total distance travelled will be 30 + 50 = 80 km. Total time taken to cover a distance of 80 km is 2 hours.

$$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

$$= \frac{80}{2} = 40 \ km \ \ hour^{-1}$$

The term average speed is used because speed, will not be the same throughout. The term speed describes 'fast' and 'slow' motions in relative context. The SI unit of speed is ms^{-1} (metre per second)

If an object covers equal distances in equal intervals of time, it is said to have uniform speed. We use the term average speed for non-uniform motions.

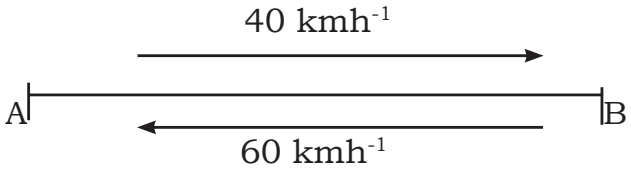
Activity 8.4

An object covers a distance of one metre during the first 30 seconds. After 30 seconds it covers a further distance of 4 m in 15 seconds. Calculate the total distance travelled and total time taken. Calculate the average speed of the object.

Let us consider another interesting numerical problem about average speed.

A bus travels from 'A' to 'B' with a speed of 40 *km per hour*. It travels from 'B' to 'A' with the speed of 60 *km per hour*. What is its overall average speed? The ready answer you may get to this question is

$\frac{40+60}{2} - \frac{100}{2} = 50 \ kmh^{-1}$.



But is it correct? Let us analyse this problem. You know that

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time}}$$

$$\text{Or Time} = \frac{\text{Distance travelled}}{\text{Speed}}$$

Hence time taken to cover a distance from A to B at a speed of 40 kmh^{-1} is

$$= \frac{\text{Distance travelled from A to B}}{\text{Speed}}$$

In short, $T_1 = \frac{d}{40}$ Speed is 40 $kmhour^{-1}$, 'd' is the distance

Similarly time taken to cover a distance from B to A at a speed of 60 km h^{-1} is =

$$\frac{\text{Distance travelled from B to A}}{\text{Speed}}$$

In short, $T_2 = \frac{d}{60}$ speed is 60 kmh^{-1}
'd' is the distance

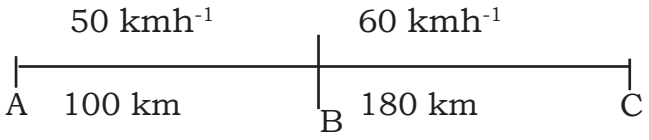
Hence total time taken = $T_1 + T_2 = \frac{d}{40} + \frac{d}{60} = \frac{5d}{120} = \frac{d}{24}$

Total distance travelled = d+d =2d

$\therefore$ Hence average speed of the bus $= \frac{\text{Total distance travelled}}{\text{Total time taken}}$

$= 2d \div \frac{d}{24}$ or $2d \times \frac{24}{d} = 48$ kmh^{-1}

Activity 8.5



An object moves from 'A' to 'B' covering a distance of 100 km with a speed of 50 kmh^{-1}. *It covers a further distance of 180 km from B and reaches C with a speed of 60* kmh^{-1}. *What is the average speed of the object?*

[Ans : 56 km per hour]

Let us imagine another situation. An object travels 5 kmh^{-1}. After two hours what is the distance travelled? It is 10 km. But we cannot give the exact position of the object. We can simply say that the object has covered 10 *km*. If the speed is mentioned along with direction in which it moves, then it is possible for us to decide the position of the object with respect to initial position after covering a distance of 10 *km*. The term **velocity** is used to describe the motion which refers to speed as well as its direction.

Velocity is the displacement of an object in unit time. The S I unit of velocity is ***metre per second***. It is expressed as ms^{-1}. It is our common practice to use the terms speed and velocity with the same meaning. But they are different.

Example: An object is moving in a circular path of radius 7 *m*. To travel from 'A' to 'B' along the circumference it takes 2 s. What is its average speed?

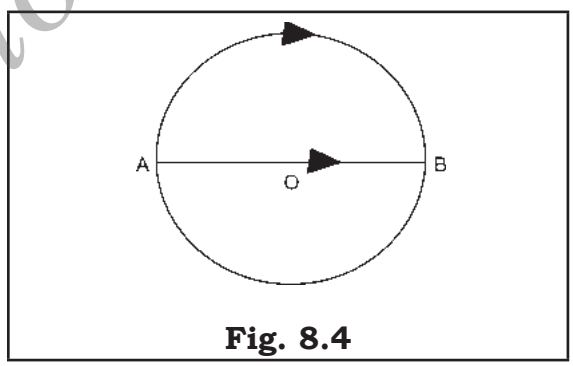


Fig. 8.4

$$\text{Speed} = \frac{\text{distance travelled}}{\text{time}} = \frac{\text{half of the circumference}}{\text{time}}$$

$$= \frac{\frac{1}{2} \times 2 \times \pi \times r}{2}$$

$$= \frac{\frac{1}{2} \times 2 \times \frac{22}{7} \times 7}{2}$$

$= 11 ms^{-1}$

Speed and velocity can be equal for uniform motions along a straight line.

Fig. 8.5

Imagine that a bus is moving with uniform speed from east to west. Do we use the word velocity instead of speed? Remember at any point of time during its journey from 'A' to 'B', the bus is changing its direction, and also the speed depending upon the road conditions. The correct word to describe the motion of the bus is speed or average speed.

Activity 8.6

An object 'A' is moving in a circular path along the circumference with 'O' as centre. What will be the direction of its velocity at the positions 'B' and 'C'?

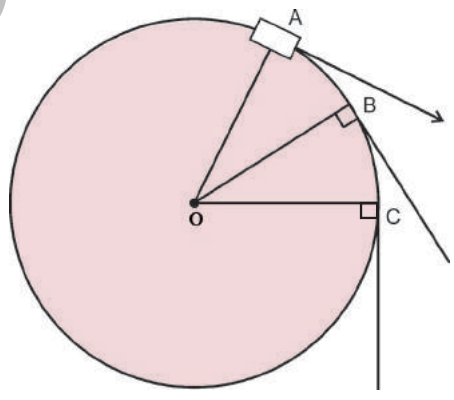


Fig. 8.6 Object moving in circular path is shown. This is an example for variable velocity. Such a motion is called accelerated motion.

Activity 8.7

Observe the sparks coming out of a knife sharpening wheel. In which direction will the sparks move?

You might have come across the word 'accelerator' which is used by people using automobiles. What is it? It is used for changing speed. That is, it is used to decrease or increase the speed of the automobile.

Imagine that you have come to a railway station to say 'happy journey' to your friend who is sitting inside the train. When the train starts moving, it will be slow. Imagine that in the first minute its average speed is 10 *km per hour*. Its speed will become 20 *km per hour* in the second minute. In the third minute its speed will become 30 *km per hour* and in the fourth minute it will be 40 *km per hour*. Here, every minute the speed of the train is changing at the rate of 10 *km per hour*.

Changes in motion such as above are described by the term **acceleration**. Acceleration need not always be uniform. It is usual practice in calculations to consider it as uniform.

Acceleration can be defined as the rate of change of velocity or change in the velocity of an object in unit time. Its SI unit is metre per square second. It is expressed as ms^{-2}.

Find out : Imagine that an object is moving at a uniform speed in a circular path. Though the speed is uniform, it is continuously accelerated. Why?

Find out : Imagine that an object moving with a uniform velocity of 7 ms^{-1} does not change its velocity for at least 10 *s*. What will be its acceleration during 10 *s*?

Example : An object at rest gains an average velocity of 40 ms^{-1} in 5 *s*. What will be its acceleration?

Its initial velocity is zero. Its velocity after 5 *s* is 40 ms^{-1}.

Time taken by it to change its velocity from zero to 40 $m\ s^{-1}$ is 5*s*.

Therefore the rate of change of velocity = $\frac{40\ ms^{-1}}{5s}$ = 8 ms^{-2}

accleration = 8 ms^{-2}

Think : A child throws a ball upwards. It goes up, appears to stop and then starts falling down. Is this motion an example for accelerated motion? Give reasons.

Equations of motion: Try to know the equations of motion of objects moving in a straight line. They are useful to calculate velocity, acceleration, time and distance travelled. They are given here for your reference.

The equations are

1. $\mathbf{a = \frac{v - u}{t}}$ or $\mathbf{v = u + at}$
2. $\mathbf{s = ut + \frac{1}{2}at^2}$
3. $\mathbf{v^2 = u^2 + 2as}$ or $\mathbf{v^2 - u^2 = 2as}$

The symbols used are:

'*u*' for initial velocity

'*v*' for final velocity

'*t*' for time

's' for distance travelled

Example 1

An object at rest starts moving and attains a velocity of 10 $m\ s^{-1}$ after 5 s. What is the acceleration?

Initial velocity $u = 0$ (rest)

Final velocity $v = 10\ m\ s^{-1}$

Time interval $t = 5\ s$

Therefore $\mathbf{a = \frac{v - u}{t} = \frac{10 - 0}{5} = 2ms^{-2}}$

Consider the opposite of the above example

An object moving with a uniform velocity of 10 ms^{-1} comes to rest after 5 s. What is the acceleration?

Initial velocity $u = 10\ ms^{-1}$

Final velocity $v = 0$

Time interval $t = 5s$

$\mathbf{a = \frac{0 - 10}{5} = -2ms^{-2}}$

The negative sign indicates that acceleration in this example is against the direction of motion.

Example 2

An object at rest starts moving with uniform acceleration of 1 ms^{-2}. Calculate the distance travelled by it in 4 seconds.

Initial velocity u = 0 acceleration a = 1 ms^{-2}

Time interval t = 4 s

Distance travelled = s = ut + ½ at^2

$s = 0 \times 4 + ½ \times 1 \times 4^2$

$= 0 + ½ \times 1 \times 16$

$= 8\ m.$

Example 3 An object starts from rest and attains a uniform acceleration of 4 $m\ s^{-2}$ What will be its velocity at the end of half a metre?

Data $u = 0$; $a = 4 ms^{-2}$ $s = ½\ m$; $v = ?$

$v^2 = u^2 + 2as$

$v^2 = 0^2 + 2 \times 4 \times ½$

$v^2 = 4$

$v = \sqrt{4}$

$= 2\ ms^{-1}$

Graphical representation of motion

Motion can be represented by line graphs. We can also obtain certain desired information from the graphs. Here are a few simple examples.

Example 1 : Distance - time graph

Situation 1 : Let us consider a body which is covering equal distances in equal intervals of time. If we represent time on the x-axis and distance travelled on the y-axis, we will get a graph as shown in the figure. This is a graphical representation of **s = ut**

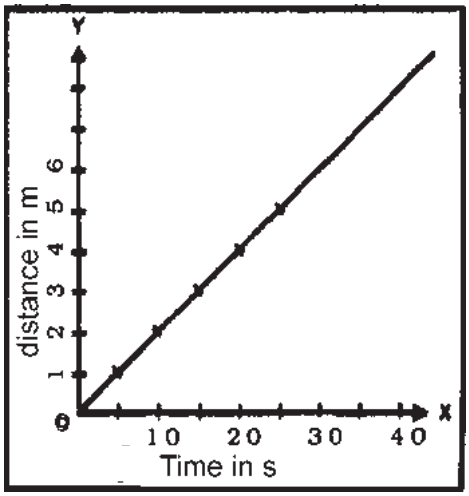


Fig. 8.7 Distance-Time Graph

From this graph we can find out the distance at which the body is present from its starting point. Time taken to cover a definite distance can also be determined from the graph. Since it is uniform motion we can also know the speed of the body.

Find the following from the graph. (fig. 8.7)

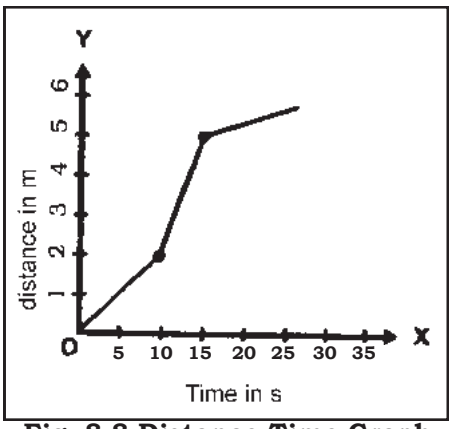


Fig. 8.8 Distance-Time Graph

- What is the distance travelled by the body in 15 seconds ?
- What is the time taken by it to cover a distance of 6 m.?
- What is the speed of the body?

Situation 2 : Let us consider a body which is covering different distances in equal intervals of time. The resulting graph will resemble the one shown in figure 8.8.

Find the following from the graph (fig. 8.8)

- What is the distance travelled by the body in 20 sec?
- What is the speed of the body in first 10 sec ?
- What is the speed of the body in second 10 sec ?
- What is the average speed of the body in 30 sec ?

Note : If the motion of a body in a straight line is in a particular direction, the numerical value of velocity is same as that of the speed. then we can also findout the velocity from the graph.

Example 2 : Velocity-time graph or speed time graph of the body moving in a straight line in a particular direction.

Situation 1 : Consider a body moving in a particular direction with uniform velocity. At any unit time-interval the velocity of such a body does not change. It means that the acceleration is zero. If we denote time on the X-axis and velocity on the Y-axis, we get a graph like the one shown in the figure 8.9. What is the velocity of the body in motion as represented by the graph ? What is its acceleration ?

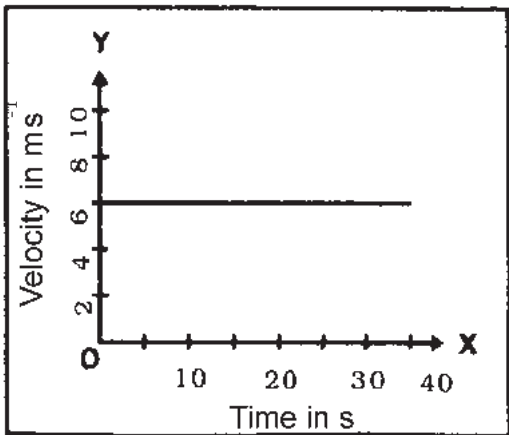


Fig. 8.9 Velocity Time/Speed Time Graph

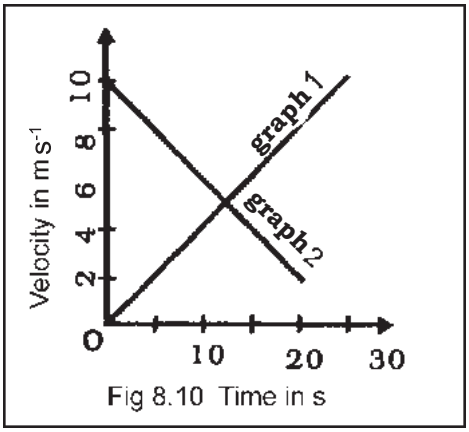


Fig 8.10

Fig. 10 Velocity Time graph

Situation 2 : Consider a body moving in a particular direction with a uniform acceleration. The graph of such a motion may be one of the two varieties shown in the figure 8.10. Identify the graph representing acceleration in the direction of motion and the one representing acceleration in opposite direction.

you have learnt

- distinction between distance travelled and displacement.
- definition of the terms speed, velocity and acceleration.
- distinction between uniform and non-uniform velocity
- graphical representation of velocity and acceleration.
- solving numerical problems on velocity and acceleration

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer :

1. Uniform circular motion is called continuously accelerated motion because,

   a. direction of motion changes continuously

   b. speed changes

   c. velocity remains the same

   d. direction of motion does not change

2. A cricketer hits a sixer . The cricket ball moves up with a velocity of 2 ms^{-1} and falls down. Its initial velocity while falling down will be

   a. 1 ms^{-1} b. 1 ms^{-2} c. 0 ms^{-1} d. 2 ms^{-1}

II. Fill in the blanks with suitable words

1. S I Unit of acceleration is _____ .
2. Velocity has both speed and _____ .
3. If an object starts from 'A' and comes back to 'A', its displacemont will be _____ .

III. Solve

1. An object is moving in a circular path of radius 3.5*m*. If it completes one full cycle, what will be the displacement and what is the distance travelled?
2. An object changes its velocity from 30 ms^{-1} to 40 ms^{-1} in a time interval of 2*s*. What is its acceleration?
3. An object at rest starts moving. It covers a distance of 2*m* in one second. It covers a further distance of 5 *m* in two seconds in the same direction. What is its average velocity and acceleration?

IV. Answer the following

1. If a body is moving with uniform velocity in a given direction its acceleration will be zero. Why?
2. Distinguish between speed and velocity.
3. Distinguish between distance travelled and displacement.
4. What are uniform and non-uniform speed?
5. While mentioning acceleration the time is mentioned two times. Why?

V. Extended activity

Represent the following motion by a graph.

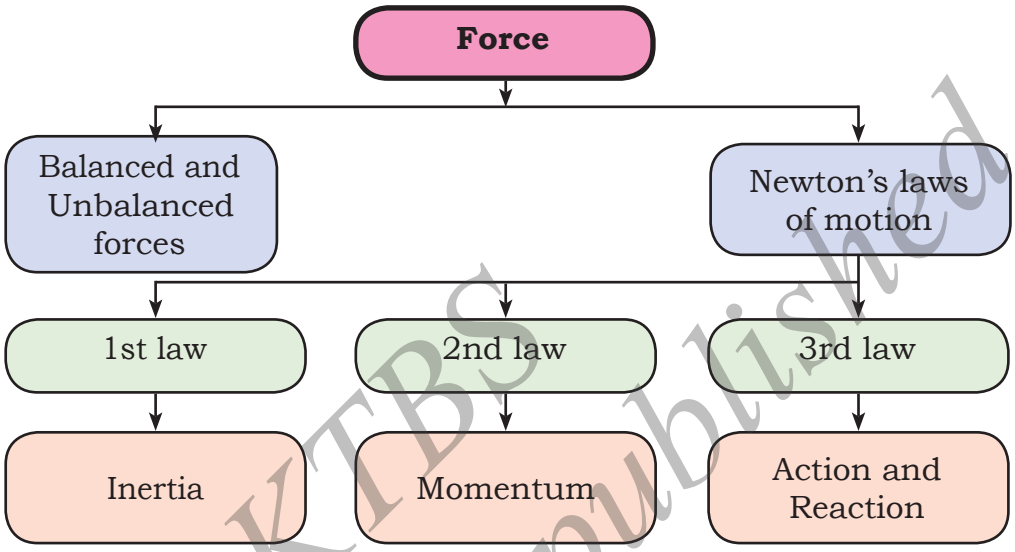
Velocity (ms^{-1})	40	30	20	10
Time (s)	1	2	3	4

1. Find the acceleration
2. Find the time taken when the velocity is 35 ms^{-1}.

★★★★★

CHAPTER 9

FORCE AND NEWTON'S LAWS OF MOTION



In the earlier chapter you have studied about motion of the objects. A marble at rest cannot move until it is pushed. There is an external physical quantity of energy that makes the marble to move. Similarly a moving marble can also be stopped. A fast moving bus can be made to slow down. It is possible to change the speed of automobiles whenever required. The physical quantity that we are referring to is **force**. The word force is used in our daily life under different contexts.

Consider the following statements -"the cricketer would have scored a sixer had he hit the ball with a greater force". "If the football player had kicked the ball with a greater force, he would have scored a goal". In these two examples there is reference to the amount of force.

Force is a physical quantity that changes the state of rest of a body or that changes the velocity of a body.

What are the other areas in which we use the word force?

Magnetic force and gravitational force are two examples. Can you give two more examples?

Activity 9.1

Take a rubber ball. Press it with both the palms. The force shows a visible effect on the ball. Press a leather cricket ball. You will not see any visible effect on the ball. Why?

Force applied on an object can

- change the velocity of an object
- change the shape of an object.

Let us consider one more example.

In the sport *tug of war* when the two teams pull the rope with equal effort, the rope and the two teams remain stationary. What happens when one of the teams pulls the rope harder? This circumstance indicates unbalanced forces. How do you define an unbalanced force?

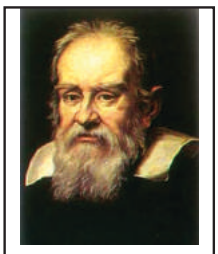
Unbalanced forces acting on an object, change its speed or direction of motion or both.

If two or more forces acting on the same object keep the object in equilibrium position or in the same state, then the forces are said to be balanced.

Imagine an object at rest. If it is pushed, it starts moving. Its speed or direction of motion depends upon the force and the direction of application of force.

Continuous application of force is necessary to maintain the motion of an object. Is it true?

A marble pushed by you starts moving, slows down and finally stops. In this case **friction force** (friction between the marble and the surface on which it is moving) stops the marble. What will happen if there is no friction?

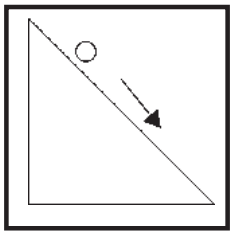


Galileo Galilei

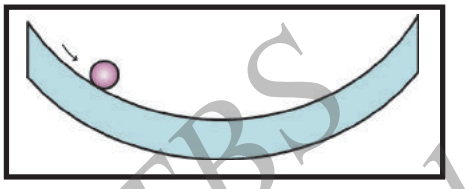
Galileo Galilei

Galileo opposed the idea of Greek philosophers that a moving body comes to rest when no forces act on it. Galileo's work inspired Sir Isaac Newton, who proposed the laws of motion systematically.

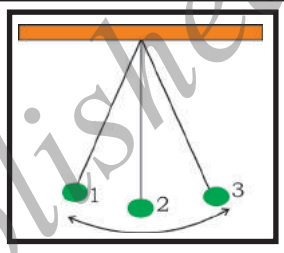
Some examples of motion studied by Galileo are given in the following diagrams.



Ball moving down an inclined plane



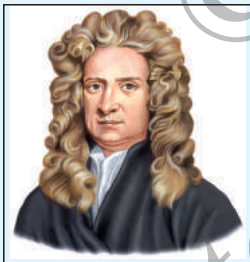
Ball moving in a hallow hemisphere



Motion of a pendulum

Fig. 9.1 Studies of Galileo

Sir Isaac Newton [1643-1727]



Sir Isaac Newton

Isaac Newton was a physicist, mathematician, astronomer and natural philosopher. The book *"Principia mathematica"* was written by him. He developed a branch of mathematics called "calculus". The first reflecting telescope was constructed by him. He demonstrated the existence of visible spectrum.

His idea of light as stream of particles or corpuscles is out dated but has a small resemblance to photon theory and quantum theory.

He was the President of Royal Society of London in 1703. He was member of the parliament of England from 1689 to 1690 and in 1701.

Well known statements of Newton:

"If I have seen further, it is by standing on the shoulders of Giants."

" I do not know what I may appear to the world, but to myself, I seem to have been only like a boy playing on the sea-shore, and diverting myself now and then, finding a smoother pebble or a prettier shell than ordinary , whilst the great ocean of truth lay all undiscovered before me. "

Newton's Laws of motion:

Sir Isaac Newton studied the motion of objects and the factors related to the change in velocity. He identified certain relationships and stated them in the form of laws. Let us know more about these laws.

Inertia:

While travelling in a bus you might have experienced that when brakes are suddenly applied, you lean forward. When the bus starts moving you lean backward. Why?

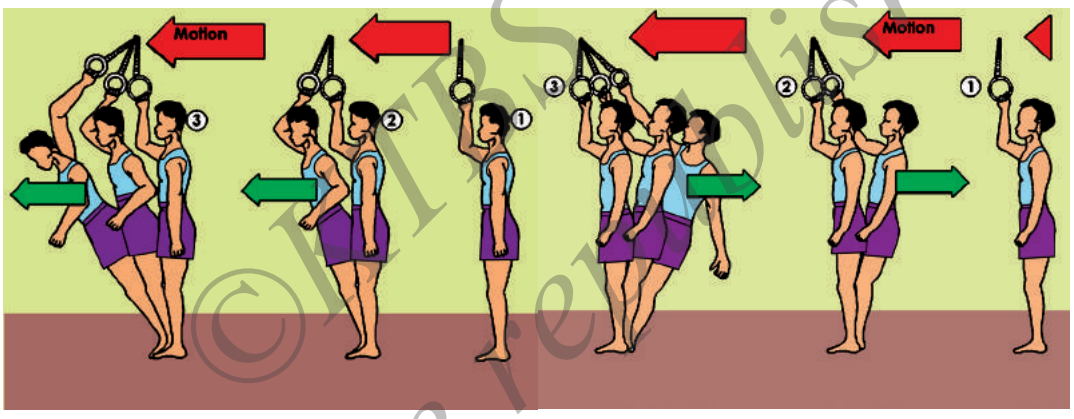


Fig. 9.2 Inertia experienced in a moving vehicle

When we are sitting inside a moving bus, our entire body will also be moving with the speed of the bus. When brakes are suddenly applied, the bus comes to rest. The part of the body that is in contact with the bus also comes to rest. However, the part of our body which is not in contact with the bus has a tendency to move in the direction of the bus before coming to rest. So we lean forward. Similarly when a bus at rest starts moving the part of our body which is not in contact with the bus has a tendency to remain at rest. So we lean backward.

Activity 9.2

You need a glass tumbler and a cardboard piece from an old invitation or greeting card and a coin to perform this simple experiment. Place the card board on the glass tumbler as in figure 9.3 . Place a coin on the cardboard. Flip the cardboard with your fingers. What is your observation?

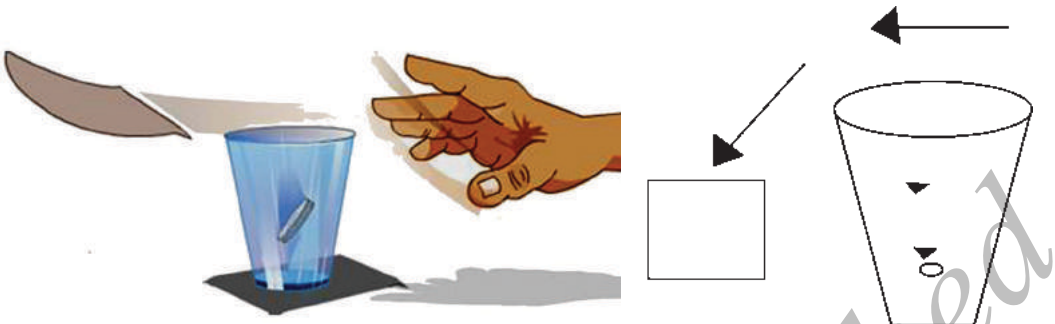


Fig. 9.3 Inertia

Activity 9.3

When the pawns in a carrom board game are arranged vertically and the bottom pawn is hit by the striker the pawn at the bottom gets removed and the vertical arrangement of the pawns remains intact. Try to recall your other experiences while playing a carrom board game.

The tendency of the objects to remain at rest or in a state of uniform motion when no forces act on them is called ***'inertia'.*** *This is described in* ***Newton's first law of motion****. "A body continues in its state of rest or of uniform motion in a straight line, unless it is compelled to change that state by forces impressed on it". Newton's first law of motion is based on the findings of Galileo. It is also called* ***law of inertia****.*

The first law of motion has the following point. To accelerate an object, an external unbalanced force is necessary. That means, to change the state of rest or state of motion of an object, an unbalanced force must act on it.

The resistance to change the state of motion depends upon the mass of the objects. It is easier to change the velocity of lighter objects than of heavier objects. Massive objects have more inertia than lighter ones. In fact mass is a measure of inertia.

Activity 9.4

Two iron spheres of 2 kg and 5 kg each are dropped from the same height into a sand pit. Which of these two causes deeper sand pit? What happens if the 2 kg sphere is thrown with a greater speed instead of dropping it?

Force, velocity and mass are all considered in comparison with the activity 9.4. It is described in the second law of motion.

Newton's second law of motion

"The acceleration given to a body by a force applied to it is directly proportional to the force and is in the same direction of the force and inversely proportional to the mass of the body".

Let the mass of a body be '*m*'. Let the resultant force acting on it be '*F*' and its acceleration be '*a*'. According to Newton's second law of motion,

1. Acceleration in the direction of force is directly proportional to the force .

   $\therefore a \propto F$ ------(1)

2. Acceleration is inversely proportional to the mass

   $\therefore a \propto \frac{1}{m}$ ------(2)

By combining (1) and (2)

We get $a \propto \frac{F}{m}$

Or $a = K\frac{F}{m}$

here '*K*' is the constant of proportionality.

If mass 'm' is 1 *kg* and acceleration 'a' is 1 ms^{-2} then the value of '*K*' will become numerically one. Then we can mathematically state Newton's second law of motion as $F = ma$

Unit force is that force which produces an acceleration of 1 ms^{-2} on a mass of 1 *kg*.

S I unit of force is *kg m* s^{-2} or newton or *N*.

Example 1. Calculate the force required to change the velocity of an object of mass *4 kg* from *2* ms^{-1} to *4* ms^{-1} in one second.

Solution:

$F = ma$ Acceleration, $a = \frac{v - u}{t} = \frac{4 - 2}{1} = 2ms^{-2}$

$m = 4\ kg$, $a = 2\ ms^{-2}$ $F = ?$

$F = 4\ kg \times 2\ ms^{-2}$

$F = 4 \times 2 = 8\ kg\ ms^{-2}$ or 8 newton or 8 N.

Example 2. An object of mass 10 *kg* is moving with initial velocity of *2 m* s^{-1}.To make it come to rest in one second, what should be the unbalanced force?

Solution: initial velocity u = $2ms^{-1}$

final velocity v = $0\ ms^{-1}$

time t = 1*s*, mass *m* = *10kg*.

Change in velocity in one second or acceleration = $\frac{change\ in\ velocity}{Time\ taken}$

$$a = \frac{v - u}{t} = \frac{0 - 2}{1} = -\ 2ms^{2}$$

$F = ma$

$F = 10 \times -2$

$= -20\ kg\ ms^{-2}$ or *-20 newton* or -20 *N*

The negative sign tells us, that the force exerted is opposite to the direction of motion.

Example 3. An object of mass 20 *kg* is moving with initial velocity of 2 *m* $s^{-1.}$ If its velocity changes to 4 *m* s^{-1} in one second, what should be the force acting on it? What will be the direction of the motion?

Solution: $F = ma$

$m = 20\ kg$

$v = 4ms^{-1}$ $u = 2ms^{-1}$ $t = 1s$

$$a = \frac{v - u}{t}$$

$$a = \frac{4 - 2}{1}$$

$= 2\ ms^{-2}$

$F = m \times a$

$\therefore F = 20 \times 2 = 40\ kg\ ms^{-2}$

$= 40$ *newton* or 40*N*

The object continues to move in the same direction as the force applied is in the same direction.

Let us try to understand Newton's Second law of motion in another way.

It is our experience that it is easier to stop a slow moving cricket ball than a fast moving one. The mass of the cricket ball is the same. Its average velocity may change.

Recall the activity 9.4.

The iron spheres have different masses. The velocity of both the spheres remains the same when dropped from the same height. Let us introduce another physical quantity called "momentum". It is defined as the product of mass and velocity.

$\therefore$ *Momentum = Mass × Velocity*

or $p = mv$

Momentum of an object is proportional to its mass and velocity or speed .Force is required to change the momentum of an object.

The S I unit of momentum is $kgms^{-1}$.Newton's second law of motion can also be stated as follows

" rate of change of momentum is directly proportional to the applied force and takes place in the direction of the force".

Know this : **Conservation of momentum**

Momentum of a system is always conserved. What does it mean? When a bullet is fired from a rifle, bullet moves fast but the rifle also moves slowly in the opposite direction of the bullet. In this case

momentum of bullet = momentum of rifle. [law of conservation]

If the mass and velocity of the bullet are '*m*' and '*v*' respectively and if the mass and velocity of the rifle are '*M*' and '*V*' respectively,

Total momentum = Initial momentum + Final momentum

$\therefore mv + M V = 0$ *or* $mv = - MV$.

- MV indicates that rifle moves in the opposite direction to that of the bullet.

The two laws of motion tell us how an applied force changes the state of motion of objects. There is yet another law of motion which tells us something more about the applied forces.

Newton's third law of motion:

"To every action there is always an opposite and equal reaction"

Remember that 'action' and 'reaction' act on different bodies.

Activity 9.5

Take a large balloon. Carefully tie a narrow tube of a discarded ball point pen to the mouth of the balloon as shown in the figure 9.4 and blow it with air. Release the air. Air moves downwards. Balloon moves upwards. Try this with different sized balloons. Also try this with balloons of comparable masses. As the mass of the balloon increases its speed decreases . Can you think why?

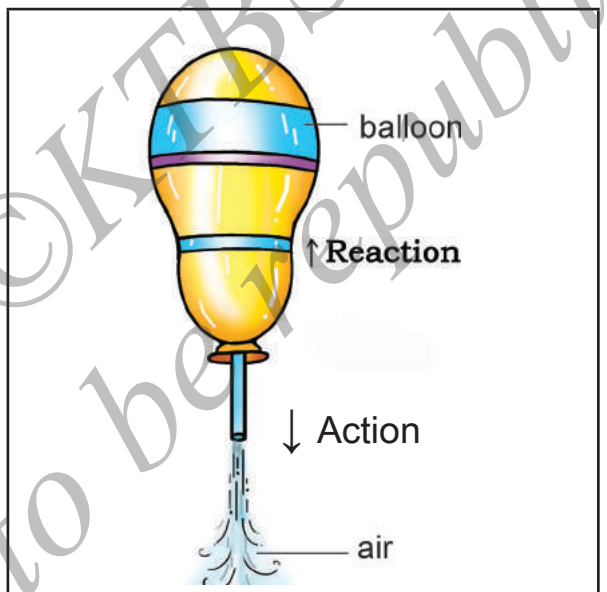


Fig. 9.4 Air balloon experiment

Activity 9.6

Observe the white stream of the exhaust of a jet plane, if you happen to spot jet planes in the sky. Observe the direction of motion of the jet plane and the exhaust fumes. What is your conclusion?

Activity 9.7

Observe the actions of a swimmer while swimming. Can you give reason for his actions?

Activity 9.8

In the traditional row boat, observe the direction of motion of the boat and the direction of motion of rowing. Can you describe this in terms of Newton's third law of motion?

Activity 9.9

You might have observed on T V the launching of rockets. The exhaust gases travel with tremendous speed downwards. But the rocket that goes up will not be as fast as the exhaust gases. Can you give reason for this?

Numerical problem

A bullet of mass 25 *g* is fired from a rifle of mass 2 *kg*. Imagine that no other forces are acting on the system. If the bullet travels with a velocity of 2 ms^{-1}, what will be the velocity of the recoil of the rifle?

Solution: Data given= Mass of the bullet (say m) = $25g = \frac{25}{1000}\ kg$

Velocity of the bullet (say v) = 2 ms^{-1}

Mass fo the Riffle (M) = 2 *kg*

Velocity of Riffle of recoil of the riffle (V) = ?

Equation used:

momentum = mass x velocity

Momentum of the Rifle = Momentum of the bullet

$$(MV)_{Riffle} = (mv)_{bullet}$$

substituting the respective values:

$$\therefore\ (2kg \times V) = \frac{25}{1000}(kg) \times 2(ms^{-1})$$

$$2V = \frac{25}{1000} \times 2$$

$$\text{or } V = \frac{25}{1000} = \frac{1}{40} = 0.025\ ms^{-1}$$

$\therefore$ Velocity of recoil is $0.025\ ms^{-1}$

you have learnt

- effects of force
- distinction between balanced and unbalanced forces
- definition of the term momentum
- Newton's laws of motion
- to solve numerical problems
- a few illustrations for inertia
- illustrations for the second and third laws of motion

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer

1. Which one of the following is not correct - Action and reaction
   a. act on the same body b. are equal
   c. are opposite d. act on different bodies
2. If the forces acting on an object are balanced, then
   a. the object will be accelerated
   b. the object will be in motion
   c. the object will be at rest
   d. the object loses its shape
3. The correct way to write the SI unit of force is
   a. Newtons b. newton c. newtons d. Newton

II. Fill in the blanks with suitable words

1. Inertia of an object is proportional to its _____ .
2. The S.I unit of momentum is _____ .
3. To cause acceleration in an object the necessary factor is unbalanced_____ .
4. Newton's first law of motion is also called law of _____.
5. The suitcases kept in a moving bus, move forward when the brakes are applied suddenly. This is due to _____.

III. Answer the following

1. In a tug of war game, if the two teams exert equal forces, none of the teams win. Why?
2. Which of the following has greater momentum?

   a. An object of mass 2 *kg* moving with uniform velocity of 2 ms^{-1}.

   b. An object of 1 *kg* mass moving with uniform velocity of 3 ms^{-1}.
3. Which of the following has greater inertia?

   a. 50 paise coin b. one rupee coin c. five rupee coin.
4. State any two illustrations for Newton's third law of motion.
5. Distinguish between balanced and unbalanced forces.
6. State Newton's second law of motion, in terms of momentum.

IV. Give reasons for the following

1. It is dangerous to get down from a moving bus even if the bus is moving slowly.
2. An athlete in long jump runs a distance before taking the leap.
3. Usually a fielder in a cricket match, moves his hands in the direction of motion of cricket ball, after taking the catch.

V. Solve the Problems

1. Calculate the force required to change the velocity of an object of mass 8 *kg* from 4 ms^{-1} to 6 ms^{-1} in 2 second.
2. A force of 25 *newton* is applied on an object of mass 10 *kg* moving with a velocity of 5 ms^{-1}. If the object gains a velocity of 10 ms^{-1}, calculate the time taken.

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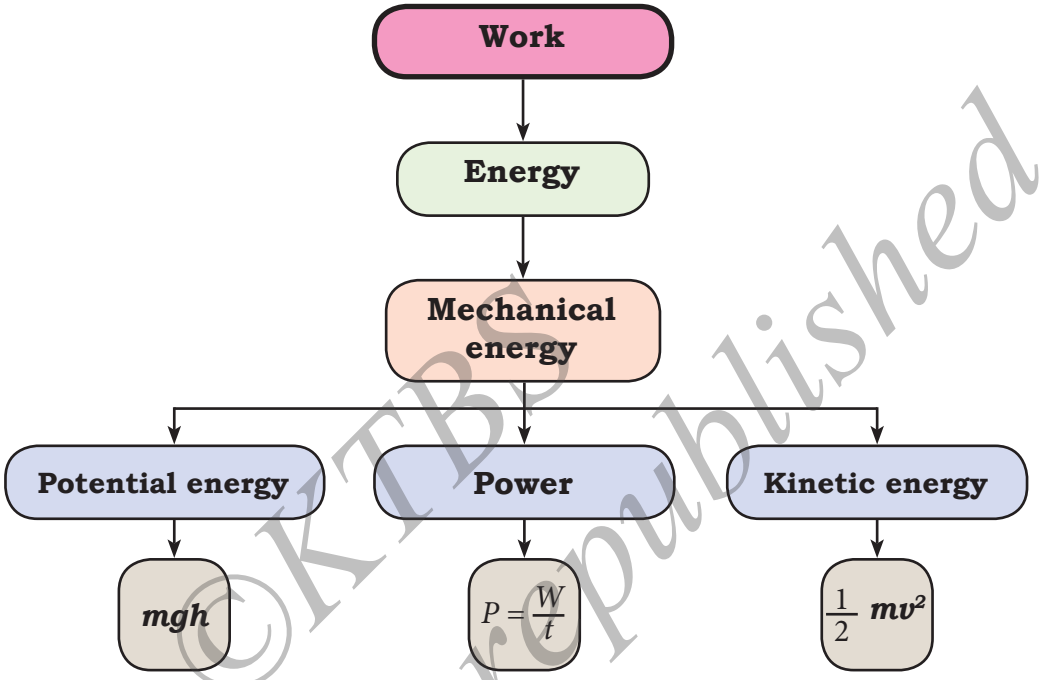
CHAPTER 10
ENERGY AND ITS FORMS



In a football match, a player kicks a stationary ball. The ball moves in a straight line. Another player deflects the moving ball to another direction. Some times a player simply pushes the moving ball to increase its speed without changing its direction. In all these cases, the players apply force with their legs.

Force

Force is an influence which tends to set a stationary body in motion or which tends to change the speed and direction of a moving body or which tends to change the shape of a body.

Work

What happens when force is applied to a marble? If a marble moves, we say work is done. What happens when force is applied to a wall? If the wall does not move no work is done. Work is said to be done when the point of application of a force moves. The amount of work done by the force on a body depends on two factors, **magnitude** of the force and **distance** that the body moves.

We are now in a position to define work and say how it is measured. Work done by moving a body is equal to the product of force exerted on the body and the distance moved by the body in the direction of force. That is, **Work = Force** × **Distance** moved in the direction of force.

Unit of work

You have studied that the unit of force is **newton(N)** and that of distance is **metre(m)**. Thus the unit of work is **newton metre,** which is written as **Nm**. This unit of work is called **joule (J)** and can be defined as follows:

when a force of *one newton* moves a body through a distance of *one metre* in its own direction, then the work done is known as **one joule**.

1 *joule* = 1 *newton* × 1 *metre*

1 J = 1 Nm

Know this : One of the much discussed topics today is energy crisis. If the demand for energy is more than the supply, then it leads to 'energy crisis'. Karnataka Government is setting up power stations to increase the production of electricity.

There are many forms of energy such as heat, light, sound and solar energy. When we talk about energy we think about usable forms of energy. We think about how to transport it, how to convert it into other forms of energy.

Think : Can you convert all the sun light we receive from the sun into work or convert it into other forms of energy.

In your previous classes you have studied about kinetic and potential energies which are forms of mechanical energy.

Activity 10.1

Classify the following into kinetic energy and potential energy.

- *Stretched rubber band*
- *Flowing water*
- *Compressed spring*
- *Water stored in a dam*
- *Wind*
- *Arrow released from the bow*

In this chapter we shall study some factors related to kinetic energy and potential energy.

Kinetic Energy

Activity 10.2

Conduct the activities related to kinetic energy as given in the table 10.1.

Table 10.1 Illustrations of kinetic energy

Sl. No.	Activities	Observation	Inference
1	*Blow air on a sheet of paper*		
2	*Flowing water falls on a turbine(wheel)*		
3	*Throw a cricket ball on the stumps*		
4	*Hit the carrom pawn with a moving striker*		

What do you find in the above activities? The moving air, the moving ball, the flowing water, the moving striker are capable of doing work. All moving objects have capacity to do work which means that they possess energy. The energy that the body possesses due to its motion is called **kinetic energy.**

Do this : List out at least 5 activities which involve doing work with kinetic energy.

Relationship between mass, velocity and kinetic energy of an object

Activity10.3

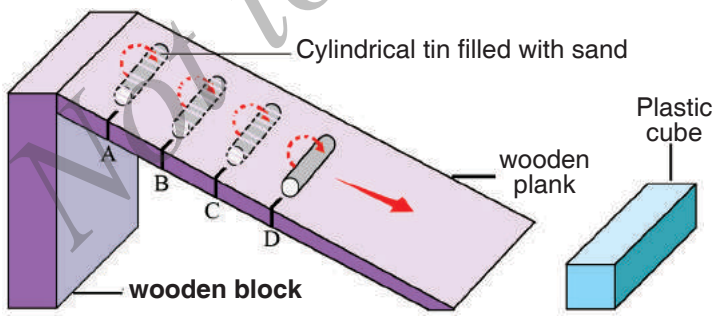


Fig. 10.1

Take a wooden plank of three feet and place it on a wooden block. This arrangement is called inclined plane. Mark A,B,C,D as shown in the figure 10.1 .Take a cylindrical tin of medium size(200 g). Fill it completely with sand and close firmly with a lid. Put an empty rectangular plastic cube container near the bottom of the inclined plane. Now release the

cylinder from the point A of inclined plane. The cylinder strikes the plastic cube container which is at rest. The rolling cylinder moves plastic cube for some distance. Mark the place where the plastic cube rests. Measure the distance between the original position and the new position of the plastic cube. Repeat the experiment by releasing the cylinder from different heights (B, C, D) and measure the distances in each case.

Is the distance moved by the cube same in all the cases? Does the cylinder strike the cube with the same velocity? What is your conclusion ?

The kinetic energy of a body depends on its velocity. Higher the velocity, higher is the kinetic energy.

Repeat the same experiment using a large size (500 g) cylindrical tin completely filled with sand.

Compare the result with the above experiment. What do you observe? What is your conclusion? The kinetic energy of a body also depends on its mass. Higher the mass of a body, higher is its kinetic energy.

The kinetic energy of a body therefore depends on

1. the mass of the body. 2. the velocity with which it is moving.

A body of mass 'm' moving with a velocity 'v' has the kinetic energy of $\frac{1}{2}mv^2$. You will study the derivation of this formula in the higher classes.

Unit of energy: Energy is the capacity to do work. it is measured in terms of work. The unit of work is '*joule*'. So the unit of energy is also *joule*.

Note : Change in the kinetic energy of a body is the measure of the work done.

Example 1: A car is moving with uniform velocity of 15 ms^{-1}. What is the kinetic energy of a boy of mass 40 *kg* sitting in the car?

Solution: Velocity of the boy = velocity of the car

Kinetic energy possessed by the boy $= \frac{1}{2}mv^2$.

Here $m = 40\ kg$, $v = 15\ ms^{-1}$ $= \frac{1}{2} \times 40\ kg \times (15\ ms^{-1})^2$

$= 4500\ J$

Example 2 : If two bodies of equal masses move with uniform velocity of 'v' and '$3v$', what will be the ratio of their kinetic energy?

Mass of first body = m

Velocity of the first body = v

Mass of second body = m

Velocity of second body = $3v$

The ratio of kinetic energy of the two bodies

$$= \frac{\text{Kinetic energy of first body}}{\text{Kinetic energy of second body}}$$

$$= \frac{\frac{1}{2}mv^2}{\frac{1}{2}m(3v)^2} = \frac{\frac{1}{2}mv^2}{\frac{9}{2}mv^2}$$

$$= \frac{1}{9}$$

The ratio of the kinetic energy = 1:9

Potential energy

How do you make a toy drum beater to beat the drum? You wind the spring before it beats the drum. Your work done on the toy gets stored up in the spring in the form of energy. Observe the shape of the spring before and after the beats of the drum.

A stone is lying on the ground. It cannot do work at that moment. How do you make the stone do work? Lift that stone up to your shoulder. Now the work has been done by lifting this stone against the force of gravity. This work gets stored up in the stone in the form of energy. Now the stone has the capacity to do work. Here stone gets energy due to its position. The energy which a body possesses either due to its position or due to its deformation is called **potential energy**.

Activity 10.4

Complete the table 10.2

Sl. No.	*Object possessing potential energy*	*energy posessed by the object due to position*	*energy possessed by the object due to shape*
1	*The wound spring of a watch*		
2	*A stretched rubber band*		
3	*Mangoes on the tree*		
4	*Water stored in the dam*		
5	*Stretched bow*		
6	*A car at the top of the hill*		
7	*Pressed spring*		
8	*Stretched sling of a catapult*		

Relationship between mass, height and potential energy of a body

What are the factors on which potential energy depends? Let us explore!

Lift two shotputs of 1 *kg* and 3 *kg* each up to your shoulder separately. In both the cases, work done is stored in the form of energy. In which shotput is more energy stored? What is your conclusion? Potential energy depends upon the mass of the body.

From the ground, lift a shot-put weighing 3 *kg* up to your shoulder level. Now again lift the same shot-put from the ground above your head. In which position does the ball acquire higher energy? What is your conclusion? Potential energy depends upon the height through which it is raised from the ground. Hence potential energy of a body depends upon the mass of a body and the height to which it is raised from the ground. If '*m*' is the mass of a body raised to a height '*h*' then its *potential energy* = *m g h* (here g= acceleration due to gravity). You will be studying the derivation of this formula in higher classes.

Examples

1. If acceleration due to gravity is $10\ ms^{-2}$, what is the potential energy of a body of mass $1\ kg$ kept at a height of $5m$?

   Potential energy = $m\ g\ h$ (here m= 1 kg, g= 10 ms^{-2}, h = 5 m).

   Potential energy = $1\ kg \times 10\ ms^{-2} \times 5\ m$

   Potential energy = $50\ J$

2. A bag of wheat weighs 200 kg. To what height should it be raised so that its potential energy is *9800 joule* ($g = 9.8\ ms^{-2}$)

   Potential energy = $m\ g\ h$ *(here* $m = 200\ Kg$, $g = 9.8\ ms^{-2}$*)*

   Potential energy = *9800 joule*

   $9800\ J = 200\ Kg \times 9.8\ ms^{-2} \times h$

   $h = \frac{9800}{200 \times 9.8} = \frac{10}{2}$

   $h = 5\ m$

   Thus, the bag of wheat should be raised to a height of 5m.

Change of energy

Rub your palms together. Why do palms get warm? Where did the heat come from? Here kinetic energy of your palms changes into heat energy. Switch on a fan. Which energy makes the fan rotate? Here, electrical energy is changed into mechanical energy. Burn a magnesium strip. What do you observe? Here the chemical energy is changed into heat and light energy. The change of energy from one form to another is known as *transformation of energy*.

Activity 10.5

Some activities in your everyday life are given below. Complete the table

Table 10.3

Sl. no.	*Situation*	*Name the form of energy before transformation*	*Name the form of energy after transformation*
1	*Combustion of petrol*		
2	*Combustion of LPG*		
3	*Burning match stick*		
4	*Running toy car*		
5	*Photosynthesis*		
6	*Falling rain drop*		
7	*Flowing water from a dam*		

When you switch on the bulb, a part of electrical energy is converted into light energy and some part of it is converted into heat energy.

Find out: To prepare a cup of tea of 100 mL how many joules of energy are required?
To pump blood by a normal heart once how many joules of energy are required?

Energy can neither be created nor destroyed. It can be converted from one form to another. This is known as the **law of conservation of energy.**

Activity 10.6

Sun is the ultimate source of different forms of energy on the earth. Observe figure 10.2 and identify the energy transformation.

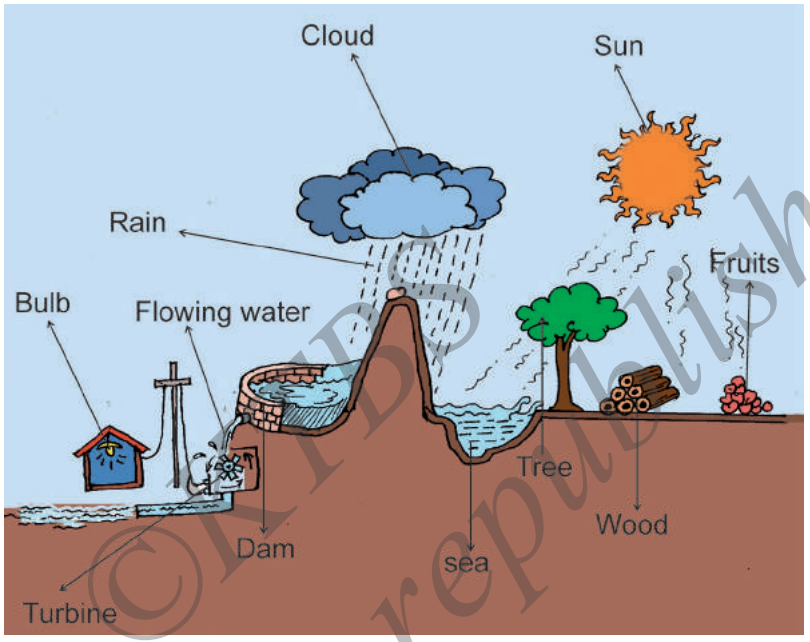


Fig. 10.2 Energy transformation

Rate of consumption of energy in relation to time

Have you seen the letter 'W' on the bulb? Between a 40 W and 60 W bulbs which bulb gives more light? 40 W, 60 W on bulbs indicate the consumption of energy in given time. Here 'W' is the unit of power. The rate of consumption of energy is known as power.

If W is the work done in time t, then power $= \frac{\textit{Work done}}{\textit{time taken}}$

$$P = \frac{W}{t}$$

The work done is measured in joules and time in seconds. So unit of power is joules/second. This unit of power is called *watt*. When the rate of consumption is higher, *kilowatt* is used.

1 kilowatt = 1000 W

1 k W = 1000 W

Problem

A body does 20J of work in 5 *s*. What is its power?

$$Power = \frac{Work\ done}{time\ taken}$$

(here work = 20 joule, time = 5 seconds

$$Power = \frac{20\ J}{5\ s}$$

$$Power = 4\ W$$

Thus, the power of this body is *4 watt.*

More activities for you

Activity 10.7

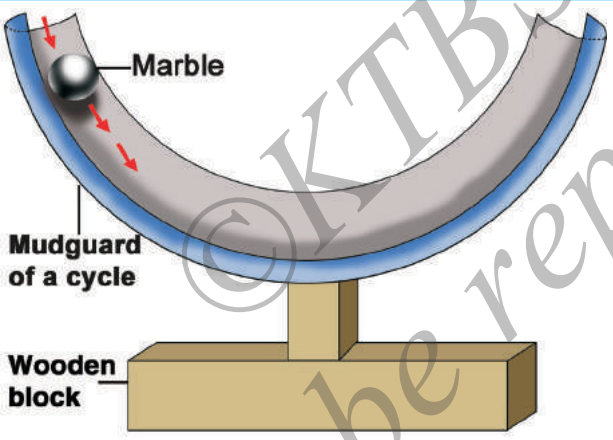


Fig.10.3

This model shows transformation of kinetic energy and potential energy. Take a mudguard and fix it on a wooden block and release the marble as shown in fig.10.3

Activity 10.8

Record the changes that take place when a simple pendulum oscillates.

you have learnt

- definition of the of terms *force* and *work*
- definition of the of terms *potential energy, kinetic energy* and *power*
- examples for *potential energy* and *kinetic energy*.
- distinction between *potential* and *kinetic energy*.
- about the con version of energy from one form to another.
- law of conservation of energy.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer :

1. The type of energy that can be easily converted into other forms is

   a. sound b. light c. heat d. electricity

2. Kinetic energy is present in the following.

   a. Water stored in a dam b. Stretched rubber band

   c. Water released from a dam d. Compressed spring

3. The correct formula to find the velocity v of a body with kinetic energy 'k' is

   a. $v = \frac{2k}{m}$ b. $v = \sqrt{\frac{2k}{m}}$ c. $v = \frac{4k^2}{m}$ d. $v = \frac{1}{2}km$

4. The correct sequence of energy changes in hydroelectric power station is,

   a. kinetic → potential → mechanical → electrical.

   b. potential → kinetic → mechanical → electrical.

   c. potential → electrical → mechanical.

   d. potential → electrical → kinetic → mechanical.

5. Which object with the mass indicated has a higher potential energy?

   a. mass = 10 kg g = 9.8 ms^{-2} h = 10 m

   b. mass = 5 kg g = 9.8 ms^{-2} h = 12 m

   c. mass = 8 kg g = 9.8 ms^{-2} h = 100 m

   d. mass = 6 kg g = 9.8 ms^{-2} h = 20 m

II. Fill in the blanks with suitable words

1. Unit of power is _____ .
2. Unit of energy is _____ .
3. If a candle is burnt, the chemical energy is transformed into _____ .

4. The water stored in an overhead tank possesses _____ energy.
5. In a cinema theatre electrical energy is transformed into _____and_____ energy.

III. Answer the following

1. State whether the energy possessed in the following is kinetic or potential;

   compressed spring, stretched bow, moving arrow, water stored in a dam, a stone at the top of a building, bird resting on the branch of a tree.
2. Distinguish between potential energy and kinetic energy of a body.
3. A bus and a car are moving at the same speed. Which of the two has a greater kinetic energy?
4. A ball of mass 200g falls from a height of 5m. What is its kinetic energy when it just reaches the ground? (g = 9.8 ms^{-2})
5. There are a number of devices in common use that change energy from one form to another. Name some devices that change
   1. electrical energy into light energy
   2. electrical energy into mechanical energy
   3. electrical energy into heat
   4. sound energy into electrical energy
   5. chemical energy into electrical energy.
6. Describe the mode of energy transformation in a mechanical and quartz clock.
7. What kind of energy transformation takes place at the thermal power station?

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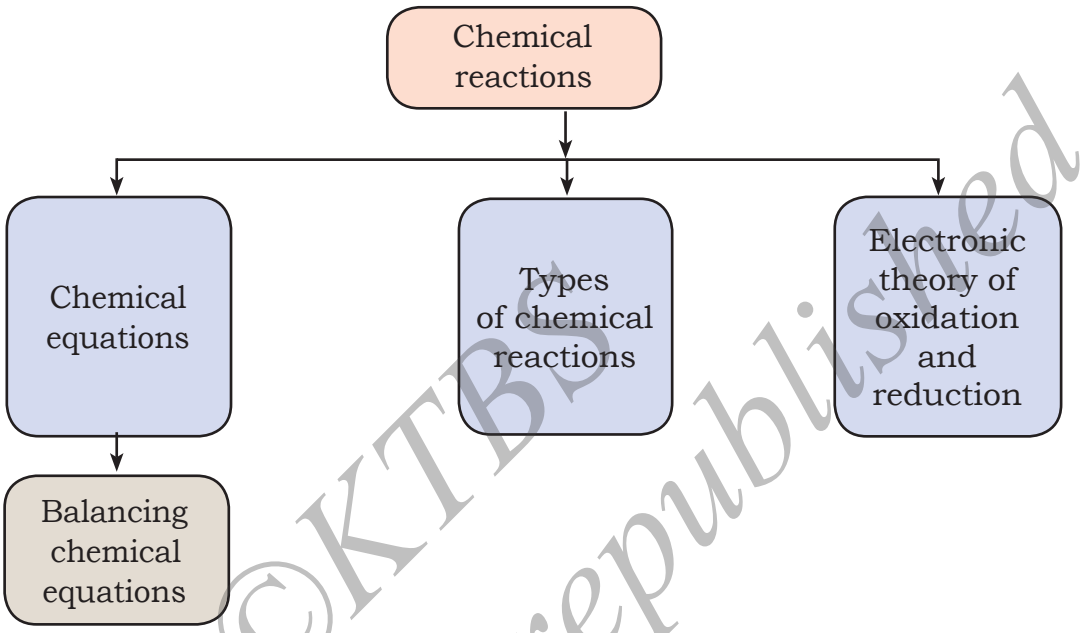
CHAPTER 11

CHEMICAL REACTIONS AND THEIR TYPES



We observe many situations such as water from sea evaporates to form water vapour which in turn forms clouds. These clouds when cooled, condense to form rain. Fuels burns to give light, heat, water vapour and carbon dioxide. i.e., matter undergoes certain changes as a result of the application of energy on them. We classify the different changes that matter undergoes as Physical and Chemical Changes.

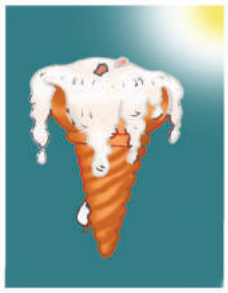
Activity 11.1

Take some ice cubes in a beaker and expose it to sunlight for sometime. What do you notice? Now we will do the reverse of the same. We will keep some water in a freezer. What happens to water?

Physical Change

A physical change is a temporary change in which no new substance is formed and the composition of the substance is not altered although certain specific physical properties may be changed.

Eg:-



Melting of Ice cream

Lighting of electric bulb

Magnetization of iron.

Characteristics of Physical Change

1. It is temporary and is easily reversible.
2. No new substance is formed during the change.
3. No alteration in mass takes place.
4. There is usually no change or a small change in energy during a physical change.

Activity 11.2

Place some bright iron nails in a test tube half filled with water and examine after two or three days. What do you notice? The nails are covered with a reddish brown mass known as rust which has properties totally different from iron.

Chemical Change

A chemical change is a permanent change in which a new chemical substance is formed with different properties than the substances which undergo chemical change.

Eg :

Burning of fuel

Bursting of explosives

Characteristics of Chemical Change

1. *It is permanent some times reversible [may or may not be]*
2. *New substances are formed.*
3. *Weight of the substance is altered.*
4. *Energy is generally involved in a chemical change*

Activity 11.3

Classify the following into chemical and physical changes.

1. Rusting of iron *2. Ripening of fruits*

3. Magnetizing a steel plate *4. Melting of iron*

5. Combustion of LPG *6. Cooling effect produced by ice*

Chemical changes lead to the formation of substances that help to grow our food, make our lives more productive and comfortable, cure our diseases and much more.

In chemical reactions electrons may get transferred from one atom to another or shared between two atoms. The electrons in the outer most orbit take part in chemical reactions. Sometimes electrons in the penultimate orbit may take part in chemical reactions along with those in the outer most orbit. These electrons which take part in chemical reactions are called **valence electrons** (Refer chapter IV).

Know this : All atoms tend to attain *octet* structure or *completed shell* of electrons. They try to acquire the electronic configuration of the nearest noble gas. In the process atoms may transfer, gain or share electrons. Main cause of chemical reaction is the tendency of atoms to attain a stable electronic configuration. Rearrangement of the configuration may also take place if there are other favourable alternatives.

Chemical equations

Consider the example of combustion of carbon in air. Carbon combines with oxygen of the air to form carbon dioxide. Can you write this reaction?

Carbon + Oxygen → Carbon dioxide

The 'word equation', has qualitative meaning only. We will not know the number of atoms of carbon and oxygen taking part in the

reaction. Carbon and Oxygen are called reactants. Carbon dioxide is called product.

Carbon + Oxygen → Carbon dioxide

reactants *product*

'word equation' tells us about the chemicals participating in a reaction. Let us write the above equation using formulae and symbols.

$C + O_2 \rightarrow CO_2$

Equation using symbols

This is a better method of writing a chemical equation.

- **Qualitative:** Helps in knowing the reactants and products only.
- **Quantitative:** Helps in knowing the relation between the quantities of reactants consumed and products formed $C:O_2 : CO_2 = 1:1:1$

We can further improve upon the equation by writing the other conditions.

$$C + O_2 \xrightarrow{\text{Heat}} CO_2 + \text{energy}$$

Remember : The reactants are written on the left hand side. The products are written on the right hand side.

Symbols and molecular formulae of reactants or products should be used to write the equations.

Consider one more example.

When magnesium ribbon is ignited in oxygen, it catches fire with dazzling white light, forming magnesium oxide.

Magnesium + Oxygen → Magnesium oxide (word equation)(Qualitative)

$2Mg + O_2 \rightarrow 2MgO$ (equation using symbols) (Quantitative)

(2 moles of Magnesium) + (one mole of Oxygen) → (2 moles of Magnesium oxide)

can we write the above equation as Mg + O → MgO ?

No. This is not the correct way. oxygen is a diatomic molecule. The ratio of atoms in the molecules of the reactants should be equal to the ratio of atoms in the molecules of the products.

$$Mg + O_2 \rightarrow MgO$$

Know this : According to the law of conservation of mass 'matter can neither be created nor destroyed'. The number of atoms of each element of the reactants on left hand side of the equation should be equal to the number of atoms of each element present in the products on right hand side.

There is one 'Mg' on the left hand side and one 'Mg' on the right hand side. But there is one 'O_2' on left hand side and one 'O' on right hand side in 'MgO'. We cannot write 'MgO' as 'MgO_2'. Also we cannot write the products as MgO + O.

Products or reactants should be multiplied by integers in order to satisfy the law of conservation of matter. If MgO is multiplied by 2, it becomes 2MgO. Now the oxygen atoms are balanced. But we have to replace Mg by 2Mg in order to balance the magnesium atoms. The balanced equation is $2Mg + O_2 \rightarrow 2MgO$

Remember : In special cases we represent the actual atomic state of an element. In that case symbol of the element is written in square bracket.

Eg: Hypochlorous acid ⟶ Hydrochloric acid + Nascent Oxygen

$$HClO \longrightarrow HCl + [O]$$

The practice of equalizing the number of atoms of elements on left hand side to the corresponding atoms on right hand side is called **balancing of equation.**

Consider one more example:

$$H_2 + O_2 \rightarrow H_2O$$

In this example, equal number of hydrogen atoms are there on either side but number of oxygen atoms are unequal. Hence Oxygen atom are to be balance first.

$$H_2 + O_2 \rightarrow 2H_2O$$

The hydrogen atoms on right hand side are four. Multiply the hydrogen molecule on left hand side by two to balance the hydrogen atoms. The balanced equation now will be

$$2H_2 + O_2 \rightarrow 2H_2O$$

Activity 11.4

Balance the following

- $Al + Cl_2 \rightarrow AlCl_3$ *[clue: multiply* $AlCl_3$ *by 2]*
- $KClO_3 \rightarrow KCl + O_2$ *[clue: multiply* $KClO_3$ *by 2]*
- $Pb_3O_4 \rightarrow PbO + O_2$ *[clue : multiply* Pb_3O_4 *by 2]*
- $Zn + HCl \rightarrow ZnCl_2 + H_2$

There is no particular method of balancing equations. It should be learnt by trial and error method. You will get used to it when you practise writing equations in the other lessons of this text book.

Let us recall some of the chemical reactions we have learnt in our previous class.

Types Of Chemical Reactions

Based on the nature of reactants and products the chemical reactions are classified as follows.

- Chemical combination
- Chemical decomposition
- Chemical displacement
- Chemical double decomposition or exchange

Chemical combination

Activity 11.5

When sulphur is ignited in air on a metal spoon, it burns with a pale blue flame, producing sulphur dioxide gas.

$$S + O_2 \rightarrow SO_2$$

This is combination between two elements.

Activity 11.6

Bring a glass rod dipped in liquor ammonia near the opened bottle of concentrated hydrochloric acid. Dense white fumes of ammonium chloride are observed.

$$NH_3 + HCl \rightarrow NH_4Cl$$

In this reaction two compounds react to form another compound.

Chemical combination is a reaction in which two or more elements or compounds combine to form a new product. An example of chemical combination with an important industrial application is the synthesis of ammonia by Haber's process.

$$N_2 + 3H_2 \rightarrow 2NH_3$$

(In Chemical combination, two or more reactants can combine to form a single product)

Know this : **Haber's process:** Ammonia gas is a raw material for manufacturing fertilizers. Haber designed a technology for synthesizing ammonia. He won Nobel prize in Chemistry for his contribution. In this process nitrogen and hydrogen are subjected to high pressure at a temperature of about 500 °C in presence of a catalyst (iron).

Activity 11.7

During lightning nitrogen and oxygen of the atmosphere combine. Can you list the reactants and products? Write the balanced equation of the reaction.

Chemical decomposition

Heat about 5 g of potassium permanganate in a test tube for some time. Bring a glowing incense stick near the mouth of the test tube. The glowing stick catches fire. It is because of the liberation of oxygen.

$$\underset{\text{(Potassium permanganate)}}{2KMnO_4} \xrightarrow{\text{heat}} \underset{\text{(potassium manganate)}}{K_2MnO_4} + \underset{\text{(manganese dioxide)}}{MnO_2} + \underset{\text{(oxygen)}}{O_2\uparrow}$$

The classic experiment of Joseph Priestley who prepared oxygen by heating mercuric oxide in a test tube by converging sun rays using a convex lens, is shown in the figure.

$$2HgO \rightarrow 2Hg + O_2 \uparrow$$

In **chemical decomposition** a compound breaks up into two or more new substances. Normally energy has to be provided for this purpose.

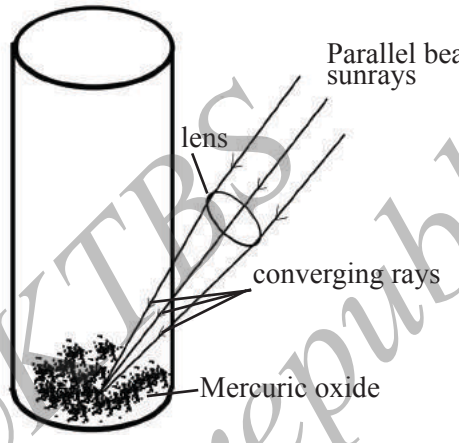


Fig. 11.1 Preparation of oxygen by heating mercuric oxide

In chemical decomposition a single reactant gives many products.

Recall : When electric current is passed through acidified water, water breaks up into hydrogen and oxygen. From this experiment it was shown that it was a compound. (Earlier water was considered as an element).

Chemical displacement

Activity 11.8

Immerse an iron nail in copper sulphate solution for some time. You will observe the deposit of copper on iron nail.

$CuSO_4 + Fe \rightarrow FeSO_4 + Cu \downarrow$

↓ The downward arrow in an equation indicates that it is precipitated and ↑ an upward arrow indicates that it is gas which is liberated

Note : Copper sulphate is poisonous, so be careful while handling

Activity 11.9

Take clear bleaching powder solution (which is a source of chlorine gas) in a test tube. Add potassium iodide solution. The solution turns pink due to the formation of iodine.

$$Cl_2 + 2KI \rightarrow 2KCl + I_2\downarrow$$

$$\left(\text{Chlorine}\right) + \left(\begin{matrix}\text{Potassium}\\ \text{iodide}\end{matrix}\right) \rightarrow \left(\begin{matrix}\text{Potassium}\\ \text{chloride}\end{matrix}\right) + \left(\text{Iodine}\right)$$

In the above two examples a more reactive metal or non metal displaces a less reactive metal or non metal respectively from their compounds. These are examples for *displacement reactions'*. Can you arrange copper, iron and silver in the increasing order of the reactivity?

Activity 11.10

Observe the following reaction:

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2\uparrow$$
(dilute)

Identify the displaced element and displacing agent in the above reaction.

In chemical displacement more reactive element displaces the less reactive element from their compounds.

Note : Though by displacement reaction we can deposit silver on iron or copper, it is not used as a method for coating. For coating silver on ornaments electroplating is used.

Chemical double decomposition or chemical exchange or chemical double displacement

Activity 11.11

Add sodium carbonate solution to magnesium sulphate solution in a test tube. We see a white precipitate of magnesium carbonate.

$$MgSO_4 + Na_2CO_3 \rightarrow MgCO_3\downarrow + Na_2SO_4$$

Activity 11.12

Add sodium carbonate solution to calcium chloride solution taken in a test tube.

We see a white precipitate of calcium corbonate

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$$

In the above two examples there is a mutual exchange of metallic and the non metallic parts. Such reactions are called double displacement or double decomposition reactions.

Activity 11.13

In the following example can you write the parts or radicals which are exchanged?

$$MgCl_2 + Na_2CO_3 \rightarrow MgCO_3\downarrow + 2\,NaCl$$

$$\left(\begin{matrix}\text{Magnesium}\\ \text{chloride}\end{matrix}\right) + \left(\begin{matrix}\text{sodium}\\ \text{carbonate}\end{matrix}\right) \rightarrow \left(\begin{matrix}\text{Magnesium}\\ \text{carbonate}\end{matrix}\right) + \left(\begin{matrix}\text{sodium}\\ \text{chloride}\end{matrix}\right)$$

word help:
Radical: A group of atoms behaving as a unit in chemical reaction

Now let us understand some other types of chemical reactions.

Neutralization Reaction

It is a type of a chemical reaction in which the reactants are a base and an acid, and the products are salt and water. It is a double decomposition reaction.

Activity 11.14

Add Hydrochloric acid solution to Sodium Hydroxide solution (base) taken in a test tube. We come across the following double decomposition reaction.

$$\underset{\text{(Base)}}{NaOH} + \underset{\text{(Acid)}}{HCl} \rightarrow \underset{\text{(Salt)}}{NaCl} + \underset{\text{(water)}}{H_2O}$$

Acids and bases are identified by their action on litmus. Acid turn moist blue litmus to red while bases turn moist red litmus blue. Since the products formed as a result of the reaction between acids and bases are neutral to litmus, the reaction is called neutralization.

Exothermic reaction

Reactions in which heat is released along with the formation of products are called exothermic chemical reaction.

Eg :- Burning of natural gas $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + Heat

Know this: Respiration is an exothermic process. During digestion carbohydrates present in our food are broken down to form glucose. The glucose combines with the oxygen in the cells of our body and provides energy. The special name for this exothermic reaction is RESPIRATION. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy

Endothermic reaction

Endothermic process describes a process or reaction in which the system absorbs energy in the form of heat from its surroundings.

Eg. Decomposition of Limestone into quicklime

$$CaCO_3 \xrightarrow{\text{heat}} CaO + CO_2$$

Oxidation and Reduction reaction

According to the old concept of oxidation, it is a reaction in which oxygen is added to a substance or hydrogen is removed from a substance.

Eg: Heat a china dish containing about 1 g of copper powder. The surface of copper powder becomes coated with black copper oxide.

$$2Cu + O_2 \xrightarrow{\text{heat}} 2CuO$$

Potassium permanganate, Potassium dichromate Potassium nitrate and Hydrogen peroxide are commonly used oxidizing agents.

Reduction is a type of chemical reaction in which oxygen is removed from a substance or hydrogen is added to a substance.

Eg : If Hydrogen gas is passed over hot Cupric Oxide material, the black coating on the surface turns brown due to the formation of copper.

$$CuO + H_2 \xrightarrow{\text{heat}} Cu + H_2O$$

Carbon, Magnesium, Hydrogen sulphide and Sulphur dioxide are commonly used reducing agents.

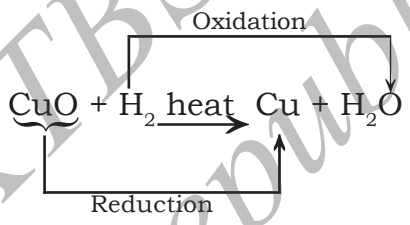
In terms of electronic theory, oxidation is a process of removal of electrons. Reductions is a process of addition of electrons.

Oxidation Reactions	Reduction Reactions
Addition of oxygen and Removal of Hydrogen	Addition of Hydrogen and Removal of Oxygen
Removal of electrons takes place (loss of electrons)	Addition of electrons takes place (gain of electrons)

Redox reactions or Oxidation-Reduction reactions

If in a reaction one reactant gets oxidized while the other reactant gets reduced. such a reactions are called Oxidation-Reduction reactions or Redox reactions.

Eg : Reaction between Cupric Oxide and Hydrogen.



Effects of Oxidation reactions in everyday life

- Ornaments loses their lustrous nature.
- Corrosion : When a metal is attacked by substances around it such as moisture, acids etc., it is said to corrode and the process is called corrosion.

The black coating on silver and green coating on copper are due to corrosion.

- Rancidity : When fats and oils are oxidized, they become rancid and their smell and taste change. Keeping food in a air tight container helps to slow down oxidation. Usually antioxidants such as nitrogen gas flushed into bags containing food.

Find out : Why is nitrogen flushed into pockets of chips ?

Know this : Gel bags are used in food preservatives.

Reversible Reactions

Usually chemical reaction proceed only in one direction. But in some cases the reaction reverses itself. Such chemical reactions are called reversible reactions.

Eg: When we pass steam over red hot iron, magnetic oxide of iron and hydrogen are formed. If hydrogen is passed over heated magnetic oxide of iron, the reverse reaction takes place, producing iron and steam.

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

Reversibility of a reaction is depicted by double arrow as shown in the example.

Thermal Dissociation

This is also a type of reversible reaction, in which a substance gets decomposed by heat. But as soon as the products are cooled, they combine to form the original substance. Here products are not allowed to escape.

Eg: When Ammonium chloride is heated, it decomposed to form ammonia and hydrogen chloride gas. Here NH_3 and HCl gases are not allowed to escape from the container after their formation. Now they will combine together to form Ammonium chloride.

$$NH_4Cl \rightleftharpoons NH_3 + HCl$$

Project Work:

Collect information about

1) Photolytic reaction Or Photolysis
2) Enzymatic reaction
3) Catalytic reaction

You have learnt

- Differences between physical and chemical changes.
- Different types of chemical reactions.
- Writing equations for different types of chemical reactions.
- Writing and balancing chemical equations.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer:

1. Balancing of equations is based on,
   a. Avogadro number
   b. principle of conservation of momentum
   c. conditions for a chemical reaction to take place
   d. law of conservation of mass or matter
2. Identify the balanced equation in the following.
   a. $SiO_2 + Mg \rightarrow Si + MgO$
   b. $SiO_2 + 2Mg \rightarrow Si + 2\ MgO$
   c. $SiO + Mg \rightarrow Si + MgO_2$
   d. $SiO_2 + Mg \rightarrow SiO + 2MgO$
3. Correct statement about chemical displacement is,
   a. less reactive element displaces more reactive element
   b. a non-metal displaces more reactive non metal
   c. more reactive element displaces less reactive element
   d. evolution of heat when carbon is burnt in air
4. Dissolving sugar in water is not an example for chemical reaction because,
   a. there is no change in energy
   b. sufficient heat is not produced
   c. no new substances are formed
   d. no gases are evolved
5. Which of the following represents combination of two compounds forming another compound ?
   a. $2SO_2 + O_2 \rightarrow 2\ SO_3$
   b. $CaCO_3 \rightarrow CaO + CO_2\uparrow$
   c. $H_2O + SO_2 \rightarrow H_2SO_3$
   d. $2Na + 2H_2O \rightarrow 2\ NaOH + H_2\uparrow$

II. Balance the following reactions :

1. $Cu + H_2SO_4 \dashrightarrow CuSO_4 + SO_2\uparrow + H_2O$
2. $Fe + H_2O \dashrightarrow Fe_3O_4 + H_2\uparrow$
3. $CH_4 + O_2 \rightarrow CO_2 + H_2O$

III. Answer the following:

1. Write any three differences between physical change and chemical change.
2. Group the following into physical change and chemical change.

   Dissolving salt in H_2O, Burning of a fuel,

   Rusting of iron, melting of ice cube.
3. Mention one example each for the different types of chemical reactions.
4. Classify the following into chemical combination, decomposition, displacement and double displacement reaction.

   a) $CaCO_3 \xrightarrow{heat} CaO + CO_2\uparrow$ b) $2AgNO_3 + Cu \rightarrow Cu(NO_3)_2 + 2Ag\downarrow$

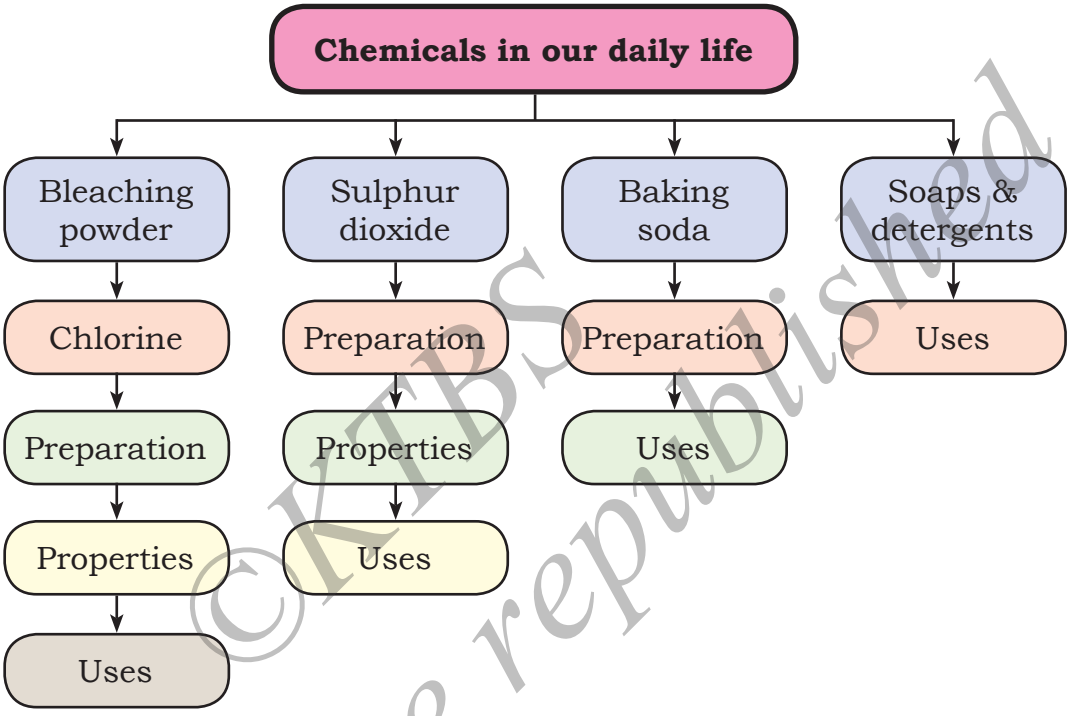
   b) $2SO_2 + O_2 \rightarrow 2SO_3\uparrow$ d) $NaCl + AgNO_3 \rightarrow AgCl\downarrow + NaNO_3$
5. Write the advantages of writing a chemical equation using formulae and symbols.
6. During winter many plant leaves fallen on the earth do not cause pollution. But plastic papers which are thrown on the earth cause pollution. Name the types of chemical reaction associated with this observation.
7. L.P.G. gas contains butane. Its molecular formula is C_4H_{10}. Name the possible products obtained by its complete combustion.
8. Suggest some measures to avoid rancidity of oils.

IV. Give scientific reason for the following.

1. Iron displaces copper from copper sulphate but copper cannot displace iron.
2. Respiration is an exothermic reaction.
3. In chemical equations oxygen is represented as O_2 but not O and chlorine is represented as Cl_2 but not Cl.
4. Use of plastic must be avoided or minimized.

CHAPTER 12

CHEMICALS IN OUR DAILY LIFE



Properties and Uses of Chlorine - Preparation,

We use a number of chemicals in our daily life. Can you imagine your food without salt? It is tasteless. Common salt gives taste to our food. What is the chemical name of common salt? What are the constituent elements present in it ?

You might have smelt pungent odour of bleaching powder used at home. Do you know that one of the constituents is common to common salt and bleaching powder? Yes, it is chlorine. As a chemical chlorine plays an important role in our daily life.

In this chapter we learn more about chlorine and other chemicals that we use in our daily life.

Minerals containing Chlorine : Halite or rock salt, sylvite, carnallite, chlorapatite are the most common minerals of chlorine.

Chlorine occurs commonly both in the earth's crust and in sea water.

Find out : An atom of Chlorine has 17 electrons. What is the number of protons present in an atom of chlorine.?

Activity 12.1

When you purchase medicines, read the constituents of the medicine on its wrapper and list out the chlorine compounds used in the medicines.

Chlorine is used for various purposes .Now let us learn about the process of manufacture of chlorine on a large scale.

In industry, chlorine is produced by passing electric current through an aqueous solution of sodium chloride or through molten sodium chloride (electrolysis). The products produced along with chlorine are sodium hydroxide (NaOH) and hydrogen (H_2).

Know this : Solutions made using water are called *aqueous* solutions. The solid state is converted into liquid state when sufficiently heated. The liquid state of matter is called *molten* state. Insoluble substance that is formed in a reaction is called *precipitate.*

Carl Wilhelm Scheele

Carl Wilhelm Scheele

In 1774, Swedish chemist Carl Wilhelm Scheele tried the reaction of hydrochloric acid on manganese dioxide. He observed a greenish gas. He thought that the liberated gas was oxygen. In 1810 Sir Humphrey Davy identified the gas as a distinct chemical element and named it "chlorine". The name chlorine has originated from the Greek word *'chloro'* meaning *'green'.*

We can prepare a small quantity of chlorine in in the laboratory.

Method 1

Set up the apparatus as shown in figure 12.1. Take nearly 20 g of manganese dioxide in the flask. Add concentrated hydrochloric acid to it through a thistle funnel, the tip of which is dipped in the acid. Heat the flask.

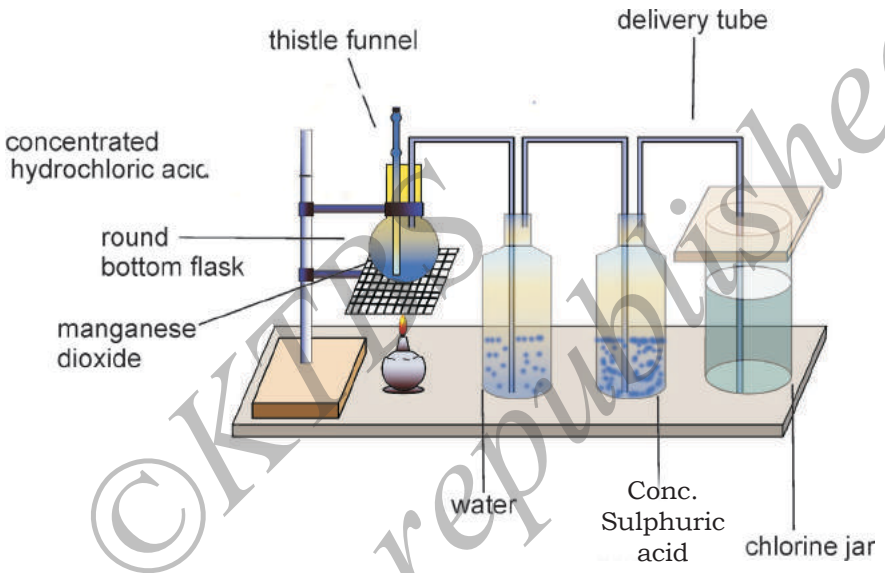


Fig. 12.1 Preparation of Chlorine

Now observe the colour of the liberated gas in the flask . Pass the liberated greenish yellow gas through a jar of water to remove the fumes of hydrogen chloride and next through another jar of concentrated sulphuric acid to remove the moisture from the gas. This gas is collected in the jar by the upward displacement of air.

$$\underset{\text{(Manganese dioxide)}}{MnO_2} + \underset{\text{(conc. Hydro Chloric acid)}}{4HCl} \xrightarrow{\text{heat}} \underset{\text{(Manganese chloride)}}{MnCl_2} + \underset{\text{(chlorine)}}{Cl_2\uparrow} + \underset{\text{(water)}}{2H_2O}$$

Method 2

The apparatus is set up as shown in figure 12.2. When concentrated hydrochloric acid is added drop by drop to solid potassium permanganate, chlorine gas is liberated. The liberated gas is collected in separate bottles by the upward displacement of air.

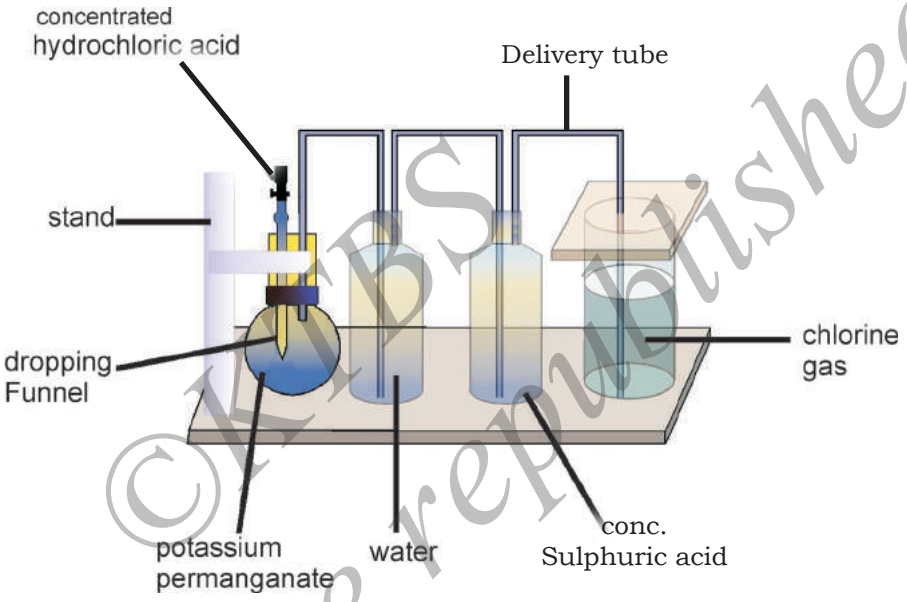


Fig. 12.2 Preparation of Chlorine

$$\underset{\text{Potassium permanganate crystals}}{2KMnO_4} + \underset{\text{conc Hydrochloric acid}}{16HCl} \xrightarrow{\text{Heat}} \underset{\text{potassium chloride}}{2KCl} + \underset{\text{Manganese chloride}}{2MnCl_2} + \underset{\text{Chlorine}}{5Cl_2} + \underset{\text{water}}{8H_2O}$$

Think : The liberated gas is collected using a gas jar by the upward displacement of air. Why?
Thistle funnel should be dipped in the acid, why?

Know this : One can get chlorine gas by using vinegar and bleaching powder.

Collect chlorine in five jars and conduct the following Activity

Activity 12.2

Experiment	Observation	Inference
Observe the colour of chlorine in the jar	*pale greenish yellow*	*Shows that chlorine gas has colour.*
Hold a wet blue litmus paper in a chlorine jar.	*blue litmus becomes red*	*Shows its acidic property*
Introduce a few rose petals soaked in water in a jar of chlorine.	*decolourises*	*Shows the bleaching property of chlorine*
Introduce a few rose petals into jar of chlorine without soaking in water	*colour does not disappear quickly.*	*It shows that in the absence of water bleaching action will not take place.*
Introduce a burning candle into a jar of chlorine gas	*burns with dull and sooty flame*	*It shows that chlorine is a supporter of combustion (but not like oxygen)*

On the basis of the above activities list the physical properties of chlorine.

Chemical properties

Let us learn about the chemical properties of chlorine.

1. Introduce a burning magnesium ribbon into a jar of chlorine with the help of a pair of tongs. What do you observe? What is the colour of magnesium chloride? Write the chemical equation.

$$\underset{\text{(Magnesium)}}{Mg} + \underset{\text{(Chlorine)}}{Cl_2} \rightarrow \underset{\text{(Magnesium Chloride)}}{MgCl_2}$$

2. Chlorine reacts with hot red phosphorus giving phosphorus pentachloride

$$\underset{\text{(Phosphorus)}}{2P} + \underset{\text{(chlorine)}}{3Cl_2} \rightarrow \underset{\text{(Phosphorus trichloride)}}{2PCl_3} \quad \text{[limited supply of chlorine]}$$

$$\underset{\text{(phosphorus)}}{2P} + \underset{\text{(chlorine)}}{5Cl_2} \rightarrow \underset{\text{(phosphorus pentachloride)}}{2PCl_5} \quad \text{[excess supply of chlorine]}$$

3. Introduce a small piece of dry sodium into a jar containing chlorine. What do you observe? Name the product formed in the jar. Write the chemical equation. Sodium burns vigorously with golden yellow flame.

   [Caution: Conduct this experiment carefully in presence of your teacher]

   $2Na + Cl_2 \rightarrow 2NaCl$

   (Sodium) (Chlorine) (Sodium Chloride)

4. Sprinkle heated aluminium powder into a jar of chlorine. What do you observe? Name the product formed in the jar. Write the chemical equation.

   $2Al + 3Cl_2 \rightarrow 2AlCl_3$

   (Aluminium) (Chlorine) (Aluminium trichloride)

   Aluminum particles burn with bright flashes of light.

5. When chlorine gas is dissolved in water, hypochlorous acid is formed. This Hypochlorous acid releases nascent oxygen [atomic form of oxygen is called *nascent* oxygen(O)] and gets converted into hydrochloric acid. Nascent oxygen is a powerful oxidising agent and this is responsible for bleaching and sterilizing properties of chlorine.

Know this: Chlorine was first used in the sterilisation of drinking water in the 19th century to control the spread of water-borne diseases such as typhoid, cholera, dysentery and gastro-enteritis [number of people killed by these diseases was more than the number that were killed in all wars in history.]

Know this : In addition to sterilisation of water, chlorine controls the growth of slime and algae in main pipes and storage tanks, and helps to remove unwanted nitrogen compounds from water.

Find out : Collect information about the method of sterilization without using chemicals.

Note : Use of excess chlorine should be avoided in the treatment of drinking water.

Uses

1. Chlorine is used in the manufacture of bleaching powder.
2. It is used in the manufacture of hydrochloric acid.
3. It is used in paper and pulp industry.
4. It is used as a bleaching agent and in purification of water.
5. It is used in the manufacture of polyvinylchloride (PVC) and chlorofluorocarbons (CFC)
6. Chlorine is used in the preparation of pesticides like benzene hexachloride commonly called BHC, dichloro diphenyl trichloroethane(DDT).
7. Medical applications:
   - Common salt is the basic component of intravenous saline solutions.
   - It is used in the preparation of chloroform which is used as an anaesthetic.

Think : Overuse of bleaching powder should be avoided in toilet pit system. Why?

Know this : When chlorine gas is passed into slaked lime at 400 ^{0}C, bleaching powder is formed.

$$\underset{\text{(calcium hydroxide)}}{Ca(OH)_2} + \underset{\text{(chlorine)}}{Cl_2} \xrightarrow{400^0C} \underset{\text{(calcium oxychloride)}}{Ca(OCl)_2} + \underset{\text{(water)}}{H_2O}$$

Know this : Bleaching is the process of whitening or removing the natural colour of textile fibre, yarns and fabrics, organic substances and of wood pulp by treatment with chemicals.

Know this : CFC was used in refrigerators. Collect information about its harmful effects.

Know this : DDT was first prepared in 1873, but was not used as a pesticide until World War II (1939-45).
Public health officials were at first delighted to learn that DDT kills disease-carrying insects very efficiently and they found it could kill many of the pests that attacked crops. By the end of the 1950s, many farmers were spraying huge amount of DDT on their land to get rid of pests.
The adverse effect of DDT on human health is now scientifically established. (For more details refer chapter 2).

Sulphur dioxide:

Preparation, Properties and Uses

Egg yolk, cauliflower, radish, onion and garlic contain sulphur. Our hair, nails and skin also contain sulphur. When they are burnt a characteristic smell is produced. The peculiar smell is due to the presence of sulphur dioxide. Let us learn more about sulphur dioxide.

Know this: During the extraction of copper and mercury from copper pyrites and cinnabar respectively, sulphur dioxide is released. In the purification of petroleum, sulphur dioxide is released. Sulphur dioxide is released from coal in power plants and during volcanic eruptions.

Discovery of Sulphur Dioxide: Joseph Priestley prepared sulphur dioxide in the year 1774 by heating concentrated sulphuric acid with mercury and called it "Vitriolic acid air". But it was Lavoisier, who proved that it was an oxide of sulphur.

Let us learn the methods by which sulphur dioxide can be manufactured.

1. Sulphur is present in many minerals. One of the them is mercuric sulphide. It is commonly called cinnabar. The sulphide ore burns in the presence of air and sulphur dioxide is obtained as a byproduct.

$$\underset{\text{(Mercuric Sulphide)}}{HgS} + \underset{\text{(oxygen)}}{O_2} \rightarrow \underset{\text{(Mercury)}}{Hg} + \underset{\text{(sulphur dioxide)}}{SO_2\uparrow}$$

2. During the extraction of zinc from zinc blende, sulphur dioxide is obtained as a byproduct.

$$\underset{\text{(Zinc sulphide)}}{2ZnS} + \underset{\text{(oxygen)}}{3O_2} \rightarrow \underset{\text{(zinc oxide)}}{2ZnO} + \underset{\text{(sulphur dioxide)}}{2SO_2\uparrow}$$

3. Let us study the laboratory method of preparation of sulphur dioxide and some of its properties. Copper turnings and concentrated sulphuric acid are used in the preparation of sulphur dioxide.

   The heating of concentrated sulphuric acid with copper turnings yields copper sulphate, sulphur dioxide and water.

$$\underset{\text{(Copper)}}{Cu} + \underset{\text{(sulphuric acid)}}{2\,H_2SO_4} \xrightarrow{heat} \underset{\text{(copper sulphate)}}{CuSO_4} + \underset{\text{(sulphur dioxide)}}{SO_2\uparrow} + \underset{\text{(water)}}{2\,H_2O}$$

Observe figure12.3. Describe the arrangement of the apparatus in your own words.

Set up the apparatus as shown. Take about 5g of copper turnings (pieces) in the round bottom flask fitted with a thistle funnel and a delivery tube. Fix the flask to a stand. Add about 10ml of concetrated sulphuric acid into the flask through the funnel. Heat the flask. Pass the liberated gas through a jar of concentrated sulphuric acid to dry the gas. Sulphur dioxide is collected in the jar by the upward displacement of air.

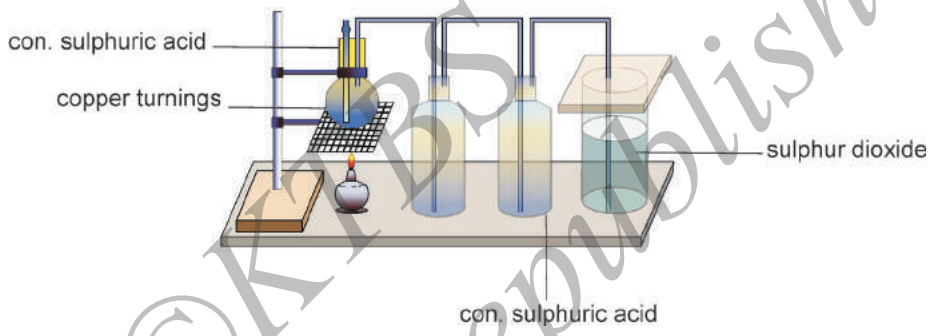


Fig. 12.3 Preparation of Sulphur dioxide

with the help of your teacher you can prepare sulphur dioxide by using sodium sulphite crystals and dilute hydrochloric acid or dilute sulphuric acid by using same apparatus set up shown above. The chemical equation is given below.

$$Na_2SO_3 + 2\,HCl \longrightarrow 2NaCl + H_2O + SO_2$$

(Sodium sulphite) (dil. Hydrochloric acid) → Sodium chloride Water Sulphur dioxide

Collect sulphur dioxide in two jars and conduct the following tests

Activity 12.3

Experiment	***Observation***	***Inference***
Introduce a burning candle into a jar of sulphur dioxide gas	*Flame is extinguished.*	*Not a supporter of combustion*
Pass sulphur dioxide for about five minutes into a 400 ml beaker half filled with water. Dip a wet blue litmus paper.	*Blue litmus turns red.*	*Solution is acidic.*

Based on the above observations, list the properties of sulphur dioxide. In addition to this, note that sulphur dioxide is colourless and has a pungent smell. Do not smell the gas directly.

Activity 12.4

Heat sulphur in a spoon. Hold a most blue litmus paper to the liberated gas. What do you observe?

Now let us study about the action of sulphur dioxide on water, moisture and magnesium.

1 Sulphur dioxide reacts with water to give sulphurous acid.

$$\underset{\text{(sulfur dioxide)}}{SO_2} + \underset{\text{(water)}}{H_2O} \rightarrow \underset{\text{(sulphurous acid)}}{H_2SO_3}$$

Acid rain: Water molecules in the atmosphere react with sulphur dioxide to form acid rain. This acid rain corrodes monuments, statues and buildings. It affects the fertility of the soil and plant growth. In certain industrial regions, the atmosphere contains more sulphur dioxide.

Find out : What is the difference between sulphuric acid and sulphurous acid ?

Collect sulphur dioxide in three jars and conduct activity 12.5 to study the properties of sulphur dioxide.

Activity 12.5

Experiment	***Observation***	***Inference***
1. Introduce a few petals of rose flower soaked in water in to a jar of sulphur dioxide.	*Decolourisation takes place.*	*Acts as bleaching agent.*
2. Take out the petals from the jar and expose them to air.	*Colour is regained.*	*Bleaching action is temporary.*
3. Introduce a few petals of rose flowers into a jar of sulphur dioxide without soaking in water.	*No change.*	*Dry sulphur dioxide is not a bleaching agent.*

1. Sulphur dioxide bleaches by reduction process. Bleaching is temporary.
2. Keep a burning magnesium ribbon in a jar containing sulphur dioxide.What do you observe?

Magnesium continues to burn displacing sulphur particles which stick to the jar.

$$\underset{\text{(Magnesium)}}{2Mg} + \underset{\text{(sulphur dioxide)}}{SO_2} \rightarrow \underset{\text{(Magnesium oxide)}}{2MgO} + \underset{\text{(sulphur)}}{S}$$

Think: Sulphur dioxide does not burn and also does not help in burning. Then how does magnesium burn?

Uses of sulphur dioxide

1. Sulphur dioxide is used in the manufacture of sulphuric acid. It is the raw material for the manufacture of detergents, fertilizers and many medicines.
2. It prevents the growth of bacteria and fungi. Hence it is used to increase the shelf life of foods.
3. In sugar industry sulphur dioxide is used to remove colouring matter from sugar.
4. It is used to prevent decolourisation of dried fruits.

Know this : Sulphur dioxide is oxidized to sulphur trioxide and treated with water to form sulphuric acid. Commonly used fertlizer ammonium sulphate is obtained by the action of sulphuric acid on ammonia gas.

Sulphuric acid is one of the most important industrial products used in the preparation of variety of chemcials.

Sodium bicarbonate (Baking soda)

You might have heard about using sodium bicarbonate while cooking some types of food. why ? Let us learn more about baking soda.

Baking soda is manufactured by passing carbon dioxide through saturated sodium carbonate solution in water.

$$\underset{\text{(Sodium carbonate)}}{Na_2CO_3} + \underset{\text{(carbon dioxide)}}{CO_2} + \underset{\text{(water)}}{H_2O} \rightarrow \underset{\text{(sodium bicarbonate)}}{2NaHCO_3}$$

Activity 12.6

- *Place a bottle on the table and remove the lid. Carefully pour 2 table spoons of vinegar into the bottle.*
- *Put 1 teaspoon of baking soda into a balloon using a separate spoon.*
- *Without spilling baking soda, stretch the mouth of the balloon over the mouth of the bottle.*
- *Turn the balloon completely upright so that baking soda inside the balloon falls into the bottle on the vinegar. Watch!*
- *What happens inside the bottle?*
- *What happens to the balloon? Why?*

Activity 12.7

Prepare solutions of the following substances:

washing soda, calcium hydroxide, lemon juice, bleaching powder, vinegar, detergent, baking soda, and Soda water.

Put a drop of each of the above solutions on a separate watch-glasses and test by dipping red and blue litmus papers.

What happens? Why?

Activities 12.8

- *Take a spoon of baking soda. Observe its colour and physical state*
- *Put blue and red litmus into the solution of baking soda. What happens? What do you understand?*
- *Take aqueous sodium bicarbonate solution in a test tube and heat it. The evolved gas is passed through lime water. What do you observe? Which is the gas liberated?*
- *Squeeze a piece of lemon on sodium bicarbonate in a test tube. What happens? Pass the gas through lime water. What happens?*

Based on the above activities list out the properties of Sodium bicarbonate

Uses of baking soda

- Baking soda is the component of baking powder used in bakery to make the bakery items.
- Sodium bicarbonate is used in medicine as an antacid, to neutralize excess of acid formed in the stomach.

- It is used as a mild cleaning agent.
- It is used to prepare aerated water (soda water)

Soaps and detergents

We are familiar with soap. Cleanliness is a good hygienic practice. You know different types of cleaning materials like shampoo, washing soap, toilet soap so on. A cleaning substance made from animal fats or vegetable oil is called soap. A cleaning substance which is made using petroleum products is called detergent. Wash the clothes in hard water using soap and detergent. What difference do you find? Soap does not give lather with hard water easily. why? There are different forms of soaps available in the market. Now let us discuss the manufacture of soap, detergent and liquid soap in detail.

Why are detergents called soapless soaps?

Detergent acts like a soap in the cleansing properties, they do not contain chemicals like sodium stearate.

The kettle method of making soap on a small scale is used even today. The raw materials used on a small scale are oil, sodium hydroxide or potassium hydroxide and common salt.

The mixture of fats and sodium hydroxide is allowed to boil in the kettle using a heating coil within the kettle. After boiling, the mass thickens as the fat reacts with sodium hydroxide producing soap and glycerine. Salt is added to separate soap from glycerine. The soap forms a layer at the top and the glycerine settles at the bottom. The glycerine is taken out from the bottom of the kettle. Soap is taken off from the top. The soap is then cooled.

Oil/fat + sodium hydroxide → soap + glycerine

Know this : Glycerol or Glycerine is a sweet viscous liquid soluble in water. It is used in the manufacture of explosives, plastics and pharmaceuticals.

Activity 12.9

Are you interested in preparing soap? Take 30 ml of vegetable oil in a beaker. Dissolve 20 g of sodium hydroxide in 100 ml of water in another beaker. Take 60 ml of this solution and add this to 30ml of oil. Heat the mixture slowly until the

mixture boils. After 15-20 minutes of boiling, add about 5 g of sodium chloride to the mixture. Stir well. What do you observe? Take soap out of the beaker and spread it on a tray and allow it to dry. Now soap is ready to be used.

During the World War I, Germany developed detergents as there was a shortage of fats for making soaps. Let us consider a method of manufacturing detergents. Long chain hydrocarbons obtained from petroleum are treated with concentrated sulphuric acid. Then it is neutralized with sodium hydroxide. The sodium salt thus obtained is detergent.

Think : Overuse of synthetic detergents causes water pollution. Why?

Now-a-days, we use liquid soap in our daily life. Let us consider a method of manufacturing liquid soap. Heat the mixture of oil and potassium hydroxide solution and stir well. As the soap boils, it will be converted to gel phase. Add distilled water and stir well. Add little scent. Liquid soap is ready.

You have learnt

- Chemicals used in our daily life.
- Compounds containing chlorine and sulphur.
- Laboratory preparation of chlorine and sulphur dioxide.
- Properties and uses of chlorine and sulphur dioxide.
- Manufacture and uses of baking soda.
- Uses of soaps and detergents.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements/ questions. Choose the right answer:

1.Chlorine is prepared in the laboratory by the action of,

a. Zn and HCl b. MnO_2 and HCl

c. $CaCO_3$ and HCl d. $Pb(NO_3)_2$ and HCl

2. The chief sources of oils used to make soap are,

a. petroleum products b. coal and coke

c. animals and plants d. detergent

II. Fill in the blanks:

1. $MnO_2 + 4HCl \rightarrow MnCl_2 +$ _____ + _____ .
2. Common name of sodium chloride is _____ .
3. Chemical name of baking soda is _____ .

III. Answer the following :

1. Pure and dry chlorine gas is collected by the upward displacement of air. Give reason.
2. Name the compound of chlorine
   1. which is an anaesthetic
   2. which is used as a refrigerant
   3. which is a disinfectant
   4. which is used to make pipes and tubes
   5. which liberates chlorine on exposure to air.
3. Mention four uses of chlorine.
4. Name the metal and the acid required to prepare sulphur dioxide in the laboratory.
5. Name the acid formed when sulphur dioxide dissolves in water.
6. Give two uses of sulphur dioxide.
7. Mention any two differences between soap and detergent
8. How is detergent industrially manufactured?
9. Why is detergent better than soap in cleaning action?

Project Work :

Visit a water treatment plant and collect information about purification of water.

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