GOVERNMENT OF TAMILNADU

STANDARD NINE

TERM III

VOLUME 3

NOT FOR SALE

Untouchability is Inhuman and a Crime

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STANDARD NINE

TERM III

Note to the teacher…

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

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

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

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

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

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

The "More To Know" snippets in the text represents some unusual and interesting facts or information in which the students need not be examined.

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

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

- Authors

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Physiology involves the study of the physical, chemical and biological functions of plants.

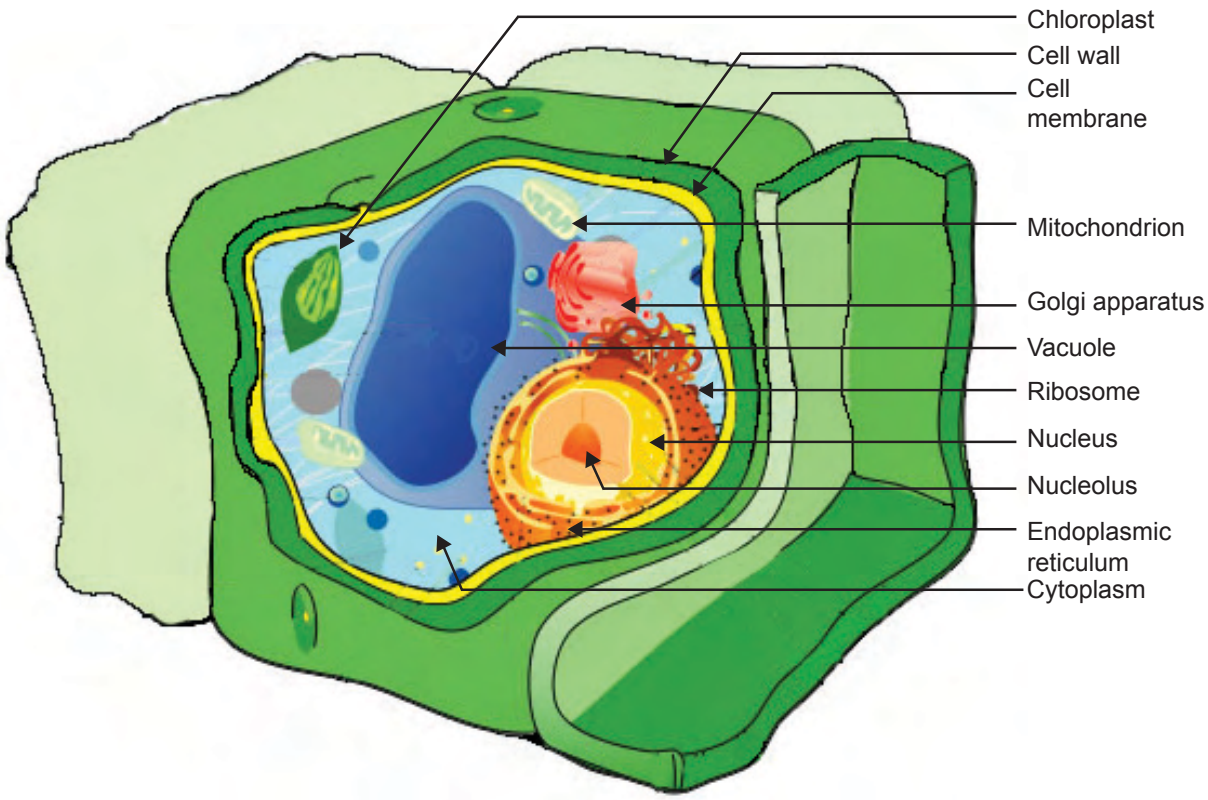
1.1. PLANT CELLS

Cells are the structural and functional units of all living organisms. The study of the structure and function of the cell is called Cytology or Cell biology.

A plant cell is typically rectangular or cube shaped. It has an outer covering called cell wall which protects and gives it shape. A cell membrane, also known as the plasma membrane, surrounds the cytoplasm and its organelles. The plasma membrane, cytoplasm and the nucleus together are referred to as the protoplast. The cytoplasm carries various cell organelles like endoplasmic reticulum, mitochondria, chloroplast, Golgi bodies and ribosomes.

Groups of cells having a common origin and performing similar functions are called tissues.

Structure of a Plant Cell



ACTIVITY 1.1 **I DO**

I cut a small piece of onion and separate the peel. I place the peel on a glass slide in a drop of water. I put a drop of methylene blue on the peel. I wash it in water to remove the excess stain. I put a drop of glycerine and cover it with a cover-slip. I observe it under the microscope.

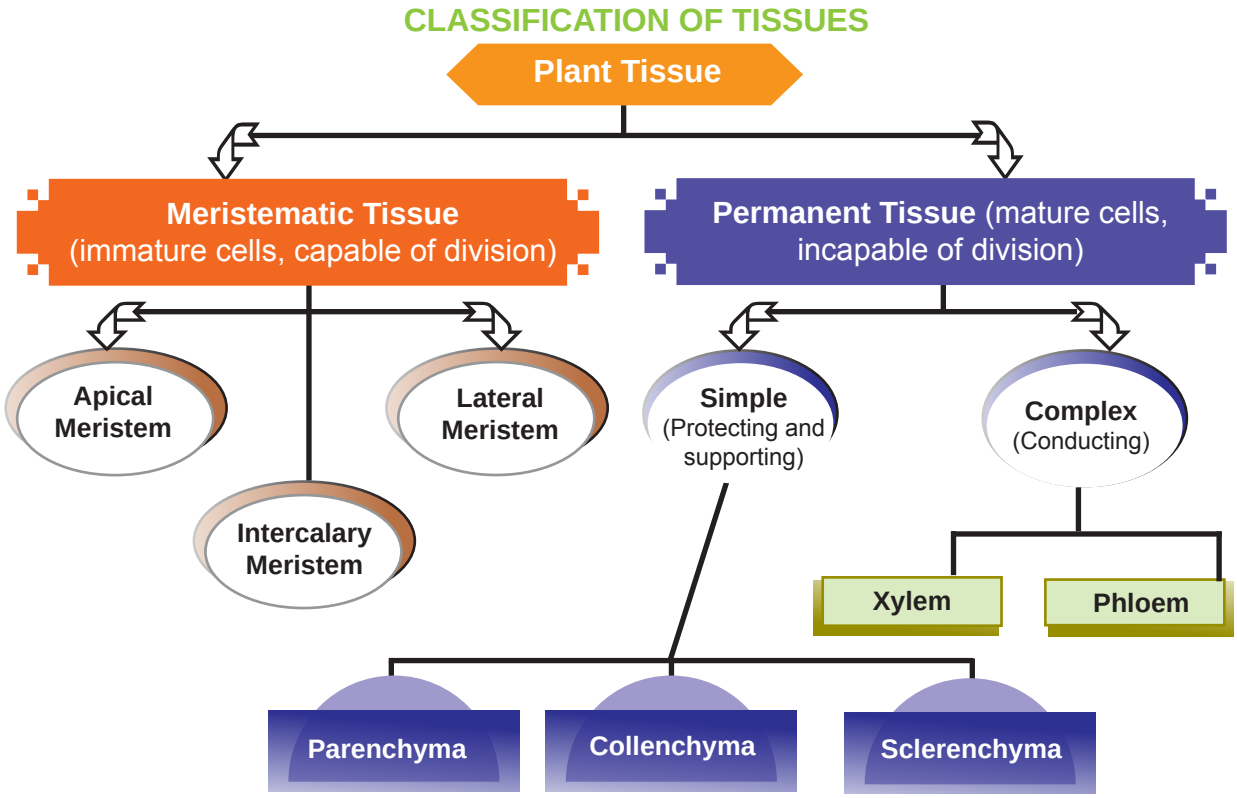
The boundary of the onion peel is the cell membrane covered by another thick outer covering called cell wall. The central dense round body in the centre of the cell is called nucleus. The substance between the nucleus and cell membrane is called cytoplasm.

1.2. TISSUES

Types, Structure and Function of Plant Tissues

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

The diagram given below shows the classification of different tissues:

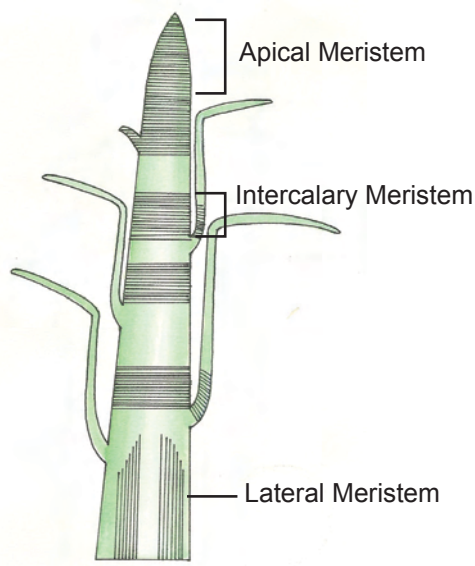


Meristematic Tissues

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

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

i) **Apical meristems:** Apical meristem is present at the growing tips of stems and



Longitudinal section of a shoot showing position of meristems

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roots and increases the length of the plant body.

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

iii) **Lateral meristems:** This includes the meristematic tissues that occupy the lateral regions of stems and roots. They bring about increase in the width of the plant body. (e.g. cork cambium and vascular cambium).

Characteristic features of meristematic tissues

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

What happens to the cells formed by meristematic tissues?

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

Transverse section of a sunflower stem

ACTIVITY 1.2 **I DO**

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

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

Permanent Tissues

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

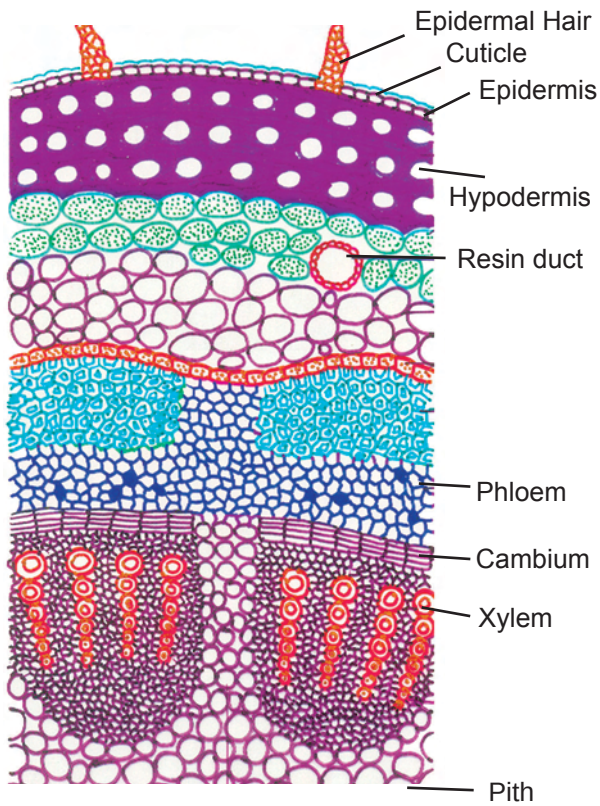
Permanent tissues are classified as:

i) Simple tissues

ii) Complex tissues

Simple Tissues

A tissue made up of cells having similar structure (one type of cells) and function



Enlarged section of a sunflower stem

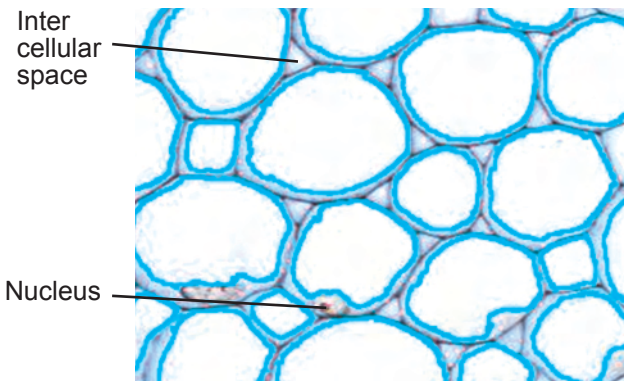
is called simple tissue. They are of three types:

a. Parenchyma
b. Collenchyma
c. Sclerenchyma

Parenchyma

The cells of the parenchyma are generally thin-walled with intercellular spaces. They are living cells. They are present in all the organs of a plant. They may be oval, spherical, rectangular or cylindrical in shape. The cell wall is made of cellulose and pectin.

Parenchyma cells serve to store and conduct food materials, water and minerals.



Parenchyma

ACTIVITY 1.3 **I DO**

- *I take a plant stem and cut it into very thin slices or sections.*
- *I stain the slices with saffranin. I place one neatly cut section on a slide and put a drop of glycerine on it.*
- *I place a cover-slip over it and observe it under a microscope. I observed the various types of cells and their arrangement.*

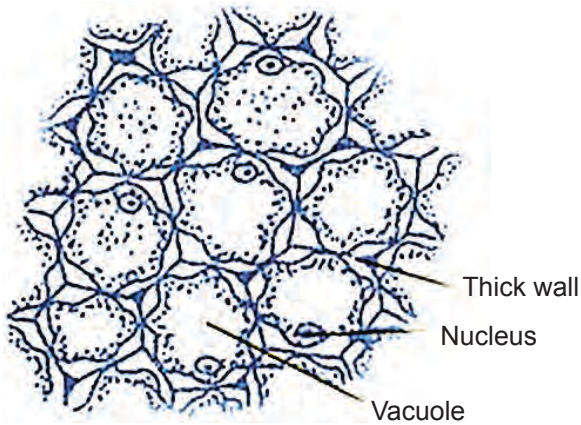
a. Are all cells similar in structure?

b. How many types of cells can be seen?

Collenchyma

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

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



Collenchyma

Sclerenchyma

Sclerenchyma is a dead tissue. The cells are thick with lignified walls. They give mechanical support to the organs.

This has two types of cells-sclereids and fibres.

Sclereids : Sclereids are stone cells which are commonly found in the shells of the nut and pulp of certain fruits such as pear and sapota.

Fibres : Fibres are elongated strands with simple pits throughout its length.

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Complex Tissues

A tissue that consists of several kinds of cells but all of them function together as single unit is called complex tissue.

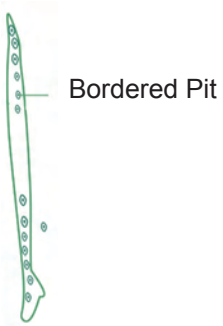
Xylem

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

It is composed of different kinds of cells, namely:

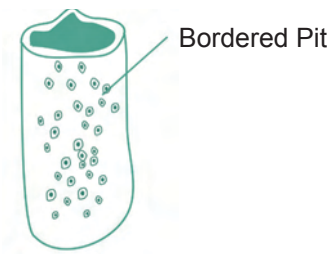
a. Tracheids b. Xylem Vessels
c. Xylem Fibres d. Xylem Parenchyma

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



Tracheid

b. Xylem Vessels : Xylem vessels have perforations at the end and are placed one above the other like a long pipe-line. They are seen in the xylem of angiosperms. They conduct water, mineral nutrients and also provide mechanical strength to the plant body.

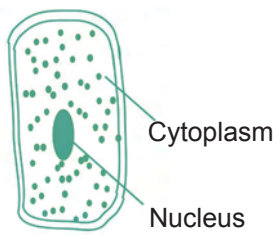


Xylem Vessel

c. Xylem Fibres : The fibres of sclerenchyma associated with xylem are known as xylem fibres. They give additional mechanical strength to the plant. They are also called as wood fibres.

Xylem Fibre

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



Xylem Parenchyma

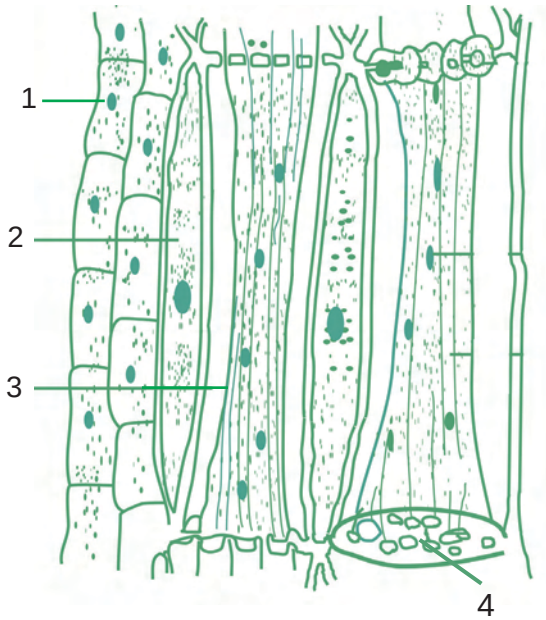
Phloem Tissue

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

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

a. Sieve Elements : Sieve elements are the conducting elements of the phloem. Sieve elements are of two types sieve cells and sieve tubes.

Phloem Tissue



1. Phloem parenchyma 2. Companion cell
3. Sieve tube 4. Sieve plate

Sieve cells are present in Pterido-phytes and Gymnosperms whereas sieve tubes are present in Angiosperms.

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

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

d. Phloem Parenchyma: The parenchyma cells associated with phloem are called phloem parenchyma. They store starch and fats.

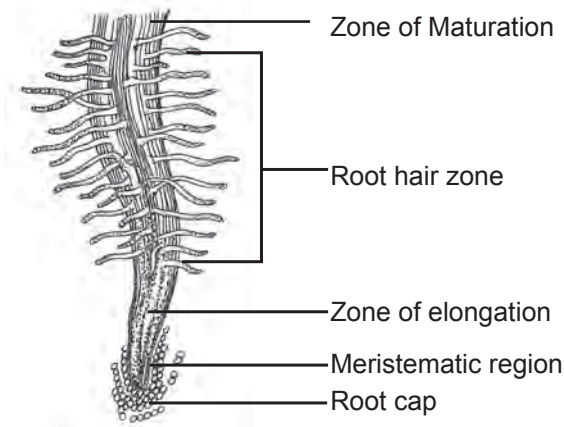
1.3. PLANT FUNCTIONS

Plants germinate from seeds, grow, develop, mature, reproduce and die. They perform absorption, photosynthesis, respiration, transportation and transpiration. Plant physiology deals with how plants function.

Water is essential for all physiological activities of plants. It plays an important role in physiological activities like photosynthesis, respiration, transpiration and transportation.

The presence of water in the soil is essential for the normal functioning of plants. Soil water contains minerals in the dissolved state.

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



Regions of the Root

The three different forces involved in absorption are:

(i) Imbibition
(ii) Diffusion
(iii) Osmosis

i) Imbibition

Imbibition is the uptake of water by the substances that do not dissolve in water causing swelling of these substances. Eg.wood and seeds. These substances are called imbibants.

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

Imbibition plays a very important role during germination. Seeds imbibe water through the seed coats. They swell and rupture, allowing the radicle and plumule to emerge.

ii) Diffusion

Dissolved molecules move from a region of higher concentration to a region of lower concentration until the molecules are evenly distributed throughout the available space. Gases such as oxygen and carbon-dioxide, and nutrients like minerals move into cells by diffusion.

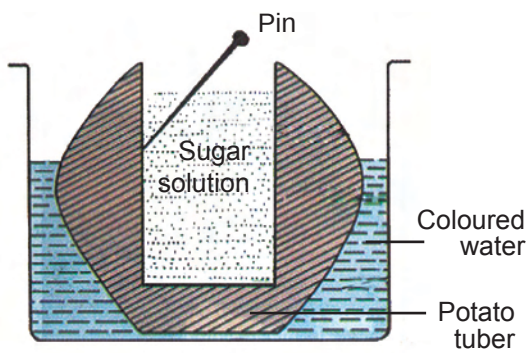
iii) Osmosis

The movement of water molecule from a region of higher concentration to a region of lower concentration through a semi-permeable membrane is called osmosis.

Demonstration of Osmosis

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

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



Potato Osmoscope Experiment

When substances move from a region of higher concentration to a region of lower concentration, without the use of metabolic energy, it is said to be passive transport. Active transport involves the use of metabolic energy for movement of molecules. The uptake of mineral ions is by active transport.

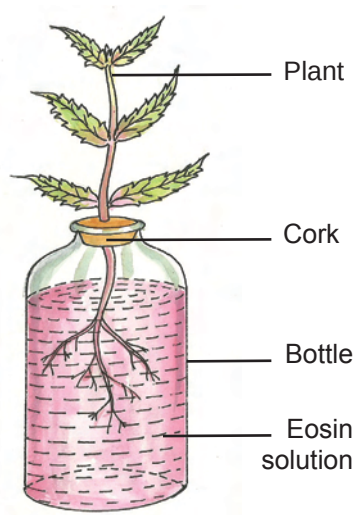
Ascent of Sap

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

Demonstration of Ascent of Sap

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

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



Ascent of Sap Experiment

ACTIVITY 1.4 **I DO**

1. *I take a few fresh grapes and keep them in a dish containing concentrated sugar solution.*
2. *I take a few raisins (dried grapes) and soak them in water. I observe the changes in both cases.*

1.4. PHOTOSYNTHESIS

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

Green leaves prepare food by combining carbon-dioxide and water in the presence of sunlight and chlorophyll.

Carbon-dioxide from the atmosphere enters leaves through tiny pores called stomata. Water taken from the soil is transported to the leaves through roots and stem. The green pigment called chlorophyll present in green leaves absorbs light energy. Sunlight provides the energy required to carry out the chemical reactions involved in the preparation of food.

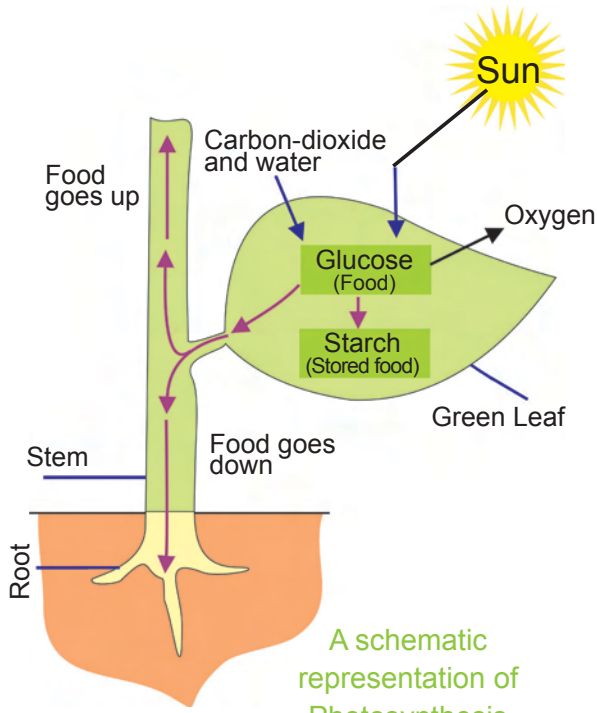
The process by which green plants synthesize carbohydrate from carbon-dioxide and water by using energy from sunlight in the presence of chlorophyll is called photosynthesis. Oxygen is released during photosynthesis.

Mechanism of Photosynthesis

The process of photosynthesis occurs in two phases: (i) Light reaction (ii) Dark reaction

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

ii) Dark Reaction: The reaction in which CO_2 is reduced to carbohydrate with the help of ATP and $NADPH_2$ generated during light reaction is called Dark reaction. Light is not required for this reaction. So it is called Dark reaction.



A schematic representation of Photosynthesis

The leaf is a flattened, lateral outgrowth of the stem. The functions of the leaf are:

a) Photosynthesis - Synthesizing carbohydrate using sunlight energy, CO_2 and water.

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

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

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

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

Overall equation:

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

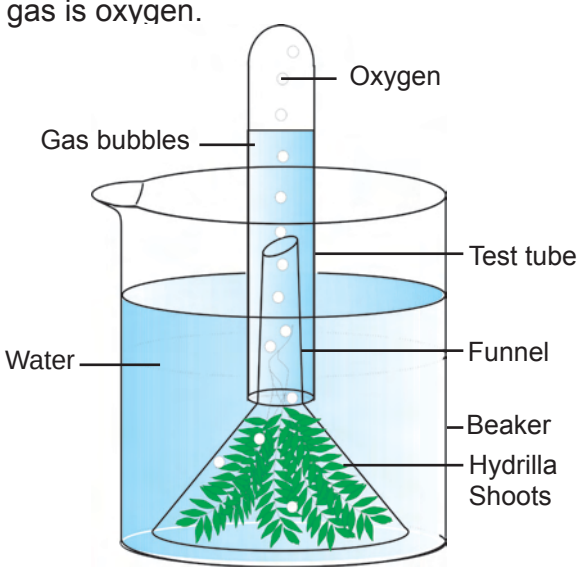
Experiment to show that oxygen is evolved during photosynthesis

Test Tube and Funnel Experiment

Aim: To show that oxygen is evolved during photosynthesis.

Procedure: Place a few cut branches of hydrilla in a beaker of water and invert a glass funnel over the cut branches in such a way that the cut end faces the stem of the funnel. The stem of the funnel should be below the level of water. A test tube is filled with water and it is inverted over the stem of the funnel. A pinch of sodium bicarbonate is added to the water as a source of carbon-dioxide. The apparatus is kept in sunlight for 4 to 6 hours.

Gas bubbles may be observed from the cut ends of Hydrilla branches. These gas bubbles are collected in the test tube by downward displacement of water. The gas is tested for oxygen. When a burnt splinter is taken near the mouth of the tube, it glows brightly. This proves that the gas is oxygen.



Test Tube and Funnel Experiment

ACTIVITY 1.5 WE DO

We pluck a leaf from a plant. We dip it in boiling water for 5 minutes. We dip it in 90% alcohol to decolourize it. We wash it in water and a add few drops of iodine solution. We observe the change if any. Why does the colour change?

This proves that oxygen is evolved during photosynthesis.

Factors Affecting Photosynthesis

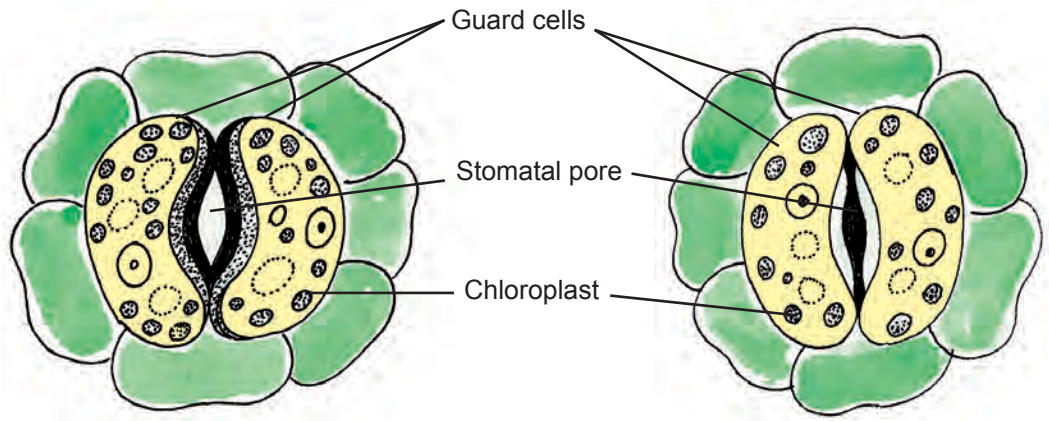
Photosynthesis is influenced by various factors. They are light, temperature, carbon-dioxide, chlorophyll distribution, water, mineral salts and age of the leaf.

1.5. TRANSPIRATION

Plants absorb a large quantity of water and use only a fraction of it. The excess of water is removed through the aerial parts of the plant such as leaves and green shoots. This is called transpiration. There are three types of transpiration: i) Stomatal transpiration ii) Cuticular transpiration iii) Lenticular transpiration

Stomatal Transpiration

Stomata are tiny pores on the epidermis of leaves and other aerial parts of the plant like stem. Each stoma (singular of 'stomata') is bounded by two kidney-shaped cells that control the opening and closing of the pores. These are called guard cells. Each guard cell has an elastic thin outer wall and a thick inner wall. When the guard cells are turgid (full of water), the outer walls are stretched and the stomata remain open. This happens during the day. At night, the guard cells lose water to the surrounding cells and become flaccid. The inner walls come closer. This reduces the stomatal opening.



(a) Open Stomata (b) Closed Stomata

This loss of water through the stomata is called stomatal transpiration. When the stomata are open, the transpiration rate increases. When they are closed, the transpiration rate decreases. A large quantity of water is lost through the stomata during transpiration.

Cuticular Transpiration

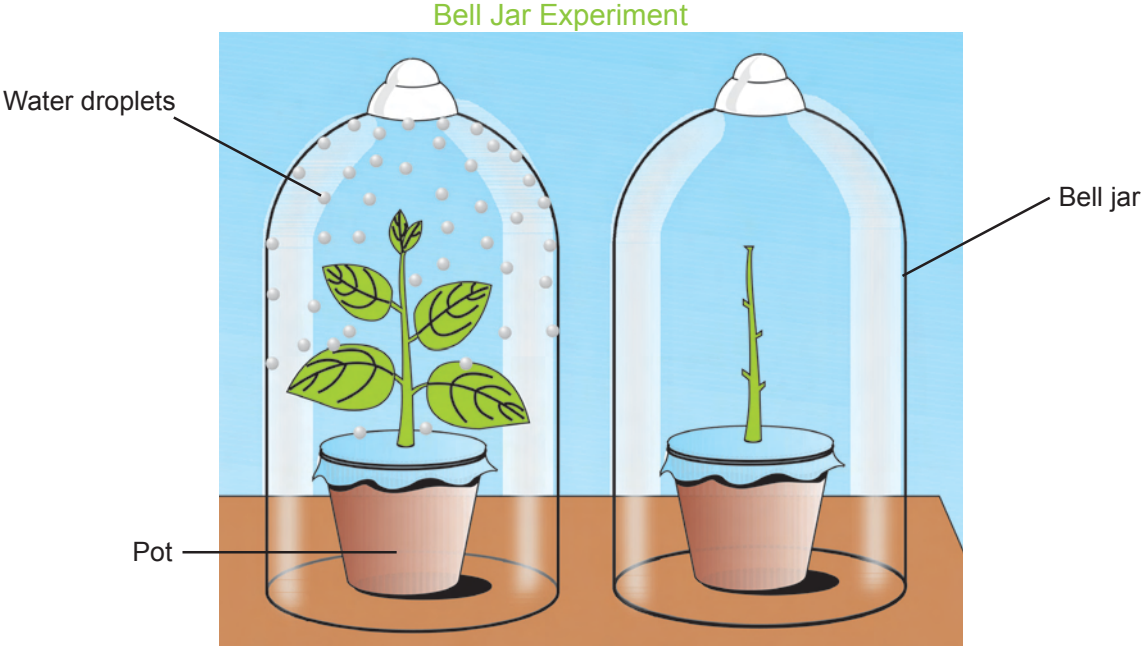
Cuticle is found as a waxy layer on the epidermis of a plant. It serves as a barrier to water movement out of a leaf. The cuticle is made of wax and is very hydrophobic or 'water-repelling'. Water does not move through it very easily. The thicker the cuticle layer on a leaf surface, the slower the transpiration rate. Cuticle thickness varies widely among plant species. In general, plants from hot, dry climates have thicker cuticles than plants from cool, moist climates. In addition, leaves that develop under direct sunlight will have much thicker cuticles than leaves that develop in the shade.

Lenticular Transpiration

Lenticels are tiny openings that protrude from the bark in woody stems and twigs as well as in other plant organs. Loss of water through lenticels is called lenticular transpiration and it is a very small percentage compared to stomatal transpiration.

Experiment to show that transpiration takes place through the leaves

Bell Jar Experiment



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Aim : To show that transpiration takes place through leaves.

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

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

ACTIVITY 1.6 **I DO**

I take some coriander leaves and keep them in a polythene bag for a few hours. I observe what happens.

ACTIVITY 1.7 **WE DO**

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

We observe the impression of the cells and the stomatal openings on the lower surface of a leaf.

Factors Affecting Transpiration:

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

1.6. RESPIRATION

Oxygen combines with glucose to bring about respiration. This process of release of energy from food is called respiration. All the energy required for life processes is obtained by the oxidation of food.

Mitochondria is the seat of biological oxidation.

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

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

Types of Respiration

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

i) Aerobic respiration
(Aerobic - with air)

ii) Anaerobic respiration
(Anaerobic - without air)

Aerobic Respiration

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

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

Anaerobic Respiration : Organisms like bacteria and yeast undergo respiration in the absence of oxygen. It is called anaerobic respiration. In this type, oxidation of food material is incomplete.

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

Factors Affecting Respiration

Oxygen, temperature, water, light, CO_2 and glucose are some of the factors that affect respiration.

1.7. TRANSPORTATION

The uptake and release of air, water, solutes and sap in plants involves transportation. It is a life process by which a substance, absorbed or made in one part of the body of an organism, is carried to the other parts of the body.

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

Therefore the transport system primarily involves transport of water, minerals and food prepared in the leaves to the various parts of the plant.This is done through two specialized transport systems made of xylem and phloem cells.

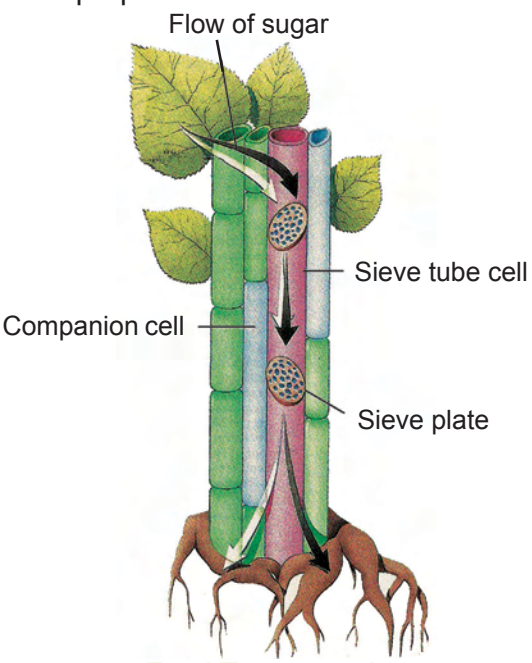
The transport of materials in a plant can be divided into two parts:

i) Transport of water and minerals in the plant.

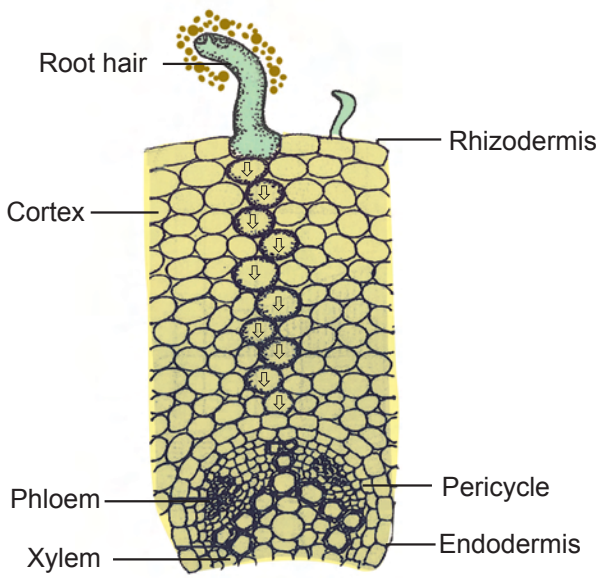
ii) Transport of food and other substances like hormones in the plant.

Transport of Water and Minerals

Water and minerals are absorbed from the soil by the roots of the plant and transported to the various parts of the plant like stem, leaves and flowers. Water, along with the minerals dissolved in it, moves from the roots to the other parts through the two kinds of xylem cells called xylem vessels and tracheids.



Food Transportation



Path of Water Across the Root

In pteridophytes and gymnosperms, tracheids are the only water conducting tissues.

In angiosperms either xylem vessels or both xylem vessels and tracheids transport water.

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

Transport of Food and Other Substances

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

Food is made in the mesophyll cells of a leaf. This enters into the sieve tubes of the phloem and is transported to all other parts of the plant body by the network of sieve tubes present inside the stem and roots.

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

1.8. PLANT NUTRITION

Intake of nutrients into the body by an organism is called nutrition. All the nutrients required by organisms are obtained through the food they consume.

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

i) Autotrophic nutrition

ii) Heterotrophic nutrition

Autotrophic Nutrition

In autotrophic nutrition, the organism synthesizes its own food. Organisms which are able to synthesize their own food materials are called autotrophs. They

Autotrophs

convert carbon-dioxide and water into various organic compounds with the help of energy. Depending on how the plants obtain energy for converting carbon-dioxide to organic compounds, they are classified as:

- Photo autotrophs
- Chemo autotrophs

Photo Autotrophs

All green plants are photo autotrophs. These are organisms which use energy from sunlight for the synthesis of food. Examples also include some bacteria like green sulphur bacteria, purple sulphur bacteria.

Chemo Autotrophs

Organisms which use chemical energy for the synthesis of carbon compounds are called chemo autotrophs. They get energy by oxidizing simple inorganic compounds such as hydrogen, sulphur containing compounds, hydrogen sulphide and ammonia. e.g. Nitrosomonas bacteria.

Heterotrophic Nutrition

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

Heterotrophic nutrition is of two types:

- Saprophytic nutrition
- Parasitic nutrition

Saprophytic Nutrition

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

Monotropa (Indian pipe)

Parasitic Nutrition

In parasitic nutrition, an organism derives its food from the body of other living organism (host). These plants are called parasitic plants. They have special structures which penetrate the host and absorb food, water and minerals. These special structures are called haustoria. e.g. : Xanthomonas citri (bacteria) Cercospora personata (fungus) Cuscuta (angiosperm).

Cuscuta (Dodder plant)

Symbiotic Nutrition

When two organisms live together, they exchange nutrients and are benefited mutually. Such type of nutrition is called symbiotic nutrition and the organisms are called symbiots. e.g. Lichen, Mycorrhiza and Rhizobium.

Lichen

Rhizobium

1.9. MOVEMENT IN PLANTS

Plants are fixed in a place with their roots in the ground. They lack the power of locomotion, but they can move individual parts or organs when subjected to external stimuli like light, water, chemical substances and touch.

These plant movements made in response to external stimuli fall into two main categories:

- Tropic movements
- Nastic movements

Tropic Movement

These are directional movements and are in response to stimulus, which comes mostly from one direction. The growth may be towards the stimulus or at the specific angle to the stimulus. Movement in which the direction of stimulus determines the direction of response is called tropism.

Depending on the types of the stimulus the tropic movement is classified as follows:

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

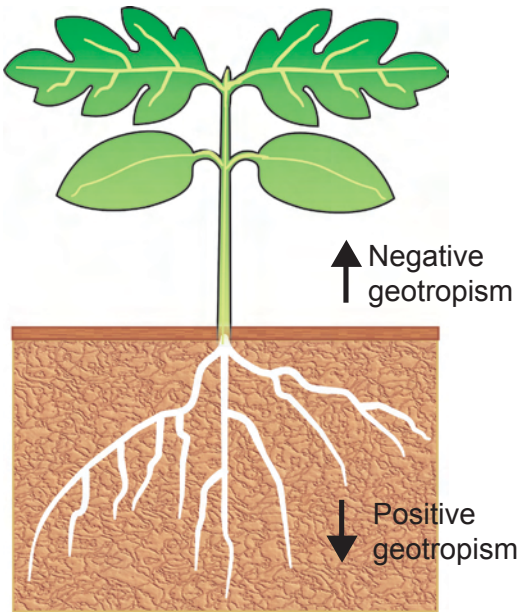
Phototropism

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

Phototropism

Geotropism

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



Geotropism

MORE TO KNOW

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

Nepenthes (Pitcher plant)

Drosera (Sundew plant)

ACTIVITY 1.8 WE OBSERVE

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

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

What is the position of the roots?

What is the position of the stem?

Are they both parallel to the ground or not?

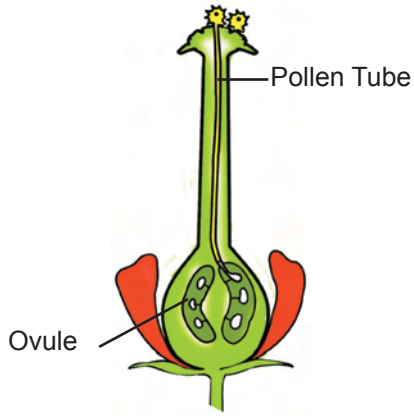
iii. Allow the plant to remain in this position for a few days. After a few days what do you observe?

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

Chemotropism

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

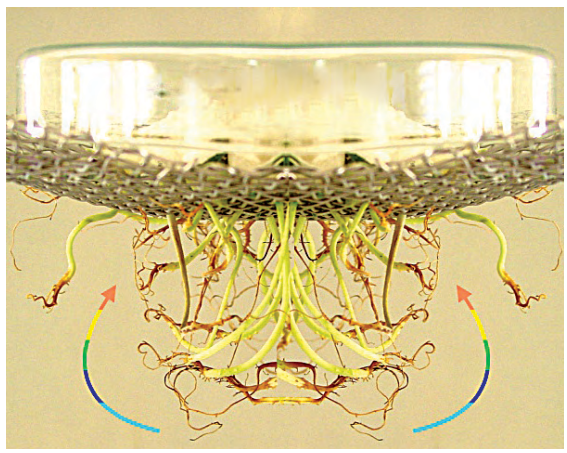
The growth (movement) of a pollen tube towards the ovule induced by a sugary substance as stimulus is an example of chemotropism. The ripe stigma in the carpel of a flower secretes a chemical substance (sugary substance) into the style towards the ovary. This sugary substance acts as a stimulus for the pollen grains which fall on the stigma.



Chemotropism

Hydrotropism

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



Hydrotropism

Thigmotropism

Climbing plants have weak stems. They cannot stand erect. They use thin thread-like climbing organs called tendrils. Tendrils are sensitive to touch or contact of other objects. When a tendril touches an object, then the side of the tendril in contact with the object grows slower than its other side. This causes the tendril to bend towards the object by growing towards it, wind around the object and cling to it. The winding

movement of the tendril of a climbing plant is an example for thigmotropism.

Thigmotropism

Nastic Movement

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

Some of the nastic movements are as follows:

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

Before touch

After touch

Mimosa pudica (Touch-me-not plant)

ii) Photonasty: The non-directional movement of a plant in response to light is called photonasty. The opening of leaves and flowers during the day and their closure at night is an example. A dandelion flower opens up in the morning in bright light but closes in the evening when the light fades and it gets dark.

Night Dandelion Day

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

1.10. SENSITIVITY IN PLANTS

When we touch the leaves of mimosa pudica, the leaves fold up. The petiole of mimosa pudica leaves have a pad-like swelling at their base. This is called a pulvinus. It contains more water than the other cells around it. They create an internal pressure that holds the leaves upright. When the leaf is touched it creates an electric impulse that acts on the plant hormone. This causes the water to migrate from the cells of the pulvinus into the intercellular spaces. This loss of water

forces the leaf to fold and droop. This water diffuses back after a brief period of 15 to 30 minutes, and the leaf returns to its original position.

ACTIVITY 1.9 **WE DO**

1. *We take two glass troughs A and B and fill each one of them with two – thirds of soil.*
2. *We plant a tiny seedling in trough A.*
3. *We plant a similar seedling in trough B and also place a small 'clay pot' inside the soil.*
4. *Water the soil in trough A daily and uniformly.*
5. *Do not water the soil in trough B but put some water in the clay pot buried in the soil.*
6. *We leave both the troughs for a few days.*
7. *After a few days, we dig up the seedlings carefully from both the troughs without damaging their roots.*

   What do you observe?

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

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

MODEL EVALUATION

Section A

Choose the correct answer:

1. *A plant cell differs from an animal cell due to the presence of _____.*
   (cell membrane, endoplasmic reticulum, plasma membrane, cell wall)
2. *_____ is the seat of biological oxidations.*
   (endoplasmic reticulum, ATP, mitochondria, Golgi complex)
3. *_____ is a parasitic plant.*
   (mushroom, mucor, cuscuta, yeast)
4. *The loss of water from the aerial parts of the plant is known as _____ .*
   (photosynthesis, transpiration, reproduction, respiration)
5. *The movement of the part of a plant in response to light is called _____*
   (geotropism, hydrotropism, phototropism, thigmotropism)
6. *Mimosa pudica displays _____ movement.*
   (phototropic, photonastic, thigmonastic, thermonastic)
7. *_____ transpiration accounts for the loss of large volumes of water.*
   (lenticular, stomatal, cuticular, areolar)

8. _____ is mainly concerned with the transport of nutrients, water and minerals upwards in the plant body.
(Phloem, Xylem, Fibres, Parenchyma)

9. The cells of the _____ are polygonal in cross-section and have unevenly thickened walls.
(parenchyma, collenchyma, aerenchyma, sclerenchyma)

10. The study of the structure and function of the cell is called _____
(Botany, Cytology, Microbiology, Bio technology)

11. Cells having dense cytoplasm and large nucleus are called _____
(simple tissue, compound tissue, meristamatic tissue, permanent tissue)

12. Find which one of the following is dead tissue?
(Parenchyma, Collenchyma, Scleren chyma, Chlorenchyma)

13. Which one the following is the xylem tissue?
(Sieve elements, Companion cells, Phloem fibres, Tracheids)

14. Which part helps the plant absorb water and mineral from the soil?
(root hairs, roots, root cap, tap root)

15. Which is shown by the experiment 'Ascent of sap'?
(The food materials are transmitted by phloem, Water is transmitted by phloem, Water is transmitted by xylem, The food material is transmitted by xylem)

16. Find out which one is not related to leaves?
(photosynthesis, respiration, transpirection, transportation)

17. Find which one of the following does anaerobic respiration?
(flies, mosquito, yeast, hydrilla)

18. This is an example of chemo autotrophs _____.
(Green sulphur bacteria, Bacillas subtilus, Nitrozomonas bacteria, Purple sulphur bacteria)

19. This is an example of insectivorous plant _____.
(Monotropa, Cuscuta, Drosera, Hibiscus)

20. Find the one that is not doing symbiotic nutrition.
(Lichen, Mycorrhiza, Mucor, Rhizobium)

21. Plants take CO_2 during
(Transpiration, Protein synthesis, Respiration, Photosynthesis)

22. In Photosynthesis
(H_2O and CO_2 are reduced, H_2O is reduced and CO_2 is oxidised, H_2O and CO_2 are oxidized, H_2 is oxidized and CO_2 is redused)

23. Which of the following is called energy currency of the cell?
(ATP, $NADPH_2$, $C_6H_{12}O_6$, C_2H_5OH)

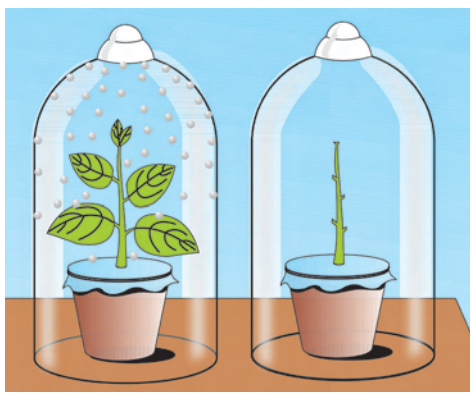
24. Aerobic and anaerobic respirations differ from each other in all aspect exept _____.
(involvement of oxygen, out put of energy, end products, breakdown of glucose in cytoplasm)

25. Find out the correct sequence of the following in the decreasing order of rate of transpiration.
(Stomatal – Cuticular – Lenticular, Cuticular – Lenticular – Stomatal, Lenticular – Stomatal – Cuticular, Stomatal – Lenticular – Cuticular)

Section B

Answer the following questions:

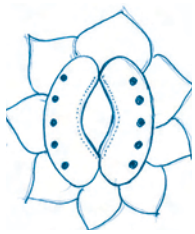
1. Carbohydrates are found in leaves. Write an equation to show how it is formed in the presence of sunlight.
2. Organisms can breathe 'without air'. Justify.
3. How are plant tissues classified according to their growth and location? What are the main features of a meristematic cell?
4. Which plant tissues are responsible for giving a plant strength and support?
5. Which are the specialized conducting tissues of the plant?
6. Name the different types of cells that form xylem.
7. a. Which ground tissue are you eating, when you eat mashed potatoes?
   b. Which ground tissue makes the shell of a groundnut hard?
8. Indicate using a flow chart (using arrows) how water and dissolved minerals move from soil to the leaves. Name the cells involved in the process.
9. 'Osmosis is an example of active transport'. True or False? Explain.
10. Photosynthesis is held in the leaf of a plant. In which synthesis organic material called _____. This food materials are transported by _____tissue to all parts of the plant.
11. Observe the given experiment and answer the following:



   a. What type of function is shown to be formed?
   b. Which part of the plant is involved in this process?

Section C

1. Draw a labelled diagram to show the Ascent of sap.



2. a) Identify the given diagram.

   b) Draw and label the parts.

   c) Describe the mechanism of its function.

3. Create a poster to depict all that you have learnt in this chapter about plant tissues.

4. The movement of water molecule from a region of higher concentration to a region of its lower concentration through a semi – permeable membrane is called Osmosis.

   a) In the above statement, "how will you differentiate active transport from passive transport?

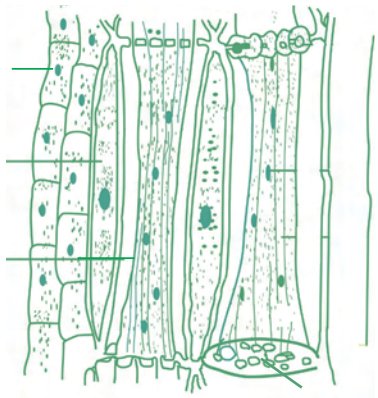
5. Intake of nutrients into the body by an organism is called nutrition.

   a) Classify the living organisms on the basis of nutrition.

   b) Which one is the angiospermic saprophyte?

   c) Nepenthes (Pitcher plant) belongs to what type of plant according to Nutrition.

6. Observe the given picture.



   a) Which one of the portions froms clear cytoplasm and prominent nucleus?

   b) Which functional portion is doing the conductivity?

   c) Which portion is considered 'dead tissue'?

   d) Which portion stores starch and fats?

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

   a) Differentiate between aerobic and anaerobic respiration.

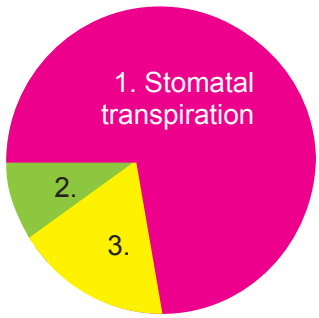
   b) $C_6H_{12}O_6 \xrightarrow[\text{zymase}]{\text{yeast}}$ _____ $+2CO_2 + 50KJ$ energy

   c) List out the factors affecting respiration.

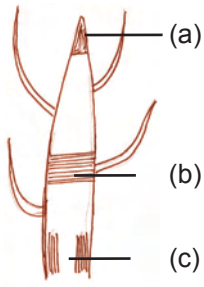
8. a) Match column A with column B

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

b) Complete the pie chart which shows the types of transpiration.



9. Answer the questions related to the given figure.



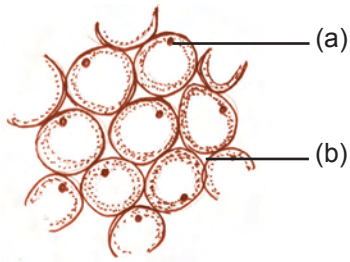
i) Copy the diagram and name the parts marked (a) to (c).

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

iii) Which part is responsible for secondary growth?

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

10. Observe the given figure.



i) Identify the tissue depicted in the figure.

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

SCIENCE

FURTHER REFERENCE

Books : 1. *Plant Anatomy 2008 - B.P Pandey, S.Chand publishers.*
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2.1. ADDICTION

Addiction is a complex disease that affects the brain. When a person who is weak-willed or vulnerable is exposed to large amounts of stress, he or she consume substances or looks for methods that create a feeling of immediate relief. It can be abuse or misuse of substance like consuming alcohol or drugs; or behavioural problems such as gambling, video games, and excessive work, food, and sex. These substances or activities can alter the way we think or the way brain functions. Continued and indiscriminate use of these substances over a period of time creates addiction.

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

This typically happens when drugs and alcohol are misused and consumed in large quantities without the consultation of medical practitioners. They affect the central nervous system, liver, spleen, kidney and heart and the individual eventually suffers from addiction.

Addiction is a chronic disease and can relapse (come back again) after a period of time. It affects the brain's respones and motivation systems. People struggling with addiction will be unable to control their actions or make sensible decisions about their behaviour, even if the consequences are negative or dangerous.

There are several reasons for addiction, both personal and social. Some become addicts due to personal trauma or emotional disturbances. Others become addicts due to peer pressure and unregulated habits.

Addiction can be due to any of these two ways of dependence:

Substance-related Addiction: This includes dependence on any of the following:

- Tobacco
- Alcohol
- Street drugs (illegally sold drugs that are taken for non-medicinal use. e.g. LSD, amphetamines)
- Prescription drugs (medicinal drugs that are misused. e.g. sleeping pills and pain-killers)

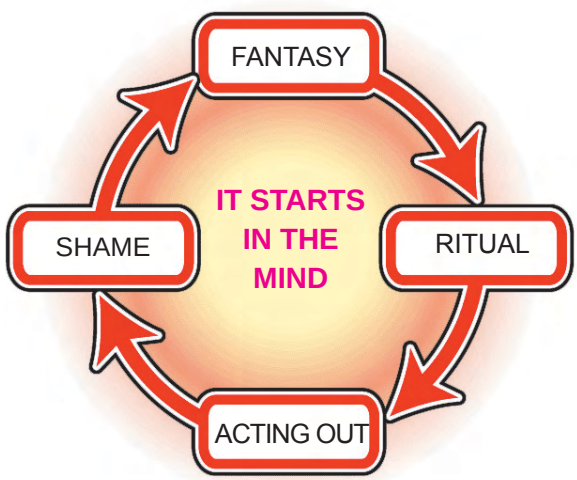
Behaviour-related Addiction: This may be due to excessive indulgence in the following activities:

- Gambling
- Eating
- the Internet
- Video Games
- Work
- Sex

2.1.1. ALCOHOLISM

Alcoholism is also known as alcohol dependence. Alcoholics suffer from an uncontrollable desire to consume alcohol

The Addiction Cycle



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individuals, it starts as social drinking that eventually leads to heavier and heavier alcohol consumption, and later causes serious health and psychological problems.

Ethyl alcohol (C_2H_5OH) or ethanol, is an intoxicating ingredient found in beer, wine and liquor. Alcohol is produced by the fermentation of yeast, sugar and starch. It is a depressant that affects the central nervous system.

Some of the symptoms of alcoholism: Drinking alone, drinking in secret, blacking out - not being able to remember the passage time, being annoyed when not able to drink, having alcohol hidden in unlikely places, gulping drinks down in order to drink more and then feel good, needing a larger quantity of alcohol to feel its effect, feeling nausea, sweating, or even shaking when not drinking.

The problems linked to alcohol dependence are extensive and affect the person physically, psychologically and socially.

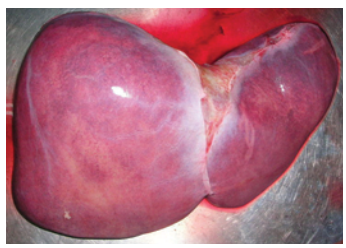
Psychologically it could cause mental illness, depression and suicidal tendencies. This could result in behavioural problems in their social life resulting in work abuse, child abuse, spouse beating, fights with neighbours and vulnerability to accidents.

Physically it could lead to fatigue, memory loss, weakening of eye muscles, gastritis, pancreas damage, hypertension, heart failure, stroke, diabetes, cancer and liver cirrhosis.

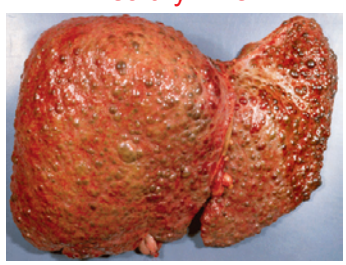
Every year, there are about 27,000 deaths all over the world because of liver cirrhosis. Alcohol-related cirrhosis leads to more death than cirrhosis due to any other cause.

Liver Cirrhosis

One of the reasons for liver cirrhosis is alcoholism. It starts with inflammation of the liver. Over a period of time it leads to scarring of the liver tissue and finally cirrhosis of the liver. A healthy liver is able to regenerate most of its own cells when they become damaged. At the final stage of cirrhosis, the liver can no longer effectively replace damaged cells.



Healthy Liver



Liver affected by liver cirrhosis

Prevention and treatment of alcoholism

Addiction to alcohol can be prevented at an early stage by taking the following steps:

- The harmful effects of alcohol must be explained to people.
- If the addiction has developed due to being idle or by the pressure of the job, both the idleness and the nature of the job should be changed.

- Psychotherapy helps the patients in changing their lifestyle.
- By educating parents and teachers how to help the patients recover from alcoholic addiction.
- Drug therapy is also a valuable treatment. Medicines like Benzodi-azepines, high dose of vitamin B and antidepressants like phenothiazines are effective in the recovery of alcoholic addiction.
- A number of voluntary organizations are financially assisting to undertake the educative work in various communities and target groups.

2.1.2. SMOKING CIGARETTES

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

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

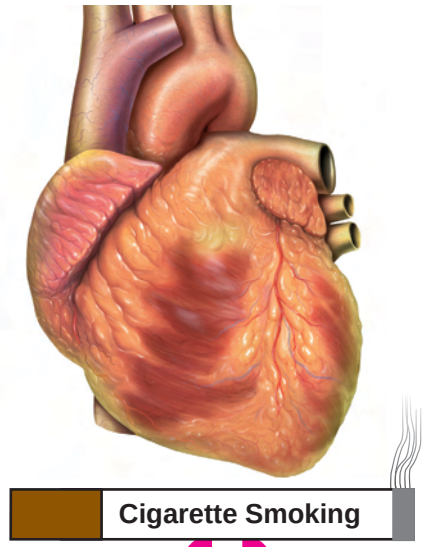
EFFECT ON THE DIGESTIVE SYSTEM: Smoking causes heart burn, delays the healing of peptic ulcer, increases risk of Crohn's diseases and formation of gall stones. It affects the liver and increases the chances of stomach cancer.

OTHER EFFECTS OF SMOKING

LEGS :Smoking affects the blood vessels of the legs causing chronic pain in legs.

EYES : The sensitive blood vessels of the eyes are easily damaged by smoking. This

EFFECTS OF SMOKING ON HEART



Smoking causes diseases like heart attack, hypertension (high blood pressure), cardio-vascular diseases and finally leads to death

SCIENCE

causes redness of eyes and itching. Heavy smoking may lead to degeneration and loss of eye sight.

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

BONES : It accelerates the process of osteoporosis.

CANCER

Smoking causes cancer in lungs, larynx, oral cavity, pharynx, oesophagus and bladder.

Tobacco smoke contains more than 60 substances that could cause cancer. Most of the lung cancer occurs due to smoking.

EFFECT ON THE REPRODUCTIVE SYSTEM

Smoking reduces fertility in both men and women.

In women : Smoking creates an imbalance in estrogen hormone in women and reduces bloodflow to genital organs. Women who smoke can develop diseases in the fallopian tubes and their egg production can be affected. Smoking can cause abortion. It accelerates the ageing process and can cause early menopause.

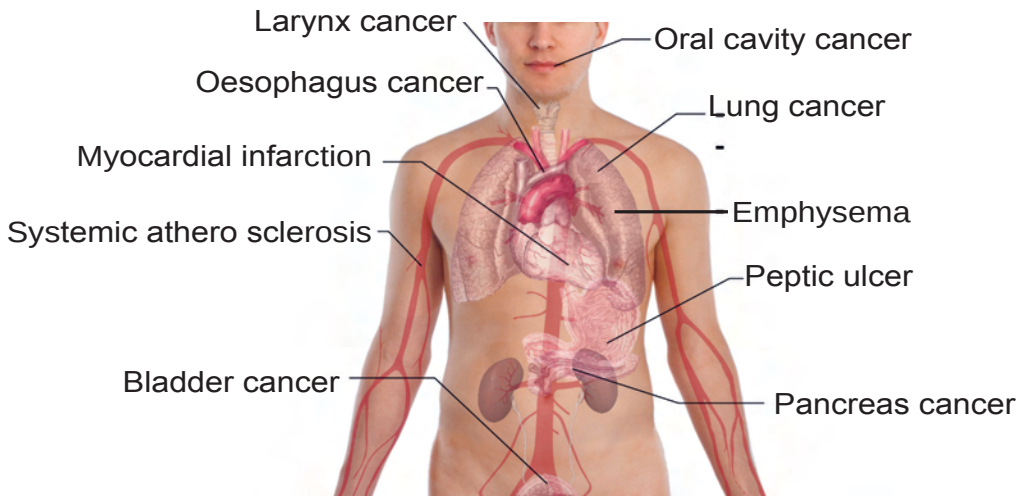
Growth can suffer retardation when a mother smokes during pregnancy. It affects the brain development of the baby and reduces the IQ. This happens even when the mother is a passive smoker. The chances of miscarriage, premature birth and foetal death also increases.

In men: Smoking causes damages to the male reproductive system in many ways. Men who smoke have a higher risk of developing impotency.

2.1.3. DRUG ABUSE - NARCOTIC DRUGS

A drug or other substance affecting mood or behaviour and sold for non-medical purposes are called illegal drugs or narcotics. Consumption of such drugs over a long period of time have a direct effect on the central nervous system and its related problems. Heroin, opium, cocaine are some examples of narcotic drugs.

Common adverse effects of
TOBACCO SMOKING



Harmful effects of drug abuse include: impaired health, absence from school and college, and tendency to commit crimes like theft, rape or murder.

Signs of drug abuse

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

Dealing in Narcotic is an offence and all these come under punishable acts

- Possession even in a small quantity.
- Cultivation of drug crops without permission.
- Allowing your premises to store, sell or consumption.
- Illicit manufacture, sale, purchase and transportation.
- Trafficking of drugs is a non-bailable offence (Prison sentence up to 20 years and fine up to Rs.2 lakhs)
- Death penalty for repeat offenders.

What we should do as students:

- Always resist peer pressure and "Say No to Drugs "
- Drugs are not "cool". Decide for yourself.
- Girl students should be cautious of taking drinks containing "date rape drugs".
- Report drug abuse or trafficking to your school or college authorities or police.

2.1.4. TREATMENT OF ADDICTION

It involves the management of alcoholism and drug abuse. There are Governmental and non-governmental organizations in our country which have rehabilitation centres to treat and counsel drug addicts and alcoholics by means of medical and psychological approaches. The following are some of the steps taken in a rehabilitation centre.

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

2.2. HEALTHY LIFESTYLE

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

Obesity

Addiction to rich food can lead to obesity. It is defined as an excessive accumulation of fat in the body. It will to increased health problems. Lethargy, sluggishness and difficulty in carrying out the activities of daily living are some of the adverse effects of obesity. The causes of obesity are unhealthy dietary habits, lack of physical activity, genetic susceptibility, endocrine disorders and some medicines.

Prevention of Obesity

In order to avoid obesity, we can make dietary and lifestyle changes, some of which are listed below:

- Eat plenty of food rich in fibre such as fruits and green leafy vegetables. Intake of steamed and oil-free foods like idli, idiyappam and puttu is recommended.
- Nuts, whole grains, seasonal fruits and vegetables can be consumed.
- Eating fish twice a week helps to prevent formation of blood clots in arteries, as it contains Omega-3 fatty acids.
- Eat less red meat (mutton, beef) and fried foods (chips, samosas) because they raise the blood cholesterol level.
- Milk and milk products (ghee, butter, cheese) are a good source of calcium, but excessive amount of creamy, fatty milk leads to obesity.
- Avoid high calorie fast foods like pizzas, burgers and French fries.
- Reduce dietary sugars (sweets, sugary drinks, chocolates) and salt (pickles, pappads) in the diet.
- Cigarette smoking and alcohol consumption should be avoided.

Physical Activities

- Reduce or limit the time of watching television, using computer and playing video games.
- Increase physical activity to burn calories which in turn enhances optimal blood circulation. e.g. Walking for an hour every day, playing outdoor games, jogging, running, cycling, swimming or dancing.
- Aim for ideal weight by following appropriate dietary habits and adequate physical activity.

Stress Relieving Activities

The following activities can relieve us from stress. Share your feelings with family and friends, manage your time, get enough sleep, spend time with nature, listen to music, engage in gardening, painting, playing with pets or going out for picnics with family, or any activity that helps you to relax.

MODEL EVALUATION

Section A

Answer the following questions:

1. What is the meaning of the term 'addiction'?
2. Why is addiction referred to as a disease?
3. What kind of people are prone to 'addiction'?
4. What are the different things that one can get addicted to?
5. How is substance-related addiction different from behaviour-related addiction?
6. How would you identify an alcoholic?
7. Write a note on liver cirrhosis.
8. Can alcoholism be treated? How?
9. Draw a flow chart to depict how the habit of smoking affects the human body.
10. Radha studies in Class 10. She weighs 90kgs. What could she be suffering from? What do you suggest to help her develop a healthy lifestyle?
11. The harmful alkaloid present in the leaves of tobacco plant is _____ (Quinine, Nicotine, Phynothiazine, Morphine)
12. Liver cirrhosis is mainly associated with _____ (smoking cigarettes, excessive use of pain killers, alcoholism, excessive use of narcotic drugs)
13. _____ is rich in Omega-3 fatty acids are rich in (red-meat, milk products, fish, green vegetable)
14. An intoxicating ingredient found in beer, wine and liquor is _____ (nicotine, ethyl alcohol, LSD, opium)

Section B

1. The United Nations "International Day Against Drug Abuse and Illicit Trafficking" falls on June 26 each year to create awareness of the major problems that illicit drugs pose to society. This day is supported by individuals, communities and various organizations all over the world. Write five lines to create awareness against illicit use of drugs.
2. This is a sign commonly seen in public places.

   a) What do you understand from this illustration?
   b) Name two diseases caused by smoking.
   c) How can we create awareness about smoking?
3. Match the following

i) Fish	–	a) rich in fibre
ii) Fruit &vegetables	–	b) Omega - 3 fatty acids
iii) Mutton & beef	–	c) high calorie fast food
iv) Pizza	–	d) red meat

4. Correct the mistake:

a) Cocoa and alcohol in any form are illegal substances in most of the countries.

b) Benzodiazepines is one of the most frequently used addictive drugs.

5. Due to smoking, the skin loses its texture. Give reasons.

6. Tobacco smoke contains more than 60 substances that could cause cancer.

Lung cancer mostly occurs due to smoking .

Frame two questions from the above sentences.

7. Observe the picture and answer the following:

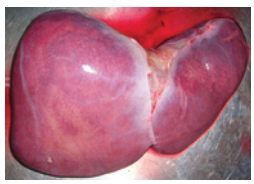
i) What does it indicate? ii) Name two ailments caused by this habit.

8. Fill in the blanks:

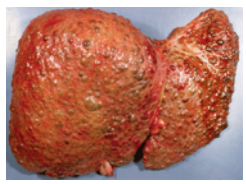
a) Lethargy, sluggishness and difficulty in carrying out daily activities are due to _____(smoking / obesity).

b) Smoking accelerates the process of _____ (fertility / osteoporosis).

9. Observe the picture and answer the following:



A



B

a) How is 'B' different from 'A' ?

b) What causes the difference?

10. Find the odd one and give reasons.

a) Heroin, opium, cocaine, ethanol.

b) Sweets, chocolates, fruits, ghee.

11. Drug therapy is a valuable treatment for alcoholism.
Name an antidepressant which is effective in recovery from alcohol addiction.

12. Give three reasons for the following:

Why do people choose to drink alcohol?	Why do people choose not to drink alcohol?
1.	1.
2.	2.
3.	3.

13. Observe the given pictures and answer the questions that follow:

(a)

(b)

(c)

(d)

i) Pick out the activities that are considered as good habits?

ii) List the activities that lead to addiction.

14. Look at the pictures and classify the type of addiction.

(a)   (b)

15. When a person consumes alcohol it is absorbed directly from the stomach into the bloodstream. Give three immediate effects.

16. A drunkard has unsteady walk, slurred speech, lack of coordination of thought speech & action.

a) Why does this happen?

b) What is the long term effect of alcoholic addiction?

17. Mr. X went to a party along with his friends. That was the first time he drank alcohol. Gradually, he became addicted to it. Analyze and list out the problems you think he will be facing now.

Mr. X and his problems:

Sl.No.	Physical	Psychological	Social
1.			
2.			
3.			

Section C

1. Prepare a poster to depict the ill-effects of smoking.
2. Create a poster to highlight the role of a student in preventing drug abuse.
3. Write a four line verse against cigarette-smoking.
4. Divide the class into two groups. Conduct a debate on the topic. "Bad Habits are Hard to Break"
5. Trafficking of narcotic drugs is an offence.

a) Name a few narcotic drugs.

b) Why do you think this is a punishable offence?

c) List out any three signs of drug abuse?

6. Ramesh's mother took him to her family physician because her son was obese. Apart from the diet the physician advised to follow certain other activities.

a) Mention the activities for the body and mind that Ramesh should carry out everyday?

b) Tabulate the activities.

c) How does Ramesh come to know his correct body weight?

d) What is BMI (To know, get the help of you teacher / your family doctor)?

POLLUTION AND OZONE DEPLETION

The atmosphere is a layer of gases which surrounds the entire Earth. It consists mainly of Nitrogen, Oxygen, as well as a few other gaseous elements. The purpose of this layer around the Earth is to prevent excessive amounts of radiation from reaching the Earth, thereby allowing us to survive. When a contaminant is introduced into the atmosphere it causes pollution.This has a direct impact on living conditions.

Pollution is an undesirable change in the physical, chemical and biological characteristics of our land, air or water caused by excessive accumulation of pollutants.

3.1. KINDS OF POLLUTION

Pollution is of four major types, namely air pollution, water pollution, land pollution and noise pollution. In terms of origin, it may be natural or anthropogenic (man-made).

Degradation of air quality and natural atmospheric condition constitutes air pollution. The air pollutant may be a gas or particulate matter.

3.1.1. AIR POLLUTANTS AND THEIR EFFECTS

1. Particulate matter : Exhaust gas from vehicles and smoke from industries contain small suspended particles such as soot, dust, pesticides and biological agents such as spores, pollen and dust mites. It causes respiratory ailments such as asthma, emphysema and chronic bronchitis.
2. Carbon-monoxide : It is a product of incomplete combustion of fossil fuels in automobiles. It is highly poisonous to animals and humans. When inhaled, carbon monoxide reduces the oxygen-carrying capacity of blood.
3. Hydrocarbons : Hydrocarbons such as methane are evolved from soil microbes (methanogens) in flooded rice fields and swamps. They are also generated during the burning of coal and petroleum products.
4. Sulphur dioxide : It is released from oil refineries and ore smelters which use sulphur-containing fuels. The sulphur dioxide that is released into the air dissolves in rain water and forms an acid causing acid rain. This acid rain has harmful effects on plants and animals. It causes chlorosis (loss of chlorophyll) and necrosis (localised death of tissues) in plants. It also has a corrosive effect on limestone and mortar structures.
5. Nitrogen oxides : These are also caused from the emissions of vehicles. These gases cause a reddish-brown haze (brown air) in polluted air caused by traffic congestion which contributes to heart and lung problems. It also contributes to the formation of acid rain.

Secondary Effects of Air Pollution

Photochemical Smog

Smog is a mixture of smoke and fog. It is formed in the atmosphere under the influence of sunlight by the photochemical reactions of hydrocarbons, oxides of nitrogen and oxygen, resulting in the formation of PAN (peroxy acetyl nitrate).

SCIENCE

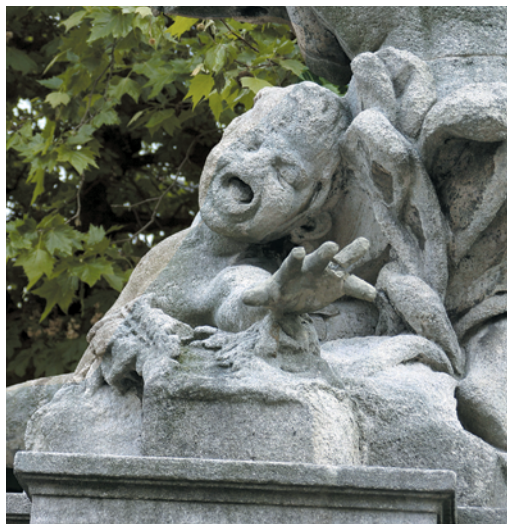
PAN damages chlorophyll and affects photosynthesis and growth. It also causes irritation of eyes and throat. Visibility is reduced due to smog.

Acid Rain

Gases such as sulphur dioxide and nitrogen oxides are oxidized to form sulphuric and nitric acid along with water, and precipitate as acid rain. It damages building, plants and animals. It also makes the soil acidic.

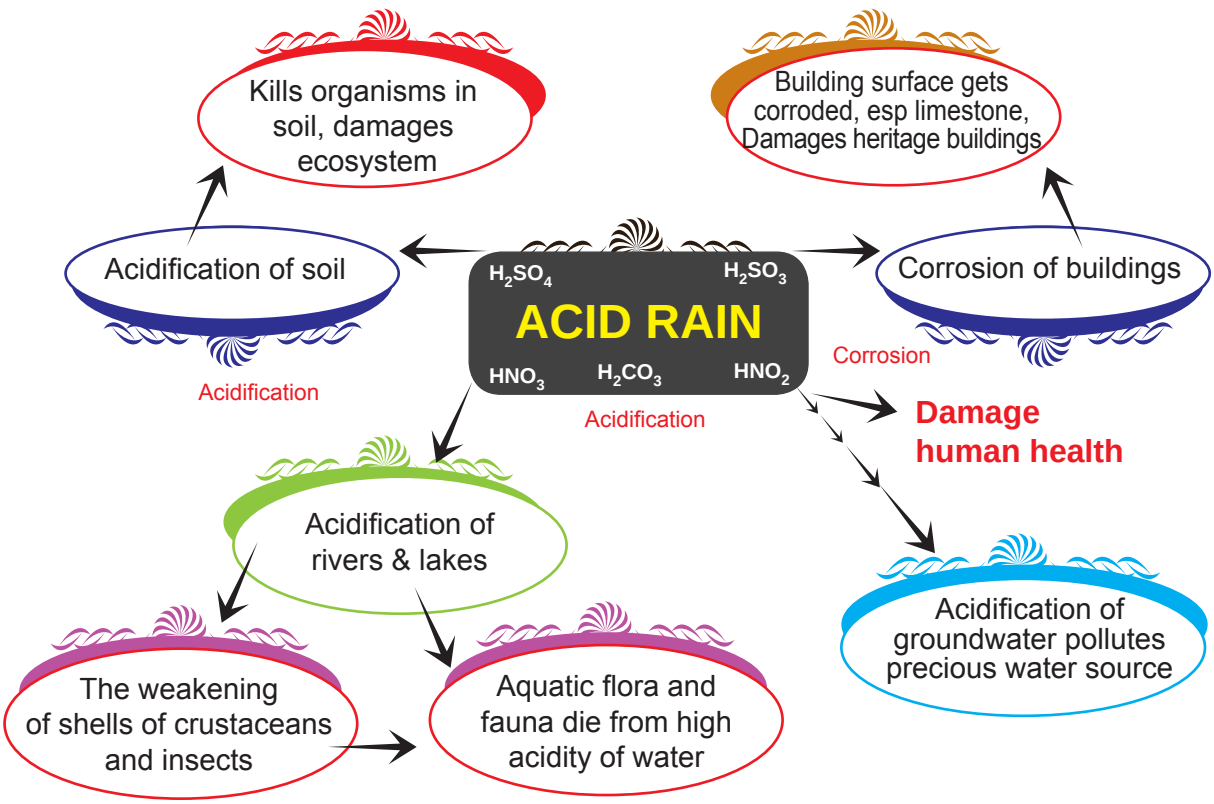
Control of Air Pollution

1. The particulates emitted by industries should be controlled by devices such as scrubbers, precipitators and filters.
2. Use of unleaded or low sulphur fuel is to be encouraged.
3. Shifting to non-conventional sources of energy (e.g solar energy, hydel energy, tidal energy, etc.) in order to reduce the dependance on conventional sources.



Sculpture affected by acid rain

4. Smoking in public places should be prohibited, because cigarette smoke contains carcinogens such as benzopyrene. It also affects non-smokers. (ie. Passive smoker)
5. Planting of trees along road sides and around industrial areas will reduce pollutants in the air. It will enrich the air with oxygen.



MORE TO KNOW

Black Lung disease

It is common among coal miners due to the inhalation of carbon particulates which leads to lung cancer.

3.1.2. WATER POLLUTION

Human activity creates several pollutants that contaminate water. Water pollution is defined as the adding of unwanted substances or the change of physical and chemical characteristics of water in any way which makes it unfit for human consumption. It is caused by waste products from industries (effluents), domestic sewage, oil spillage, agricultural and industrial run-offs.

Sources and Effects of Water Pollution

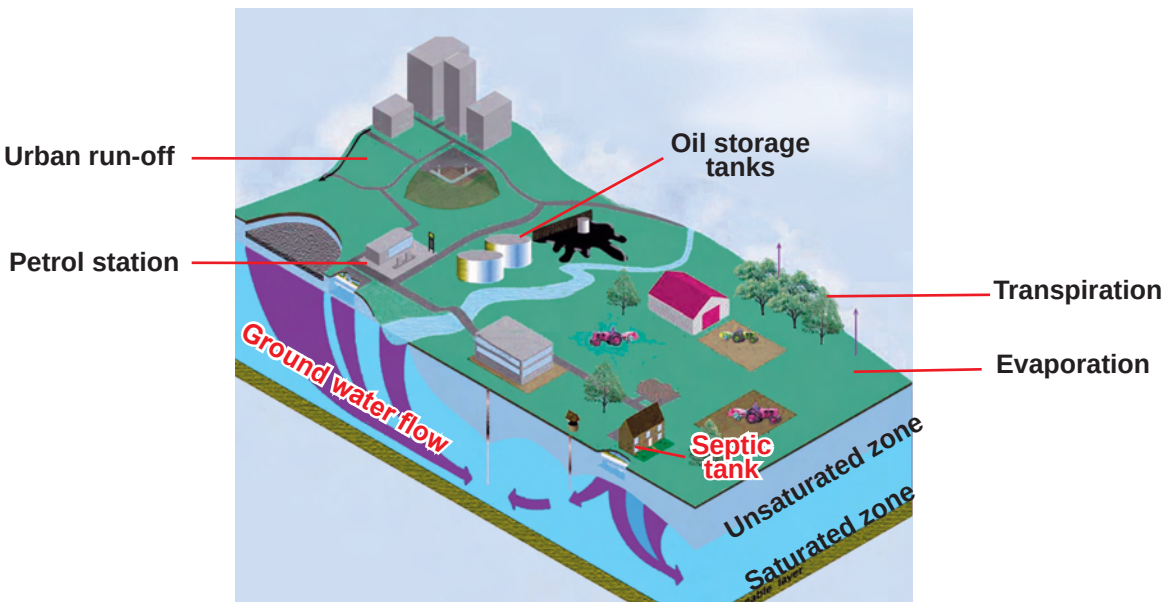
1. **Industrial Wastes** : Industrial effluents containing heavy metals and chemicals such as arsenic, cadmium, copper, chromium, mercury, zinc and nickel are directly released into water bodies such as lakes, ponds and rivers without proper treatment. These wastes contaminate the water bodies and make them unsuitable for human consumption. Industries also use water as a coolant for machinery and releases hot waste water into the water bodies causing thermal pollution which affect both plant and animal life.

MORE TO KNOW

BHOPAL GAS TRAGEDY (2nd & 3rd Dec 1984) refers to the industrial disaster which killed thousands of people and animals due to inhaling of methyl iso cyanate (MIC) gas which leaked out from a fertilizer factory owned by the Union Carbide Company. Many people who inhaled the gas still suffer from respiratory, immunological and neurological disorders, cardiac failure, birth defects, etc.

2. **The Surface Run-offs** : The water that runs off the surface come from agricultural lands that are contaminated with pesticides and the residue of inorganic fertilizers rich in organic and inorganic compounds. These pollutants contaminate both surface and groundwater.

3. **Oil Spills** : An oil spill is an accidental discharge of petroleum products into oceans and estuaries from capsized oil tankers, offshore drilling and



SCIENCE

exploration operations. It can cause drastic damage to marine and coastal biodiversity.

4. **Domestic Sewage** : It is rich in organic matter and detergents. Decomposition of organic matter increases the nutrient content of the water bodies.

Availability of excess nutrients results in algal bloom on the surface of water resulting in the deficiency of oxygen content. This oxygen shortage leads to the death of aquatic organisms. This process is known as eutrophication.

Control of Water Pollution

1. Sewage treatment plants should be installed to treat sewage before releasing it into water bodies.
2. Excessive use of pesticides, herbicides and fertilizers should be avoided.
3. Biological control of insect pests and organic farming is to be followed in order to reduce the dependence on pesticides and inorganic fertilizers.
4. Control pollution through legislation and strict enforcement.
5. Create social awareness among people about water pollution and the need for pure water.

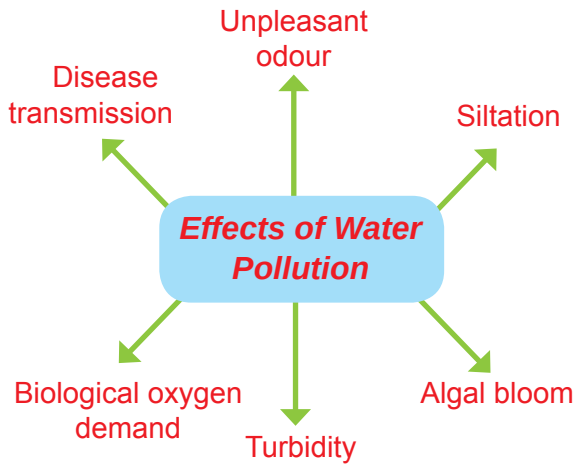
MORE TO KNOW

Biological magnification of DDT (dichloro diphenyl trichloroethane) is seen in aquatic food chain. The concentration of DDT gradually increases at each trophic level. DDT inhibits calcium carbonate deposition in the oviducts of certain birds which result in the laying of thin-shelled eggs. These eggs can easily break during incubation and the developing embryos are destroyed.

MORE TO KNOW

MINAMATA DISEASE

Mercury poisoning due to the consumption of fish captured from mercury contaminated Minamata Bay in Japan was detected in 1952. Mercury compound in waste water are converted by bacterial action into extremely toxic methyl mercury which can cause numbness of limbs, lips and tongue. It can also cause deafness, blurring of vision and mental derangement.



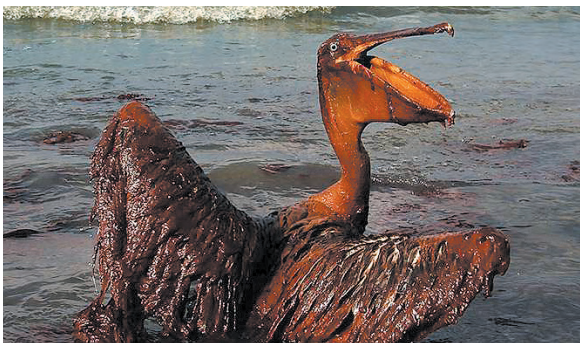
3.1.3. OIL SPILL

An oil spill is a release of liquid petroleum hydrocarbons into the environment mainly due to human activities. It includes the release of crude oil from tankers, offshore platforms, drilling rigs and wells.

Environmental impacts:

Oil spills affect the physical, chemical and biological characteristics of water and land. It forms a thick black layer above the sea water and considerably increases its viscosity. This interferes with the locomotion of organisms.

The oil floating on the surface of the water reduces the penetration of sunlight, limiting photosynthesis by marine plants



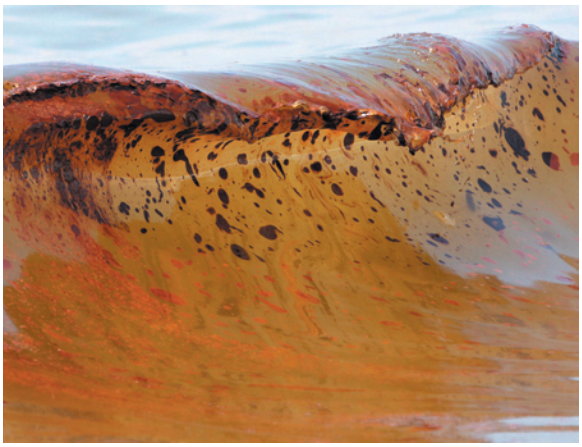
and phytoplanktons (producers). It will, in turn, affect the other members of the marine food chain. Oil also covers the plumage of birds and impairs their ability to fly and thus escape from predators. Birds may also ingest the oil while preening their feathers. This could result in kidney damage, altered liver function and metabolic imbalances.

The oil which covers the coats of aquatic mammals such as seals can reduce their heat insulation capacity, resulting in hypothermia (decrease in body temperature).

Crude oil contains a mixture of volatile hydrocarbons like benzene, toluene and xylene which are carcinogenic in nature (cancer causing). Symptoms of exposure include dizziness, headaches, nausea, rapid heartbeat and dehydration.

Control and Preventive Measures

- Oil spills can be controlled by preventing the release of oil or hydrocarbons during transit, exploration or through accidents.



Oil spill in gulf of mexico

Pseudomonas putida

- Sea food should be thoroughly tested for contaminants before consumption.

Oil spills may be cleared by using certain micro-organisms such as bacteria. This process of clearing oil spills by using bacteria is known as bio-remediation. One of the notable achievements in bio-remediation is the creation of Pseudomonas putida, a genetically engineered bacterium by an Indian American scientist, Dr. Ananda Mohan Chakraborty.

Pseudomonas putida is a rod-shaped saprophytic soil bacteria with the ability to breakdown hydrocarbons and organic solvents like octane and toluene.

Mumbai Oil Spill (August 2010)

The spill occurred due to the collision of two oil tankers, MSV Chitra and MV Khalijia, off the coast of Mumbai. An estimated 400 tonnes of oil was spilled into the Arabian sea. The oil spill proved to cause extensive damage to the marine eco-system, as well as the sensitive mangrove plants.

3.1.4. SOIL POLLUTION

Soil pollution is the unfavourable alteration of soil by the addition or removal of substances which decrease soil productivity and groundwater quality.

It usually results from human activities like dumping of waste, use of agro chemicals, mining operations and urbanization.

Causes and Effects

Industrial solid waste and sludge contain toxic organic and inorganic compounds as well as heavy metals. The radioactive waste from nuclear power plants and nuclear explosions also contaminate the soil. Fly ash contains fine particulates which are released from thermal power plants. It settles on the ground and causes pollution.

Domestic waste is rich in organic matter and undergoes decomposition. Hospital waste contains a variety of pathogens that can seriously affect human health.

Agricultural chemicals such as pesticides, insecticides and inorganic fertilizers may pollute drinking water and can change the chemical properties of the soil adversely affecting the soil organisms.

Control of soil pollution

Management of soil wastes includes collection and categorization of wastes. We must also recover scrap metals and plastics for recycling and reuse and ensure safe disposal of waste with minimum environmental hazards.

Other notable methods of waste disposal include incineration (burning in the presence of oxygen) and pyrolysis (burning in the absence of oxygen). Afforestation and reforestation should be undertaken on a large scale to prevent soil erosion and loss of soil nutrients.

MORE TO KNOW

REVERSE OSMOSIS (RO)

It is the most efficient way of obtaining purified drinking water. During this process, pressure is applied on the solution which has more concentration. This reverses the natural direction of water flow and osmosis from a high gradient to a low gradient. This process involves energy expenditure. The membranes used as a barrier for RO process have a dense layer which allow only the water to pass through and prevents the passage of solutes. Hence, it is best suited for desalination of sea water (removal of salt).

3.1.5.RADIOACTIVE POLLUTION

The emission of protons, electrons and electromagnetic radiations released by the disintegration of radioactive substances such as radium, thorium, uranium cause air, water and land pollution.

Effects : The ionising radiations can cause mutations.

- Strontium-90 accumulates in bones causing bone cancer.
- Iodine-131 can damage bone marrow, spleen, lymph nodes and can cause leukemia (blood cancer).

Preventive Measures

- Care should be taken to prevent the leakage of radioactive substances from nuclear reactors.

Nuclear power plant

Nuclear explosion

- Radioactive wastes should be disposed off safely.
- Strict measures should be followed in the construction and maintenance of nuclear power plants to prevent nuclear accidents.
- Control or prevention of nuclear tests.
- We must also ensure that old batteries and radioactive parts of electronic goods are returned for recycling and not discarded into the soil or water.

MORE TO KNOW

Chernobyl Disaster (Ukraine) : The explosion at the Chernobyl nuclear power station was undoubtedly the world's worst nuclear disaster. Deadly radioactive material was released into the atmosphere and the inhabitants of Chernobyl were exposed to radioactivity which was a hundred times greater than at Hiroshima. Babies were born with infirmities and people suffered from serious diseases like thyroid cancer.

3.1.6. NOISE POLLUTION

Noise may be defined as an unwanted and unpleasant sound that may have adverse effect on animals and humans. The unit of sound level is decibels (db). Noise level above 120 db is considered harmful to human beings.

Sources

The different sources associated with noise pollution are industrial machinery, road, rail and air transport, loudspeakers, construction equipments, household appliances and crackers.

Effects

Noise seriously affects heartbeat, breathing and can cause constriction of blood vessels. It can cause headache, sleeplessness, irritability and may seriously affect the productive performance of a human. Loud noises (above 130 db) can cause damage to the ear drum, hair cells of cochlea (organ of hearing) and thereby resulting in temporary or permanent loss of hearing. It can also seriously affect the concentration of students while learning.

Control Measures

Industries should be established away from residential areas. Trees should be planted along roadside or highways to reduce noise levels. Industrial machinery and motor vehicles should be properly maintained in order to minimize the noise. The use of loudspeakers and bursting of crackers should be restricted. Effort must

MORE TO KNOW

Jet Aircraft (take off)	*145 db*
Heavy city traffic	*90 db*
Vaccum cleaner	*85 db*
Window Air conditioner	*60 db*
Normal speech	*60 db*

be made to create awareness among people about the harmful effects of noise and the need to control it.

3.2. GLOBAL WARMING

- July 1998 was the hottest month the world over.
- In 1998 India had the hottest period in 50 years.
- 2012 was 9th warmest year on record. The nine warmest years have all occurred since 1998.
- There is a rapid melting of glaciers and a subsequent rise in sea level.

What could be the reason for these alarming changes in the climate and environment?

The answer is global warming. It refers to an average increase in the temperature of the atmosphere or simply it is the warming of the earth.

The root cause of this adverse climatic change is the greenhouse effect caused by greenhouse gases.

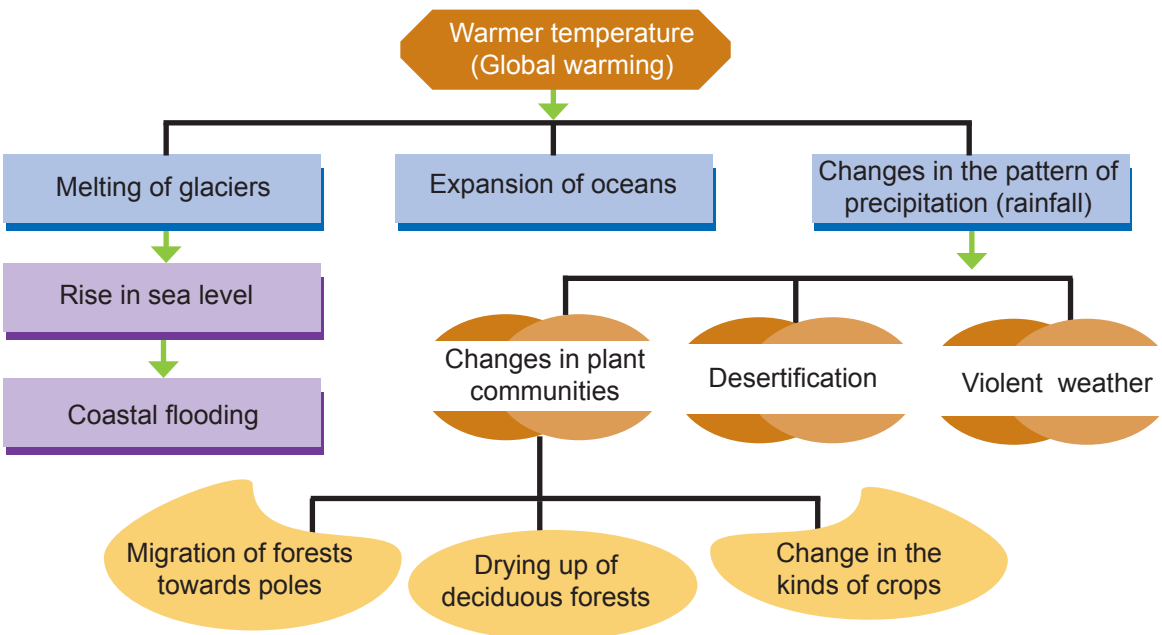
Melting of glaciers

3.2.1. GREENHOUSE EFFECT

The trapping of energy from the sun by greenhouse gases in the atmosphere leading to rise in earth's temperature is known as the greenhouse effect. Greenhouse gases such as carbon dioxide, methane, nitrous oxide and chloro fluro carbons absorb and reflect infra red waves radiated by the earth causing increase in temperature. The effect is very similar to what happens inside a greenhouse.

GREENHOUSE

A greenhouse is a structure primarly of glass or plastic in which temperature



and humidity can be controlled for the cultivation or growth of plants.

Greenhouse Gases

- **Carbon-dioxide** : It is the most abundant greenhouse gas released by burning of fossil fuels, deforestation, respiration of animals, decaying of organic matter. At present there is an increase of 31% of carbon dioxide.
- **Methane**: It is produced by the incomplete decomposition of organic compounds by methanogenic bacteria under anaerobic condition. It is also produced by the enteric fermentation in the cow and from flooded rice fields.
- **Nitrous oxide:** It is released by the burning of fossil fuels, industrial processes and agricultural practices like ploughing.
- **Chloroflurocarbons**: These are coolant gases used in refrigerators, aerosols and solvents.

Effects of Global Warming

- The level of seas rises due to the melting of glaciers and thermal expansion of water. It can submerge costal areas of countries.
- Due to global warming the rise in temperature could create unexpected changes in weather conditions, making some regions hotter and others colder.
- The rainfall pattern could also change causing drought in some areas and flooding in others.
- Crops and forests may be affected by insect pests and plant diseases resulting in severe damage.
- Water-borne and insect-borne diseases such as malaria and dengue, could spread to temperate countries.

A greenhouse

- It can also result in the loss of biodiversity due to the extinction of coral reefs and other key species.

Control Measures

Global warming can be controlled by reducing the use of fossil fuels, afforestation, carbon sequestration (trapping Co_2), shifting to renewable sources of energy such as solar power, wind power and hydel power.

Ten things you can do to reduce global warming:

1. Use less heat and air-conditioning.
2. Car pool, use bicycles and walk when you can.

Polar bear in melting snow

SCIENCE

MORE TO KNOW

Various laws and rules have been promulgated from time to time by the Government of India to control pollution. Some of them are:
1974 - Water (prevention, control of pollution) Act.
1980 - Forest Act.
1981 - Air (prevention, control of pollution) Act.
1986 - Environmental pollution Act.
1988 - Motor Vehicles Act

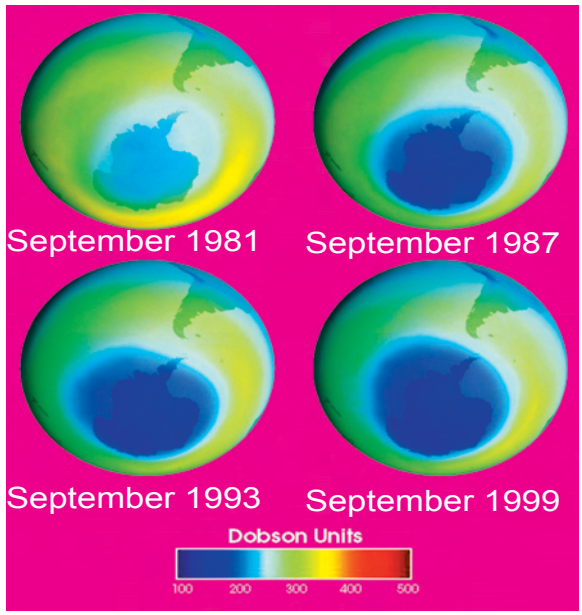
3. Buy energy efficient products (based on the ★rating).
4. Use CFL (Compact Fluorescent Light) bulbs.
5. Reduce, reuse and recycle resources.
6. Use less hot water.
7. "Switch off" equipment when not in use.
8. Plant trees.
9. Encourage others to conserve energy.
10. Do the energy auditing of household appliances.

Compact Fluorescent Light

CFLs are a great way to save energy even though they cost a little more and are slower to brighten up than an ordinary bulb. This is because they produce less amount of heat.

3.3. OZONE DEPLETION

The ozone layer in the stratosphere is protective in function. It filters the harmful ultraviolet rays of the sun. The ozone in this layer is continuously broken down and reformed; these two processes perfectly balance each other. Due to human activity, this balance is upset leading to the thinning of the ozone layer causing holes in the layer. The decrease in the amount of ozone in the stratosphere is called ozone depletion.



Ozone depletion

Reasons: The hole formed in the ozone layer is due to chlorine and bromine being formed in the atmosphere. The common forms are chloroflurocarbons, methyl bromide and nitrogen oxides, which are released from freezers, air conditioners, aerosol products and industrial solvents.

Exposure to UV rays can have the following effects:

- In humans, it can cause skin cancer, cataracts and poor immune response.
- In plants, it can affect crop yield and productivity.
- The UV radiation can also cause the death of phytoplanktons (producers), young fishes and larval forms.

Control Measures

Controlling the production, use and emission of ozone depleting substances, recycling of chemicals and the adoption of measures of protection from the sun's radiation are some of the measures to control ozone depletion.

Agencies of Environmental Management

C.P.R (C.P.Ramaswamy)

Environmental Education Centre Chennai: This centre promotes environmental awareness among the public. It gives guidance for creation and implementation of environmental laws, environmental impacts and environmental management studies. It promotes the use of renewable sources of energy.

Madras Naturalists Society: It creates environmental consciousness through seminars, camps, video shows and visits to wild life sanctuaries and national parks. It conducts surveys regarding pollution and deforestation.

MORE TO KNOW

EL NINO EFFECT

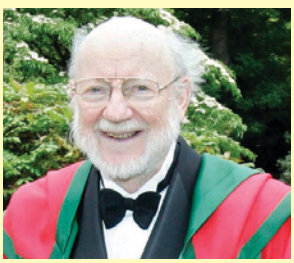
It causes erratic weather patterns which occur due to the interaction of unusually warm or cold sea surface temperatures in the eastern and central Pacific Ocean. It was once a rare cyclical weather condition which has become more frequent, persistent and intense.

MSSRF (M.S.Swaminathan Research Foundation): It is a non-profit research organisation and was established in 1998. It carries out research and development in six major areas such as bio-diversity, bio-technology, food scarcity, coastal system research, information, education and communication.

MORE TO KNOW

The Nobel Prize in Physiology or Medicine 2015 was divided, one half jointly to William C. Campbell and Satoshi Omura "for their discoveries concerning a novel therapy against infections caused by roundworm parasites" and the other half to Youyou Tu "for her discoveries concerning a novel therapy against Malaria".

Field : Physiology / Medicine



William C. Campbell

Born: 1930, Ramelton, Ireland.
Affiliation at the time of the award: Drew University, Madison, New Jersey, USA.

Satoshi Omura

Born: 1935, Yamanashi prefektur, Japan.
Affiliation at the time of the award: Kitasato University, Tokyo, Japan.

Youyou Tu

Born: 1930, Zhejiang Ningpo, China.
Affiliation at the time of the award: China Academy of Traditional Chinese Medicine, Beijing, China.

MODEL EVALUATION

Section A

1. Bursting of crackers and use of loud speakers are restricted at night due to noise pollution. Mention any two harmful effects of noise pollution.
2. On 10/10/10 at 10 p.m. lights were switched off all over the world for an hour, marking the 'earth hour'. Mention its significance.
3. The man made pollutants are _____.
4. The process of clearing oil spills by using bacteria is known as _____.
5. _____ can damage bone marrow, spleen, lymph nodes and can cause leukemia.
6. Loud noises above 130db can cause damage to the _____.
7. The trapping of energy from the sun by green house gases in the atmosphere which increases earth's temperature is known as _____.
8. _____ are coolant gases used in refrigerators.
9. The use of _____ bulbs is a great way to save energy.
10. The Ozone layer is continuously broken down by human activity and becomes very thin. This leads to _____
11. The most efficient way to convert sea water into purified drinking water is by _____
12. The oxygen shortage which leads to the death of aquatic organisms found in the water is known as _____.
13. Biological magnification of _____is seen in aquatic food chain.
14. Oil spills have proved to cause extensive damage to the _____ ecosystem.
15. Find out the conventional sources of energy
    (Solar energy, Hydel energy, Tidal energy, Hydrocarbon energy)
16. The Tajmahal which is a historical monument built with marble is being corroded due to the gases let out by the nearby oil refineries. The chief pollutant is _____
    (CO, CO_2, SO_2, NO_2)
17. It is found that Crop fields located near the highways give less yield due to low Photosynthetic activity and stunted growth. The Pollutant responsible for this _____ (PAN , CFC's ,HNO_3, MIC)
18. The Pollutant responsible for Ozone depletion is _____
    (CFC's, MIC, CO_2, SO_2)

Section B

1. Water pollution due to domestic sewage leads to algal bloom and eutrophication. How can this damage the aquatic ecosystems?
2. Prepare two posters containing slogans to create awareness about the harmful effects of noise.
3. Mention any two climatic and seasonal changes that occur due to global warming.
4. Planting of sapling is being carried out. At the same time, felling of trees occurs at an alarming rate. How can we strike a balance between the two.

5. *Some examples of non-conventional sources of energy are Solar Energy, Hydel Energy and Tidal Energy. What role do they play in reducing pollution?*

6. *Oil spills in seas and oceans are a frequent occurrence due to oil explorations and tanker accidents. Write a note on the effects of oil spills on marine life.*

7. *The atmosphere is a layer of gases which consists of nitrogen, oxygen and other gaseous elements. Explain.*

8. *Match the following:*

i) Smog	*- a) acidic soil*
ii) Acid rain	*- b) reduces O_2 carrying capacity of blood*
iii) Carbon Monoxide	*- c) reduced visibility*

9. *Choose the correct answer:*

a) PAN is *i) Peroxide Acetic Nitrate* *ii) Peroxy Acetyl Nitrate* *iii) Peroxy Acetic Nitrate*

b) Hypothermia in aquatic mammals is due to

i) noise pollution *ii) air pollution* *iii) oil spills*

10. *Correct the mistakes :*

a) Particulate matter is a mixture of smoke and fog.

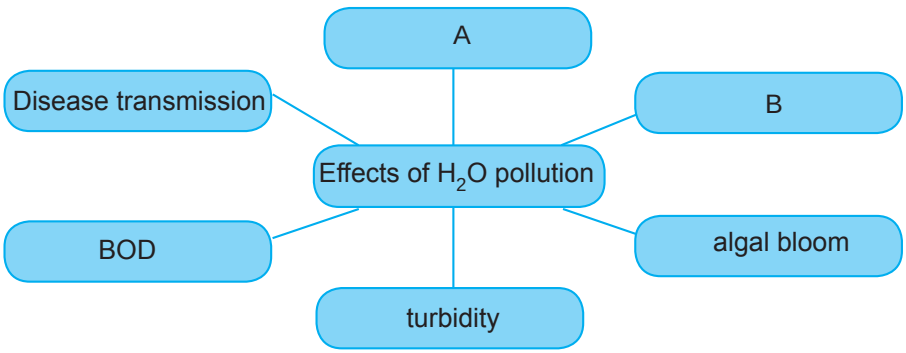
b) Solar energy, hydel energy and tidal energy are conventional sources of energy.

11. *Find the odd one out and give reasons:*

a) radium, thorium, uranium, domestic sewage

b) benzene, toluene, xylene, acid rain.

12. *Complete the given diagram.*



13. *Fill in the blanks:*

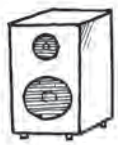
i) Benzopyrene is a _____ (effluent / carcinogen)

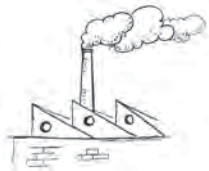
ii) Planting of trees along road sides will reduce _____ in the air (pollutants / oxygen).

14. Observe the pictures and write down the types of pollution:


(a)


(b)


(c)


(d)

Types of Pollution

a) _____ b) _____ c) _____ d) _____

15. Expand the following abbreviation:

CFL, CFC's, MIC, MSSRF

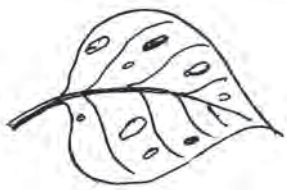
16. Who am I?

a) I am a rod-shaped saprophytic soil bacteria with the ability to breakdown hydro carbons and organic solvents like octane and toluene _____

b) I get accumulated in bones causing bone cancer _____

17. Observe the colour of leaves and find out the names of the plant disease:


Pale yellow coloured leaf


Black spotted leaf

a) Disease caused by the loss of cholorphyll is called _____

b) Disease that causes Localized death of tissues in leaf is called _____

Section C

1. Prepare a poster to warn people about the ill-effects of water pollution or air pollution.

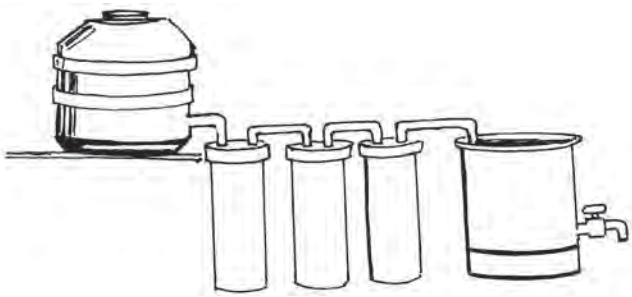
2. Hold a discussion on the issue of air pollution. Discuss answers to the following questions:

i) What are the effect of air pollution?

ii) What measures can we adopt to change this?

iii) Prepare a poster based on the information you have gathered.

3. Sea Water / Bore-well Water



Water purifier

It is the most efficient way of obtaining purified drinking water. During this process, pressure is applied on the solution which has more concentration. This reverses the natural direction of water flow and osmosis occurs from high gradient to low gradient. This process involves energy expenditure. The membranes used for this process have a dense barrier layer which allows only the water to pass through and prevents the passage of solutes.

Questions:

i) Which process takes place in the water purifier?

ii) What is the difference between osmosis and reverse osmosis?

iii) Why should we use the dense barrier layer?

iv) What is the direction of water molecules movement?

v) Is energy used or not in this process?

4.Find the hidden gases:

(a) Decomposition

(b) Refrigerator

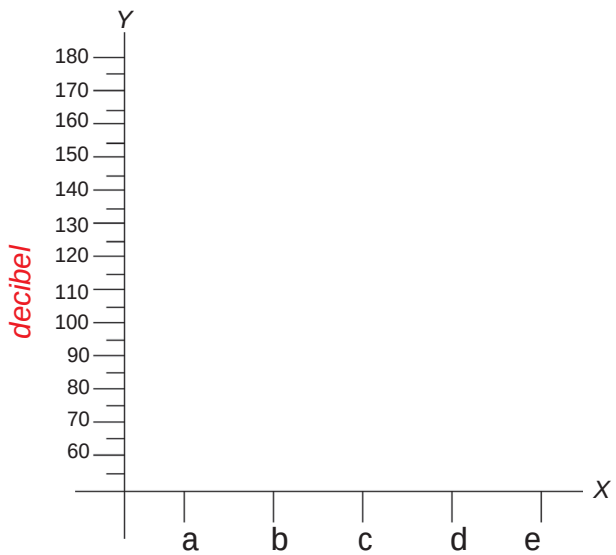
(c) Greenhouse

(d) Ploughing

A:_____ B:_____ C:_____ D:_____

E: The precipitate of acid rain is a mixture of _____ and _____

5. Find out the level of noise pollution in a,b,c,d,e



a) Normal speech

b) Noise of a vaccum cleaner

c) Noise of heavy city traffic

d) Noise can cause damage to the eardrum

e) Noise of a jet air craft

SCIENCE

FURTHER REFERENCE

Books: 1. Elements of Ecology - Clarke G.L., John wiley & sons, Newyork.

2. Fundamentals of Ecology - Odum E.P., W.B.Saunders Company, Philadelphia.

Webliography : http://www.ecology.com http://www.nationalgeographic.com

Scientific names, Common names and Tamil names of some plants

S.No.	Scientific Name	Common Name	Tamil Name	How is it called locally?
1.	Brassica oleracea	Cabbage	முட்டைக்கோசு	
2.	Cyamopsis tetragonoloba	Cluster bean	கொத்தவரை	
3.	Arachis hypogea	Groundnut	நிலக்கடலை	
4.	Oryza sativa	Rice(Paddy)	நெல்	
5.	Vasella rubra	Spinach	பசலைக்கீரை	
6.	Crotalaria juncea	Sunn-hemp	சணப்பை	
7.	Eichhornia crassipes	Water hyacinth	ஆகாயத்தாமரை	
8.	Triticum vulgare	Wheat	கோதுமை	
9.	Impatiens balsamina	Balsam	காசித்தும்பை	
10.	Utricularia polyvaloides	Bladderwort	யுட்ரிகுலேரியா	
11.	Coriandrum sativum	Coriander	கொத்துமல்லி	
12.	Taraxacum officinale	Dandelion	டேண்டலியான்	
13.	Cuscutta reflexa	Dodder plant	அம்மையார் கூந்தல் (அல்லது)சடதாரி	
14.	Monotropa uniflora	Indian pipe	புகையிலைக் காளான்	
15.	Agaricus campestris	Mushroom	நாய்க்குடை	
16.	Allium cepa	Onion	வெங்காயம்	
17.	Nepenthes khasiana	Pitcher plant	குடுவைத்தாவரம்	
18.	Solanum tuberosum	Potato	உருளைக்கிழங்கு	
19.	Crocus sativus	Saffron	குங்குமப்பூ	
20.	Drosera burmannii	Sundew plant	எறும்புத்திண்ணி (சூரியப்பனித்துளித் தாவரம்)	
21.	Mimosa pudica	Touch-me-not plant (Sensitive plant)	தொட்டாற்சுருங்கி (தொட்டாற்சிணுங்கி)	

Scientific names, Common names and Tamil names of some animals

S.No.	Scientific Name	Common Name	Tamil Name	How is it called locally?
1.	Amoeba proteus	Amoeba	அமீபா	
2.	Paramoecium caudatum	Paramoecium	பாரமீசியம்	
3.	Hydra vulgaris	Hydra	ஹைடிரா	
4.	Obelia geniculata	Jelly fish	நொங்குமீன்	
5.	Periplaneta americana	Cockroach	கரப்பான்பூச்சி	
6.	Pila globosa	snail	நன்னீர் நத்தை	
7.	Lamellidans lamellidans	Freshwater mussel	நன்னீர் மட்டி	
8.	Asterias rubens	Star fish	நட்சத்திர மீன்	
9.	Naja naja	Cobra	நல்ல பாம்பு	
10.	Pavo cristatus	Peacock	மயில்	
11.	Tyto alba	Owl	ஆந்தை	

4. PERIODIC CLASSIFICATION OF ELEMENTS

When you go to a big library, you see many racks with books. If you need a book on Science, you would go to the section labelled as Science. In the Science section you will find separate racks for various branches like Chemistry, Physics etc. where books are arranged in a certain order. Thus, wherever a large number of items are involved, proper classification is needed for easy identification.

In the early days, when elements were being discovered, scientists tried to classify elements based on their nature, and then according to their atomic mass. This classification of elements is called 'periodic table'. Finally, they succeeded with a classification system based on atomic number. In this periodic table, elements which show similar physical and chemical properties are arranged in rows and columns. This table also led to the discovery of elements not known till then.

4.1. EARLY ATTEMPTS AT CLASSIFICATION OF ELEMENTS

Lavoisier's Classification of Elements

In 1789, Lavoisier first attempted to classify the elements into two divisions, namely Metals and Non-metals. However, this classification was not satisfactory as there were many exceptions in each category.

ACTIVITY 4.1 **I DO**

Element	*Atomic Mass*
Calcium	*40*
Strontium	*88*
Barium	*137*
Chlorine	*35.5*
Bromine	*80.0*
Iodine	*127.0*

I can arrange the above elements in two groups of triads.

Dobereiner's Classification of Elements

In 1817, Johann Wolfgang Dobereiner grouped three elements together into what he termed triads.

Elements with similar chemical properties were arranged in a group of three, in which the atomic mass of the middle element was approximately the arithmetic mean of the two extreme elements..

For example, elements like lithium, sodium and potassium were grouped together into a triad as shown below. The atomic mass is shown in brackets.

Li (7)	Na (23)	K (39)

Note that the atomic mass of sodium is the average of atomic masses of lithium and potassium.

Limitation of Dobereiner's Law

After the discovery of elements many of them could not be grouped this way.

Newland's Classification of Elements

In 1863, John Newland arranged the elements in the increasing order of Atomic Mass. He observed that there appeared to be a repetition of similar properties in every eighth element like that of eighth note in an octave of music.

MORE TO KNOW

Chemically alike elements could be arranged in a group of three, in which the atomic mass of the middle element would be approximately the arithmetic mean of the two extreme elements.

Therefore, he placed seven elements in each group. Then he classified the 49 elements known at that time into seven groups of seven each. Newland referred to this arrangement as the Law of Octaves.

Note	1 (Sa)	2 (re)	3 (ga)	4 (ma)	5 (pa)	6 (dha)	7 (ni)
Element	Li	Be	B	C	N	O	F
	Na	Mg	Al	Si	P	S	Cl
	K	Ca	Cr	Ti	Mn	Fe	-

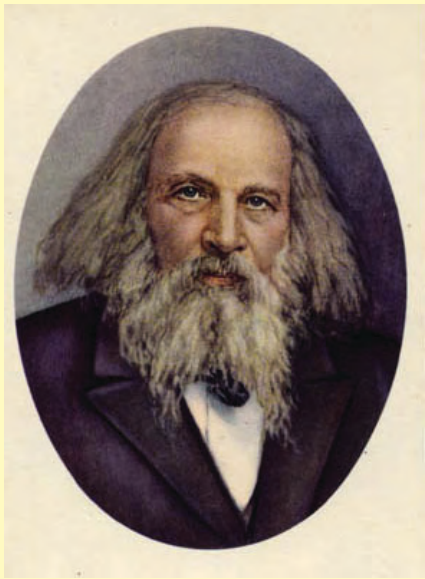
Note: Sodium is similar to Lithium. Likewise, Magnesium is similar to Beryllium.

Limitations of Newland's Classification

Inert gases were discovered at a later stage. With the inclusion of inert gas, 'Neon' between 'Fluorine' and 'Sodium', the 9th element became similar to the first one. Similarly, the inclusion of inert gas 'Argon' between 'Chlorine' and 'Potassium' made the 9th element similar to the first one.

Lothar Meyer's Classification of Elements

In 1864, Lothar Meyer plotted the atomic weight against the atomic volume of various elements. He found out that the elements with similar properties and valency fell under one another. However, this also could not give a better understanding the sequences.



Mendeleev (1834-1907)

Dimitri Ivanovich Mendeleev, a Russian chemist, suggested that the chemical elements can be sorted out based on certain similarities in their properties. The arrangement he proposed is called the Periodic Table. His table proved to be a unifying principle in chemistry and led to the discovery of many new chemical elements.

ACTIVITY 4.2 **I DO**

I can write the names of elements with similar properties

Element	*Element with similar property*
Aluminium	
Silicon	
Phosphorous	
Sulphur	
Chlorine	

MORE TO KNOW

Periodicity is the recurrence of similar physical and chemical properties of elements, when they are arranged in a particular order.

SCIENCE

4.2. MENDELEEV'S PERIODIC TABLE

Groups	I	II	III	IV	V	VI	VII	VIII		
Oxide : Hydride:	R_2O RH	RO RH_2	R_2O_3 RH_3	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4		
Periods	A B	A B	A B	A B	A B	A B	A B	Transition		Series
1	H 1.008									
2	Li 6.941	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998			
3	Na 22.99	Mg 24.31	Al 26.98	Si 28.09	P 30.97	S 32.06	Cl 35.453			
4 First Series	K 39.10	Ca 40.08	--	Ti 47.90	V 50.94	Cr 52.20	Mn 54.94	Fe 55.85	Co 58.93	Ni 58.69
Second series	Cu 63.55	Zn 65.39	--	--	As 74.92	Se 78.96	Br 79.90			
5 First series	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc 98	Ru 101.07	Rh 102.9	Pd 106.4
Second series	Ag 107.87	Cd 112.41	In 114.82	Sn 118.71	Sb 121.76	Te 127.90	I 126.90			
6. First series	Cs 132.90	Ba 137.34	La 138.91	Hf 178.49	Ta 180.95	W 183.84	--	Os 190.2	Ir 192.2	Pt 195.2
Second series	Au 196.97	Hg 200.59	Tl 204.38	Pb 207.2	Bi 208.98					

Fig: Mendeleev's Periodic Table
("R" is used to represent any of the elements in a group)

4.3. MENDELEEV'S CLASSIFICATION OF ELEMENTS

Mendeleev's periodic table is based on a law called Mendeleev's periodic law which states that :

"The physical and chemical properties of elements are the periodic functions of their atomic masses".

ACTIVITY 4.3 **I DO**

I can answer the following questions. Name the elements missing in the Mendeleev's periodic table with atomic masses 44, 68 and 72. To which group do they belong? Is there any group for noble gases?

Characteristics of Mendeleev's Periodic Table

- Mendeleev felt that similar properties occurred after periods (horizontal rows) of varying length.
- He created a table with eight columns.
- He left a few cells empty so that all the elements with similar properties could be grouped in the same column.
- Mendeleev inferred that there must be other elements that had not yet been discovered.
- He predicted the properties and atomic masses of several elements that were not discovered at that time. Later on, when these elements were discovered, their properties remarkably agreed with his prediction

For example, he left a gap below silicon in group IV A, and called the yet undiscovered element as 'Eka Silicon'. The discovery of 'Germanium' later on, during his lifetime, proved him correct.

Property	Mendeleev's prediction in 1871	Actual property of Germanium discovered in 1886
1.Atomic Mass	About 72	72.59
2.Specific Gravity	5.5	5.47
3.Colour	Dark grey	Dark grey
4.Formula of Oxide	EsO_2	GeO_2
5.Nature of Chloride	$EsCl_4$	$GeCl_4$

- Similarly, Scandium for 'eka-boron' and Gallium for 'eka-aluminium' were later discovered.
- Eight out of ten vacant spaces left by Mendeleev were filled by the discovery of new elements.
- Incorrect atomic masses of some of the already arranged elements were corrected. For example, the atomic mass of Beryllium was corrected as 9 from 13.

Characteristics of modified Mendeleev's Periodic Table

1. Elements are arranged in the increasing order of their atomic masses.
2. Vertical columns are called 'groups' and horizontal rows are called 'periods'.
3. There are 'nine groups' numbered from I to VIII and 0.
4. Groups I to VII are subdivided into subgroups A and B.

ACTIVITY 4.4 — **I DO**

I can write down the names of elements belonging to groups I and II in Mendeleev's periodic table.

Group	*IA*	*IB*	*IIA*	*IIB*
Elements				

ACTIVITY 4.5 — **WE DO**

Using Mendeleev's periodic table, we can write the formula of oxides of:

1.Lithium - _____

2. Boron - _____

3.Sodium - _____

4.Beryllium- _____

5. Calcium- _____

MORE TO KNOW

The inadequacy in the Mendeleev's periodic table has been overcome by the introduction of the Modern periodic table. It is also known as Long form of periodic table. In this table, the properties of elements are dependent on their electronic configurations (distributions). Hence, the modern periodic law is defined as: "the properties of elements are the periodic function of their atomic numbers " .

Groups↓ Periods →	I A B	II A B	III A B	IV A B	V A B	VI A B	VII A B	VIII			0 (ZERO)
1	1.008 H 1										4.003 He 2
2	6.941 Li 3	9.012 Be 4	10.81 B 5	12.011 C 6	14.007 N 7	15.999 O 8	18.998 F 9				20.18 Ne 10
3	22.99 Na 11	24.31 Mg 12	26.98 Al 13	28.09 Si 14	30.97 P 15	32.06 S 16	35.45 Cl 17				39.95 Ar 18
4	39.10 K 19	40.08 Ca 20	44.96 Sc 21	47.90 Ti 22	50.94 V 23	52.20 Cr 24	54.94 Mn 25	55.85 Fe 26	58.93 Co 27	58.69 Ni 28	83.90 Kr 36
	63.55 Cu 29	65.39 Zn 30	69.72 Ga 31	72.61 Ge 32	74.92 As 33	78.96 Se 34	79.90 Br 35				
5	85.47 Rb 37	87.62 Sr 38	88.91 Y 39	91.22 Zr 40	92.91 Nb 41	95.94 Mo 42	98 Tc 43	101.07 Ru 44	102.91 Rh 45	106.4 Pd 46	131.30 Xe 54
	107.87 Ag 47	112.41 Cd 48	114.82 In 49	118.71 Sn 50	121.76 Sb 51	127.90 Te 52	126.90 I 53				
6	132.9 Cs 55	137.34 Ba 56	138.9 La* 57	178.49 Hf 72	180.97 Ta 73	183.84 W 74	186.2 Re 75	190.2 Os 76	192.2 Ir 77	195.2 Pt 78	222 Rn 86
	196.97 Au 79	200.59 Hg 80	204.38 Tl 81	207.20 Pb 82	208.98 Bi 83	209 Po 84	210 At 85				
7	223 Fr 87	226 Ra 88	227 Ac** 89								

6	* Lanthanides	140.12 Ce 58	140.91 Pr 59	144.2 Nd 60	145 Pm 61	150.4 Sm 62	152.0 Eu 63	157.3 Gd 64	158.9 Tb 65	162.5 Dy 66	164.9 Ho 67	167.3 Er 68	168.9 Tm 69	173.0 Yb 70	174.9 Lu 71
7	** Actinides	232.04 Th 90	231 Pa 91	238.02 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	252 Es 99	257 Fm 100	258 Md 101	259 No 102	260 Lr 103

Fig: Modified Mendeleev's Periodic Table

5. There are 'seven periods'.
6. The first three periods contain 2, 8, 8 elements respectively. They are called 'short periods'.
7. The fourth, fifth and sixth periods have 18, 18 and 32 elements respectively.
8. The seventh period is an incomplete period.
9. Blank spaces are left for elements yet to be discovered.
10. The series of 'fourteen elements' following lanthanum is called 'Lanthanide series'.
11. The series of 'fourteen elements' following actinium is called 'Actinide series'.
12. Lanthanides and actinides are placed at the bottom of the periodic table.

Limitations of modified Mendeleev's Periodic Table

1. A few elements that have a higher atomic mass were placed before those having a lower atomic mass.

   Example: Argon (39.9) was placed before Potassium (39.1)

   Cobalt (58.9) was placed before Nickel (58.6).

   Tellurium (127.9) was placed before Iodine (126.9).

2. There were no provisions for placing Isotopes.
3. Hydrogen was placed in group IA although its properties resembled elements in group IA as well as group VIIA.
4. Chemically dissimilar elements were placed in the same group.

For example, alkali metals like sodium and potassium were placed along with coinage metals like copper, silver and gold.

MORE TO KNOW

Gallium is a metal. It has a melting point of 29.8°C. The temperature of a human body is enough to melt Gallium.

4.4. METALS AND NON-METALS

All the elements in the periodic table are broadly divided into three categories.

- Metals
- Non-metals
- Metalloid (semi-metals)

Metals

Metals are a group of elements which have similar properties. Most of the known elements are metals and they occupy a large area in the periodic table. The left side of the periodic table contains metals. Metals are further classified into:

MORE TO KNOW

- *Tungsten has the highest melting point of over 3300°C.*
- *Lithium is the lightest metal. It weighs about half as much as water.*
- *Osmium is the heaviest metal. It is about 22½ times heavier than water and nearly 3 times heavier than iron.*

SCIENCE

ACTIVITY 4.6 **WE OBSERVE**

We take samples of iron, copper, aluminium and magnesium. Note the appearance of the samples first. Clean the surface of each sample by rubbing them using sandpaper. Now note the appearance of the samples again. Name the elements in the decreasing order based on their lustrous character.

i. Alkali metals
e.g. sodium and potassium

ii. Alkaline earth metals
e.g. calcium and magnesium

iii. Transition metals
e.g. iron and nickel

iv. Other metals
e.g. aluminium, tin.

Non-metals

Elements that do not exhibit the properties of metals are called non-metals. Non-metals occupy the left side of the periodic table. e.g. Carbon, Iodine.

Metalloids

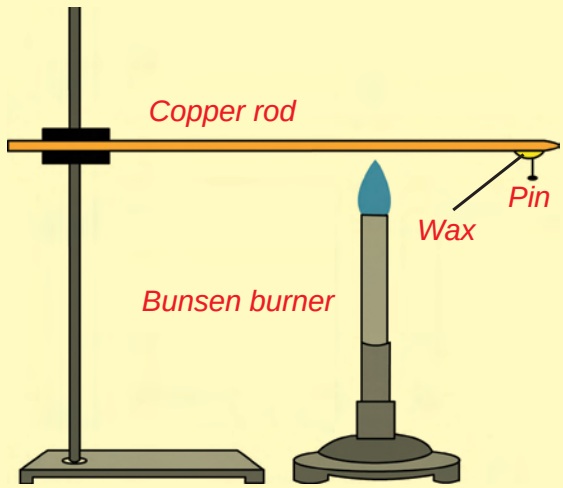
Elements which have the properties of both metals and non-metals are called metalloids. They are very good semi-conductors e.g. Silicon, Germanium.

MORE TO KNOW

- *Among metals, silver is the best conductor of electricity.*
- *Mercury is a metal with a very low melting point and it turns into a liquid at room temperature.*

ACTIVITY 4.7 **WE OBSERVE**

Take a copper rod. Clamp this rod on a stand. Fix a pin to the free end of the rod using wax. Heat the rod using a Bunsen burner as shown in the figure. Observe what happens. Write down the reason.



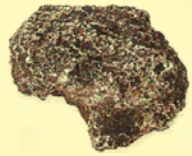
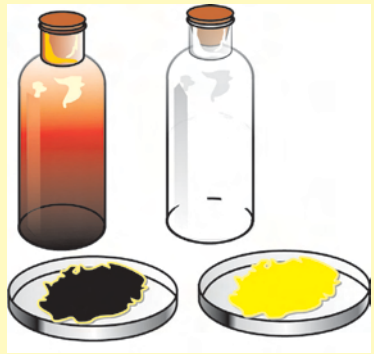
ACTIVITY 4. 8 **WE DO**

We take an iron rod, a copper rod and an aluminium rod. We strike each rod several times with a hammer and observe the sound produced. We record the sonorous character of these metals.

ACTIVITY 4.9 **I DO**

Ductility is the ability of metals to be drawn into thin wires or filaments. I can write which of the following metals are available in the form of wires: iron, magnesium, lead, copper, aluminium and calcium.

4.4.1. PHYSICAL PROPERTIES OF METALS AND NON-METALS

S. No.	Properties	Metals	Non-metals
1.	Appearance	Have a lustre, known as metallic lustre. The surface is polishable.  Platinum  Gold  Silver	Have no lustre and look dull. Surface cannot be polished. (Exceptions: Graphite and iodine are lustrous).  Yellow - Sulphur, White - Phosphorous, Red - Bromine, Black-Carbon
2.	Physical state	In general, they are hard crystalline solids.(Exception: Mercury is a liquid).	They exist as soft solids or gases. (Exceptions: Diamond is a hard solid and bromine is a liquid).
3.	Density	They have a high density. (Exceptions: Sodium and Potassium).	They have a low density.
4.	Melting and boiling points	Usually they have high melting and boiling points. (Exceptions: Sodium and Potassium).	They have low melting and boiling points. (Exceptions: Diamond and graphite).
5.	Malleability and ductility	They are malleable and ductile.	Solid non-metals are brittle.
6.	Heat conductivity	They are good conductors	They are bad conductors. (Exception: Diamond).
7.	Electrical conductivity	They are good conductors	They are bad conductors. (Exception: Graphite)
8.	Sonority (phenomenon of producing a characteristic sound when a material is struck)	They are sonorous.	They are non-sonorous. (Exception: Iodine crystals produce a soft metallic clink when they are shaken in a bottle).
9.	Alloy formation	Metals form alloys with each other and also with some non-metals	Non-metals usually do not form alloys. (Exceptions: B, C, Si and P form alloys with metals).

4.4.2. CHEMICAL PROPERTIES OF METALS

1. Electropositivity:

Metals are electropositive. They lose electrons and form cations.

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

$Mg \rightarrow Mg^{2+} + 2e^-$

2. Reaction with Oxygen:

Metals combine with oxygen to form metallic oxides.

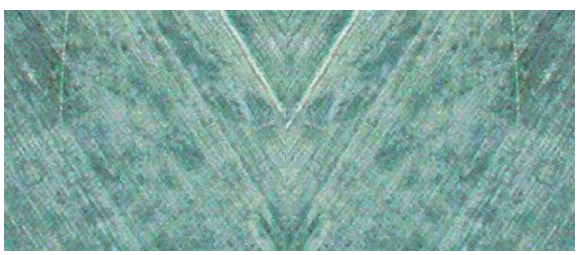
i. Magnesium burns in oxygen to form magnesium oxide.

$$2Mg + O_2 \longrightarrow 2MgO$$

Magnesium burns in oxygen

ii. Aluminium combines with oxygen to form a layer of aluminium oxide.

$$4Al + 3O_2 \longrightarrow 2Al_2O_3$$



Formation of aluminium oxide over a surface of aluminium

iii. Iron wool (thread) burns in oxygen to form iron oxide along with the release of thermal energy and light energy.

$$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$$

Iron wool (made into thin fibres) burns in oxygen to produce both heat and light energy

Note: Metal oxides are mostly basic in nature though some are amphoteric. (Shows both acidic and basic properties)

3. Action of water

(i) Metals like sodium and potassium react with cold water vigorously and liberate hydrogen gas.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2\uparrow$$

$$2K + 2H_2O \longrightarrow 2KOH + H_2\uparrow$$

(ii) Magnesium and Iron react with steam to form magnesium oxide and iron oxide respectively. Hydrogen gas is liberated.

$$Mg + H_2O \longrightarrow MgO + H_2\uparrow$$

$$3Fe + 4\,H_2O \longrightarrow Fe_3O_4 + 4\,H_2\uparrow$$

(iii) Aluminium reacts slowly with steam to form aluminium hydroxide and hydrogen.

$$2Al + 6\,H_2O \longrightarrow 2Al(OH)_3 + 3\,H_2\uparrow$$

Other metals like copper, nickel, silver and gold do not react with water.

4. Action of acids on metals

Metals such as sodium, magnesium and aluminium react with dilute hydrochloric acid to give the respective salts. Hydrogen gas is liberated.

$Mg + 2HCl \longrightarrow MgCl_2 + H_2\uparrow$

$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2\uparrow$

5. Action of halogens

Metals react with halogens to form ionic halides.

$2Na + Cl_2 \longrightarrow 2NaCl$

$2Al + 3Br_2 \longrightarrow 2AlBr_3$

6. Reducing property:

When a reactant gains electrons during the reaction, it is said to be reduced.

In a chemical reaction between a metal and a non-metal, the metal loses one or more electrons, which are accepted by the non-metal. So the metal is oxidised and the non-metal is reduced. The metal acts as a reducing agent.

$6Na + Al_2O_3 \xrightarrow{heat} 3Na_2O + 2Al$

$2Mg + CO_2 \xrightarrow{heat} 2MgO + C$

4.4.3. CHEMICAL PROPERTIES OF NON-METALS

1. Electronegativity:

Non-metals are electronegative. They gain electrons and form anions.

ACTIVITY 4.10 WE OBSERVE

We take 10 ml of diluted hydrochloric acid in a test tube. We drop a small piece of iron into it. We shall observe the changes.

$Cl + e^- \longrightarrow Cl^-$

$O + 2e^- \longrightarrow O^{2-}$

2. Reaction with oxygen:

Non-metals when heated with oxygen produce covalent oxides.

1. Sulphur burns in air at 250° C with a pale blue flame to form sulphur dioxide.

   $S + O_2 \longrightarrow SO_2\uparrow$

2. Phosphorous burns in air to form phosphorous pentoxide.

   $4P + 5O_2 \longrightarrow 2P_2O_5$

3. Carbon burns in air to form carbon monoxide and carbon dioxide.

   $2C + O_2 \longrightarrow 2CO\uparrow$

   $C + O_2 \longrightarrow CO_2\uparrow$

Note: Most of the non-metal oxides are acidic in nature. Some of them are neutral oxides.

3. Action of water:

Carbon reacts with water to form carbon monoxide and hydrogen.

$C + H_2O \longrightarrow CO + H_2$

4. Action of acids on non-metals:

Generally non-metals do not react with acids, but when they are heated with conc.HNO_3 or conc. H_2SO_4, the respective oxides or oxoacids are formed.

$C + 4HNO_3 \text{ (conc.)} \xrightarrow{heat} 2H_2O + NO_2\uparrow + CO_2\uparrow$

$C + 2H_2SO_4 \text{ (conc.)} \xrightarrow{heat} 2H_2O + 2SO_2\uparrow + CO_2\uparrow$

5. Action of chlorine:

Non-metals react with chlorine to form covalent chlorides.

$H_2 + Cl_2 \longrightarrow 2HCl$

$2P + 3Cl_2 \longrightarrow 2PCl_3$

$2P + 5Cl_2 \longrightarrow 2PCl_5$

SCIENCE

6. Oxidising property:

When a reactant loses electrons during a reaction, it is said to be oxidised.

In a chemical reaction between a metal and a non-metal, the metal loses one or more electrons, which are accepted by the non-metal. So the metal is oxidised and the non-metal is reduced. The non-metal acts as an oxidising agent.

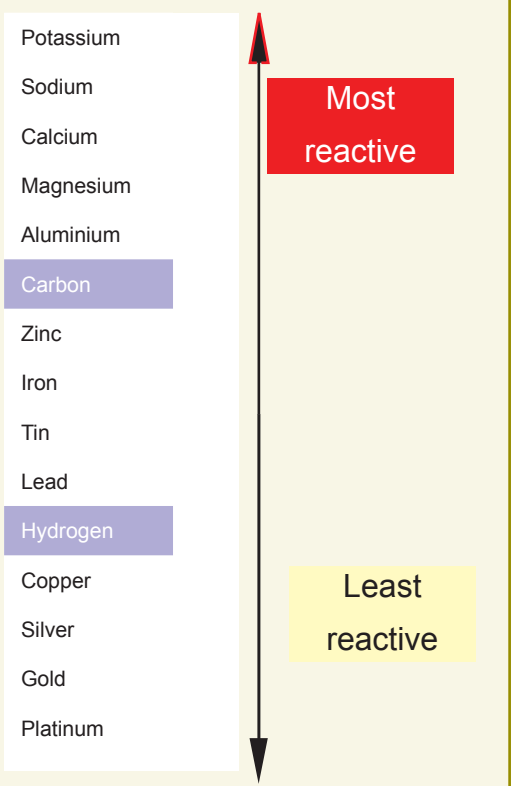
$2Na + Cl_2 \longrightarrow 2NaCl$

$2Mg + O_2 \longrightarrow 2MgO$

4.4.4. REACTIVITY SERIES

The reactivity series or activity series is the arrangement of some common metals according to their reactivity. The reactivity of the metals decreases as we go down. The two non-metals, hydrogen and carbon, are included in the series to compare the reactivity of the metals above and below them in specific reactions.

Reactivity series of metals:



C and H are added for comparison

ACTIVITY 4.11 **I DO**

I can classify the following oxides into acidic or basic.

1. *Sodium oxide*
2. *Zinc oxide*
3. *Aluminium oxide*
4. *Carbon dioxide*
5. *Sulphur dioxide*

4.4.5. USES OF REACTIVITY SERIES

1. Highly reactive metals occupy the top portion of the series. They readily react with other chemical compounds. Most of the reactions are exothermic.
2. The electropositive nature of metals decreases as the reactivity decreases. So the reducing nature of metals decreases too.
3. The metals above hydrogen in the reactivity series displace hydrogen from water.
4. The metals above hydrogen in the reactivity series react with dilute acids and liberate hydrogen gas. Lead is an exception.
5. A more reactive metal can displace a less reactive metal from its salt solution.

Example:

$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$

6. The reactive metals are susceptible to corrosion.
7. Metals above carbon cannot be extracted from their carbon ores.

4.4.6. ALLOYS

The idea of making alloys is not new. It was known to people of ancient times. Thousands of years ago, people discovered that they could use copper instead of stone to make tools. Around 3500 B.C., people

An alloy is a homogeneous mixture consisting of two or more metals fused together in the molten state in a fixed ratio.

discovered the alloy called “bronze”. They combined tin, a fairly soft metal, with copper to produce bronze. Bronze is a very hard alloy and is used for many purposes. Bronze prove to be a better material, when compared to tin or copper.

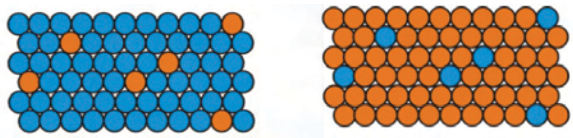
Composition of Alloys

There are two types of alloys. They are,

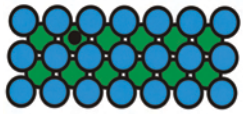
(i) Substitutional alloys

(ii) Interstitial alloys

In substitutional alloys, atoms of one metal randomly take the place of atoms of another metal.



Substitutional alloy



Interstitial alloy

In interstitial alloys, small non-metallic atoms such as H(Hydrogen), B(Boron), C(Carbon) and N(Nitrogen) occupy the holes in the crystal structure of the metal.

4.4.7. USES OF ALLOYS

Name of the alloy	Metals present in it	Uses
Brass	Copper, Zinc	To make screws, windows and door fittings
Bronze	Copper, Tin	To mould statues, machine parts
Solder	Tin, Lead	In electrical and plumbing industries, to join metal surfaces without melting them.
Steel	Iron, Carbon, Chromium, Nickel, Tungsten	In construction of bridges, buildings, household products, cooking utensils
Duralumin	Aluminium, Copper, Manganese, Magnesium	To manufacture aircraft parts, cars, ships and nails.

Characteristics of alloys

1. An alloy is harder than the metals in it.
2. An alloy enhances the tensile strength of the base metal.
3. An alloy improves corrosion resistance.
4. The density and melting point of the individual metal is different from the density and melting point of the alloy.
5. An alloy enables better castability.

MORE TO KNOW

- *Ferrous alloys contain iron as the base metal.*
- *Non-ferrous alloys contain a little iron or no iron.*

MORE TO KNOW

Amalgam is an alloy in which one of the constituents is mercury.

SCIENCE

MODEL EVALUATION

Section A

Choose the correct answer:

1. Classification of elements into two divisions, namely metals and non-metals was first attempted by_____

   (Dobereiner, Lavoisier, Mendeleev).

2. As per Newland's 'Law of Octaves', which of the two elements in the given table have repetition of similar properties?

1	2	3	4	5	6	7	8
Na	Mg	Al	Si	P	S	Cl	K

3. In Mendeleev's periodic table, all the elements are sorted by the periodic functions of their _____

   (Mass number, Atomic number).

4. One of the coinage metals is _____

   (Copper, Sodium, Nickel).

5. Liquid metal at room temperature is _____

   (Mercury, Bromine, Tin).

6. Osmium is the heaviest metal. It is _____ (22½, 3, about half) times heavier than iron.

7. Metalloids have some metallic properties and some non-metallic properties. An example of a metalloid is_____

   (Silicon, Argon, Iodine).

8. Complete the reaction: $Mg + O_2 \longrightarrow$ _____.

9. Sodium reacts with water and gives sodium hydroxide and _____ (O_2, H_2, Cl_2).

10. Arrange the following elements in the increasing order of reactivity. (Na, Ca, Mg)

11. Bronze is an alloy of _____ (copper and tin, silver and tin, copper and silver).

12. An alloy used in manufacturing aircraft parts is _____ (solder, brass, duralumin).

13. Write a balanced chemical equation for the reaction between zinc and iron(II) sulphate.

14. Choose the correct word:

    A _____(more/less) reactive metal displaces a _____(more/less) reactive metal from its salt solution.

15. From the following metals, pick out the ones which can displace hydrogen from dilute acids. (zinc, copper, calcium, aluminium, gold, silver, magnesium).

16. Which of the following metal does not liberate H_2 from dilute acids? (Zinc , Iron,Tin, Lead)

17. Which of the following metal/metals can be displaced by Zn to form their salt solutions? (Iron, Copper, Silver, Gold)

Section B

1. Mendeleev's periodic table is constructed into vertical columns and horizontal rows.
   a) Mention the name of the vertical columns.
   b) Mention the name of the horizontal rows.
2. In the periodic table, the position of hydrogen is not certain. Give reason.
3. Pick the odd one out:
   a) Coins, Brass, Copper, Gold ornaments
   b) Bromine, Carbon, Hydrogen, Aluminium
4. What is an alloy? Give an example.
5. $2Na + Cl_2 \longrightarrow 2NaCl$
   a) Name the product. b) What is the colour of Cl_2 gas.
6. Complete and balance the following reactions:
   1. $Na + Al_2O_3 \longrightarrow$ _____ 2. $Mg + O_2 \longrightarrow$ _____
   3. $C + HNO_3 \longrightarrow$ _____ 4. $K + H_2O \longrightarrow$ _____
7. What will happen (appear) if a metal reacts with a non-metal?
8. What are the metallic properties shown by the non-metal graphite?
9. Answer the following:
   a) Name the alloy that is used to make statues.
   b) Write the composition of solder.
10. X and Y are two elements which have similar properties and obey Newland's law of Octaves. How many elements are there between X and Y ?
11. Rewrite the following statements after correction, if necessary.
    a) Groups have element with consecutive atomic number.
    b) The elements of group II A are called noble gases.
12. An element A has atomic number 20 :
    a) Write the electronic configuration.
    b) To which group and period does it belong?
    c) What is its valency?
13. Arrange the following statements in chronological order.
    a) Chemically alike elements could be arranged in a group of three in which atomic mass of the middle element was approximately the arithmetic mean of the two extreme elements.
    b) The properties of the element are periodic function of their atomic numbers.
    c) The properties of the element are periodic function of their atomic masses.
    d) If elements be arranged in the ascending order of their atomic masses, then every eighth element is a kind of repetition of the first one either succeeding or preceding it, like the eighth note in octave of music.

14. *List out the metals and non-metals from the following:*

Carbon, Sodium,Iron, Iodine, Fluorine, Aluminium.

15. *Fill in the blanks.*

a) Number of groups in Mendeleev's Periodic Table is _____ (8,9,10)

b) Number of periods in Mendeleev's Periodic Table is _____ (6,7,8)

16. *Pick out the alkali metals.*

Sodium, Potassium, Calcium, Magnesium, Nickel, Aluminium, Tin, Silicon.

17. *Identify the incorrect combinations:*

i) Brass	*a) Sn, pb*	*k) construction of bridges*
ii) Duralumin	*b) Fe, C, Cr, Ni,W*	*l) plumbing industries to join metal surface*
iii) Bronze	*c) Cu, Sn*	*m) statues*
iv) Solder	*d) Cu, Zn*	*n) aircraft parts*

18. *Pick the odd one out and give reasons for your answer.*

a) Na_2O b) MgO c) SO_2 d) CaO

19. *Before the development of Modern Periodic Table, a German scientist, Dobereiner, noticed that some elements could be grouped into sets of three with similar properties. He called these sets of three elements triads.*

Complete the following triads by inserting the missing element.

Chlorine (cl), _____ , Iodine (I)

Lithium (Li), _____ , Potassium (K)

Calcium (Ca), _____ , Barium

20. *Give one suitable example to show that:*

a) Sodium is a good reducing agent

b) Chlorine is a good oxidizing agent.

Write the balanced equation for the reaction.

21. *Name the gases that are released when carbon is heated with concentrated HNO_3 and concentrated H_2SO_4. Write an equation for the reaction.*

22. *Pick out the incorrect statement regarding the characteristics of alloys:*

i) An alloy improves corrosion resistance.

ii) An alloy enhances the tensile strength of the base metal.

iii) An alloy is softer than the metals in it.

iv) An alloy provides better castability.

23. *Gallium and Cesium melt when kept on the palm. Why?*

Section C

1. *Choose one metal or non-metal that fits each of the descriptions given below and name it. Then write a balanced equation for the reaction that takes place.*

   (i) A metal that burns in oxygen.

   (ii) A Non-metal that burns in oxygen and forms a gas which is used to extinguish a fire.

   (iii) A metal that reacts gently with dilute hydrochloric acid.

   (iv) A metal that displaces Copper from Copper (II) Sulphate solution.

   (v) A metal that floats on water and reacts vigorously with it.

   (vi) A metal and a non-metal that reacts between themselves and forms common salt.

2. *Use the reactivity series:*

   a) Calcium is not used for household articles.

   b) Copper is used for making water pipes and not lead. Why?

   c) Powdered magnesium is used in fireworks.

   d) Gold is an excellent material for filling the cavity in teeth.

3. *The following statements are about elements from the families of alkali metals, alkaline earth metals, transition metals, halogens and noble gases. Identify them.*

   a) It is a soft silvery metal that reacts violently with cold water.

   b) It is a gas at room temperature. It reacts violently with other elements, without heating. It is the most electronegative element.

   c) It is a liquid metal with a very low melting point.

   d) It is the heaviest metal. It is about nearly 3 times heavier than iron.

   e) It is the best conductor of electricity and it is used for making coins along with copper.

   f) It is a gas used for inflating aeroplane tyres and it is also used by deep sea divers.

   g) It is a metal present in the chlorophyll of a plant and it reacts with steam to form corresponding oxide with the liberation of H_2.

   (i) For each of the elements above, say which of the listed families it belongs to.

   (ii) Comment on the position of elements a,b,c and g in the modified Mendeleev's Periodic Table.

   (iii) Name the elements that fit descriptions a to f.

4. *Read the following passage about metals.*

Elements are divided into metals and non-metals. All metals are electrical conductors. Many of them have a high density and they are usually ductile and malleable. All these properties influence the way the metals are used. Some metals are sonorous and so they are used for special purposes.

a) *Explain the underlined terms?*

b) *Copper is ductile . How is this property useful in everyday life?*

c) *Aluminium is hammered and bent to make large structures for use in ships and planes. What property allows it to be shaped like this?*

d) *Name one metal that has a low density?*

e) *Some metals are cast into bells. What property must the chosen metals have?*

f) *Complete the statement with correct words.*

Metals are good conductors of _____ and _____.

5. *Based on the order of reactivity.*

a) *Which element is stored in oil?*

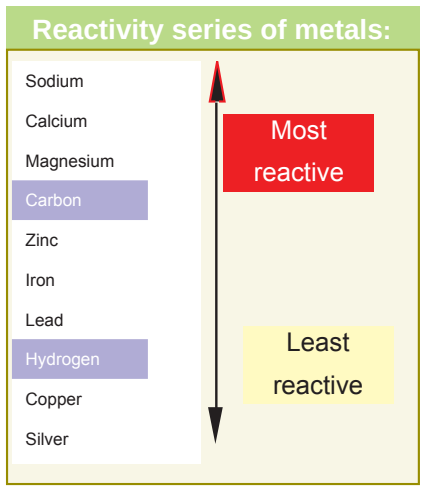
b) *Which element will react with cold water?*

c) *Choose one metal that will react with steam but not with cold water.*

d) *Name the gas given off during reaction in b and c.*

e) *Name another reagent that reacts with many metals to emit the same gas.*

f) *Write balanced chemical equations for the reactions in b, c and e.*



6. *Based on the order of reactivity of metals, answer the following questions:*
Iron is more reactive than copper. It removes the sulphate from copper sulphate.

a) *Write a word equation for the reaction.*

b) *Will these react together when heated?*

(i) *Magnesium + lead (II) oxide.*

(ii) *Iron + Magnesium oxide.*

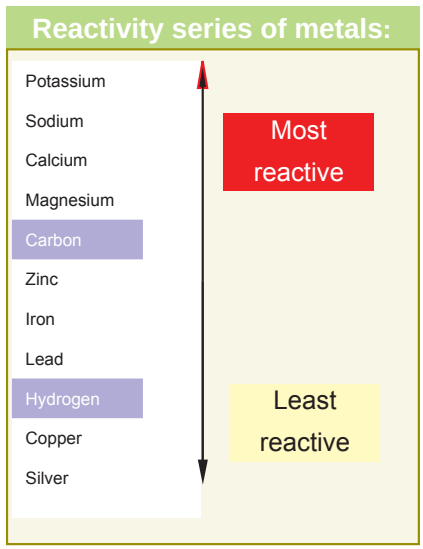
(iii) *Zn + iron (III) oxide.*

c) *For those pairs that react:*

(i) *Describe what you would see.*

(ii) *Write a balanced equation.*

d) *What are the reaction of this type called?*



7. *There are 115 elements known till today. Some are metals and some are non-metals. Metals are usually hard, malleable and ductile and have a metallic lustre. Non-metals are usually soft, do not possess lustre and are not malleable and ductile, but iodine is a non-metal which has metallic lustre. Iodine is also important for our body.*

   a) Why is iodine important for us?

   b) Name a non-metal which is a good conductor of heat and electricity.

   c) Comment on the statement "Iodised salt is good for health". Give any two reasons.

8. *Relate the names of the following scientists with the statements given below. (Lavoisier, Dobereiner, Lothar Meyer, Mendeleev, Newlands)*

   a) Arranged elements with similar chemical properties in a group of three.

   b) Arranged elements in the increasing order of their atomic mass.

   c) Classified the elements as metals and non-metals.

   d) Arranged elements in a groups of seven with increasing atomic masses and eight elements with similar chemical properties kept below the first like eight note in an octave of music.

   e) Plotted atomic weight against atomic Volume.

FURTHER REFERENCE

Book : Textbook of Inorganic Chemistry - P.L. Soni Sultan Chand & Sons

Webliography : http://www.chymist.com http://www.khanacademy.org

5. CHEMICAL BONDS

In a garland, flowers are stringed together with a thread. Unless the flowers are tied, they cannot be held together. The role of the thread is to hold all the flowers together. Similarly, a bond holds the atoms in a molecule together.

Two or more atoms are joined together by a force to form a stable molecule. This force is referred to as a chemical bond.

A chemical bond is defined as a force that acts between two or more atoms to hold them together as a stable molecule.

5.1. OCTET RULE

Gilbert Newton Lewis used the knowledge of electronic configuration of elements to explain "why atoms are joined to form molecules". He visualized that inert (noble) gases have a stable electronic configuration, while atoms of all other elements have an unstable or incomplete electronic configuration.

In 1916, G.N.Lewis gave the "electronic theory of valence". This electronic theory of valence could well be named as the "octet theory of valence".

Atoms interact either by electron-transfer or by electron-sharing, so as to achieve the stable outer shell of eight electrons. This tendency of atoms to have eight electrons in the outer shell is known as the "octet rule" or "Rule of eight".

ACTIVITY 5.1 **I DO**

I can pick out the elements which either share or transfer electrons to obey the octet rule.

1. Helium *2. Argon*

3. Lithium *4. Chlorine*

5.2. TYPES OF CHEMICAL BOND

Scientists have recognized three different types of bonds.

They are:

- Ionic or electrovalent bond
- Covalent bond
- Co-ordinate covalent bond

5.3. FORMATION OF IONIC AND COVALENT BONDS

1. Formation of ionic (or) electrovalent bond

Let us consider two atoms A and B. Atom A has 1 electron in its valence (outermost) shell. Atom B has 7 electrons in its valence shell. A has 1 electron more and B has 1 electron less than the stable octet configuration. Therefore, A transfers an electron to B. In this transaction, both the atoms A and B acquire a stable

MORE TO KNOW

Elements with stable electronic configurations have eight electrons in their outermost shell. They are called inert gases.

Ne (Atomic number 10) = 2, 8 and Ar (Atomic number 18) = 2, 8, 8

MORE TO KNOW

Lewis used dot-symbols to represent the valence electrons which make bonds.

Lewis Symbol	Electron distribution	Valence electrons
H	(1)	1
Be	(2,2)	2
B	(2,3)	3
C	(2,4)	4
N	(2,5)	5

SCIENCE

ACTIVITY 5.2 **I DO**

The following elements have no stable electronic configuration. I can write the electron distribution.

Element	Atomic number	Electron distribution
Sodium		
Carbon		
Fluorine		
Chlorine		

ACTIVITY 5.3 **I DO**

The atom which gives off electron becomes cation and that which accepts electron becomes anion. I can write which atoms form cations or anions.

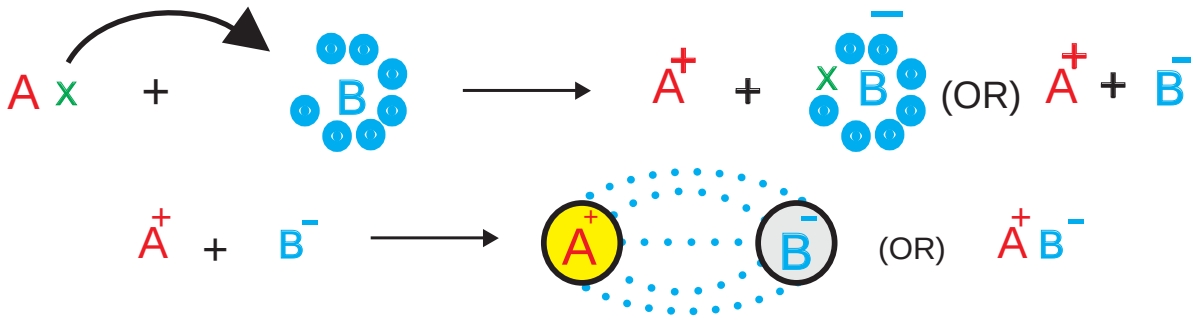
1. *Lithium*
2. *Sodium*
3. *Fluorine*
4. *Chlorine*

MORE TO KNOW

Electronegativity is the tendency of an atom to attract bonded pairs of electrons towards itself in a molecule.

Electrostatic attraction is found between oppositely charged ions. It is also known as coulombic force of attraction.

electron-octet configuration. 'A' becomes a positive ion (cation) and 'B' becomes a negative ion (anion). Both the ions are held together by electrostatic force of attraction. The formation of ionic bond between A and B can be shown as:



Thus the electrostatic attraction between cation (+) and anion (-) produced by electron transfer constitutes an ionic or electrovalent bond. The compounds containing such a bond are referred to as "ionic or electrovalent compounds".

Factors favourable for the formation of ionic bond:

(i) Number of valence electrons

The atom A should possess 1, 2 or 3 valence electrons, while the atom B should have 5, 6 or 7 valence electrons.

(ii) Low ionisation energy

If the ionisation energy of A is lower, it easily loses electrons and forms a cation. So, metals which have low ionisation energy tend to form ionic bonds.

(iii) Net lowering of energy

To form a stable ionic compound, there must be a net lowering of energy. In other words, energy must be released as a result of electron transfer from one atom to another.

(iv) Attraction towards electrons

Atoms A and B should differ in their attracting powers towards electrons.

'A' has less attraction for electrons and hence gives off the electron while 'B' has more attraction towards electrons and hence gains electrons.

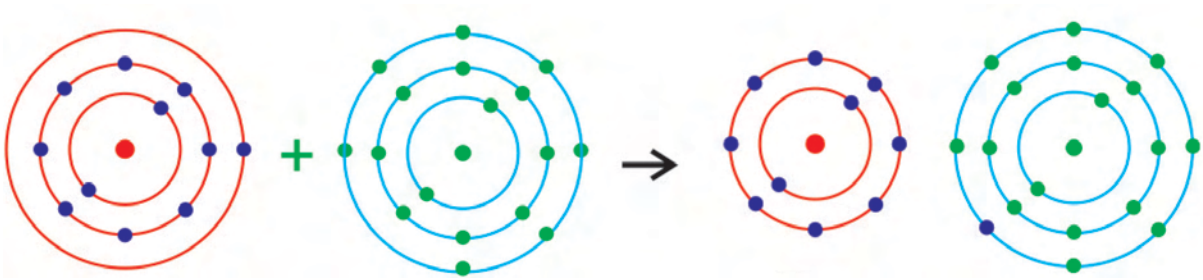
Illustration: 1

Formation of Sodium chloride

Atom	Atomic number	Electron distribution
Sodium	11	2,8,1
Chlorine	17	2,8,7

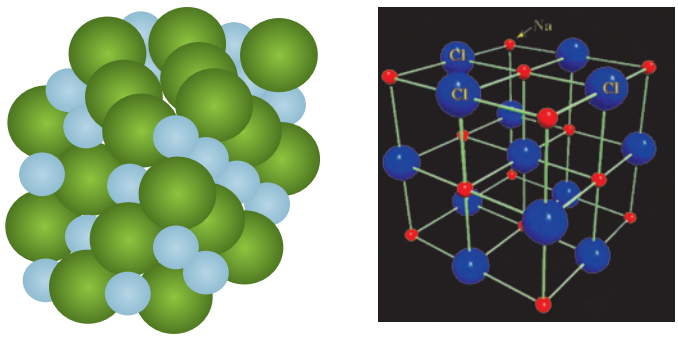
Sodium has one valence electron while chlorine has 7 valence electrons.

Sodium atom transfers the electron to chlorine atom and thus both the atoms achieve stable octet electronic configuration.



2,8,1 Sodium atom (Na) | 2,8,7 Chlorine atom (Cl) | 2,8 Sodium cation (Na^+) | 2,8,8 Chloride anion (Cl^-)

Sodium (Na) becomes sodium cation (Na^+) and chlorine (Cl) becomes chloride anion (Cl^-). Both the ions are joined together by an electrostatic force of attraction to make an ionic bond. In the crystalline state, each Na^+ ion is surrounded by 6 Cl^- ions and each Cl^- ion is surrounded by 6 Na^+ ions.



Structure of sodium chloride

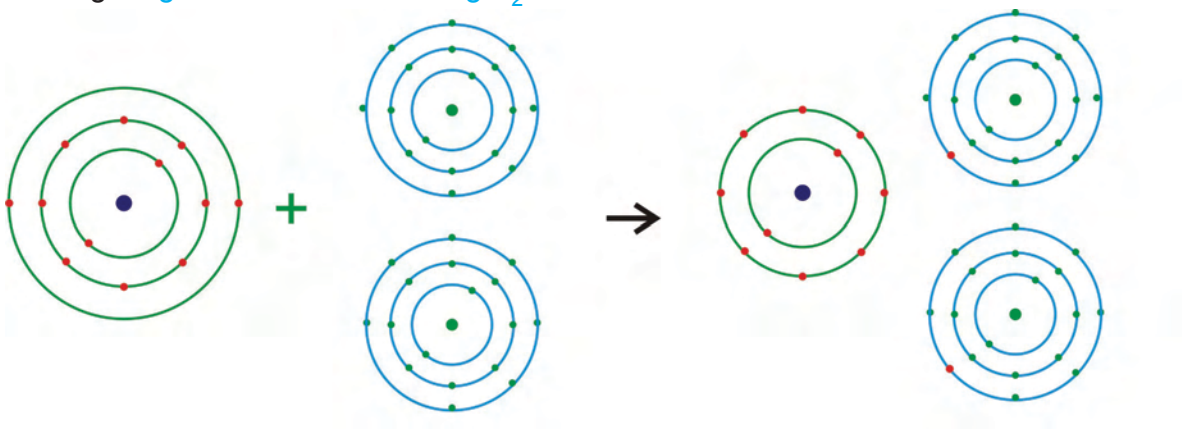
Illustration: 2

Formation of Magnesium chloride

Atoms	Atomic number	Electron distribution
Magnesium	12	2,8,2
Chlorine	17	2,8,7

Magnesium has 2 valence electrons while chlorine has 7 valence electrons. Magnesium atom gives 2 electrons. Each chlorine atom receives one electron and thus all three atoms achieve the stable octet electronic configuration.

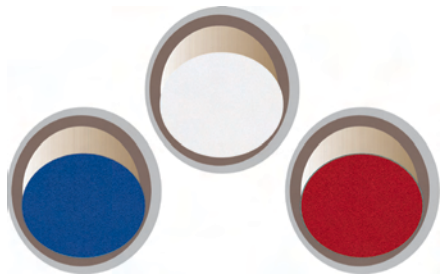
Magnesium atom becomes Mg^{2+} ion and the 2 chlorine atoms become 2 Cl^- ions forming Magnesium chloride as $MgCl_2$.



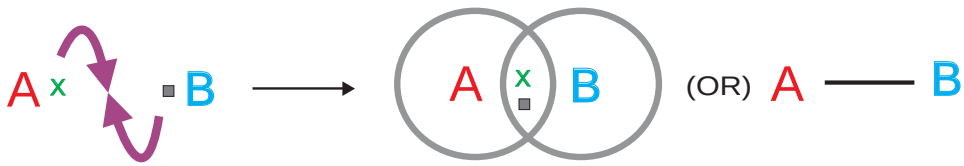
2,8,2 Magnesium atom | 2,8,7 Chlorine atom | 2,8 Magnesium cation | 2,8,8 Chloride anion

2. Formation of Covalent bonds

G.N.Lewis suggested that two atoms could achieve stable 2 or 8 electrons in the outer shell by sharing electrons between them. Atom A has 1 valence electron and atom B has 1 valence electron. As they approach each other, each atom contributes one electron and the resulting electron pair fills the outer shell of both the atoms.



Blue - copper sulphate
White - sodium chloride
Red - cobalt chloride
} Ionic compounds



Thus a shared pair of electrons contributes a covalent bond or an electron pair bond. The compounds containing a covalent bond are called covalent compounds.

Factors which favour the formation of covalent bond:

(i) Number of valence electrons : A and B should have 5, 6 or 7 valence electrons so that both of them achieve a stable (octet) electronic configuration by sharing 3, 2 or 1 electron pair.

(ii) High ionisation energy : If A has high ionisation energy, it is unable to lose its valence electrons easily. The cation formation is difficult. So A prefers covalent bonding.

(iii) Equal electronegativities : When A and B have equal electronegativities, electron transfer from one atom to another does not take place. Thus the bond formed between A and B is covalent.

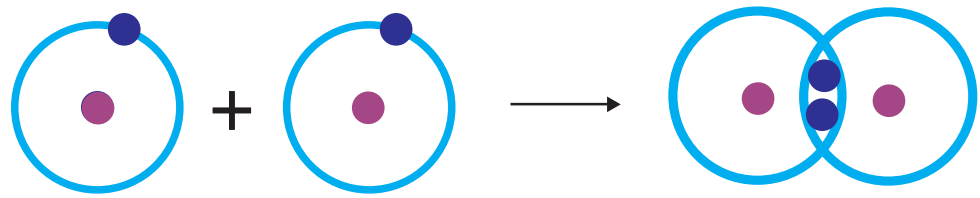
(iv) Equal electron gain enthalpy : When A and B have equal electron gain

enthalpies, A and B exhibit an equal attraction towards the bonded pair of electrons. So the bond formed between A and B is covalent.

Illustration: 1

Formation of hydrogen molecule

Hydrogen molecule is made up of two hydrogen atoms. Each hydrogen atom has one valence electron. Each hydrogen atom contributes an electron to the shared pair and both the atoms attain a stable electronic configuration.

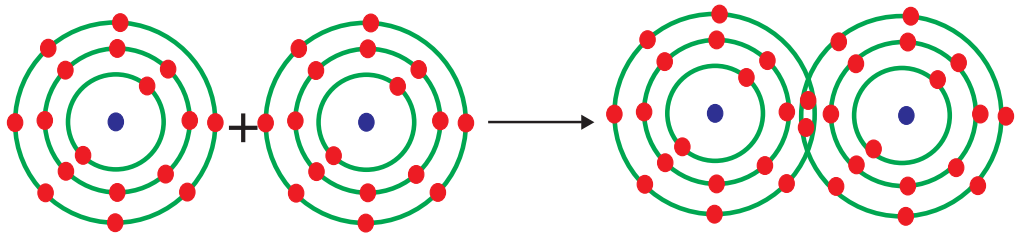


Hydrogen atom Hydrogen atom Hydrogen molecule

Illustration: 2

Formation of chlorine molecule

Each chlorine atom (2, 8, 7) has seven valence electrons. Each of them shares an electron and attains stable electronic configuration.

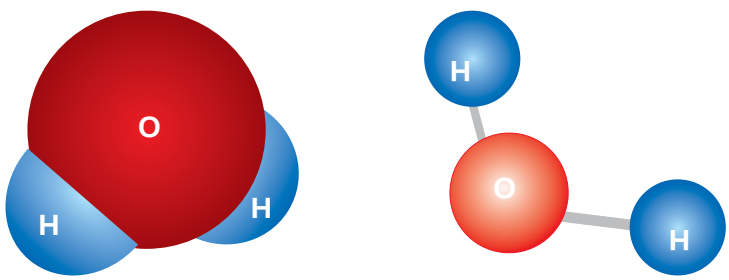


Chlorine atom Chlorine atom Chlorine molecule

Illustration: 3

Formation of water molecule

Oxygen atom (2, 6) has six valence electrons. Hydrogen atom has one valence electron each. Oxygen atom shares two electrons, one each with two hydrogen atoms.



Water molecule

MORE TO KNOW

Multiple bonds enable more atoms to achieve an octet electronic configuration.

SCIENCE

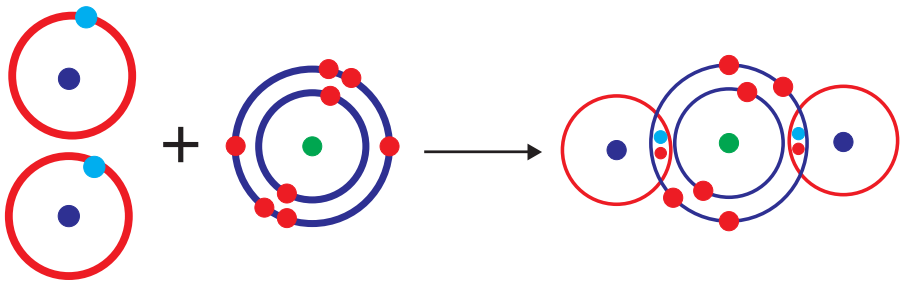
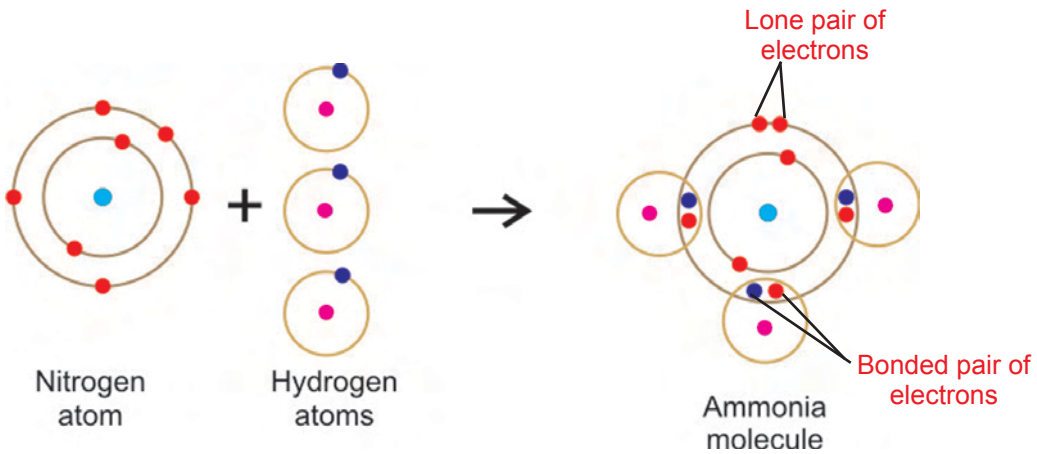


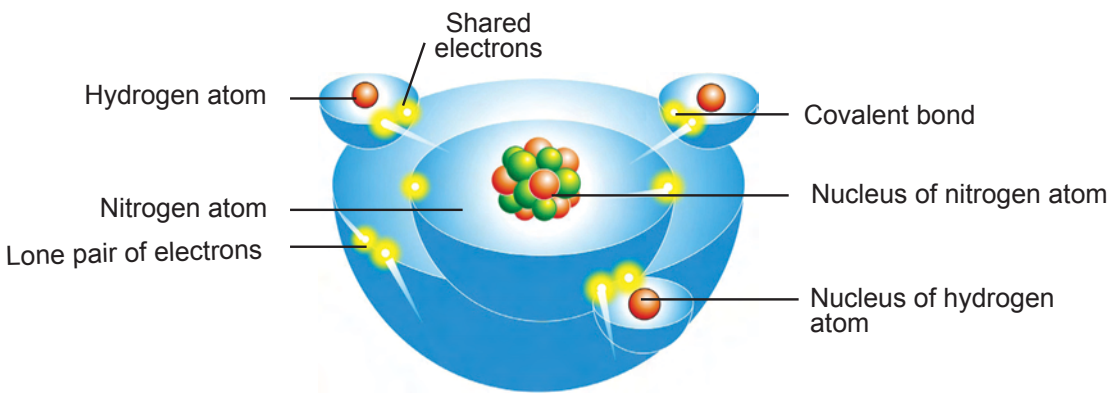
Illustration: 4

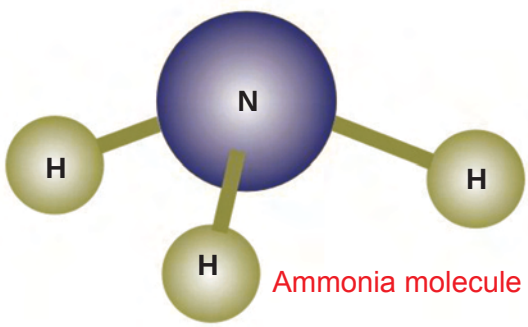
Formation of ammonia molecule

Nitrogen atom (2, 5) has five valence electrons.

Hydrogen atom has one valence electron. Nitrogen atom shares three electrons, one each with three hydrogen atoms.







MORE TO KNOW

Lone pair of electrons are the electrons that are not involved in bond formation.

ACTIVITY 5.4 *I DO*

I can write the Lewis' formula and predict the number of covalent bonds in:

1. Chlorine *2. Ammonia*

3. Fluorine

MORE TO KNOW

Refractory materials are heat resistant materials. They have very high melting points. They are used in the extraction of metals from their ores. Some refractory materials are ionic compounds.

5.3.1. COMMON PROPERTIES OF IONIC COMPOUNDS

Solids at room temperature

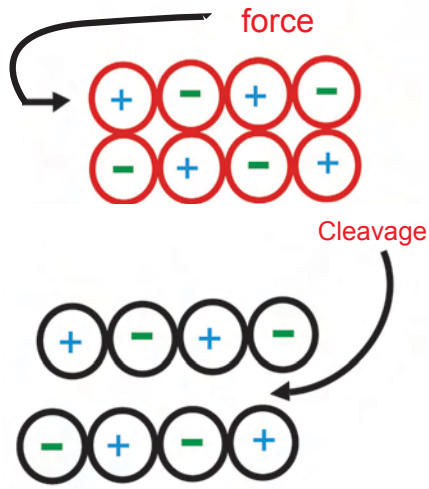
On account of strong electrostatic force between the opposite ions, these ions do not have a free movement. Hence ionic compounds are solid at room temperature.

High melting point

Since the (+) and (-) ions are tightly held in their positions, only at high temperature, these ions acquire sufficient energy to overcome the attractive force causing movement. Hence ionic compounds have high melting point.

Hard and brittle

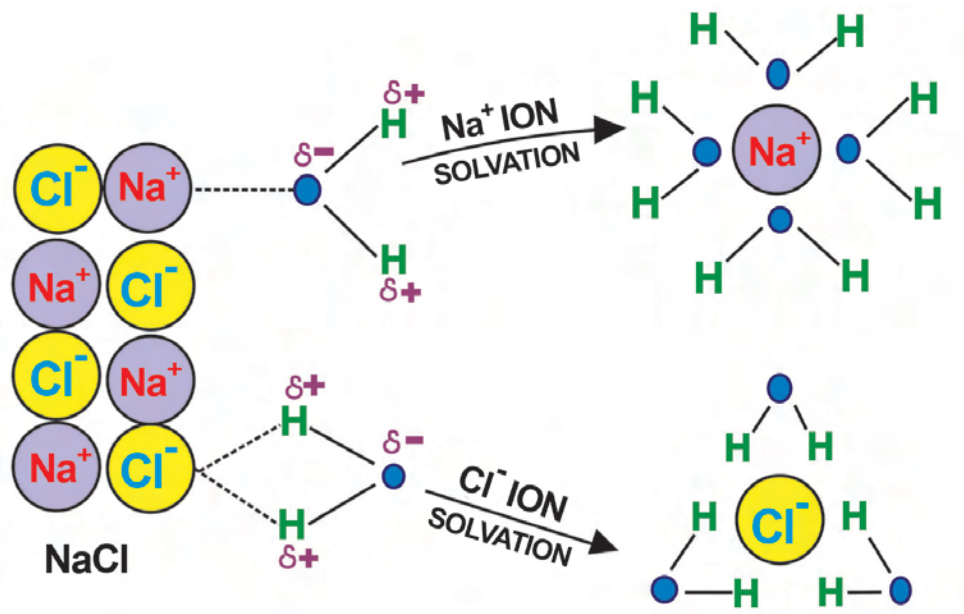
Their hardness is due to strong electrostatic force of attraction. When external force is applied, a slight shift takes



place bringing like-ions in front of each other. It causes repulsion and cleavage.

Soluble in water

When a crystal is put in water, the polar water molecules separate the (+) and (-) ions making the crystal soluble.



SCIENCE

ACTIVITY 5.5 **WE DO**

1. *We take two beakers.*
2. *We take a little water in one beaker and a little kerosene in another beaker.*
3. *We add sodium chloride salt to each of the beakers.*
4. *We observe the solubility.*

Conductors of electricity

In the solid state, the ions are fixed in their positions. Hence they are poor conductors of electricity. In molten state and in aqueous solutions, the ions are free to move.Therefore, they conduct electricity in molten state or in aqueous solutions.

Ionic reactions are fast

Ionic compounds give reactions between ions. Hence their reactions are fast.

5.3.2. COMMON PROPERTIES OF COVALENT COMPOUNDS

Gases, liquids or solids at room temperature

Due to weak intermolecular forces between the molecules, covalent compounds exist as gases, liquids or relatively soft solids.

Low boiling point

In solids, the molecules are held by weak forces of attraction. When heat is applied, the molecules are readily pulled out and get free movement as in liquids.

Soft solids

A molecular layer in the crystal easily slips relative to adjacent layers.

MORE TO KNOW

Bonds in which electron pairs are equally shared are non-polar bonds. Bonds in which electron pairs are not equally shared are polar bonds.

ACTIVITY 5.6 **WE DO**

We can classify the following solvents into polar and non-polar.

1. *Benzene*
2. *Water*
3. *Ether*
4. *Chloroform*

Thus the crystals are easily broken.

Soluble in organic solvents

These compounds readily dissolve in non-polar solvents like toluene, benzene etc. The solvent molecules easily overcome the weak inter-molecular forces of attraction.

Non-conductors of electricity

Since there are no (+) and (-) ions in covalent molecules, they are not capable of conducting electricity in molten state or in solution state.

Molecular reactions are slow

In reaction of covalent compounds, the molecules as a whole undergo a change. Therefore there is no electrical force to speed up the reactions, these reactions are slow.

ACTIVITY 5.7 **WE DO**

- *We take two beakers of water.*
- *We add sodium chloride in one and paraffin wax in another.*
- *We observe the solubility.*
- *We take two beakers of turpentine.*
- *We add sodium chloride in one and paraffin wax in another.*
- *We observe the solubility.*

5.4. DIFFERENCES BETWEEN IONIC AND COVALENT COMPOUNDS

Ionic bond	Covalent bond
Formed by transfer of electrons from a metal to a non-metal atom.	Formed by sharing of electrons between non-metal atoms.
Consists of electrostatic force of attraction between (+) and (-) ions.	Consists of weak force of attraction between atoms.
Non-rigid and non-directional.	Rigid and directional.
Properties of compound	**Properties of compound**
Solids at room temperature.	Gases, liquids or soft solids at room temperature.
Has high melting and boiling points.	Has low melting and boiling points.
Hard and brittle.	Soft and much readily broken.
Soluble in polar solvents and insoluble in organic solvents.	Soluble in non-polar solvents and insoluble in polar solvents.
Conductor of electricity in molten or solution state.	Non-conductor of electricity in molten or solution state.
Undergoes ionic reactions which are fast.	Undergoes molecular reactions which are slow.

5.5. COORDINATE COVALENT BOND

In a normal covalent bond, the bond is formed by mutual sharing of electrons between the combining elements. If the shared pair of electrons are contributed only by one of the combining elements, the covalent bond is called coordinate covalent bond or coordinate bond or dative bond.

Thus, the coordinate covalent bond is a covalent bond in which both the electrons of the shared pair come from one of the two atoms or ions. The compounds containing a coordinate bond are called coordinate compounds. The atom which donates electron pair is called 'donor atom' and the atom which accepts electron pair is called 'acceptor atom'. A coordinate covalent bond is represented by an arrow '→'.

If an atom 'A' has an unshared pair of electrons (lone pair) and another atom 'B' is in short of two electrons, then a coordinate bond is formed. 'A' donates the lone pair (2 electrons) to 'B' which in turn accepts it.

SCIENCE

MORE TO KNOW

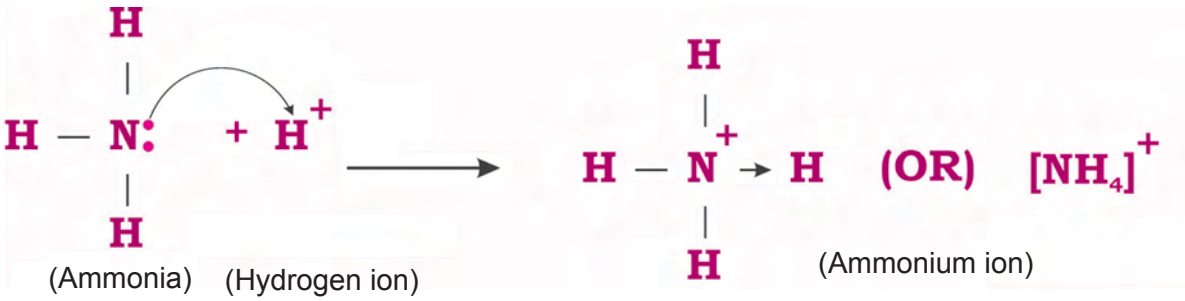
Sharing of two pairs of electrons makes a double bond. Sharing of three pairs of electrons makes a triple bond. These are called multiple covalent bonds.

1. Carbon dioxide O=C =O (two double bonds)
2. Oxygen O=O (one double bond)
3. Nitrogen N≡N (one triple bond)

Illustration

Ammonium ion (NH_4^+)

Ammonium ion is formed by the addition of hydrogen ion (H^+) with ammonia (NH_3).In ammonia molecule, the central nitrogen atom is linked to three hydrogen atoms and still nitrogen has an unshared pair of electrons. Nitrogen donates this lone pair of electrons to hydrogen ion of an acid forming ammonium ion.



(Ammonia) (Hydrogen ion) (Ammonium ion)

5.5.1. COMMON PROPERTIES OF COORDINATE COMPOUNDS

Conductors of electricity

They do not give individual ions in water and are poor conductors of electricity.

Soluble in organic solvents

They are sparingly soluble in water and dissolve in organic solvents.

Melting and boiling points

They are semi polar in nature. They possess melting and boiling points higher than those of purely covalent compounds, but lower than that of ionic compounds.

Exceptions to the Octet Rule

It is true that quite a few molecules had non-octet structure. Atoms in these molecules could have a number of electrons in the valence orbit, in short of the octet or in excess of the octet.

(i) Four electrons around the central atom

Berylliumdichloride ($BeCl_2$)

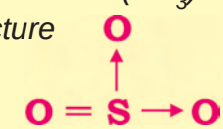
MORE TO KNOW

Under ordinary conditions of temperature and pressure, carbon dioxide is a gas because molecules of carbon dioxide are non-polar.

Water is in a liquid state as a result of the great polarity of water molecules.

ACTIVITY 5.8 **I DO**

Sulphur trioxide (SO_3) has the following structure



I can write how many coordinate linkages are present in this molecule. I can identify the acceptor and the donor atoms.

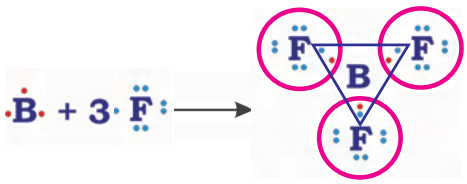
	Beryllium	Chlorine
Atomic number	4	17
Electron distribution	2,2	2,8,7
Valence electrons	2	7

Each chlorine atom is surrounded by 8 electrons but a beryllium atom has only 4 electrons around it.

(ii) Six electrons around the central atom

Borontrifluoride (BF_3)

	Boron	*Fluorine*
Atomic number	*5*	*9*
Electron distribution	*2,3*	*2,7*
Valence electrons	*3*	*7*



ACTIVITY 5.9 **I DO**

Carbon monoxide is a gas. It is a coordinate compound. Structure of carbon monoxide is

C ⇆ O

I can identify the donor and the acceptor atoms.

ACTIVITY 5.10 **I DO**

The Atomic number of phosphorous is 15. I can write the electron distribution of phosphorous`. The Atomic number of chlorine is 17. I can write the electron distribution of chlorine. One phosphorous atom combines with five chlorine atoms to form phosphorous penta chloride (PCl_5). I can draw the electron dot structure of PCl_5.

Each fluorine atom is surrounded by 8 electrons but a boron atom has only 6 electrons around it.

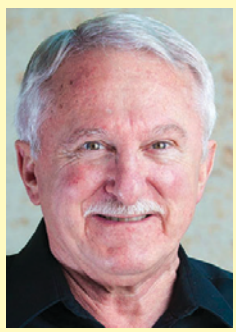
MORE TO KNOW

The Nobel Prize in Chemistry 2015 was awarded jointly to Tomas Lindahl, Paul Modrich and Aziz Sancar "for mechanistic studies of DNA repair".

Field : Bio-Chemistry

Tomas Lindahl

Born: 1938, Stockholm, Sweden
Affiliation at the time of the award: Francis Crick Institute, Clare Hall Laboratory, Hertfordshire, United Kingdom



Paul Modrich

Born: 1946
Affiliation at the time of the award: Howard Hughes Medical Institute, Duke University School of Medicine, Durham, North Carolina, USA

Aziz Sancar

Born: 1946, Savur, Turkey.
Affiliation at the time of the award: University of North Carolina, Chapel Hill, North Carolina, USA

SCIENCE

MODEL EVALUATION

Section A

Choose the correct answer:

1. As per the octet rule, noble gases are stable in nature. This is due to the presence of _____ (eight, seven, six) electrons in their outermost shell.
2. The element that would form cation due to loss of electron during the chemical reaction is _____ (chlorine, lithium, fluorine).
3. The Atomic number of magnesium is 12. Then its electron distribution is _____ (2,2,8 / 2,8,2 / 8,2,2).
4. An element X has 6 electrons in its outermost shell. Then the number of electrons shared by X with another atom to form a covalent bond is _____ (3, 2, 6).
5. The compound that possesses high melting point is _____ (NH_3, NaF).
6. The bond in which the electrons are equally shared is _____ (polar bond, non-polar bond, ionic bond).
7. Pick out the wrong statement about the properties of covalent compounds.

   a) They are neither hard nor brittle. b) Molecular reactions are fast.
8. CH_4 is a /an _____ (covalent / ionic) compound.

Section B

1. NaCl is an ionic compound. How is an ionic bond formed?
2. All the elements tend to attain eight electrons in their outermost shell either by sharing or by transfer of electron. The electronic distribution of X = 2, 7 and Y = 2, 8, 1. What is the bond formed between X and Y? How is it formed?
3. Which of the following compound does not obey the octet rule?

   i. $BeCl_2$ ii. NaCl iii. $MgCl_2$ iv. NH_4Cl
4. Explain coordinate covalent bond with an example.
5. Differentiate an ionic bond from a covalent bond.
6. What is an octet rule?
7. Why are noble gases inert in nature?
8. Draw the electron dot diagram of CH_4 and justify your answer.
9. Find the odd one out:

   a) NaCl, $MgCl_2$, H_2 (based on type of bonding)

   b) Li, Na, F (based on metals and non-metals)
10. Correct the wrong statement.

    a) Bonds in which electrons are polar bonds.

    b) Sharing of 3 pairs of electrons make a double bond.

11. Match the following:

a) $MgCl_2$ - Co-ordinate Covalent

b) Cl_2 - Ionic Compound

c) NH_4^+ - Covalent Compound

12. Fill in the blanks:

a) If an atom loses an electron, it forms a _____.(Cation/Anion)

b) Ionic compounds are _____ in nature. (solids/liquid)

Section C

1. $Na + Cl \longrightarrow Na^+ + Cl^- \longrightarrow Na^+Cl^-$

(2,8,1) (2,8,7) (2,8) (2,8,8)

The above equation represents the formation of sodium chloride. Observe the equation and answer the following:

a) How many electrons are transferred from Na to Cl?

b) Name the force acting between Na^+ and Cl^-.

c) Name the nearest noble gas to Cl^-.

d) Name the bond between Na^+ and Cl^- .

e) How many electrons are present in Na^+ ion?

2. a) Complete the table:

Atoms	Atomic Number	Electronic Distribution
Na	11	
Mg	12	
Cl		2,8,7

b) Draw the structure of H_2O and NH_3 molecules.

3. Ionic bond is formed between sodium (Atomic No. 11) and chlorine (Atomic No: 17) to form sodium chloride molecule. Answer the following questions based on this.

a) How many electrons are present in the sodium atom? Represent it diagrammatically.

b) Draw the structure of a sodium ion.

c) How does chlorine become an anion?

d) Give the two properties of this compound.

e) Which force exists between sodium and chlorine ions?

f) Sodium Chloride is a good conductor of electricity in the molten state but does not conduct electricity in the solid state. Give reason.

4. Name the following :

a) An element which forms triple covalent bond.

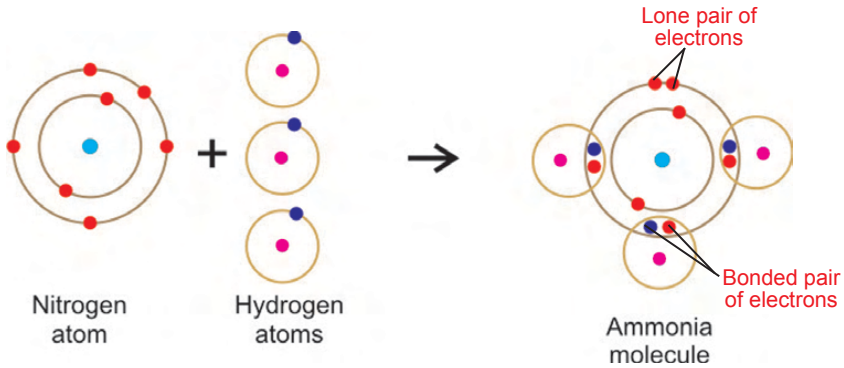
b) An element which obtains the noble gas configuration of Neon by losing three electrons.

c) An element which gains two electrons to obtain noble gas configuration of Neon.

d) Name a compound which is an exception to the octet rule.

e) In SO_2 molecule, which element is a donor of electrons.

5.



Refer to the diagram of Ammonia molecule and answer the following questions (based on the above diagram).

a) Name the gas and give its formula.

b) Which type of bond holds the atoms together?

c) What happens when the above gas is treated with hydrochloric acid?

d) What type of bond is formed when Nitrogen donates its lone pair of electrons to Hydrogen ion.

e) Does ammonia conduct electricity. Why?

6. Identify the incorrect statements and correct them.

a) When two elements have equal electro negatives, the electron transfer does not take place from one atom to another.

b) When an element has high Ionisation energy, it prefers to form Ionic bond.

c) The electrons which are not involved in bonding are called valence electrons.

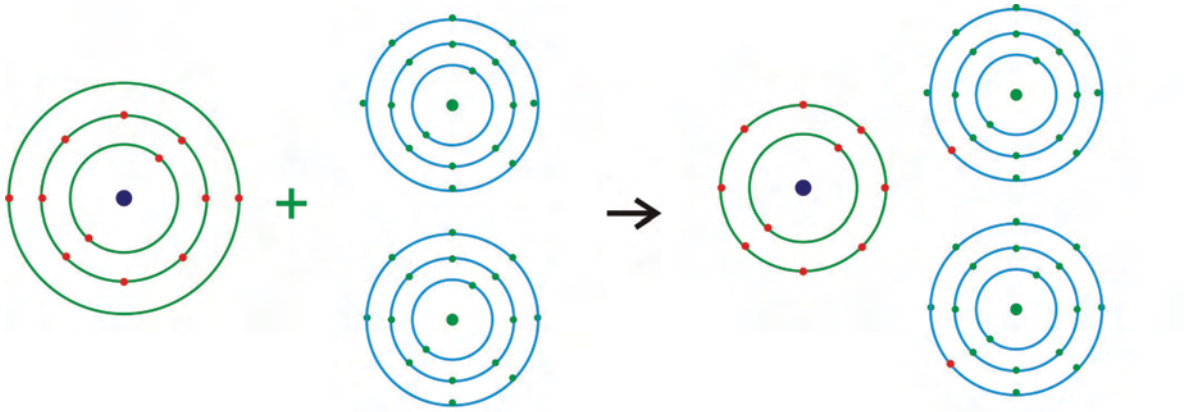
d) Benzene is a non polar solvent.

e) Ionic bonds are rigid and directional.

7. Complete the following Table:

Element	Electronic Configuration	Bond it forms	Valency
Magnesium			
Oxygen			
Chlorine			

8. The following shows the electronic arrangement of two elements, magnesium and chlorine. These elements react to form an ionic compound called magnesium chloride.



2,8,2 Magnesium atom | 2,8,7 Chlorine atom | 2,8 Magnesium cation | 2,8,8 Chloride anion

a) Answer these questions about magnesium atom and chlorine atom:

(i) Do they gain or lose electons, to form an ion?

(ii) How many electrons are transferred?

(iii) Is the ion that is formed positive or negative?

(iv) What is the name of the ion formed?

b) Which noble gas configurations do these ions resemble.

c) Name another non-metal that forms an ionic compound with magnesium, in a similar reaction with chlorine.

9. Give a single term for the following statements:

a) The tendency of atoms to have eight electrons in the outer shell.

b) Energy required to remove a valence electron to have an isolated atom.

c) The pair of electrons that are not involved in bond formation.

d) Tendency of an atom to attract bonded pairs of electrons towards itself in a molecule.

e) Bonds in which shared electron pair comes from one of the bonded atoms.

10. a) The electronic configurations of a neon atom and an argon atom are (2,8) and (2,8,8) respectively. What is special about the outer shell of the neon atom and the argon atom.

b) The electronic configuration of a calcium atom is (2,8,8,2). What must happen to the calcium atom for it to achieve a noble gas structure?

c) Draw a diagram of an oxygen atom. Show eight protons(p), eight neutrons (n) and eight electrons(e).

d) What happens to the outer shell electrons of a calcium atom, when it reacts with an oxygen atom?

e) Name the compound that is formed when calcium and oxygen react together. Which type of bonding does it contain?

f) Write the formula for the compound.

g) Does this compound have a high or low melting point? Explain your answer.

11. Which of the following statement is incorrect about coordinate compounds?

a) Sparingly soluble in water.

b) Soluble in organic solvents.

c) Poor conductor of electricity.

d) Their boiling points are higher than ionic compounds.

FURTHER REFERENCE

Book: 1. Essentials of Physical Chemistry - B.S.Bahl,G.D.Tuli,Arun Bahl.S. Chand & Company Ltd

Webliography : http://www.beyondbooks.com http://www. visionlearning.com

WORK, POWER AND ENERGY

One day Kumar went to see his father in their paddy field. The crop had been harvested and the yield was good. Nature had been kind and his father was happy that there were nearly a 100 bags of grain this year. His father said, “There is so much work to do. We have to load all these 100 bags of grain into the truck and transport it to the rice mill. Kumar, can you please call Ramu, Somu and Kittu?” Kumar ran to bring them.

The three workers arrived and loaded the bags quickly into the truck, as Kumar watched. The three workers were sweating. He noticed that Ramu loaded as many as 32 bags in the same time that Somu loaded 26 bags and Kittu loaded 42. He shared his observation with his father. His father wondered at his son’s keen sense of observation. He appreciated Kumar for it and explained that Ramu had more power when compared to Somu and hence was able to do more work in the same duration of time. He added that it had something to do with energy. Now, let us help Kumar and others understand more about work, power and energy as well as the relationship among the three.

WORK, POWER AND ENERGY

In earlier classes, you have learnt about wind energy, solar energy and how electrical energy can be generated from chemical energy in a battery or cell. You have also learnt about non-renewable and renewable sources of energy. In this chapter, you will learn:

- How to define and explain 'work', 'power' and 'energy' with examples.
- The different forms of energy, in particular, kinetic and potential energy.
- The law of conservation of energy.

6.1. WORK

We shall first learn about 'Work'. When we write or read or when we lift or move an object like a chair; in everyday language we call it 'work'. In physics, however, the word 'work' has a very specific definition and is related to force and movement.

Work is said to be done, when a force acts on a body and the point of application of the force is displaced in the direction of force.

We must note that when a force acts on a body at rest, it results in acceleration, which in turn results in velocity and displacement. In the definition of work, however, we are merely concerned about the resultant displacement and not the rate at which the displacement happens (velocity).

(i) If the body is displaced in the same direction as the force, then work is said to be done by the force.

(ii) If the body is displaced in the opposite direction to that of the force, then work is said to be done by the body against the force.

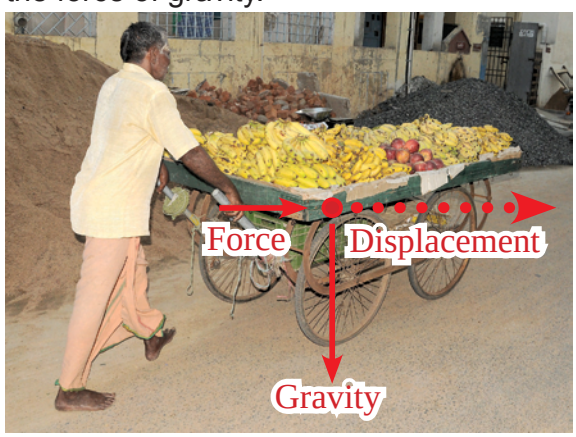
(iii) If the body is displaced in the direction perpendicular to that of the force, then no work is done either by the force on the body or against the force. The work done is said to be zero.

When a cart man applies a force on the cart and the cart moves forward, then work can be said to be done by the force applied by the cart man on the cart.

Fig. 6.1. work done by a force

The weight of an object is the force of gravity acting on the object. When the object is lifted up from the ground to a point above, then work is said to be done against the force of gravity.

In the example of the cart man pushing the cart, no work is done by the force of gravity and no work is done against it, since the displacement is perpendicular to the force of gravity.



SCIENCE

Work (W) is measured as the product of the force (F) and the displacement (S) in the direction of the force.

$$W = F \times S$$

When work is done by a force, then both force and displacement are positive and the work done is also positive. When work is done against the force, then force has a positive sign but displacement has a negative sign and the work done has a negative sign.

The SI unit for measuring the quantity of work done is the joule. One joule of work is said to be done when a force of one newton acting on a body displaces it by one metre. The SI unit of work is named after **James Prescott Joule** an eminent British scientist who was one of the pioneers in the field of work and energy.

For example, if a force of 10N acting on a football moves it by 20m in the same direction as the applied force, then the work done is calculated as follows:-

W = F x S = 10N x 20m = 200J

Imagine lifting a small apple or a large banana (about 100g) through a height of one metre. This would amount to one joule of work. It is a very small quantity of work. To measure larger quantities of work, we use larger units of work such as the kilo joule (10^3 joules) and the mega joule (10^6 joules).

6.2. POWER

In everyday language, the word 'power' is often used to imply 'a large force or electric power supply' and the word 'powerful' to mean 'strong'. In physics, the word "power" has a very specific definition and is related to work.

Power (P) is defined as 'the rate of doing work'. It can also be defined as 'the work done per unit time'.

James Prescott Joule

James Prescott Joule experimentally established that a pound weight falling through seven hundred and seventy-two feet could generate enough heat to raise the temperature of a pound of water exactly by one degree Fahrenheit, thus establishing the equivalence between the amount of work done and the quantity of heat produced. The SI unit of work is named after him. He also established the law according to which, heat is produced in a conductor of electricity when electric current is passed through it. He also established the equivalence among the quantity of electric work, the quantity of heat energy and the quantity of mechanical work.

Imagine a young boy running up a flight of stairs in 10 seconds and an old man climbing up the same flight of stairs in 20 seconds. The work done by both of them is the same. The boy, however, does it in lesser time. The boy is said to be producing more power than that of the old man. The boy produces twice as much power as the old man.

Power (P) is calculated by dividing the work done (W) by the time taken (t) to do that work.

$$\text{Power} = \frac{\text{work done}}{\text{time taken}}$$

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

The SI unit for measuring power is Watt. Power is said to be one watt when one joule of work is done in one second. One watt of power is the same as one joule per second. The SI unit of power is named after the Scottish inventor and engineer, James Watt.

Imagine lifting a small apple or a large banana (about 100g) through one metre in one second. This would amount to one watt of power. If the same work is done in two seconds, it would amount to half a watt. The watt is a fairly small unit of power. To measure larger quantities of power, we use larger units of power such as the kilowatt (10^3 watts) and the megawatt (10^6 watts).

6.3. ENERGY

Energy is defined as the capacity to do work.

We must note that by definition the concepts of energy and work are related to each other. Energy is invisible but work is not. So when we see work being done, we conclude that energy must be present for that work to be done. Usually an object (or even a liquid or gas) generates the force that does the work. Therefore energy is associated with the object (or liquid or gas) that generates the force which does the work. For example, when water is boiled and steam is released, the steam can generate a force that can move a whole train.

Find out and write the power (in watt) consumed by the following electrical appliances in your house.

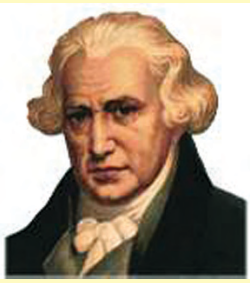
- *Tube light* - _____
- *Ceiling Fan* - _____
- *Mixie* - _____
- *Grinder* - _____
- *Water heater* - _____
- *Air-conditioner* - _____
- _____
- _____

We can, therefore, conclude that the steam must have had energy, since it has done a work. When a leaf sways due to the force of the wind, then work is done by the wind and wind must have had energy that was used to do the work. If X units of work is done we assume that the same number of units of energy must have been used up and the energy within the object or agency doing the work must have been reduced by the same quantity.

The SI unit for measuring energy is the same as that of measuring work, which is the joule. The larger units for measuring energy are also correspondingly kilo joule and mega joule.

The practical unit of measuring electrical energy is the kilowatt-hour which

James Watt (1736-1819)



A Scottish inventor and mechanical engineer James Watt was interested in the technology of steam engines. Watt improved the efficiency of the steam engine greatly and its cost-effectiveness.

SCIENCE

is also colloquially referred to as "unit". One kilowatt-hour is the energy consumed at the rate of one kilowatt for one hour. This is equivalent to 3600000J [1000W x 3600s = 3600000J

$= 3.6 \times 10^6$ J].

Example: How much electrical energy will be consumed when a hundred watt bulb is used for 10 hours?

Energy = 100 watt x 10 hour

= 0.1kW x 10h = 1kWh.

Different forms of energy

Anything that can do work contains energy. We understand that heat can do work from the example of the steam engine. Therefore, heat is a form of energy. Electricity can produce heat when it is passed through a resistance.

Electricity is also used to run fans and lights. Therefore, electricity must also be a form of energy. Wind can be used to do work and so it is also a form of energy. Thus there are various forms of energy and all of them can perform some work.

Some important forms of energy are: chemical energy, light energy, heat energy, electrical energy, nuclear energy, sound energy and mechanical energy. We shall discuss mechanical energy with a little more detail, later in this chapter.

6.4. OBTAINING ENERGY

In the preceding section, we spoke about how energy gets lost by steam (or any other object) while doing work. The question that naturally arises is: "Where does an object get its energy from?" The answer to this question leads us to one of the most important laws in mechanics after Newton's Laws.

An object can acquire energy in two different ways. It can get energy when,

MORE TO KNOW

The earliest evidence for controlled use of fire was found at an Early Stone Age excavation site in the Middle east, (now Israel) 790,000 years ago, from where charred wood and seeds were recovered. Evidence also shows that human beings have used wind from about 3500 BCE.

Systematic use of these elements from nature (earth, water, wind and fire) to do pieces of work, which human beings would otherwise have had to do with their own hands started from the time of the Greeks around 200 BCE. Yet, surprisingly, it was not until 1802 that the term 'energy' was used in the modern scientific sense for the first time.

Even more surprising is the fact that importance was not given to the concept of energy, till the late nineteenth century, when two important concepts were proven beyond doubt.

The first was that 'energy' could neither be created nor destroyed and that it could only be converted from one form to another. The second was that every time energy is converted from one form to another, a part of that energy is invariably converted into a form that is not usable thereafter (loss of energy). Let us learn more about these two concepts.

TRY THIS

- *How long will a 40W bulb need to glow in order to consume one unit of electricity?*
- *How much electric energy will be consumed when a 500W motor runs for four hours?*

(i) energy in some other form is converted and added to the energy that the object already possesses. Energy can never be created.

(ii) work is done.

6.4.1. OBTAINING ENERGY THROUGH ENERGY CONVERSION – THE LAW OF CONSERVATION OF ENERGY

The law of conservation of energy states that:

'Energy can neither be created nor destroyed; it can only be changed from one form to another.'

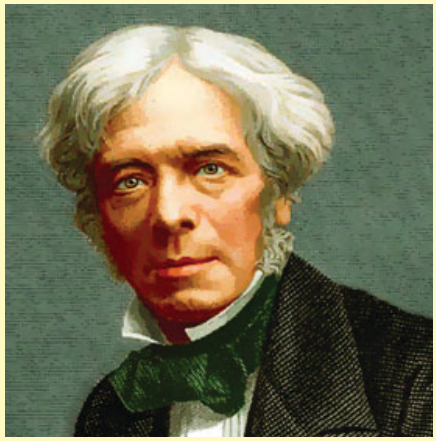
A car engine burns fuel, converting the fuel's chemical energy into heat energy, which in turn is converted into mechanical energy to make the car move. Windmills transform wind energy into mechanical energy, which can be used to turn a turbine to produce electricity. The electrical energy can be changed into light energy in a bulb. It can also be converted into mechanical energy, to turn a fan or changed into heat energy to cook food. The cooking of food itself is a chemical reaction which can be turned into energy inside the human body. Going backwards on the chain of energy transformation, the wind energy comes from the heat energy flowing from the sun and the sun's energy itself comes from nuclear reactions within the sun.

In fact, if you take any form of energy, you will find that it is obtained from another form of energy; and that form of energy has been obtained from another; to form an endless chain of transformation of energies without a beginning or an end. That is an awesome fact and you should pause to think over the enormity of it!! Therefore when we say, we are using energy what we really mean is that we are converting one form of energy into another form.

6.4.2. THE ALTERNATIVE STATEMENT OF THE LAW OF CONSERVATION OF ENERGY

The Law of Conservation of Energy can also be stated as follows: 'The total amount of energy in an isolated system remains constant but can be transferred from one object to another within the system.'

Michael Faraday (1791-1867)



Michael Faraday was perhaps the first person to point out the interconnections between various phenomena. He pointed out that from chemical reactions come electricity: from electricity comes magnetism: from magnetism, we can obtain electricity, from electricity we can go back to chemical reactions. He knew fully well that none of these can be produced endlessly from another. "Nowhere," he says, "is there a pure creation or production of power without a corresponding exhaustion of something to supply it."

He was very close to it but narrowly missed articulating the all-important Law of Conservation of Energy in its exact form. Faraday was still alive, when many scientists working for nearly fifty years came to the conclusion that energy could neither be created nor destroyed and articulated it in the modern form as the Law of Conservation of Energy.

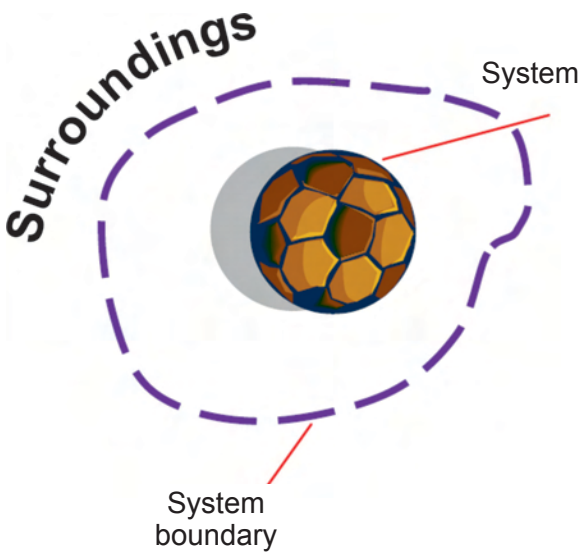
What is a system?

When we study an object, we usually fix our attention on the object and analyse the various aspects of it. The object of our study is usually referred to as a system. Sometimes the system may consist of more than one object. It is useful to think of our system as separate from everything else. To do this, we draw a boundary around the object. Sometimes the boundary is real. At other times, a simple imaginary boundary will do. Everything else outside the boundary is referred to as its surroundings.

The surroundings interact with the object and influence it. We can visualize these interactions as crossing the boundary to interact with the object. When there are no influencing factors on the system from the surroundings, then we call it an isolated system or a closed system.

Explanation for the Alternative Statement of the Law of Conservation of Energy

The alternative form of the Law of Energy states that the total energy within the closed system remains a constant in the absence of any interaction with the surroundings. You can now understand that both the statements of the conservation law mean almost the same.



6.4.3. GETTING ENERGY FROM WORK

When an object generates the force that does work, then there is a decrease in energy in that object. On the other hand, when the force generated by some other agency acts on an object and does a work, then the object's energy increases. In this case, we say that the work is done on the object.

Energy gained by an object is measured in terms of the work done on the object.

For example, if an object is lifted up to a certain height, work is done on the object. This results in an increase in energy of the object. The energy in the same object can decrease by the same amount, when the object falls back to its original position, doing 'work' in the process.

This is a specific case of the law of conservation of energy since the work is done only by drawing energy from some other source. In the example given above, the work is done by the muscles, which obtain their energy from the chemical reactions, transforming the food we eat into energy.

Another example is that when a spring is compressed, work is done on the spring which is stored in the spring as energy. When the spring is released, the same quantity of energy can be recovered as 'work' when it springs back to its original state.

6.5. MECHANICAL ENERGY

When a work is done on an object, then the object gains energy. The energy acquired by objects upon which work is done is known as mechanical energy.

When work is done on an object, then it can result in one of the following:

(i) Increase in speed. (Kinetic Energy)

(ii) Increase in height or state of strain. (Potential Energy)

For example, a book is lying on a table. If we apply a force on it and the book starts sliding on the table, then its speed has increased.

When a force is applied to lift an object, it results in an increase in height. When a force is applied to compress a spring it results in the decrease of spring's length. We call this as a state of strain and it is not the natural state.

6.5.1. KINETIC ENERGY

Moving objects can do work, hence they posses energy. For example, a moving block of wood colliding with a stationary block of wood can cause a displacement (and therefore 'work'). Hence, we can conclude that a moving object must hold energy.

Energy possessed by an object due to its motion (or velocity) is called kinetic energy.

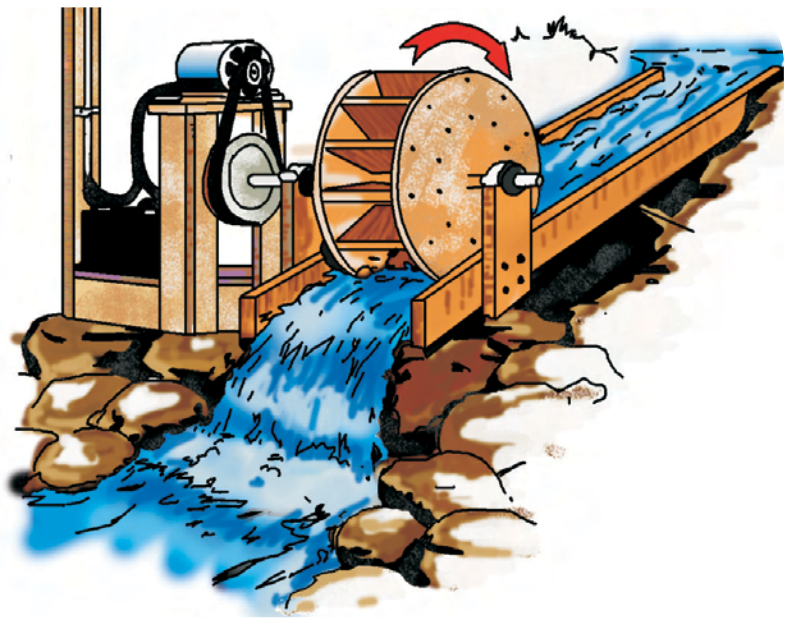
Here is another example of kinetic energy. The moving water which can rotate a wheel can be used to grind grain or to generate electricity.

A moving hammer can drive a nail into a wall or a piece of wood.

Kinetic energy can be calculated using the formula $KE = \frac{1}{2} mv^2$ where 'm' is the mass of the moving body and 'v' is its velocity.

This formula can be derived using the equation of motion that you learnt earlier in this class.

Let us suppose that an object of mass 'm' is moving with a velocity 'v'. To bring it to rest, a force is required to act opposite to the direction of motion. The object will slow down and come to a halt. Let us suppose that the distance covered during the retardation is 's'.



The work done on the object is given by the formula:

$W = F \times S$. ....(1)

Using the formula F = ma we can substitute 'F' in equation (1).

We get,

$W = m \times a \times S$ ....(2)

Using the equation of motion $v^2 = u^2 + 2as$, *we can substitute 'a' in equation (2).*

Since the initial velocity was v and the final velocity was zero we can substitute these values in equation (3).

We get,

$$W = m \times \frac{(v^2 - u^2)}{2s} \times s \quad ...(3)$$

$$W = m \times \frac{(0^2 - v^2)}{2s} \times s$$

∴ *We get*

$$W = (-)\frac{1}{2} \times m \times v^2$$

Since this work, W, is done on the object, it must be stored in the object as energy. Notice that the work done by the external force is a negative quantity. The negative sign indicates that the object's energy has decreased, while slowing down to a halt. Therefore, the original value of the kinetic energy (KE) in the body, when it was moving must have been

$$= (+) \frac{1}{2} mv^2$$

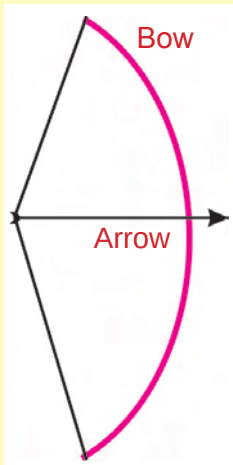
which reduced to zero when it came to a halt. Hence KE of a moving body is given by the formula $KE = \frac{1}{2} mv^2$

6.5.2. POTENTIAL ENERGY

The energy possessed by a body by virtue of its position or due to a state of strain, is called potential energy.

Potential energy of an object raised through a height 'h' (gravitational potential energy) is calculated using the formula PE = mgh, where 'm' is the mass of the body, 'g' is the acceleration due to gravity and 'h' is the height through which the object has been raised.

ACTIVITY 6.1 **I DO**

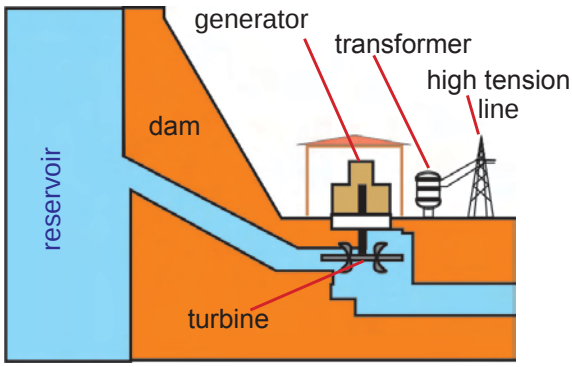


Bow and Arrow

I take a bamboo stick and make a bow. I place an arrow made of a light stick with one end supported by the string. I stretch the string and note the change in the shape of the bow.

I release the arrow, which flies off. The potential energy stored in the bow due to the change of shape has transferred to the moving arrow as kinetic energy.

Example: Water stored in a reservoir has a large amount of potential energy due to which it can drive a water turbine when allowed to fall down. This is the principle of production of hydro-electric energy.



Hydropower Station

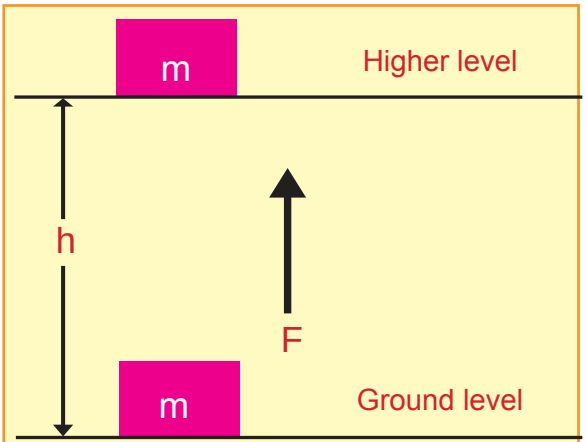


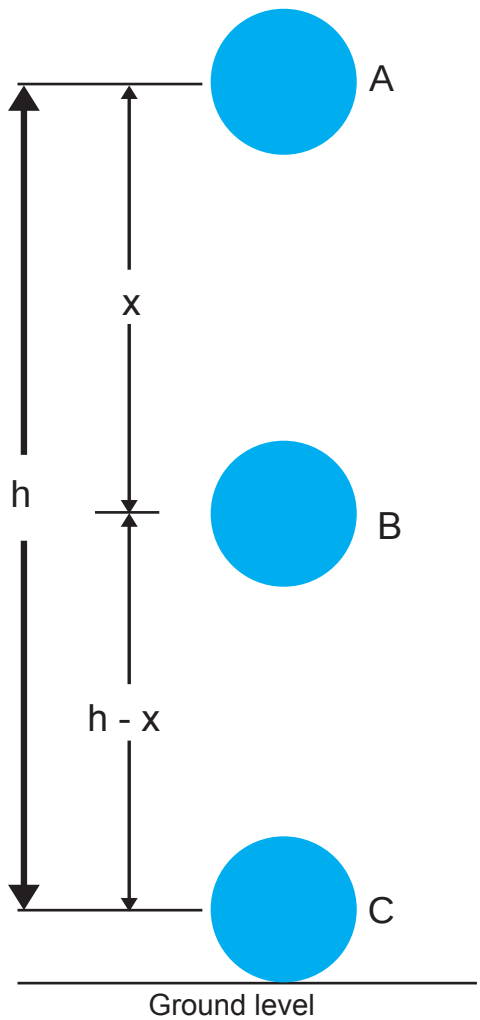
Fig. 6.2.

Consider an object of mass 'm' raised through a height 'h'. The force of gravity acting on the object is 'mg'. The work done in raising the object through a vertical displacement 'h' is:

$W = F \times S = mg \times h$

6.5.3. CONSERVATION OF MECHANICAL ENERGY

The law of conservation of energy is applicable to mechanical energy as well. Consider an object falling from a height 'h'. Assuming that all other forms of energy remain constant through the process(such as chemical energy, heat energy, sound energy, electrical energy, etc.) then mechanical energy should be conserved during every moment of the journey downwards. This means that the sum total of the potential and kinetic energy at any point of the journey must be a constant. At the top, the potential energy is considerable. As the object falls freely, its potential energy keeps reducing (as the height reduces) and its kinetic energy keeps increasing(as the speed increases). Let us verify mathematically whether the total mechanical energy is constant, using the two formulae that we have learnt : PE = mgh and KE = ½ mv^2.



SCIENCE

Consider a body of mass 'm' falling from a point 'A' which is at a height 'h' from the ground as shown in the figure.

At 'A', at the instant of release its velocity is zero. At 'C', at the instant just before striking the ground its height is zero and its velocity maximum. At an intermediary point B, it has fallen through a height 'x' and has acquired a certain velocity.

At A

$PE = mgh$

$KE = 0$

Total mechanical energy, PE + KE = mgh

At C

$PE = 0$

$KE = \frac{1}{2} mv^2 = \frac{1}{2} m(2gh) = mgh$ *[Using* $v^2 = u^2 + 2as$ *where* $u = 0$, $a = g$ *and* $s = h$*]*

Total mechanical energy, PE + KE = mgh

At B

$PE = mg(h-x)$

$KE = \frac{1}{2} mv^2$

$= \frac{1}{2} m(2gx)$

$= mgx$ *[Using* $v^2 = u^2 + 2as$ *where* $u = 0$, $a = g$ *and* $s = x$*]*

Total mechanical energy

$= PE + KE$

$= mg(h-x) + mgx = mgh$

Thus, we see that at each point of the journey, the total mechanical energy is constant. In other words, the total mechanical energy is conserved.

MODEL EVALUATION

Section A

1. Work done by the force is said to be negative, if the displacement of a body is _____. *(along the force, against the force)*
2. Pick the odd one out from the following based on the nature of energy possessed by them. *(moving car, water stored in a tank, a book on a table, ceiling fan in 'OFF' position)*
3. Commercial unit of electrical energy is _____. *(joule, joule/second, watt, kilowatt-hour).*
4. The SI unit of work is_____ *(watt, joule).*
5. Capacity of doing work is called_____ *(power, energy).*
6. Work done= power X_____ *(time taken, displacement).*
7. One Kwh is equal to _____ *($3.6X10^6$ J, 360000 J).*
8. Potential energy of an object raised through a height h is _____ *($\frac{1}{2} mv^2$, mgh).*

9. *For the following situations, determine whether work was done. Write 'work done' (or) 'no work done' for each situation:*

   a) An ice skater glides for two metres across the ice.

   b) The ice skater's partner lifts her up to a distance of 1 metre.

   c) The ice skater's partner carries her across the ice for a distance of 3 m.

   d) After setting her down, the ice skater's partner pulls her across the ice for a distance of 10 m.

   e) After skating practice, the ice skater lifts her 20 N gym bag upto 0.5 m.

10. *An ant sits on the back a mouse. The mouse carries the ant across the floor for a distance of 10 m. Was there work done by the mouse? Explain.*

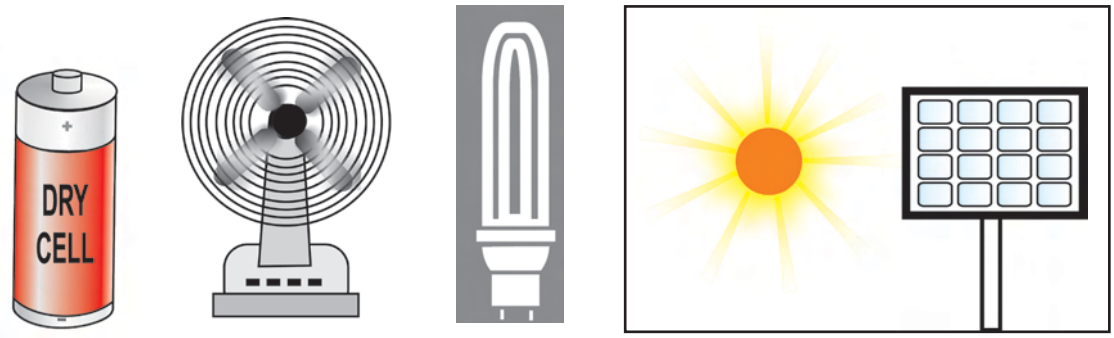
Section B

1. *What is the work done by the force of gravity on a satellite moving around the earth? Justify your answer.*
2. *"Energy can neither be _____ nor _____; it can only be changed from one form to another".*
3. *How is work measured?*
4.

(i)

Observe the figures above. State and explain in each case, whether work is done or not?

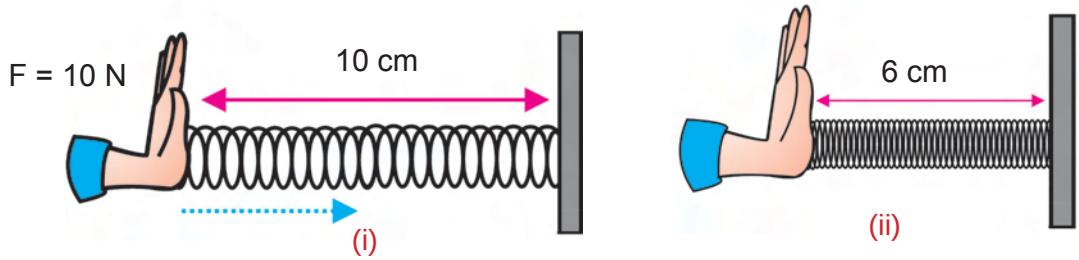
5. *Define 'power'.*
6. *Give some important forms of energy.*
7. *Define kinetic energy.*
8. *Look at the following pictures. Mention the nature of energy transformation, that takes place in each.*



(i) (ii) (iii) (iv)

9. Raja weighing 40 kg claimbs up a staircase of 20 steps, each of 16 cm height, in 20 seconds. Find the power generated by Raja.

10. Look at the two diagrams given below. Calculate the work done in compressing each spring completely, assuming that the force applied remains constant.



11. a) How are work, force and distance related.

b) Find the work done by a pulley when it lifts a block which is 5 m off the ground with a 10 N force.

12. You did 150 joules of work lifting a 120- Newton backpack.

a) How high did you lift the backpack?

b) How much did the backpack weigh in pounds? [Hint: 1 pound = 4.448 newtons]

13. You lift a 450 newton bag of rice 1.2 metres and carry it a distance of 10 metres to the kitchen. How much work is done?

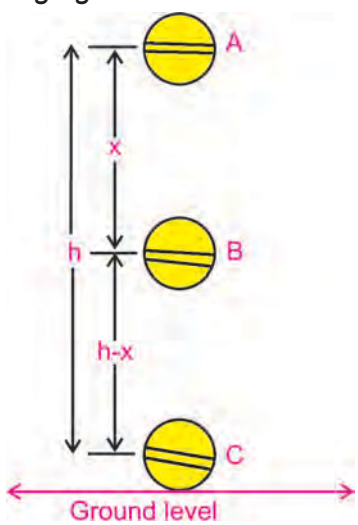
14. Determine the amount of potential energy of a 5 N book that is moved from the ground to three different shelves on a book case. The height of each shelf is 1 m, 1.5 m and 2 m from the ground,

15. Malathy's vacuum cleaner has a power rating of 200 watts. If the vacuum cleaner does 360,000 joules of work, how long did Malathy spend vacuuming.

16. A 1000 watt microwave oven takes 90 seconds to heat a bowl of soup. How many joules of energy does it use?

Section C

1. Consider the case of a freely falling body given in the following figures:



At A

Kinetic energy=0

Potential energy=mgh

At B

Kinetic energy=mgx

At C

Kinetic energy=mgh

Potential energy=0

a) Find the potential energy of the body at B.

b) Find the total energy at A,B and C.

c) Is there any variation in total energy? What do you infer from the result?

2. *Define potential energy. Obtain the expression for potential energy.*

3. *Name the energy transformations that occur in the following.*

   a) Electric motor *b) Photoelectric cell*

   c) Electric heater *d) Photosynthesis in plants*

   e) Light bulb

4. *Which person did the maximum work?*

   a) Venu walks 1,000 meters to the store. He buys 4.448 newtons of chocolates and then carries it to his friend's house which is 500 metres away.

   b) Kala lifts her 22 newton cat to a distance of 0.5 metre.

   c) Ramu carries groceries from a car to his house. Each bag of grocery weighs 40 N. He has 10 bags. He lifts each bag up 1 metre to carry it and then walks 10 m from his car to his house.

5. *Two objects were lifted by a machine. One object had a mass of 2 kg and was lifted at a speed of 2 m/s. The other had a mass of 4 kg and was lifted at a rate of 3 m/s.*

   a) Which object had more kinetic energy while it was being lifted?

   b) Which object had more potential energy when it was lifted to a distance of 10 m? (gravity – 9.8 m/s^2)

6. *Mitra and Akshaya are helping a neighbour to arrange the books in a book shelf. Mitra and Akshaya each carry 10 bundles of books weighing 300 N each to a shelf which is 7 metres from the ground. Mitra is able to carry the books to the shelf in 10 minutes where as Akshaya needs 20 minutes. Who has more power?*

7. *A machine that uses 200 watts of power moves an object to a distance of 15 m in 25 seconds. Find the force needed and the work done by this machine.*

SCIENCE

FURTHER REFERENCE

Books : 1. Physics Foundation and Frontiers - G.Gamov and J.M.Clereland – Tata McGraw Hill
2. Complete Physics for IGCSE - OXFORD PUBLICATIONS

Webliography : http://www.edugreen.teri.res.in/explore/n_renew/energy.htm
http://www.arvindguptatoys.com
http://www.physics.about.com
http://www.khanacademy.org

HEAT AND GAS LAWS

The Montgolfier brothers, Joseph and Jacques, born in Annonay, France, were the first to build and demonstrate the flight of a hot air balloon in June, 1783, in their home town. Within months after that, they demonstrated the first manned flight where two passengers floated freely in a hot air balloon. At around the same time, but a little after the Montgolfiere flight, Jacques Charles and the Robert brothers launched the world's first hydrogen filled balloon from the Champ de Mars, (now the site of the Eiffel Tower) where Ben Franklin was among the crowd of onlookers.

There is evidence to show that long before the balloon flights in France, the Chinese had a tradition of floating lamps attached to paper bags.

Early balloon flights were uncontrolled and went wherever the winds took them. They had no control over where they landed and the balloon passengers were often beaten up by the public, since they were unaware and scared of objects that came from the sky. In 1852, Henri Giffard attached a small steam-powered engine and a huge propeller and flew for seventeen miles at a top speed of five miles per hour. In 1898, Alberto Santos-Dumont flew a gasoline powered airship. In 1900, Ferdinand Zeppelin evolved a balloon structure made of rigid aluminium and wood strips, that had an engine for propulsion, used rudders and elevator flaps for steering, and carried passengers in a gondola, suspended under the balloon. This was used during the first world war for military purposes and became a source of terror for enemy forces.

How do balloons rise up in the sky? One of the pioneers of manned balloon flights Jacques Charles studied this closely and articulated the law that governed the behaviour of volume and temperature of gasses. This law can be used to explain the flight of balloons. Would you like to learn all about gasses and how balloons fly?

HEAT AND GAS LAWS

In your earlier classes, you have learnt something about temperature and heat. You have also learnt about the three states of matter – solids, liquids and gases. You have learnt about the Fahrenheit and Centigrade scales of temperature as well. Besides all these you have learnt about the effects of heat on solids, liquids and gases. In this chapter, you are going to learn a little more about heat and temperature, apart from the behaviour of gases. The behaviour of gases is also linked with heat in a way and the measurement of temperature. We shall now study about the absolute scale of temperature, also known as the Kelvin scale.

7.1. HEAT

In the previous chapter, we discussed that the physics definition of "work" is quite different from the common usage of the word in English language. Similarly, the physics definition of "heat" is quite different from the common usage of the word in English language.

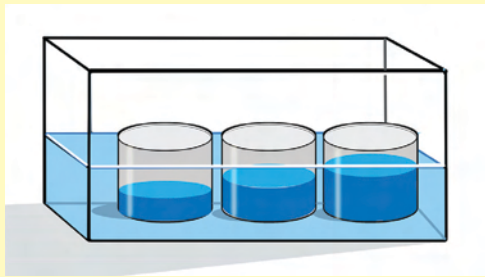
In physics, "Heat is a form of energy transfer between two systems or between a system and its surroundings due to temperature difference between them". We represent heat transfer by the symbol Q.

There are two important points put forward by this definition that you must make note of.

Firstly, energy transferred into or out of a system can be in any form; however, that form of energy which is transferred due to temperature difference alone is referred to as heat.

Secondly, heat is a moving energy. It means that the term 'heat' is used only to indicate energy that is transferred. Once the heat transfer that takes place 'in' or 'out' of a system is completed, it is no longer referred to as heat, as it becomes part of the internal energy. Just as we do not talk about the amount of "work" contained in an object, we never talk about the amount of "heat" contained in an object. The reason for this is that energy can be in any form and energy and work are inter-convertible. For example, heat can be transferred into a body and the energy in the body can be extracted as work or as energy in any form. Alternatively, work can be done on an object and it will result in an increase in temperature of the object which in turn can be retrieved as work.

ACTIVITY 7.1 WE OBSERVE



Take three identical glass beakers, three thermometers and a stopwatch. Fill the first beaker with 50g of any substance, say water. Take 75g of water in the second beaker and 100g of water in the third. Leave the three beakers on the table for some duration of time to ensure that they are at the same temperature.

Measure the temperature of the water in each beaker (say 28°C). Immerse the three beakers to the same level in the same hot water bath (say 90°C) and simultaneously start the stop watch. Note the time taken for every 10°C rise in temperature. As soon as the temperature of the water in each beaker reaches 60°C, remove the beaker from the water bath and note the time taken.

7.2. CALCULATING THE QUANTITY OF HEAT TRANSFERRED

Let us learn how to calculate the quantity of heat energy transferred in or out of a system. Whenever an object at a higher temperature is brought into contact with an object at lower temperature, heat energy is transferred from the object of higher temperature to the object of lower temperature. In general, the addition of heat energy results in increase in temperature of the object at lower temperature. Simultaneously, the temperature of the hotter object would decrease as it loses heat energy. The transfer of heat energy would continue to take place till both objects attain the same temperature.

Let us now learn the principles that govern the quantity of heat energy transferred from the hotter object to the cooler object.

What did you notice about the time taken for the water in each of the three beakers to attain the same rise in temperature in activity 7.1?

You would have noticed that the greater the quantity of water in the beaker, the greater the time taken for it to reach 60°C. We could say that if the mass of water is more, more heat energy is required to raise the temperature through the same range. We could conclude, therefore, that the quantity of heat transferred (Q) is proportional to the mass (m) of the substance. In mathematical language, we write it as follows:

$Q \alpha m$……..(1)

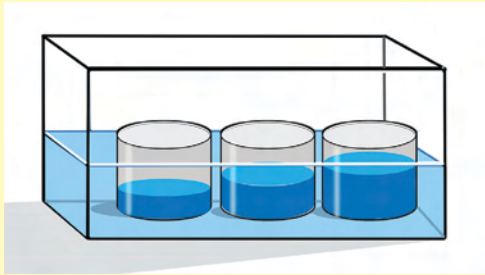
You would also have noticed that the rise in temperature is proportional to time. We could say that more rise in temperature requires more heat energy. We could, therefore, conclude that the quantity of transferred heat energy is proportional to the rise in temperature (Δt). In mathematical language, we say:

$Q \alpha \Delta t$……(2)

What did you notice about the time taken for the liquid in each of the three beakers to attain the same rise in temperature in activity 7.2?

You would have noticed that each substance has a characteristic rate at which the temperature rises. You could say that the equal mass of each substance takes different quantities of heat to attain the same rise in temperature. In order to be able to compare the heat characteristics of different substances, we define a quantity called the specific heat capacity.

ACTIVITY 7.2 WE OBSERVE



Repeat activity 7.1 with three beakers. Instead of water in all beakers, take 50g of coconut oil in the first beaker, 50g of kerosene in the second and 50g of water in the third. Leave the three beakers on the table for some duration of time to ensure that they are of the same temperature. Measure the temperature of the liquid in each beaker (say 28°C). Immerse the three beakers to the same level in the same hot water bath and simultaneously start the stop watch.

Note the time taken for every 10°C rise in temperature. As soon as the temperature of the liquid in each beaker reaches 60°C, remove the beaker from the water bath and note the time taken.

SCIENCE

Specific Heat Capacity

"Specific Heat Capacity (SHC) is the heat required to raise the temperature of unit mass of a substance through unit temperature". The symbol for specific heat capacity is c. In the SI system, the Specific Heat Capacity of a substance is defined as:

"The amount of heat energy required to raise the temperature of 1 kg of a substance through 1 K."

The SI unit of SHC is J kg^{-1} k^{-1}

Quantity of heat transferred

We can now combine equations (1) and (2) to write as follows:-

$$Q = m \times c \times \Delta t$$

[Where Q is the quantity of heat transferred, m is the mass of the substance/ object, c is the specific heat capacity of the substance or object and Δt is the change in temperature]

Thermal capacity

Although scientifically the Specific Heat Capacity is an important quantity, practically objects rarely have an exact mass of one kg. The concept of thermal capacity is more useful. Thermal capacity is the "quantity of heat required to raise the temperature of an object through 1k". Its unit is joule / kelvin (J/K or JK^{-1}).

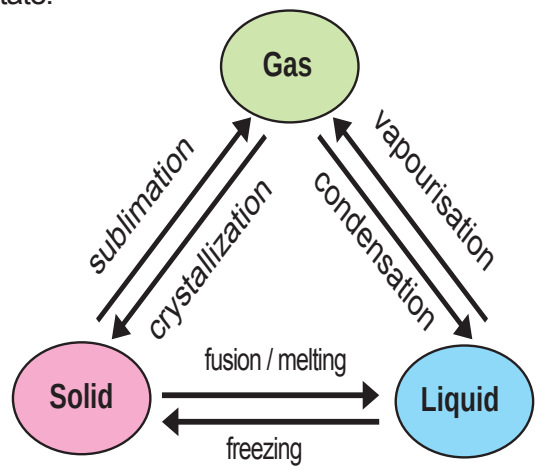
Thermal Capacity of an object = *m* x *c*

MORE TO KNOW

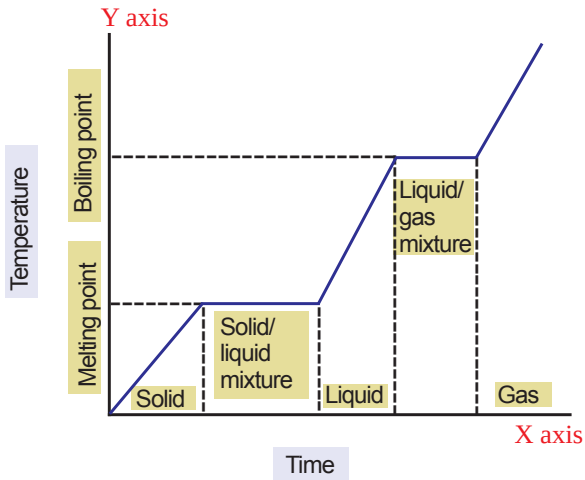
The specific heat capacity of water is the highest of all substances. It is 4180 J/kg/K. It is 30 times the specific heat capacity of mercury, which is about 140J/kg/K. That is why water is used for cooling. Water is also used in hot water bottles for treating pain in the body.

7.3. CHANGE OF STATE

The process of converting a substance from one state to another is called change of state.



If we take a solid such as wax and heat it, the temperature will start rising. While heating the substance note the temperature every 15 seconds. If we plot time on the x axis and the corresponding temperature on the y axis this is what we would see.



The graph shows that the temperature of the wax increases steadily with time till it reaches the melting point. As the wax melts the temperature remains constant even though heat is being transferred from the surroundings into the wax. This would happen till all the wax melts. Thereafter the temperature of the molten wax rises once again till it reaches the boiling point.

At the boiling point, once again the temperature remains constant till all the wax

gets evaporated. Even though heat is being transferred to the molten wax, its temperature does not increase.

Early scientists were amazed at the fact that heat energy seemed to be absorbed by the substance without any change in temperature. They therefore, called it "Latent Heat". The word "latent" means – present but not visible (hidden).

The quantity of latent heat required to melt a substance is the same as the heat energy that is released when it solidifies. Similarly, the quantity of latent heat energy required to evaporate a substance will be the same as the heat energy that will be released when the substance condenses. The latent heat required to evaporate a liquid is referred to as the latent heat of vapourisation. The latent heat required to melt a substance is referred to as the latent heat of fusion.

Specific Latent Heat

The Specific Latent Heat of Fusion of any substance is the quantity of heat energy required to melt one kilogram of a substance without change in temperature.

The symbol used is L. The unit for specific latent heat is joules/kilogram or J/kg.

The specific Latent Heat of Vapourisation of any substance is the quantity of heat required to evaporate one kilogram of a substance without change in temperature.

The quantity of heat energy required to melt a given quantity of substance is calculated using the formula Q = mL, where m is the mass of the substance and L the appropriate specific latent heat. The same formula can be used to calculate the heat energy required to evaporate a given quantity of liquid.

7.4.THE GAS LAWS

7.4.1. BOYLE'S LAW

It is a common experience that gases can be compressed to occupy small spaces. When compressed, the pressure would increase. If a small quantity of a gas enters a large container it will expand to occupy the whole space.

The pressure of the gas would then decrease. Robert Boyle was the first to study the relationship between the pressure and the volume of gases in a systematic manners. He noticed that there was a regular relationship between the pressure and the volume. Today it is called Boyle's Law.

Boyle's Law states that "Temperature remaining constant, the pressure of a given mass of gas is inversely proportional to its volume". In mathematical language we express the same as follows:

[Temperature remaining constant]

$$P \propto \frac{1}{V}$$

It can also be stated as

$$PV = \text{a constant}$$

A sample graph of the pressure and the volume of a given mass of gas is shown in Fig 7.1.

Robert Boyle

Robert Boyle is best known for his work in physics and chemistry. He formulated Boyle's law. He is regarded as the first modern chemist.He described the elements as primitive, simple and perfectly complete bodies. From 1661, the term 'element' has been reserved for material substances.

SCIENCE

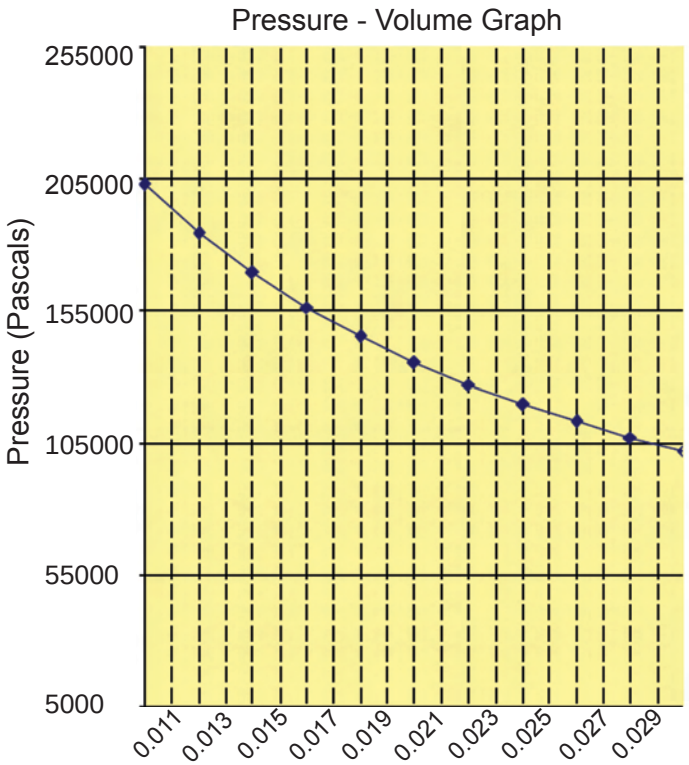


Fig. 7.1

7.4.2. VERIFICATION OF BOYLE'S LAW

Apparatus

By using a simple U tube apparatus, Boyle's Law can be verified as shown in figure 7.2.

The U tube is a glass tube closed on one end (left side) and left open to the atmosphere on the other side. It is filled with mercury in such a way that some air or any other gas used for the experiment is trapped in the closed end of the U tube. The height of the mercury column AB (height h in the figure) along with the atmospheric pressure P_A gives the pressure of the trapped gas in mm of mercury.

Procedure

Note the atmospheric pressure, P_A, from the standard laboratory mercury barometer (in mm of mercury)

Note the height h of the mercury column in the U tube.

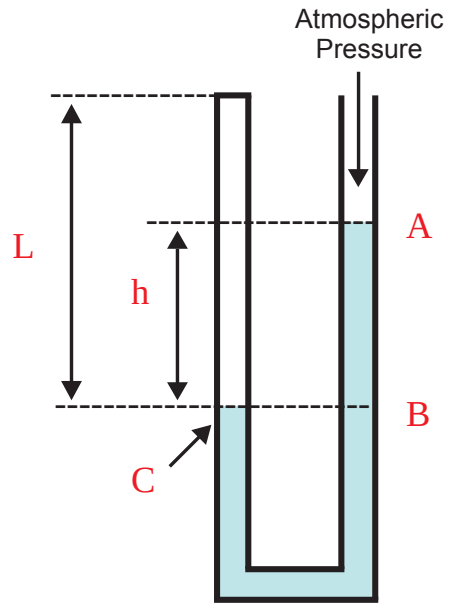


Fig. 7.2

Note down the value of $(P_A + h)$.

Note 'L', the length of the gas column trapped in the closed end of the U tube (in mm).

Calculate the product of $(P_A + h)$ and L.

Tabulate 'L' and (P_A+h) and (P_A+h) x L as shown:

You will notice that the value of (P_A+h) x L is a constant.

Sl. No.	(P_A+h)mm of mercury	L mm	(P_A+h) X L
1.			
2.			
3.			
4.			
5.			

7.5. CHARLES' LAW

Charles' Law states that "Pressure remaining constant, the volume of a given mass of gas is directly proportional to the absolute temperature". This is referred to as the law of volumes.

$V \alpha T$ [pressure remaining constant]

It can also be stated as $\frac{V}{T}$ = a constant

The graph of the volume plotted against temperature would be a straight line (shown as the solid line in fig 7.3)

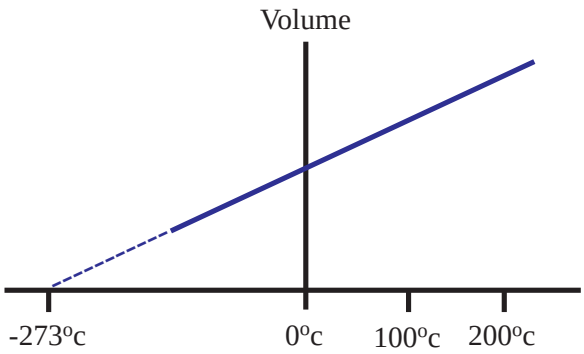


Fig. 7.3

7.6. THE GAS EQUATION

As per Boyle's Law PV = a constant

As per Charles's Law

$\frac{V}{T}$ = a constant

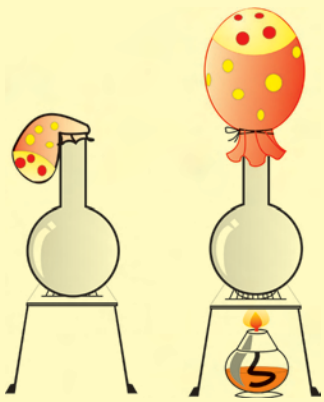
Combining both the laws we get :

$\frac{PV}{T}$ = a constant.

Of course, the value of the constant in each of the three cases is different. The equation ' $\frac{PV}{T}$ = a constatnt' is also referred to as the ideal gas equation and you will learn more about it in higer classes

From the ideal gas equation, we also derive the equation $\frac{P}{T}$ = a constant, for a given mass of gas provided volume remains constant and is sometimes referred to as the Law of Pressures.

ACTIVITY 7.3 WE OBSERVE



A balloon is fixed to the mouth of an empty and dry flask. Heat the flask over a flame or place the flask in a hot water bath and observe the balloon. It starts inflating as the air in the flask gets heated. Why does it happen? As the temperature of the air trapped inside the flask increases the volume expands. You have learnt something about that in your earlier classes. Charles Law explains this and is applied to fly hot air balloons.

Jacques Charles (1746 – 1823)

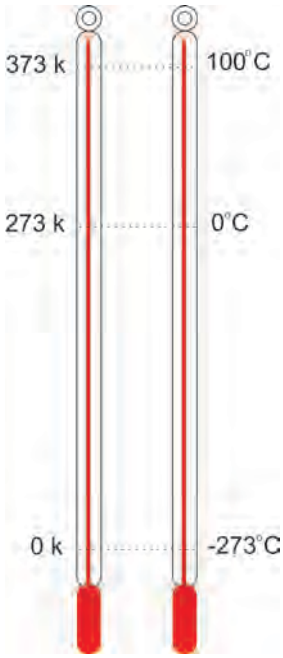
Jacques Charles was a French inventor, scientist, mathematician, balloonist and a Professor of Physics in Paris. He found the relation between the temperature and the volume. His experiment revealed that all gases expand and contract to the same extent when heated through the same temperature intervals. He constructed the first hydrogen balloon, which brought him fame and royal patronage. He also invented the hydrometer.

7.7. KELVIN SCALE OR ABSOLUTE TEMPERATURE SCALE

The zero of the Kelvin scale corresponds to -273°C and is written as 0K (without the degree symbol). One division on the Kelvin scale has the same magnitude of temperature as one division of the Celsius or Centigrade scale. Thus 0°C corresponds to +273K.

Kelvin scale(K) = Celsius scale (0°C) + 273

Celsius scale (0°C) = Kelvin scale (K) – 273



$T_k = T_c + 273$

Kelvin, Celsius scale

7.8. CHARLES LAW AND THE GAS EQUATION REVISITED

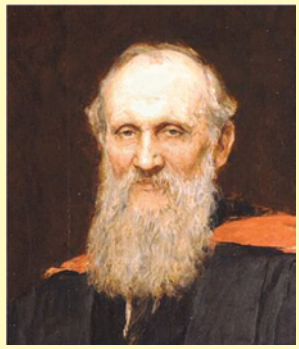
After much more research, 'kelvin' has been accepted as the SI unit of temperature. According to Charles's Law, V/T is a constant.

As per the ideal gas equation, PV/T is a constant.

According to the Law of Pressures, P/T is a constant.

In all these equations, we use the Kelvin temperature. You will learn more about this in higher classes.

Lord Kelvin



Lord Kelvin was a physicist and an engineer. He is widely known for his significant contribution to thermodynamics. He devised the Kelvin scale of temperature. The unit of temperature was named after him to honour his outstanding contribution and achievements.

MORE TO KNOW

Boyle's Law was stated publicly in 1662.

Charles' Law was first published by the French natural philosopher Joseph Louis Gay-Lussac in 1802, although he credited the discovery to the unpublished work from the 1780s by Jacques Charles. The law was independently discovered by the British natural philosopher John Dalton in 1801, although Dalton's description was less thorough than Gay-Lussac's. In those days, the Kelvin scale of temperature did not exist. Developing on the work done by Jacques Charles' and many others, William Thomson (Lord Kelvin) proposed the concept of absolute zero or the lowest possible temperature in 1848. His calculated value came to -273.16°C. Extending the Charles Law graph backwards, the straight line intersects the x-axis at -273.16°C . This temperature of -273.16°C became the origin of the Kelvin scale or the absolute temperature scale.

MORE TO KNOW

MANGALYAAN

Space scientists root for GSLM III success

TIRUNELVELI : After the Mars Orbiter Mission's (MOM) resounding success in its maiden attempt, scientists at the Indian Space Research Organisation's Propulsion Complex (IPRC) at Mahendragiri here are eagerly waiting to witness the Geosynchronous Satellite Launch Vehicle Mark III engine's performance during its proposed test flight in the next two months.

It was in this complex the cryogenic propellant of this engine was synthesized, tested and supplied. It was at the same facility the liquid apogee motor (LAM), which played the crucial role in the MOM programme, was successfully tested for the first time in October 2012. Then it was known as Liquid Propulsion Systems Centre.

Since LAM's engine had to be restarted after 300 days when the MOM enters the Red Planet's orbit, the IPRC, after keeping it idle in a vacuum, operated it on the 528th day to test its efficacy.

"Since the LAM performed exceptionally well during the test on the 528th day, we were quite confident that the MOM would be a roaring success. Now, we are waiting to witness GSLV's 110 tonne Mk III's performance during its test flight in October or November as its cryogenic propellants were tested and perfected here last March," D. Karthikesan, Director of ISRO Propulsion Research Complex, told reporters at Mahendragiri on Friday.

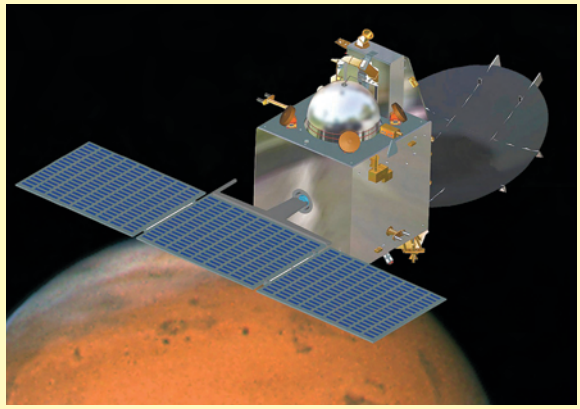
"If this test flight also becomes a success, it will enable ISRO to send astronauts to space. Hence, the ISRO plans to carry a crew capsule without astronauts during the proposed test flight. The capsule that will return to earth with the help of parachutes will be recovered by a specialised team kept ready for the purpose," he said.

Since the capsule should be heat resistant as it re-enters the atmosphere, the ISRO has indigenously developed special carbon composite for fabricating this specialised crew capsule.

The IPRC was actively creating facilities for assembly, integration and testing of Semi Cryo Engine at Mahendragiri since it had gained vast experience in the production and supply of cryogenic propellants for ISRO's cryogenic rocket programs over the years.

India's Mars Orbiter Spacecraft successfully entered into an orbit around planet Mars on September 24, 2014 by firing its 440 Newton Liquid Apogee Motor (LAM) along with eight smaller liquid engines. This Liquid Engines firing operation which began at 07:17:32 Hrs IST lasted for 1388.67 seconds which changed the velocity of the spacecraft by 1099 metre/sec. With this operation, the spacecraft entered into an elliptical orbit around Mars.

The events related to Mars Orbit Insertion progressed satisfactorily and the spacecraft performance was normal. The Spacecraft is now circling Mars in an orbit whose nearest point to Mars (periapsis) is at 421.7 km and farthest point (apoapsis) at 76,993.6 km. The inclination of orbit with respect to the equatorial plane of Mars is 150 degree, as intended. In this orbit, the spacecraft takes 72 hours 51 minutes 51 seconds to go round the Mars once.



Mars Orbiter Spacecraft

ISRO's Propultion Complex(IPRC), Mahendragiri, Tirunelveli District

Mars Orbiter Spacecraft was launched on-board India's workhorse launch vehicle PSLV on November 05, 2013 into a parking orbit around the Earth. On December 01, 2013, following Trans Mars Injection (TMI) manoeuvre, the spacecraft escaped from orbiting the earth and followed a path that would allow it to encounter Mars on September 24, 2014.

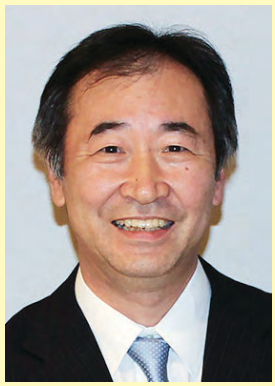
With successful Mars Orbit Insertion operation, ISRO has become the fourth space agency to successfully send a spacecraft to Mars orbit. In the coming weeks, the spacecraft will be thoroughly tested in the Mars orbit and the systematic observation of that planet using its five scientific instruments would begin.

SCIENCE

MORE TO KNOW

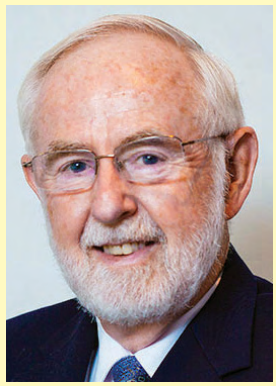
The Nobel Prize in Physics, 2015 was awarded jointly to Takaaki Kajita and Arthur B. McDonald " for the discovery of neutrino oscillations, which shows that neutrinos have mass".

Field : Neutrino Physics



Takaaki Kajita

Born: 1959, Higashimatsuyama, Japan.
Affiliation at the time of the award:
University of Tokyo, Kashiwa, Japan.



Arthur B. McDonald

Born: 1943, Sydney, Canada.
Affiliation at the time of the award:
Queen's University, Kingston, Canada.

MODEL EVALUATION

Section A

1. The degree of hotness or coldness of a body is _____ *(heat, temperature).*
2. Select the liquid which has the specific heat capacity of 4180 $JKg^{-1}K^{-1}$ from the following. *(mercury, kerosene, water, coconut oil)*
3. The two important points emerging from the definition of heat are:
   a) Heat is the form of energy which is transferred from one object to another due to _____*(height difference, temperature difference, mass difference, velocity difference).*
   b) Heat is an energy that is _____*.(in transit, stationary, contained in a body).*
4. The quantity of heat transferred is equal to the product of _____, _____ and _____ .
5. Heat is_____ *(moving energy, unmoving energy)*

6. Absolute scale of temperature is known as_____ (Celsius scale, Kelvin scale)

7. The SI unit of specific heat capacity is _____ ($J\ kg^{-1}K^{-1}$, $J\ K^{-1}$).

8. The zero of Kelvin scale corresponds to_____ (0 K, 0^0C).

9. Thermal capacity of an object = _____ (m x c x Δt, m x c).

10. How much heat is required to raise a temperature of 100 g of water from 10^0C to 25^0C? (The specific heat of water is 4180 J / Kg / K.)

11. A scientist wants to raise the temperature of 0.1 Kg sample of glass from -45^0C to 15^0C. How much heat energy is required to raise the temperature? (SHC of glass 8 J/Kg/ ^0C)

12. What is the heat energy required to melt an ice slab of mass 3 Kg? The specific heat of water is 4180 J / Kg / K.

13. What is the amount of heat energy required to convert ice of mass 20 Kg at -4^0C to water at 20^0C? Use the relevant option for calculation.

a) Latent heat of fusion of ice 3.34 x 10^5 J / Kg.

b) Specific heat capacity of water is 4180 J / Kg / K

c) Specific heat of ice 2093 J / Kg / K

Section B

1. Match the following:

a.

Change of state	Examples
1) vapourisation	a) burning of camphor
2) condensation	b) water changed into ice
3) freezing	c) steam
4) sublimation	d) rain

b.

1) Boyle's Law	a) P/T= a constant
2) Charles' Law	b) PV= a constant
3) Law of Pressures	c) V/T = a constant

2. The boiling point of water is 100^oK. Identify the mistake(s) in the statement and correct it in Kelvin scale.

3. Why do people prefer to use copper bottom vessels for cooking?

4. Why is heat given out when vapour condenses into a liquid?

5. Explain why evaporation is accompanied by cooling.

6. Explain the following using the gas laws:-

   a) The pressure in a car tyre will be higher at the end of the journey.

   b) A football inflated till it is hard on a hot mid-summer day around noon time will become softer by late evening.

   c) A balloon filled with hydrogen gas will go up in the air when it is released. When it reaches higher altitudes, say one kilometre altitude, it will burst. Why?

7. State Boyle's Law.

8. Mention the applications of high specific heat capacity of water.

9. What is change of state?

10. Define specific heat capacity.

11. What is the mass of a block of concrete that gains 52,800 J of energy, when its temperature is increased by 5^0C? (SHC of concrete 880 J / Kg / ^{0}C)

12. What is the use of kink in clinical thermometer?

13. The specific heat of sulphur is 4.84 J / Kg and the quantity of heat is 0.706 J. Calculate its mass.

14. Ramesh is travelling from the Pacific Ocean towards Indian Ocean. In the Pacific Ocean he has a balloon with 2 litre capacity at 18^0C. When he reaches the Indian Ocean, the temperature will be 25^0C. What will be the volume of the balloon?

15. Why is it not possible to cool the liquid at absolute OK?

16. What will happen to a pressure cooker if you don't switch off the heat supply after sometime? Justify your answer.

17. As an air bubble rises from the bottom of the river to the top, its volume increases. Why?

18. At 600K, a volume of gas has a pressure 0.4 atm. What is the pressure of gas at 273K?

19. A kit used to fix flat tyres consists of an aerosol can which contains compressed gas and a patch to seal the hole in the tyre. Suppose 10 L of air at atmospheric pressure is compressed into a one-litre aerosol can, what is the pressure of the compressed air in the can?

20. A 12.5 scuba tank holds oxygen gas at the pressure of 202 kilo pascal. What is the original volume of oxygen at atmospheric pressure that is required to fill this scuba tank?

Section C

1. I initially have a gas with a pressure of 84 KPa and a temperature of 35^0C and I heat it to an additional 23^0 C . What will be the new pressure? Assume that the volume of the container is constant.

2. A toy balloon filled with air has an internal pressure of 1.25 atm and a volume of 2.50 L. If I take the balloon to the bottom of the ocean where the pressure is 95 atmospheres at constant temperature, what will be the new volume of the balloon?

3. Describe an experiment to verify the Boyle's law.

4. Explain the change of state.

5. Due to a fire accident in a building, the room's temperature started increasing. At what temperature will the cylinder of 18.4 litre capacity at room temperature explode. [The maximum volume the cylinder can reach is 36.8 litres]

6. The air inside a tyre pump occupies a volume of 130 CC at a pressure of 1 atm. If the volume decreases to 40 CC, what is the pressure of atm inside the pump?

7. Use Charles Law to fill the following table:

	V_1	T_1	V_2	T_2
A		840 K	1070 ml	147 K
B	3250 ml	475°C		50°C
C	10 Litre		15 Litre	50°C

8. Explain the experiment of the melting point of wax using a graph.

FURTHER REFERENCE

Books : 1. Physics Foundation and Frontiers - G.Gamov and J.M.Clereland – Tata McGraw Hill
2. Complete Physics for IGCSE - OXFORD PUBLICATIONS

Webliography : http://www.edugreen.teri.res.in/explore/n_renew/energy.htm
http://www.arvindguptatoys.com
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LIST OF PRACTICALS

S.No.	Name of the Experiment	Aim of the Experiment	Apparatus/ Materials required	Time
1	Osmosis	To study the phenomenon of osmosis by using potato osmoscope	Potato, knife, sugar solution, beaker, coloured water, pins, etc.	40 minutes
2	Ascent of Sap	To prove the ascent of sap through xylem vessels by using balsam plant.	A bottle or a beaker, water, eosin stain or red ink and balsam plant	40 minutes
3	Ethyl Alcohol	To find out ethyl alcohol in a medium.	Ethyl alcohol, acidified potassium dichromate, test tube	40 minutes
4	Identification of acid radicals in the given salt	To identify carbonate, chloride, sulphate acid radicals present in the given salt	Test tube, Carbonate salt, Sulphate salt, Chloride salt, $BaCl_2$ $AgNO_3$, Dil. HCl,	40 minutes
5	Temperature – Time Relation	To determine the boiling point of water and to draw the cooling curve	Beaker with water, electric heater, tripod stand, wire gauze	40 minutes

1. TO STUDY THE PHENOMENON OF OSMOSIS

Aim:

To study the phenomenon of osmosis by potato osmoscope.

Principle:

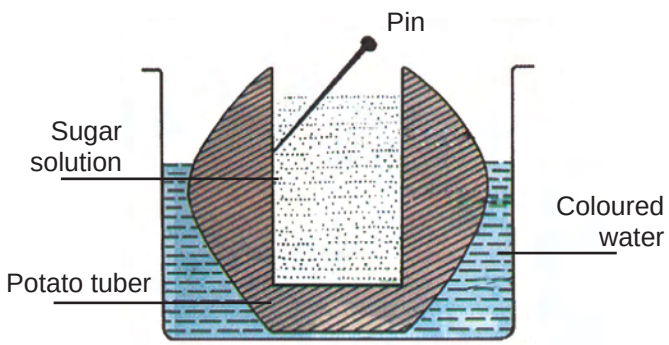
Movement of molecules of water or solvent from a region of its higher concentration to the region of its lower concentration through a semipermeable membrane is called osmosis.

Materials Required:

Potato, knife, sugar solution, beaker, coloured water, pins, etc.

Procedure:

a. A potato is taken and peeled.
b. Its base is cut to make it flat.
c. A hollow cavity is made in the centre of the tuber and is filled with sugar solution.
d. The initial level of the solution is marked with the help of a pin.
e. It is placed in a beaker containing coloured water.
f. This experimental set up is left for sometime.
g. The final level of the sugar solution is measured.



Record the observations in the table:

Initial level of sugar solution (mm)	Final level of sugar solution (mm)	Difference between initial level and final level (mm)

Inference:

The level of sugar solution _____ and becomes _____ due to _____.

2. TO PROVE THE ASCENT OF SAP

Aim:

To prove the ascent of sap through xylem vessels by using Balsam plant (Kasithumbai plant).

Principle:

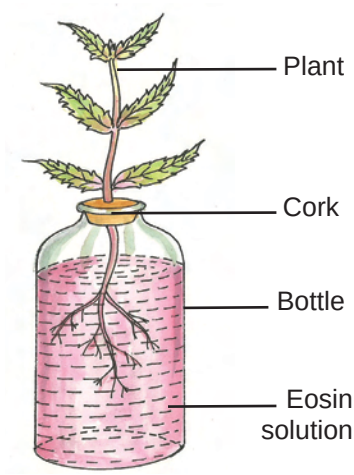
The conduction of water and mineral salts from the roots upward by the stem through the xylem vessels is known as the ascent of sap.

Materials Required:

A bottle, water, eosin stain or red ink and Balsam plant.

Procedure:

a) Take a bottle containing water and add a few drops of eosin stain or red ink.
b) Close the mouth of the bottle with a one-holed rubber cork.
c) Insert a balsam plant into it.
d) Keep the apparatus undisturbed for some time.



Record the periodical observations in an interval of 10 minutes each.

Sl.No	Periodicity	Observations
1.	After 10 Minutes	
2.	After 20 Minutes	
3.	After 30 Minutes	

Inference:

Red streaks seen in the stem and in the veins of leaves prove that _____
_____

3. TO FIND OUT ETHYL ALCOHOL IN THE MEDIUM

Aim:

To find out the presence of ethyl alcohol in the medium.

Materials Required:

Ethyl alcohol, acidified potassium dichromate.

Procedure:

Take 5 ml of acidified potassium dichromate in a test tube. Add a drop of ethyl alcohol and shake well. Slowly the red orange colour of the mixture will turn green. This shows the presence of alcohol.

Inference:

In this reaction, chromium ions (Cr VI) red orange is converted into (Cr III), which is green in colour.

Experiment	Observation	Inference
Acidified potassium dichromate is treated with a drop of ethyl alcohol	_____ colour of the mixture changes into _____	The presence of _____

Result:

The presence of _____ is confirmed / not confirmed.

Important application of this test:

This test is used to find if a person has consumed alcohol / liquor. It is a respiratory analysis.

4. TO IDENTIFY ACID RADICALS

Aim:

To identify the acid radical present in the given salt.

Identification of Carbonate acid radical

Experiment	Observation
1. Take about 1g of the salt in a test tube. Add 2-3ml of **diluted hydrochloric acid**.	**Brisk effervescence** due to the liberation of **CO_2** gas.
2. To the salt solution, add a few drops of **Magnesium sulphate** solution.	A **white** precipitate of **magnesium carbonate** is formed.

Report: The acid radical present in the salt is _____.

Identification of Chloride acid radical

Experiment	Observation
1. Take about 1g of the given salt in a test tube. Add a very little amount of **manganesedioxide** to it followed by **conc.sulphuric acid**. Heat the mixture for a few seconds.	Evolution of **greenish yellow chlorine** gas (Cl_2).
2. Add a few drops of **silver nitrate** solution to the aqueous solution of the salt.	A **curdy white** precipitate of **silver chloride** is formed.

Report: The acid radical present in the salt is _____.

Identification of Sulphate acid radical

Experiment	Observation
1. Take a pinch of the given salt in a test tube. Add water. If the salt is insoluble in water add **dil.hydrochloric acid** till the effervescence ceases. Then add **Barium chloride** solution.	Formation of a **white precipitate** of Barium sulphate.
2. Add a few drops of **lead acetate** solution to the aqueous solution of the salt.	Formation of a **white precipitate** of Lead sulphate.

Report: The acid radical present in the salt is _____.

5. TEMPERATURE – TIME RELATIONSHIP

Aim:

To determine the boiling point of water and to draw the cooling curve.

Apparatus required:

Beaker with water, electric heater, tripod stand, wire gauze, graph sheet, thermometer.

Procedure:

- Keep the beaker containing water over the wire gauze placed on the tripod stand.
- Fix a thermometer to a stand and immerse it in water.
- Heat the beaker with an electric heater.
- When water boils, note the thermometer reading.
- It gives the boiling point of water.
- Stop heating and allow the water to cool.
- Take the thermometer reading, while switching on the stop clock.
- Find the temperature interval using a stop clock.
- Similarly, note the thermometer reading at every one minute interval till the temperature falls upto 60^{o}C.
- Record the readings in the tabulation.

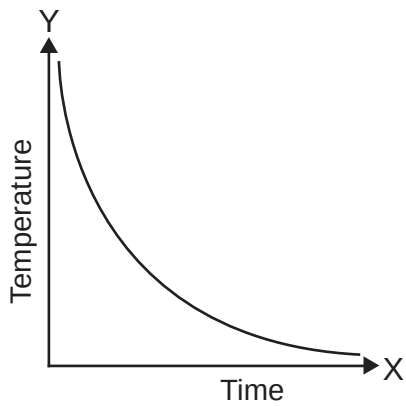
Observation:

The maximum temperature measured = ___ ^{o}C

$\therefore$ The boiling point of water = ___ ^{o}C

Time (minute)	Temperature (^{o}C)
0	
1	
2	
3	
4	
5	
6	
7	

For a suitable scale, draw the cooling curve by taking time along the x axis and temperature along the y axis.



Result:

1. The boiling point of water = ___ ^{o}C
2. The cooling curve is drawn.

'I can, I did'

Student's Activity Record

Subject:

Sl.No.	Date	Lesson No.	Topic of the Lesson	Activities	Remarks