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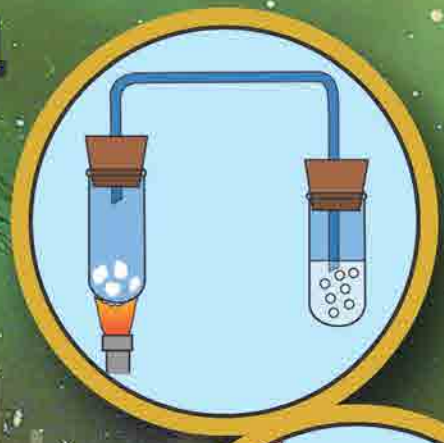
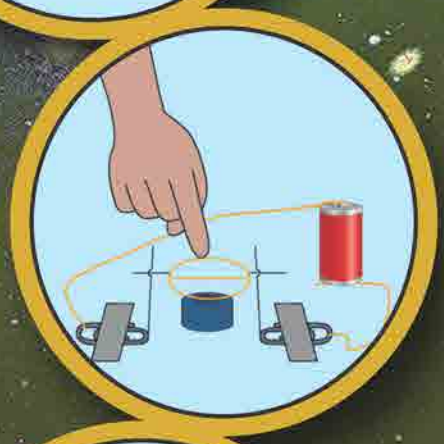
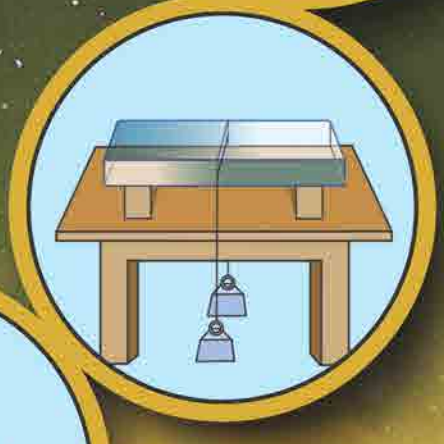
SCIENCE AND TECHNOLOGY

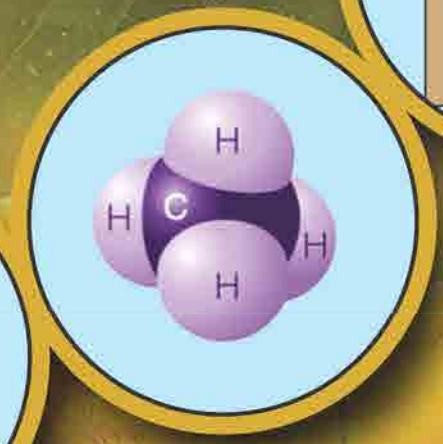
STANDARD TEN

PART - 1









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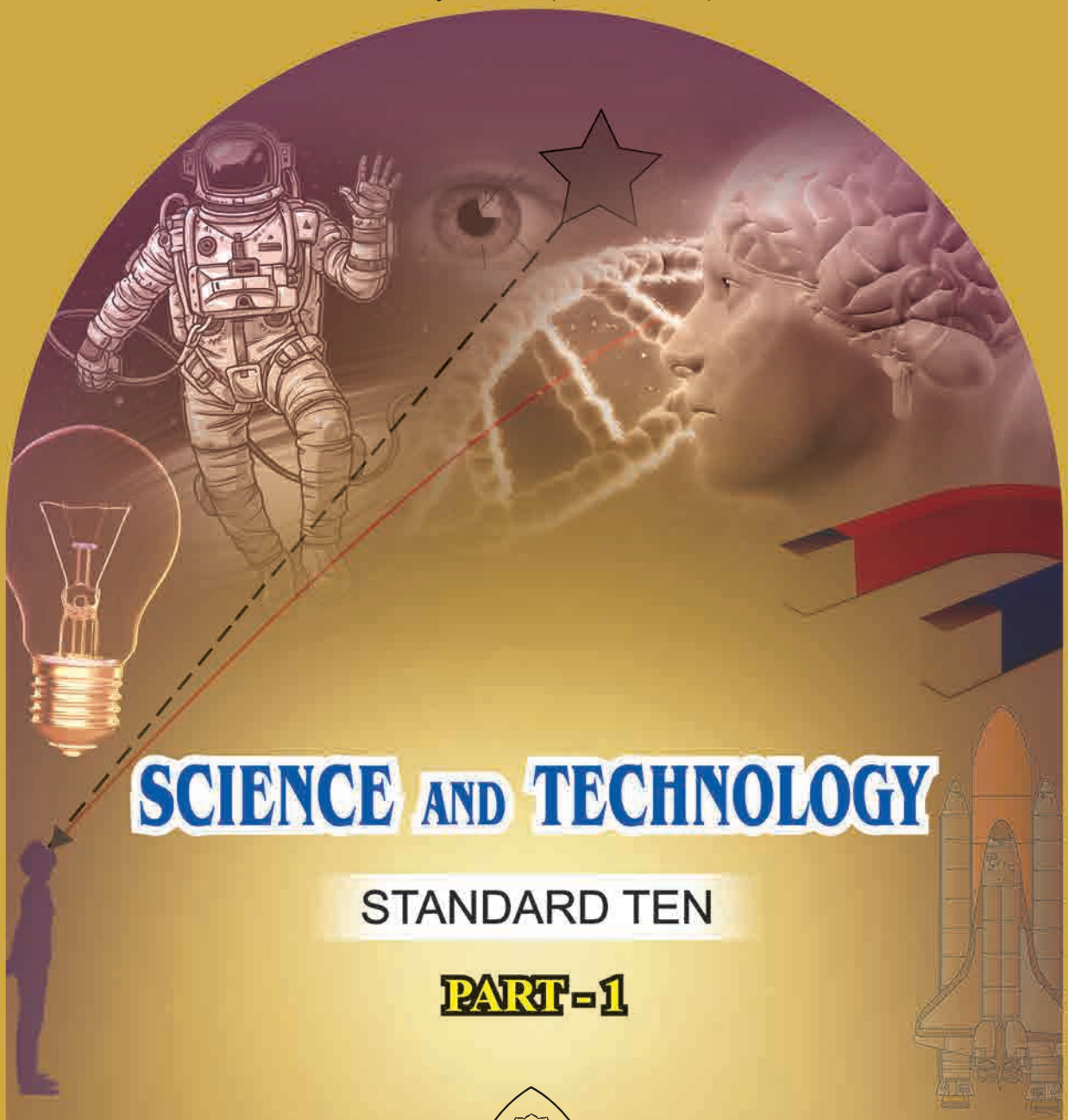

SCIENCE AND TECHNOLOGY

STANDARD TEN

PART-1

Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune.

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The Constitution of India

Preamble

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC and to secure to all its citizens:

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the unity and integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.

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NATIONAL ANTHEM

Jana-gana-mana-adhināyaka jaya hē
Bhārata-bhāgya-vidhātā,

Panjāba-Sindhu-Gujarāta-Marāthā
Drāvida-Utkala-Banga

Vindhya-Himāchala-Yamunā-Gangā
uchchala-jaladhi-taranga

Tava subha nāmē jāgē, tava subha āsisa māgē,
gāhē tava jaya-gāthā,

Jana-gana-mangala-dāyaka jaya hē
Bhārata-bhāgya-vidhātā,

Jaya hē, Jaya hē, Jaya hē,
Jaya jaya jaya, jaya hē.

PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

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Preface

Dear students

Welcome to Std X. We have great pleasure in offering you this Science and Technology textbook based on the new syllabus. From the primary level till today, you have studied science from various textbooks. In this textbook, you will be able to study the fundamental concepts of science and technology from a different point of view through the medium of the different branches of Science.

The basic purpose of this textbook Science and Technology Part-1 can be said to be 'Understand and explain to others' the science and technology that relates to our everyday life. While studying the concepts, principles and theories in science, do make the effort to understand their connection with day to day affairs. While studying from this textbook, use the sections 'Can you recall?' and 'Can you tell?' for revision. You will learn science through the many activities given under the titles such as 'Observe and discuss' and 'Try this' or 'Let's try this. Make sure that you perform all these activities. Activities like 'Use your brain power!', 'Research', 'Think about it' will stimulate your power of thinking.

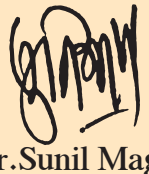
Many experiments have been included in the textbook. Carry out these experiments yourself, following the given procedure and making your own observations. Ask your teachers, parents or classmates for help whenever you need it. Interesting information which reveals the science underlying the events we commonly observe, and the technology developed on its basis, has been given in details in this textbook through several activities. In this world of rapidly developing technology, you have already become familiar with computers and smartphones. While studying the textbook, make full and proper use of the devices of information communication technology, which will make your studies easier. For more effective studies, you can avail additional audio-visual material for each chapter using the Q.R code through an App.This will definitely help you in your studies.

While carrying out the given activities and experiments, take all precautions with regard to handling apparatus, chemicals, etc. and encourage others to take the same precautions.

It is expected that while carrying out activities or observation involving plants and animals, you will also make efforts towards conservation of the environment. You must of course take all the care to avoid causing any harm or injury to them.

Do tell us about the parts that you like, as well as about the difficulties that you face as you read and study and understand this textbook.

Our best wishes for your academic progress.



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For Teachers

- In Standards I to V we have told the simple science in day to day life through the study of surroundings. In VI to VIII standard we have given brief introduction to science. In the textbook 'Science and Technology' for standard IX we have given the relation between science and technology.
- The real objective of science education is to learn to be able to think logically and with discretio about events that are happening around us.
- In view of the age group of Std X students, it would be appropriate, in the process of science education, to give freedom and scope to the students' own curiosity about the events of the world, their propensity to go looking for the causes behind them and to their own initiative and capacity to take the lead.
- As experimental skills are necessary for observation, logic, estimation, comparison and application of information obtained in science education, deliberate efforts must be made to develop these skills while dealing with laboratory experiments given in the textbook. All observations that the students have noted should be accepted, and then they should be helped to achieve the expected results.
- These two years in middle school lay the foundation of higher education in Science. Hence, it is our responsibility to enrich and enhance student's interest in science. You all will of course always actively pursue the objective of imbuing them with a scientific temper in them and developing their creativity and along with internet and skill.
- You can use 'Let's recall' to review the previous knowledge required for a lesson and 'Can you tell?' to introduce a topic by eliciting all the knowledge that the students already have about it from their own reading or experience. You may of course use any of your own activities or questions that occur to you for this purpose. Activities given under 'Try this' and 'Let's try this' help to explain the content of the lesson. The former are for students to do themselves and the latter are those that you are expected to demonstrate. 'Use your brain power!' is meant for application of previous knowledge for the new lesson, and 'Always remember' gives important suggestions/information or values. 'Research', 'Find out', 'Do you know?', 'Introduction to scientists' and 'Institutes at work' are meant to give some information about the world outside the textbook and to develop the habit of doing independent reference work to obtain additional information.
- This textbook is not only meant for reading and explaining in the classroom but is also for guiding students to learn the methods of gaining knowledge by carrying out the given activities. An informal atmosphere in the classroom is required to achieve the aims of this textbook. maximum number of students should be encouraged to participate in discussions, experiments and activities. Special efforts should be made to organise presentations or report-reading in the class based on students' activities and projects, besides observing of Science Day and other relevant occasions/ days.
- The science and technology content of the textbook has been complemented with Information Communication Technology. These activities are to be conducted under your guidance while learning various new scientific concepts.

Front and back covers : Pictures of various activities, experiments and concepts in the book.

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Competency Statements

The students are expected to achieve the following competency level after studying the text book Science and Technology Part 1

Motion, Force and Machines

* To be able to explain the scientific reasons behind various phenomenol on the basis of relationship between gravitational force and motion.
* To be able to write formulae discribing the relations between gravitation and motion and using these solve various numerical problems.

Energy

* To adapt an environment friendly lifestyle taking into account the grave effects of energy crisis and to encourage others to adapt it.
* To prepare , use and repair the equipments based on energy.
* To varify the laws of current electricity and to draw conclusions based on them
* To develop to solve numerical problems based on effects of current electricity.
* To observe various apparatus based on effects of current electricity and explain their functions with reasons.
* To give a scientific explaination of the images formed by lenses by drawing accurate ray diagrams.
* To explain properties of light, the images formed by lenses and their use in different equipments used in day to day life.
* To find out the focal length of a lense using given data.
* To study defects of vision in human eye and their remedies
* To draw neat and labelled diagram of human eye.

Substances in our use

* To explain systematic classifications of elements and their possitions in the periodec table.
* To identify type of chemical reaction in two components.
* To veryfy chemical reaction experimentally and draw conclustions.
* To correct the chemicals equation which is incomplete or wrong.
* To verify the properties of carbon compounds through experiments.
* To take proper care while performing the experiments and handling of the apparatus considering the effects of chemical reactions on human health.
* To guide the society through scientific attitude about the use of carbon compounds in daily life.
* To understand the realationship between chemical reaction of metals in daily life and use them to solve verious problem.

The Universe

* To analyze the information obtained from space reaserch and remove superstitions prevailing in society.
* To review the contribution made by India to space research.
* To search for future opportunities in the field of space research.

Information Communication technology (ICT)

* To use information communication Technology in day today life.
* To share the information about science and technology by using the internet.
* To explain amazing that have occured fields by using information communication technology

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Academic Planning

Two separate books have been prepared for Science and technology. Science and technology part 1 contains ten chapters mainly related to physics and chemistry. While thinking about science and technology, it is expected that an integrated approach will be taken while teaching and a connection will be made between different components of science and technology. In previous standards, we have studied various topics in science and technology together. For technical case two separate books science and technology part 1 and part 2 have been prepared, but it is necessary that an integrated perspective be taken while teaching.

Out of the ten chapters included in text book science and technology part 1, the first five chapters are expected to be taught in the first session while the next five chapters in the second session. At the end of a session a written examination for 40 marks and a practical examination for ten marks should be conducted. Exercises and projects have been given at the end of every chapters in the text book.

In view of evaluation, representative questions similar to those in the activity sheets of language books are given in exercises. You may make similar other questions for your use. The students should be evaluated based on these questions detailed information above to this will be given in separate evaluation scheme.

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1. Gravitation

- Gravitation
- Circular motion and centripetal force
- Kepler's laws
- Newton's universal law of gravitation
- Acceleration due to the gravitational force of the Earth
- Free fall
- Escape velocity

Can you recall?

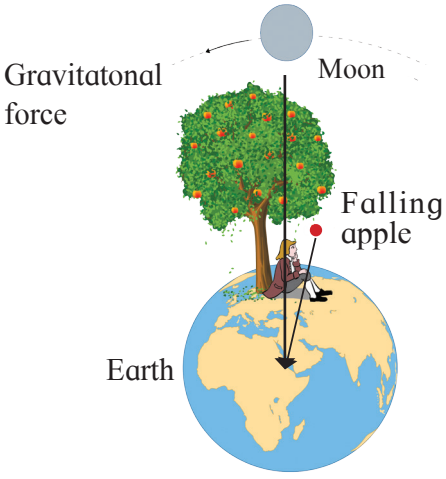
1. What are the effects of a force acting on an object?
2. What types of forces are you familiar with?
3. What do you know about the gravitational force?

We have seen in the previous standard that the gravitational force is a universal force and it acts not only between two objects on the earth but also between any two objects in the universe. Let us now learn how this force was discovered.

Gravitation

As we have learnt, the phenomenon of gravitation was discovered by Sir Isaac Newton. As the story goes, he discovered the force by seeing an apple fall from a tree on the ground. He wondered why all apples fall vertically downward and not at an angle to the vertical. Why do they not fly off in a horizontal direction?

After much thought, he came to the conclusion that the earth must be attracting the apple towards itself and this attractive force must be directed towards the center of the earth. The direction from the apple on the tree to the center of the earth is the vertical direction at the position of the apple and thus, the apple falls vertically downwards.



1.1 Concept of the gravitational force and the gravitational force between the earth and the moon.

Figure 1.1 on the left shows an apple tree on the earth. The force on an apple on the tree is towards the center of the earth i.e. along the perpendicular from the position of the apple to the surface of the earth. The Figure also shows the gravitational force between the earth and the moon. The distances in the figure are not according to scale.

Newton thought that if the force of gravitation acts on apples on the tree at different heights from the surface of the earth, can it also act on objects at even greater heights, much farther away from the earth, like for example, the moon? Can it act on even farther objects like the other planets and the Sun?

Use of ICT : Collect videos and ppts about the gravitational force of different planets.

Force and Motion

We have seen that a force is necessary to change the speed as well as the direction of motion of an object.

Can you recall? What are Newton's laws of motion?

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Introduction to scientist

Great Scientists: Sir Issac Newton (1642-1727) was one of the greatest scientists of recent times. He was born in England. He gave his laws of motion, equations of motion and theory of gravity in his book Principia. Before this book was written, Kepler had given three laws describing planetary motions. However, the reason why planets move in the way described by Kepler's laws was not known. Newton, with his theory of gravity, mathematically derived Kepler's laws.

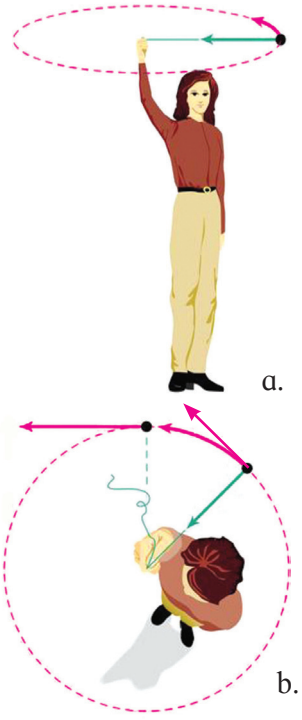
In addition to this, Newton did ground breaking work in several areas including light, heat, sound and mathematics. He invented a new branch of mathematics. This is called calculus and has wide ranging applications in physics and mathematics. He was the first scientist to construct a reflecting telescope.

Circular motion and Centripetal force

Try this

Tie a stone to one end of a string. Take the other end in your hand and rotate the string so that the stone moves along a circle as shown in figure 1.2 a. Are you applying any force on the stone? In which direction is this force acting? How will you stop this force from acting? What will be the effect on the stone?

As long as we are holding the string, we are pulling the stone towards us i.e. towards the centre of the circle and are applying a force towards it. The force stops acting if we release the string. In this case, the stone will fly off along a straight line which is the tangent to the circle at the position of the stone when the string is released, because that is the direction of its velocity at that instant of time (Figure 1.2 b). You may recall that we have performed a similar activity previously in which a 5 rupee coin kept on a rotating circular disk flies off the disk along the tangent to the disk.Thus, a force acts on any object moving along a circle and it is directed towards the centre of the circle. This is called the **Centripetal force.** `Centripetal' means centre seeking, i.e. the object tries to go towards the centre of the circle because of this force.



1.2 A stone tied to a string, moving along a circular path and its velocity in tangential direction

You know that the moon, which is the natural satellite of the earth, goes round it in a definite orbit. The direction of motion of the moon as well as its speed constantly changes during this motion. Do you think some force is constantly acting on the moon? What must be the direction of this force? How would its motion have been if no such force acted on it? Do the other planets in the solar system revolve around the Sun in a similar fashion? Is similar force acting on them? What must be its direction?

From the above activity, example and questions it is clear that for the moon to go around the earth, there must be a force which is exerted on the moon and this force must be exerted by the earth which attracts the moon towards itself. Similarly, the Sun must be attracting the planets, including the earth, towards itself.

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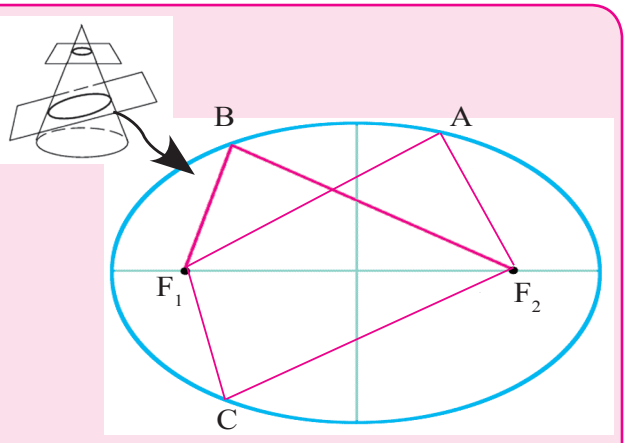
Kepler's Laws

Planetary motion had been observed by astronomers since ancient times. Before Galileo, all observations of the planet's positions were made with naked eyes. By the 16th century a lot of data were available about planetary positions and motion. Johannes Kepler, studied these data. He noticed that the motion of planets follows certain laws. He stated three laws describing planetary motion. These are known as Kepler's laws which are given below.

Do you know ?

An ellipse is the curve obtained when a cone is cut by an inclined plane. It has two focal points. The sum of the distances to the two focal points from every point on the curve is constant. F_1 and F_2 are two focal points of the ellipse shown in figure 1.3. If A, B and C are three points on the ellipse then,

$$AF_1 + AF_2 = BF_1 + BF_2 = CF_1 + CF_2$$



1.3 An ellipse

Kepler's first law :

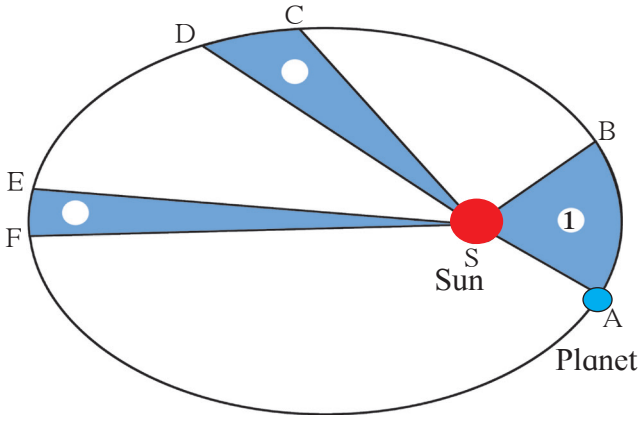
The orbit of a planet is an ellipse with the Sun at one of the foci.

Figure 1.4 shows the elliptical orbit of a planet revolving around the sun. The position of the Sun is indicated by S.

Kepler's second law :

The line joining the planet and the Sun sweeps equal areas in equal intervals of time.

AB and CD are distances covered by the planet in equal time i.e. after equal intervals of time, the positions of the planet starting from A and C are shown by B and D respectively.



1.4 The orbit of a planet moving around the Sun.

The straight lines AS and CS sweep equal area in equal interval of time i.e. area ASB and CSD are equal.

Kepler's third law :

The square of its period of revolution around the Sun is directly proportional to the cube of the mean distance of a planet from the Sun.

Thus, if r is the average distance of the planet from the Sun and T is its period of revolution then,

$T^2 \propto r^3$ i.e. $\frac{T^2}{r^3} = \text{constant} = K$ ..... (1)

Kepler obtained these laws simply from the study of the positions of planets obtained by regular observations. He had no explanation as to why planets obey these laws. We will see below how these laws helped Newton in the formulation of his theory of gravitation.

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Use your brain power

If the area ESF in figure 1.4 is equal to area ASB, what will you infer about EF?

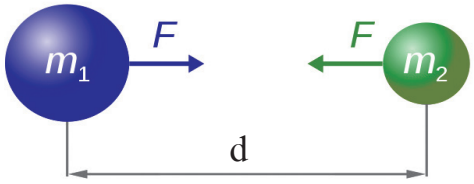
Newton's universal law of gravitation

All the above considerations including Kepler's laws led Newton to formulate his theory of Universal gravity. According to this theory, every object in the Universe attracts every other object with a definite force. This force is directly proportional to the product of the masses of the two objects and is inversely proportional to the square of the distance between them.

An introduction to scientists

Johannes Kepler (1571-1630) was a German astronomer and mathematician. He started working as a helper to the famous astronomer Tycho Brahe in Prague in 1600. After the sudden death of Brahe in 1601, Kepler was appointed as the Royal mathematician in his place. Kepler used the observations of planetary positions made by Brahe to discover the laws of planetary motion. He wrote several books. His work was later used by Newton in postulating his law of gravitation.

Figure 1.5 shows two objects with masses m_1 and m_2 kept at a distance d from each other. Mathematically, the gravitational force of attraction between these two bodies can be written as



1.5 Gravitational force between two objects

$$F \propto \frac{m_1 m_2}{d^2} \quad \text{or} \quad F = G\frac{m_1 m_2}{d^2} \quad \ldots\ldots (2)$$

Here, G is the constant of proportionality and is called the Universal gravitational constant.

The above law means that if the mass of one object is doubled, the force between the two objects also doubles. Also, if the distance is doubled, the force decreases by a factor of 4. If the two bodies are spherical, the direction of the force is always along the line joining the centres of the two bodies and the distance between the centres is taken to be d. In case when the bodies are not spherical or have irregular shape, then the direction of force is along the line joining their centres of mass and d is taken to be the distance between the two centres of mass.

From equation (2), it can be seen that the value of G is the gravitational force acting between two unit masses kept at a unit distance away from each other. Thus, in SI units, the value of G is equal to the gravitational force between two masses of 1 kg kept 1 m apart.

Use your brain power

Show that in SI units, the unit of G is Newton m^2 kg^{-2}. The value of G was first experimentally measured by Henry Cavendish. In SI units its value is 6.673×10^{-11} N m^2 kg^{-2}.

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The centre of mass of an object is the point inside or outside the object at which the total mass of the object can be assumed to be concentrated. The centre of mass of a spherical object having uniform density is at its geometrical centre. The centre of mass of any object having uniform density is at its centroid.

Why did Newton assume inverse square dependence on distance in his law of gravitation? He was helped by Kepler's third law in this as shown below.

Uniform circular motion / Magnitude of centripetal force

Consider an object moving in a circle with constant speed. We have seen earlier that such a motion is possible only when the object is constantly acted upon by a force directed towards the centre of the circle. This force is called the centripetal force. If m is the mass of the object, v is its speed and r is the radius of the circle, then it can be shown that this force is equal to $F = m v^2/r$.

If a planet is revolving around the Sun in a circular orbit in uniform circular motion, then the centripetal force acting on the planet towards the Sun must be $F = mv^2/r$, where, m is the mass of the planet, v is its speed and r is its distance from the Sun.

$$\text{Speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

The speed of the planet can be expressed in terms of the period of revolution T as follows.

The distance travelled by the planet in one revolution =perimeter of the orbit $2\pi r$; r = distance of the planet from the Sun, Time taken = Period of revolution = T

$$v = \frac{\text{distance travelled}}{\text{time taken}} = \frac{2\pi r}{T}$$

$$F = \frac{mv^2}{r} = \frac{m\left(\frac{2\pi r}{T}\right)^2}{r} = \frac{4m\pi^2 r}{T^2}$$, multiplying and dividing by r^2 we get,

$$F = \frac{4m\pi^2}{r^2} = \left(\frac{r^3}{T^2}\right)$$. According to Kepler's third law, $\frac{T^2}{r^3} = K$

$$F = \frac{4m\pi^2}{r^2 K}$$, But $\frac{4m\pi^2}{K}$ = Constant

Thus, Newton concluded that the centripetal force which is the force acting on the planet and is responsible for its circular motion, must be inversely proportional to the square of the distance between the planet and the Sun. Newton identified this force with the force of gravity and hence postulated the inverse square law of gravitation. The gravitational force is much weaker than other forces in nature but it controls the Universe and decides its future. This is possible because of the huge masses of planets, stars and other constituents of the Universe.

Use your brain power

Is there a gravitational force between two objects kept on a table or between you and your friend sitting next to you? If yes, why don't the two move towards each other?

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Solved examples

Example 1 : Mahendra and Virat are sitting at a distance of 1 metre from each other. Their masses are 75 kg and 80 kg respectively. What is the gravitational force between them?

Given : r = 1 m, m_1 = 75 kg, m_2 = 80 kg and G = 6.67 x 10^{-11} Nm^2/kg^2

According to Newton's law

$$F = \frac{G m_1 m_2}{r^2}$$

$$F = \frac{6.67 \times 10^{-11} \times 75 \times 80}{1^2} N$$

= 4.002 x 10^{-7} N

The gravitational force between Mahendra and Virat is 4.002 x 10^{-7} N

This is a very small force. If the force of friction between Mahendra and the bench on which he is sitting is zero, then he will start moving towards Virat under the action of this force. We can calculate his acceleration and velocity by using Newton's laws of motion.

Example 2 : In the above example, assuming that the bench on which Mahendra is sitting is frictionless, starting with zero velocity, what will be Mahendra's velocity of motion towards Virat after 1 s ? Will this velocity change with time and how?

Given: Force on Mahendra = F = 4.002 x 10^{-7} N, Mahendra's mass = m = 75 kg

According to Newton's second law, the acceleration produced by the force on Mahendra = m = 75 kg.

$$a = \frac{F}{m} = \frac{4.002 \times 10^{-7}}{75} = 5.34 \times 10^{-9} \ m/s^2$$

Using Newton's first equation, we can calculate Mahendra's velocity after 1s, Newton's first equation of motion is

v = u + a t;

As Mahendra is sitting on the bench, his initial velocity is zero (u=0)

Assuming the bench to be frictionless,

v = 0 + 5.34 x 10^{-9} x 1 m/s

= 5.34 x 10^{-9} m/s

Mahendra's velocity after 1 s will be 5.34 x 10^{-9} m/s .

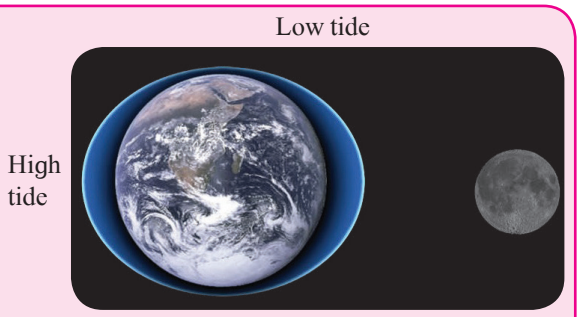
This is an extremely small velocity. The velocity will increase with time because of the acceleration. The acceleration will also not remain constant because as Mahendra moves towards Virat, the distance between them will decrease, causing an increase in the gravitational force, thereby increasing the acceleration as per Newton's second law of motion.

Use your brain power !

Assuming the acceleration in Example 2 above remains constant, how long will Mahendra take to move 1 cm towards Virat?

Do you know ?

You must be knowing about the high and low tides that occur regularly in the sea. The level of sea water at any given location along sea shore increases and decreases twice a day at regular intervals. High and low tides occur at different times at different places. The level of water in the sea changes because of the gravitational force exerted by the moon. Water directly under the moon gets pulled towards the moon and the level of water there goes up causing high tide at that place. At two places on the earth at 90° from the place of high tide, the level of water is minimum and low tides occur there as shown in figure 1.6



1.6 Low and high tides

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Collect information about high and low tides from geography books. Observe the timing of high and low tides at one place when you go for a picnic to be a beach. Take pictures and hold an exhibition.

Earth' gravitational force

Will the velocity of a stone thrown vertically upwards remain constant or will it change with time? How will it change? Why doesn't the stone move up all the time? Why does it fall down after reaching a certain height? What does its maximum height depend on ?

The earth attracts every object near it towards itself because of the gravitational force. The centre of mass of the earth is situated at its centre, so the gravitational force on any object due to the earth is always directed towards the centre of the earth. Because of this force, an object falls vertically downwards on the earth.

Similarly, when we throw a stone vertically upwards, this force tries to pull it down and reduces its velocity. Due to this constant downward pull, the velocity becomes zero after a while. The pull continues to be exerted and the stone starts moving vertically downward towards the centre of the earth under its influence.

Solved Examples

Example 1: Calculate the gravitational force due to the earth on Mahendra in the earlier example.

Given: Mass of the earth = $m_1 = 6 \times 10^{24}$ kg
Radius of the earth = $R = 6.4 \times 10^6$ m
Mahendra's mass = $m_2 = 75$ kg
$G = 6.67 \times 10^{-11}$ Nm^2/kg^2

Using the force law, the gravitational force on Mahendra due to earth is given by

This force is 1.83×10^9 times larger than the gravitational force between Mahendra and Virat.

$$F = \frac{G m_1 m_2}{R^2}$$

$$F = \frac{6.67 \times 10^{-11} \times 75 \times 6 \times 10^{24}}{(6.4 \times 10^6)^2} \text{ N} = 733 \text{ N}$$

Example 2: Starting from rest, what will be Mahendra's velocity after one second if he is falling down due to the gravitational force of the earth?

Given: $u = 0$, $F = 733$ N,
Mahendra's mass = $m = 75$ kg
time $t = 1$ s
Mahendra's acceleration

$$a = \frac{F}{m} = \frac{733}{75} \text{ m/s}^2$$

According to Newton's first equation of motion,
$v = u + a t$
Mahendra's velocity after 1 second
$v = 0 + 9.77 \times 1$ m/s
$v = 9.77$ m/s
This is 1.83×10^9 times Mahendra's velocity in example 2, on page 6.

Use your brain power !

According to Newton's law of gravitation, every object attracts every other object.

Thus, if the earth attracts an apple towards itself, the apple also attracts the earth towards itself with the same force. Why then does the apple fall towards the earth, but the earth does not move towards the apple?

The gravitational force due to the earth also acts on the moon beacause of which it revolves around the earth. Similar situation exists for the artificial satellites orbiting the earth. The moon and the artificial satellites orbit the earth. The earth attracts them towards itself but unlike the falling apple, they do not fall on the earth, why? This is beacause of the velocity of the moon and the satellites along their orbits. If this velocity was not there, they would have fallen on the earth.

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Earth's gravitational acceleration

The earth exerts gravitational force on objects near it. According to Newton's second law of motion, a force acting on a body results in its acceleration. Thus, the gravitational force due to the earth on a body results in its acceleration. This is called acceleration due to gravity and is denoted by 'g'. Acceleration is a vector. As the gravitational force on any object due to the earth is directed towards the centre of the earth, the direction of the acceleration due to gravity is also directed towards the centre of the earth i.e. vertically downwards.

Think about it

1. What would happen if there were no gravity?
2. What would happen if the value of G was twice as large?

Value of g on the surface of the earth

We can calculate the value of g by using Newton's universal law of gravitation for an object of mass m situated at a distance r from the centre of the earth. The law of gravitation gives

$F = \frac{G M m}{r^2}$ ..... (3) M is the mass of the earth.

$F = m g$ ..... (4) From (3) and (4), $mg = \frac{G M m}{r^2}$

$g = \frac{G M}{r^2}$ ..... (5) If the object is situated on the surface of the earth, r = R = Radius of the earth. Thus, the value of g on the surface of the earth is.

$g = \frac{G M}{R^2}$ ..... (6) The unit of g in SI units is m/s^2. The mass and radius of the earth are 6×10^{24} kg and 6.4×10^6 m, respectively. Using these in (6)

$$g = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{(6.4 \times 10^6)^2} = 9.77 \text{ m/s}^2 \quad \ldots\ldots\ldots\ldots (7)$$

This acceleration depends only on the mass M and radius R of the earth and so the acceleration due to gravity at a given point on the earth is the same for all objects. It does not depend on the properties of the object.

Can you tell? What would be the value of g on the surface of the earth if its mass was twice as large and its radius half of what it is now?

Variation in value of g

A. Change along the surface of the earth : Will the value of g be the same everywhere on the surface of the earth? The answer is no. The reason is that the shape of the earth is not exactly spherical and so the distance of a point on the surface of the earth from its centre differs somewhat from place to place. Due to its rotation, the earth bulges at the equator and is flatter at the poles. Its radius is largest at the equator and smallest at the poles. The value of g is thus highest (9.832 m/s^2) at the poles and decreases slowly with decreasing latitude. It is lowest (9.78 m/s^2) at the equator.

B. Change with height : As we go above the earth's surface, the value of r in equation (5) increases and the value of g decreases. However, the decrease is rather small for heights which are small in comparison to the earth's radius. For example, remember that the radius of the earth is 6400 km. If an aeroplane is flying at a height 10 km above the surface of the earth, its distance from the earth's surface changes from 6400 km to 6410 km and the change in the value of g due to it is negligible. On the other hand, when we consider an artificial satellite orbiting the earth, we have to take into account the change in the value of g due to the large change in the distance of the satellite from the centre of the earth. Some typical heights and the values of g at these heights are given in the following table.

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Place	Height (km)	g (m/s^2)
Surface of the earth (average)	0	9.8
Mount Everest	8.8	9.8
Maximum height reached by man-made balloon	36.6	9.77
Height of a typical weather satellite	400	8.7
Height of communication satellite	35700	0.225

1.7 Table showing change of g with height above the earth's surface

C. Change with depth : The value of g also changes if we go inside the earth. The value of r in equation (5) decreases and one would think that the value of g should increase as per the formula. However, the part of the earth which contributes towards the gravitational force felt by the object also decreases. Which means that the value of M to be used in equation (5) also decreases. As a combined result of change in r and M, the value of g decreases as we go deep inside the earth.

Think about it

1. Will the direction of the gravitational force change as we go inside the earth?
2. What will be the value of g at the centre of the earth?

Every planet and satellite has different mass and radius. Hence, according to equation (6), the values of g on their surfaces are different. On the moon it is about 1/6th of the value on the earth. As a result, using the same amount of force, we can jump 6 times higher on the moon as compared to that on the earth.

Mass and Weight

Mass : Mass is the amount of matter present in the object. The SI unit of mass is kg. Mass is a scalar quantity. Its value is same everywhere. Its value does not change even when we go to another planet. According to Newton's first law, it is the measure of the inertia of an object. Higher the mass, higher is the inertia.

Weight : The weight of an object is defined as the force with which the earth attracts the object. The force (F) on an object of mass m on the surface of the earth can be written using equation (4)

$$\therefore \text{Weight, } W = F = m\,g \quad .... \quad \left(g = \frac{G\,M}{R^2} \right)$$

Weight being a force, its SI unit is Newton. Also, the weight, being a force, is a vector quantity and its direction is towards the centre of the earth. As the value of g is not same everywhere, the weight of an object changes from place to place, though its mass is constant everywhere.

Colloquially we use weight for both mass and weight and measure the weight in kilograms which is the unit of mass. But in scientific language when we say that Rajeev's weight is 75 kg, we are talking about Rajeev's mass. What we mean is that Rajeev's weight is equal to the gravitational force on 75 kg mass. As Rajeev's mass is 75 kg, his weight on earth is F = mg = 75 x 9.8 = 735 N. The weight of 1 kg mass is 1 x 9.8 = 9.8 N. Our weighing machines tell us the mass. The two scale balances in shops compare two weights i.e. two masses.

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Use your brain power !

1. Will your weight remain constant as you go above the surface of the earth?
2. Suppose you are standing on a tall ladder. If your distance from the centre of the earth is 2R, what will be your weight?

Solved Examples

Example 1: If a person weighs 750 N on earth, how much would be his weight on the Moon given that moon's mass is $\frac{1}{81}$ of that of the earth and its radius is $\frac{1}{3.7}$ of that of the earth ?

Given: Weight on earth = 750 N,

Ratio of mass of the earth (M_E) to mass of the moon (M_M) = $\frac{M_E}{M_M} = 81$

Ratio of radius of earth (R_E) to radius of moon (R_M) = $\frac{R_E}{R_M} = 3.7$

Let the mass of the person be m kg

Weight on the earth = m g = 750 = $\frac{m\,G\,M_E}{R_E^2}$ $\quad \therefore\ m = \frac{750\,R_E^2}{(G\,M_E)}$ ..... (i)

Weight on Moon $= \frac{m\,G\,M_M}{R_M^2}$ using (i)

$$= \frac{750\,R_E^2}{(G\,M_E)} \times \frac{G\,M_M}{R_M^2} = 750\,\frac{R_E^2}{R_M^2} \times \frac{M_M}{M_E} = 750 \times (3.7)^2 \times \frac{1}{81} = 126.8\ \text{N}$$

The weight on the moon is nearly $1/6^{th}$ of the weight on the earth. We can write the weight on moon as mg_m (g_m is the accelaration due to gravity on the moon). Thus g_m is $1/6^{th}$ of the g on the earth.

Do you know ?

Gravitational waves

Waves are created on the surface of water when we drop a stone into it. Similarly you must have seen the waves generated on a string when both its ends are held in hand and it is shaken. Light is also a type of wave called the electromagnetic wave. Gamma rays, X-rays, ultraviolet rays, infrared rays, microwave and radio waves are all different types of electromagnetic waves. Astronomical objects emit these waves and we receive them using our instruments. All our knowledge about the universe has been obtained through these waves.

Gravitational waves are a very different type of waves. They have been called the waves on the fabric of space-time. Einsteine predicted their existence in 1916. These waves are very weak and it is very difficult to detect them. Scientists have constructed extremely sensitive instruments to detect the gravitational waves emitted by astronomical sources. Among these, LIGO (Laser Interferometric Gravitational Wave Observatory) is the prominent one. Exactly after hundred years of their prediction, scientists detected these waves coming from an astronomical source. Indian scientists have contributed significantly in this discovery. This discovery has opened a new path to obtain information about the Universe.

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Free fall

Try this

Take a small stone. Hold it in your hand. Which forces are acting on the stone? Now release the stone. What do you observe? What are the forces acting on the stone after you release it?

We know that the force of gravity due to the earth acts on each and every object. When we were holding the stone in our hand, the stone was experiencing this force, but it was balanced by a force that we were applying on it in the opposite direction. As a result, the stone remained at rest. Once we release the stone from our hands, the only force that acts on it is the gravitational force of the earth and the stone falls down under its influence. Whenever an object moves under the influence of the force of gravity alone, it is said to be falling freely. Thus the released stone is in a free fall. In free fall, the initial velocity of the object is zero and goes on increasing due to the acceleration due to gravity of the earth. During free fall, the frictional force due to air opposes the motion of the object and a buoyant force also acts on the object. Thus, true free fall is possible only in vacuum.

For a freely falling object, the velocity on reaching the earth and the time taken for it can be calculated by using Newton's equations of motion. For free fall, the initial velocity $u = 0$ and the acceleration $a = g$. Thus we can write the equations as

$$v = g\,t$$

$$s = \frac{1}{2} g\,t^2$$

$$v^2 = 2\,g\,s$$

For calculating the motion of an object thrown upwards, acceleration is negative, i.e. in a direction opposite to the velocity and is taken to be $-g$. The magnitude of g is the same but the velocity of the object decreases because of this -ve acceleration.

The moon and the artificial satellites are moving only under the influence of the gravitational field of the earth. Thus they are in free fall.

Do you know ?

The value of g is the same for all objects at a given place on the earth. Thus, any two objects, irrespective of their masses or any other properties, when dropped from the same height and falling freely will reach the earth at the same time. Galileo is said to have performed an experiment around 1590 in the Italian city of Pisa. He dropped two spheres of different masses from the leaning tower of Pisa to demonstrate that both spheres reached the ground at the same time.

When we drop a feather and a heavy stone at the same time from a height, they do not reach the earth at the same time. The feather experiences a buoyant force and a frictional force due tov air and therefore floats and reaches the ground slowly, later than the heavy stone. The buoyant and frictional forces on the stone are much less than the weight of the stone and does not affect the speed of the stone much. Recently, scientists performed this experiment in vacuum and showed that the feather and stone indeed reach the earth at the same time.

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Solved Examples

Example 1. An iron ball of mass 3 kg is released from a height of 125 m and falls freely to the ground. Assuming that the value of g is 10 m/s^2, calculate

(i) time taken by the ball to reach the ground

(ii) velocity of the ball on reaching the ground

(iii) the height of the ball at half the time it takes to reach the ground.

Given: m = 3 kg, distance travelled by the ball s = 125 m, initial velocity of the ball = u = o and acceleration a = g = 10 m/s^2.

(i) Newton's second equation of motion gives

$$s = u\,t + \frac{1}{2} a\,t^2$$

$$\therefore\ 125 = 0\,t + \frac{1}{2} \times 10 \times t^2 = 5\,t^2$$

$$t^2 = \frac{125}{5} = 25 \qquad , t = 5 \text{ s}$$

The ball takes 5 seconds to reach the ground.

(ii) According to Newton's first equation of motion final velocity = v = u + a t

$= 0 + 10 \times 5$

$= 50$ m/s

The velocity of the ball on reaching the ground is 50 m/s

(iii) Half time $= t = \frac{5}{2} = 2.5$ s

Ball's height at this time = s

According to Newton's second equation

$$s = u\,t + \frac{1}{2} a\,t^2$$

$$s = 0 + \frac{1}{2} 10 \times (2.5)^2 = 31.25 \text{ m.}$$

Thus the height of the ball at half time

$= 125\text{-}31.25 = 93.75$ m

Example 2. A tennis ball is thrown up and reaches a height of 4.05 m before coming down. What was its initial velocity? How much total time will it take to come down? Assume g = 10 m/s^2

Given: For the upward motion of the ball, the final velocity of the ball = v = 0

Distance travelled by the ball = 4.05 m

acceleration a= - g = -10 m/s^2

Using Newton's third equation of motion

$v^2 = u^2 + 2\,a\,s$

$0 = u^2 + 2\,(-10) \times 4.05$

$\therefore\ u^2 = 81$

u = 9 m/s The initial velocity of the ball is 9 m/s

Now let us consider the downward motion of the ball. Suppose the ball takes t seconds to come down. Now the initial velocity of the ball is zero, u = 0. Distance travelled by the ball on reaching the ground = 4.05 m. As the velocity and acceleration are in the same direction,

a = g=10 m/s

According to Newton's second equation of motion

$$s = u\,t + \frac{1}{2} a\,t^2$$

$$4.05 = 0 + \frac{1}{2} 10\,t^2$$

$$t^2 = \frac{4.05}{5} = 0.81\ , \qquad t = 0.9 \text{ s}$$

The ball will take 0.9 s to reach the ground. It will take the same time to go up. Thus, the total time taken = 2 x 0.9 = 1.8 s

Use your brain power !

According to Newton's law of gravitation, earth's gravitational force is higher on an object of larger mass. Why doesn't that object fall down with higher velocity as compared to an object with lower mass?

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Gravitational potential energy

We have studied potential energy in last standard. The energy stored in an object because of its position or state is called potential energy. This energy is relative and increases as we go to greater heights from the surface of the earth. We had assumed that the potential energy of an object of mass m, at a height h from the ground is mgh and on the ground it is zero. When h is small compared to the radius R of the earth, we can assume g to be constant and can use the above formula (mgh). But for large values of h, the value of g decreases with increase in h. For an object at infinite distance from the earth, the value of g is zero and earth's gravitational force does not act on the object. So it is more appropriate to assume the value of potential energy to be zero there. Thus, for smaller distances, i.e. heights, the potential energy is less than zero, i.e. it is negative.

When an object is at a height h from the surface of the earth, its potential energy is $-\frac{GMm}{R+h}$

here, M and R are earth's mass and radius respectively.

Escape velocity

We have seen than when a ball is thrown upwards, its velocity decreases because of the gravitation of the earth. The velocity becomes zero after reaching a certain height and after that the stone starts falling down. Its maximum height depends on its initial velocity. According to Newton's third equation of motion is

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

v = the final velocity of the ball $= 0$ and $a = -g$

$\therefore\ 0 = u^2 + 2(-g)s$ and maximum height of the ball $= s = -\frac{u^2}{2g}$

Thus, higher the initial velocity u, the larger is the height reached by the ball.

The reason for this is that the higher the initial velocity, the ball will oppose the gravity of the earth more and larger will be the height to which it can reach.

We have seen above that the value of g keeps decreasing as we go higher above the surface of the earth. Thus, the force pulling the ball downward, decreases as the ball goes up. If we keep increasing the initial velocity of the ball, it will reach larger and larger heights and above a particular value of initial velocity of the ball, the ball is able to overcome the downward pull by the earth and can escape the earth forever and will not fall back on the earth. This velocity is called escape velocity. We can determine its value by using the law of conservation of energy as follows.

An object going vertically upwards from the surface of the earth, having an initial velocity equal to the escape velocity, escapes the gravitational force of the earth. The force of gravity, being inversely proportional to the square of the distance, becomes zero only at infinite distance from the earth. This means that for the object to be free from the gravity of the earth, it has to reach infinite distance from the earth. i.e. the object will come to rest at infinite distance and will stay there.

For an object of mass m

on the surface of earth	at infinite distance from the earth
A. Kinetic energy $= \frac{1}{2}\ mv^2_{esc}$	A. Kinetic energy $= 0$
B. Potential energy $= -\frac{GMm}{R}$	B. Potential energy $= -\frac{GMm}{\infty} = 0$
C. Total energy = E_1 = Kinetic energy + Potential energy $= \frac{1}{2}\ mv^2_{esc} - \frac{GMm}{R}$	C. Total energy = E_2 = Kinetic energy + potential energy $= 0$

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From the priciple of conservation of energy

$E_1 = E_2$

$$\frac{1}{2} mv^2_{esc} - \frac{GMm}{R} = 0$$

$$v^2_{esc} = \frac{2\,GM}{R}$$

$$v_{esc} = \sqrt{\frac{2\,GM}{R}}$$

$$= \sqrt{2\,g\,R}$$

$$= \sqrt{(2 \times 9.8 \times 6.4 \times 10^6)} = 11.2 \text{ km/s}$$

The spacecrafts which are sent to the moon or other planets have to have their initial velocity larger than the escape velocity so that they can overcome earth's gravitational attraction and can travel to these objects.

Solved Examples

Example 1. Calculate the escape velocity on the surface of the moon given the mass and radius of the moon to be 7.34×10^{22} kg and 1.74×10^6 m respectively.

Given: $G = 6.67 \times 10^{-11}$ N m^2/kg^2, mass of the moon = $M = 7.34 \times 10^{22}$ kg and radius of the moon = $R = 1.74 \times 10^6$ m.

Escape velocit y = $v_{esc} = \sqrt{\frac{2\,GM}{R}}$

$$\sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 7.34 \times 10^{22}}{1.74 \times 10^6}}$$

$= 2.37$ km/s

Escape velocity on the moon 2.37 km/s.

Do you know ?

Weightlessness in space

Space travellers as well as objects in the spacecraft appear to be floating. Why does this happen? Though the spacecraft is at a height from the surface of the earth, the value of g there is not zero. In the space station the value of g is only 11% less than its value on the surface of the earth. Thus, the height of a spacecraft is not the reason for their weightlessness. Their weightlessness is caused by their being in the state of free fall. Though the spacecraft is not falling on the earth because of its velocity along the orbit, the only force acting on it is the gravitational force of the earth and therefore it is in a free fall. As the velocity of free fall does not depend on the properties of an object, the velocity of free fall is the same for the spacecraft, the travelers and the objects in the craft. Thus, if a traveller releases an object from her hand, it will remain stationary with respect to her and will appear to be weightless.

Exercise

1. Study the entries in the following table and rewrite them putting the connected items in a single row.

I	II	III
Mass	m/s^2	Zero at the centre
Weight	kg	Measure of inertia
Acceleration due to gravity	Nm^2/kg^2	Same in the entire universe
Gravitational constant	N	Depends on height

2. Answer the following questions.

a. What is the difference between mass and weight of an object. Will the mass and weight of an object on the earth be same as their values on Mars? Why?

b What are (i) free fall, (ii) acceleration due to gravity (iii) escape velocity (iv) centripetal force ?

c. Write the three laws given by Kepler. How did they help Newton to arrive at the inverse square law of gravity?

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d. A stone thrown vertically upwards with initial velocity u reaches a height 'h' before coming down. Show that the time taken to go up is same as the time taken to come down.

e. If the value of g suddenly becomes twice its value, it will become two times more difficult to pull a heavy object along the floor. Why?

3. Explain why the value of g is zero at the centre of the earth.

4. Let the period of revolution of a planet at a distance R from a star be T. Prove that if it was at a distance of 2R from the star, its period of revolution will be $\sqrt{8}$ T.

5. Solve the following examples.

a. An object takes 5 s to reach the grond from a height of 5 m on a planet. What is the value of g on the planet?

Ans: 0.4 m/s^2

b. The radius of planet A is half the radius of planet B. If the mass of A is M_A, what must be the mass of B so that the value of g on B is half that of its value on A?

Ans: 2 M_A

c. The mass and weight of an object on earth are 5 kg and 49 N respectively. What will be their values on the moon? Assume that the acceleration due to gravity on the moon is 1/6th of that on the earth.

Ans: 5 kg and 8.17 N

d. An object thrown vertically upwards reaches a height of 500 m. What was its initial velocity? How long will the object take to come back to the earth? Assume g = 10 m/s^2

Ans: 100 m/s and 20 s

e. A ball falls off a table and reaches the ground in 1 s. Assuming g = 10 m/s^2, calculate its speed on reaching the ground and the height of the table.

Ans. 10 m/s and 5 m

f. The masses of the earth and moon are 6 x 10^{24} kg and 7.4x10^{22} kg, respectively. The distance between them is 3.84 x 10^5 km. Calculate the gravitational force of attraction between the two?

Use G = 6.7 x 10^{-11} N m^2 kg^{-2}

Ans: 2 x 10^{20} N

g. The mass of the earth is 6 x 10^{24} kg. The distance between the earth and the Sun is 1.5x 10^{11} m. If the gravitational force between the two is 3.5 x 10^{22} N, what is the mass of the Sun?

Use G = 6.7 x 10^{-11} N m^2 kg^{-2}

Ans: 1.96 x 10^{30} kg

Project:

Take weights of five of your friends. Find out what their weights will be on the moon and the Mars.

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2.Periodic Classification of Elements

- Elements and their classification
- Newlands Law of Octaves
- Modern Periodic Table
- Dobereiner's Triads
- Mendeleev's Periodic Table

Can you recall?

1. What are the types of matter?
2. What are the types of elements?
3. What are the smallest particles of matter called?
4. What is the difference between the molecules of elements and compounds?

Classification of elements

We have learnt in the previous standards that all the atoms of an element are of only one type. Today 118 elements are known to the scientific world. However, around year 1800 only about 30 elements were known. More number of elements were discovered in the course of time. More and more information about the properties of these elements was gathered. To ease the study of such a large number of elements, scientists started studying the pattern if any, in the vast information about them. You know that in the initial classification elements were classified into the groups of metals and nonmetals. Later on another class of elements called metalloids was noticed. As the knowledge about elements and their properties went on increasing different scientists started trying out different methods of classification.

Dobereiner's Triads

In the year 1817 a German scientist Dobereiner suggested that properties of elements are related to their atomic masses. He made groups of three elements each, having similar chemical properties and called them triads. He arranged the three elements in a triad in an increasing order of atomic mass and showed that the atomic mass of the middle element was approximately equal to the mean of the atomic masses of the other two elements. However, all the known elements could not be classified into the Dobereiner's triads.

Sr. No.	Triad	Element -1 Actual atomic mass(a)	Element - 2		Element - 3 Actual atomic mass (c)
			Mean = $\frac{a+c}{2}$	Actual atomic mass	
1	Li, Na, K	Lithium (Li) 6.9	Sodium $\frac{6.9 + 39.1}{2} = 23.0$	(Na) 23.0	Potassium (K) 39.1
2	Ca, Sr, Ba	Calcium (Ca) 40.1	Strontium $\frac{40.1+ 137.3}{2} = 88.7$	(Sr) 87.6	Barium (Ba) 137.3
3	Cl, Br, I	Chlorine (Cl) 35.5	Bromine $\frac{35.5 + 126.9}{2} = 81.2$	(Br) 79.9	Iodine (I) 126.9

2.1 Dobereiner's Triads

Can you tell?

Identify Dobereiner's triads from the following groups of elements having similar chemical properties.

1. Mg (24.3), Ca (40.1), Sr (87.6)
2. S (32.1), Se (79.0), Te (127.6)
3. Be (9.0), Mg (24.3), Ca (40.1)

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Newlands' Law of Octaves

The English scientist John Newlands correlated the atomic masses of elements to their properties in a diffrent way. In the year 1866 Newlands arranged the elements known at that time in an increasing order of their atomic masses. It started with the lightest element hydrogen and ended up with thorium. He found that every eighth element had properties similar to those of the first. For example, sodium is the eighth element from lithium and both have similar properties. Also, magnesium shows similarity to beryllium and chlorine shows similarity with fluorine. Newlands compared this similarity with the octaves in music. He called the similarity observed in the eighth and the first element as the **Law of octaves.**

Do you know ?

In the Indian music system there are seven main notes, namely, Sa, Re, Ga, Ma, Pa, Dha, Ni, and their collection is called 'Saptak'. The frequency of the notes goes on increasing from 'Sa' to 'Ni'. Then comes, the 'Sa' of the upper 'Saptak' at the double the frequency of the original 'Sa'. It means that notes repeat after completion of one 'Saptak'. The seven notes in the western music are Do, Re, Mi, Fa, So, La, Ti.

The note 'Do' having double the original frequency comes again at the eighth place. This is the octave of western notes. Music is created by the variety in the use of these notes.

Musical Note	Do (Sa)	Re (Re)	Mi (Ga)	Fa (Ma)	Sol (Pa)	La (Dha)	Ti (Ni)
Elements	H	Li	Be	B	C	N	O
	F	Na	Mg	Al	Si	P	S
	Cl	K	Ca	Cr	Ti	Mn	Fe
	Co &Ni	Cu	Zn	Y	In	As	Se
	Br	Rb	Sr	Ce & La	Zr		

2.2 Newlands' Octaves

Many limitation were found in Newlands' octaves. This law was found to be applicable only upto calcium. Newlands fitted all the known elements in a table of 7 X 8 that is 56 boxes. Newlands placed two elements each in some boxes to accommodate all the known elements in the table. For example, Co and Ni, Ce and La. Moreover, he placed some elements with different properties under the same note in the octave. For example, Newlands placed the metals Co and Ni under the note 'Do' along with halogens, while Fe, having similarity with Co and Ni, away from them along with the nonmetals O and S under the note 'Ti'. Also, Newlands' octaves did not have provision to accommodate the newly discovered elements. The properties of the new elements discovered later on did not fit in the Newlands' law of octaves.

Mendeleev's Periodic table

The Russian scientist Dmitri Mendeleev developed the periodic table of elements during the period 1869 to 1872 A.D. Mendeleev's periodic table is the most important step in the classification of elements. Mendeleev considered the fundamental property of elements, namely, the atomic mass, as standard and arranged 63 elements known at that time in an increasing order of their atomic masses. Then he transformed this into the periodic table of elements in accordance with the physical and chemical properties of these elements.

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Mendeleev organized the periodic table on the basis of the chemical and physical properties of the elements. These were the molecular formulae of hydrides and oxides of the elements, melting points, boiling points and densities of the elements and their hydrides and oxides. Mendeleev found that the elements with similar physical and chemical properties repeat after a definite interval. **On the basis of this finding Mendeleev stated the following periodic law.**

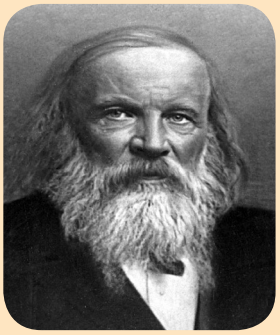
Properties of elements are periodic function of their atomic masses.

The vertical columns in the Mendeleev's periodic table are called groups while the horizontal rows are called periods.

Series ↓	Group I - R^2O	Group II - RO	Group III - R^2O^3	Group IV RH^4 RO^2	Group V RH^3 R^2O^5	Group VI RH^2 RO^3	Group VII RH R^2O^7	Group VIII - RO^4
1	H=1							
2	Li=7	Be=9.4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27.3	Si=28	P=31	S=32	Cl= 35.5	
4	K=39	Ca=40	- = 44	Ti= 48	V=51	Cr= 52	Mn=55	Fe=56, Co=59 Ni=59, Cu=63
5	(Cu=63)	Zn=65	-=68	-=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	-=100	Ru=104,Rh=104 Pd=106,Ag=108
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	-	-	-	----
9	(-)	-	-	-	-	-	-	
10	-	-	?Er=178	?La=180	Ta=182	W=184	-	Os=195, Ir=197 Pt=198, Au=199
11	(Au=199)	Hg=200	Ti=204	Pb=207	Bi= 208	-	-	
12	-	-	-	Th=231	-	U=240	-	---

2.3 Mendeleev's Periodic Table

(The general molecular formulae of compounds shown as R^2O, R^2O^3, etc, in the upper part of Mendeleev's periodic table, are written as R_2O, R_2O_3,etc. in the present system.)



Dmitri Mendeleev

Introduction to scientist

Dmitri Mendeleev (1834-1907) was a professor in the St. Petersburg University. He made separate card for every known element showing its atomic mass. He arranged the cards in accordance with the atomic masses and properties of the elements which resulted in the invention of the periodic table of elements.

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1. There are some vacant places in the Mendeleev's periodic table. In some of these places the atomic masses are seen to be predicted. Enlist three of these predicted atomic masses along with their group and period.
2. Due to uncertainty in the names of some of the elements, a question mark is indicated before the symbol in the Mendeleev's periodic table. What are such symbols?

Merits of Mendeleev's periodic table

Science is progressive. There is a freedom in science to revise the old inference by using more advanced means and methods of doing experiments. These characteristics of science are clearly seen in the Mendeleev's periodic table.

While applying the law that the properties of elements are a periodic function of their atomic masses, to all the known elements, Mendeleev arranged the elements with a thought that the information available till then was not final but it could change. As a result of this, Mendeleev's periodic table demonstrates the following merits.

1. Atomic masses of some elements were revised so as to give them proper place in the periodic table in accordance with their properties. For example, the previously determined atomic mass of beryllium, 14.09, was changed to the correct value 9.4, and beryllium was placed before boron.

2. Mendeleev kept vacant places in the periodic table for elements not discovered till then. Three of these unknown elements were given the names eka-boron, eka-aluminium and eka-silicon from the known neighbours and their atomic masses were indicated as 44, 68 and 72, respectively. Not only this but their properties were also predicted. Later on these elements were discovered and named as scandium (Sc), gallium (Ga) and germanium (Ge) respectively. The properties of these elements matched well with those predicted by Mendeleev. See table 2.4. Due to this success all were convinced about the importance of Mendeleev's periodic table and this method of classification of elements was accepted immediately.

Property	Eka- aluminium(E) (Mendeleev's prediction)	Gallium (Ga)(actual)
1. Atomic mass	68	69.7
2. Density (g/cm^3)	5.9	5.94
3. Melting point(^0C)	Low	30.2
4. Formula of chloride	ECl_3	$GaCl_3$
5. Formula of oxide	E_2O_3	Ga_2O_3
6. Nature of oxide	Amphoteric oxide	Amphoteric oxide

2.4 Actual and predicted properties of gallium.

3. There was no place reserved for noble gases in Mendeleev's original periodic table. However, when noble gases such as helium, neon and argon were discovered towards the end of nineteenth century, Mendeleev created the ' zero' group without disturbing the original periodic table in which the noble gases were fitted very well.

Use your brain power !

Chlorine has two isotopes,viz, C1-35 and C1-37. Their atomic masses are 35 and 37 respectively. Their chemical properties are same. Where should these be placed in Mendeleev's periodic table? In different places or in the same place?

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Demerits of Mendeleev's periodic table

1. The whole number atomic mass of the elements cobalt (Co) and nickel (Ni) is the same. Therefore there was an ambiguity regarding their sequence in Mendeleev's periodic table.
2. Isotopes were discovered long time after Mendeleev put forth the periodic table. As isotopes have the same chemical properties but different atomic masses, a challenge was posed in placing them in Mendeleev's periodic table.
3. When elements are arranged in an increasing order of atomic masses, the rise in atomic mass does not appear to be uniform. It was not possible, therefore, to predict how many elements could be discovered between two heavy elements.
4. Position of hydrogen : Hydrogen shows similarity with halogens (group VII). For example, the molecular formula of hydrogen is H_2 while the molecular formulae of fluorine and chlorine are F_2 and Cl_2, respectively. In the same way, there is a similarity in the chemical properties of hydrogen and alkali metals (groupI). There is a similarity in the molecular formulae of the compounds of hydrogen alkali metals (Na, K, etc) formed with chlorine and oxygen. On considering the above propereties it can not be decided whether the correct position of hydrogen is in the group of alkali metals (group I) or in the group of halogens (group VII).

Compounds of H	Compounds of Na
HCl	NaCl
H_2O	Na_2O
H_2S	Na_2S

2.5 Similarity in hydrogen and alkali metals

Element (Molecular formula)	Compounds with metals	Compounds with nonmetals
H_2	NaH	CH_4
Cl_2	NaCl	CCl_4

2.6 : Similarity in hydrogen and halogens

Use your brain power !

1. Write the molecular formulae of oxides of the following elements by referring to the Mendeleev's periodic table. Na, Si, Ca, C, Rb, P, Ba, Cl, Sn, Ca
2. Write the molecular formulae of the compounds of the following elements with hydrogen by referring to the Mendeleev's periodic table. C, S, Br, As, F, O, N, Cl

Modern Periodic Law

The scientific world did not know anything about the interior of the atom when Mendeleev put forth the periodic table. After the discovery of electron, scientists started exploring the relation between the electron number of an atom and the atomic number. The atomic number in Mendeleev's periodic table only indicated the serial number of the element.

In 1913 A.D. the English scientist Henry Moseley demonstrated, with the help of the experiments done using X-ray tube, that the atomic number (Z) of an element corresponds to the positive charge on the nucleus or the number of the protons in the nucleus of the atom of that element. This revealed that 'atomic number' is a more fundamental property of an element than its atomic mass. Accordingly the statement of the modern periodic law was stated as follows:

Properties of elements are a periodic function of their atomic numbers.

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Modern periodic table : long form of the periodic table

The classifiacation of elements resulting from an arrangement of the elements in an increasing order of their atomic numbers is the modern periodic table. The properties of elements can be predicted more accurately with the help of the modern periodic table formed on the basis of atomic numbers. The modern periodic table is also called the long form of the periodic table.

In the modern periodic table the elements are arranged in accordance with their atomic number. (see table 2.7) As a result, most of the drawbacks of Mendeleev's periodic table appear to be removed. However, the ambiguity about the position of hydrogen is not removed even in the modern periodic table.

We have seen in the previous standard that the electronic configuration of an atom, the way in which the electron are distributed in the shells around the nucleus, is determined by the total number of electrons in it; and the total number of electrons in an atom is same as the atomic number. The relation between the atomic number of an element and its electronic configuration is clearly seen in the modern periodic table.

Structure of the Modern Periodic Table

The modern periodic table contains seven horizontal rows called the periods 1 to 7. Similarly, the eighteen vertical columns in this table are the groups 1 to 18. The arrangement of the periods and groups results into formation of boxes. Atomic numbers are serially indicated in the upper part of these boxes. Each box corresponds to the place for one element.

Use your brain power !

Position of the elements in the periodic elements.....

1. How is the problem regarding the position of cobalt (^{59}Co) and nickel (^{59}Ni) in Mendeleev's periodic table resolved in modern periodic table?
2. How did the position of $^{35}_{17}$Cl and $^{37}_{17}$C1 get fixed in the modern periodic table?
3. Can there be an element with atomic mass 53 or 54 in between the two elements, chromium $^{52}_{24}$Cr and manganese $^{55}_{25}$Mn ?
4. What do you think? Should hydrogen be placed in the group 17 of halogens or group 1 of alkali metals in the modern periodic table?

Apart from these seven rows, two rows are shown separately at the bottom of the periodic table. These are called lanthanide series and actinide series, respectively. There are 118 boxes in the periodic table including the two series. It means that there are 118 places for elements in the modern periodic table. Very recently formation of a few elements was established experimentally and thereby the modern periodic table is now completely filled. All the 118 elements are now discovered.

The entire periodic table is divided into four blocks,viz, s-block, p-block, d-block and f-block. The s-block contains the groups 1 and 2. The groups 13 to 18 constitute the p-block. The groups 3 to 12 constitute the d-block, while the lanthanide and actinide series at the bottom form the f-block. The d-block elements are called transition elements. A zig-zag line can be drawn in the p-block of the periodic table. The three traditional types of elements can be clearly shown in the modern periodic table with the help of this zig-zag line. The metalloid elements lie along the border of this zig-zag line. All the metals lie on the left side of the zig-zag line while all the nonmetals lie on the right side.

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Modern periodic Table and electronic Configuration of Elements

Within a period the neighbouring elements differ slightly in their properties while distant elements differ widely in their properties. Elements in the same group show similarity and gradation in their properties. These characteristics of the groups and periods in the modern periodic table are because of the electronic configuration of the elements. It is the electronic configuration of an element which decides the group and the period in which it is to be placed.

Characteristics of Groups and Periods

The characteristics of the groups and periods in the periodic table are understood by comparison of the properties of the elements. Various properties of all the elements in a group show similarity and gradation. However, the properties of elements change slowly while going from one end to the other (for example, from left to right) in a particular period.

Groups and electronic configuration

Can you tell?

1. Go through the modern periodic table (table no. 2.7) and write the names one below the other of the elements of group 1.
2. Write the electronic configuration of the first four elements in this group.
3. Which similarity do you find in their configuration?
4. How many valence electrons are there in each of these elements?

You will find that the number of valence electrons in all these elements from the group 1, that is, the family of alkali metals, is the same. Similarly, if you look at the elements from any other group, you will find the number of their valence electrons to be the same. For example, the elements beryllium (Be), magnesium (Mg) and calcium (Ca) belong to the group 2, that is, the family of alkaline earth metals. There are two electrons in their outermost shell. Similarly, there are seven electrons in the outermost shell of the elements such as fluorine (F) and chlorine (Cl) from the group 17, that is, the family of halogens. While going from top to bottom within any group, one electronic shell gets added at a time. From this we can say that the electronic configuration of the outermost shell is characteristic of a particular group. However, as we go down a group, the number of shells goes on increasing.

Do you know ?

Uranium has atomic number 92. All the elements beyond uranium (with atomic numbers 93 to 118) are manmade. All these elements are radioactive and unstable, and have a very short life.

In the modern periodic table.....

1. Elements are arranged in an increasing order of their atomic numbers.
2. Vertical columns are called groups. There are 18 groups. The chemical properties of the elements in the same group show similarity and gradation.
3. Horizontal rows are called periods. There are in all 7 periods. The properties of elements change slowly from one end to the other in a period.

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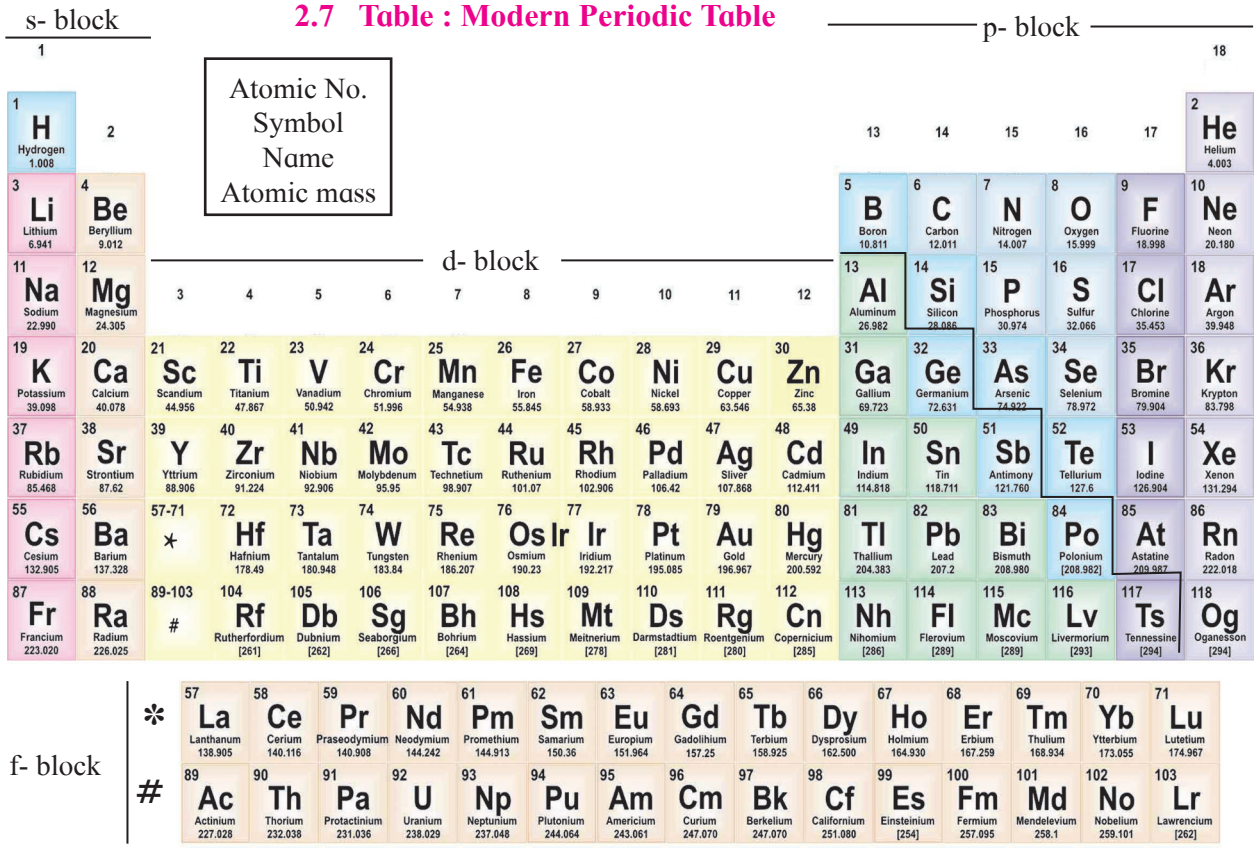
2.7 Table : Modern Periodic Table

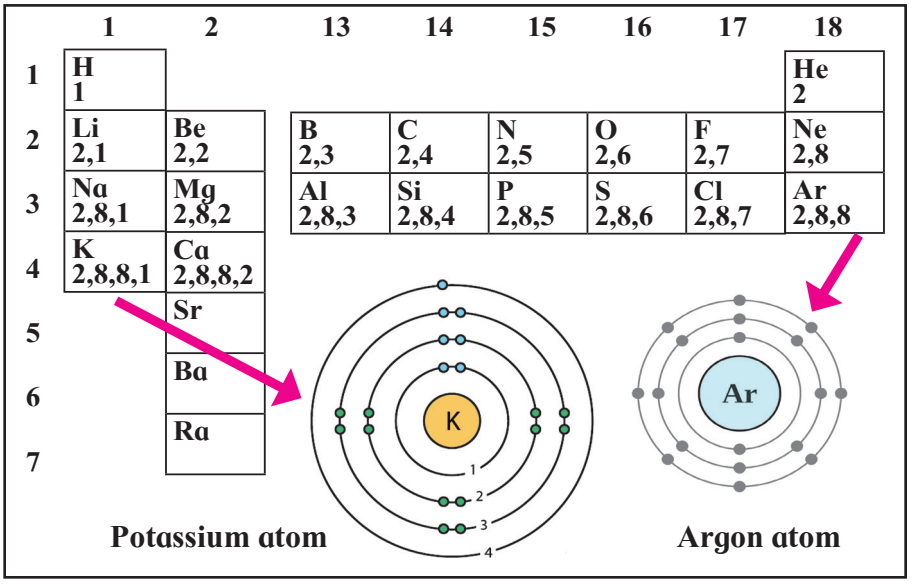


Periods and electronic configuration

Can you tell?

1. On going through the modern periodic table it is seen that the elements Li, Be, B, C, N, O, F and Ne belong to the period-2. Write down electronic configuration of all of them.
2. Is the number of valence electrons same for all these elements?
3. Is the number of shells the same in these ?

You will find that the number of valence electrons is different in these elements. However, the number of shells is the same. You will also find that, while going from left to right, within the period, the atomic number increases by one at a time and the number of valence electrons also increases by one at a time.



2.8 New period new shell

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We can say that the elements with the same number of shells occupied by electrons belong to the same period. The elements in the second period, namely, Li, Be, B, C, N, O, F and Ne have electrons in the two shells, K and L. The elements in the third period, namely, Na, Mg, Al, Si, P, S, Cl and Ar have electrons in the three shells; K, L and M. Write down the electronic configuration of these elements and confirm. In the modern periodic table, electrons are filled in the same shell while going along a period from left to right, and at the begining of the next period a new electron shell starts filling up (See the table 2.8).

The number of elements in the first three periods is determined by the electron capacity of the shells and the law of electron octet. (See the Table 2.9)

Can you recall ?

1. hat are the values of 'n' for the shells K, L and M?
2. What is the maximum number of electrons that can be accommodated in a shell? Write the formula.
3. Deduce the maximum electron capacity of the shells K, L and M.

As per the electron holding capacity of shells 2 elements are present in the first period and 8 elements in the second period. The third period also contains only eight elements due to the law of electron octet. There are few more factors which control the filling of electrons in the subsequent periods which will be considered in the next standards.

Shell	n	$2n^2$	Electron Capacity
K	1	$2x1^2$	2
L	2	$2x2^2$	8
M	3	$2x3^2$	18
N	4	$2x4^2$	32

2.9 Electron Capacity of Electron shells

The chemical reactivity of an element is determined by the number of valence electrons in it and the shell number of the valence shell. The information on these points is obtained from the position of the element in the periodic table. That is, the modern periodic table has proved useful for study of elements.

Periodic trends in the modern periodic table

When the properties of elements in a period or a group of the modern periodic table are compared, certain regularity is observed in their variations. It is called the periodic trends in the modern periodic table. In this standard we are going to consider the periodic trends in only three properties of elements; namely, valency, atomic size and metallic- nonmetallic character.

Valency : You have learnt in the previous standard that the valency of an element is determined by the number of electrons present in the outermost shell of its atoms, that is, the valence electrons.

Think about it

1. What is the relationship between the electronic configuration of an element and its valency?
2. The atomic number of beryllium is 4 while that of oxygen is 8. Write down the electronic configuration of the two and deduce their valency from the same.
3. The table on the next page is made on the basis of the modern periodic table. Write in it the electronic configuartion of the first 20 elements below the symbol, and write the valency (as shown in a separate box).
4. What is the periodic trend in the variation of valency while going from left to right within a period? Explain your answer with reference to period 2 and period 3.
5. What is the periodic trend in the variation of valency while going down a group? Explain your answer with reference to the group 1, group 2 and group 18.

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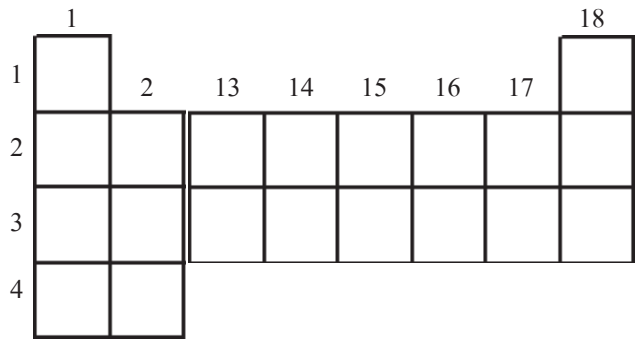
Symbol	$_{19}K$
Electronic configuration	2, 8, 8, 1
Valency	1



Atomic size

You have seen in the previous standards that size/volume is a fundamental property of matter. The size of an atom is indicated by its radius. Atomic radius is the distance between the nucleus of the atom and its ouermost shell.

Atomic radius is expressed in the unit picometer (pm) which is smaller than nanometer ($1\ pm = 10^{-12}\ m$).

Some elements and their atomic radii are given here.

Element	:	O	B	C	N	Be	Li
Atomic radius (pm)	:	66	88	77	74	111	152

Use your brain power !

1. By referring to the modern periodic table find out the periods to which the above elements belong.
2. Arrange the above elements in a decreasing order of their atomic radii.
3. Does this arrangement match with the pattern of the second period of the modern periodic table?
4. Which of the above elements have the biggest and the smallest atom?
5. What is the periodic trend observed in the variation of atomic radius while going from left to right within a period?

You will find that atomic radius goes on decreasing while going from left to right within a period. The reason behind this is as follows. While going from left to right within a period, the atomic number increases one by one, meaning the positive charge on the nucleus increases by one unit at a time. However, the additional electron gets added to the same outermost shell. Due to the increased nuclear charge the electrons are pulled towards the nucleus to a greater extent and thereby the size of the atom decreases.

Element	:	K	Na	Rb	Cs	Li
Atomic radius (pm)	:	231	186	244	262	152

Some elements and their atomic radii are given here.

Use your brain power !

1. By referring to the modern periodic table find out the groups to which above the elements belong.
2. Arrange the above elements vertically downwards in an increasing order of atomic radii.
3. Does this arrangement match with the pattern of the group 1 of the modern periodic table?
4. Which of the above elements have the biggest and the smallest atom?
5. What is the periodic trend observed in the variation of atomic radii down a group?

You will find that while going down a group the atomic size goes on increasing. This is because while going down a group a new shell is added. Therefore the distance between the outermost electron and the nucleus goes on increasing. As a result of this the atomic size increases in spite of the increased nuclear charge.

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Metallic- Nonmetallic Character

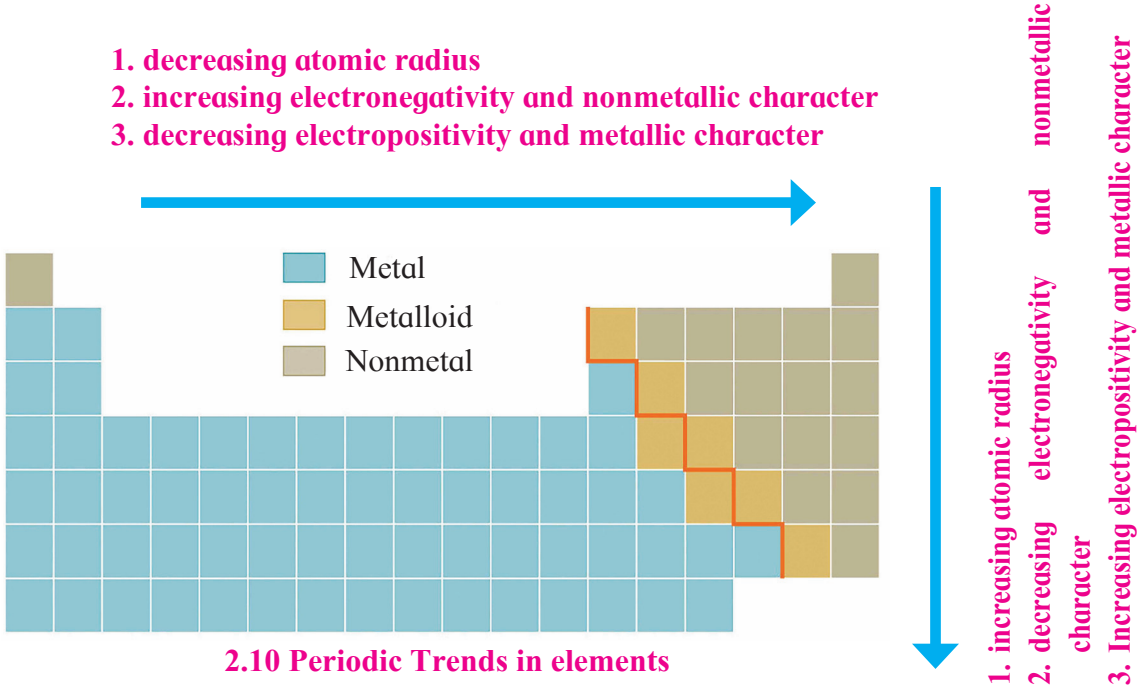
Use your brain power !

1. Look at the elements of the third period. Classify them into metals and nonmetals.
2. On which side of the period are the metals? Left or right?
3. On which side of the period did you find the nonmetals?

It is seen that the metallic elements like sodium, magnesium are towards the left. The nonmetallic elements such as sulphur, chlorine are towards the right. The metalloid element silicon lies in between these two types. A similar pattern is also observed in the other periods.

It is seen that the zig- zag line separates the metals from nonmetals in the periodic table. Elements appear to have arranged in such a way that metals are on left side of this line, nonmetals on the right side and metalloids are along the border of this line. How did this happen?

Let us compare the characteristic chemical properties of metals and nonmetals. It is seen from the chemical formulae of simple ionic compounds that the cation in them is formed from a metal while the anion from a nonmetal. From this it is understood that metal atoms have a tendency to form a cation by losing its valence electron, this property is called electropositivity of an element. On the other hand an atom of a nonmetal has a tendency to form an anion by accepting electrons from outside into its valence shell. We have already seen that ions have a stable electronic configuration of a noble gas. How is the ability to lose or accept electrons in the valence shell determined? All the electrons in any atom are held by the attractive force exerted on them by the positively charged nucleus. Electrons in the inner shells lie in between the valence shell and the nucleus. Because of their presence the effective nuclear charge exerting an attractive force on the valence electrons is somewhat less than the actual nuclear charge. Thus, the number of valence electrons in metals is small (1 to 3). Also the effective nuclear charge exerting attractive force on the valence electrons is small. As a combined effect of these two factors metals have a tendency to lose the valence electrons to form cations having a stable noble gas configuration. This tendency of an element called electropositivity is the metallic character of that element.



2.10 Periodic Trends in elements

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The periodic trend in the metallic character of elements is clearly understood from their position is the modern periodic table. Let us first consider the metallic character of elements belonging to the same group. While going down a group a new shell gets added, resulting in an increase in the distance between the nucleus and the valence electrons. This results in lowering the effective nuclear charge and thereby lowering the attractive force on the valence electrons. As a result of this the tendency of the atom to lose electrons increases. Also the penultimate shell becomes the outermost shell on losing valence electrons. The penultimate shell is a complete octet. Therefore, the resulting cation has a special stability. Due to this, the tendency of the atom to lose electrons increases further. The metallic character of an atom is its tendancy to lose electrons. Therefore, the following trend is observed : The metallic character of elements increases while going down the group.

While going from left to right within a period the outermost shell remains the same. However, the positive charge on the nucleus goes on increasing while the atomic radius goes on decreasing and thus the effective nuclear charge goes on increasing. As a result of this the tendency of atom to lose valenece electrons decreases within a period from left to right (See Table 2.10).

The two factors namely, the increasing nucleur charge and decreasing atomic radius as we go from left to right within a period, are responsible for increasing the effective nuclear charge. Therefore, the valence electrons are held with greater and greater attractive force. This is called electronegativity of an atom. Due to increasing electronegativity from left to right within a period, the ability of an atom to become anion by accepting outside electrons goes on increasing. The tendency of an element to form anion or the electronegativity is the nonmetallic character of an element.

Use your brain power !

1. What is the cause of nonmetallic character of elements?
2. What is the expected trend in the variation of nonmetallic character of elements from left to right in a period?
3. What would be the expected trend in the variation of nonmetallic character of elements down a group?

Always remember

1. While going downwards in any group the electropositivity of elements goes on increasing while their electronegativity goes on decreasing.
2. While going from left to right in any period the electronegativity of elements goes on increasing while their electropositivity goes on decreasing.
3. Larger the electropositivity or electronegativity of the element higher the reactivity.

Gradation in Halogen Family

The group 17 contains the members of the halogen family. All of them have the general formula X_2. A gradation is observed in their physical state down the group.Thus, fluorine (F_2) and chlorine (Cl_2) are gases, bromine (Br_2) is a liquid while iodine (I_2) is a solid.

Internet my friend

Collect the information & mail it

1. Inert gas elements.
2. Uses of various elements.

Read the following reference books from your library.

1. Understanding chemistry - C.N.R. Rao
2. The Periodic Table Book: A Visual Encyclopedia of the Elements

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Do you know ?

$M + 2H_2O \longrightarrow M(OH)_2 + H_2$

A general chemical equation indicating the reaction of alkaline earth metals is given above. While going down the second group as Be⟶ Mg ⟶Ca⟶Sr⟶Ba, the gradation in this chemical property of the alkaline earth metals is seen. While going down the second group the reactivity of the alkaline earth metals goes on increasing and thereby the ease with which this reaction takes place also goes on increasing. Thus beryllium (Be) does not react with water. Magnesium (Mg) reacts with steam, while calcium (Ca), strontium (Sr) and barium (Ba) react with water at room temperature with increasing rates.

Exercise

1. Rearrange the columns 2 and 3 so as to match with the column 1.

Column 1	Column 2	Column 3
i. Triad	a. Lightest and negatively charged particle in all the atoms	1. Mendeleev
ii. Octave	b. Concentrated mass and positive charge	2. Thomson
iii.Atomic number	c. Average of the first and the third atomic mass	3. Newlands
iv. Period	d. Properties of the eighth element similar to the first	4. Rutherford
v. Nucleus	e. Positive charge on the nucleus	5. Dobereiner
vi. Electron	f. Sequential change in molecular formulae	6. Moseley

2. Choose the correct option and rewrite the statement.

a. The number of electrons in the outermost shell of alkali metals is.....

(i) 1 (ii) 2 (iii) 3 (iv) 7

b. Alkaline earth metals have valency 2. This means that their position in the modern periodic table is in .....

(i) Group 2 (ii) Group16

(iii) Period 2 (iv) d-block

c. Molecular formula of the chloride of an element X is XCl. This compound is a solid having high melting point. Which of the following elements be present in the same group as X.

(i) Na (ii) Mg (iii) Al (iv) Si

d. In which block of the modern periodic table are the nonmetals found?

(i) s-block (ii) p-block

(iii) d-block (iv) f-block

3. An element has its electron configuration as 2,8,2. Now answer the following questions.

a. What is the atomic number of this element?

b. What is the group of this element?

c. To which period does this element belong?

d. With which of the following elements would this element resemble? (Atomic numbers are given in the brackets)

N (7), Be (4) , Ar (18), Cl (17)

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4. Write down the electronic configuration of the following elements from the given atomic numbers. Answer the following question with explanation.

a. $_{3}Li$, $_{14}Si$, $_{2}He$, $_{11}Na$, $_{15}P$ Which of these elements belong to be period 3?

b. $_{1}H$, $_{7}N$, $_{20}Ca$, $_{16}S$, $_{4}Be$, $_{18}Ar$
Which of these elements belong to the second group?

c. $_{7}N$, $_{6}C$, $_{8}O$, $_{5}B$, $_{13}A1$
Which is the most electronegative element among these?

d. $_{4}Be$, $_{6}C$, $_{8}O$, $_{5}B$, $_{13}A1$
Which is the most electropositive element among these?

e. $_{11}Na$, $_{15}P$, $_{17}C1$, $_{14}Si$, $_{12}Mg$
Which of these has largest atoms?

f. $_{19}K$, $_{3}Li$, $_{11}Na$, $_{4}Be$
Which of these atoms has smallest atomic radius?

g. $_{13}A1$, $_{14}Si$, $_{11}Na$, $_{12}Mg$, $_{16}S$
Which of the above elements has the highest metallic character?

h. $_{6}C$, $_{3}Li$, $_{9}F$, $_{7}N$, $_{8}O$
Which of the above elements has the highest nonmetallic character?

5. Write the name and symbol of the element from the description.

a. The atom having the smallest size.
b. The atom having the smallest atomic mass.
c. The most electronegative atom.
d. The noble gas with the smallest atomic radius.
e. The most reactive nonmetal.

6. Write short notes.

a. Mendeleev's periodic law.
b. Structure of the modern periodic table.
c. Position of isotopes in the Mendeleev's and the modern periodic table.

7. Write scientific reasons.

a. Atomic radius goes on decreasing while going from left to right in a period.
b. Metallic character goes on decreasing while going from left to right in a period.
c. Atomic radius goes on increasing down a group.
d. Elements belonging to the same group have the same valency.
e. The third period contains only eight elements even through the electron capacity of the third shell is 18 .

8. Write the names from the description.

a. The period with electrons in the shellsK, L and M.
b. The group with valency zero.
c. The family of nonmetals having valency one.
d. The family of metals having valency one.
e. The family of metals having valency two.
f. The metalloids in the second and third periods.
g. Nonmetals in the third period.
h. Two elements having valency 4.

Project

Find out the applications of all the inert gases, prepare a chart and display it in the class.

HZGUU3

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3. Chemical Reactions and Equations

- Chemical reactions
- Balacing a chemical equation
- Rules of writing chemical reaction
- Types of chemical reactions

Can you recall?

1. What are the types of molecules of elements and compounds?
2. What is meant by valency of elements?
3. What is the requirement for writing molecular formulae of different compounds? How are the molecular formulae of the compounds written?

In earlier standards we have seen how compounds are formed by chemical combination of elements. We have also learnt that the driving force behind formation of a chemical bond is to attain an electronic configuration with a complete octet. The atoms attain a complete octet by giving, taking or sharing of electrons with each other.

Chemical Reaction

Some of the scientists of the 18th and 19th century carried out fundamental experiments on chemical reactions. They proved from their experiments that during chemical reactions composition of the matter changes and that change remains permanent. On the contrary during physical change only the state of matter changes and this change is often temporary in nature.

Identify physical and chemical changes from the phenomena given in the following table.

Phenomenon	Physical change	Chemical change
1. Transformation of ice into water.	✓	
2. Cooking of food.		✓
3. Ripening of fruit.		
4. Milk turned in to curd.		
5. Evaporation of water.		
6. Digestion of food in the stomach.		
7. Size reduction of naphtha balls exposed to air.		
8. Staining of Shahbadi or Kadppa tile by lemon juice.		
9. Breaking of a glass object on falling from a height.		

3.1 Some common phenomenon

Note : Do the following activities in group a of friends. Take help of your teacher wherever necessary.

Try this.

Apparatus: Thermometer, evaporating dish, tripod stand, funnel, Bunsen burner, etc.

Chemicals : Lime stone powder, copper sulphate, calcium chloride, potassium chromate, zinc dust, sodium carbonate, phthalic anhydride, etc.

Procedure : Carry out the activities 1 to 5 as given below. Read and record the temperatures in the activities 2 to 4.

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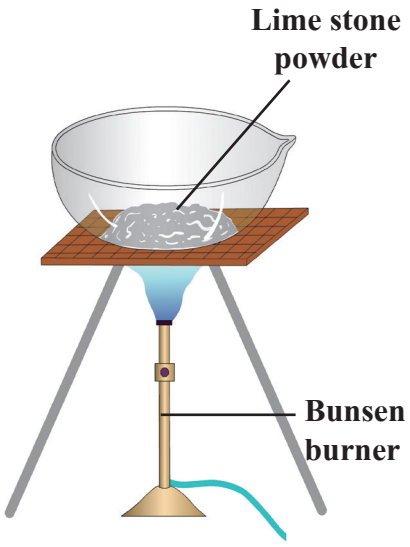
1. Take a spoonful of lime stone powder in an evaporating dish. Heat it strongly on a high blue flame.
2. Add zinc (Zn) dust into the copper sulphate ($CuSO_4$) solution.
3. Add potassium chromate (K_2CrO_4) solution to barium sulphate ($BaSO_4$) solution.
4. Add sodium carbonate (Na_2CO_3) solution to the calcium chloride ($CaCl_2$) solution.
5. Take phthalic anhydride in the evaporating dish. Close the end of the stem of a funnel with a cotton plug. Keep this funnel inverted on the evaporating dish. Heat the evaporating dish on a tripod stand slowly on a low flame. What did you observe in the funnel during heating?



3.2 To heat lime stone powder

Record the observation of all the activities. What did you find?

Complete the following observation table with reference to the activities 1 to 5.

Activity	Colour change (if present)	Gas released (yes/no)	Temperature change (if present)	Nature of change (chemical /physical)
1				
2				
3				
4				
5				

3.3 Observation table

Find out

Observe and keep a record of the physical and chemical changes that you experience in your daily life.

A physical change takes place due to change in the parameters such as temperature, pressure. Often a physical change in reversible. The composition of matter remains the same in a physical change. For example, ice is transformed into water on heating and water is transformed into ice on cooling. On the contrary, if the composition of matter changes during a process then it is called a chemical change. When we call a particular process or phenomenon as a chemical change, some chemical reactions are taking place in the concerned matter.

A chemical reaction is a process in which some substances undergo bond breaking and are transformed into new substances by formation of new bonds. The substances taking part in chemical reaction are called reactants, whereas the substances formed as a result of a chemical reaction by formation of new bonds are called products. For example, formation of carbon dioxide gas by combustion of coal in air is a chemical reaction. In this reaction coal (carbon) and oxygen (from air) are the reactants while carbon dioxide is the product. A chemical reaction is represented by writing a chemical equation.

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Chemical equations

Let us first look at a chemical reaction. In the activity 2, a colourless solution of zinc sulphate ($ZnSO_4$) is formed on addition of zinc dust to the blue solution of copper sulphate ($CuSO_4$). This chemical reaction can be written in brief as follows.

Aqueous solution of copper sulphate + zinc dust ⟶ Aqueous solution of zinc sulphate + copper ..... (1)

This simple way of representating a chemical reaction in words is called a 'Word Equation'.

A word equation can be written in a further condensed form by using chemical formulae as follows.

$$CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu \text{.....(2)}$$

The representation of a chemical reaction in a condensed form using chemical formulae is called as the chemical equation. In the above equation coper sulphate ($CuSO_4$) and zinc(Zn) are the reactants. They react with each each other to form copper particles (Cu) and a solution of the colourless zinc sulphate ($ZnSO_4$) as the products having totally different properties. The ionic bond in the reaction $CuSO_4$ breaks and the ionic bond in the product $ZnSO_4$ is formed during the reaction.

Writing a Chemical Equation

Let us now see the conventions followed while writing a chemical equation.

1. In a chemical equation the reactants are written on the left hand side while the products on the right hand side. An arrow heading towards the products is drawn in between them. This arrow indicates the direction of the reaction.

2. If the reactants or products are two or more, they are linked with a plus sign (+) in between them. For example, in the equation (2) a plus sign (+) is drawn in between the reactants $CuSO_4$ and Zn. Similarly, a plus sign (+) is drawn in between the products $ZnSO_4$ and Cu.

3. To make the chemical equation more informative the physical states of the reactants are indicated in the equation. Their gaseous, liquid and solid states are indicated by writing the letters (g), (l) and (s), respectively in the brackets. Moreover, if the product is gaseous, instead of (g) it can be indicated by an arrow ↑ pointing upwards. If the product formed is insoluble solid, in the form of a precipitate, then instead of (s) it can be indicated by an arrow ↓ pointing downwards. When reactants and products are in the form of solution in water, they are said to be present in aqueous solution state. This state is indicated by putting the letters aq in brackets after their formula. Thus, the equation (2) is rewritten as equation (3) shown below.

$$CuSO_4\,(aq) + Zn\,(s) \longrightarrow ZnSO_4\,(aq) + Cu\,(s) \text{ ..... (3)}$$

4. When heat is to be given from outside to bring about a reaction, it is indicated by the sign △written above the arrow that indicates the direction of the reaction. For example, the reaction in which slaked lime is formed on heating lime stone is written as follows.

$$CaCO_3\,(s) \xrightarrow{\Delta} CaO\,(s) + CO_2\uparrow \text{ ..... (4)}$$

Similarly, the fact that heat is released during the reaction between the aqueous solution of copper sulphate and zinc dust is indiacted as follows.

$$CuSO_4\,(aq) + Zn\,(s) \longrightarrow ZnSO_4\,(aq) + Cu\,(s) + \text{Heat ..... (5)}$$

5. It is necessary to fulfil certain conditions like specific temperature, pressure, catalyst, etc, to bring about some reactions. These conditions are indicated below or above the arrow indicating the direction of the reaction. For example, the reaction of a vegetable oil takes place at the temperature of 60 ^{0}C with hydrogen gas in presence of the Ni catalyst and is written as follows.

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$$\text{Vegetable oil (l)} + H_2(g) \xrightarrow[\text{Ni Catalyst}]{60^0\,C} \text{Vanaspathi ghee (s)} \ldots\ldots\ldots\ldots (6)$$

6 . Special information or names of reactants/ products are written below their formulae. For example, copper on reaction with concentrated nitric acid gives reddish coloured poisonous nitrogen di oxide gas.

$$Cu(s) + 4\,HNO_3(aq) \longrightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l) \ldots\ldots\ldots\ldots (7)$$

(Concentrated)

However, on reaction with dilute nitric acid, the product formed is nitric oxide gas.

$$3Cu(s) + 8HNO_3(aq) \longrightarrow 3Cu(NO_3)_2(aq) + 2NO(g) + 4H_2O(l) \ldots\ldots\ldots\ldots (8)$$

(dilute)

Try this.

Apparatus: Test tube, conical flask, balance, etc.
Chemicals : Sodium chloride and silver nitrate.

Procedure :

1. Take sodium chloride solution in a conical flask and silver nitrate solution in a test tube.
2. Tie a thread to the test tube and insert it carefully into the conical flask. Make the conical flask air tight by fitting a rubber cork.
3. Weigh the conical flask with the help of a balance.
4. Now tilt the conical flask and mix the solution present in the test tube with the solution in the conical flask.
5. Weigh the conical flask again.

Which changes did you find? Did any insoluble substance form? Was there any change in the weight?

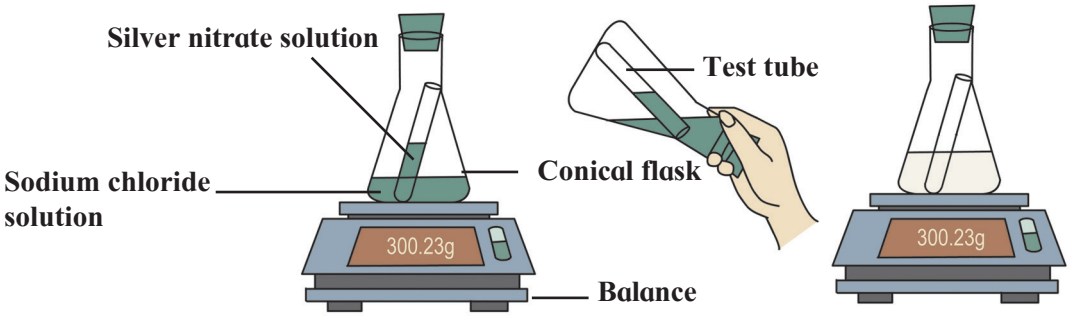
A word equation is written for the above activity as shown below.

Silver nitrate + Sodium chloride ⟶ Silver chloride + Sodium nitrate

The above word equation is represented by the following chemical equation.

$$AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl\downarrow + NaNO_3(aq) \ldots\ldots\ldots (9)$$

(white)



3.4 The reaction of sodium chloride with silver nitrate

Do you know ? Silver nitrate is used in the voters-ink.

Find out What are the other uses of silver nitrate in everyday life?

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Balancing a Chemical Equation

Complete the table aside on the basis of the equation (9).

It is seen that the number of atoms of the elements in the reactants in this equation is same as the number of atoms of those elements in the products. Such an equation is called a 'balanced equation'. If the number of atoms of each element is not the same on the two sides of an equation, it is called an 'unbalanced equation'.

	Reactants (Left side)	Products (Right side)
Element	Number of atoms	Number of atoms
Ag		
N		
O		
Na		
Cl		

3.5 Details of equation (9)

Always remenber

In any reaction, the total mass of each of the elements in the reactants is same as the total mass of each of the respective elements in the products. This is in accordance with the law of conservation of mass that you studied in the previous standard.

Steps in balancing a chemical reaction

A chemical equation is balanced step by step. A trial and error method is used for this purpose.Consider the following equation as an example :

Sodium hydroxide + Sulphuric acid ⟶ Sodium sulphate + water.

STEP I. Write the chemical equation from the given word equation.

$NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$ .....(10)

STEP II. Check whether the equation (10) is balanced or not by comparing the number of atoms of the various elements present on the two sides of the equation.

It is seen that the number of atoms of all the elements on the two sides are not the same. It means that the equation (10) is not balanced.

	Reactants (Left side)	Products (Right side)
Element	Number of atoms	Number of atoms
Na	1	2
O	5	5
H	3	2
S	1	1

STEP III : It is convenient to start balancing an equation from the compound which contains the maximum number of atoms. Moreover it is convenient to first consider that element in this compound, which has unequal number of atoms on the two sides.

(i) In the equation (10), there are two components Na_2SO_4 and H_2SO_4, which contain the maximum number that is seven atoms each. Any one of them can be selected. Select the compound Na_2SO_4. Further select sodium for balancing as the number of atoms of sodium in this compound is unequal on the two sides. It should be remembered that, the formula of a compound cannot be changed while balancing the number of atoms. It means that, here to make the number of sodium atoms in the reactants as '2' the formula NaOH cannot be changed to Na_2OH. Instead a factor of '2' will have to be applied to NaOH. Write down the resulting equation (10)′ on doing this.

Number of sodium atoms	In the Reactants (in NaOH)	In the Produtcts (in Na_2SO_4)
Initially	1	2
To balance	1 x 2	2

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$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$ .....(10)′

(ii) Check whether the equation (10)′ is balanced or not.

We find that the equation (10)′ is not balanced, as the number of oxygen and hydrogen atoms are unequal on the two sides. First balance the hydrogen number as it requires a smaller factor.

(iii) Apply a factor '2' to the product 'H_2O' for balancing the equation (10)′

Now write down the resulting equation (10)″.

$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$ .... (10)″

(iv) Check whether the equation (10)″ is balanced or not. It is seen that the number of atoms of all the elements are equal on both the sides. It means that the equation (10)″ is a balanced equation.

	Reactants (Left side)	Products (Right side)
Element	Number of atoms	Number of atoms
Na	2	2
O	6	5
H	4	2
S	1	1

Step IV : Write down the final balanced equation again.

$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$ ....(11)

In this way, a balanced equation is obtained from an unbalanced equation by applying proper factors to appropriate reactant/product so as to balance the number of each element in steps.

Number of atoms of Hydrogen	In the reactants (In NaOH & H_2SO_4)	In the Products (In H_2O)
i) Initially	4	2
ii) To balance	4	2 x 2

Use your brain power!

1. (a) Identify the reactants and products of equation (6).

(b) Write down the steps in balancing the equation

$N_2(g) + H_2(g) \rightleftharpoons NH_3(g)$

2. Write down a balanced chemical equation for the following reaction

Calcium chloride + Sulfuric acid $\longrightarrow$ Calcium sulphate + hydrogen chloride

3.Write down the physical states of reactants and products in following reactions.

a. $SO_2 + 2H_2S \longrightarrow 3S + 2H_2O$

b. $2Ag + 2HCl \longrightarrow 2AgCl + H_2$

We saw that in a chemical reactions reactants get converted into the new substances called products. During this some chemical bonds in the reactants break and some new chemical bonds are formed so as to transform the reactants into the products. In this chapter we will be studying the types of reactions in detail.

Types of chemical reactions

Chemical reactions are classified into the following four types in accordance with the nature and the number of the reactants and the products.

1. Combination reaction

Try this.

Apparatus: Test tube, glass rod, beaker, etc.
Chemicals: hydrochloric acid, ammonia solution, slaked lime, etc.

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Activity 1: Take a small amount of hydrochloric acid in a test tube. Heat the test tube. Dip a glass rod in the ammonia solution and hold on the top of the test tube. You will observe a white smoke emanating from the tip of the glass rod.

What must have happened?

Due to heating HCl vapours started coming out from the test tube, and NH_3 gas came out from the solution on the glass rod. The ammonia gas and hydrogen chloride gas reacted to form the salt ammonium chloride in gaseous state first, but immediately due to the condensation process at room temperature it got transformed into the solid state. As a result white smoke was formed. The chemical equation for this is as follows.

$$NH_3\,(g) + HCl\,(g) \longrightarrow NH_4Cl(s) \quad \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Ammonia Hydrogen chloride Ammonium chloride

Activity 2: Hold a magnesium (Mg) strip in a pair of tongs and ignite. On burning in air a white powder of magnesium oxide is formed. The reaction can be written in the form of equation as shown below.

$$2Mg + O_2 \longrightarrow 2\,MgO \quad \ldots\ldots\ldots\ldots\ldots\ldots (13)$$

In this reaction magnesium oxide is formed as the single product by combination of magnesium and oxygen.

Activity 3: Take water in a beaker up to half of its capacity. Add a few pieces of slaked lime (calcium oxide, CaO) to it. Calcium hydroxide ($Ca(OH)_2$) is formed by combination of calcium oxide and water with generation of large amount of heat.

$$CaO + H_2O \longrightarrow Ca(OH)_2 + \text{Heat} \quad \ldots\ldots\ldots\ldots\ldots (14)$$

Calcium oxide calcium hydroxide

Use your brain power!

1. What is the number of reactants in each of the above reactions?
2. What is the number of molecules of reactants taking part in the above reactions?
3. How many products are formed in each of the above reactions?

When two or more reactants combine in a reaction to form a single product, it is called a combination reaction.

2. Decomposition reaction

Try this.

Apparatus: Evaporating dish, Bunsen burner, etc.
Chemicals : Sugar, calcium carbonate, sulphuric acid, etc.

Procedure: Take some sugar in an evaporating dish and heat it with the help of a Bunsen burner. After some time you will see the formation of a burnt out black substance. Exactly what must have happened in this activity?

In the above activity a single reactant sugar is divided into two substances (C and H_2O)

$$C_{12}H_{22}O_{11} \longrightarrow 12\,C + 11H_2O \quad \ldots\ldots\ldots\ldots\ldots\ldots (15)$$

Sugar carbon

The reaction in which there is only one reactant giving rise to two or more products is called a decomposition reaction.

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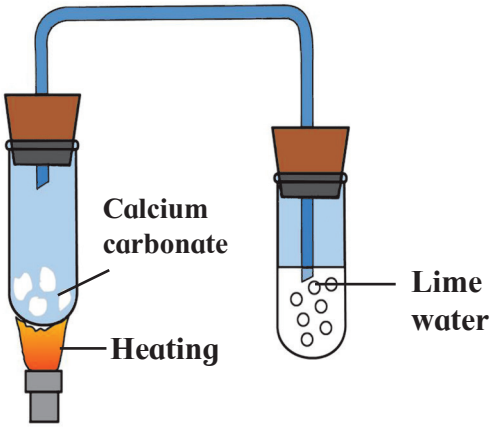
Try this. **Apparatus :** Two test tubes, bent tube, rubber cork, burner, etc.

Chemicals : Calcium carbonate, freshly prepared lime water.

Procudure : Take some calcium carbonate in a test tube. Fit a bent tube to this test tube with the help of a rubber cork. Insert the other end of the bent tube in the freshly prepared lime water taken in the other test tube. Heat the powdered calcium carbonate in the first test tube strongly. The lime water will turn milky.



3.6 Decomposition of calcium carbonate

We saw in the above activity that calcium carbonate undergoes decomposition reaction and the carbon dioxide gas formed turns the lime water milky (Eq. 16). The second product of the reaction, the calcium oxide powder, remains behind in the first test tube. Similarly, in another reaction (Eq. 17) hydrogen peroxide naturally undergoes slow decomposition into water and oxygen.

$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2 \uparrow$ ..... (16); $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2 \uparrow$ .... (17)

(16) and (17) both are decomposition reactions.

Can you recall? Is it possible to produce hydrogen by decomposition of water by means of heat, electricity or light ?

We have studied in the previous standard that water decomposes into hydrogen and oxygen gases on passing electric current through acidulated water. This decomposition takes place by means of electrical energy. Therefore it is called electrolysis.

$$2H_2O(l) \longrightarrow 2H_2 \uparrow + O_2 \uparrow \text{.....(18)}$$

The chemical reaction in which two or more products are formed from a single reactant is called ‘‘Decomposition reaction”.

Many degradation precesses take place in the nature surrounding us. Organic waste is decomposed by microorganisms and as a result manure and biogas are formed. Biogas is used as a fuel.

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3. Displacement reaction

We saw in the beginning of this chapter that on adding zinc dust to blue coloured copper sulphate solution, a colourless solution of zinc sulphate is formed and heat is generated. See the equation (3) for this reaction.

From that we learnt that the Zn^{2+} ions formed from Zn atoms take the place of Cu^{2+} ions in copper sulphate, and Cu atoms, formed from Cu^{2+} ion come out. It means that Zn displaces Cu from $CuSO_4$.

The reaction in which the place of the ion of a less reactive element in a compound is taken by another more reactive element by formation of its own ions, is called displacement reaction.

(We will learn about reactivity of elements in the chapter on metallurgy.) The elements iron and lead, similar to zinc, displace copper from its compound.

Use your brain power !

Complete the following reactions and give names of the products.

1. $CuSO_4(aq) + Fe(s) \longrightarrow$ ..... + ...
2. $CuSO_4(aq) + Pb(s) \longrightarrow$ ..... + ...

4. Double displacement reaction

We have seen in the equation (9) that a white precipitate of silver chloride is formed by an exchange of silver and sodium ions present in the reactants.

The reaction in which the ions in the reactants are exchanged to form a precipitate are called double displacement reactions.

Recall the activity (3) in which you added potassium chromate (K_2CrO_4) into the solution of barium sulphate ($BaSO_4$).

1. What was the colour of the precipitate formed ?
2. Write the name of the precipitate.
3. Write down the balanced equation for this reaction.
4. Will you call this reaction a displacement reaction or a double displacement reaction.

Endothermic and Exothermic Processes and Reaction :

Heat is absorbed and given away in various processes and reactions. Accordingly processes and reactions are classified as 'Endothermic or Exothermic'.

Endothermic and Exothermic Processes

Heat from outside is absorbed during some physical changes. For example, (i) melting of ice (ii) dissolution of potassium nitrate in water. Therefore, these are **'Endothermic processes.'**

On the other hand, heat is given away during some physical changes. For example, (i) formation of ice from water, (ii) dissolution of sodium hydroxide in water. Therefore these are **'Exothermic processes.'** In the process of dilution of concentrated sulphuric acid with water, very large amount of heat is liberated. As a result, water gets evaporated instantaneously, if it is poured in to the concentrated sulphuric acid, which may cause an accident. To avoid this, required amount of water is taken in a glass container and small quantity of concentrated sulphuric acid at a time is added with stirring. Therefore, only a small amount of heat is liberated at a time.

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To carry out endothermic and exothermic processes

Try this.

Apparatus : Two plastic bottles, measuring cylinder, thermometer etc.
Chemicals : Potassium nitrate, sodium hydroxide, water etc.
(Sodium hydroxide being corrosive, handle it carefully in presence of Teacher.)

Procedure : Take 100 ml water in each of the two plastic bottles. Plastic being insulator of heat, the dissipation of heat can be prevented. Note the temperature of water in the bottles. Put 5 g potassium nitrate (KNO_3) in the bottle and shake well. Note the temperature of the solution formed. Put 5 g sodium hydroxide (NaOH) in the other bottle. Shake the bottle well. Note the temperature.

In the first bottle the process of dissolution of potassium nitrate took place while in the second bottle the process of dissolution of sodium hydroxide took place. As per your observation which one is exothermic process and which is an endothermic process?

During the process of the dissolution of KNO_3 in water, heat from the surroundings is absorbed and therefore the temperature of the resulting solution is less. The process in which heat is absorbed from the outside, is called endothermic process. When the solid NaOH is dissolved in water heat is given out, and therefore the temperature increases. The processes in which heat is given out are called exothermic processes.

Endothermic and Exothermic Reactions

There is an exchange of heat in chemical reactions as well. Accordingly some chemical reactions are exothermic while some other are endothermic. During exothermic chemical reactions heat is given away when reactants are transformed into the products, while during endothermic chemical reactions heat is either absorbed from the surroundings or has to be supplied continuously from outside. For example,

$CaCO_3$ (s) + heat $\longrightarrow$ CaO (s) + CO_2(g) **(Endothermic Reaction)**

CaO (s) + H_2O (*l*) $\longrightarrow$ $Ca(OH)_2$ (aq) + heat **(Exothermic Reaction)**

Use your brain power !

1. What is the difference in the process of dissolution and a chemical reaction ?
2. Does a new substance form when a solute dissolves in a solvent ?

Rate of Chemical Reaction

Can you tell?

Take into account the time required for following processes. Classify them into two groups and give titles to the groups.

1. Cooking gas starts burning on ignition .
2. Iron article ungergoes rusting.
3. Errosion of rocks takes place to form soil.
4. Alcohol is formed on mixing yeast in glucose solution under proper condition.
5. Effervescence is formed on adding baking soda into a test tube containing dilute acid.
6. A white precipitate is formed on adding dilute sulphuric acid to barium chloride solution.

It can be seen from the above examples that some reactions are completed in short time, that is, occur rapidly, while some other require long time for completion, that is, occur slowly. It means that the rate of different reactions is different.

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The same reaction occurs at a different rate on changing the conditions. For example, during winter long time is required for setting milk into curd, while at the higher temperature during summer, the rate of setting of milk increases and the curd is formed early.

Now let us see the factors which decide the rate of a chemical reaction.

Factors affecting the rate of a chemical reaction

a. Nature of the Reactants

Let us see the reaction of the metals aluminium (Al) and zinc (Zn) with dilute hydrochloric acid.

On reaction of both Al and Zn with dilute hydrochloric acid H_2 gas is liberated and water soluble salts of these metals are formed. However, the reaction of aluminium metal takes place faster as compared to zinc metal. The nature of the metal is responsible for this difference. Al is more reactive than Zn. Therefore the rate of reaction of Al with hydrochloric acid is higher than that of Zn. Nature or reactivity of reactants influences the rate of a chemical reaction. (We are going to learn more about the reactivity of metals in the chapter on Metallurgy.)

b. Size of the Particles of Reactants

Try this.

Apparatus: Two test tubes, balance, measuring cylinder, etc.
Chemicals: Pieces of Shahabad tile, powder of Shahabad tile, dilute HCl etc.

Procedure : Take pieces and powder of shahabad tile in equal weights in two test tubes. Add 10 ml dilute HCl in each of the test tubes. Observe whether effervescence of CO_2 is formed at a faster or slower speed.

You must have found in the above activity that the CO_2 effervescence is formed slowely with the pieces of Shahabad tile while at a faster speed with the powder.

The above observation indicates that the rate of a reaction depends upon the size of the particles of the reactants taking part in the reaction. Smaller the size of the reactant particles, higher is the rate of the reaction.

c. Concentration of the reactants

Let us consider the reaction of dilute and concerntrated hydrochloric acid with $CaCO_3$ powder.

Dilute HCl reacts slowly with $CaCO_3$ and thereby $CaCO_3$ disappears slowly and CO_2 also liberates slowly. On the other hand the reaction with concentrated HCl takes place rapidly and $CaCO_3$ disappears fast.

Concentrated acid reacts faster than dilute acid, which means that rate of a reaction is proportional to the concentration of reactants.

d. Temperature of the Reaction

While studying decomposition reaction, you have carried out decomposition of lime stone. In this activity, the lime water does not turn milky before heating the lime stone; because of the zero rate of reaction. From this it is learnt that the rate of a reaction increases on increasing the temperature.

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e. Catalyst

On heating potassium chlorate ($KClO_3$) decomposes slowly.

$$2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2 \text{ ..... (19)}$$

The rate of the above reaction neither increases by reducing the particle size nor by increasing the reaction temperature. However, $KClO_3$ decomposes rapidly in presence of manganese dioxide (MnO_2) to liberate O_2 gas. No chemical change takes place in MnO_2 in this reaction.

"The substance in whose presence the rate of a chemical reaction changes, without causing any chemical change to it, is called a catalyst."

The decomposition of hydrogen peroxide into water and oxygen takes place slowly at room temperature (Eq. 17). However, the same reaction occurs at a faster rate on adding manganese dioxide (MnO_2) powder in it.

Do you know ?

1. One or more chemical reactions take place during every chemical change.
2. Some chemical reactions occur at fast speed whereas some occur at slow speed.
3. Strong acid and strong base react instantaneously.
4. In our body, enzymes increase the rate of physiological reactions.
5. Perishable foodstuff gets preserved longer in a refrigerator. The rate of decomposition of foodstuff gets lowered due to low temperature, and its freshness is maintained.
6. Vegitables cook quickly on oil rather than on water.
7. The chemical reactions are profitable in the chemical factories if their rate is fast.
8. The rate of chemical reaction is important from environmental point of view as well.
9. The ozone layer in the earth's atmosphere protects the life on earth from the ultraviolet radiation of the sun. The process of depletion or maintenance of this layer depends upon the rate of production or destruction of ozone molecules.

Oxidation and Reduction

Many types of substances give reactions called oxidation and reduction. Let us learn more about these reaction.

$$2Mg + O_2 \longrightarrow 2MgO \text{ .....(20)}$$

$$C + O_2 \longrightarrow CO_2 \text{ .....(21)}$$

$$MgH_2 \longrightarrow Mg + H_2 \text{ .....(22)}$$

$$CH_3\text{-}CH_3 \longrightarrow CH_2{=}CH_2 \text{ ....(23)}$$

In the reactions (20) and (21) a reactant combines with oxygen, whereas in (22) and (23) hydrogas is removed from the reactant. All these are examples of the oxidation reaction.

The chemical reaction in which a reactant combines with oxygen or loses hydrogen to form the product is called oxidation reaction.

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Some oxidation reactions are brought about by use of specific chemical substances. For example,

$$\underset{\text{Ethyl alcohol}}{CH_3 - CH_2 - OH} \xrightarrow[K_2Cr_2O_7/H_2SO_4]{[O]} \underset{\text{Acetic acid}}{CH_3 - COOH} \quad \ldots\ldots (24)$$

Here the acidic potassium dichromate makes oxygen available for the oxidation of the reactant ethyl alcohol. Such chemical subastances which bring about an oxidation reaction by making oxygen available are called oxidants or oxidizing agents.

Do you know ?

A variety of oxidants are used to bring about a controlled oxidation.

$K_2Cr_2O_7/H_2SO_4$, $KMnO_4/H_2SO_4$ are the commonly used chemical oxidants. Hydrogen paroxide (H_2O_2) is used as a mild oxidant. Ozone (O_3) is also a chemical oxidant. Nascent oxygen is generated by chemical oxidants and it is used for the oxidation reaction.

$O_3 \rightarrow O_2 + [O]$

$H_2O_2 \rightarrow H_2O + [O]$

$K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3\,[O]$

$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5\,[O]$

Nascent oxygen is a state prior to the formation of the O_2 molecule. It is the reactive form of oxygen and is represented by writing the symbol as [O].

Use your brain power !

1. Which is the oxidant used for purification of drinking water?
2. Why is potassium permanganate used during cleaning water tanks?

We have seen just now that potassium permanganate is a chemical oxidant. Now have a look at the following reaction.

$$2KMnO_4 + 10FeSO_4 + 8H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 8H_2O \quad \ldots\ldots (25)$$

Which compound is oxidised by $KMnO_4$ in presence of acid in this reaction? Of course $FeSO_4$.

Here $FeSO_4$ is transformed into $Fe_2(SO_4)_3$. Let us now see, how this conversion is an oxidation reaction.

$$2FeSO_4 \longrightarrow Fe_2(SO_4)_3$$

Ionic reaction $\quad Fe^{2+} + SO_4^{2-} \longrightarrow 2Fe^{3+} + 3SO_4^{2-}$

The net change taking place in the above conversion is shown by the net ionic reaction as shown below.

Net ionic reaction $\quad Fe^{2+} \longrightarrow Fe^{3+}$

(Ferrous) (Ferric)

This net ionic reaction represents the oxidation brought about by $KMnO_4$. When ferric ion is formed from ferrous ion the positive charge is increased by one unit. While this happens the ferrous ion loses one electron. From this, we understand a new defination of oxidation, which is "oxidation means losing one or more electrons."

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Can you tell?

Look at the chemical equation (6). What is the type of this reaction, in which vanaspathi ghee is formed from vegetable oil?

The chemical reactions in which reactants gain hydrogen are called 'reduction' reactions. Similarly, the reaction in which a reactant loses oxygen to form the product is also called reduction reaction. The substance that brings about reduction is called a reductant, or a reducing agent.

When hydrogen gas is passed over black copper oxide a reddish coloured layer of copper is formed.

$$CuO + H_2 \longrightarrow Cu + H_2O \quad \text{..... (26)}$$

Which is the reductant in this reaction? And which reactant has undergone reduction?

In this reaction an oxygen atom goes away from CuO (copper oxide), which means that reduction of copper oxide takes place, whereas hydrogen molecule takes up oxygen atom and water (H_2O) is formed meaning, oxidation of hydrogen takes place. Thus oxidation and reduction reactions occur simultaneously. The reductant is oxidized by the oxidant and the oxidant is reduced by the reductant. Due to this characteristics of the reduction and oxidation reactions, a single term 'redox reaction' is used in place of the two terms.

Redox Reaction = Reduction + Oxidation

Use your brain power !

1. Some more examples of redox reaction are as follows. Identify the reductants and oxidants from them.

$$2H_2S + SO_2 \longrightarrow 3S\downarrow + 2H_2O \quad \text{..... (27)}$$

$$MnO_2 + 4\,HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2\uparrow \quad \text{..... (28)}$$

2. If oxidation means losing electrons, what is meant by reduction?

3. Write the reaction of formation of Fe^{2+} by reduction Fe^{3+} by making use of the symbol (e^-).

Think about it

The luster of the surface of the aluminium utensils in the house is lost after a few days. Why does this happen?

When the positive charge on an atom or an ion increases or the negative charge on them decreases it is called oxidation, and when the positive charge decreases or the negative charge increases it is called reduction.

$$Fe \underset{\text{reduction}}{\overset{\text{oxidation}}{\rightleftharpoons}} FeO \underset{\text{reduction}}{\overset{\text{oxidation}}{\rightleftharpoons}} Fe_2O_3$$

Do you know ?

A redox reaction takes place during cellular respiration. Here the molecule of the enzyme called cytochrome C oxidase helps the transport of electron to bring about this reaction.

For more information refer to life processes in the living organisms.

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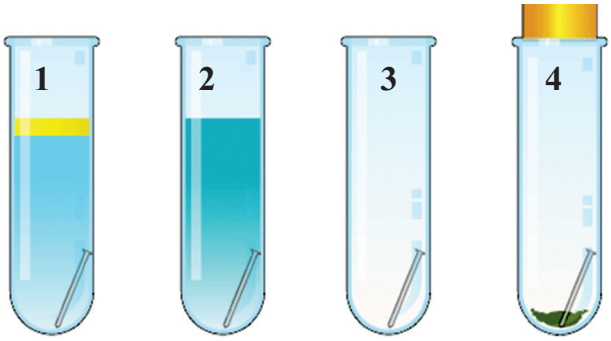
Corrosion

Try This.

Apparatus : Four test tubes, four small iron nails, rubber cork, etc.
Chemicals : Anhydrous calcium chloride, oil, boiled water, etc.

Procedure : Place four test tubes on a test tube stand. Take some boiled water in one test tube and put an oil layer on it. Take some salt water in the second test tube. Let there be only air in the third test tube. Take some anhyrous calcium chloride in the fourth test tube. Place a small iron nail in every test tube. Close the fourth test tube with a rubber cork. Let all the four test tubes remain un attended for a few days.



3.7 To study rusting

Observe all the four test tubes after a few days. What did you find? Which test tubes had the nails as before? Both water and air are necessary for rusting. The rusting process takes place rapidly in presence of a salt. Have you seen the effect of redox reaction in your everyday life? The new vehicles look shiny, on the contrary old vehicles look dull. A certain type of reddish coloured solid layer collects on their metallic surface. This layer is called 'rust'. Its chemical formula is $Fe_2O_3 \cdot X\ H_2O$.

The rust on iron does not form by a simple reaction of oxygen with iron surface. The rust is formed by an electrochemical reaction. Different regions on the surface of iron become anode and cathode.

1. Fe is oxidised to Fe^{2+} in the anode region.

$$Fe\ (s) \longrightarrow Fe^{2+}\ (aq) + 2\ e^-$$

2. O_2 is reduced to form water in the cathode region.

$$O_2\ (g) + 4H^+\ (aq) + 4\ e^- \longrightarrow 2H_2O\ (l)$$

When Fe^{2+} ions migrate from the anode region they react with water and further get oxidised to form Fe^{3+} ions.

A redish coloured hydrated oxide is formed from Fe^{3+} ions. It is called rust. It collects on the surface.

$$2Fe^{3+}(aq) + 4H_2O\ (l) \longrightarrow Fe_2O_3 \cdot H_2O\ (s) + 6H^+\ (aq) \quad \ldots\ldots\ldots (29)$$

Due to various components of atmosphere, oxidation of metals takes place, consequently resulting in their damage. This is called 'corrosion'. Iron rusts and a redish coloured layer is collected on it. This is corrosion of iron. Corrosion is a very serious problem . We are going to study about it in the next chapter.

Find out

How are the blackened silver utensils and patinated (greenish) brass utensils cleaned?

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Rancidity

When we use old, left over cooking oil for making food stuff, it is found to have foul odour called rancidity. If food is cooked in such oil, its taste also changes. When oil or ghee is left aside for a long time or fried food is left aside for a long time it undergoes air oxidation and becomes rancid. Rancidity in the food stuff cooked in oil or ghee is prevented by using antioxidants. The process of oxidation reaction of food stuff can also be slowed down by storing it in air tight container.

Exercise

1. Choose the correct option from the bracket and explain the statement giving reason.

(Oxidation, displacement, electrolysis, reduction, zinc, copper, double displacement, decomposition)

a. To prevent rusting, a layer of ..... metal is applied on iron sheets.

b. The conversion of ferrous sulphate to ferric sulphate is ..... reaction.

c. When electric current is passed through acidulated water ..... of water takes place.

d. Addition of an aqueous solution of $ZnSO_4$ to an aqueous solution of $BaCl_2$ is an example of ..... reaction.

2. Write answers to the following.

a. What is the reaction called when oxidation and reduction take place simultaneously? Explain with one example.

b. How can the rate of the chemical reaction, namely, decomposition of hydrogen peroxide be increased?

c. Explain the term reactant and product giving examples.

d. Explain the types of reaction with reference to oxygen and hydrogen. Illustratre with examples.

e. Explain the similarity and difference in two events, namely adding NaOH to water and adding CaO to water.

3. Explain the following terms with examples.

a. Endothermic reaction

b. Combination reaction

c. Balanced equation

d. Displacement reaction

4. Give scientific reasons.

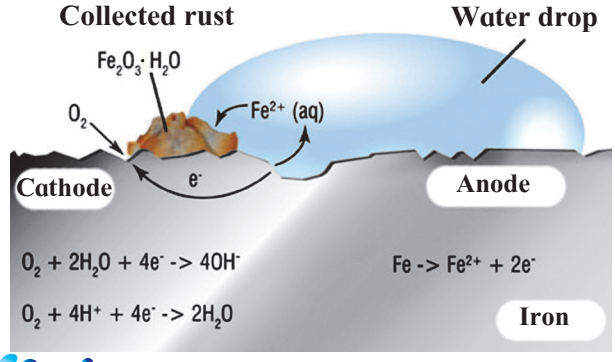
a. When the gas formed on heating limstone is passed through freshly prepared lime water, the lime water turns milky.

b. It takes time for pieces of Shahabad tile to disappear in HCl, but its powder disappears rapidly.

c. While preparing dilute sulphuric acid from concentrated sulphuric acid in the laboratory, the concentrated sulphuric acid is added slowly to water with constant stirring.

d. It is reccommended to use air tight container for storing oil for long time.

5. Observe the following picture a write down the chemical reaction with explanation.



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6. Identify from the following reactions the reactants that undergo oxidation and reduction.

a. $Fe + S \longrightarrow FeS$

b. $2Ag_2O \longrightarrow 4\ Ag + O_2\uparrow$

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

d. $NiO + H_2 \longrightarrow Ni + H_2O$

7. Balance the following equation stepwise.

a. $H_2S_2O_7(l) + H_2O(l) \longrightarrow H_2SO_4(l)$

b. $SO_2(g) + H_2S(aq) \longrightarrow S(s) + H_2O\ (l)$

c. $Ag(s) + HCl(aq) \longrightarrow AgCl\downarrow + H_2\uparrow$

d. $NaOH\ (aq) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + H_2O(l)$

8. Identify the endothermic and exothermic reaction.

a. $HCl + NaOH \longrightarrow NaCl + H_2O + heat$

b. $2KClO_3(s) \xrightarrow{\Delta} 2KCl(s) + 3O_2\uparrow$

c. $CaO + H_2O \longrightarrow Ca(OH)_2 + heat$

d. $CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2\uparrow$

9. Match the column in the following table.

Reactants	Products	Type of chemical reaction
$BaCl_2\,(aq) + ZnSO_4\,(aq)$	$H_2CO_3(aq)$	Displacement
$2AgCl(s)$	$FeSO_4\,(aq) + Cu\,(s)$	Combination
$CuSO_4\,(aq) + Fe\,(s)$	$BaSO_4\downarrow + ZnCl_2\,(aq)$	Decomposition
$H_2O(l) + CO_2(g)$	$2Ag(s) + Cl_2(g)$	Double displacement

Project

Prepare aqueous solutions of various solid salts available in the laboratory. Observe what happens when aqueous solution of sodium hydroxide is added to these. Prepare a chart of double displacement reactions based on these observation.

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4. Effects of electric current

- **Energy transfer in electric circuit.**
- **Heating effects of electric current.**
- **Magnetic effects of electric current.**

Can you recall?

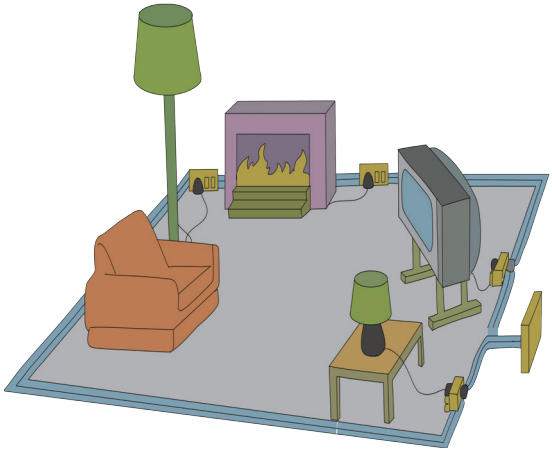
1. How do we decide that a given material is a good conductor of electricity or is an insulator?
2. Iron is a conductor of electricity, but when we pick up a piece of iron resting on the ground, why don't we get electric shock?

We have learnt in earlier standards about static electricity. We performed various experiments regarding negatively and positively charged objects. The reason behind the object becoming positively and negatively charged is the transfer of negatively charged particles from one object to another object. In previous standard, we also studied about electric current.

In this chapter, we will study about an electric current flowing through a conducting wire, an electric current flowing through a resistor, electromagnetic induction, electric motor and generator.

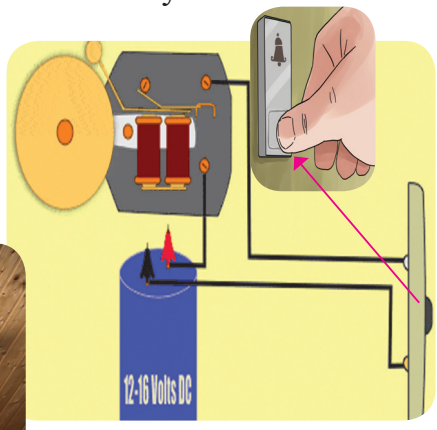
Observe and Discuss

What do you observe in the following pictures?
Which effects of electric current do you find?



a

b



c

4.1 Effects of electric current

Energy transfer in an electric circuit

Try this

Materials: connecting wires, electric cells, electrical resistance, voltmeter, ammeter, plug key.

Procedure: Connect the circuit as shown in the accompanying figure 4.2 after taking the components with proper values. Measure the current (I). Also measure the potential difference (V_{AB}) between the two ends (A and B) of the resistance.

The potential at A is higher than the potential at B as the point A is connected to the positive electrode of the cell and the point B to the negative electrode of the cell.

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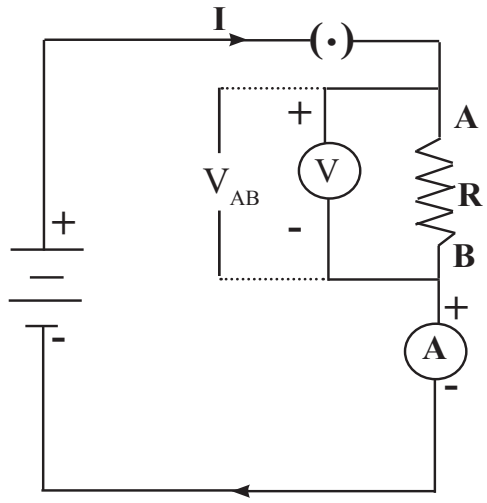


4.2 Electric circuit

If a charge Q flows from A to B, work V_{AB} Q, has been done on Q while going from A to B (Refer to chapter 3 of std 9). From where does the energy come to do this work? The source of energy is the cell. The cell gives this energy through the charge Q to the resistance where work V_{AB} Q is performed. If the charge Q flows from A to B in time t, i.e. the work is performed in time t, then during that time the energy V_{AB} Q is given to the resistor.

What happens to this energy? This energy is received by the resistor and is converted into heat energy, the temperature of the resistor is increased.

Use your brain power !

If in the circuit, the resistor is replaced by a motor, in which form will the energy given by the cell get transformed into?

$$P = \text{Electrical power} = \frac{\text{Energy}}{\text{Time required}} = \frac{V_{AB}\,Q}{t} = V_{AB}\,I \quad \ldots\ldots\ldots\ldots\ldots\ldots (1) \quad \because \quad \frac{Q}{t} = I \ ,$$

The source of energy, the cell, gives in time t, the energy P x t to the resistor. If I is the current flowing continuously through the circuit, the heat produced in the resistor in time t will be

$$H = P \times t = V_{AB} \times I \times t \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

According to Ohm's law,

$$V_{AB} = I \times R \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$H = V^2_{AB} \times \frac{t}{R} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Similarly, $H = I \times I \times R \times t = I^2 \times Rt$ ..... (5)

$H = I^2 \times R \times t$ is called Joules law of heating

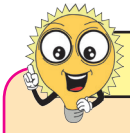
Unit of electrical power

$$P = V_{AB} \times I = \text{Volt x Amp} \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$1 \text{ Volt} \times 1 \text{ Amp} = \frac{1J}{1C} \times \frac{1C}{1s} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$\frac{1J}{s} = W \text{ (watt)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Thus the unit of electrical power is 1W (watt).



Think about it

How can we write mechanical power in a manner similar to the electrical power?

Heating effect of electric current

When a resistor is connected in an electrical circuit, heat is produced in it due to the current. This is known as the heating effect of current.

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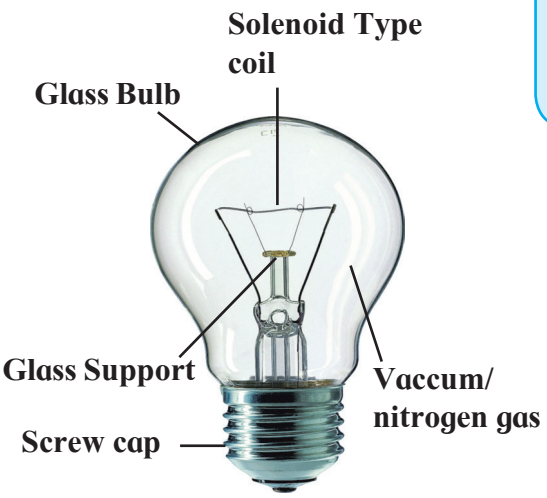
Coiled coil

Coil (Solenoid type)

Coil of cooker

Coil of Heater



4.3 Uses of coil

Find out

Check monthly electricity bill received from the electricity distribution Co. Ltd. Observe various details and get information about them. The electricity bill specifies the usage in 'Units'. What is this unit? When 1 kWh electrical energy is used, it is termed as 1 unit of energy.

Equipment such as water boiler, electric cooker, electric bulb make use of the heating effect of electric current. Electrical conductors having higher resistivity are used here. For example, a coil made up of an alloy Nichrome is used in the electric heater-cooker as a resistor, while a tungsten wire is used in an electric bulb. Because of the current, this wire gets heated (to nearly 3400 ^{0}C) and emits light. The hot wire also radiates heat to a certain extent.

Always remember

The unit of electric power 1W is a very small unit, hence 1000 W or 1 kW is used as a unit to measure electric power, in practice. If 1 kW power is used for 1 hour, it will mean 1kW × 1 hr of electrical energy is used (see equation 1)

1kWh =1 kilowatt hour = 1000 W × 3600 s

= 3.6 × 10^6 Ws = 3.6 x 10^6 J

Several times we hear or read about a building catching fire due to short circuit. Sometimes, if we switch on an equipment in our house, the electrical fuse wire melts and the electric supply shuts down. Let us discuss about the cause briefly. The home electrical connection consists of 'live', 'neutral' and 'earth' wires. The 'live' and the 'neutral' wires have potential difference of 220V. The 'earth' is connected to ground. Due to a fault in the equipment or if the plastic coating on the 'live' and the 'neutral' wires gives way, the two wires come in contact with each other and a large current flows through it producing heat. If any inflammable material (such as wood, cloth, plastic etc) exists around that place it can catch fire. Therefore, a fuse wire is used as a precautionary measure. We have learnt about fuse wire in the previous standard. As soon as high current flows in a circuit, the fuse wire melts and breaks the circuit and any mishap is avoided.

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Many times particularly in the summer season, huge electrical power is used in the evenings due to home lighting, fans, air conditioners, use of electricity in shops etc. As a result, excessive current is drawn from the transformer supplying the electricity, and if the capacity of the transformer is insufficient, its fuse wire melts and the supply gets shut down. Such events occur due to overloading.

4.4 Different types of fuses in use

Do you know ?

These days' miniature circuit breakers (MCB) switches are used in homes. When the current in the circuit suddenly increases this switch opens and current stops. Different types of MCBs are in use. For the entire house, however the usual fuse wire is used.

Solved examples

Example 1. A 6 m long wire made from an alloy, nichrome, is shaped into a coil and given for producing heat. It has a resistance of 24 ohms. Can we get more heat if the wire is cut into half of its original length and shaped into a coil? For getting energy, the two ends of the wire are connected to a source with a potential difference of 220V.

Given : Resistance 24 ohm, potential difference = 220 V

A. Coil of whole wire.

$$P = \frac{V^2}{R} = \frac{(220)^2}{24} = 201 \text{ watts}$$

B. Coil of half-length wire

$$P = \frac{V^2}{R} = \frac{(220)^2}{12} = 403 \text{ watts}$$

This means that more heat will be obtained after cutting the wire into half.

Example 2. A cell is connected to a 9 ohm resistance, because of which heat of 400 J is produced per second due to current flowing through it. Obtain the potential difference applied across the resistance.

Given:

Heat at 400 J per second means

$$P = \frac{400 \text{ J}}{1 \text{ s}}$$

$$P = \frac{V^2}{R}$$

$$400 = \frac{V^2}{9}$$

$$400 \times 9 = V^2$$

$$\therefore V = \sqrt{(400 \times 9)} = 20 \times 3 = 60 \text{ V}$$

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Example 3. An electrical iron uses a power of 1100 W when set to higher temperature. If set to lower temperature, it uses 330 W power. Find out the electric current and the respective resistances for the two settings. The iron is connected to a potential difference of 220 V.

Given: potential difference = 220 V.

Power P = (A) 1100 W, (B) = 330 W.

A. Power = 1100 W.

$$I_1 = \frac{P}{V} = \frac{1100}{220} = 5 \text{ A}$$

B. Power = 330 W

$$I_2 = \frac{P}{V} = \frac{330}{220} = 1.5 \text{ A}$$

$$\text{Resistance } R_1 = \frac{V}{I_1} = \frac{220}{5} = 44\ \Omega$$

$$\text{Resistance } R_2 = \frac{V}{I_2} = \frac{220}{1.5} = 146\ \Omega$$

Example 4. An electric tungsten bulb is connected into a home circuit. The home electric supply runs at 220 V potential difference. When switched on, a current of 0.45 A flows through the bulb. What must be power (wattage) of the bulb? If it is kept on for 10 hours, how many units of electricity will be consumed?

Given : Potential difference = 220 V.

Current = 0.45 A.

Power (W) = Potential difference(V) x Current (A)

= 220 x 0.45 W

= 99 W.

The bulb must be of power 99 W.

In 10 hrs,

99 W x 10 h =990 Wh.

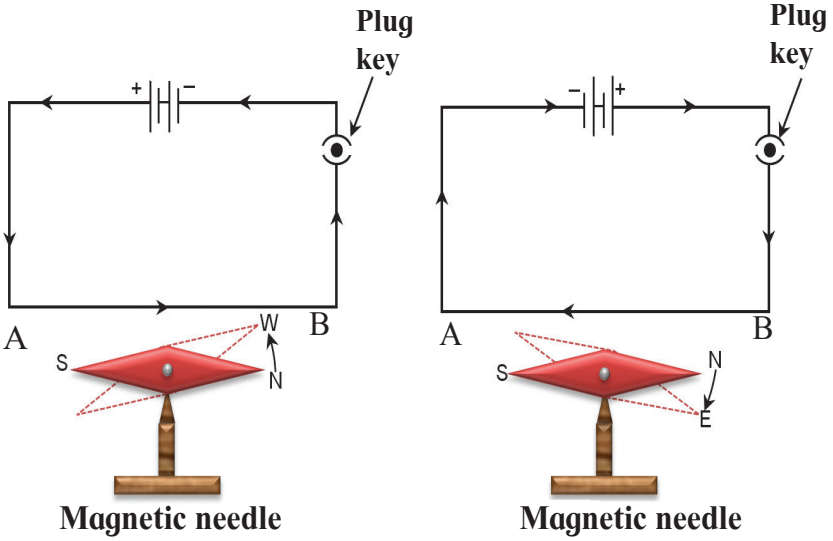
= 0.99 kWh.

Magnetic effect of electric current

We have learnt about heating effect of electric current. In previous standards, we have studied about magnets and magnetic lines of force. However, it will be interesting to see if an electric current and magnetic field are related to each other.

Try this

Connect the circuit as shown in figure 4.5. Connect a copper wire, thicker and straight as compared to the connecting wires, between A and B. Keep a magnetic needle adjacent to the wire. Keep the plug key open in the circuit and observe the direction of the needle. Close the plug key and observe the direction of the needle. What do you notice? Now interchange the connecting wires connected to the cell and observe the direction of the magnetic needle. Do you notice any relation between the direction of current and position of the needle?



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What do you learn from this experiment? The magnetic effect is observed because of the current in the wire. This means electricity and magnetism are closely related! On the contrary, if a magnet is moved and kept moving, will we observe any electric effect? Is it not exciting? Therefore, we are going to study magnetic fields and such 'electromagnetic' effects. Finally, we will study the principles, construction and working of electric motor and electric generator.

Introduction of Scientist

Hans Christian Oersted (1777-1851)

As a scientist at the forefront in the 19th century, Hans Christian Oersted played an important role in understanding 'electromagnetism'. He observed, in 1820, that when a current passes through a metal wire, the magnetic needle near the wire turns through a certain angle. He pointed out the relation between electricity and magnetism. Today's advanced technology is developed as a consequence. In his honour, the unit of intensity of the magnetic field is termed as Oersted.

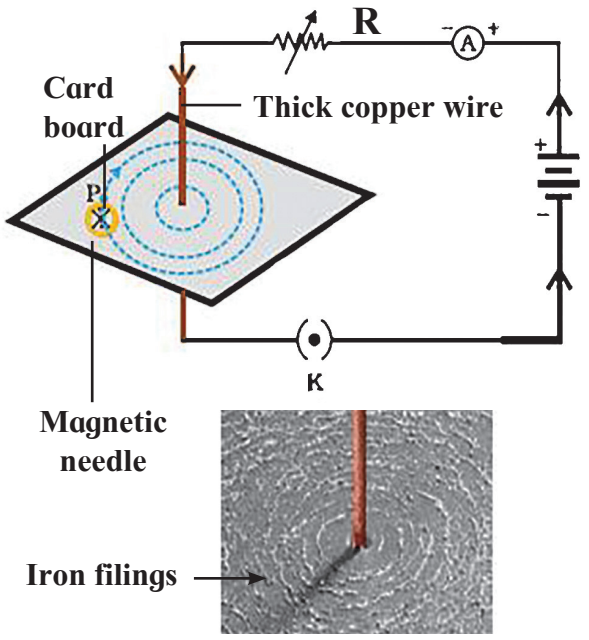
Try this

Connect the circuit as shown in fig. 4.6 When a large current (approximately 1A or more) flows through the thick copper wire passing through a cardboard, the magnetic needle kept at different points on the cardboard around the wire stands in different directions. Mark these directions with a pencil.

(Discuss with your friends and teachers about the requirement of the current, number of cells, cells of what potential difference, thickness of the wire etc., and then perform the experiment). The direction of the current shown in the circuit is its convential direction.

What changes are caused by increasing or decreasing current? What do you see when the magnetic needle is kept a little away from the wire? Now, instead of the magnetic needle, spread iron filings on the cardboard and observe. The iron filings arrange themselves in a circular manner around the wire. Why does this happen?

You have studied magnetism and magnetic field in previous standard. The iron filings spread along the magnetic lines of force.



4.6 Magnetic field produced around the conductor

Always remember

A magnetic field is produced around a straight current carrying conductor. If the current is unchanged, this magnetic field reduces as the distance from the wire increases. Therefore, the concentric circles representing the magnetic lines of force are shown bigger and rarefied as the distance from the wire increases. If the current through the wire is increased, the intensity of the magnetic field increases.

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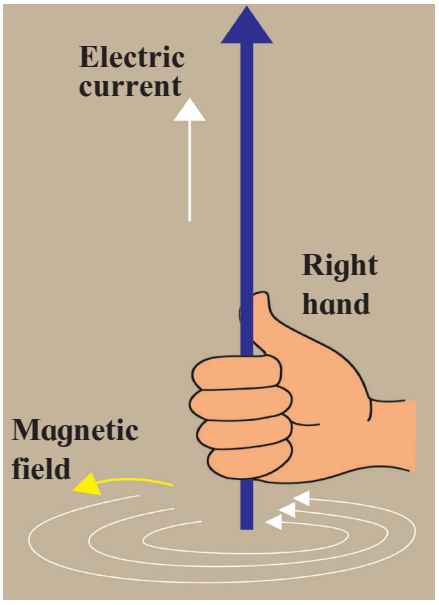
Right hand thumb Rule



4.7 Right hand thumb Rule

This is a convenient rule for finding out the direction of the magnetic field produced by a current flowing through an electrical conductor. Imagine that you have held the conductor in your right hand in such a way that your thumb points in the direction of the current. Then turn your fingers around the conductor, the direction of the fingers is the direction of the magnetic lines of force (Fig. 4.7).

Find Out

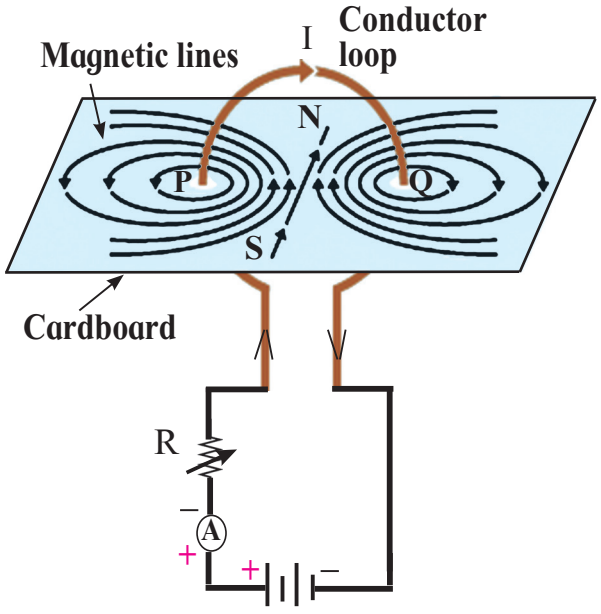
The right hand thumb rule is called Maxwell's cork-screw rule. What is the cork-screw rule?

Magnetic field produced by current through a circular loop of a conducting wire.

We learnt about the magnetic lines of force of a magnetic field produced by a current flowing through a straight conductor. What will happen to the magnetic lines of force of the field produced by a current flowing through a loop made by bending the straight wire?

A circuit is completed by connecting various components as shown in the figure 4.8. If the current passes through the loop, magnetic lines of force are produced at each point on the loop. As we go away from the wire, the concentric cirlces representing the magnetic lines of force will become bigger and bigger.

As we go towards the centre of the loop the circle become so big that its arc can be shown as a straight line.



4.8 Magnetic field produced by a current through a loop of conducting wire

In fig. 4.8, the magnetic lines of force are shown near the points P and Q only, however, they will be created near each point on the loop. Likewise, each point will produce magnetic field at the centre of the loop.

By making use of the right hand thumb rule, check that every point on the loop contributes the magnetic lines of force at the centre of the loop and these lines of force at the centre of the loop are in the same direction.

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The intensity of magnetic field at any point produced by a current flowing through a wire, is dependent on the current, as we have seen in the experiment (fig 4.6 Try this). This means that if there are n turns in the loop, the magnetic field n times of that produced by a single loop will be created.

On discussing with your teachers, with their guidance, see if you can perform the above experiment by collecting appropriate materials. The direction of the magnetic field can be determined with the help of a magnetic needle.

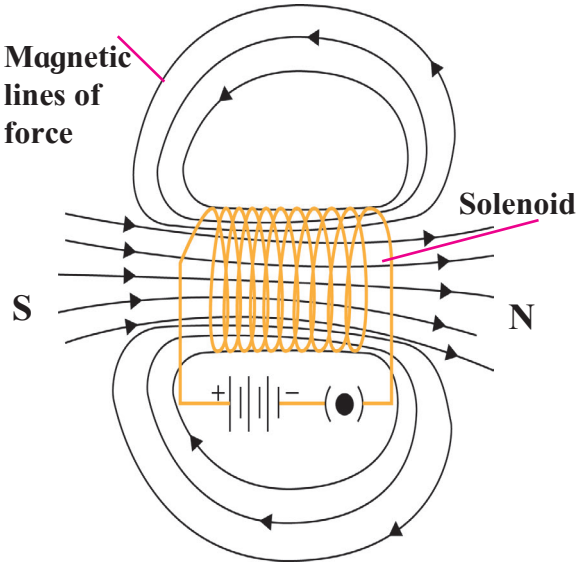
Magnetic field due to a current in a solenoid.

When a copper wire with a resistive coating is wound in a chain of loops (like a spring), it is called solenoid.

Whenever an electric current passes through a solenoid, magnetic lines of force are produced in a pattern as shown in figure 4.9.

You are aware of the magnetic lines of force of a bar magnet. The properties of the magnetic field of a solenoid are very similar to the magnetic field produced by a bar magnet.

One of the open ends of a solenoid acts as a magnetic north pole and the other as the magnetic south pole. The magnetic lines of force inside the solenoid are parallel to each other. What does this mean?



4.9 Magnetic lines of force of a magnetic field produced by a current passsing through a solenoid coil.

This means that the intensity of the magnetic field within the solenoid is uniform everywhere, i.e. the magnetic field in a solenoid is uniform.

Force acting on current carrying conductor in a magnetic field

Try this

Materials: Flexible copper wire, stand, electric cell, a horse shoe magnet with a strong magnetic field.

Procedure : Using the stand, fix the copper wire so that it passes through the poles of the horse shoe magnet as shown in the figure 4.10. Connect the circuit as well. What do you observe?

Whenever a current is not flowing through the wire, it remains straight (position A). When the current flows from top to bottom, the wire bends and comes into position C.

If the current direction is reversed, i.e. it flows from the bottom to the top end, the wire bends but comes in the position B. This means the direction of the force on the wire is perpendicular to both the magnetic field and the direction of the current.

Here, the direction of magnetic field is from N to S, (H). In this experiment it is noted that whenever current flows through a conductor in the presence of magnetic field a force is exerted on the conductor. If the direction of the current is reversed, the direction of the force also gets reversed. If the magnet is kept reversed, i.e. its south pole is brought at the positon of its North pole and its North pole brought to the position of its south pole, what will happen?

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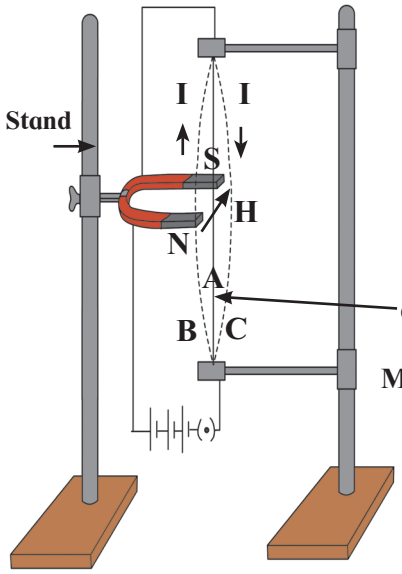
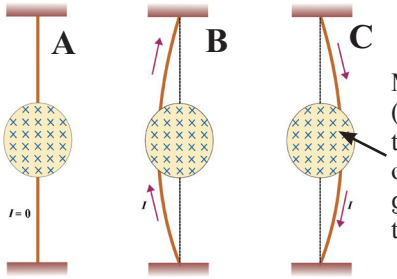


Experimental Setup

The above experiment clearly shows that a force is exerted on the current carrying conductor. The direction of this force depends on both the direction of the current and the direction of the magnetic field.

Experimentally, it is possible to show that this force is maximum when the direction of the current is perpendicular to the direction of the magnetic field. How will you do this?

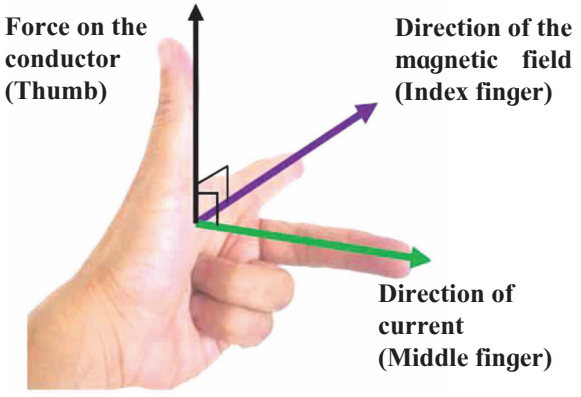


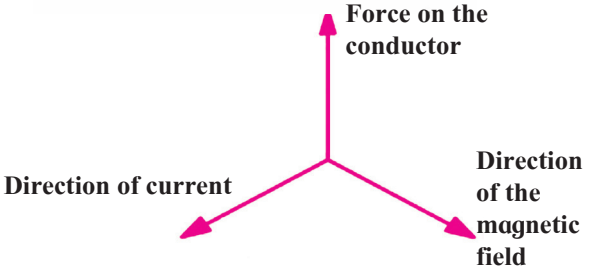
Schematic Diagram

4.10 Force acting on a current carrying conductor in the presence of a magnetic field

Fleming's left hand rule

In the above experiment we considered the direction of the electric current and the direction of the magnetic field and found that the direction of the force exerted is perpendicular to both. There is a simple rule relating these three directions. This rule is called Fleming's left hand rule. According to this rule, the left hand thumb, index finger, and the middle finger are stretched so as to be perpendicular to each other. If the index finger is in the direction of the magnetic field, and the middle finger points in the direction of the current, then the direction of the thumb is the direction of the force on the conductor.





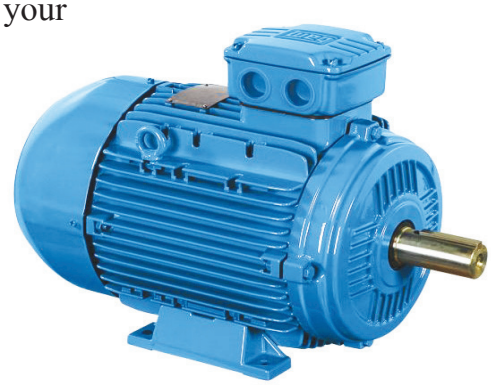
4.11 Fleming's left hand rule

Try this.

Determine the direction of the force on the wire in the above experiment and verify your finding.

Electric Motor

You know various forms of energy. You also know that energy can change its form. A device changing electrical energy into mechanical energy is known as electric motor. Around us, in our day-to day life, an electric motor is a boon. It is used in fans, refrigerators, mixers, washing machines, computers, pumps, etc. How does this motor work?



4.12 Electric motor in daily use

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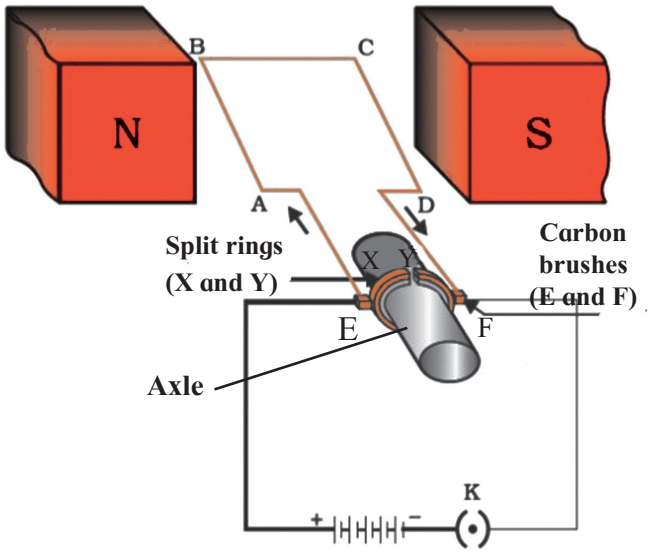
The electric motor consists of rectangular loop of copper wire having resistive coating. As shown in the figure, it is placed between the north pole and south pole of a magnet (such as a horse shoe magnet) in such a way that its branches AB and CD are perpendicular to the direction of magnetic field. The two ends of the loop are connected to the two halves (X and Y) of the split ring. The two halves of the ring have resistive coating on their inner surfaces and are tightly fitted on the axle. The two halves of the split ring, X and Y, have their outer conducting surfaces in contact with the two stationary carbon brushes, (E and F), respectively.



4.13 Electric motor: Principle and Working

When the circuit is completed as shown in the figure, the current flows in the branch AB of the loop from A to B through the carbon brushes E and F. Since the direction of the magnetic field is from north pole to south pole, according to the Fleming's left hand rule, a force is exerted on the branch AB and pushes it down. The current in the CD branch is in a opposite direction to that in the AB branch, and therefore, a force is exerted on the branch CD in upward direction. Thus, the loop and the axle start rotating in an anticlockwise direction. After half rotation, the two halves of the split ring X and Y come in contact with carbon brushes F and E, respectively, and the current in a loop starts flowing in the direction DCBA. Therefore, a force is exerted on the branch DC in downward direction and on the branch BA in the upward direction, and the loop continues to rotate in the anticlockwise direction. Thus, the current in the loop is reversed after each half rotation and the loop and the axle continue to rotate in the anticlockwise direction.

Commercial motors run on the same principle, but practical changes are made in their construction; you will learn that later.

Find Out

Why are carbon brushes used? How do these work? In order to find answers to such questions, visit a nearby workshop and try to understand the construction of an electric motor.

Electromagnetic Induction

We have seen in the previous section that if we keep an electric conductor in a magnetic field such that direction of the current flowing through the conductor in perpendicular to the magnetic field, then a force is exerted on the conductor. Because of this, the conductor moves. But if an electric conductor is moving in a magnetic field or the magnetic field around a stationary conductor is changing, what will happen? In order to find out an answer to this question, research was done by the great scientist Michael Faraday. In the year 1831 Faraday showed that an electric current can be produced in a conductor with the help of a moving magnet.

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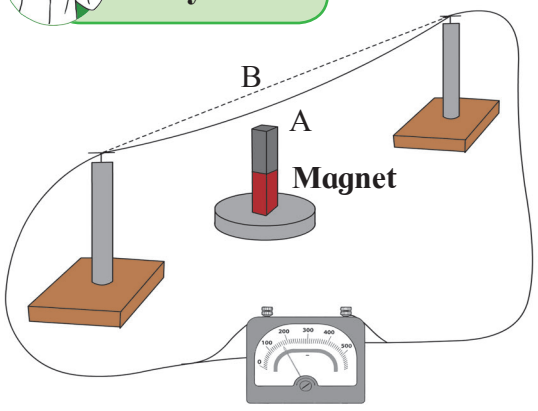
Galvanometer

Galvanometer is a sensitive device which works on the same principle as that of an electric motor that we have studied earlier. We can make some electrical measurements with it. A coil is positioned between the pole pieces of a magnet in such a way that the pointer on the galvanometer dial is connected to it. When a small current (for example 1 mA) flows through the coil, the coil will rotate. The rotation will be proportional to the current. Voltmeter and Ammeter also work on the same principle. In galvanometer, the pointer deflects on both the sides of the zero mark depending on the direction of the current.

4.14 Galvanometer

Try this.



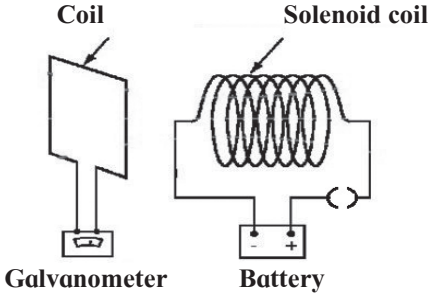
4.15 If a conducting wire is kept moving in a magnetic field, a current is produced in it.

Collect the material as shown in figure 4.15. Complete the circuit by connecting the galvanometer. Keep the bar magnet erect in such a way that its north or south pole is just below the copper wire. Now if the wire is kept moving from A ⟶ B , the pointer of the galvanometer gets deflected. This is called Faraday's electromagnetic induction. Now move the magnet with the wire fixed. The Galvanometer pointer still gets deflected.

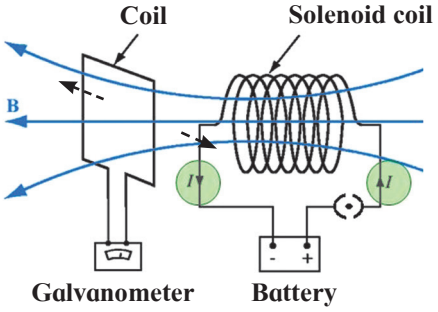
Try this.

Complete the circuit as shown in figure 4.16a. Discuss about and select the components as required. In this experiment, if we open the plugkey and make the current zero in the coil, the pointer of the Galvanometer deflects to a side and quickly comes back to zero. If the current in the coil is started again, the pointer again deflects to the other side and then returns quickly to zero.

Now when the electrical current is flowing through the solenoid coil and the solenoid coil is displaced with respect to the coil, the current is still produced in the coil.



4.16 (a) When the current in the solenoid coil is switched on or off



4.16 (b) when a current is passing through the solenoid coil and the coil is displaced laterally with respect the coil

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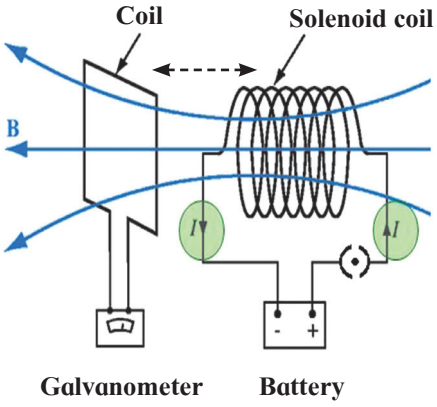
What can be inferred from these two experiments?

Even if the solenoid coil is kept stationary, a change in current in the solenoid coil produces a current in the coil. If the solenoid coil is moved towards or away from the coil, we see a deflection in the Galvanometer (fig 4.16c) Also, the faster is the displacement of the solenoid, larger is the deflection of the Galvanometer pointer. If the current in the solenoid coil is changed, a current is produced in the coil or if the solenoid coil is moved towards the coil, then also a current is produced in the coil.



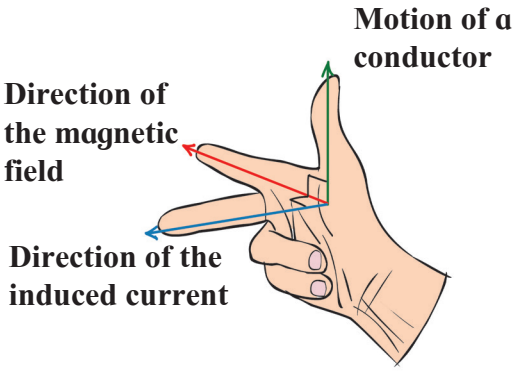
4.16 c) When a current passing through the solenoid coil and the solenoid coil is displaced longitudinally with respect to the coil

Faraday's law of induction:

If a current is switched on or off in the solenoid coil, a current is induced in the coil. Such as induction is also observed when the current in the solenoid coil is incresed or decreased. Current is induced in the coil when it is moved aside from front of the solenoid. From these experiments it is understood that whenever the number of magnetic lines of force passing through the coil changes, current is induced in the coil. This is known as Faraday's law of induction. The current produced in the coil is called the induced current.

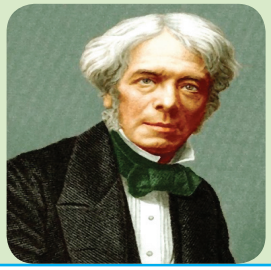
Fleming's right hand rule :

When will the induced current in the electrical conductor (coil) be maximum? It will be maximum when the direction of motion of the electric conductor is perpendicular to the magnetic field. In order to show the direction of the induced current, Fleming's right hand rule is very useful. Stretch the thumb, the index finger and the middle finger in such a way that they will be perpendicular to each other. In this position, the thumb indicates the direction of motion of the conductor, the index finger the direction of the magnetic field, and the middle finger shows the direction of the induced current. This rule is known as Fleming's right hand rule (fig 4.17).



4.17 Fleming's right hand rule

Introduction to Scientist



Michael Faraday (1791-1867) was an experimental scientist. He was not formally educated. Teenager Michael started working in a bookbinding shop. While reading books there, he got interested in science. Sir Humphrey Davy appointed him as a laboratory assistant in the Royal Institute London. There he discovered the laws of electrmagnetic induction and the laws of electrolysis. Several Universities offered him honorary degree, but Faraday refused to accept such honours.

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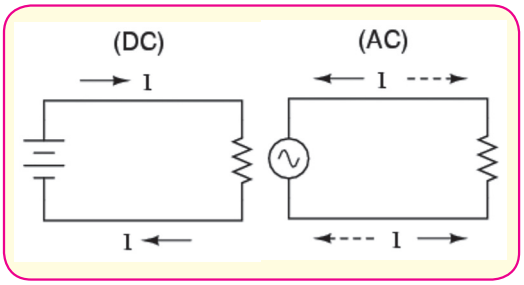
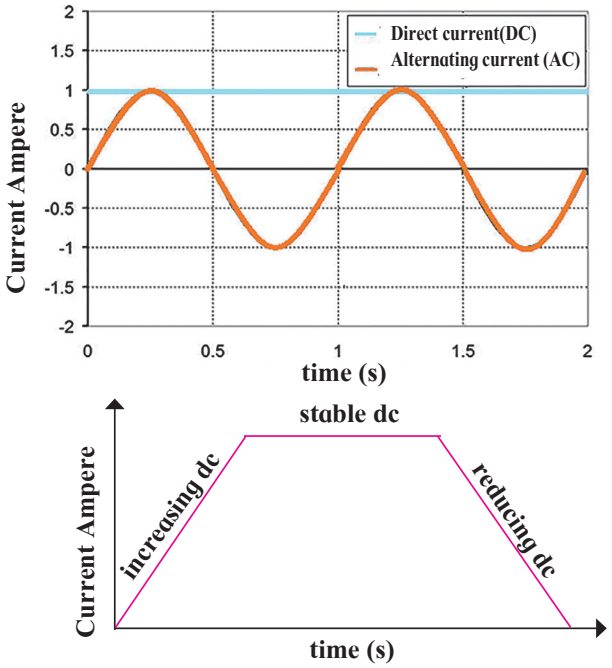
Alternating current (AC) and Direct Current (DC)

So far we have learnt about a non oscillatory current flowing in one direction, in a circuit, from the cell to the cell. Such a current is called a direct current (DC) as against a current changing in magnitude and direction after equal intervals of time which is called alternating current (AC).



4.18 AC current and DC current

The direct current can increase, can be stable, or can reduce also, but it is not osciallatory. This is shown graphically in the figure. Alternating current is oscillatory. As shown in the graph (fig 4.19), it increases to a maximum, then reduces to zero and increases to maximum in the other direction and again reduced to zero. (in the figure, magnitudes like -1, -2 have been used to show the reverse direction). The oscillation of the alternating current occurs in a sinusoidal manner with time and hence is shown by the symbol ~. Direct current flows in one direction, but the alternating current flows in periodic manner, in one cycle, in forward and reverse directions.



4.19 Alternating current and Direct current (Graphical)

In india, in the power stations generating electricity, one cycle changes in $\frac{1}{50}$ second i.e. the frequency of AC is 50 Hz (50 cycles per second). When the electric power is transmitted over a long distance, it is beneficial to have it in AC form as it results into minimum power loss during transmission. The home supply is of alternating current (AC). We have learnt in the previous class about the precautions to be taken while using the electricity.

Electric Generator

We have seen the experiments based on electromagnetic induction. The current produced in these experiments was of very small magnitude. But the same principle can be harnessed for the use of mankind to produce large current. Here, mechanical energy is used to rotate the current carrying coil in a magnetic field, around an axle, thereby producing electricity.

Fig 4.20 shows a copper wire coil ABCD, kept between th e two pole pieces of a magnet. The two ends of the coil are conected to the conducting rings R_1 and R_2 via carbon brushes. Both the rings are fixed to the axle, but there is a resistive coating in between the ring and the axle. The axle is rotated with the help of a machine from outside. Because of this, the coil ABCD starts rotating. The stationary carbon brushes B_1 and B_2 are connected to a galvanometer, which shows the direction of current in the circuit. Upon rotating the axle, the branch AB goes up and the branch CD goes down (i.e. the coil ABCD rotates clockwise).

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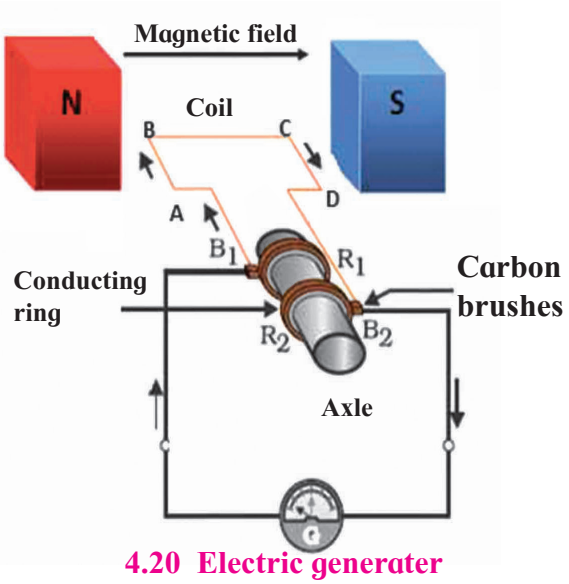
According to Fleming's right hand rule, electric current is produced in the branches AB and CD in the direction. A ⟶ B and C⟶D. Thus, the current flows in the direction A ⟶B⟶ C⟶ D (as shown by arrows in the figure). In the external circuit, the current flows from B_2 to B_1 through the galvanometer. If instead of one loop coil, a coil consisting of several turns is used, the current of magnitude several times flows. After half rotation, the branch AB takes the place of branch CD and the branch CD takes the position of the branch AB. Therefore, the induced current goes as D ⟶C ⟶B ⟶A .



4.20 Electric generater

But, the branch BA is always in contact with the brush B_1 and branch DC in the contct with B_2. Hence, in the external circuit current flows from B_1 to B_2 i.e. opposite to the previous half rotation. This reapeats after every half rotation and alternating current is produced. This is what is called an AC generator .

What will be required to make a DC generator? The DC does not change the direction in the external circuit. To achieve this, a split ring is fixed on the axle like a split ring used in electric motor. Because of this arrangement, the branch of the coil going upwards is always in contact with one brush and the branch going downwards is always in contact with the other brush. Hence, the current flows in one direction in the external circuit. This is why this generator is called as a DC generator.

Use your brain power !

Draw the diagram of a DC generator. Then explain as to how the DC current is obtained .

Exercise

1. Tell the odd one out. Give proper explanation.

a. Fuse wire, bad conductor, rubber gloves, generator.

b. Voltmeter, Ammeter, galvanometer, thermometer.

c. Loud speaker, microphone, electric motor, magnet.

2. Explain the construction and working of the follwoing. Draw a neat diagram and label it.

a. Electric motor

b. Electric Generator(AC)

3. Electromagnetic induction means-

a. Charging of an electric conductor.

b. Production of magnetic field due to a current flowing through a coil.

c. Generation of a current in a coil due to relative motion between the coil and the magnet.

d. Motion of the coil around the axle in an electric motor.

4. Explain the difference : AC generator and DC generator.

5. Which device is used to produce electricity? Describe with a neat diagram.

a. Electric motor

b. Galvanometer

c. Electric Generator (DC)

d. Voltmeter

6. How does the short circuit form? What is its effect?

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7. Give Scientific reasons.

a. Tungsten metal is used to make a solenoid type coil in an electric bulb.

b. In the electic equipment producing heat e.g. iron, electric heater, boiler, toaster etc, an alloy such as Nichrome is used, not pure metals.

c. For electric power transmission, copper or aluminium wire is used.

d. In practice the unit kWh is used for the measurement of electrical energy, rather than joule.

8. Which of the statement given below correctly describes the magnetic field near a long, straight current carrying conductor?

a. The magnetic lines of force are in a plane, perpendicular to the conductor in the form of straight lines.

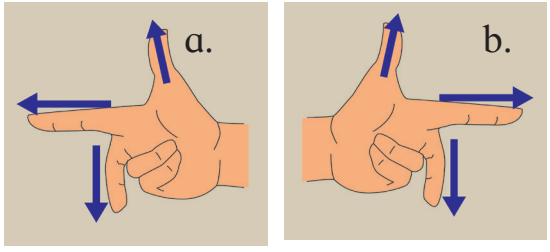
b. The magnetic lines of force are parallel to the conductor on all the sides of conductor.

c. The magnetic lines of force are perpendicular to the conductor going radially outword.

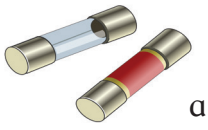
d. The magnetic lines of force are in concentric circles with the wire as the center, in a plane perpendicular to the conductor.

9. What is a solenoid? Compare the magnetic field produced by a solenoid with the magnetic field of a bar magnet. Draw neat figures and name various components.

10. Name the following diagrams and explain the concept behind them.

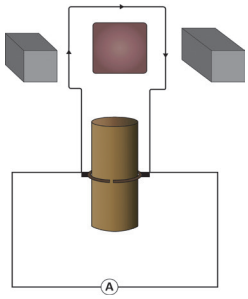


11. Identify the figures and explain their use.


a.


b.

c.



12. Solve the following example.

a. Heat energy is being produced in a resistance in a circuit at the rate of 100 W. The current of 3 A is flowing in the circuit. What must be the value of the resistance?**(Ans : 11 Ω)**

b. Two tungsten bulbs of wattage 100 W and 60 W power work on 220 V potential difference. If they are connected in parallel, how much current will flow in the main conductor? **(Ans : 0.72A)**

c. Who will spend more electrical energy? 500 W TV Set in 30 mins, or 600 W heater in 20 mins? **(Ans : TV Set)**

d. An electric iron of 1100 W is operated for 2 hrs daily. What will be the electrical consumption expenses for that in the month of April? (The electric company charges Rs 5 per unit of energy). **(Ans : Rs 330)**

Project

Under the guidance of your teachers, make a 'free-energy generator'.

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5. Heat

- Latent heat
- Anomalous behaviour of water
- Specific heat capacity
- Regelation
- Dew point and humidity

Can you recall?

1. What is the difference between heat and temperature?
2. What are the different ways of heat transfer?

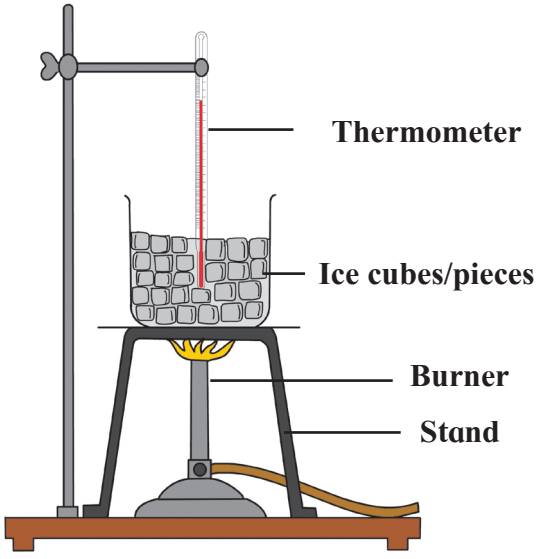
In the previous standard, we have learnt about heat and different types of heat transfer. We have also performed few experiments related to expansion and contraction of solids, liquids and gases. We have learnt about the difference between heat and temperature. We have also seen how temperature is measured using a thermometer.

Concepts like latent heat of phase transformation, anomalous behaviour of water, dew point, humidity, specific heat capacity etc are related to certain phenomena experienced by us in our day-to-day life. Let us learn more about these concepts.

Latent heat

Try this

1. Take a few pieces of ice in a glass beaker. As shown in figure 5.1.
2. Insert the bulb of a thermometer in ice and measure its temperature.
3. Put the beaker on a stand and heat the ice using a burner.
4. Record the temperature using the thermometer after every minute.
5. As the ice is heated, it starts melting. Stir the mixture of ice and water.
6. Continue the heating even after ice starts melting.
7. Draw a graph of temperature versus time.



5.1 Latent heat

You will observe that the temperature of the mixture remains 0 °C till the ice melts completely. If we continue heating, even after conversion of all the ice into water, the temperature of water starts rising and reaches 100 °C. At this temperature water starts converting into steam. The temperature of water remains constant at 100 °C till all water converts into steam. The graph of temperature versus time is shown in figure 5.2.

In this graph, line AB represents conversion of ice into water at constant temperature. When ice is heated it melts at 0 °C and converts into water at this constant temperature. The ice absorbs heat energy during this transition and the absorption of energy continues till all the ice converts into water.

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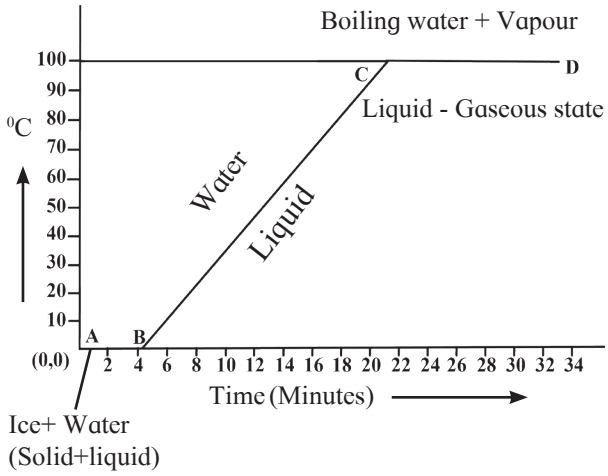
The temperature remains constant during this transition. This constant temperature, at which the ice converts into water is called the melting point of ice.

Thus, during transition of solid phase to liquid, the object absorbs heat energy, but its temperature does not increase. This heat energy is utilised for weakening the bonds between the atoms or molecules in the solid and transform it into liquid phase. The heat energy absorbed at constant temperature during transformation of solid into liquid is called the latent heat of fusion.



5.2 Temperature vs Time Graph

The amount of heat energy absorbed at constant temperature by unit mass of a solid to convert into liquid phase is called the specific latent heat of fusion.

Once all the ice is transformed into water, the temperature of water starts rising. It increases upto 100 °C. Line BC in the graph represents rise in temperature of water from 0 °C to 100 °C. Thereafter, even though heat energy is supplied to water, its temperature does not rise. The heat energy is absorbed by water at this temperature and used to break the bonds between molecules of the liquid and convert the liquid into gaseous state. Thus, during transformation from liquid phase to gas phase, heat energy is absorbed by the liquid, but its temperature does not change. The constant temperature at which the liquid transforms into gaseous state is called the boiling point of the liquid. The heat energy absorbed at constant temperature during transformation of liquid into gas is called the latent heat of vaporization.

The amount of heat energy absorbed at constant temperature by unit mass of a liquid to convert into gaseous phase is called the specific latent heat of vaporization.

Different substances have different melting points and boiling points. The values of melting point, boiling point and latent heat depend on atmospheric pressure.

Substance	Melting point ^{0}C	Boiling point ^{0}C	Specific latent heat of fusion		Specific latent heat of vaporization	
			kJ/kg	cal/g	kJ/kg	cal/g
Water/ Ice	0	100	333	80	2256	540
Copper	1083	2562	134	49	5060	1212
Ethyl alcohol	-117	78	104	26	8540	200
Gold	1063	2700	144	15.3	1580	392
Silver	962	2162	88.2	25	2330	564
Lead	327.5	1749	26.2	5.9	859	207

Use your brain power !

1. Is the concept of latent heat applicable during transformation of gaseous phase to liquid phase and from liquid phase to solid phase?
2. Where does the latent heat go during these transformations?

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Regelation

You may have seen the preparation of an ice-ball. First, an ice slab is shredded and then the shredded ice is pressurised around the tip of a stick to prepare the ice-ball. How does the shredded ice convert into solid ice ball? If two small pieces of ice are taken and pressed against each other for a while, they stick to each other. Why does this happen?

Try this

Take a small slab of ice, a thin wire, two identical weights.

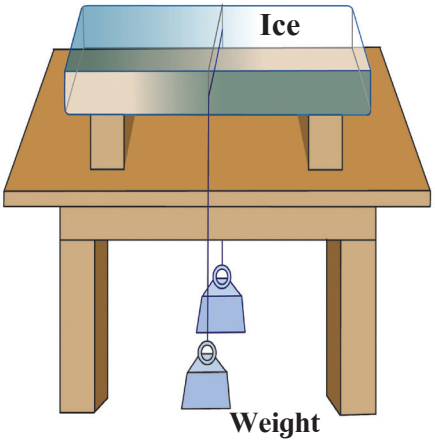
Activity:

1. Put a slab of ice on a stand as shown in Figure 5.3.
2. Hang two equal weights to the two ends of a metal wire and put the wire on the slab as shown in the figure.

   What do you observe?

   It is observed that the wire gradually penetrates the ice slab. After some time, the wire comes out of the lower surface of the ice slab. However, the ice slab does not break. The phenomenon in which the ice converts to liquid due to applied pressure and then re-converts to ice once the pressure is removed is called regelation.

   The melting point of ice becomes lower than 0 ^{0}C due to pressure. This means that at 0 ^{0}C, the ice gets converted into water. As soon as the pressure is removed, the melting point is restored to 0 ^{0}C and water gets converted into ice again.



5.3 Regelation

Use your brain power !

1. In the above experiment, the wire moves through the ice slab. However, the ice slab does not break. Why?
2. Is there any relationship of latent heat with the regelation?
3. You know that as we go higher than the sea level, the boiling point of water decreases What would be effect on the melting point of solid?

Can you tell?

We feel that some objects are cold, and some are hot. Is this feeling related in some way to our body temperature?

Anomalous behaviour of water

In general, when a liquid is heated upto a certain temperature, it expands, and when cooled it contracts. Water, however, shows a special and exceptional behaviour. If we heat water from 0 ^{o}C upto 4 ^{o}C, it contracts instead of expanding. At 4 ^{o}C its volume is minimum (due to contraction). If the water is heated further, it expands and its volume increases. The behaviour of water between its temperature from 0 ^{o}C to 4 ^{o}C is called anomalous behaviour of water.

If 1 kg of water is heated from 0 ^{o}C and its volume is plotted as a function of temperature, we get the graph, shown in fig 5.4. At 4 ^{o}C, the volume of water is minimum. It means that the density of water is maximum at 4 ^{o}C.

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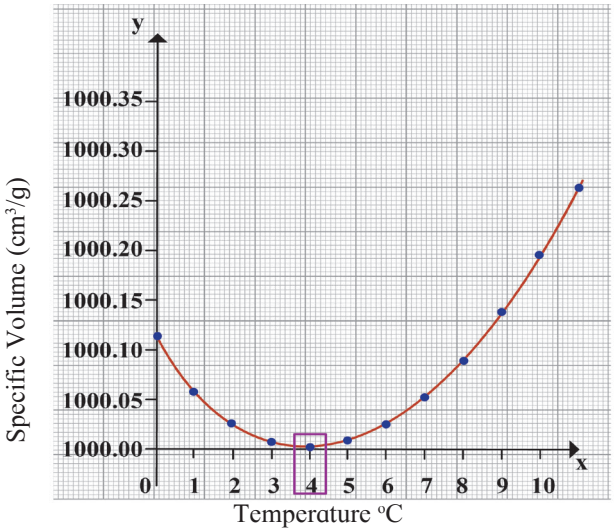
Study of anomalous behaviour of water using Hope's apparatus.

The anomalous behaviour of water can be studied with Hope's apparatus. In Hope's apparatus, a flat bowl is attached to a cylindrical container as shown in figure 5.5. There is provision to attach thermometers above (to measure temperature T_2) and below (to measure temperature T_1) the flat bowl on the cylindrical container. Water is filled in the cylindrical container and a mixture of ice and salt (freezing mixture) is put in the flat bowl.



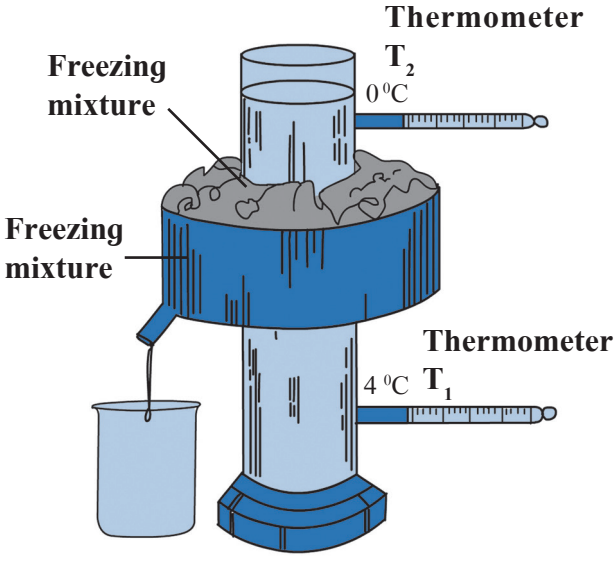
5.4 Graph between the volume and temperature of water

During the study of anomalous behaviour of water using Hope's apparatus, temperature T_1 and T_2 are recorded after every 30 seconds.

The temperatures are plotted on the Y-axis and the time in minutes on the X-axis. The graph is shown in figure 5.6. The graph shows that initially, both the temperatures T_1 and T_2 are identical. However, as time passes, temperature T_1 of water in the lower part of the cylinder decreases fast, while, temperature T_2 of water in the upper part of the cylinder decreases comparatively slowly.

However, once the temperature T_1 of the lower part reaches 4 °C, it remains almost stable at that temperature. T_2 decreases slowly to 4 °C. Thereafter, since T_2 starts changing rapidly, it records 0 °C first and after that the lower thermometer T_1 records 0°C temperature. The point of intersection of the two curves shows the temperature of maximum density.

How can we explain these observations? Initially, the temperature of water in the middle of cylinder lowers due to freezing mixture in the outer bowl. Since the temperature of water there decreases, its volume decreases, and its density increases. The water with higher density moves downwards. Therefore, the lower thermometer T_1 shows rapid fall in temperature and this continues till the temperature of water becomes equal to 4 °C. When the temperature of water starts decreasing below 4 °C, its volume increases, and density decreases. It, therefore, moves in the upward direction. The temperature of water in upper part (T_2), therefore, decreases rapidly to 0 °C. The temperature of water in the lower part (T_1), however, remains at 4 °C for some time and then decreases slowly to 0 °C.



5.5 Hope's Apparatus

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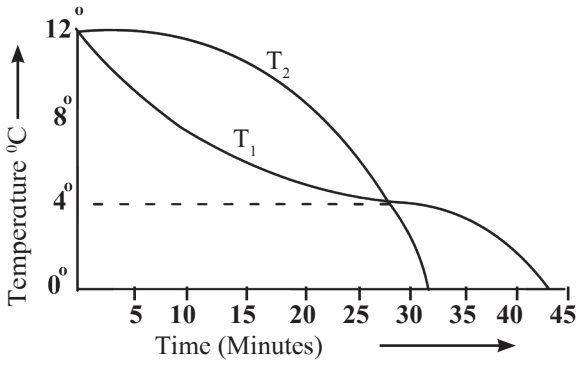
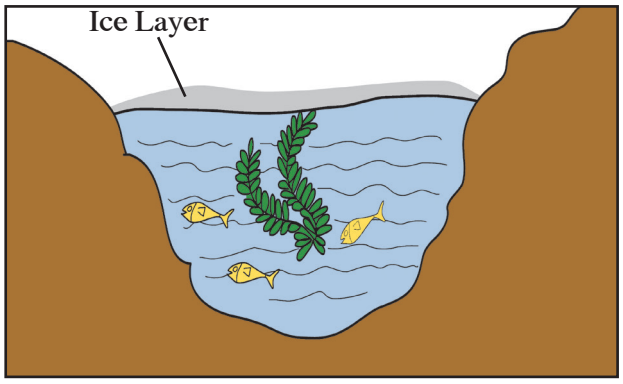


5.6 Time - Temperature Graph



5.7 Aquatic animals in cold regions

Use your brain power !

How will you explain following statements with the help of the anomalous behaviour of water?

1. In regions with cold climate, the aquatic plants and animals can survive even when the atmospheric temperature goes below 0 °C (See figure 5.7).
2. In cold regions in winter the pipes for water supply break and even rocks crack.

Dew point and Humidity

About 71% surface of the Earth is covered with water. Due to constant evaporation of water, water vapor is always present in the atmosphere. The amount of water vapor in the atmosphere helps us to understand the state of daily weather. The presence of water vapor in the air makes it moist. The moisture in the atmosphere is called humidity.

For a given volume of air, at a specific temperature, there is a limit on how much water vapor the air can contain. If the amount exceeds this limit, the excess vapor converts into water droplets. When the air contains maximum possible water vapor, it is said to be saturated with vapor at that temperature. The amount of vapor needed to saturate the air depends on temperature of the air. If air temperature is low, it will need less vapor to saturate the air. For example, if temperature of air is 40 °C, it can contain 49 grams of water vapor per kilogram of dry air without condensation. If the amount of vapor exceeds this limit, the additional vapor will condense. However, if the temperature of air is 20 °C, it can contain only 14.7 grams of water vapor per kilogram of dry air without condensing. If the vapor contained in air is less that the maximum limit, then the air is said to be unsaturated.

Suppose unsaturated air at a certain temperature is taken and its temperature is decreased, a temperature is reached at which the air becomes saturated with vapor. This temperature is called the dew point temperature.

The vapor content in the air is measured using a physical quantity called absolute humidity. The mass of vapor present in a unit volume of air is called absolute humidity. Generally absolute humidity is measured in kg/m^3.

The feeling of humid or dry nature of air not only depends on the amount of vapor in the air, but it also depends on how close that amount is for making the air saturated with vapor. It means that it depends on temperature of the air also.

The ratio of actual mass of vapor content in the air for a given volume and temperature to that required to make the air saturated with vapor at that temperature is called the relative humidity.

$$\% \text{ Relative humidity} = \frac{\text{actual mass of water vapor content in the air in a given volume}}{\text{mass of vapor needed to make the air saturated in that volume}} \times 100$$

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The relative humidity at the dew point is 100%. If the relative humidity is more than 60% we feel that the air is humid. If the relative humidity is less than 60%, we feel that the air is dry.

During winter season, you may have observed a white trail at the back of a flying plane in a clear sky. As the plane flies, the vapor released by the aeroplane engine condenses and forms clouds. If the surrounding air is having more relative humidity, it takes a long time for the white trail, formed by condensation of the vapor, to disappear. If relative humidity of the surrounding air is less, either the size of the white trail may be small or it may not even get formed.

Try this.

1. Take a bottle of cold water out of a refrigerator and keep it outside for a while. Observe the outer surface of the bottle.
2. Drops of water can be observed on the outer surface of bottle. In the same way, if we observe the leaves of plants/grass or window-glass of a vehicle in the early morning we see water droplets collected on the surface.

Through these two observations, we sense the presence of water vapor in the atmosphere. When air cools, due to decrease in temperature it becomes saturated with water vapor. As a result, the excess water vapor gets converted into tiny droplets. The dew-point temperature is decided by the amount of vapor in the air.

Unit of heat

The units of heat are Joule (J) in SI units, cal (calorie) in cgs units.

The amount of heat necessary to raise temperature of 1 g of water by 1 ^{o}C from 14.5 ^{o}C to 15.5 ^{o}C is called one cal heat.

Similarly, the amount of heat necessary to raise the temperature of 1 kg of water by 1 ^{o}C from 14.5 ^{o}C to 15.5 ^{o}C is called one kcal heat.

It is clear that (1 kcal= 1000 cal).

Always remenber

If we heat 1 kg of water by 1^{o}C in different temperature range than 14.5 ^{o}C to 15.5 ^{o}C, the amount of heat required will be slightly different. It is, therefore, essential to define a specific temperature range while defining the unit of heat. Calorie and Joule are related by following relation: 1 cal = 4.18 Joule

Introduction to Scientist

James Prescot Joule (1818-1889) : He was the first person to show that the kinetic energy of tiny particles of matter appears as heat energy and also that energy can be converted from one form to another. Conversion of heat energy to work gives the first law of thermodynamics. The unit of heat is called Joule (J) after him.

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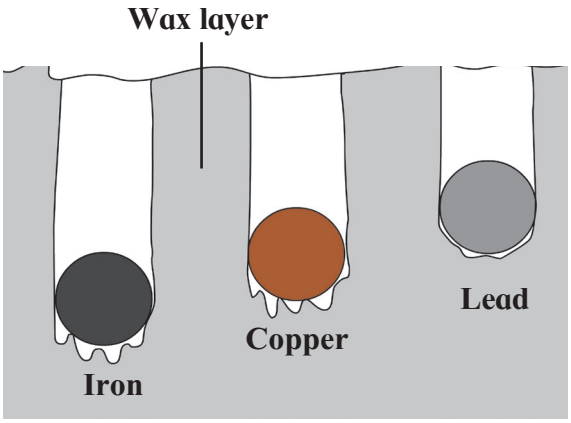
Specific Heat Capacity

Try this.

Material : A tray with thick layer of wax, solid spheres of iron, lead and copper of equal mass, burner or spirit lamp, large beaker.

Procedure :

1. Take three spheres of iron, copper and lead of equal mass (Fig. 5.8)
2. Put all the three spheres in boiling water in the beaker for some time.
3. Take the three spheres out of the water. All the spheres will be at temperature 100 °C. Put them immediately on the thick slab of wax.
4. Note, the depth that each of the sphere goes into the wax.



5.8 Specific heat capacity of metals

The sphere which absorbs more heat from the water will give more heat to wax. More wax will thus melt and the sphere will go deeper in the wax. It can be observed that the iron sphere goes deepest into the wax. Lead sphere goes the least and copper sphere goes to intermediate depth. This shows that for equal rise in temperature, the three spheres have absorbed different amounts of heat. This means that the property which determines the amount of heat absorbed by a sphere is different for the three spheres. This property is called the specific heat capacity.

The amount of heat energy required to raise the temperature of a unit mass of an object by 1 °C is called the specific heat of that object.

The specific heat capacity is denoted by letter 'c'. The SI unit of specific heat is J/ °C kg, and the CGS unit is cal/g °C.

S. No.	Substance	Specific heat (cal/g °C)	S. No.	Substance	Specific heat (cal/g °C)
1.	Water	1.0	5.	Iron	0.110
2.	Paraffin	0.54	6.	Copper	0.095
3.	Kerosene	0.52	7.	Silver	0.056
4.	Aluminium	0.215	8.	Mercury	0.033

5.9 Specific heat capacity of some substances

If specific heat of an object is 'c', the mass of the object is 'm' and if the temperature of the object is raised by ΔT °C, the heat energy absorbed by the object is given by,

$$m \times c \times \Delta T.$$

In the same way if specific heat of an object is 'c', the mass of the object is 'm' and if the temperature of the object is decreased by ΔT °C, then the heat energy lost by the object will be,

$$m \times c \times \Delta T.$$

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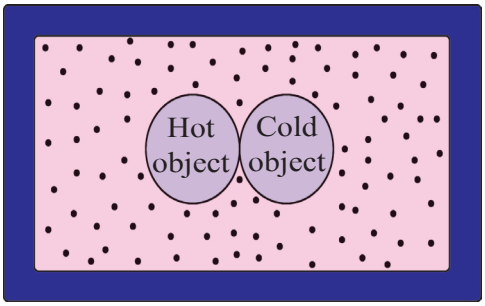
Heat Exchange If heat is exchanged between a hot and cold object, the temperature of the cold object goes on increasing due to gain of energy and the temperature of the hot object goes on decreasing due to loss of energy. The change in temperature continues till the temperatures of both the objects attain the same value. In this process, the cold object gains heat energy and the hot object loses heat energy. If the system of both the objects is isolated from the environment by keeping it inside a heat resistant box (meaning that the energy exchange takes place between the two objects only), then no energy can flow from inside the box or come into the box (fig 5.10). In this situation, we get the following principle



5.10 Box of heat resistant material

Heat energy lost by the hot object = Heat energy gained by the cold object. This is called as 'Principle of heat exchange'

Measurement of specific heat: (mixing method) and calorimeter

The specific heat of an object can be measured using mixing method. For this calorimeter is used. You have learnt about calorimeter in the previous standard. If a hot solid object is put in the water in a calorimeter, heat exchange between the hot object and the water and calorimeter starts. This continues till the temperatures of the solid object, water and the calorimeter become equal. Therefore,

Heat lost by solid object = heat gained by water in calorimeter + heat gained by the calorimeter.

Here, heat lost by the solid object (Q) = mass of the solid object × its specific heat × decrease in its temperature.

Similarly,

Heat gained by the water (Q_1)= mass of the water × its specific heat × increase in its temperature

Heat gained by the calorimeter (Q_2)= mass of the calorimeter × its specific heat × increase in its temperature.

Heat lost by hot object = Heat gained by calorimeter + Heat gained by water.

$$Q = Q_2 + Q_1$$

Using these equations, if the specific heat of water and the calorimeter are known, the specific heat of the solid object can be calculated.

ICT :

Prepare a presentation using videos, pictures,audios, graphs etc. to axplain various concepts in this chapter. Collect all such material from the Internet, using Information Technology. Under the guidance of your teachers, arrange a competition of such presentations in your class.

Solved Examples

Example 1: How much heat energy is necessary to raise the temperature of 5 kg of water from 20 °C to 100 °C.

Given: m= 5 kg, c = 1 kcal/kg °C and change in temperature ΔT = 100-20 = 80°C

Energy to be supplied to water = energy gained by water

= mass of water × specific heat of water × change in temperature of water

= m × c × ΔT

= 5 × 80 °C

= 400 kcal

Hence, the heat energy necessary to raise the temperature of water = 400 kcal.

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Example 2: A copper sphere of 100 g mass is heated to raise its temperature to 100 °C and is released in water of mass 195 g and temperature 20 °C in a copper calorimeter. If the mass of calorimeter is 50 g, what will be the maximum temperature of water?

Given: Specific heat of copper = 0.1 cal/g °C

And so specific heat of calorimeter= 0.1 cal/ g °C

Suppose the copper ball water and the calorimeter attain final temperature T.

Heat lost by solid object = heat gained by water in calorimeter + heat gained by the calorimeter.

Here, heat lost by the copper ball = mass of the copper ×specific heat of copper × decrease in temperature of the ball

$Q = 100 \times 0.1 \times (100 - T)$

Similarly,

Heat gained by the water = mass of the water X its specific heat X increase in its temperature

$Q_1 = 195 \times 1 \times (T - 20)$ and

Heat gained by the calorimeter = mass of the calorimeter × its specific heat × increase in its temperature

$Q_2 = 50 \times 0.1 \times (T - 20)$

$Q = Q_1 + Q_2$

$100 \times 0.1 \times (100 - T) = 195 \times 1 \times (T - 20) + 50 \times 0.1 \times (T - 20)$

$10 (100 - T) = 195 (T - 20) + 5 (T - 20)$

$10 (100 - T) = 200 (T - 20)$

$210\ T = 5000$

$T = 23.8$ °C

∴ The maximum temperature of water will be 23.8 °C.

Example 3: If 80 g steam of temperature 97 °C is released on an ice slab of temperature 0 °C, how much ice will melt? How much energy will be transferred to the ice when the steam will be transformed to water?

Given: Latent heat of melting the ice = L_{melt} = 80 cal/g

Latent heat of vaporization of water = L_{vap}. = 540 cal/g

Solution: mass of steam = m_{steam} = 80 g

Temperature of steam = 97 °C

Temperature of ice = T_{ice} = 0 °C

Heat released during conversion of steam of temperature 97 °C into water of temperature 97 °C = $m_{steam} \times L_{vap.}$

= 80 X 540 ---------- (1)

Heat released during conversion of water of 97 °C into water at 0 °C

= $m_{steam} \times \Delta T \times c$

= $80 \times (97 - 0) \times 1 = 80 \times 97$ ---------- (2)

Total heat gained by the ice $80 \times 540 + 80 \times 97$ from equations (1) and (2)

$= 80 (540 + 97)$

$= 80 \times 637 = 50960$ cal.

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Some mass, of the ice, m_{ice}, will melt due to this heat gained by the ice, then,

$m_{ice} \times L_{melt} = 50960$ cal

$m_{ice} \times 80 = 50960$

$m_{ice} = 637$ g

Thus, 637 g ice will melt and 50960 cal kcal will be given to the ice.

Books are My Friends : Read for more information

1. A Textbook of heat - J.B. Rajam
2. Heat - V.N Kelkar
3. A Treatise on Heat - Saha and Srivastava

Exercise

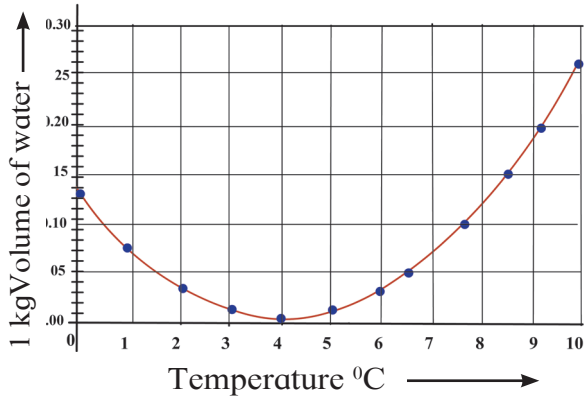
1. Fill in the blanks and rewrite the sentence.

a. The amount of water vapor in air is determined in terms of its ……

b. If objects of equal masses are given equal heat, their final temperature will be different. This is due to difference in their ……...

c. During transformation of liquid phase to solid phase, the latent heat is ……

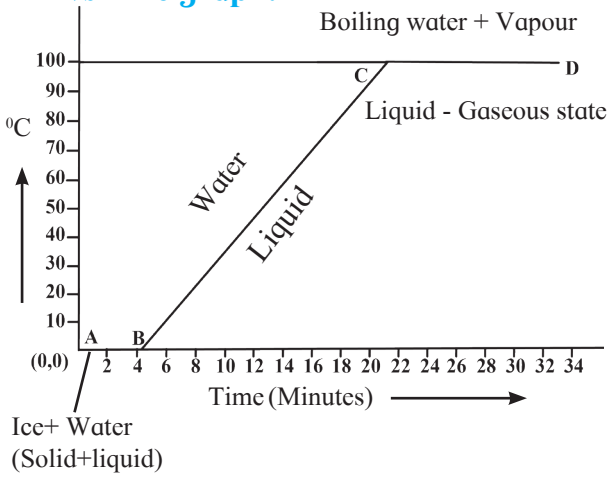
2. Observe the following graph. Considering the change in volume of water as its temperature is raised from 0 °C, discuss the difference in the behaviour of water and other substances. What is this behaviour of water called?



3. What is meant by specific heat capacity? How will you prove experimentally that different substances have different specific heat capacities?

4. While deciding the unit for heat, which temperatures interval is chosen? Why?

5. Explain the following temperature vs time graph.



6. Explain the following:

a. What is the role of anomalous behaviour of water in preserving aquatic life in regions of cold climate?

b. How can you relate the formation of water droplets on the outer surface of a bottle taken out of refrigerator with formation of dew?

c. In cold regions in winter, the rocks crack due to anomolous expansion of water.

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7. Answer the following:

a. What is meant by latent heat? How will the state of matter transform if latent heat is given off?

b Which principle is used to measure the specific heat capacity of a substance?

c. Explain the role of latent heat in the change of state of a substances?

d. On what basis and how will you determine whether air is saturated with vapor or not?

8. Read the folowing paragraph and answer the questions.

If heat is exchanged between a hot and cold object, the temperature of the cold object goes on increasing due to gain of energy and the temperature of the hot object goes on decreasing due to loss of energy.

The change in temperature continues till the temperatures of both the objects attain the same value. In this process, the cold object gains heat energy and the hot object loses heat energy. If the system of both the objects is isolated from the environment by keeping it inside a heat resistant box (meaning that the energy exchange takes place between the two objects only), then no energy can flow from inside the box or come into the box.

i. Heat is transferred from where to where?

ii. Which principle do we learn about from this process?

iii. How will you state the principle briefly?

iv. Which property of the substance is measured using this principle?

9. Solve the following problems:

a. Equal heat is given to two objects A and B of mass 1 g. Temperature of A increases by 3 °C and B by 5 °C. Which object has more specific heat? And by what factor?

Answer : A, $\frac{5}{3}$

b. Liquid ammonia is used in ice factory for making ice from water. If water at 20 °C is to be converted into 2 kg ice at 0 °C, how many grams of ammonia are to be evaporated? (Given: The latent heat of vaporization of ammonia= 341 cal/g)

Answer : 586.4 g

c. A thermally insulated pot has 150 g ice at temperature 0 °C. How much steam of 100 °C has to be mixed to it, so that water of temperature 50 °C will be obtained?
(Given : latent heat of melting of ice = 80 cal/g, latent heat of vaporization of water = 540 cal/g, specific heat of water = 1 cal/g °C)

Answer : 33 g

d. A calorimeter has mass 100 g and specific heat 0.1 kcal/ kg °C. It contains 250 gm of liquid at 30 °C having specific heat of 0.4 kcal/kg °C. If we drop a piece of ice of mass 10 g at 0 °C, What will be the temperature of the mixture?

Answer : 20.8 °C

Project

Take help of your teachers to make a working model of Hope's apparatus and perform the experiment. Verify the results you obtain.

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6. Refraction of light

- Refraction of light
- Refractive index
- Laws of refraction
- Dispersion of light

Can you recall?

1. What is meant by reflection of light?
2. What are the laws of reflection?

We have seen that, generally light travels in a straight line. Because of this, if an opaque object lies in its path, a shadow of the object is formed. We have also seen in previous classes how these shadows change due to the change in relative positions of the source of light and the object. But light can bend under some special circumstances as we will see below

Refraction of light

Try this. **Material:** Glass, 5 rupee coin, Pencil, metallic vessel etc.

Activity 1:

1. Take a transparent glass and fill it with water.
2. Dip some portion of a pencil vertically in water and observe the thickness of the portion of the pencil, in water.
3. Now keep the pencil inclined to water surface and observe its thickness.

In both cases, the portion of the pencil inside water appears to be thicker than the portion above water. In the second case, the pencil appears to be broken near the surface of water. Why does it happen?

Activity 2:

1. keep a 5 rupee coin in a metallic vessel.
2. Slowly go away from the vessel
3. Stop at the place when the coin disappears.
4. Keep looking in the direction of the coin.
5. Ask a friend to slowly fill water in the vessel. You will be able to see the coin once the level of water reaches a certain height. Why does it happen?

In both the above activities the observed effects are created due to the change in the direction of light while coming out of water. **Light changes its direction when going from one transparent medium to another transparent medium. This is called the refraction of light.**

Activity 3:

1. Keep a glass slab on a blank paper and draw its outline PQRS as shown in figure 6.1.
2. Draw an inclined straight line on the side of PQ so that it intersects PQ at N. Pierce two pins vertically at two points A and B along the line.
3. Look at the pins A and B from the opposite side of the slab and pierce pins C and D vertically so that the images of A and B are in line with C and D.
4. Now remove the chip and the pins and draw a straight line going through points C and D so that it intersects SR at M.
5. Join points M and N. Observe the incident ray AN and emergent ray MD.

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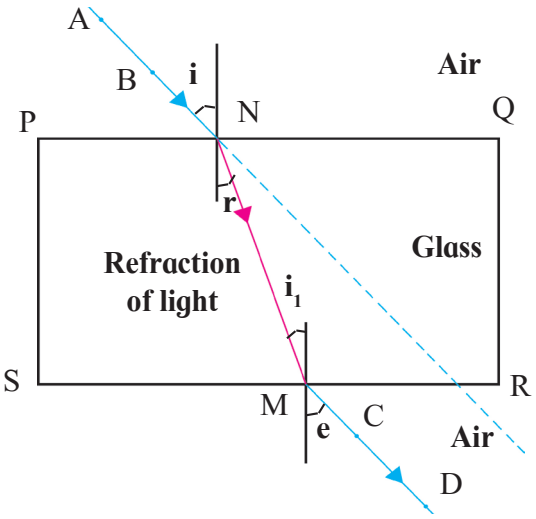
The first refraction occurs when light ray enters the glass from air at N on the side PQ. The second refraction occurs when light enters air through glass at point M on the side SR. For the first refraction the angle of incidence is i while for the second it is i_1. The angle of refraction at N is r.

Note that i_1 = r. In the second refraction, the angle of refraction is e which is equal to i. On both parallel sides PQ and RS of the glass slab, the change in direction of light ray is equal but in opposite directions.

Thus, the light ray MD emerging from the glass slab is parallel to the incident ray AN on the side PQ of the slab. But the emergent ray is somewhat displaced with respect to the incident ray.



6.1 Refraction of light passing through a glass slab

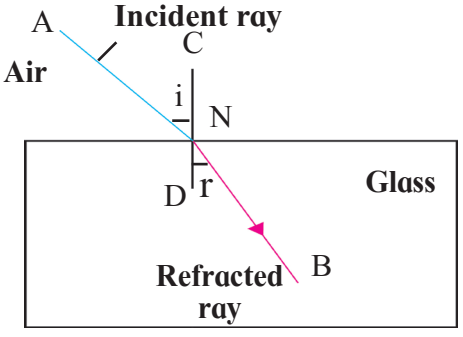
Use your brain power !

1. Will light travel through a glass slab with the same velocity as it travels in air?
2. Will the velocity of light be same in all media?

Laws of refraction

Let us study the light ray entering a glass slab from air as shown in the figure 6.2. Here AN is the incident ray and NB is the refracted ray.

1. Incident ray and refracted ray at the point of incidence N are on the opposite sides of the normal to the surface of the slab at that point i.e. CD, and the three, incident ray, refracted ray and the normal, are in the same plane.
2. For a given pair of media, here air and glass, the ratio of sin i to sin r is a constant. Here, i is the angle of incidence and r is the angle of refraction.



6.2 Light ray entering a glass slab from air

Refractive index

The change in the direction of a light ray while entering different media is different. It is related to the refractive index of the medium. The value of the refractive index is different for different media and also for light of different colours for the same medium. The refractive indices of some substances with respect to vacuum are given in the table. The refractive index of a medium with respect to vacuum is called its absolute refractive index.

Refractive index depends on the velocity of light in the medium.

$$\frac{\sin i}{\sin r} = \text{constant} = n$$

n is called the refractive index of the second medium with respect to the first medium. This second law is also called Snell's law. A ray incident along the normal (i = 0) goes forward in the same direction (r = 0).

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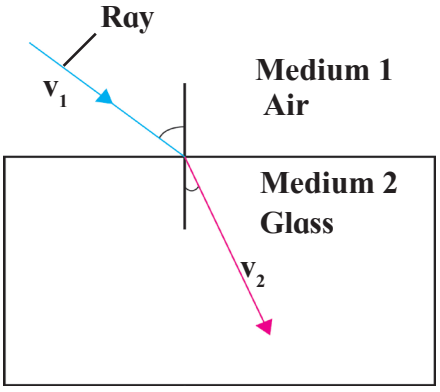
Substance	Refractive index	Substance	Refractive index	Substance	Refractive index
Air	1.0003	Fused Quartz	1.46	Carbon disulphide	1.63
Ice	1.31	Turpentine oil	1.47	Dense flint glass	1.66
Water	1.33	Benzene	1.50	Ruby	1.76
Alcohol	1.36	Crown glass	1.52	Sapphire	1.76
Kerosin	1.39	Rock salt	1.54	Diamond	2.42

Absolute refractive indices of some media

Let the velocity of light in medium 1 be v_1 and in medium 2 be v_2 as shown in figure 6.3. The refractive index of the second medium with respect to the first medium, ${}_2n_1$ is equal to the ratio of the velocity of light in medium 1 to that in medium 2.

$$\text{Refractive index } {}_2n_1 = \frac{\text{Velocity of light in medium 1 } (v_1)}{\text{Velocity of light in medium 2 } (v_2)}$$

Similarly, the refractive index of medium 1 with respect to medium 2 is



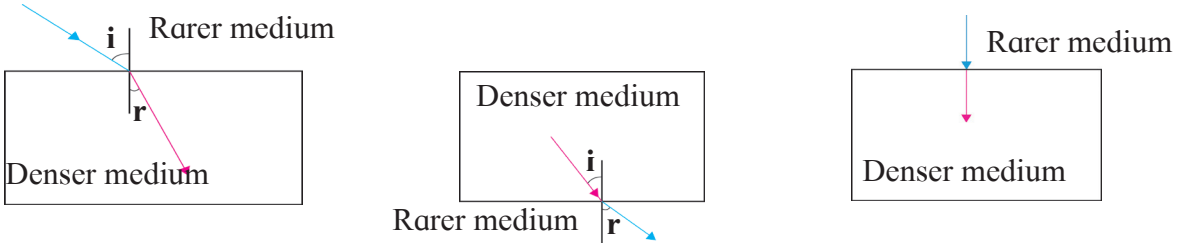
6.3 Light ray going from medium 1 to medium 2

$${}_1n_2 = \frac{v_2}{v_1}$$

If the first medium is vacuum then the refractive index of medium 2 is called absolute refractive index and it is written as n.

Can you tell?

If the refractive index of second medium with respect to first medium is ${}_2n_1$ and that of third medium with respect to second medium is ${}_3n_2$, what and how much is ${}_3n_1$?



6.4 Refraction of light in different media

When a light ray passes from a rarer medium to a denser a medium, it bends towards the normal.

When a light ray passes from a denser medium to a rarer medium, it bends away from the normal.

When a light ray is incident normally at the boundary between two media, it does not change its direction and hence does not get refracted.

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Twinkling of stars

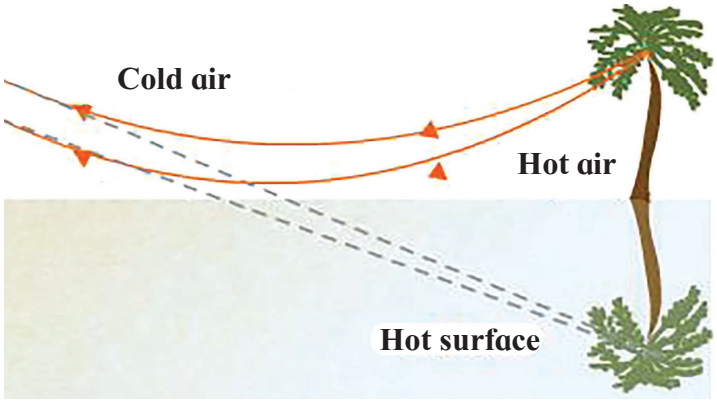
Can you tell?

1. Have you seen a mirage which is an illusion of the appearance of water on a hot road or in a desert?
2. Have you seen that objects beyond and above a holi fire appear to be shaking? Why does this happen?

Local atmospheric conditions affect the refraction of light to some extent. In both the examples above, the air near the hot road or desert surface and near the holi flames is hot and hence rarer than the air above it. The refractive index of air keeps increasing as we go to increasing heights. In the first case above, the direction of light rays, coming from a distance, keeps changing according to the laws of refraction.

The light rays coming from a distant object appear to be coming from the image of the object inside the ground as shown in figure 6.5. This is called a mirage.

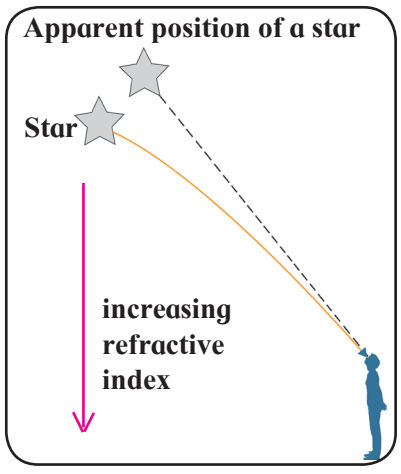
In the second example, the direction of light rays coming from objects beyond the holi fire changes due to changing refractive index above the fire. Thus, the objects appear to be moving.



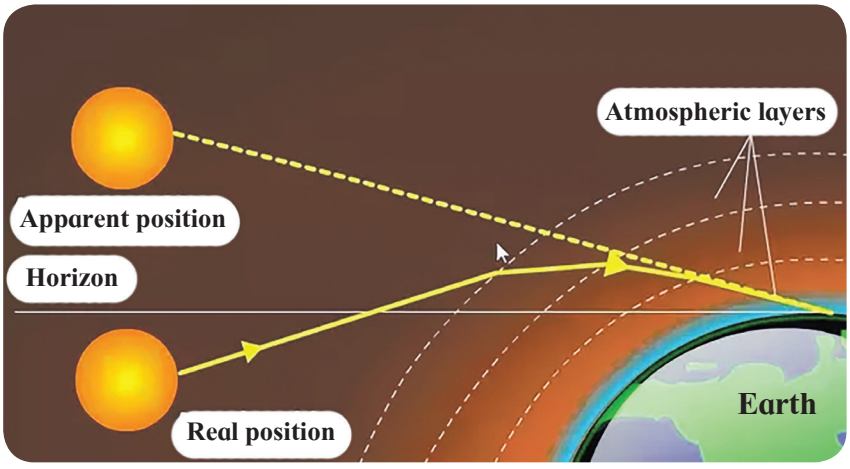
6.5 Mirage

Effect of atmospheric conditions on refraction of light can be seen in the twinkling of the stars.

Stars are self luminous and can be seen at night in the absence of sunlight. They appear to be point sources because of their being at a very large distance from us. As the desity of air increases with lowering height above the surface of the earth, the refractive index also increases. Star light coming towards us travels from rarer medium to denser medium and constantly bends towards the normal. This makes the star appear to be higher in the sky as compared to its actual position as shown in the figure, 6.6.



6.6 Apparent position of a star



6.7 Effect of atmospheric refraction

The apparent position of the star keeps changing a bit. This is because of the motion of atmospheric air and changing air density and temperature. Because of this, the refractive index of air keeps changing continuously. Because of this change, the position and brightness of the star keep changing continuously and the star appears to be twinkling.

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We do not see twinkling of planets. This is because, planets are much closer to us as compared to stars. They, therefore, do not appear as point sources but appear as a collection of point sources. Because of changes in atmospheric refractive index the position as well as the brightness of individual point source change but the average position and total average brightness remains unchanged and planets do not twinkle.

By Sunrise we mean the appearance of the Sun above the horizon. But when the Sun is somewhat below the horizon, its light rays are able to reach us along a curved path due to their refraction through earth's atmosphere as shown in the figure 6.7. Thus, we see the Sun even before it emerges above the horizon. Same thing happens at the time of Sunset and we keep seeing the Sun for a short while even after it goes below the horizon.

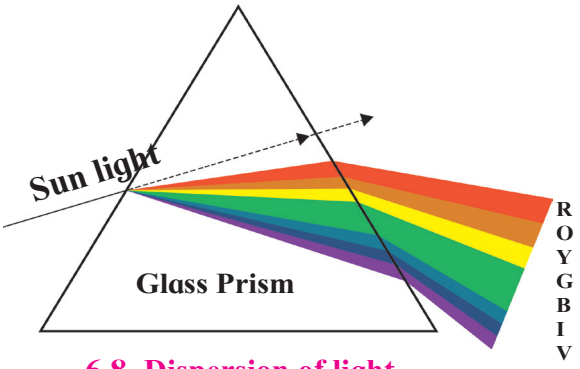
Dispersion of light

Hold the plastic scale in your compass in front of your eyes and see through it while turning it slowly. You will see light rays divided into different colours. These colours appear in the following order: violet, indigo, blue, green, yellow, orange and red. You know that light is electromagnetic radiation. Wavelength is an important property of radiation. The wavelength of radiation to which our eyes are sensitive is between 400 and 700 nm. In this interval, radiation of different wavelengths appears to have different colours mentioned above. The red light has maximum wavelength i.e. close to 700 nm while violet light has the smallest wavelength, close to 400 nm. Remember that 1 nm = 10^{-9} m.

In vacuum, the velocity of light rays of all frequencies is the same. But the velocity of light in a medium depends on the frequency of light and thus different colours travel with different velocity. Therefore, the refractive index of a medium is different for different colours. Thus, even when white light enters a single medium like glass, the angles of refraction are different for different colours. So when the white light coming from the Sun through air, enters any refracting medium, it emerges as a spectrum of seven colours.

The process of separation of light into its component colours while passing through a medium is called the dispersion of light.

Sir Issac Newton was the first person to use a glass prism to obtain Sun's spectrum. When white light is incident on the prism, different colours bend through different angles. Among the seven colours, red bends the least while violet bends the most. Thus, as shown in figure 6.8, the seven colours emerge along different paths and get separated and we get a spectrum of seven colours.



6.8 Dispersion of light

Use your brain power !

1. From incident white light how will you obtain white emergent light by making use of two prisms?

2. You must have seen chandeliers having glass prisms. The light from a tungsten bulb gets dispersed while passing through these prisms and we see coloured spectrum. If we use an LED light instead of a tungsten bulb, will we be able to see the same effect?

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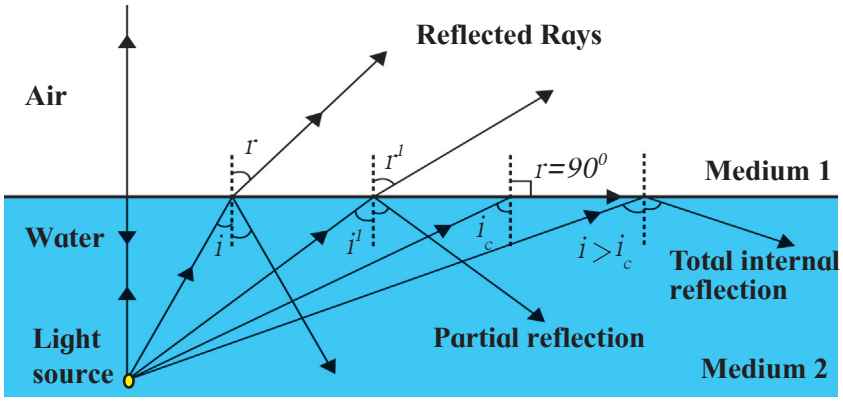
Partial and total internal reflection

When light enters a rarer medium from a denser medium, it gets partially reflected i.e. part of the light gets reflected and comes back into the denser medium as per laws of reflection. This is called partial reflection. The rest of the light gets refracted and goes into the rarer medium.

As light is going from denser to rarer medium, it bends away from the normal i.e. the angle of incidence i, is smaller than the angle of reflection r. This is shown on the left side of the figure 6.9. If we increase i, r will also increase according to Snell's law as the refractive index is a constant.



6.9 Partial and total internal reflection

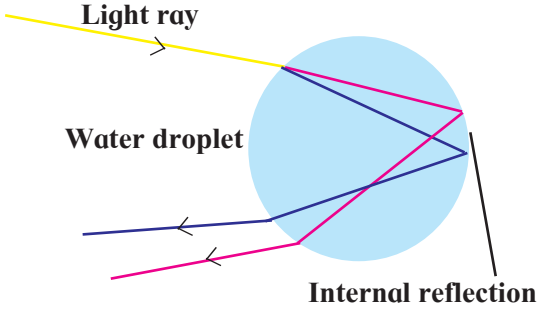
For a particular value of i, the value of r becomes equal to 90°. This value of i is called the critical angle. For angles of incidence larger than the critical angle, the angle of refraction is larger than 90°. Such rays return to the denser medium as shown towards the right in figure 6.9. Thus, all the light gets reflected back into the dense medium. This is called total internal reflection. We can determine the value of the critical angle the as follows.

$${}_1n_2 = \frac{\sin i}{\sin r}$$

For total internal reflection, i = critical angle, r = 90^0

$${}_1n_2 = \frac{\sin i}{\sin 90^0} = \sin i \quad (\because \sin 90^0 = 1)$$

Rainbow is a beautiful natural phenomenon. It is the combined effect of a number of natural processes. It is the combined effect of dispersion, refraction and total internal reflection of light. It can be seen mainly after a rainfall. Small droplets of water act as small prisms. When light rays from the Sun enter these droplets, it gets refracted and dispersed. Then there is internal reflection as shown in the figure, and after that once again the light gets refracted while coming out of the droplet. All these three processes together produce the rainbow.



6.10 Rainbow production

Books are my friends

1. Why the Sky is Blue - Dr. C.V. Raman talks about science : C. V. Raman and Chandralekha
2. Optics : Principles and Applications : K.K. Sharma
3. Theoretical concepts in Physics : M.S. Longair

Some Fun

Try to see if you can see dispersion of light using plastic jar, mirror and water.

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Solved Examples

1. The absolute refractive index of water is 1.36. What is the velocity of light in water? (velocity of light in vacuum 3 x10 ^{8} m/s)

Given:

$V_1 = 3x10^8$ m/s

$n = 1.36$

$n = \frac{V_1}{V_2}$ $\quad 1.36 = \frac{3 x10^8}{V_2}$

$V_2 = \frac{3x10^8}{1.36} = 2.21x10^8$ m/s

2. Light travels with a velocity 1.5 x 10^8 m/s in a medium. On entering second medium its velocity becomes 0.75 x 10^8 m/s. What is the refractive index of the second medium with respect to the first medium?

Given:

$V_1 = 1.5 x10^8$ m/s, ,$V_2 = 0.75 x10^8$ m/s

$_2n_1 = ?$ $\quad _2n_1 = \frac{1.5 x 10^8}{0.75 x 10^8} = 2$

Exercise

1. Fill in the blanks and Explain the completed sentences.

a . Refractive index depends on the ..... of light.

b. The change in ..... of light rays while going from one medium to another is called refraction.

2. Prove the following statements.

a. If the angle of incidence and angle of emergence of a light ray falling on a glass slab are i and e respectively, prove that, i = e.

b. A raibow is the combined effect of the refraction, dispersion, and total internal reflection of light.

3. Mark the correct answer in the following questions.

A. What is the reason for the twinkling of stars?

i . Explosions occurring in stars from time to time

ii. Absorption of light in the earth's atmosphere

iii. Motion of stars

iv. Changing refractive index of the atmospheric gases

B. We can see the Sun even when it is little below the horizon because of

i. Reflection of light

ii. Refraction of light

iii. Dispersion of light

iv. Absorption of light

C. If the refractive index of glass with respect to air is 3/2, what is the refractive index of air with respect to glass?

a. $\frac{1}{2}$ $\quad$ b. 3

c. $\frac{1}{3}$ $\quad$ d. $\frac{2}{3}$

4. Solve the following examples.

a. If the speed of light in a medium is 1.5 x 10^8 m/s, what is the absolute refractive index of the medium?

Ans : 2

b. If the absolute refractive indices of glass and water are 3/2 and 4/3 respectively, what is the refractive index of glass with respect to water?

Ans : $\frac{9}{8}$

Project :

Using a laser and soap water, study the refraction of light under the guidance of your teacher.

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7. Lenses

- Lenses
- Sign convention
- Defects of vision and their correction
- Uses of lenses
- Ray diagram for refracted light
- Working of human eye and lens

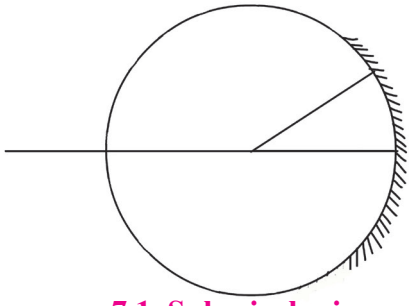
Can you recall?

1. Indicate the following terms related to sperical mirrors in figure 7.1: poles, centre of curvature, radius of curvature, principal focus.
2. How are concave and convex mirrors constructed?

Lenses

You must have seen lenses used in day to day life. Some examples are: the lenses used by old persons for reading, lens embedded in the front door of the house, the lens which the watch maker attaches to his eye etc.

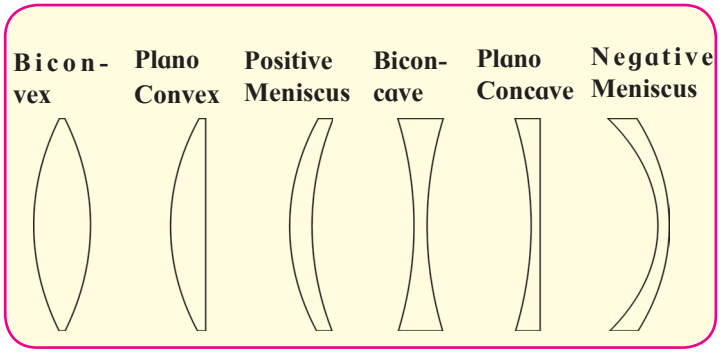
Lenses are used in spectacles. They are also used in telescopes as you have learnt in the previous standard.



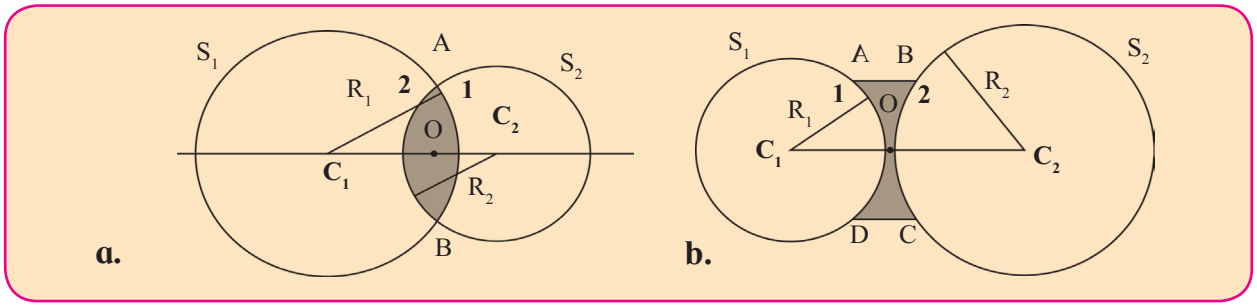
7.1 Spherical mirror

A lens is a transparent medium bound by two surfaces. The lens which has two spherical surfaces which are puffed up outwards is called a convex or double convex lens. This lens is thicker near the centre as compared to the edges. The lens with both surfaces spherical on the inside is called a concave or double concave lens. This lens is thinner at the centre as compared to its edges.

Different types of lenses are shown in figure 7.2. A ray of light gets refracted twice while passing through a lens, once while entering the lens and once while emerging from the lens. The direction of the ray changes because of these refractions. Both the surfaces of most lenses are parts of a sphere.



7.2 Types of lenses



7.3 Cross-sections of convex and concave lenses.

The cross-sections of convex and concave lenses are shown in parts a and b of figure 7.3. The surface marked as 1 is part of sphere S_1 while surface 2 is part of sphere S_2.

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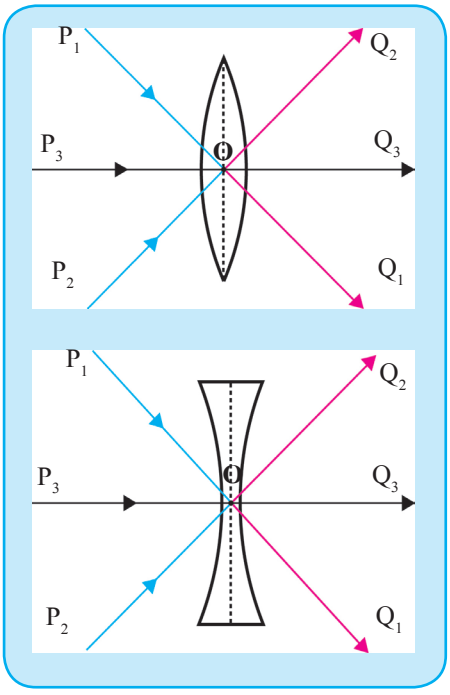
Centre of curvature (C) : The centres of spheres whose parts form surfaces of the lenses are called centres of curvatures of the lenses. A lens with both surfaces sperical, has two centres of curvature C_1 and C_2.

Radius of curvature (R) : The radii (R_1 and R_2) of the spheres whose parts form surfaces of the lenses are called the radii of curvature of the lens.

Principal axis : The imaginary line passing through both centres of curvature is called the principal axis of the lens.

Optical centre (O) : The point inside a lens on the principal axis, through which light rays pass without changing their path is called the optical centre of a lens. In figure 7.4, rays P_1Q_1, P_2Q_2 passing through O are going along a straight line. Thus O is the optical centre of the lens.

Principal focus (F) : When light rays parallel to the principal axis are incident on a convex lens, they converge to a point on the principal axis. This point is called the principal focus of the lens. As shown in figure 7.5a F_1 and F_2 are the principal foci of the convex lens.



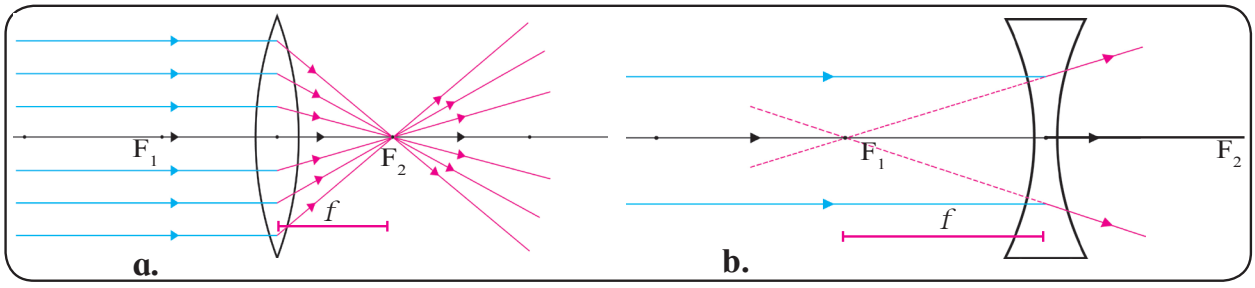
7.4 Optical centre of a lens

Light rays parallel to the principal axis falling on a convex lens come together i.e. get focused at a point on the principal axis. So this type of lens is called a converging lens.

Rays travelling parallel to the principal axis of a concave lens diverge after refraction in such a way that they appear to be coming out of a point on the pricipal axis. This point is called the principal focus of the concave lens. As shown in figure 7.5b F_1 and F_2 are the principal foci of the concave lens.

Light rays parallel to the principal axis falling on a concave lens go away from one another (diverge) after refraction. So this type of lens is called a divergent lens.

Focal length (f) : The distance between the optical centre and principal focus of a lens is called its focal length.



7. 5 Principal focus of a lens

Try this.

Material: Convex lens, screen, meter scale, stand for the lens etc.

Method:

Keeping the screen fixed, obtain a clear image of a distant object like a tree or a building with the help of the lens on the screen. Measure the distance between the screen and the lens with the help of the meter scale. Now turn the other side of the lens towards the screen. Again obtain a clear image of the distant object on the screen by moving the lense forward or backward. Measure the distance between the screen and the lens again.

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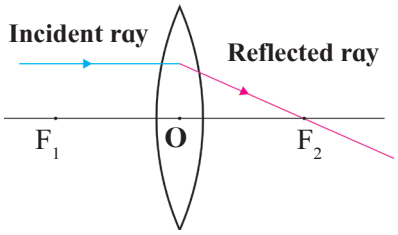
What is this distance between the lens and the screen called? Discuss the relation What is the distance between this distance and the radius of curvature of the lens with your teacher. The image of a distant object is obtained close to the focus of the lens, hence, the above distance is the focal length of the lens. What will happen if you use a concave lens in this experiment?

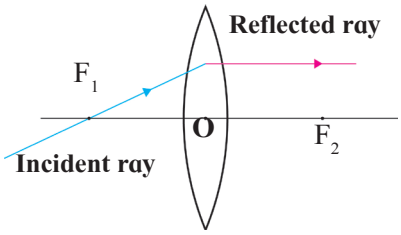
Ray diagram for refraction : You have learnt the rules for drawing ray diagrams for spherical mirrors. Similarly, one can obtain the images formed by lenses with the help of ray diagrams. One can obtain the position, size and nature of the images with the help of these diagrams.

Images formed by convex lenses

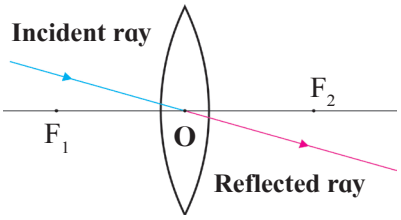
One can use following three rules to draw ray diagrams of images obtained by convex lenses.



Rule 1: When the incident ray is parallel to the principal axis, the refracted ray passes through the principal focus.



Rule 2: When the incident ray passes through the principal focus, the refracted ray is parallel to the principal axis.



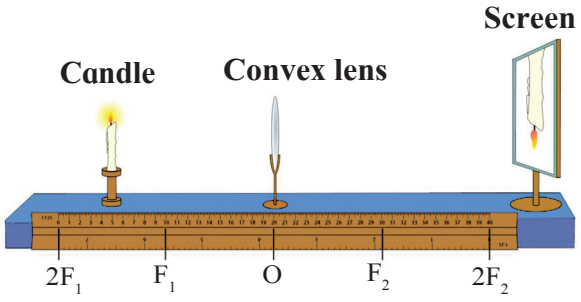
Rule 3: When the incident ray passes through the optical centre of the lens, it passes without changing its direction.

Try This

Material: A convex lens, screen, meter scale, stand for the lens, chalk, candle etc

Method:

1. Draw a straight line along the centre of a long table.
2. Place the lens on the stand at the central point (O) of the line.
3. Place the screen on one side, of the lens. Move it along the line so as to get a clear image of a distant object. Mark its position as F_1.
4. Measure the distance between O and F_1. Mark a point at distance $2F_1$ from O on the same side of F_1 and mark it as $2F_1$.



7. 6 Arrangement for the experiment

5. Repeat actions 3 and 4 on the other side of the lens and mark F_2 and $2F_2$ on the staraight line.
6. Now place the burning candle on the other side of lens far beyond $2F_1$. Place the screen on the opposite side of the lens and obtain a clear image of the candle by moving it forward or backward along the line. Note the position, size and nature of the image.
7. Repeat action 6 by placing the candle beyond $2F_1$, at $2F_1$, between $2F_1$ and F_1, at F_1 and between F_1 and O. Note your observations.

Can you recall?

What are real and virtual images? How will you find out whether an image is real or virtual? Can a virtual image be obtained on a screen?

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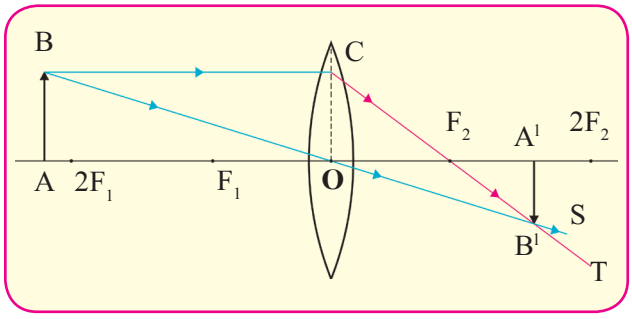
As shown in the figure 7.7, an object AB is placed beyond the point $2F_1$. The incident ray BC, starting from B and going parallel to the principal axis, goes through the principal focus F_2 after refraction along CT. The ray BO, starting from B and passing through the optical centre O of the lens goes along OS without changing its direction. It intersects CT in B′. This means that the image of B is formed at B′.

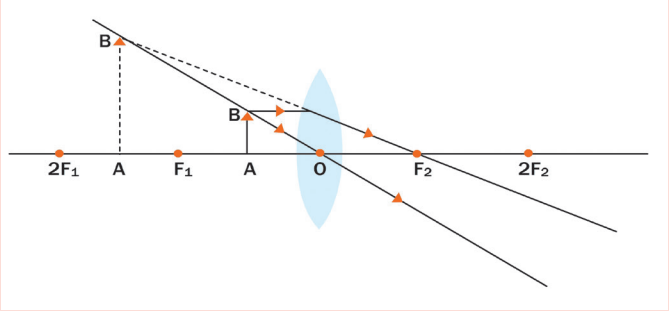


7.7 Real image formed by a convex lens

As A is situated on the principal axis, its image will also be located along the principal axis at A′, vertically above B′. Thus, A′B′ will be the image of AB formed by the lens. So we learn that if an object is placed beyond $2F_1$, the image is formed between F_2 and $2F_2$. It is real and inverted and its size is smaller than that of the object.

Observe

Study figure 7.8. Determine the position, size and nature of images formed for different positions of an object with the help of ray diagrams. Check your conclusions and observations in the previous activity with those given in the table.



7.8 Images formed by position of an object

Images formed by convex lenses for different positions of the object.

S. No.	Position of the object	Position of the image	Size of the image	Nature of the image
1	At infinity	At focus F_2	Point image	Real and inverted
2	Beyond $2F_1$	Between F_2 and $2F_2$	Smaller	Real and inverted
3	At $2F_1$	At $2F_2$	Same size	Real and inverted
4	Between F_1 and $2F_1$	Beyond $2F_2$	Larger	Real and inverted
5	At focus F_1	At infinity	Very large	Real and inverted
6	Between F_1 and O	On the same side of the lens as the object	Very large	Virtual and erect

Images formed by concave lenses

We can obtain the images obtained by concave lenses using the following rules.

1. When the incident ray is parallel to the principal axis, the refracted ray when extended backwards, passes through the focus.
2. When the incident ray passes through the focus, the refracted ray is parallel to the principal axis.

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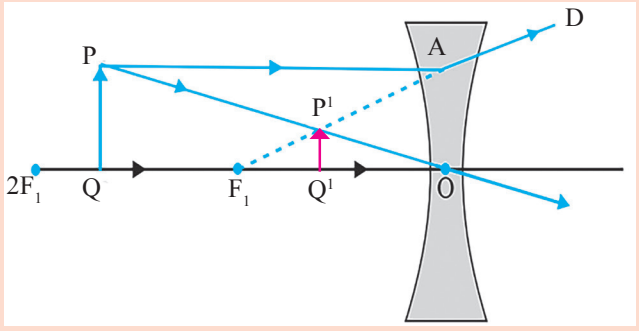
As shown in figure 7.9, object PQ is placed between F_1 and $2F_1$ in front of a concave lens. The incident ray PA, starting from P and going parallel to the principal axis goes along AD after refraction. If AD is extended backwards, it appears to come from F_1. The incident ray PO, starting from P and passing through O, goes along the same direction after refraction. PO intersects the extended ray AF_1 at P^1, i.e. P^1 is the image of P.



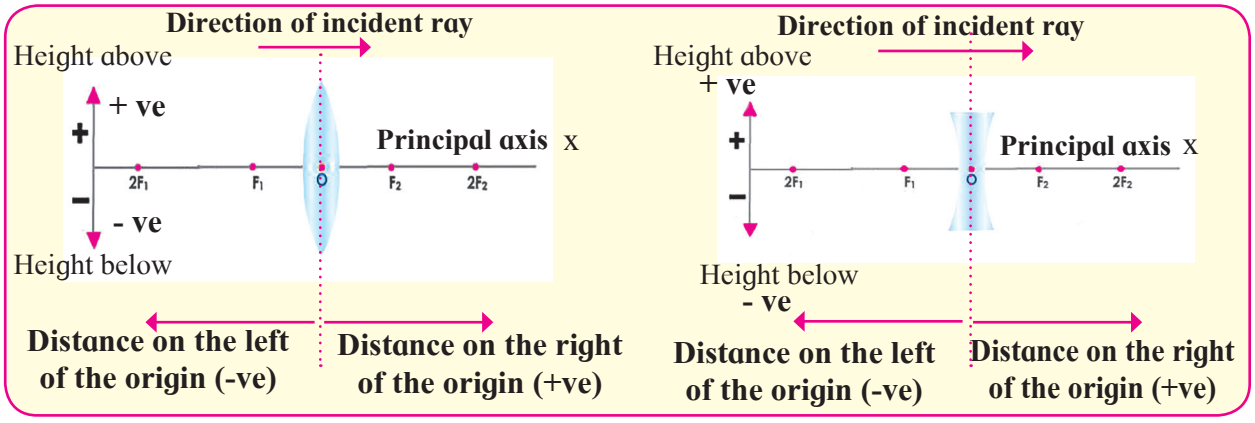
7.9 Image formed by a concave lens

As the point Q is on the principal axis, its image is formed along the axis at the point Q^1 directly below P^1. Thus, P^1Q^1 is the image of PQ. The image formed by a concave lens is always virtual, erect and smaller than the object.

Sr. No.	Position of the object	Position of the image	Size of the image	Nature of the image
1	At infinity	On the first focus F_1	Point image	Virtual and erect
2	Anywhere between optical centre O and infinity	Between optical centre and focus F_1	Small	Virtual and erect

Can you recall? What is the Cartesian sign convention used for spherical mirrors?

Sign convention



7.10 Cartesian sign convention

Lens formula

The formula showing the relation between distance of the object (u), the distance of the image (v) and the focal length (f) is called the lens formula. It is given below.

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

The lens formula is same for any spherical lens and any distance of the object from the lens. It is however necessary to use the sign convention properly.

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According to the Cartesian sign convention, the optical centre (O) is taken to be the origin. The principle axis is the X-axis of the frame of reference. The sign convention is as follows.

1. The object is always placed on the left of the lens, All distances parallel to the principal axis are measured from the optical centre (O).
2. The distanced measured to the right of O are taken to be positive while those measured to the left are taken to be negative.
3. Distances perpendicular to the principal axis and above it are taken to be positive.
4. Distances perpendicular to the principal axis and below it are taken to be negative.
5. The focal length of a convex lens is positive while that of a concave lens is negative.

Magnification (M)

The magnification due to a lens is the ratio of the height of the image (h_2) to the height of the object (h_1).

$$\text{Magnification} = \frac{\text{Height of the Image}}{\text{Height of the object}} \quad \text{i.e. } M = \frac{h_2}{h_1} \qquad \ldots\ldots\ldots\ldots\ldots (1)$$

The magnification due to a lens is also related to the distance of the object (u) and that of the image (v) from the lens.

$$\text{Magnification} = \frac{\text{Distance of the Image}}{\text{Distance of the object}} \quad \text{i.e. } M = \frac{v}{u} \qquad \ldots\ldots\ldots\ldots\ldots (2)$$

Use your brain power !

From equations (1) and (2) what is the relation between h_1, h_2, u and v?

Take two convex lenses of different sizes. Collect sunlight on a paper using one of the lenses. The paper will start burning after a while. Note the time required for the paper to start burning. Repeat the process for the second lens. Is the time required the same in both cases? What can you tell from this ?

Power of a lens

The capacity of a lens to converge or diverge incident rays is called its power (P). The power of a lens depends on its focal length. Power is the inverse of its focal length (f); f is expressed in meters.

The unit of the power of a lens is Dioptre (D).

$$P = \frac{1}{f\,(m)} \qquad 1 \text{ Dioptre} = \frac{1}{1\text{ m}}$$

Combination of lenses

If two lenses with focal lengths f_1 and f_2 are kept in contact with each other, the combination has an effective focal length given by

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

If the powers of the two lenses are P_1 and P_2 then the effective power of their combination is $P = P_1 + P_2$. Thus, when two lenses are kept touching each other, the power of the combined lens is equal to the sum of their individual powers.

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Solved Examples

1. An object is placed vertically at a distance of 20 cm from a convex lens. If the height of the object is 5 cm and the focal length of the lens is 10 cm, what will be the position, size and nature of the image? How much bigger will the image be as compared to the object?

Given:
Height of the object (h_1) = 5 cm,
focal length (f) = 10 cm,
distance of the object (u) = - 20 cm
Image distance (v) = ?,
Height of the image (h_2) = ?,
Magnification (M) = ?

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{u} + \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{-20} + \frac{1}{10}$$

$$\frac{1}{v} = \frac{-1+2}{20}$$

$$\frac{1}{v} = \frac{1}{20},$$

v = 20 cm

The positive sign of the image distance shows that image is formed at 20 cm on the other side of the lens.

$$\text{Magnification (M)} = \frac{h_2}{h_1} = \frac{v}{u}$$

$$h_2 = \frac{v}{u} \times h_1$$

$$h_2 = \frac{20}{-20} \times 5$$

$$h_2 = (-1) \times 5$$

$$h_2 = -5 \text{ cm}$$

$$M = \frac{v}{u} = \frac{20}{-20} = -1$$

The negative sign of the height of the image and the magnification shows that the image is inverted and real. It is below the principal axis and is of the same size as the object.

2. The focal length of a convex lens is 20 cm. What is its power?
Given: Focal length = f = 20 cm = 0.2 m
Power of the lens = P = ?

$$P = \frac{1}{f\,(m)} = \frac{1}{0.2} = 5 \text{ D}$$

The power of the lens is 5 D.

Observe and Discuss

Study the model depicting the construction of human eye with the help of teachers.

Human eye and working of its lens

There is a very thin transparent cover (membrane) on the human eye. This is called cornea (fig 7.11). Light enters the eye through it. Maximum amount of incident light is refracted inside the eye at the outer surface of the cornea. There is a dark, fleshy screen behind the cornea. This is called the Iris. The colour of the Iris is different for different people. There is a small hole of changing diameter at the centre of the Iris which is called the pupil. The pupil controls the amount of light entering the eye. If the light falling on the eye is too bright, pupil contracts while if the light is dim, it widens. On the surface of the iris, there is bulge of transparent layers. There is a double convex transparent crystalline lens, just behind the pupil. The lens provides small adjustments of the focal length to focus the image. This lens creates real and inverted image of an object on the screen inside the eye.

This screen is made of light sensitive cells and is called the retina. These cells get excited when light falls on them and generate electric signals. These signals are conveyed to the brain through optic nerve. Later, the brain analyses these signals and converts them in such a way that we perceive the objects as they actually are.

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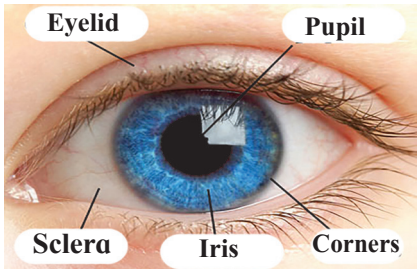
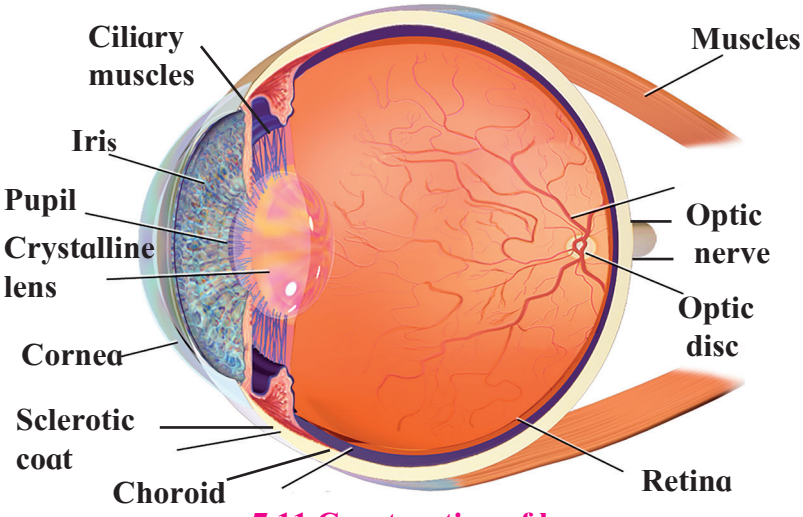
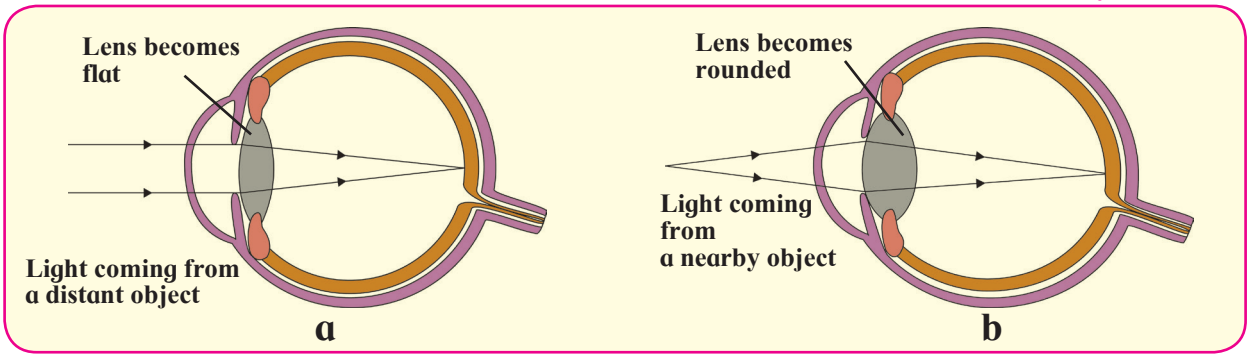
While seeing objects at large, infinite distances, the lens of the eye becomes flat and its focal length increases as shown in part a of the figure 7.12. While seeing nearby objects the lens becomes more rounded and its focal length decreases as shown in part b of the figure 7.12. This way we can see objects clearly irrespective of their distance.

The capacity of the lens to change its focal length as per need is called its power of accommodation. Although the elastic lens can change its focal length, to increase or decrease it, it can not do so beyond a limit.





7.11 Construction of human eye



7.12 The change in the shape of the lens while seeing distant and nearby objects.

The minimum distance of an object from a normal eye, at which it is clearly visible without stress on the eye, is called as minimum distance of distinct vision. The position of the object at this distance is called the near point of the eye, for a normal human eye, the near point is at 25 cm. The farthest distance of an object from a human eye, at which it is clearly visible without stress on the eye is called farthest diastance of distinct vision. The position of the object at this distance is called the far point of the eye. For a normal human eye, the far point is at infinity.

Do you know ?

The eye ball is approximately sperical and has a diameter of about 2.4 cm. The working of the lens in human eye is extremely important. The lens can change its focal length to adjust and see objects at different distances. In a relaxed state, the focal length of healthy eyes is 2 cm. The other focus of the eye is on the retina.

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Try this.

1. Try to read a book keeping it very far from your eyes.
2. Try to read a book keeping it very close to your eyes.
3. Try to read a book keeping it at a distance of 25 cm from your eyes. At which time you see the alphabets clearly? Why?

Defects of Vision and their corrections

Some people can not see things clearly due to loss of accommodation power of the lenses in their eyes. Because of defective refraction by the lenses their vision becomes faint and fuzzy. In general, there are three types of refraction defects.

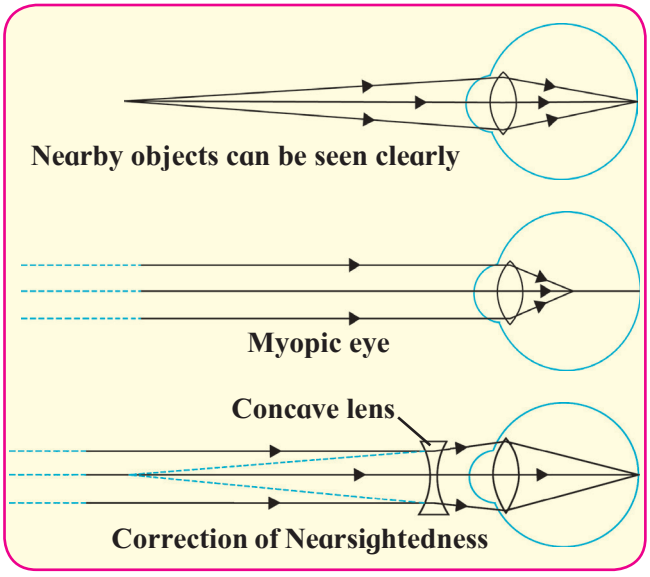
1. Nearsightedness/ Myopia

In this case, the eye can see nearby objects clearly but the distant objects appear indistinct.

This means that the far point of the eye is not at infinity but shifts closer to the eye. In nearsightedness, the image of a distant object forms in front of the retina (see figure 7.13). There are two reasons for this defect.

1.The curvature of the cornea and the eye lens increases.The muscles near the lens can not relax so that the converging power of the lens remains large.

2. The eyeball elongates so that the distance between the lens and the retina increases.



7.13 Nearsightedness

This defect can be corrected by using spectacles with concave lens of proper focal length. This lens diverges the incident rays and these diverged rays can be converged by the lens in the eye to form the image on the retina. The focal length of concave lens is negative, so a lens with negative power is required for correcting nearsightedness. The power of the lens is different for different eyes depending on the magnitude of their nearsightedness.

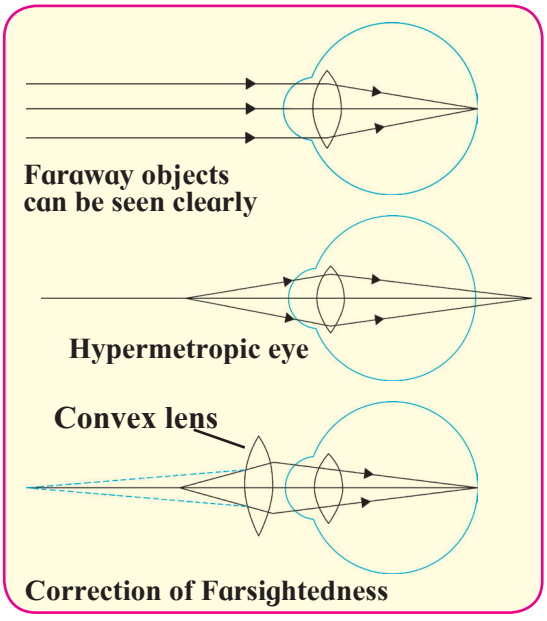
2. Farsightedness or hypermetropia

In this defect the human eye can see distant objects clearly but cannot see nearby objects distinctly. This means that the near point of the eye is no longer at 25 cm but shifts farther away. As shown in the figure (7.14), the images of nearby objects get formed behind the retina.

There are two reasons for farsightedness.

1. Curvature of the cornea and the eye lens decreases so that, the converging power of the lens becomes less.

2. Due to the flattening of the eye ball the distance between the lens and retina decreases.



7.14 Farsightedness

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This defect can be corrected by using a convex lens with proper focal length. This lens converges the incident rays before they reach the lens. The lens then converges them to form the image on the retina.

The focal length of a convex lens is positive thus the spectacles used to correct farsightedness has positive power. The power of these lenses is different depending on the extent of farsightedness.

3. Presbyopia

Generally, the focusing power of the eye lens decreases with age. The muscles near the lens lose their ability to change the focal length of the lens. The near point of the lens shifts farther from the eye. Because of this old people cannot see nearby objects clearly.

Sometimes people suffer from nearsightedness as well as farsightedness. In such a case bifocal lenses are required to correct the defect. In such lenses, the upper part is concave lens and corrects nearsightedness while the lower part is a convex lens which corrects the farsightedness.

Try this.

1. Make a list of students in your class using spectacles.
2. Record the power of their lenses.

Find out and note which type of defect of vision they suffer from. Which defect is most common among the students?

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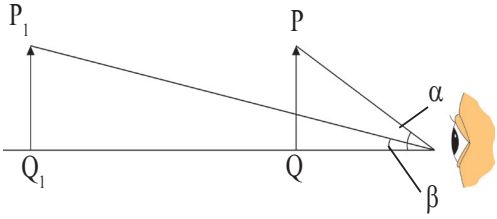
www.physics.org
www.britannica.com

Apparent size of an object

Consider two objects, PQ and P_1Q_1, having same size but kept at different distances from an eye as shown in figure 7.15. As the angle α subtended by PQ at the eye is larger than the angle β subtended by P_1Q_1, PQ appears bigger than P_1Q_1. Thus, the apparent size of an object depends on the angle subtended by the object at the eye.



7.15 Apparent Size of An object.

Use your brain power !

1. Why do we have to bring a small object near the eyes inorder to see it clearly?
2. If we bring an object closer than 25 cm from the eyes, why can we not see it clearly even though it subtends a bigger angle at the eye?

Use of concave lenses

a. Medical equipments, scanner, CD player – These instuments use laser light. For proper working of these equipments concave lenses are used.
b. The peep hole in door- This is a small safety device which helps us see a large area outside the door. This uses one or more concave lenses.
c. Spectacles- Concave lenses are used in spectacles to correct nearsightedness.
d. Torch- Concave lens is used to spread widely the light produced by a small bulb inside a torch.
e. Camera, telescope and microscope- These instruments mainly use convex lenses. To get good quality images a concave lens is used in front of the eyepiece or inside it.

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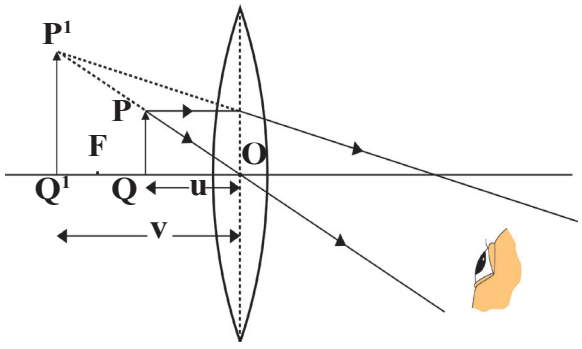
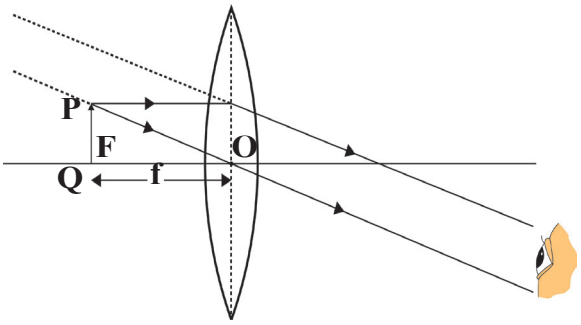
Use of convex lenses

a. Simple microscope : A convex lens with small focal length produces a virtual, erect and bigger image of an object as shown in the figure. Such a lens is called simple microscope or magnifying lens. One can get a 20 times larger image of an object using such microscopes. These are used for watch repair, testing precious gems and finding their defects.



a. Object is close to the lens

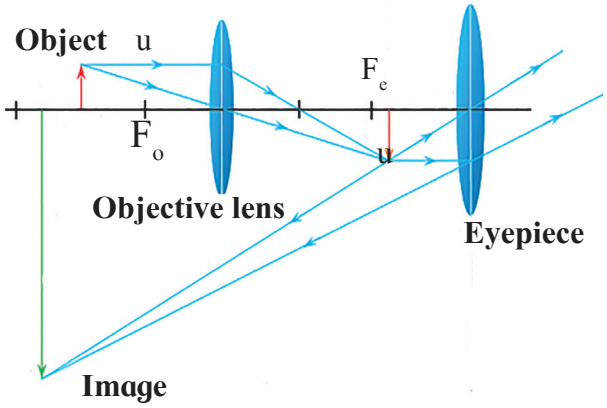


b. Object is at the focus

7.16 Simple microscope

b. Compound microscope

Simple microscope is used to observe small sized objects. But minute objects like blood cells, cells of plants and animals and minute living beings like bacteria cannot be magnified sufficiently by simple microscope. Compound microscopes are used to study these objects. A compound microscope is made of two convex lenses: objective and eye piece. The objective has smaller cross-section and smaller focal length. The eye piece has bigger cross-section, its focal length is also larger than that of the objective. Higher magnification can be obtained by the combined effect of the two lenses.



7.17 A compound microscope

As shown in the figure 7.17, the magnification occurs in two stages. The image formed by the first lens acts as the object for the second lens. The axes of both lenses are along the same line. The lenses are fitted inside a metallic tube in such a way that the distance between can be changed.

c. Telescope

Telescope is used to see distant objects clearly in their magnified form. The telescopes used to observe astronomical sources like the stars and the planets are called astronomical telescopes. Telescopes are of two types.

1. Refracting telescope – This uses lenses
2. Reflecting telescope – This uses mirrors and also lenses.

In both of these, the image formed by the objective acts as object for the eye piece which forms the final image. Objective lens has large diameter and larger focal length because of which maximum amount of light coming from the distant object can be collected.

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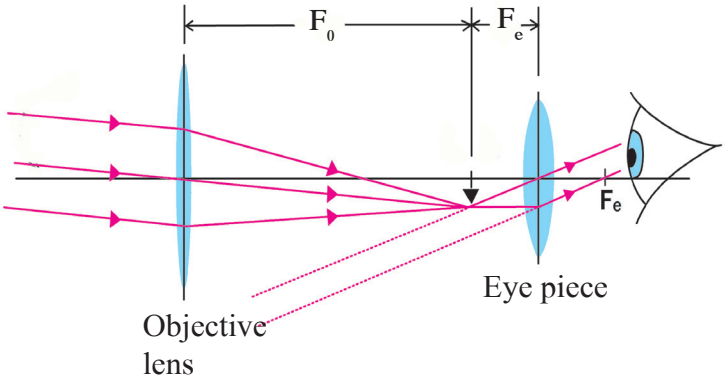
On the other hand the size of the eyepiece is smaller and its focal length is also less. Both the lenses are fitted inside a metallic tube in such a way that the distance between them can be changed. The principal axes of both the lenses are along the same straight line. Generally, using the same objective but different eye pieces, different magnification can be obtained.



7.18 Refracting telescope

d. Optical instrument

Convex lenses are used in various other optical instruments like camera, projector, spectrograph etc.

e. Spectacles

Convex lenses are used in spectacles for correcting farsightness .

Try this.

1. Take a burning incense stick in your hand and rotate it fast along a circle.
2. Draw a cage on one side of a cardboard and a bird on the other side. Hang the cardboard with the help of a thread. Twist the thread and leave it. What do you see and why?

Persistence of vision

We see an object because the eye lens creates its image on the retina. The image is on the retina as long as the object is in front of us. The image disappears as soon as the object is taken away. However, this is not instantaneous and the image remains imprinted on our retina for 1/16th of a second after the object is removed. The sensation on retina persists for a while.This is called persistence of vision. What examples in day to day life can you think about this?

Can you tell? How do we perceive different colours?

The retina in our eyes is made up of many light sensitive cells. These cells are shaped like a rod and like a cone. The rod like cells respond to the intensity of light and give information about the brightness or dimness of the object to the brain. The conical cells respond to the colour and give information about the colour of the object to the brain. Brain processes all the information received and we see the actual image of the object. Rod like cells respond to faint light also but conical cells do not. Thus we perceive colours only in bright light. The conical cells can respond differently to red, green and blue colours. When red colour falls on the eyes, the cells responding to red light get excited more than those responding to other colours and we get the sensation of red colour. Some people lack conical cells responding to certain colours. These persons cannot recognize those colours or cannot distinguish between different colours. These persons are said to be colour blind. Apart from not being able to distinguish between different colours, their eye sight is normal.

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Exercise

1. Match the columns in the following table and explain them.

Column 1	Column 2	Column 3
Farsightdness	Nearby object can be seen clearly	Bifocal lens
Presbyopia	Far away object can be seen clearly	Concave lens
Nearsightness	Problem of old age	Convex lens

2. Draw a figure explaining various terms related to a lens.

3. At which position will you keep an object in front of a convex lens so as to get a real image of the same size as the object ? Draw a figure.

4. Give scientific resons:

a. Simple microscope is used for watch repairs.

b. One can sense colours only in bright light.

c. We can not clearly see an object kept at a distance less than 25 cm from the eye.

5. Explain the working of an astronomical telescope using refraction of light.

6. Distinguish between:

a. Farsightedness and Nearsightedness

b. Concave lens and Convex Lens

7. What is the function of iris and the muscles connected to the lens in human eye?

8. Solve the following examples.

i. Doctor has prescribed a lens having power +1.5 D. What will be the focal length of the lens? What is the type of the lens and what must be the defect of vision?

(Ans: +0.67m, farsightedness)

ii. 5 cm high object is placed at a distance of 25 cm from a converging lens of focal length of 10 cm. Determine the position, size and type of the image.

(Ans : 16.7 cm, 3.3 cm, Real)

iii. Three lenses having power 2, 2.5 and 1.7 D are kept touching in a row. What is the total power of the lens combination?

(Ans : 6.2 D)

iv. An object kept 60 cm from a lens gives a virtual image 20 cm in front of the lens. What is the focal length of the lens? Is it a converging lens or diverging lens?

(Ans: -30 cm, lens is diverging or concave)

Project

Make a Power point presentation about the construction and use of binoculars.

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8. Metallurgy

- Physical properties of metals
- Chemical properties of metals
- Chemical properties of nonmetals
- Metallurgy: Various concepts.
- Physical properties of nonmetals
- Reactivity series of metals
- Ionic compounds.

Earth was born about 4.5 billion years ago. Various formative processes have been taking place in the core of the earth and its surroundings since its creation till today. These have resulted in the formation of various ores, liquids and gases.

Think about it Which method do we use when we want to study many things together and at the same time?

The substances around us are in the form of some or the other elements or their compounds. In the beginning, elements were classified in accordance with their chemical and physical properties into the types metals, nonmetals and metalloids, and these are in use even today. You have studied their characteristics in the last standard. We are going to get more information about them in this lesson.

Can you tell? What are the physical properties of metals and nonmetals?

Physical properties of metals

Metals exist mainly in solid state. The metals namely, mercury and gallium exist in liquid state at room temperature. Metals possess luster. The metallic luster goes on decreasing due to exposure to atmospheric oxygen and moisture and also in presence of some reactive gases.

We know that metals have the properties namely, ductility and malleability. Similarly, all metals are good conductors of heat and electricity. Generally, all metals are hard. However, the alkali metals from group 1 such as lithium, sodium and potassium are exceptions. These metals can be cut with knife as they are very soft. Metals have high melting and boiling points. For example, tungsten metal has the highest melting point (3422 ^{0}C). On the contrary, the melting and boiling points of the metals such as sodium, potassium, mercury, galium are very low. A sound is produced when certain metals are struck. This is called sonority. These metals are known as sonorous metals.

Physical properties of nonmetals

When properties of nonmetals are considered, it is found that some nonmetals are in solid state while some are in gaseous state. Exception is the nonmetal bromine which exists in liquid state. Nonmetals do not posses luster, but iodine is the exception as its crystals are shiny. Nonmetals are not hard. Diamond which as an allotrope of carbon is the exception. Diamond is the hardest natural substance. Nonmetals have low melting and boiling points. Nonmetals are bad conductors of electricity and heat. Graphite, an allotrope of carbon, is an exception, as it is a good conductor of electricity.

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Chemical properties of metals

Metals are reactive. They lose electrons easily and become positively charged ions. That is why metals are called electropositive elements.

Do you know ?

Substances which are good conductors of heat are usually good conductors of electricity as well. Similarly bad conductors of heat are also bad conductors of electricity. The exception is diamond which is bad conductor of electricity but good conductor of heat.

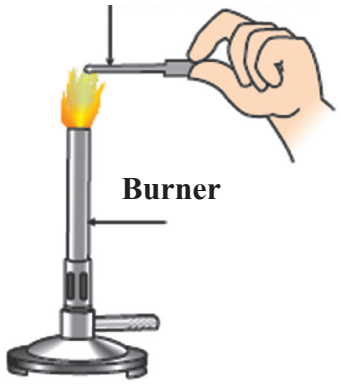
Try this.

Apparatus : Pair of tongs or spatula, knife, burner, etc.

Chemicals : Samples of aluminium, copper, iron, lead, magnesium, zinc and sodium.
(**Note:** Use sodium carefully, in presence of teacher)

Procedure : Hold the sample of each of the above metals at the top of the flame of a burner with the help of a pair of tongs, or a spatula.

1. Which metal catches fire readily?
2. How does the surface of a metal appear on catching fire?
3. What is the colour of the flame while the metal is burning on the flame?



8.1 Combustion of metal

Reactions of Metals:

a. Reaction of metals with oxygen

Metals combine with oxygen on heating in air and metal oxides are formed. Sodium and potassium are very reactive metals. Sodium metal combines with oxygen in the air even at room temperature and forms sodium oxide.

$$4Na(s) + O_2(g) \longrightarrow 2Na_2O(s)$$

On exposure to air sodium readily catches fire. Therefore, to prevent accident in the laboratory or elsewhere it is kept in kerosene. Oxides of some metals are soluble in water. They react with water to form alkali.

$$Na_2O(s) + H_2O(l) \longrightarrow 2NaOH(aq)$$

We know that magnesium oxide is formed on burning magnesium ribbon in the air. Magnesium oxide reacts with water to form an alkali, called magnesium hydroxide.

$$2Mg(s) + O_2(g) \longrightarrow 2\,MgO(s)$$

$$MgO + H_2O \longrightarrow Mg(OH)_2$$

b. Reaction of metals with water

Apparatus : Beakers.

Chemicals : Samples of various metals (Important note : Sodium metal should not be taken), water.

Procedure : Drop a piece of each of the metal in separate beakers filled with cold water.

1. Which metal reacts with water?
2. Which metal floats on water? Why? Prepare a table with reference to the above procedure and note your observations in it.

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Sodium and potassium metal react rapidly and vigorously with water and liberates hydrogen gas.

$$2Na\ (s) + 2H_2O\ (l) \longrightarrow 2NaOH\ (aq) + H_2(g) + \text{heat}$$

$$2K(s) + 2H_2O\ (l) \longrightarrow 2KOH\ (aq) + H_2(g) + \text{heat}$$

On the other hand, calcium reacts with water slowly and less vigorously. The hydrogen gas released in this reaction collects on the surface of the metal in the form of bubbles and the metal floats on water.

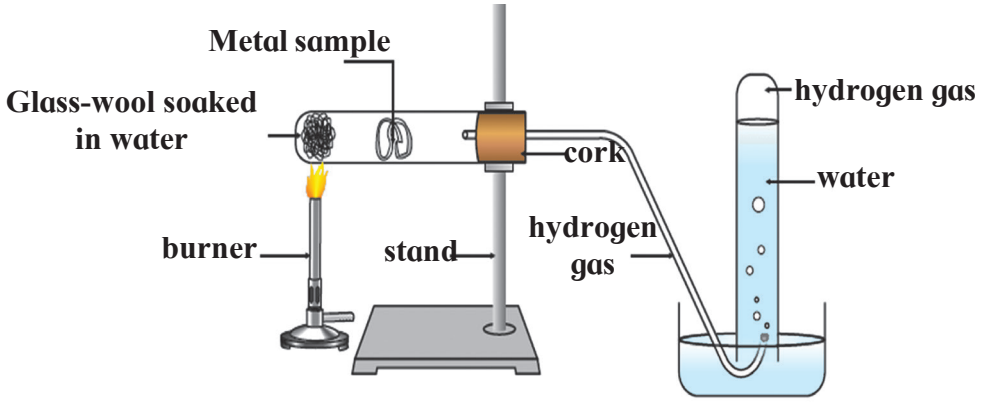
$$2Ca(s) + 2H_2O\ (l) \longrightarrow 2Ca(OH)_2(aq) + H_2(g)$$

The metals; aluminium, iron and zinc do not react with cold or hot water, but they react with steam to form their oxides. Hydrogen gas is released in this reaction.

$$2Al(s) + 3H_2O(g) \longrightarrow Al_2O_3\ (s) + 3H_2(g)$$

$$3Fe(s) + 4H_2O(g) \longrightarrow Fe_3O_4(s) + 4H_2(g)$$

$$Zn(s) + H_2O(g) \longrightarrow ZnO(s) + H_2(g)$$



8.2 Reaction of a metal with water

Try out and think about it

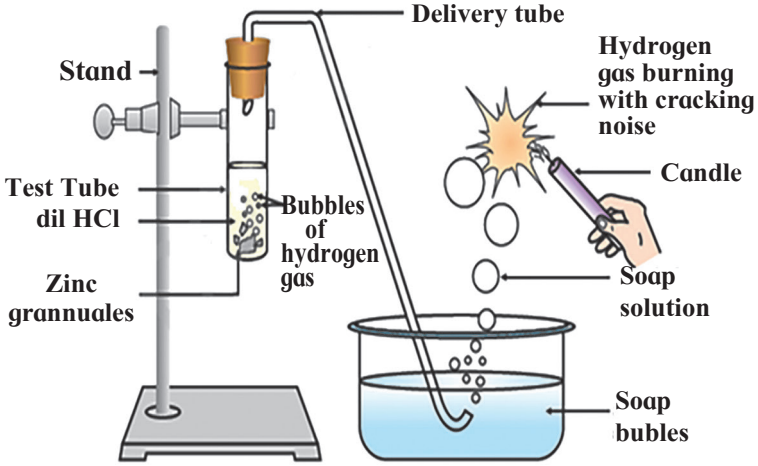
Test whether the metals gold, silver and copper react with water and think over the finding.

c. Reaction of metals with oxygen

In the earlier chapter we have looked into reaction of metals with acids. Are all the metals equally reactive?

When samples of aluminium, magnesium, iron or zinc are treated with dilute sulphuric or hydrochloric acid, sulphate or chloride salts of metals are formed. Hydrogen gas is liberated in this reaction. The reactivity of these metals can be indicated by the following sequence.

Mg > Al > Zn > Fe



8.3 Reaction of metals with dilute acid

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$$Mg(s) + 2HCl\ (aq) \longrightarrow MgCl_2(aq) + H_2(g)$$
$$2Al\ (s) + 6HCl\ (aq) \longrightarrow 2AlCl_3(aq) + 3H_2(g)$$
$$Fe(s) + 2HCl\ (aq) \longrightarrow FeCl_2(aq) + H_2(g)$$
$$Zn\ (s) + HCl\ (aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

d. Reaction of metals with nitric acid

Nitrate salts of metals are formed on reaction of metals with nitric acid. Various oxides of nitrogen (N_2O, NO, NO_2) are also formed in accordance with the concentration of nitric acid.

$$Cu(s) + 4\ HNO_3\ (aq) \longrightarrow Cu\ (NO_3)_2\ (aq) + 2NO_2(g) + 2H_2O\ (l)$$
(Concentrated)

$$3\ Cu(s) + 8HNO_3\ (aq) \longrightarrow Cu\ (NO_3)_2\ (aq) + 2NO(g) + 4H_2O\ (l)$$
(Dilute)

Aqua Regia: Aqua regia is a highly corrosive and fuming liquid. It is one of the few reagents which can dissolve the noble metals like gold and platinum. Aqua regia is freshly prepared by mixing concentrated hydrochloric acid and concentrated nitric acid in the ratio 3:1.

e. Reaction of metals with salts of other metals

Try this.

Apparatus: Copper wire, iron nail, beaker or big test tube etc.
Chemicals: Aqueous solutions of ferrous sulphate and copper sulphate.

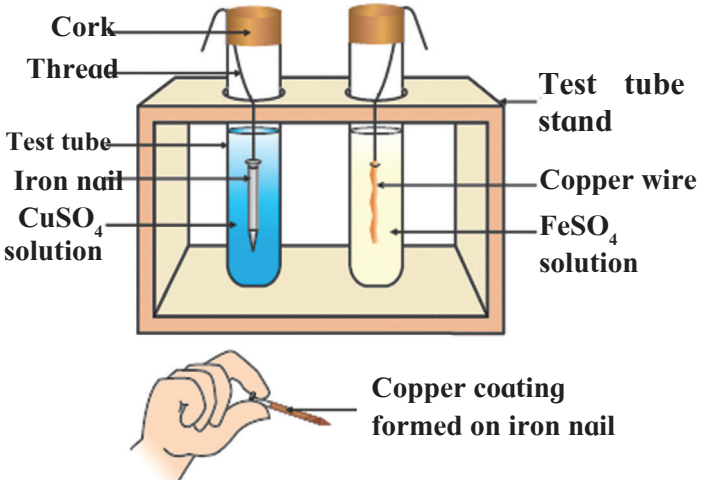
Procedure:

1. Take a clean copper wire and a clean iron nail.
2. Dip the copper wire in ferrous sulphate solution and the iron nail in copper sulphate solution.
3. Keep on observing continually at a fixed interval of time.

a. In which test tube a reaction has taken place?

b. How did you recognize that a reaction has taken place?

c. What is the type of the reaction?



8.4 Reaction of metal with solution of salts of other metals

Reactivity series of metals

We have seen that reactivity of all metals is not the same. However, the reagents oxygen, water and acids are not useful to determine the relative reactivities of all the metals, as all the metals do not react with them. The displacement reaction of metals with solutions of salts of other metals serves this purpose. If a metal A displaces another metal B from the solution of its salt then it means that the metal A is more reactive than the metal B.

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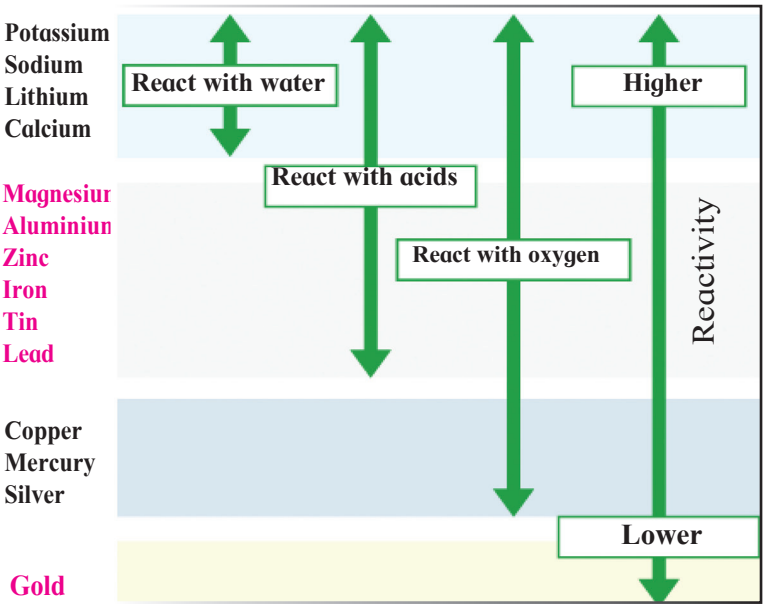
Metal A + Salt solution of metal B ⟶ Salt solution of metal A + Metal B

Answer from your observations in the previous activity 8.4, which metal is more reactive, copper or iron?

In the previous activity, iron has displaced copper from copper sulphate. It means that metallic iron is more reactive than metallic copper.



8.5 Reactivity series of metals.

Scientists have developed the reactivity series by doing many experiments of displacement reaction. The arrangement of metals in the increasing or decreasing order of reactivity is called the reactivity series of metals. Metals are divided into the following groups according to their reactivity.

1. Highly reactive metals.
2. Moderately reactive metals.
3. Less reactive metals.

f. Reaction of metals with nonmetals

Noble gases (like helium, neon, argon) do not take part in the chemical reactions. So far, we have seen from the reactions of metals that cations are formed by oxidation of metals. If we look into the electronic configuration of some metals and nonmetals, it will be seen that the driving force behind a reaction is to attain the electronic configuration of the nearest noble gas with complete octet. Metals do this by losing electrons while nonmetals do this by gaining electrons. The outermost shell of noble gases being complete, they are chemically inert.

You have seen in the last standard that the ionic compound sodium chloride is formed as sodium metal gives away one electron while the nonmetal chlorine takes up one electron.

$2\,Na + Cl_2 \longrightarrow 2\,NaCl$
(Metal) (nonmetal) (ionic compound)

Similarly, magnesium and potassium form the ionic compounds $MgCl_2$ and KCl, respectively.

Chemical properties of nonmetals

Nonmetals are a collection of elements having less similarity in physical and chemical properties. Nonmetals are also called electronegative elements, as they form negatively charged ions by accepting electron. Some examples of chemical reactions of nonmetals are as follows.

1.Reaction of nonmetals with oxygen:

Generally, nonmetals combine with oxygen to form acidic oxides.
In some cases, neutral oxides are formed.

$C + O_2 \xrightarrow{\text{Complete combustion}} CO_2$ (Acidic)

$2C + O_2 \xrightarrow{\text{Partial Combustion}} 2CO$ (Neutral)

$S + O_2 \xrightarrow{\text{Combustion}} SO_2$ (Acidic)

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2. Reaction of nonmetals with water : Generally, nonmetals do not react with water, except the halogens. For example, chlorine on dissolving in water gives the following reaction.

$$Cl_2(g) + H_2O(l) \longrightarrow HOCl(aq) + HCl(aq)$$

3. Reaction of dilute acids with nonmetals : Generally, nonmetals do not react with dilute acids, halogens are exception to this. For example, chlorine reacts with dilute hydrobromic acid by the following reaction.

$$Cl_2(g) + 2HBr(aq) \longrightarrow 2HCl(aq) + Br_2(aq)$$

4. Reaction of nonmetals with hydrogen :

Nonmetals react with hydrogen under certain condition (such as proper temperature, pressure, use of catalyst, etc.)

$$S + H_2 \longrightarrow H_2S$$
$$N_2 + 3H_2 \longrightarrow 2NH_3$$

Use your brain power ! In the reaction between chlorine and HBr a transformation of HBr into Br_2 takes place. Can this transformation be called oxidation? Which is the oxidant that brings about this oxidation?

Ionic compounds

The compounds formed from two units, namely cation and anion are called ionic compounds. The cation and anion being oppositely charged, there is an electrostatic force of attraction between them. You know that, this force of attraction between cation and anion is called as the ionic bond. The number of cations and anion in a compound and the magnitude of the electric charge on them is such that the positive and negative charges balance each other. As a result, an ionic compound is electrically neutral.

Ionic compounds are crystalline in nature. The surfaces of all the particles of a crystalline substance have a definite shape and are smooth and shiny. The regular arrangement of ions in the solid ionic compounds is responsible for their crystalline nature. The arrangement of ions is different in different ionic compounds, and therefore the shapes of their crystals are different. The main factor that determines the general arrangement of ions in a crystal is the attractive force between oppositely charged ions and the repulsive force between similarly charged ions. Because of this the general crystalline structure has negative ions arranged around a positive ion and positive ions arranged around a negative ion. Two of the important factors responsible for a certain crystal structure are as follows.

1) Size of the positively and negatively charged ions.
2) Magnitude of the electrical charge on the ions.

The electrostatic attraction in the neighbouring ions with opposite charges is very strong. That is why the melting points of ionic compounds are high. Also, the ionic compounds are hard and brittle.

Properties of ionic compounds

Try this.

Apparatus: Metal spatula, burner, carbon electrodes, beaker, cell, lamp, press key, electrical wires, etc.
Chemicals: Samples of sodium chloride, potassium iodide and barium chloride, water.

Procedure: Observe the above samples. Place sample of one of the above salts on the spatula and heat it on flame of the burner. Repeat the procedure using the other salts. As shown in the figure, assemble an electrolyte cell. Assemble an electrolytic cell by using a beaker and connecting the carbon electrodes to the positive and negative terminal of the cell. Dip the electrodes in solution of any one of the salts. Do you see the lamp glowing? Check this with all the other salts as well.

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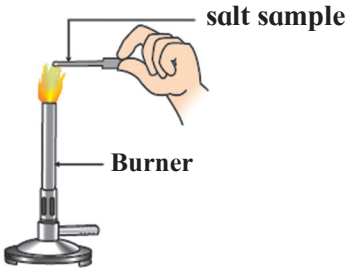
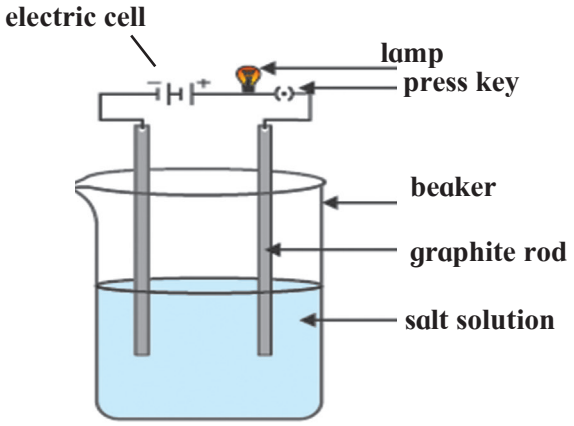


a. To heat salt sample



b. To check conductivity of salt solution

8.6 To verify the properties of ionic compounds

5. The ionic compounds cannot conduct electricity when in solid state. In this state the ions cannot leave their places. However, in the fused/molten state they can conduct electricity, as in this state the ions are mobile. The aqueous solutions of ionic compounds conduct electricity as they contain the dissociated ions. On passing current through the solution the ions move to the oppositely charged electrodes. Due to the electrical conductivity in fused and dissolved state the ionic compounds are called electrolytes.

General properties of ionic compounds

1. The attractive force between the positively and negatively charged ions is strong Therefore, the ionic compounds exist in solid state and are hard.
2. The ionic compounds are brittle and can be broken into pieces by applying pressure.
3. The intermolecular force of attraction is high in ionic compounds and, large energy is required to overcome it. Therefore, the melting and boiling points of ionic compounds are high. (see table 8.7)
4. Ionic compounds are water soluble. This is because the water molecules orient in a particular manner around the ions separated by dissociation process. As a result of this a new force of attraction is established between the ion and the surrounding water molecules, replacing the original intermolecular attraction; and aqueous solutions of ionic compounds are formed. Ionic compounds are however, insoluble in solvents like kerosene and petrol. This is because unlike water a new attractive force can not be established in these solvents.

Compound	ionic/ nonionic	Melting point ^{0}C	Boiling point ^{0}C
H_2O	nonionic	0	100
$ZnCl_2$	ionic	290	732
$MgCl_2$	ionic	714	1412
NaCl	ionic	801	1465
NaBr	ionic	747	1390
KCl	ionic	772	1407
MgO	ionic	2852	3600

8.6 Melting and boiling points of some ionic compounds

Metallurgy

The science and technology regarding the extraction of metals from ores and their purification for the use is called metallurgy.

Occurrence of metals

Most metals being reactive do not occur in nature in free state but are found in combined state as their salts such as oxides, carbonates, sulphides and nitrates. However, the most unreactive metals that are not affected by air, water and other natural factors like silver, gold, platinum, generally occur in free state.The compounds of metals that occur in nature along with the impurities are called minerals.

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The minerals from which the metal can be separated economically are called ores. Ores contain many types of impurities such as soil, sand and rocky substances along with the metal compounds. These impurities are called gangue. Metals can be extracted from their ores by means of various methods of separation. The process of extraction of metal in pure state from the ores is also a part of metallurgy.

Ores are taken out from the mines and the gangue is usually separated from the ore at the site itself by various methods. Then the ores are carried out to the place where metals are produced. There metals are extracted in pure form. Then metals are further purified by different methods of purification. This entire process is called metallurgy.

Basic principles of metallurgy

Pure metal is obtained from the ore by the following stages.

1. Concentration of ores

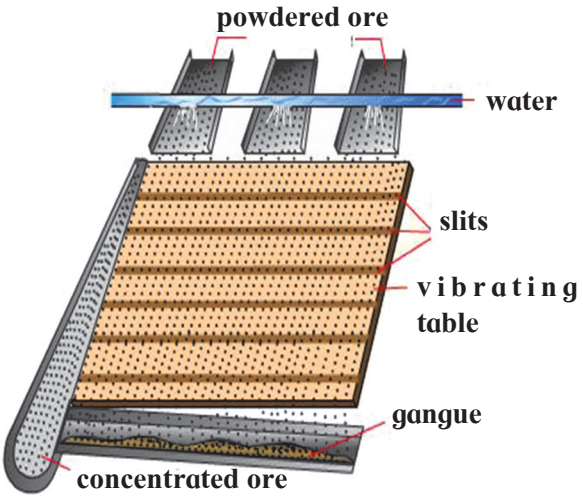
The process of separating gangue from the ores is called concentration of ores. In this process the concentration of the compound of the desired metal is increased. Various ways are used for this purpose. However, exact way to be used depends upon the physical properties of the metal present in the ores and the gangue. It also depends upon the reactivity of the metal and the facilities available for the purification. Various factors that could be responsible for the environmental pollution are also considered. Some general methods for the concentration of ores are as follows.

a. Separation based on gravitation

The heavy particles of ores can be easily separated from the light particles of gangue by the gravitational method. The processes to carry out this separation are as follows.

i. Wilfley table method

In this method of separation, the Wilfley table is made by fixing narrow and thin wooden riffles on inclined surface. The table is kept vibrating continuously. Powdered ore obtained from lumps of the ore using ball mill is poured on the table and a stream of water is also released from the upper side. As a result, the lighter gangue particles are carried away along with the flowing water, while the heavier particles in which proportion of minerals is more and proportion of gangue is less, are blocked by the wooden riffles and get collected on the slits between them.



8.8 Wilfley table method

ii. Hydraulic separation method

The hydraulic separation method is based on the working of a mill. There is a tapering vessel similar to that used in a grinding mill. It opens in a tank-like container that is tapering on the lower side. The tank has an outlet for water on the upper side and a water inlet on the lower side.

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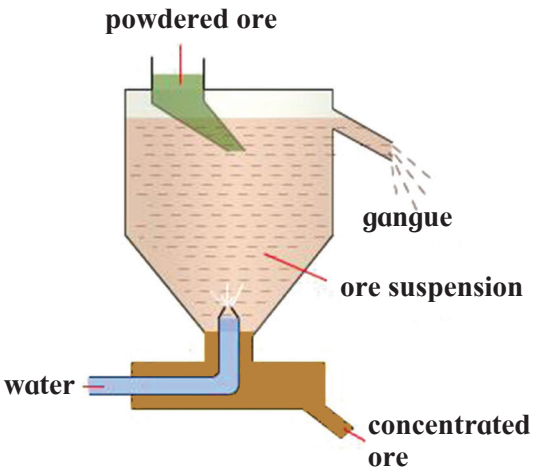
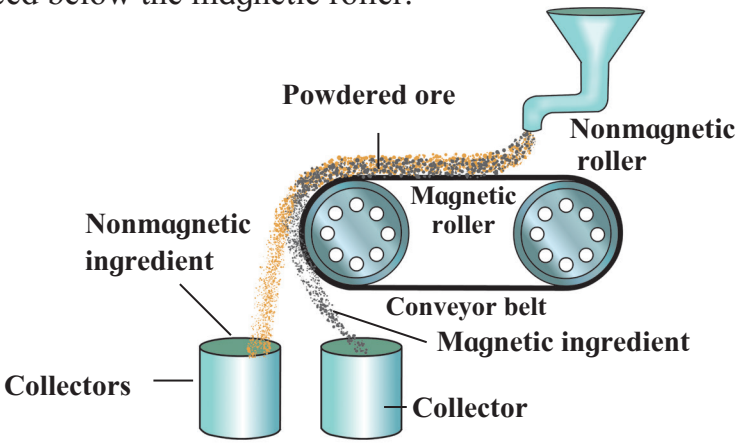
Finely ground ore is released in the tank. A forceful jel of water is introduced in the tank from the lower side. Gangue particles are lighter and therefore they flow out along with the water jet from the outlet on the upper side of the tank and get collected separately. At the same time the heavy particles of the ore are collected at the bottom from the lower side of the tank. In short, this method is based on the law of gravitation, wherein particles of the same size are separated by their weight with the help of water.



8.9 Hydraulic separation

b. Magnetic separation Method : This method requires an electromagnetic machine. The main parts of this machine are two types of iron rollers and the conveyor belt moving continuously around them. One of the rollers is nonmagnetic while the other is electromagnetic. The conveyor belt moving around the rollers is (nonmagnetic) made up of leather or brass. The powdered ore is poured on the conveyor belt near the nonmagnetic roller. Two collector vessels are placed below the magnetic roller.

The particles of the nonmagnetic part in the ore are not attracted towards the magnetic roller. Therefore, they are carried further along the belt and fall in the collector vessel places is away from the magnetic roller. At the same time the particles of the magnetic ingredients of the ore stick to the magnetic roller and therefore fall in the collector vessel near the magnetic roller.



8.10 Magnetic separation

In this way the magnetic and nonmagnetic ingredients in the ore can be separated depending on their magnetic nature. For example, cassiterite is a tin ore. It contains mainly the nonmagnetic ingredient stannic oxide (SnO_2) and the magnetic ingredient ferrous tungstate ($FeWO_4$). These are separated by the electromagnetic method.

c. Froth floatation method

The froth floatation method is based on the two opposite properties, hydrophilic and hydrophobic, of the particles. Here the particles of the metal sulphides, due to their hydrophobic property, get wetted mainly with oil, while due to the hydrophilic property the gangue particles get wetted with water. By using these properties certain ores are concentrated by froth floatation method.

Internet my friend

Collect the information about the different steps of metal extraction & explain it in the class.

Collect the related videos.

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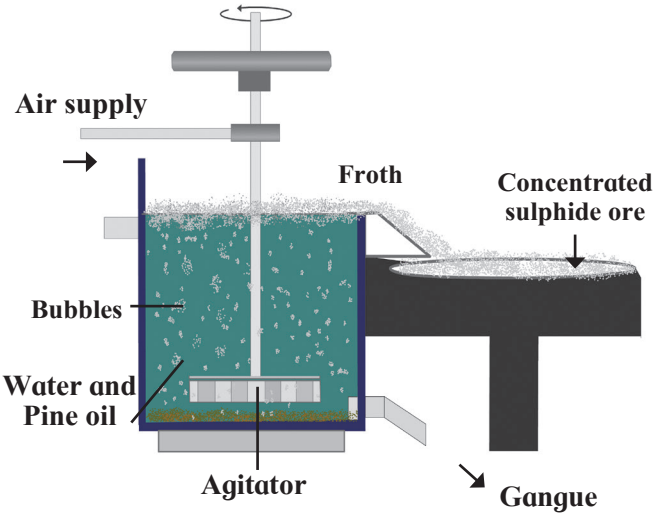
In this method the finely ground ore is put into a big tank containing ample amount of water. Certain vegetable oil such as pine oil eucalyptus oil, is added in the water for the formation of froth. Pressurised air is blown through the water. There is an agitator rotating around its axis in the centre of the floatation tank. The agitator is used as per the requirement. Bubbles are formed due to the blown air. Due to agitation a foam is formed from oil, water and air bubbles together, due to the agitating. This foam rises to the surface of water and floats. That is why this method is called froth floatation process.



8.11 Froth floatation method

Particles of certain sulphide ore float with the foam on water as they preferencially get wetted by the oil. For example, this method is used for the concentration of zinc blend (ZnS) and copper pyrite ($CuFeS_2$)

d. Leaching

The first step in the extraction of the metals aluminium, gold and silver from their ores is the method of leaching. In this method the ore is soaked in a certain solution for a long time. The ore dissolves in that solution due to a specific chemical reaction. The gangue, however, does not react and therefore does not dissolve in that solution. So it can be separated. For example, concentration of bauxite, the aluminium ore, is done by leaching method. Here bauxite is soaked in aqueous NaOH or aqueous Na_2CO_3 which dissolves the main ingredient alumina in it.

Do you know ?

Water does not stick to colocasia leaves. Similarly, water does not stick to wax. On the other hand common salt or soap stick to water that is, they get wetted by water.

Can you recall? What is the electronic defination of oxidation and reduction?

During the extraction of metals from their ores, metal is obtained from the cation of metal. In this process the metal cation is to be reduced. How to bring about the reduction depends upon the reactivity of the metal. We have already learnt about the reactivity series of metals.

2. Extraction of metals

a. Extraction of reactive metals

The metals at the top of the reactivity series are highly reactive. Their reactivity decreases down the series. For example, potassium, sodium, aluminium are reactive metals. Reactive metals have large capacity to form cations by losing the electrons in their outermost shell. For example, reactive metals react vigorously with dilute acids to give hydrogen gas. Highly reactive metals burn by reacting with oxygen from air at room temperature. Their extraction has to be done by electrolytic reduction. For example, the metals sodium, calcium and magnesium are obtained by electrolysis of their molten chloride salts. In this process metal is deposited on the cathode while chlorine gas is liberated at the anode. The electrode reactions during the electrolysis of molten sodium chloride to get metallic sodium are as shown below.

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Cathode reaction $Na^+ + e^- \longrightarrow Na$ (Reduction)

Anode reaction $2Cl^- \longrightarrow Cl_2 + 2e^-$ (Oxidation)

Use your brain power !

Write the electrode reaction for electrolysis of molten magnesium chloride and calcium chloride.

We are now going to see how aluminium is obtained by electrolytic reduction of aluminium oxide in the ore bauxite.

Extraction of Aluminium.

Aluminium Symbol : Al Colour : Silver white
Atomic number : 13 Electronic configuration: 2, 8, 3 Valency : 3

Aluminium being reactive metal does not occur in nature in free state. Aluminium is the third highly abundant element in the earth crust after oxygen and silicon. Aluminium is extracted from its ore bauxite ($Al_2O_3nH_2O$). Bauxite contains 30% to 70% of Al_2O_3 and remaining part is gangue. It is made up of sand, silica, iron oxide etc. There are two steps in the extraction of aluminium.

i. Concentration of bauxite ore:

Bauxite is the main ore of aluminium. Silica (SiO_2), ferric oxide (Fe_2O_3) and titanium oxide (TiO_2) are the impurities present in bauxite. Separation of these impurities is done by leaching process using either Bayer's method or Hall's method. In both these methods finally the concentrated alumina is obtained by calcination.

In the Bayer's process the ore is first ground in a ball mill. Then it is leached by heating with concentrated solution of caustic soda (NaOH) at 140 to 150 ^{0}C under high pressure for 2 to 8 hours in a digester. Aluminium oxide being amphoteric in nature, it reacts with the aqueous solution of sodium hydroxide to form water soluble sodium aluminate. This means that bauxite is leached by sodium hydroxide solution.

$$Al_2O_3 \cdot 2H_2O\ (s) + 2\ NaOH\ (aq) \longrightarrow 2NaAlO_2\ (aq) + 3\ H_2O\ (l)$$

The iron oxide in the gangue does not dissolve in aqueous sodium hydroxide. It is separated by filtration. However, silica in the gangue dissolves in aqueous sodium hydroxide to form water soluble sodium silicate.

Aqueous sodium aluminate is diluted by putting in water and is cooled to 50 ^{0}C. This results in precipitation of aluminium hydroxide.

$$NaAlO_2 + 2H_2O \longrightarrow NaOH + Al(OH)_3$$

In the Hall's process the ore is powdered and then leached by heating with aqueous sodium carbonate in the digester to form water soluble sodium aluminate. Then the insoluble impurities are filtered out. The filtrate is warmed and neutralised by passing carbon dioxide gas through it. This results in the precipitation of aluminium hydroxide.

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$Al_2O_3{\cdot}2H_2O\ (s) + Na_2CO_3(aq) \longrightarrow 2NaAlO_2(aq) + CO_2\uparrow + 2\ H_2O\ (l)$

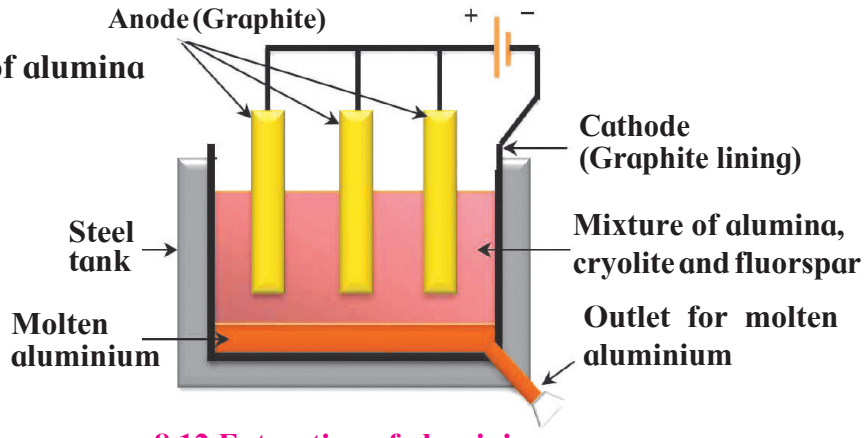
$2NaAlO_2(aq) + 3H_2O + CO_2(g) \longrightarrow 2Al\ (OH)_3\downarrow + Na_2CO_3$

The precipitate of $Al(OH)_3$ obtained in both, Bayer's and Hall's processes is filtered, washed, dried and then calcined by heating at 1000 ^{0}C to obtain alumina.

$2Al(OH)_3 \longrightarrow Al_2O_3 + 3H_2O$

ii. Electrolytic reduction of alumina

a. In this method electrolysis of molten mixture of alumina (melting point > 2000 ^{0}C) is done in a steel tank. The tank has a graphite lining on the inner side. This lining does the work of a cathode. A set of graphite rods dipped in the molten electrolyte works as anode. Cryolite (Na_3AlF_6) and fluorspar (CaF_2) are added in the mixture to lower its melting point upto 1000 ^{0}C.



8.12 Extraction of aluminium

b. Aluminium is deposited on the cathode on passing electric current. Molten aluminium being heavier than the electrolyte, is collected at the bottom of the tank. It is taken out from there from time to time, Oxygen gas is liberated at the anode.

The electrode reactions are as shown below.

Anode reaction $2O^{2-} \longrightarrow O_2 + 4e^-$ (Oxidation)

Cathode reaction $Al^{3+} + 3e^- \longrightarrow Al\ (l)$ (Reduction)

The liberated oxygen reacts with the anodes to form carbon dioxide gas. The anodes have to be changed from time to time as they get oxidised during the electrolysis of alumina.

b. Extraction of moderately reactive metals

Can you tell?

1. What are the moderately reactive metals?
2. In which form do the moderately reactive metals occur in nature?

The metals in the middle of the reactivity series such as iron, zinc, lead, copper are moderately reactive. Usually they occur in the form of their sulphide salts or carbonate. It is easier to obtain metals from their oxides rather than sulphides or carbonates. Therefore, the sulphide ores are strongly heated in air to transform them into oxides. This process is called **roasting**. Carbonate ores are strongly heated in a limited supply of air to transform them into oxides.This process is called **calcination**.

The following reactions occur during roasting and calcination of zinc ore.

Roasting $2\ ZnS + 3O_2 \longrightarrow 2\ ZnO + 2\ SO_2\uparrow$

Calcination $ZnCO_3 \longrightarrow ZnO + CO_2\uparrow$

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The zinc oxide so obtained is reduced to zinc by using suitable reductant such as carbon.

$ZnO + C \longrightarrow Zn + CO\uparrow$

Apart from carbon, reactive metals such as sodium, calcium, aluminium are also used as reducing agent for the reduction of metal oxide to obtain the metal. This is because these metals displace a moderately reactive metal from its compound. For example, when manganese dioxide is ignited with aluminium powder the following reaction takes place.

$3\ MnO_2 + 4\ Al \longrightarrow 3Mn + 2Al_2O_3 + heat$

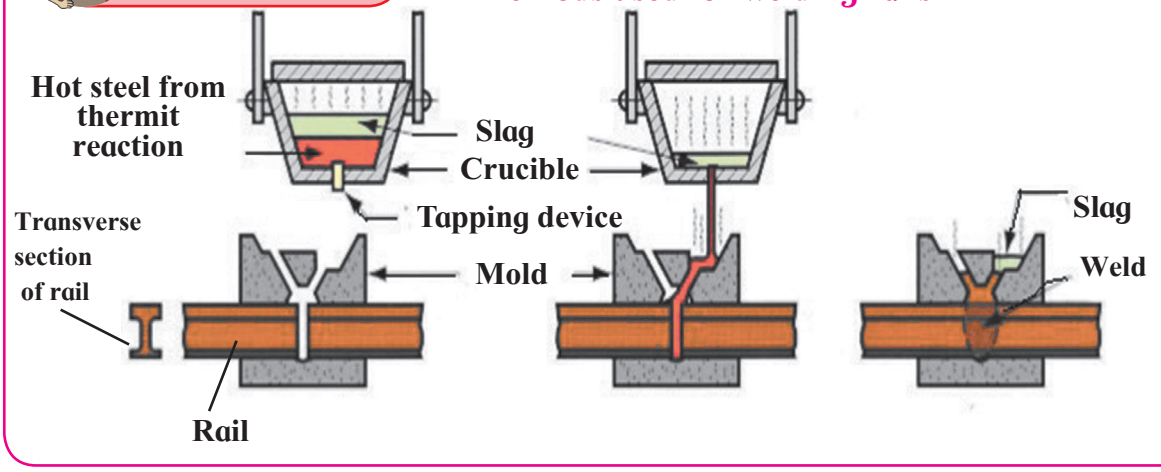
Identify the substances undergone oxidation and reduction in this reaction.

The heat evolved in the above reaction is so large that the metal is formed in the molten state. Another similar example is the thermit reaction. Here, iron oxide reacts with aluminium to form iron and aluminium oxide.

$Fe_2O_3 + 2\ Al \longrightarrow 2\ Fe + Al_2O_3 + heat$

Do you know ?

Methods used for welding rails



8.13 Thermit Welding

c. Extraction of less reactive metals

The metals at the bottom of the reactivity series of metals are less reactive. That is why they are found in free state in nature. For example gold, silver, platinum. The reserves of copper in free state are very few. Presently copper is found mainly in the form of Cu_2S.

Copper is obtained from Cu_2S ore just by heating in air.

$2Cu_2S + 3O_2 \longrightarrow 2\ Cu_2O + 2SO_2\uparrow$

$2\ Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2\uparrow$

Collect information

Collect the information regarding how mercury is extracted from its ore cinnabar and write the corresponding chemical reaction.

3. Refining of metals

Metals obtained by the various reduction processes discribed above are not very pure. They contain impurities. The impurities need to be separated to obtain pure metal. Electrolysis method is used to obtain pure metals from impure metals.

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Corrosion of metals

Can you recall?

1. What is meant by corrosion?
2. Have you seen the following things?

Old iron bars of buildings, copper vessels not cleaned for long time, silver ornaments or idols exposed to air for long time, old abundoned vehicles fit to be thrown away.

Think about it

1) Why do silver articles turn blackish while copper vessels turn greenish on keeping in air for a long time?
2) Why do pure gold and platinum always glitter?

Rusting of iron articles causes large financial loss. Thus corrosion of iron, that is, rusting is a big problem.

1. Iron reacts with moist air and a deposit of reddish substance ($Fe_2O_3 \cdot H_2O$) is formed on it. This substance is called rust.
2. Carbon dioxide in moist air reacts with the surface of copper vessel. Copper loses its luster due to formation of greenish layer of copper carbonate ($CuCO_3$) on its surface. This is called patination of copper.
3. On exposure to air, silver articles turn blackish after some time. This is because of the layer of silver sulphide (Ag_2S) formed by the reaction of silver with hydrogen sulphide in air.
4. By oxidation of aluminium, a thin layer of aluminium oxide forms on it.

Blackened silver vessel

Rusted shackles

The copper cladded statue of Liberty made 300 years ago has turned green.

8.14 Effects of corrosion

Prevention of corrosion

Can you tell?

1. Which measures would you suggest to stop the corrosion of metallic articles or not to allow the corrosion to start?
2. What is done so to prevent rusting of iron windows and iron doors of your house?

Various methods are used to protect metals from corrosion. Special attention is paid in almost all the methods so that iron does not rust. We can lower the rate of the process of rusting of iron. Corrosion of metals can be stopped by keeping metals isolated from a direct contact with air. The prevention of corrosion can be achieved by various ways. Some of these methods are as follows.

1. To fix a layer of some substance on the metal surface so that the contact of the metal with moisture and oxygen in the air is prevented and no reaction would occur between them.

2. To prevent corrosion of metals by applying a layer of paint, oil, grease or varnish on heir surface. For example, corrosion of iron can be prevented by this method.

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Use your brain power !

Can we permanently prevent the rusting of an iron article by applying a layer of paint on its surface?

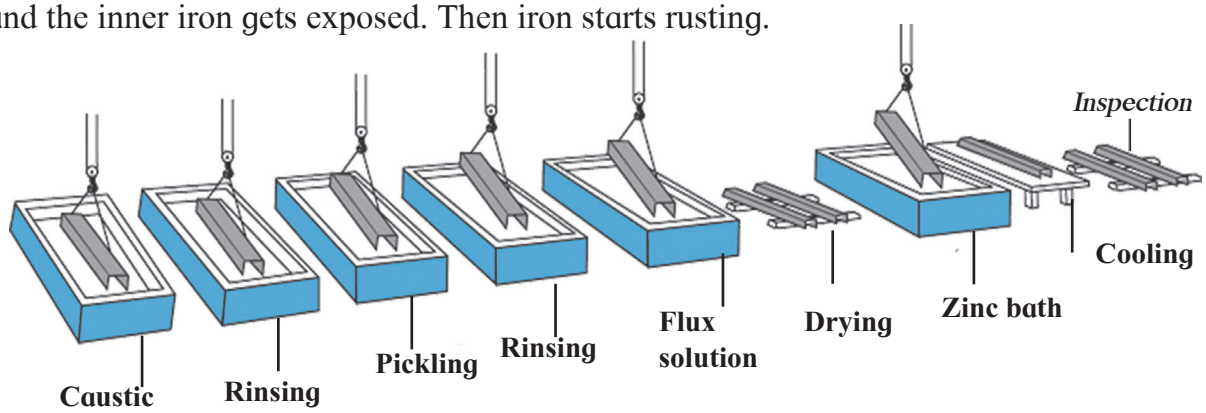
We cannot protect the articles permanently from rusting by painting them. The method of painting is suitable for short time. If there is a scratch on the paint on the surface of the article and if a small surface of the metal comes in contact with air, the process of rusting starts below the layer of the paint.

Why do new iron sheets appear shiny?

Corrosion can be prevented by putting a layer of noncorrodible metal on a corrodible metal. This can be done in many ways.

1. Galvanizing

In this method a thin layer of zinc is applied to prevent corrosion of iron or steel. For example, shining iron nails, pins, etc. In this method corrosion of zinc occurs first because zinc is more electropositive than iron. After a few rainy seasons the zinc layer goes away and the inner iron gets exposed. Then iron starts rusting.



8.15 Galvanizing process

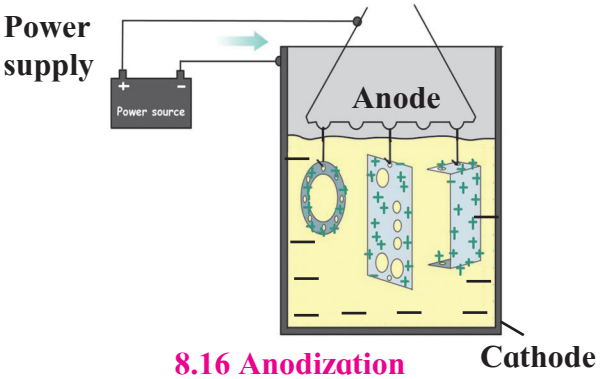
2. Tinning

In this method a layer of molten tin is deposited on metals. We call this as '*kalhaee*'.A greenish layer forms on the surface of a copper or brass vessel. This greenish layer is poisonous. If buttermilk or curry is placed in such a vessel it gets spoiled. Tinning is done to prevent all such damages.

3. Anodization

In this method metals like copper, aluminium are coated with a thin and strong layer of their oxides by means of electrolysis. For this the copper or aluminium article is used as anode. As this oxide layer is strong and uniform all over the surface, it is useful for prevention of the corrosion of the metal.

For example, when aluminium is anodised, the thin layer of aluminium oxide is formed. It obstructs the contact of the aluminium with oxygen and water. This prevents further oxidation. This protection can be further increased by making the oxide layer thicker during the anodization.



8.16 Anodization

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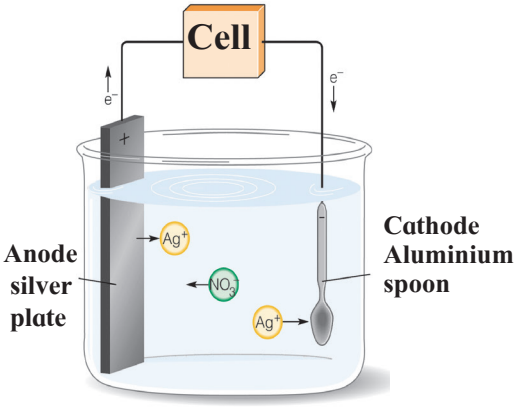
4. Electroplating

In this method a less reactive metal is coated on a more reactive metal by electrolysis. Silver plated spoons, gold plated ornaments are the examples of electroplating.



8.17 Electroplating

5. Alloying

Majority of the metallic substances used presently are in the form of alloys. The main intention behind this is to decrease the intensity of corrosion of metals. The homogenous mixture formed by mixing a metal with other metals or nonmetals in certain proportion is called an alloy. For example, bronze is an alloy formed from 90% copper and 10 % tin. Bronze statues do not get affected by sun and rain. Stainless steel does not get stains with air or water and also does not rust. It is an alloy made from 74% iron, 18% chromium and 8% carbon. In recent times various types of alloys are used for minting coins.

8.18 Coins made from various alloys

Do you know ?

When one of the metals in an alloy is mercury the alloy is called amalgam. For example, sodium amalgam, zinc amalgam, etc. Silver amalgam was earlier used by dentists. Gold amalgam is used for extraction of gold.

Collect information

1. What are the various alloys used in daily life? Where are those used?
2. What are the properties that the alloy used for minting coins should have?

Exercise

1. Write names.
   a. Alloy of sodium with mercury.
   b. Molecular formula of the common ore of aluminium.
   c. The oxide that forms salt and water by reacting with both acid and base.
   d. The device used for grinding an ore.
   e. The nonmetal having electrical conductivity.
   f. The reagent that dissolves noble metals.

2. Make pairs of substances and their properties

Substance	Property
a. Potassium bromide	1.Combustible
b. Gold	2.Soluble in water
c. Sulphur	3.No chemical reaction
d. Neon	4.High ductility.

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3. Identify the pairs of metals and their ores from the following.

Group A	Group B
a. Bauxite	i. Mercury
b. Cassiterite	ii. Aluminium
c. Cinnabar	iii. Tin

4. Explain the terms.

a. Metallurgy b. Ores
c. Minerals d. Gangue.

5. Write scientific reasons.

a. Lemon or tamarind is used for cleaning copper vessels turned greenish.
b. Generally the ionic compounds have high melting points.
c. Sodium is always kept in kerosene.
d. Pine oil is used in froth flotation.
e. Anodes need to be replaced from time to time during the electrolysis of alumina.

6. When a copper coin is dipped in silver nitrate solution, a glitter appears on the coin after some time. Why does this happen? Write the chemical equation.

7. The electronic configuration of metal 'A' is 2,8,1 and that of metal 'B' is 2,8,2. Which of the two metals is more reactive? Write their reaction with dilute hydrochloric acid.

8. Draw a neat labelled diagram.

a. Magnetic separation method.
b. Froth floatation method.
c. Electrolytic reduction of alumina.
d. Hydraulic separation method.

9. Write chemical equation for the following events.

a. Aluminium came in contact with air.
b. Iron filings are dropped in aqueous solution of copper sulphate.
c. A reaction was brought about between ferric oxide and aluminium.
d. Electrolysis of alumina is done.
e. Zinc oxide is dissolved in dilute hydrochloric acid.

10. Complete the following statement using every given options.

During the extraction of aluminium……..

a. Ingredients and gangue in bauxite.
b. Use of leaching during the concentration of ore.
c. Chemical reaction of transformation of bauxite into alumina by Hall's process.
d. Heating the aluminium ore with concentrated caustic soda.

11. Divide the metals Cu, Zn, Ca, Mg, Fe, Na, Li into three groups, namely reactive metals, moderately reactive metals and less reactive metals.

Project:

Collect metal vessels and various metal articles. Write detailed informaton. Write the steps in the procedure that can be done in the laboratory for giving glitter to these. Seek guidance from your teacher.

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9. Carbon Compounds

- Bonds in carbon compounds
- Hydrocarbons, Functional Groups and homologous series
- Chemical Properties of Carbon Compounds
- Carbon : A Versatile Element
- Nomenclature of Carbon compounds
- Macromolecules and Polymers

Can you recall?

1. What are the types of compounds ?
2. Objects in everyday use such as foodstuff, fibers, paper, medicines, wood, fuels, are made of various compounds. Which consituent elements are common in these compounds?
3. To which group in the periodic table does the element carbon belongs ? Write down the electronic configuration of carbon and deduce the valency of carbon.

In the previous standards we have seen that organic and inorganic compounds are the two important types of compounds. Except materials fabricated from metal and glass/soil several other materials from foodstuff to fuels are made up of organic compounds. The essential element in all the organic compounds is carbon. About 200 years back it was believed that organic compounds are obtained directly or indirectly from the organisms. However, after synthesis of the organic compound urea from an irganic compounds in the laboratory, the organic compounds received a new identity as carbon compounds. All the compounds having carbon as a constituent element are called as organic compounds. The compounds carbon dioxide, carbon monoxide, carbide salts, carbonate salts and bicarbonate salts are exception; they are inorganic compounds of carbon.

Bonds in Carbon compounds

You have learnt about the ionic compounds in the previous chapter. You have seen that ionic compounds have high melting and boiling points and they conduct electricity in the molten and dissolved state. You have also seen that these properties of ionic compounds are explained on the basis of the ionic bonds in them. The table 9.1 shows melting and boiling points of a few carbon compounds. Are these values higher or lower as compared to the ionic compounds?

Generally the melting and boiling points of carbon compounds are found to be lower than 300 ^{0}C. From this we understood that the intermolecular attractive forces are weak in carbon compounds.

In the previous stanadard on testing the electrical conductivity of carbon compounds, glucose and urea you have observed that they are not electrical condutors. Generally most of the carbon compounds are found to be bad conductors of electricity. From it we understand that structures of most of the carbon compounds lack ionic bonds. It means that the chemical bonds in carbon compounds do not produce ions.

Compound	Melting point ^{0}C	Boiling point ^{0}C
Methane (CH_4)	- 183	- 162
Ethanol (CH_3CH_2OH)	- 117	78
Chloroform ($CHCl_3$)	- 64	61
Acetic acid (CH_3COOH)	17	118

9.1 Melting and Boiling Points of a few carbon compounds

Can you tell?

1. What is meant by a chemical bond?
2. What is the number of chemical bonds that an atom of an element forms called?
3. What are the two important types of chemical bonds?

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In the previous standards you have learnt about the relatioship between electronic configuration and valency of an element, and also about the ionic and covalent bonds. Let see at the background of electronic configuration of carbon and the covalent bonds formed. (See Table 9.2).

Carbon atom	Electronic Configuration	Number of electron in the Valence shell	Nearby noble gas and the ele ctronic configuration	
			He	Ne
$_6C$	2, 4	4	2	2,8

9.2 Background of bond formation by carbon

You have seen that the driving force behind the formation of bond by an atom is to attain the stable electronic configuration of the nearby noble gas and obtain stability. As the valence shell of carbon contains 4 electrons, there can be many alternative routes to attain a noble gas configuration.

(i) To attain the configuaration of noble gas helium (He) by losing one after another all the four valence electrons : In this method the net positive charge on the carbon atom goes on increasing during loss of every electrons. Therefore to lose the next electron more energy is required, which makes the task more difficult. Moreover, the C^{4+} cation that would ultimately form in this process becomes unstable in spite of its noble gas configuration, because it has a small size with high net charge. Therefore carbom atom does not take this route to attain a noble gas configuration.

(ii) To attain the stable configuration of the noble gas neon (Ne) by accepting one by one ass the four electrons in the valence shell. In this method the net negative charge on the carbon atom goes on increasing while accepting every new electron. Therefore, more energy is required for accepting the next electron by overcoming the increasing repulsive force making the task more and more difficult. Moreover the C^{4-} anion ultimately formed would be unstable in spite of its noble gas configuration, as it would have a small size with high net charge making it difficult for the nuclear charge +6 to hold 10 electrons around it. Therefore, carbon atom does not take this route to attain a noble gas configuration.

(iii) To attain the configuaration of neon by sharing four electrons of valence shell with four valence electrons of other atoms: In this method two atoms share valence electrons with each other. Valence shells of both the atoms overlap and accomodate the shared electrons, As a result, both the atoms attain a noble gas configuration without generating any net charge on them, which means that atoms remain electrically neutral. Due to these factors atoms attain stability. Therefore, carbon atom adopt this route to attain a noble gas configuration.

The chemical bond formed by sharing of two valence electron between the two atoms is called covalent bond.

A covalent bond is represented clearly by drawing an electron - dot structure. In this method a circle is drawn around the atomic symbol and each of the valence electrons is indicated by a dot or a cross. The covalent bond formed between the atoms is indicated by showing the circles around the atomic symbols crossing each other. The shared electrons are shown in the overlapping regions of the two circles by dot or cross. The electron - dot structure is also drawn without showing the circle. One pair of shared electrons constitutes one covalent bond . A covalent bond is also represented by a small line joining the symbols of the two atoms. The line structure is also called structural formula.

9.3 Electron dot structure and line structure of hydrogen molecule with a single bond

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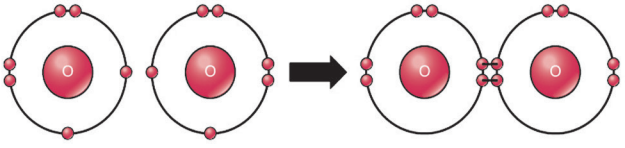
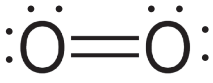
Let us first look at the hydrogen molecule which is the simplest example of a molecule formed by covalent bonding. You have already learnt that the atomic number of hydrogen being 1, its atom contains 1 electron in K shell. It requires one more elctron to complete the K shell and attain the configuration of helium (He). To meet this requirement two hydrogen atoms share their electrons with each other to form H_2 molecule. One covalent bond, that is a single bond is formed between two hydrogen atoms by sharing of two electrons. (see fig 9.3).

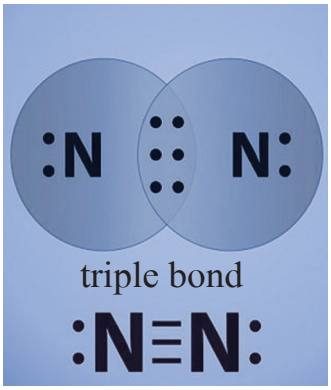
The O_2 molecule is formed by chemical combination of two oxygen atoms; and N_2 molecule is formed by the chemical combination of two nitrogen atoms. On drawing the electron-dot structures of these two molecules, it becomes clear that the two oxygen atoms in O_2 molecule are joined with each other by two covalent bonds, that is, a double bond, while the two nitrogen atoms in the N_2 molecule are joined with each other by three covalent bonds, that is, a triple bond (See figure 9.4)



Two atoms of oxygen



double bond



9.4 Double Bond and Triple Bond

Use your brain power !

1. Atomic number of chlorine is 17.
   What is the number of electron in the valence shell of chlorine?
2. Molecular formula of chlorine is Cl_2. Draw electron-dot and line structure of a chlorine molecule.
3. The molecular formula of water is H_2O. Draw electron-dot and line structures for this triotomic molecule. (Use dots for electron of oxygen atom and crosses for electrons of hydrogen atoms.)
4. The molecular formula of ammonia is NH_3. Draw electron-dot and line structures for ammonia molecule.

Now let us consider a carbon compound methane (CH_4). You have learnt about the occurrence, properties and uses of methane molecule in the previous standard. Just now we saw that carbon atom forms four covalent bonds using the four valence electrons and attain the configuration of the nearby noble gas neon (Ne) and obtains stability: Fig 9.5 shows the line structure and also the electron-dot structure of methane.

Do you know ?

To understand the structures of carbon compounds various types of molecular models are used. The fig 9.6 shows ball and stick model and space filling model of methane molecule.

Use your brain power !

1. The molecular formula of carbon dioxide is CO_2. Draw the electron-dot srtucture (without showing circle) and line structure for CO_2.
2. With which bond C atom in CO_2 is bonded to each of the O atoms?
3. The molecular formula of sulphur is S_8 in which eight sulphur atoms are bonded to each other to form one ring. Draw an electron-dot structure for S_8 without showing the circles.

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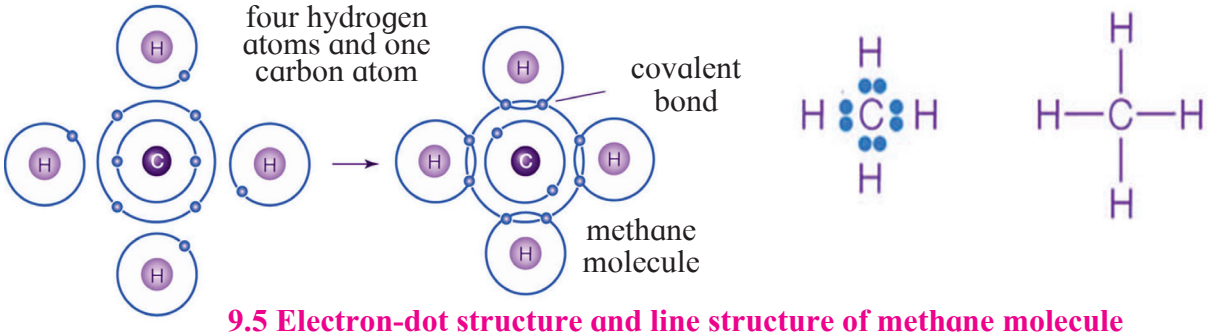
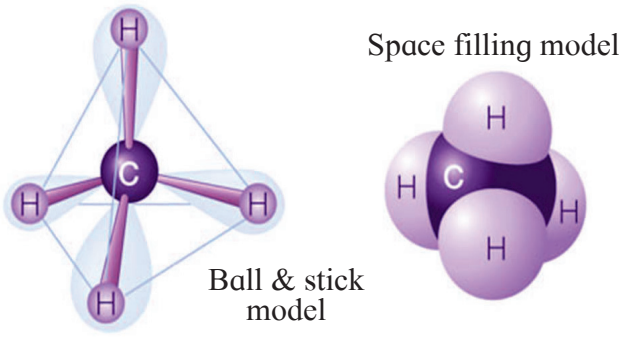


9.5 Electron-dot structure and line structure of methane molecule

Carbon : A Versatile Element

We saw that carbon atoms, like some other atoms, share the valence electrons to form covalent bonds. Similarly, we also saw the structure of the simple carbon compound, methane. But carbon is different than the other elements; the number of compounds formed from carbon is extremely large. In the beginning we saw that except for the objects formed from metals and glass/soil all the other objects are made from carbon. In short, brief the entire living kindom is made from carbon, our body is also made from carbon. Millions of molecules ranging from the small and simple methane molecule to the extremely big D.N.A. molecule are made from carbon. The molecular masses of carbon compounds range upto 10^{12}. This means that carbon atoms come together in a large number to form extremely big molecules. What is the cause of this unique property of carbon? It is due to the peculiar nature of the covalent bonds formed by carbon, it can form large number of compounds. From this we come to know the following **characteristics of carbon**.

a. Carbon has a unique ability to form strong covalent bonds with other carbon atoms; this results in formation of big molecules. This property of carbon is called catenation power. The carbon compounds contain open chains or closed chains of carbon atoms. An open chain can be a straight chain or a branched chain. A closed chain is a ring stucture. The covalent bond between two carbon atoms is strong and therefore stable. Due to the strong and stable covalent bonds carbon is bestowed with catenation power.



9.6 Models of methane molecule

Till now the number of known carbon copmounds is about 10 million. This number is larger than the total number of compounds formed by all the other elements. The range of molecular masses of carbon compounds is 10^{1} - 10^{12}.
(See table 9.7)

Use your brain power !

1. Hydrogen peroxide decomposes on its own by the following reaction

   $$H\text{-}O\text{-}O\text{-}H \longrightarrow 2H\text{-}O\text{-}H + O_2$$

   From this, what will be your inference about the strenght of O-O covalent bond?
2. Tell from the above example whether oxygen has catenation power or not.

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Carbon Compound	Molecular mass
Methane CH_4 (The smallest carbon compound)	16
Cooking gas ($C_3H_8 + C_4H_{10}$)	44/58
Benzene (C_6H_6)	78
Camphor ($C_{10}H_{16}O$)	152
Penicillin ($C_{16}H_{18}N_2O_4S$)	334
Sugar ($C_{12}H_{22}O_{11}$)	342
Sodium dodecyl benzene sulphate (a detergent)	347
Fat	~ 700
Starch	~ 10^3
Cellulose	~ 10^5
Protein	~ 10^5
Polyethylene	~ 10^6
D.N.A.	~ 10^{12}

9.7 Carbon compounds and molecular masses

b. Two carbon atoms can be bonded together by one, two or three covalent bonds. These are called single bond, double bond, and triple bond respectively. Due to the ability of carbon atoms to form multiple bonds as well as single bonds, the number of carbon compounds increases. For example, there are three compounds, namely, ethane (CH_3-CH_3), ethene (CH_2=CH_2) and ethyne (CH ≡ CH) which contain two carbon atoms.

c. Being tetravalent one carbon atom can form bonds with four other atoms (carbon or any other). This results in formation of many compounds. These compounds possess different properties as per the atoms to which carbon is bonded. For example, five different compounds are formed using one carbon atom and two monovalent elements hydrogen and chlorine : CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4. Similarly carbon atoms form covalent bonds with atoms of elements like O, N, S, halogen & P to form different types of carbon copmounds in large number.

d) Carbon has one more characteristics which is responcible for large number of carbon compounds. It is 'isomerism'. Shortly, we will learn about it.

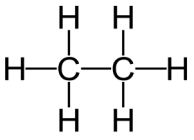
Hydrocarbons : Saturated and Unsaturated

Carbon compounds contain many elements. The element hydrogen is present to a smaller or larger extent in majority of carbon compounds. The compounds which contain carbon and hydrogen as the only two elements are called hydrocarbons. Hydrocarbons are the simplest and the fundamental organic compounds. The smallest hydrocarbon is methane (CH_4) formed by combination of one carbon atom and four hydrogen atoms. We have already seen the structure of methane. Ethane is one more hydrocarbon. Its molecular formula is C_2H_6. The first step in writing the line structure (structural formula) of a hydrocarbon is to join the carbon atoms in the molecule with single bonds, and then in the second step use the hydrogen atoms in the molecular formula so as to fulfil the remaining valencies of the tetravalent carbon atoms. (See fig. 9.8), Fig. 9.9 shows electron-dot structure using two methods.

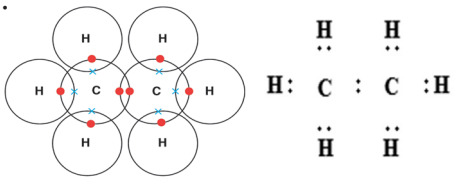
Ethane : Molecular formula C_2H_6

Step 1 : Join the two carbon atoms with single bonds C - C

Step 2 : Use the 6 hydrogen atoms in the molecular formula for fulfilling the tetravalency of both the carbon atoms.



9.8 Line structure / structural formula of ethane



9.9. Electron-dot structure of ethane

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Use your brain power !

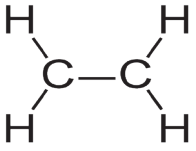
Molecular formula of propane is C_3H_8. From this draw its structural formula.

From the stuctural formula of ethane & propane it is seen that the valencies of all the atoms are satisfied by the single bonds. Such compounds are called saturated compounds. Ethane & propane are saturated hydrocarbons. Saturated hydrocarbons are also called 'Alkanes' .

There are two more hydrocarbons that contain two carbon atoms, namely, ethene (C_2H_4) and ethyne(C_2H_2). Let us see the method to draw the structural formula (line stucture) of ethene (C_2H_4). (Fig 9.10)

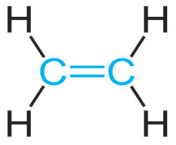
Step 1 : Join the two carbon atoms with single bond C-C.

Step 2 : Use the 4 hydrogen atoms in the molecular formula for satisfying tetravalency of both the carbon stoms.

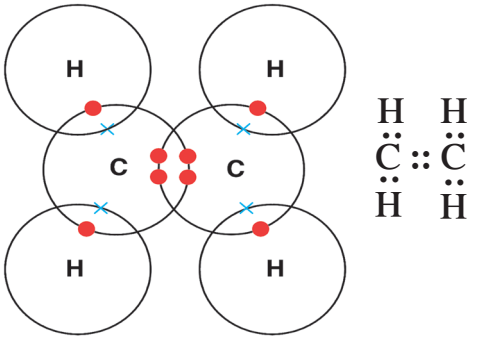


It appears that one valency of each of the two carbon atoms is not satisfied.

Step 3: Satisfy the tetravalency of the two carbon atoms by drawing a double bond in place of the single bond between them.



9.10 Line structure/ structural formula



9.11 Elctron-dot structures of ethane

Use your brain power !

1. The molecular formula ethyne is C_2H_2. From this draw its structural formula and electron - dot structure.
2. How many bonds have to be there in between the two carbon atoms in ethyne so as to satisfy their tetravalency?

The carbon compounds having a double bond or triple bond between two carbon atoms are called unsaturated compounds. Ethene and ethyne are unsaturated hydrocarbons. The unsaturated hydrocarbons containing a carbon-carbon double bond are called 'Alkenes'. The unsaturated hydrocarbons whose structures contain a carbon-carbon triple bond are called 'Alkynes'. Generally the unsaturated compounds are more reactive than the saturated compounds.

Straight chains, Branched chains and Rings of Carbon atoms

Let us compare the structural formulae of methane, ethane and propane. From these sructural formulae it is seen that the carbon atom (single or more carbon atoms bonded to each other) lie in the core of the molecule, while the hydrogen atoms bonded to each of the carbon atoms are on the periphery of the molecule. The mutually bonded carbon atoms in the core are like the skeleton of the molecule. The carbon skeleton determines the shape of the molecule of a carbon compound.

A straight chain of carbon atoms is formed by joining the carbon atoms are next to the other. The first column of the table 9.12 shows straight chains of carbon atoms. Write the structural formulae of the corresponding straight chain hydrocarbons in the second column satisfying the tetravalency of the carbon atom by joining them to hydrogen atoms. Work out the molecular formula from this and write it down in the third column. The name of the hydrocarbon is given in the fourth column.

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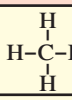
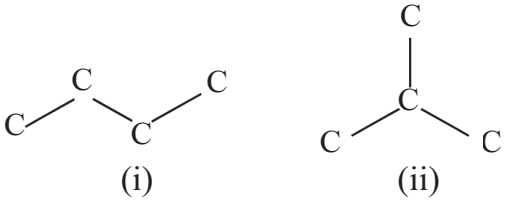
Straight chain of carbon atoms	Structural formula	Molecular formula	Name
C		CH_4	Methane
C-C			Ethane
C-C-C			Propane
C-C-C-C			Butane
C-C-C-C-C			Pentane
C-C-C-C-C-C			Hexane
C-C-C-C-C-C-C			Heptane
C-C-C-C-C-C-C-C			Octane
C-C-C-C-C-C-C-C-C			Nonane
C-C-C-C-C-C-C-C-C-C			Decane

Do you know ?

In the course of millions of years the reserves of crude oil were formed from the dead organisms buried under the sea floor. This crude oil and natural gas are now recovered from the oil wells. The natural gas is mainly methane . The crude oil is a complex mixture of thousands of different compounds. It mainly contains various hydrocarbons. Various useful componenets such as CNG, LPG, petrol (gasoline), rockel, diesel, engine oil, lubricant, etc. are obtained by separation crude oil using fractional distillation.

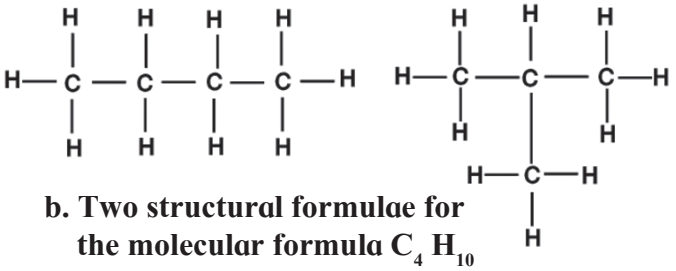
9.12 Straight chain hydrocarbon

Now let us pay more attention to the carbon chain in butane. The four carbon atoms can be joined to form a carbon chain in yet another way. (See fig 9.13 a)



(i) (ii)

a. Two possible carbon chains



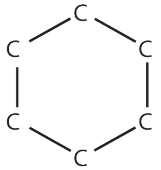
b. Two structural formulae for the molecular formula C_4H_{10}

9.13 Two isomeric compounds with molecular formula C_4H_{10}

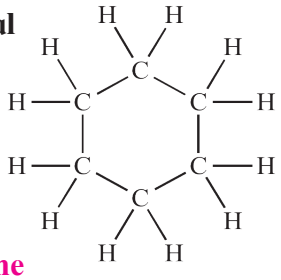
Two different structural formulae are obtained on joining hydrogen atoms to these two chains so as to satisfy the tetravalency of the carbon atoms. The molecular formula of both these structural formulae is the same which is C_4H_{10}. These are two different compounds as their structural formulae are different. The phenomenon in which compounds having different structural formulae have the same molecular formula is called 'structural isomerism'. The number of carbon compounds increases futher due to the isomerism obeserved in carbon compounds. The carbon chain (i) in the figure 9.13 (a) is a straight chain of carbon atoms, whereas the carbon chain (ii) is a branched chain of carbon atoms.

Apart from the straight chains and branched chains, closed chains of carbon atoms are present in some carbon compounds. Where in rings of carbon atoms form. For example, the molecular formula of cyclohexane is C_6H_{12} and its structural formula contains a ring of six carbon atoms. (See fig 9.14)

a. the carbon ring in cyclohexane



b. Structural formula of cyclohexene



9.14 Ring Structure of Cyclohexane

Use your brain power !

Draw electron-dot structure of cyclohexane.

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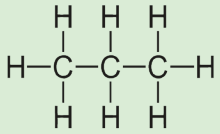
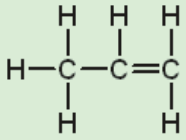
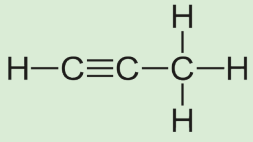
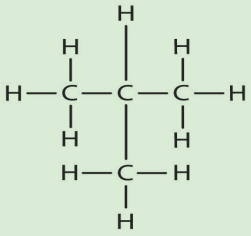
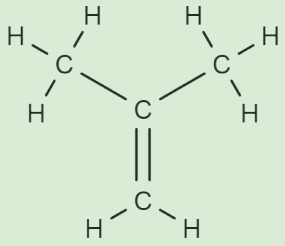
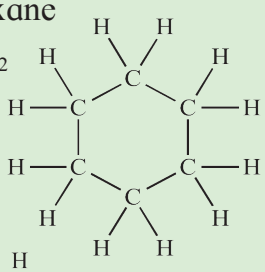
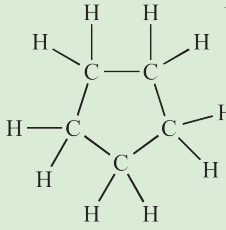
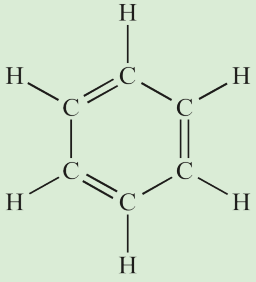
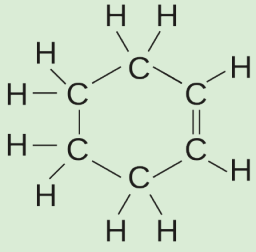
All types of carbon compounds whether straight chain, branched chain or cyclic, can be saturated or unsaturated. This is explained by the various examples of hydrocarbons in table 9.15

	Saturated hydrocarbons	Unsaturated hydrocarbons
Straight chain hydrocarbons	Propane C_3H_8 	 Propene C_3H_6  Propyne C_3H_4
Branched chain hydrocarbons	isobutane C_4H_{10} 	isobutylene C_4H_8 
Cyclic hydrocarbons	Cyclohexane C_6H_{12}   Cyclopentane C_5H_{10}	Cyclohexene C_6H_{10}   Benzene C_6H_6

9.15 Various Types of Hydrocarbons

It is learnt from the structural formula of benzene that it is a cyclic unsaturated hydrocarbon. There are three alternate double bonds in the six memebered ring srtructure of benzene. The compounds having this characteristic unit in their structure are called aromatic compounds.

Functional Groups in Carbon Compounds

Till now you have learnt about the hydrocarbon compounds formed by combination of the elements carbon and hydrogen. Many more types of carbon compounds are formed by formation of bonds of carbon with other elements such as halogens, oxygen, nitrogen, sulphur. The atoms of these elements substitute one or more hydrogen atoms in the hydrocarbon chain and thereby the tetravalency of carbon is satisfied. The atom of the element which is substitute for hydrogen is referred to as a hetero atom. Sometimes hetero atoms are not alone but exist in the form of certain groups of atoms. (See the table 9.16).

The compound acquire specific chemical properties due to these hetero atoms or the groups of atoms that contain heteroatoms, irrespective of the length and nature of the the carbon chain in that compound. Therefore these hetero atoms or the groups of atoms containing hetero atoms are called functional groups. The table 9.16 shows a few functional groups that occurs in carbon compounds.

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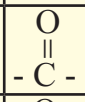
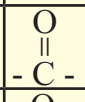
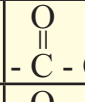
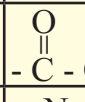
Here the free valency of the functional group is indicated by a short line. The fuctional group taking place a of hydrogen is joined to the carbon chain with this valency. The **carbon- carbon double and triple bonds** are also recognised as functional groups as the respective compounds get specific chemical properties due to them.

Hetero Atom	Functional Group		
	Name	Structural formula	Condensed Structural formula
Halogen (chlorine, bromine, iodine)	Halo (chromo/ bromo / iodo)	-X (-C1, -Br, -I)	- X (-C1, -Br, -I)
Oxygen	1. Alcohol	- O - H	-OH
	2. Aldehyde		-CHO
	3. Ketone		-CO-
	4. Carboxylic Acid		-COOH
	5. Ether	- O -	-O-
	6. Ester		-COO-
Nitrogen	Amines		- NH_2

9.16 Some functional groups in carbon compounds

Homologous series

You have seen that chains of different length are formed by joining the carbon atoms to each other. Moreover you have also seen that a functional group can take place of a hydrogen atom on these chains. As a result of this, large number of compounds are formed having the same functional groups but different length of carbon chain. For example, there are many compounds such as CH_3-OH, CH_3-CH_2-OH, CH_3-CH_2-CH_2-OH, CH_3-CH_2-CH_2-CH_2-OH which contain alcohol as the functional group. Though the length of the carbon chains in them is different, their chemical properties are very much similar due to the presence of the same fuctional group in them. The series of compounds formed by joining the same functional group in the place of a particular hydrogen atom on the chains having sequencially increasing length is called homologous series. There are different homologous series in accourdance with the functional group. For example, homologous series of alcohols, homologous series of carboxylic acids, homologous series of aldehydes, etc. All the memebrs of the homologous series are homologues of each other. Earlier you filled the structural formulae and molecular formulae in the table 9.12. From that the initial part of the homologous series of alkanes was formed.

Let us understand the characteristics of homologous series by considering initial parts of homologous series of alkanes, alkenes and alcohols. (See table No. 9.17.)

Complete the table Fill in the gaps in the table 9.17 a,b and c of homologous series.

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a. Homologous Series of Alkanes

Name	Molecular formula	Condensed Structural formula	Number of carbon atoms	Number of $-CH_2-$ units	Boiling point ^0C
Methane	CH_4	CH_4	1	1	- 162
Ethane	C_2H_6	CH_3-CH_3	2	2	- 88.5
Propane	C_3H_8	$CH_3-CH_2-CH_3$	3	3	- 42
Butane	C_4H_{10}	$CH_3-CH_2-CH_2-CH_3$	...	...	0
Pentane	C_5H_{12}	$CH_3-CH_2-CH_2-CH_2-CH_3$	...	...	36
Hexane	C_6H_{14}	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$	...	...	69

b. Homologous Series of Alcohols

Name	Molecular formula	Condensed Structural formula	Number of carbon atoms	Number of $-CH_2-$ units	Boiling point ^0C
Methanol	CH_4O	CH_3-OH	1	1	63
Ethanol	C_2H_6O	CH_3-CH_2-OH	2	2	78
Propanol	C_3H_8O	$CH_3-CH_2-CH_2-OH$	...	...	97
Butanol	$C_4H_{10}O$	$CH_3-CH_2-CH_2-CH_2-OH$	...	...	118

c. Homologous Series of Alkenes

Name	Molecular formula	Condensed Structural formula	Number of carbon atoms	Number of $-CH_2-$ units	Boiling point ^0C
Ethene	C_2H_4	$CH_2= CH_2$	2	0	- 102
Propene	C_3H_6	$CH_3-CH=CH_2$	3	1	- 48
1-Butene	C_4H_8	$CH_3-CH_2-CH=CH_2$	...	...	- 6.5
1-Pentene	C_5H_{10}	$CH_3-CH_2-CH_2-CH=CH_2$	...	...	30

9.17 Some Homologous Series

Use your brain power !

1. By how many $-CH_2-$ (methylene) units do the formulae of the first two members of homologous series of alkanes, methane (CH_4) and ethane (C_2H_6) differ? Similarly, by how many - CH_2- units do the neighbouring members ethane (C_2H_6) and propane (C_3H_8) differ from each other?
2. How many methylene units are extra in the formula of the fourth member than the third member of the homolous series of alcohols?
3. How many methylene units are less in the formula of the second member than the third member of the homologous series of alkenes?

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You have found that in any homologous series while going in an increasing order of the length of the carbon chain, every time one methylene unit (-CH_2-) goes on increasing. Therefore, while going in an increasing order of the length there is a rise in the molecular mass of the members by 14 u.

Inspection of the table 9.15 (a), (b) and (c) will reveal one more point to you, and that is gradation in the boiling points. Boiling point is a physical property of a compound. Generally it is found that, while going in an increasing order in any homologous series the physical properties show variation in one direction, that is, a gradation is observed in the physical properties.

Use your brain power !

1. The table 9.15 (c) shows the homologous series of alkenes. Inspect the molecular formulae of the members of this series. Do you find any relationship, in the number of carbon atoms and the number of hydrogen atoms in the molecular formulae?
2. If the number of carbon atoms in the molecular formulae of alkenes is denoted by 'n' , what will be the number of hydrogen atoms?

The molecular formulae of the members of the homologous series of alkenes can be represented by a general formula C_nH_{2n}. When the value of 'n' is '2'. We get the molecular formula of the first member of this series as C_2H_{2x2}, that is, C_2H_4. When the value of 'n' is '3', the molecular formula of the second member of the alkene series is obtained as $C_3H_{2x3,}$ that is, $C_3H_{6.}$

1. What would be the general formula for the molecular formulae of the members of the homologous series of alkanes? What would be the value of 'n' for the first member of this series?

2. The general molecular formula for the homologous series of alkynes is C_nH_{2n-2} .Write down the individual molecular formulae of the first, second and third members by substituting the values 2,3 and 4 respectively for 'n' in this formula. From the above examples we come to know the following characteistics of the homologous series.

(i) While going from one member to the next in a homologous series.
(a) One methylene (-CH_2-) unit gets added. (b) molecular mass increases by 14 u.
(c) number of carbon atoms increases by one.

(ii) Chemical properties of members of a homologhous series show similarity.

(iii) All the members of a homologous series can be represented by The same a general molecular formula.

Use your brain power !

1. Write down structural formulae of the first four members of the various homologous series formed by making use of the functional groups in the table 9.16
2. General formula of the homologous series of alkanes is C_nH_{2n+2}. Write down the molecular formula of the 8^{th} and 12^{th} member using this.

Nomenclature systems of carbon compounds

a. System of common names : We have seen that today millions of carbon compounds are known. Initially when the number of known carbon compounds was small, scientists named them in a variety of ways. Now those names are called common names. For example, the sources of the names of the first four alkanes, namely methane, ethane, propane and butane are different. The names of the alkanes thereafter were given from number of carbon atoms in them. Two isomeric compounds having a straight chain or branched chain in their structural formulae are possible for the molecular formula C_4H_{10}. the difference and interrelationship in them was indicated by naming them as n-butane (normal-butane) and i- butane (iso-butane).

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Use your brain power !

1. Draw three structural formulae having molecular formula C_5H_{12}.
2. Give the names n-pentane, 1(i-pentane) and neo-pentane to the above three structural formulae. (Use the same logic as used in the names of the isomeric butanes for this purpose.)
3. Draw all the possible structural formulae having molecular formula C_6H_{14}. Give names to all the isomers. Which difficulties were faced by you while naming?

As the time progressed, the carbon compounds became very large in number and their common names caused confusion. A need was felt to have a logical system acceptable to all for naming the carbon compounds.

IUPAC nomenclature system

International Union for Pure and Applied Chemistry (IUPAC) put forth a nomenclature system based on the structure of the compounds, and it was accepted all over the world. There is a provision in this system for giving a unique name to all the carbon compounds. Let us see how some straight chain compounds containing one functional group are given IUPAC names and let us also see their common names.

There are three units in the IUPAC name of any carbon compound : parent, suffix and prefix. These are arranged in the name as follows

prefic - parent - suffix

An IUPAC name is given to a compound on the basis of the name of its parent alkane. The name of the compound in constructed by attaching appropriate suffix and prefix to the name of the parent alkane. The steps in the IUPAC nomenclature of straight chain compounds are as follows.

Step 1 : Draw the structural formula of the straight chain compound and count the number of carbon atoms in it. The alkane with the same number of carbon atoms is the parent alkane of the concerned compound. Write the name of this alkane. In case the carbon chain of the concerned compound contains a double bond, change the ending of the parent name from 'ane' to 'ene'. If the carbon chain in the concerned compound contains a triple bond, change the ending of the parent name from 'ane' to 'yne'. (See the table 9.18)

Sr.No.	Structural formula	Straight chain	Parent name
1	CH_3-CH_2-CH_3	C-C-C	propane
2	CH_3-CH_2-OH	C-C	ethane
3	CH_3-CH_2-COOH	C-C-C	propane
4	CH_3-CH_2-CH_2- CHO	C-C-C-C	butane
5	CH_3-CH=CH_2	C-C=C	propene
6	CH_3-C ≡ CH	C-C≡C	propyne

9.18 IUPAC Nomenclature of straight chain compounds: step 1

Step 2: If the structural formula contains a functional group replace the last letter 'e' from the parent name by the condesed name of the functional group as the suffix. (Exception : The condesed name of the functional group 'halogen' is always attached as the prefix.) (see the table 9.19)

Step 3: Number the carbon atoms in the carbon chain from one end to the other. Assign the number '1' to carbon in the functional group -CHO or -COOH, if present, Otherwise, the chain can be numbered in two directions. Accept that numbering which gives smaller number to the carbon carrying the functional group. In the final name a digit (number) and a character (letter) should be separated by a small horizontal line (See the table 9.20) (Usually numbering is not required if the carbon chain contain only two carbon atoms)

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Sr. No	Structural formula	Functional group (Condensed name)	Parent name	parent-suffix	prefix-parent
1	CH_2-CH_2-OH	- OH (ol)	ethane	ethanol	-
2	CH_3-CH_2-Cl	- C1 (chloro)	ethane	-	chloroethane
3	Br-CH_2-CH_3	-Br (bromo)	ethane	-	bromoethane
4	CH_3-CH_2-CHO	- CHO (al)	propane	propanal	-
5	CH_3-COOH	- COOH (oic acid)	ethane	ethanoic acid	-
6	CH_3-NH_2	- NH_2 (amine)	methane	methanamine	-
7	CH_3 - CO - CH_3	- CO- (one)	propane	propanone	-

9.19 IUPAC Nomenclature : Step- 2

Sr. No	Structural formula	Two numberings of the carbon chain	Acceptable numbering	IUPAC name of the compound
1.	CH_3-CH-CH_3 OH	C^1-C^2-C^3 OH C^3-C^2-C^1 OH	Both the numberings equivalent	Propan-2-ol
2.	CH_3-CH_2-CH_2-CH-CH_3 Cl	C^1-C^2-C^3 C^4-C^5 Cl C^5-C^4-C^3- C^2-C^1 Cl	C^5-C^4-C^3- C^2-C^1 Cl	2 - chloropentane
3.	O || CH_3- C-CH_2-CH_2-CH_3	O || C_1-C_2-C_3-C_4-C_5 O || C_5-C_4-C_3-C_2-C_1	O || C_5-C_4-C_3-C_2-C_1	pentan-2-one

9.20 IUPAC Nomenclature : Step- 3

Some more steps are required for writing IUPAC names of compounds having more complex structural units such as branched chains, carbon rings, heterocycles, etc. Study of these will be included in the further standards. At the same time, also keep in mind that there is a practice of using common names of the carbon compounds which are frequently use in the laboratory.

Complete the table

The table 9.19 shows common names and structural formulae of a few carbon compounds. Complete the table by writing their IUPAC names in the third column.

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Sr. No.	Common name	Structural formula	IUPAC Name
1	ethylene	$CH_2=CH_2$	
2	acetylene	$HC\equiv CH$	
3	acetic acid	CH_3-COOH	
4	methyl alcohol	CH_3-OH	
5	ethyl alcohol	CH_3-CH_2-OH	
6	acetaldehyde	CH_3-CHO	
7	acetone	CH_3-CO-CH_3	
8	ethyl methyl ketone	CH_3-CO-CH_2- CH_3	
9	ethyl amine	CH_3-CH_2-NH_2	
10	n-propyl chloride	CH_3- CH-CH_2-Cl	

9.21 Common and IUPAC names of some carbon compounds

Chemical Properties of Carbon Compounds

Can you recall?

1. Which is the component of biogas that makes it useful as fuel?
2. Which product is formed by the combustion of elemental carbon?
3. Is the biogas combustion reaction endothermic or exhothermic?

1. Combusion : Let us first look at combustion as a chemical property of carbon compounds. We have seen in the previous standard that, carbon in the form of various allotropes on ignition in presence of oxygen undergoes combustion to emit heat and light, and forms carbon dioxide. Hydrocarbons as well as most of the carbon compounds under goes combustion in presence of oxygen to emit heat and light and form carbondioxide and water as the common products. Some of the combustion reactions are as follows.

(i) $C + O_2 \rightarrow CO_2$ + heat + light
(Carbon)

(ii) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + heat + light
(methane)

(iii) CH_3- CH_2- OH + $3O_2 \rightarrow 2CO_2 + 3H_2O$ + heat + light
(Ethanol)

Use your brain power !

Propane (C_3H_8) is one of the combustible component of L.P.G. Write down the reaction for Propane (C_3H_8)

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Try this.

Apparatus : Bunsen burner, copper gauze, metal plate, etc.

Chemicals : Ethanol, acetic acid, napthalene

Procedure : Place one of the above chemicals (3-4 drops or a pinch) on a clean copper gauze at room temperature, hold it on a blue flame of the Bunsen burner and observe. Is smoke/ soot seen to form due to combustion? Hold the metal plate on the flame when the substance is undergoing combustion. Does any deposit get collected on the plate? Which colour? Repeat the same procedure using other chemicals from the above list.

In the above activity ethanol is a saturated carbon compound, while napthalene is an unsaturated compound. Generally saturated carbon compounds burn with a clean blue flame while unsaturated carbon compounds burn with a yellow flame and release black smoke. It is this black smoke due to which a deposit of black soot got collected on the metal plate.

Comparison of the molecular formulae indicates that the proportion of carbon is larger in unsaturated compounds than in saturated compounds. As a result, some unburnt carbon particles are also formed during combustion of unsaturated compounds. While in the flame, these hot carbon particles emit yellow light and therefore the flame appears yellow. However, if oxygen supply is limited a yellow flame is obtained by combustion of saturated compounds as well.

Compare

The proportion of carbon atoms in ethanol (C_2H_5OH) and napthalene ($C_{10}H_8$)

Try this.

Light a Bunsen burner. Open and close the air hole at the bottom of the burner by means of the movable ring around it. When do you get yellow sooty flame? When do you get blue flame?

2. Oxidation

You have seen that carbon compounds start burning by combining easily with oxygen in the air when ignited in air. In this process of combustion all the chemical bonds in the molecule of the carbon compound break and CO_2 and H_2O are formed as the products. In other words the carbon compounds is completely oxidised during combustion. Chemical compounds can also be used as source of oxygen. Substances that can give oxygen to other substances are called oxidants or oxidizing agents. Potassium permanganate or potassium dichromate are commonly used as oxidizing agents. An oxidising agents affects on certain functional groups in present carbon compounds.

Always remeber

There are inlets for air in the gas or kerosene stove at home. It is because of these air inlets that the gaseous fuel is mixed with sufficient oxygen and a clean blue flame is obtained. In case there is deposition of black soot on the bottom of cooking vessels it is an indication of choking of the air inlets and thereby the wastage of fuel. In such case the air inlets of the stove should be got cleaned.

Try this.

Apparatus : Test tube, Bunsen burner,measuring cylinder, dropper, etc.

Chemicals : Ethanol, dilute solution of sodium carbonate, dilute solution of potassium permanganate.

Prodecure : Take 2-3 ml ethanol in a test tube, add 5 ml sodium carbonate solution to it and warm the mixture by holding the test tube on the burner for a while. Do droprise addition of a dilute solution of potassium permanganate to this warm mixture with stirring. Does the typical pink colour of potassium permanganate stay as it is on addition ? Does the pink colour stop vanishing and stays on after some time of the addition process?

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In the above activity ethanol gets oxidised by alkaline potassium permanganate to form ethanoic acid. Only certain bonds in the vicinity of the functional group take part in this reaction. The following equation will explain this.

$$\underset{\text{(ethanol)}}{CH_3 - CH_2 - OH} \xrightarrow[\text{acidic } KMnO_4]{(O)} \underset{\text{(ethanoic acid)}}{CH_3 - \overset{\overset{O}{||}}{C} - OH}$$

Compare

How is the transformation of ethanol into ethanoic acid an oxidation reaction?

On adding the pink coloured solution of potassium permanganate to ethanol, the pink colour disappears in the begining. This is because potassium permanganate is used up in the oxidation reaction. At a certain point of the addition, oxidation of all the quantity of ethanol in the test tube is complete. If the addition of potassium permanagate is continued beyond this point, it is not used up and becomes excess. The pink colour of this excess potassium permanagate does not vanish but stays as it is.

3. Addition Reaction

Try this.

Apparatus : test tubes, droppers, etc.

Chemicals : tincture iodine, bromine water, liquified vanaspati ghee, various vegetable oils (peanut, safflower, sunflower, olive, etc.)

Procedure : Take 4 ml oil in a test tube and add 4 drops of tincture iodine or bromine water in it. Shake the test tube. Find out whether the original colour of bromine or iodine disappears or not. Repeat the same procedure using other oils and vanaspati ghee.

In the above activity, the obeservation of the disappearing /dimishing colour of bromine / iodine indicates that bromine / iodine is used up. This means that bromine/ iodine has undergone a reaction with the concerned substance. This reaction is an 'addition reaction'. When a carbon compound combines with another compound to form a product that contain all the atoms in both the reactants, it is called an addition reaction. Unsaturated compounds contains a multiple bond as their functional group. They undergo addition reaction to form a saturated compound as the product. The addtition reaction of an unsaturated compound with iodine or bromine takes place instantaneously at room temperature. Moreover the colour change can be felt by eyes. therefore this reaction is used as a test for detection of a multiple bond in a carbon compound. In the above activity, the colour of iodine / bromine disappeares in the reaction between an oil and iodine, however, there is no colour change with vanaspati ghee. What inference will you draw from this? Which of the substances do contain a multiple bond?

Name	Molecular Formula	Number of C=C double bonds	Will it decolourize I_2?
Stearic acid	$C_{17}H_{35}COOH$	.....	yes / no
Oleic acid	$C_{17}H_{33}COOH$	.....	yes / no
Plamitic acid	$C_{15}H_{31}COOH$	.....	yes / no
Linoleic acid	$C_{17}H_{31}COOH$	.....	yes / no

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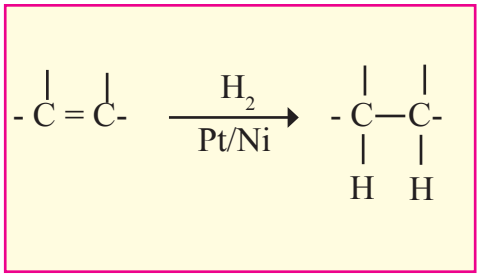
The unsaturated compound can also undergo addition reaction with hydrogen to form a saturated compound. However, it is necessary to use a catalyst like platinum or nickel for this reaction. We have already seen that catalyst is such a substance due to presence of which rate of reaction changes without causing any disturbance to it.



This reaction is used for hydrogenation of vegetable oils in presence of nickel catalyst. You have seen in the above activity that iodine test indicates presence of multiple bonds (double bond in particular) in the molecules of oils while vanaspati ghee is found to be saturated. The molecules of vegetable oil contain long and unsaturated carbon chains. Hydrogenation transforms them into saturated chains and thereby vanaspati ghee is formed.

Unsaturated fats containing double bonds are healthy while sarturated fats are harmful to health.

4. Substitution reaction

As the single bonds C-H and C-C are very strong, the saturated hydrocarbons are not reactive, and therefore them remain inert in presence of most reagents. However, saturated hydrocarbons, in presence of sunlight react rapidly with chlorine. In this reaction chlorine atoms replace, one by one, all the hydrogen atoms in the saturated hydrocarbon. The reaction in which the place of one type of atom / group in a reactant is taken by another atom / group of atoms, is called substitution reaction. Chlorination of methane, is a substitution reaction which gives four products.

$$CH_4 + Cl_2 \xrightarrow{\text{Sunlight}} CH_3\text{-}Cl + HCl$$

$$CH_3Cl + Cl_2 \xrightarrow{\text{Sunlight}} CH_2Cl_2 + HCl$$

$$CH_2Cl_2 + Cl_2 \xrightarrow{\text{Sunlight}} CHCl_3 + HCl$$

$$CHCl_3 + Cl_2 \xrightarrow{\text{Sunlight}} CCl_4 + HCl$$

Still larger number of products are formed in chlorination raction of higher homologues of alkanes.

Use your brain power !

In the chlorination, substitutuion reaction of propane two isomeric products containing one chlorine atom are obtained. Draw their structural formulae and give their IUPAC names.

You have learnt about four types of common reactions in the previous chapter. In which of these four types the addition and substitution reaction of carbon compounds can be included? What are the additional details and difference in the addition and substitution reaction?

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Important carbon compounds : Ethanol and Ethanoic Acid

Ethanol and ethanoic acid are two of the commercially important carbon compounds. Let us now learn more about them.

At room temperature colourless ethanol is a liquid and its boiling points is 78 ^{0}C. Generally ethanol is called alcohol or spirit. Ethanol is soluble in water in all proportions. When aqueous solution of ethanol is tested with litmus paper it is found to be neutral. Consumption of small quantities of dilute ethanol shows its effect, even though is condemned still it has remained socially widespread practice. Consumption of alcohol harms health in a number of ways. It adversely affects the physiological processes and the central nervous system. Consumption of even a small quantitiy of pure ethanol (called absolute alcohol) can be lethal. Ethanol being good solvent, it is used in medicines such as tincture iodine (solution of iodine and ethanol), cough mixture and also in many tonics.

Do you know ?

Metanol (CH_3OH), the lower homologue of ethanol, is poisonous, and intake of its small quantity can affect vision and at times can be lethal. To prevent the misuse of the important commercial solvent ethanol, it is mixed with the poisonous methanol. Such ethanol is called denatured spirit. A blue dye is also added to it, so that it is easily recognised.

Chemical properties of ethanol

You have learnt about the oxidation reaction of ethanol in a previous unit of this chapter. Two more reactions of ethanol are as follows. The functional group -OH plays an important role in the reactions of ethanol.

(i) Reaction with sodium

$$2Na + 2\ CH_3\text{-}CH_2\text{-}OH \longrightarrow 2\ CH_3\text{-}CH_2\text{-}ONa + H_2$$

(Sodium ethoxide)

All the alcohols react with sodium metal to liberate hydrogen gas and form sodium alkoxide salts. In the reaction of ethanol with sodium metal, hydrogen gas and sodium ethaoxide are formed as products.

Try this.

Note : This activity should be demonstrated by the teacher.

Apparatus : Big test tube, delivery tube fitted in a rubber cork, knife, candle, etc.

Chemicals : Sodium metal, ethanol, magnesium ribbon, etc.

Procedure : Take 10 ml ethanol in a big test tube. Cut sodium metal into 2-3 pieces of a serial grain size. Put the sodium pieces into the ethanol in the test tube and fix the gas delivery tube to the test tube. Take a burning candle near the out let of the gas delivery tube and observe.

1. Which is the combustible gas coming out of the gas delivery tube?
2. Why do the sodium pieces appear to dance on the surface of ethanol?
3. Repeat the above procedure using magnesium ribbon instead of sodium.
4. Do you see gas bubble released from the piece of magnesium ribbon?
5. Does magnesium metal react with ethanol?

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In previous standard you have learnt that a moderately reactive metal such as magnesium reacts with strong acid to liberate hydrogen gas. Though ethanol is neutral, it reacts with sodium metal and liberates hydrogen gas. Sodium being highly reactive metal, it reacts with the neutral functional group-OH of ethanol.

(ii) Dehydration reaction : When ethanol is heated at the temperature 170 ^{0}C with excess amount of concentrated sulphuric acid, one molecule of water is removed from its molecule to form ethene, an unsaturated compound.

$$CH_3\text{-}CH_2\text{-}OH \xrightarrow[\text{conc. } H_2SO_4]{170^0C} CH_2{=}CH_2 + H_2O$$

Here, concentrated sulphuric acid acts as a dehydrating agent.

Use your brain power !

1. Explain by writing a reaction, what will happen when pieces of sodium metal are put in n- propyl alcohol.
2. Explain by writing a reaction, which product will be formed on heating n - butyl alcohol with concentrated sulphuric acid.

Science : Alcohol : A fuel

The sugarcane plant transforms solar energy into chemical energy very efficiently. When molasses, obtained during production of sugar from sugarcane, is subjected to fermentation, alcohol (ethanol) is obtained. On combustion in sufficient air ethanol gives carbon dioxide and water as the only products. In this way, ethanol is a clean fuel. Therefore in some countries it is used as an additive to increase the efficiency of petrol. Such a fuel is called gasohol.

Ethanoic acid: Ethanoic acid is a colourless liquid with boiling point118^{0}C. Ethanoic acid is commonly known as acetic acid. Its aqueous solution is acidic and turns blue litmus red. Vineger, which is used as preservative in pickles, is a 5-8 % aqueous solution of acetic acid. The melting point of pure ethanoic acid is 17^{0}C . Therefore during winter in cold countries ethanoic acid freezes at room temperature itself and looks like ice. Therefore it is named 'glacial acetic acid'.

Try this.

Apparatus: Glazed tile, glass rods, pH paper, blue litmus paper.
Chemicals : Dilute ethanoic acid, dilute hydrochloric acid

Procedure: Place two strips of blue litmus paper on a glazed tile. Put one drop of dilute hydrochloric acid on one strip with the help of a glass rod. Put one drop dilute ethanoic acid with the help of another glass rod on the other strip. Note the colour change taken place in the litmus strip. Repeat the same procedure using strips of pH paper. Note all the observation in the following table.

Substance	Colour change in blue litmus paper	Corresponding pH (Scratch the unwanted)	Colour change seen on the pH paper	Corresponding pH
Ethanoic acid		< 7 / 7 / > 7		
Hydrochloric acid		< 7 / 7 / > 7		

9.23 Testing ethanoic acid & Hydrochloric acid

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Use your brain power !

1. Which one of ethanoic acid and hydrochloric acid is stronger?
2. Which indicator paper out of blue litmus paper and pH paper is useful to distinguish between ethanoic acid and hydrochloric acid?

Chemical Properties of ethanoic Acid

Ethanoic acid contain carboxylic acid as its functional group. The chemical reaction of ethanoic acid are mainly due to this functional group.

i. Reaction with base

a. A reaction with strong base

Ethanoic acid gives neutralization reaction with a strong base sodium hydroxide to form a salt and water.

CH_3-COOH + NaOH $\rightarrow$ CH_3-COO Na + H_2O

(Acid) (Base) (Salt) (Water)

The IUPAC name of the salt formed here is sodium ethanoate while its common name is sodium acetate. You have learnt in the previous standard that acetic acid is a weak acid. Will the salt sodium acetate be neutral?

b. Reaction with carbonate and bicarbonate

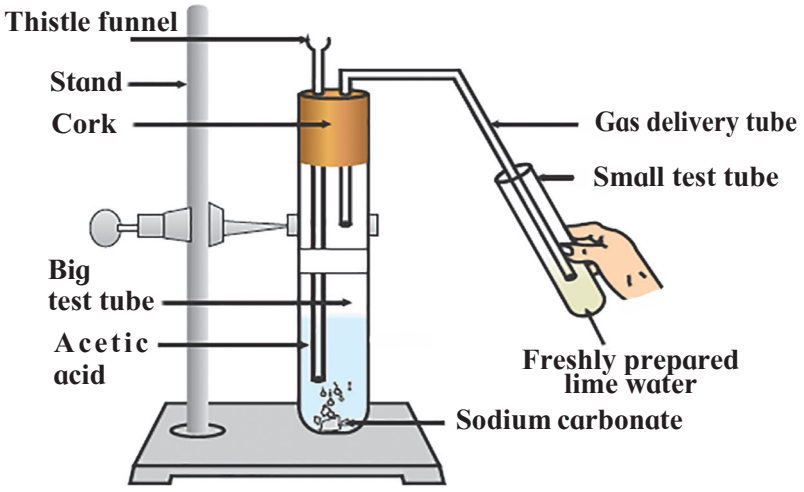
Try this.

Apparatus : Big test tube, small test tube, bent gas delivery tube, rubber cork, thistle funnel, stand, etc.

Chemicals : Acetic acid , sodium carbonate powder, freshly prepared lime water.

Procedure : Arrange the apparatus as shown in figure. Place sodium carbonate powder in the big test tube. Pour 10 ml acetic acid through the thistle funnel. Observe the changes taking place in the two test tubes.

1. Which gas does come out as effervescence in the big test tube?
2. Why are bubbles seen in the small test tube ?
3. What is the colour change in the lime water? Write the related equation.



9.24 Reaction of acetic acid and sodium carbonate

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In this activity ethanoic acid reacts with the basic salt, namely, sodium carbonate, to form a salt , named sodium ethanoate, water and carbon dioxide gas.

$$2CH_3COOH\ (aq) + Na_2CO_3\ (g) \rightarrow CH_3COONa\ (aq) + H_2O\ (l) + CO_2\ (g)$$

The CO_2 gas of the effervescence passes through the gas delivery tube and reacts with the lime water in the small test tube. 'Lime water turning milky' is the test of carbon dioxide gas. If sodium bicarbonate is used instead of sodium carboanate in the above activity, similar observation are obtained.

$$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$$

Use your brain power !

1. Explain with reaction why does the lime water turn milky in the above activity.
2. Explain the reaction that would take place when a peice of sodium metal is dropped in ethanoic acid.
3. Two test tubes contain two colourless liquids ethanol and ethanoic acid. Explain by writing reaction which chemical test you would perform to tell which substance is present in which test tube.

ii. Esterification Reaction : Substances having ester as the functional group are formed by reaction between a carboxylic acid and an alcohol.

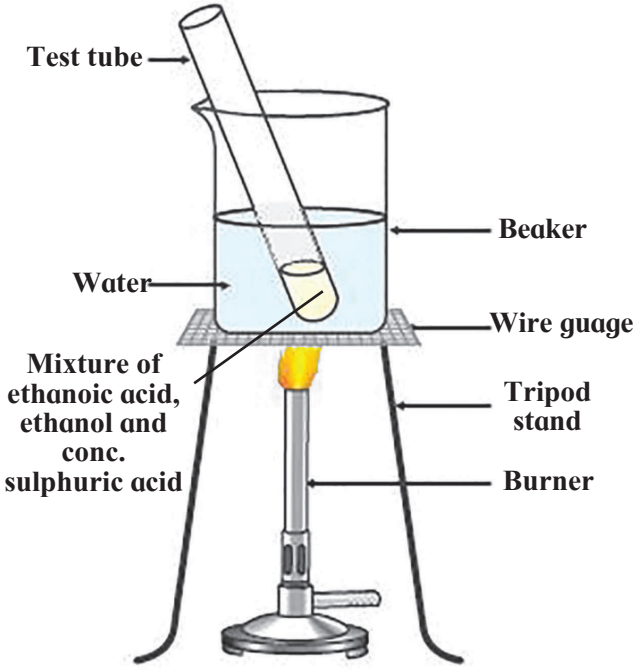
Try this.

Apparatus : Test tube, beakers, burner etc.

Chemicals : Glacial ethanoic acid,ethanol concentrated sulphuric acid etc.

Procedure : Take 1 ml ethanol and 1 ml glacial ethanoic acid in a test tube. Add a few drops of concentrated sulphuric acid in it. Keep this test tube in the beaker containing hot water (hot water bath) for five minutes. Then take 20-30 ml water in another beaker, and pour the above reaction mixture in it and smell it.

Ethanoic acid reacts with ethanol in presence of an acid catalyst and ester, ethyl ethanoate is formed.



9.25 Esterification Reaction

$$\underset{\text{(Etahnoic acid)}}{CH_3\text{-}COOH} + \underset{\text{(Ethanol)}}{CH_3\text{-}CH_2\text{-}OH} \xrightarrow[\text{Catalyst}]{\text{Acid}} \underset{\text{(Ethyl Ethanoate)}}{CH_3\text{-}COO\text{-}CH_2\text{-}CH_3} + \underset{\text{(Water)}}{H_2O}$$

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Esters have sweet odour. Majority of fruits owe their odour to a particular ester present in them. Esters are used for making fragrances and flavouring agents. When an ester is reacted with the alkali sodium hydroxide, the corresponding alcohol and carboxyclic acid (in the form of its sodium salt) are obtained back. This reaction is called saponification reaction, as it is used for preparation of soap from fats.

Ester + Sodium hydroxide ⟶ Sodium Carboxylate + Alcohol

Use your brain power !

When fat is heated with sodium hydroxide solution, soap and glycerin are formed. Which functional groups might be present in fat and glycerin? What do you think?

Macro molecules and Polymers

Can you tell?

1. What are the chemical names of the nutrients that we get from the food stuff, namely, serials, pulses and meat?

2. What are the chemical substances that make cloth, furniture and elastic objects?

Macromolecules : We have seen in the begining of this chapter that the number of the known carbon compounds is as large as about 10 million, and the range of their molecular masses is as large as 10^{1}- 10^{12}. The number of constituent atoms is very large for the molecules with high molecular mass. The giant carbon molecules formed from hundreds of thousands of atoms are called macromolecules. They are from the type of compounds called polymers.

Natural macromolecules : The natural macromolecules namely, polysaccarides, proteins and nucleic acids are the supporting pillars of the living world. We get food, clothing and shelter from polysaccarides, namely, starch and cellulose. Proteins constitute a large part of the bodies of animals and also are responsible for their movement and various physiological processes. Nucleic acids control the heredity at molecular level. Rubber is another type of natural macromolecule.

Manmade macromolecules : Macromolecules were produced for the first time in the laboratory and factory with an intention to invent an alternative for rubber and silk. Today manmade macromolecules are in use in every walk of life. Manmade fibres which have strength along the length similar to natural fibres cotton, wool and silk; elastomers which have the elastic property of rubber; plastics from which innumerable types of articles, sheets, pipes and surface coatings are made are all examples of manmade macromolecules. The structure of natural and manmade macromolecules is formed by joining several small units in a regular manner. As a result the macromolecules are polymeric in nature.

Polymers : A macromolecule formed by regular repeatition of a small unit is called polymer. The small unit that repeats regularly to form a polymer is called monomer. The reaction by which monomer molecules are converted into a polymer is called polymerization.

One important method of polymerization is to make a polymer by joining alkene type monomers. For example, synthesis of polyethylene is as shown further (see 9.26). Also, the table 9.27 shows the polymers used in large scale.

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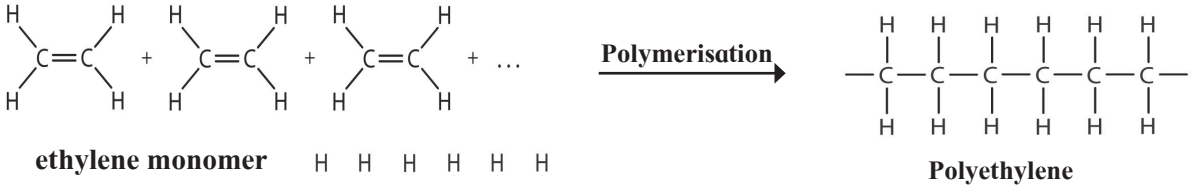
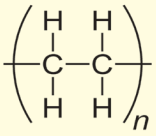
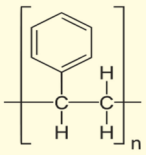
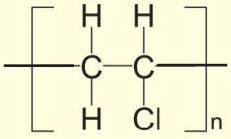
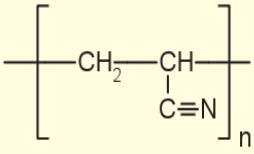
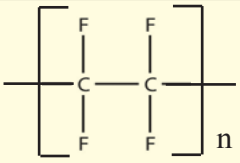
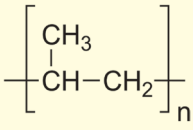


ethylene monomer

Polyethylene

9.24 Synthesis of polyethylene

Name of polymer	Constituent monomer	Structural formula of the polymer	Uses
Polyethylene	Ethylene $CH_2 = CH_2$		Carry bags, sports wear
Polystyrene	Styrene $C_6H_5 - CH = CH_2$		Thermocoal articles
Polyvinyl chloride (PVC)	Vinyl chloride $Cl - CH = CH_2$		P.V.C. pipes, door mats, tubes and bags in hospital kits.
Polyacrylo nitrile	Acrylo nitrile $CH_2 = CH - C \equiv N$		Winter clothing, blankets
Teflon	Tetrafluro ethylene $CF_2 = CF_2$		Nonstick cookware
Polypropylene	Polypropylene $CH_3 - CH = CH_2$		Injection syringe, Furniture

9.27 Various polymers and their uses

The polymers in the above examples are formed by repetition of single monomer. These are called homopolymers. The other type of polymers are formed from two or more monomers. They are called copolymers. For example, PET is poly ethylene terephthalate. The structures of polymers are linear as in the above examples or they are branched and cross linked as well. Polymers aquire various properties as per the nature of the monomers and the type of structure.

The composition and structure of natural polymers were understood after carrying out their decomposition. The composition of the main natural polymers in given in the Table 9.28.

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Polymer	Name of the monomer	Occurrence
Polysaccaride	Glucose	Starch
Cellulose	Glucose	Wood (cell walls of plant cells)
Proteins	alpha amino acids	Muscles, hair, enzymes, skin, egg
D.N.A.	Nucleotide (base-deoxyribose-phosphate)	Chromosomes of animals
R.N.A.	Nucleotide (base-ribose-phosphate)	Chromosomes of plants
Rubber	Isoprene $CH_2= C(CH_3)-CH=CH_2$	Latex of rubber tree

9.28 Some natural polymers and their occurence

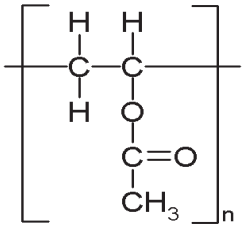
Use your brain power !

1. Structural formulae of some monomers are given below. Write the structural formula of the homopolymer formed from them.

a. $CH_2= C(CH_3)-CH_3$

b. $CH_2= C(CH_3)-CN$

2. From the given structural formula of polyvinyl acetate, that is used in paints and glues, deduce the name and structural formula of the corresponding monomer.



Exercise

1. Match the pairs.

Group 'A'	Group 'B'
a. C_2H_6	1. Unsaturated hydrocarbon
b. C_2H_2	2. Molecular formula of an alcohol
c. CH_4O	3. Saturated hydrocarbon
d. C_3H_6	4. Triple bond

2. Draw an electron dot structure of the following molecules. (Without showing the circles)

a. Methane b. Ethene

c. Methanol d. Water

3. Draw all possible structural formulae of compounds from their molecular formula given below.

a. C_3H_8 b. C_4H_{10} c . C_3H_4

4. Explain the following terms with example.

a. Structural isomerism
b. Covalent bond
c. Hetero atom in a carbon compound
d. Functional group
e. Alkane
f. Unsaturated hydrocarbon
g. Homopolumer
h. Monomer
i. Reduction
j. Oxydant

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5. Write the IUPAC names of the following structural formulae.

a. CH_3-CH_2-CH_2-CH_3 b. CH_3-CHOH-CH_3

c. CH_3-CH_2-COOH d. CH_3-CH_2-NH_2

e. CH_3-CHO f. CH_3-CO-CH_2-CH_3

6. Identify the type of the following reaction of carbon compounds.

a. CH_3-CH_2-CH_2-OH $\longrightarrow$ CH_3-CH_2-COOH

b. CH_3-CH_2-CH_3 $\longrightarrow$ 3 CO_2 + 4 H_2O

c. CH_3-CH= CH -CH_3 + Br_2 $\longrightarrow$ CH_3-CHBr - CHBr -CH_3

d. CH_3-CH_3 + Cl_2 $\longrightarrow$ CH_3-CH_2-Cl + HCl

e. CH_3-CH_2-CH_2-CH_2-OH $\longrightarrow$ CH_3-CH_2-CH=CH_2 + H_2O

f. CH_3-CH_2-COOH + NaOH $\longrightarrow$ CH_3-CH_2-COO^-Na^+ + H_2O

g. CH_3-COOH + CH_3-OH $\longrightarrow$ CH_3-COO- CH_3 + H_2O

7. Write structural formulae for the following IUPAC names.

a. pent-2-one b. 2- chlorobutane

c. propan- 2 ol d. methanal

e. butanoic acid e. 1- bromopropane

f. ethanamine g. butanone

8. Write answers as directed.

a. What causes the existance of very large number of carbon compound ?

b. Saturated hydrocarbons are classified into three types. Write these names giving one example each.

c. Give any four functional groups containing oxygen as the heteroatom in it. Write name and structural formula of one example each.

d. Give names of three functional groups containing three different hetero atoms. Write name and structural formula of one example each.

e. Give names of three natural polymers. Write the place of their occurance and names of monomers from which they are formed.

f. What is meant by vinegar and gashol? What are their uses ?

g. What is a catalyst ? Write any one reaction which is brought about by use of catalyst ?

Project

Prepare a chart giving detailed information of carbon compounds in everyday use. Display it in the class and discuss.

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10. Space Missions

- Space Missions
- Classification of artificial satellites
- Satellite launch vehicles
- Artificial satellites
- Orbits of artificial satellites
- Space missions away from the Earth

Can you recall

1. What is the difference between space and sky?
2. What are different objects in the Solar system?
3. What is meant by a satellite?
4. How many natural satellites does the earth have?

Man has always been curious about unknown places and he has always been eager to expand the horizons of his knowledge by exploring the unknown world. He must have had deep curiosity about the space and the many twinkling stars in the dark sky. He must have had dreams to fly to the space and must have been working for that.

Space missions

Substantial developments in technology, specially space technology, in the later half of twentieth century resulted in the development of space crafts making space voyage possible. Since then, more than a thousand artificial satellites have been placed into orbits around the earth. Additionally, space missions have been undertaken for close observation of various objects in our solar system. We will learn about all this in this chapter.

We can classify the space missions into two categories. In one type of missions, the objective is to put artificial satellites in orbits around the earth for research and various other useful applications. The objective of second type of missions is to send the spacecrafts to outer space for close observations and understanding of the objects in solar system, or even outside the solar system.

Do you know ?

The first person to go into the space in a spacecraft was Yuri Gagarin of the then USSR. He orbited the earth in 1961. The first person to step on the Moon (1969) was Neil Armstrong of USA. Rakesh Sharma of India orbited the earth in 1984 in a Russian spacecraft. Kalpana Chawla and Sunita Williams of Indian origin also participated in space explorations through missions organized by NASA (National Aeronautics and Space Administration) of USA.

Can you recall?

Which types of telescopes are orbiting around the earth? Why it is necessary to put them in space?

Can you tell?

Where does the signal in your cell phone come from? Where from does it come to mobile towers? Where does the signal to your TV set come from? You may have seen photographs showing the position of monsoon clouds over the country, in the newspaper. How are these images obtained?

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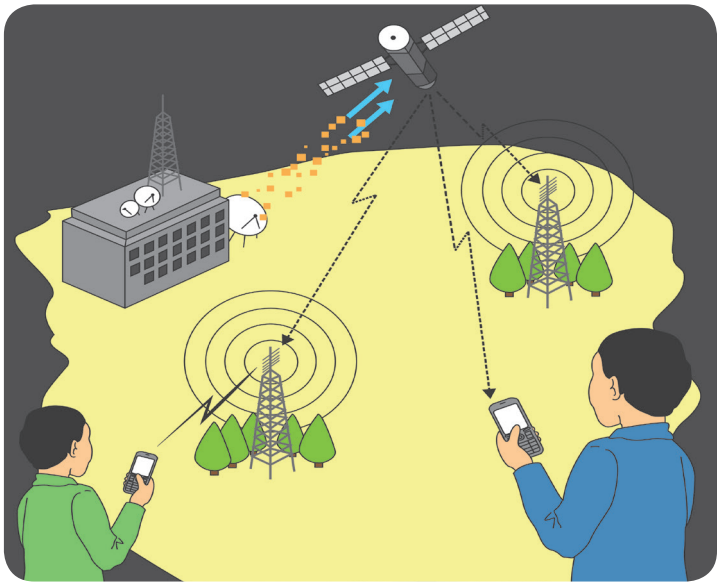


10.1 Communication by artificial satellite

Need and importance of space missions:

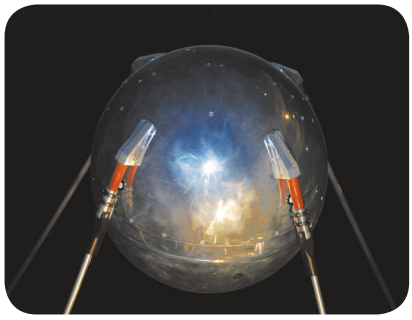
The world has become a global village due to space missions. Today, we can contact a person in any part of the world within a second. We can gather information about worldwide events sitting at home. You all know the importance of internet. Due to internet, every information is available at our fingertips. It has become possible to get advance alert about natural calamities and take proper precautions.

During war, it is possible to get information about the actions of the enemy through aerial surveillance using satellites. It is also possible to explore the fossil reserves and minerals in the earth. Thus, there are unlimited applications of space missions. Today, space technology is an inevitable part for development of a nation.

Artificial satellite

A natural satellite is an astronomical object orbiting the earth or any other planet. The moon is the only natural satellite of the earth. Some other planets in the solar system have more than one natural satellites. Similarly if a manmade object revolves around the earth or any other planet in a fixed orbit it is called an artificial satellite (fig 10.1).

The first artificial satellite *'Sputnik'* was sent to space by Soviet Union in 1957(see figure 10.2). Today, more than thousand satellites are orbiting the earth. The satellites work on solar energy. So, solar photovoltaic panels are attached on both sides of these satellites like wings. Instruments are installed in the satellites to receive and transmit signals from and to the earth.



10.2 *Sputnik*

The satellites have various other types of instruments, depending on their functions. One such satellite is shown in figure 10.1. Signals transmitted from the earth to the satellite and from the satellite to a mobile tower and mobile phone are also shown. These satellites are sent into the space to perform various functions. Depending on their functions, satellites are classified into following categories:

Use of ICT

Prepare a power point presentation showing India's contribution in space research and present it in the class.

INSAT: Indian National Satellite
GSAT: Geosynchronous Satellite
IRNSS: Indian Regional Navigation Satellite System
IRS : Indian Remote Sensing Satellite
GSLV: Geosynchronous Satellite Launch Vehicle
PSLV: Polar Satellite Launch Vehicle

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Type of satellite	Function of the satellite	The names of Indian satellite series and their launch vehicles
Weather satellite	Study and prediction of weather.	INSAT and GSAT. Launcher: GSLV.
Communication satellite	Establish communication between different location in the world through use of specific waves.	INSATand GSAT. Launcher: GSLV.
Broadcast satellite	Telecasting of television programs.	INSAT and GSAT. Launcher: GSLV.
Navigational satellite	Fix the location of any place on the earth's surface in terms of its very precise latitude and longitude.	IRNSS. Launcher : PSLV.
Military Satellite	Collect information for security aspects.	
Earth Observation Satellite	Study of forests,deserts, oceans, polar ice on the earth's surface, exploration and management of natural resources, observation and guidance in case of natural calamities like flood and earthquake.	IRS. Launcher : PSLV.

Types of satellites

Internet is my friend

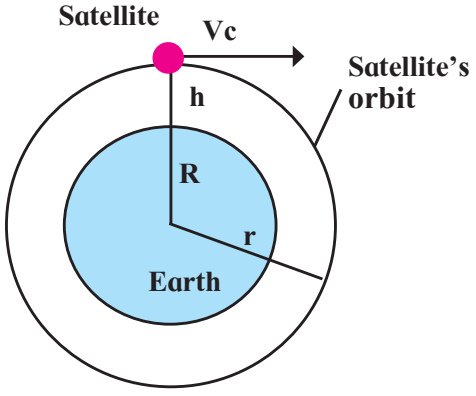
Watch and share with others
1.https://youtu.be/cuqYLHaLB5M
2. https://youtu.be/y37iHU0jK4s

Orbits of Artificial Satellites

All artificial satellites do not revolve in similar orbits around the earth. The functions of the satellite decide the height of the satellite's orbit from the earth's surface, the nature of the orbit (circular/elliptical) and whether the orbit shall be parallel to equator or making some angle with it. To put the satellite in its proper orbit at specific height above the earth's surface, the satellite is taken to that height using a satellite launcher. Then the satellite is given a specific velocity known as the critical velocity (v_c) in a tangential direction to the orbit (fig 10.3). The satellite then starts revolving around the earth. The formula for the velocity v_c can be derived as below.

If a satellite of mass 'm' is revolving around the earth in an orbit of height 'h' with speed 'v_c', then as seen in the chapter on 'Gravitation', a centripetal force $\frac{mv_c^2}{r}$ will act on it.

Here, 'r' is the orbital radius of the satellite from the centre of the earth.



10.3 Orbit of an artificial satellite

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This centripetal force is provided by the gravity of the earth.

Therefore, centripetal force=gravitational force between the Earth and the satellite.

$$\frac{mv_c^2}{R+h} = \frac{GMm}{(R+h)^2}$$

$$v_c^2 = \frac{GM}{R+h}$$

$$v_c = \sqrt{\frac{GM}{R+h}} \quad \text{..... (1)}$$

G = Gravitational constant $= 6.67 \times 10^{-11}$ N m^2/kg^2

M = Mass of the earth = 6×10^{24} kg

R = Radius of the earth = 6.4×10^6 m = 6400 km

h = Height of the satellite above earth surface

R + h = Radius of the orbit of satellite.

It can be seen that the critical velocity does not depend on the mass of the satellite. As the height of the satellite's orbit from the earth's surface increases, the critical velocity decreases. Depending on the height of the satellite's orbit above the earth's surface, the satellite orbits are classified as below:

High Earth Orbits : (Height from the earth's surface > 35780 km)

If the height of the satellite's orbit above the earth's surface is greater than or equal to 35780 km, the orbit is called High earth Orbit. As we will see in the next solved example, a satellite revolving in an orbit 35780 km above the earth's surface, will take around 24 hours to complete one revolution. We know, that the earth also takes almost 24 hrs for one revolution. If the satellite is revolving in an orbit parallel to the equator, the time of revolution for the earth around itself and that for the satellite to revolve around the earth being the same, the satellite will appear to be stationary with respect to the earth. For a passenger in one vehicle, another vehicle, moving parallel to him with equal velocity, appears to be stationary. This is what happens here also. These satellites are, therefore, called geosynchronous satellites. Since, these satellites are stationary with reference to the earth, they can observe a specific portion of the earth, continuously. Therefore, they are used in applications like meteorology and for carrying signals for telephone, television, radio etc.

Medium Earth Orbit (height above the earth's surface 2000 km to 35780 km)

If the height of the satellite orbit above the earth's surface is in between 2000 km and 35780 km, the orbits are called medium earth orbits. The geostationary satellites orbit above the equator. These are, therefore, not useful in the study of polar regions. For this purpose, elliptical medium earth orbits passing over the polar region are used. These orbits are called polar orbits. In these orbits, the satellites complete one revolution in 2 to 24 hours.

Some of these satellites revolve in circular orbits at a height of around 20,200 km above the earth's surface. Global positioning satellites revolve in such orbits.

Low Earth Orbits (height above the earth's surface: 180 km to 2000 km)

If the height of the satellite orbit above the earth's surface is in between 180 km and 2000 km, the orbits are called Low earth Orbits. The satellites used for scientific experiments and atmospheric studies revolve in low earth orbits. Depending on the height of their orbits, they complete one revolution in around 90 minutes. International Space Station and Hubble telescope also revolve in Low earth Orbits.

Figure 10.4 shows various orbits of satellites.

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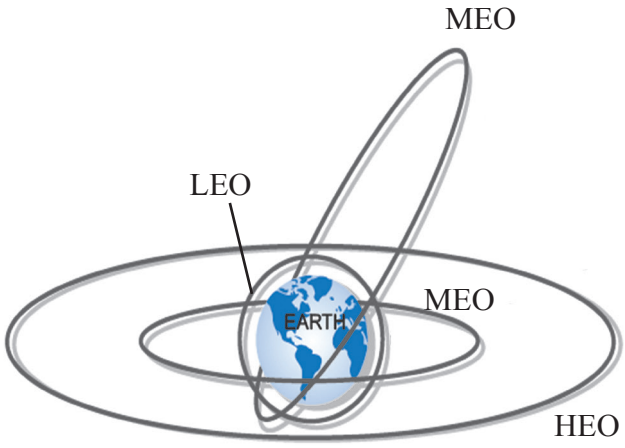

10.4 Orbits of satellites

Do you know ?

A group of students from COEP (College of Engineering, Pune) made a small satellite and sent it to the space through ISRO in 2016. The name of the satellite is 'Swayam' and it weighs around 1 kg. It is orbiting the earth at a height of 515 km. The main objective of the satellite was to provide point to point messaging services using a special method.

Solved Example

Example 1. Suppose the orbit of a satellite is exactly 35780 km above the earth's surface. Determine the tangential velocity of the satellite.

Given : $G = 6.67 \times 10^{-11}$ N m^2/kg^2 ,
$M = 6 \times 10^{24}$ kg (for earth)
$R = 6400$ km (for earth) $= 6.4 \times 10^6$ m ,
h = height of the satellite above the earth's surface 35780 km.
v = ?
$R + h = 6400 + 35780 = 42180 \times 10^3$ m

$$v = \sqrt{\frac{GM}{R+h}}$$

$$= \sqrt{\frac{(6.67 \times 10^{-11}) \times (6 \times 10^{24})}{42180 \times 10^3 \text{ m}}}$$

$$= \sqrt{\frac{40.02 \times 10^{13}}{42180 \times 10^3}}$$

$$= \sqrt{\frac{40.02}{42180} \times 10^{10}}$$

$$= \sqrt{0.0009487909 \times 10^{10}}$$

$$= \sqrt{9487909}$$

$v = 3080.245$ m/s $= 3.08$ km/s

Example 2. In the previous example, how much time the satellite will take to complete one revolution around the earth?

Given: Height of the satellite above the earth's surface= 35780 km.

Velocity of the satellite=3.08 km/sec

Solution: Suppose, the satellite takes T seconds to complete one revolution around the earth. The distance travelled during this one revolution is equal to the circumference of the circular orbit. If r is the radius of the orbit, the satellite will travel a distance $2\pi r$ during one revolution. Thus, the time required for one complete revolution can be obtained as follows:

$$v = \frac{\text{distance}}{\text{time}} = \frac{\text{circumference}}{\text{time}} = \frac{2\pi r}{T}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi (R+h)}{v}$$

$$= \frac{2 \times 3.14 \times (6400 + 35780)}{3.08}$$

$$= 86003.38 \text{ sec}$$

$= 23.89$ hrs. $= 23$ hrs 54 M.

(Here, since the velocity is taken in the unit of km/s, the radius is also taken in unit of km)

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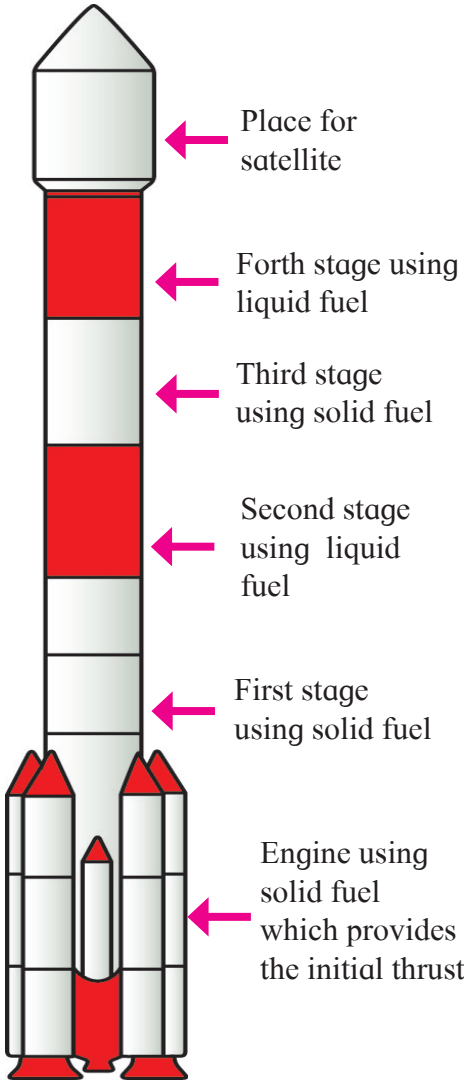
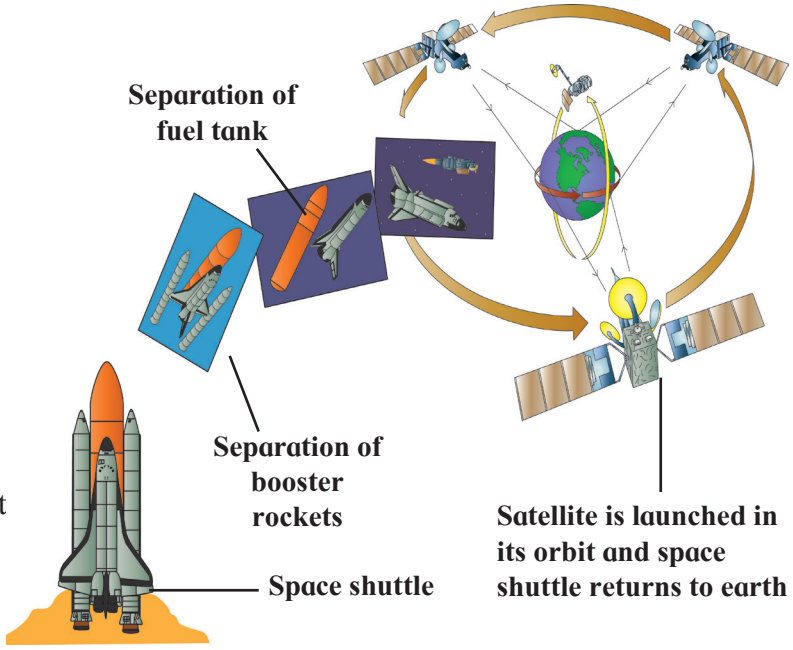
Satellite Launch Vehicles

Satellite launch vehicles are used, to place the satellites in their specific orbits. The functioning of the satellite launch vehicle is based on the Newton's third law of motion. The launch vehicle uses specific type of fuel. The gas produced due to combustion of the fuel expands due to its high temperature and is expelled forcefully through the nozzles at rear side of the launch vehicle. As a reaction of this, a thrust acts on the vehicle, which drives the vehicle high in to the space.

The structure of the launch vehicle is decided by the weight of the satellite and the type of satellite orbit. The fuel of the vehicle also depends on these factors. The fuel forms a major portion of the total weight of the launch vehicle. Thus, the vehicle has to carry a large weight of the fuel with it. To overcome this problem, launch vehicles with more than one stage are used. Due to this, the weight of the vehicle can be reduced step by step, after its launching. For example, consider a launch vehicle having two stages. For launching the vehicle, the fuel and engine in the first stage are used. This imparts a specific velocity to the vehicle and takes it to a certain height. Once the fuel in this first stage is exhausted, the empty fuel tank and the engine are detached from the main body of the vehicle and fall either into a sea or on an unpopulated land. As the fuel in the first stage is exhausted, the fuel in the second stage is ignited. However, the vehicle now contains only one (i.e. the second) stage. The weight now being reduced, the vehicle can move with higher speed. Almost all vehicles are made of either two or more stages. As an example, the structure of a Polar Satellite Launch Vehicle (PSLV) developed by ISRO of India is shown in fig 10.5a.



10.5 a. Structure of PSLV made by ISRO



10.5 b. Space shuttle

The launch vehicles are costly, because they can be used only once. USA has, therefore, developed space shuttle (fig 10.5b) which returns to the earth except for the fuel tank and can be reused in multiple launches.

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Always Remember

The 'rocket', a type of fire-cracker used in Diwali, is also a sort of launcher. In this rocket, the fuel is ignited using a fuse and the rocket is projected into the sky just like a satellite launcher. Similarly, if a balloon is blown and released with its end open, the air in the balloon is forcefully ejected and the balloon is pushed in opposite direction. This can be explained using the Newton's third law of motion.

Space missions away from earth

As we have seen above, artificial satellites are being used for making our life more and more enriched. However, in the previous standard, we have learnt about how the telescopes aboard artificial satellites are used to gather information about various objects in the universe. Similarly some space missions are used to gain futher knowledge about the universe. In these missions, spacecrafts are sent to the nearby objects in the solar system to observe them more closely. New information has been obtained from such missions and it is helping us to understand the creation and evolution of our solar system.

For such missions, the spacecrafts must escape the earth's gravitational force to travel into the outer space. To achieve this, the initial velocity of the moving object must be greater than the escape velocity of the earth as we have learnt in the Chapter on Gravity. Escape velocity on a planet can be obtained using following formula:

$$v_{esc} = \sqrt{\frac{2GM}{R}}$$

G = Gravitational constant = 6.67×10^{-11} N m^2/kg^2
M = mass of the planet = 6×10^{24} kg (for earth)
R = Radius of the planet = 6.4×10^{6} m (for earth)

$$v_{esc} = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 6 \times 10^{24}}{6.4 \times 10^{6}}} = 11.18 \times 10^{3} \text{ m/s} = 11.18 \text{ km/s}$$

Thus, if a spacecraft is to escape the earth's gravitational force to travel to the outer space, it must have minimum velocity of 11.2 km/s.

Do you know ?

The astronomical object closest to us is the moon. Light takes 1s to reach from moon to the earth. It means that if we travel with the speed of light, it will take 1s to reach the moon. However, since a spacecraft travels at much smaller speed, it takes longer time to reach the moon. The shortest time taken by a spacecraft to reach the moon, so far, is 8 hours and 36 minutes.

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Moon missions

Since the moon is the closest astronomical object to us, the first space missions to objects in the solar system were the missions to the moon. Such missions have so far been executed by USA, Soviet Union, European countries, China, Japan and India. The space crafts in the Luna series sent by Soviet Union reached near the moon. Luna 2, launched in 1959 was first such craft. After that, till 1975, 15 space crafts made chemical analysis of the moon and also measured its gravity, density and radiations. Last four crafts even landed on the moon and brought the samples of stones on the moon for analysis in the laboratories. All these missions were unmanned.

America also executed moon missions from 1962 to 1972. The specialty of these missions was that some of these were manned missions. In July, 1969, Neil Armstrong became the first human to step on the moon. In 2008, Indian Space Research Organization (ISRO) successfully launched Chandrayaan- 1 and placed it an into an orbit around the moon. It sent useful information to earth for about a year. The most important discovery made during the mission was the presence of water on the moon surface. India was the first country to discover this.

Mars missions

Next to the moon, the astronomical object nearest to the earth is the Mars. Many nations sent space crafts to the Mars. Mars mission is difficult and almost half the missions were unsuccessful. However, ISRO's performance in this mission is remarkable and we all must be proud of it. The spacecraft '*Mangalyaan*' made by ISRO using mimimum expences was launched in November, 2013 and was placed into orbit around the Mars in September, 2014. It obtained very useful information about the surface of the Mars and the atmosphere around it.

Rakesh Sharma

Rakesh Sharma was the first Indian to travel to space. He went into space along with two Russian astronauts under the joint Indo - USSR space programme. He stayed in space for 8 days.

Kalpana Chawla

Kalpana Chawla obtained her Engineering in Aeronautics degree from Punjab and in 1988 obtained her doctarate from University of Colorado. She was in space for 336 hrs during research mission.While returning to earth from space, on 1st February, 2003, the Columbia space craft exploded and Kalpana perished.

Sunita Williams

Sunita Williams travelled to the international space station in space shuttle Discovery in 2006. She worked for 29 hrs outside the space station. She created a record by staying for 192 days in space.

Missions to other planets

Many missions have been executed to study other planets also. In some of these missions the space crafts orbited the planets, some landed on the planets and some just passed near the planet and observed them. Additionally, spacecrafts have been sent to observe asteroids and comets and they have successfully collected some dust and stones from the asteroids and brought them back on the earth. We are getting very useful information from all these missions clarifying our concepts about the origin and evolution of the solar system.

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India and space technology

India also has made remarkable progress in the science and technology of launch vehicles. Various types of launch vehicles have been developed to put satellites having weight upto 2500 kg, into all types of orbits. PSLV and GSLV are two important launchers. The scientific and technological feats achieved by India in this field have a significant contribution to the national and social development. INSAT and GSAT satellite series is activly working in the field of telecommunication, television broadcasting and meteorological services. Availability of television, telephone and internet services all over the nation has been possible due to these satellites only. EDUSAT satellite in this series is used specially in the field of education. IRS satellite series is working for monitoring and management of natural resources and disaster management. To exactly locate position of any place on the earth's surface in terms of its precise latitude and longitude, the IRNSS satellite series has been established.

Read about:

Satellite Launch Centers:
1. Thumba, Thiruvanathapuram
2. Sriharikota
3. Chandipur, Odisha

Space Research Organizations:
1. Vikram Sarabhai Space Center, Thiruvanathapuram
2. Satish Dhavan Space Research Center, Sriharikota
3. Space Application Center, Ahmedabad

Introduction to scientists

Vikram Sarabhai is considered as the father of Indian space program. His efforts led to foundation of Physical Research Laboratory (PRL) at Ahmedabad. In 1962, Indian government constituted 'Indian National Committee for Space Research' under his Chairmanship and first satellite launch center was established at Thumba in 1963. The launching of India's first satellite 'Aryabhatta' into the space, was the result of his efforts. He played an important role in the establishment of Indian Space Research Organization (ISRO).

Space Debris and its management

In addition to the artificial satellite, some other objects are also revolving around the earth. It includes, non-functional satellites, parts of the launcher detached during launching and debris generated due to collision of satellite with other satellite or any other object in the space. According to one estimation made in 2016, there are about 2 crore pieces of length more than 1 cm, revolving around the earth! All this is nothing but the debris in space.

This debris can be harmful to the artificial satellites. It can collide with these satellites or space crafts and damage them. This debris is increasing day by day. Soon, it will be difficult to launch new spacecrafts. It is, therefore, very essential to manage the debris. Some studies and experiments are being done with this in view. Hope that soon we will have a solution for this problem and the future satellites and spacecrafts will not be in danger any more.

Books are my friends: For more information read the reference books in your library.

1. Space and science - Dr. J V Narlikar.
2. Story of ISRO - Dr. V. R. Gowarikar.

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Exercise

1. Fill in the blanks and explain the statements with reasoning:

a. If the height of the orbit of a satellite from the earth surface is increased, the tangential velocity of the satellite will …

b. The initial velocity (during launching) of the Managalyaan, must be greater than ……..of the earth.

2. State with reasons whether the following sentences are true or false

a. If a spacecraft has to be sent away from the influence of earth's gravitational field, its velocity must be less than the escape velocity.

b. The escape velocity on the moon is less than that on the earth.

d. A satellite needs a specific velocity to revolve in a specific orbit.

e. If the height of the orbit of a satellite increases, its velocity must also increase.

3. Answer the following questions:

a. What is meant by an artificial satellite? How are the satellites classified based on their functions?

b. What is meant by the orbit of a satellite? On what basis and how are the orbits of artificial satellites classified?

c. Why are geostationary satellites not useful for studies of polar regions?

d. What is meant by satellite launch vehicles? Explain a satellite launch vehicle developed by ISRO with the help of a schematic diagram.

e. Why it is beneficial to use satellite launch vehicles made of more than one stage?

4. Complete the following table.

IRNSS		
	Weather study & predict	
		Earth's observation

5. Solve the following problems.

a. If mass of a planet is eight times the mass of the earth and its radius is twice the radius of the earth, what will be the escape velocity for that planet?

Ans : 22.4 km/s

b. How much time a satellite in an orbit at height 35780 km above earth's surface would take, if the mass of the earth would have been four times its original mass?

Ans : ~ 12 hrs

c. If the height of a satellite completing one revolution around the earth in T seconds is h_1 meter, then what would be the height of a satellite taking $2\sqrt{2}\,T$ seconds for one revolution?

Ans : $R + 2h_1$

Project :

1. Collect information about the space missions undertaken by Sunita Williams.
2. Assume that you are interviewing Sunita Williams. Preapare a questionaire and also the answers.

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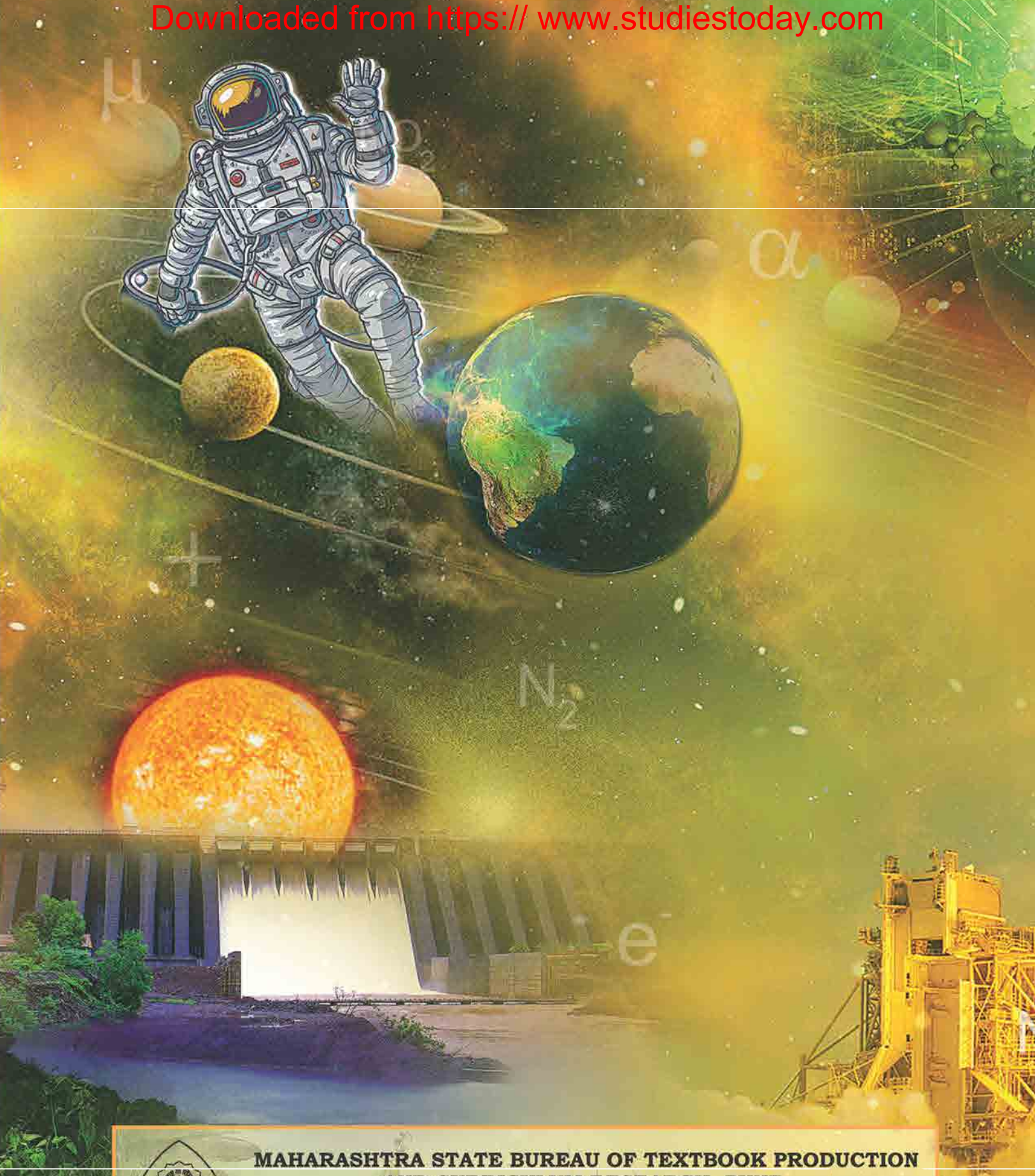

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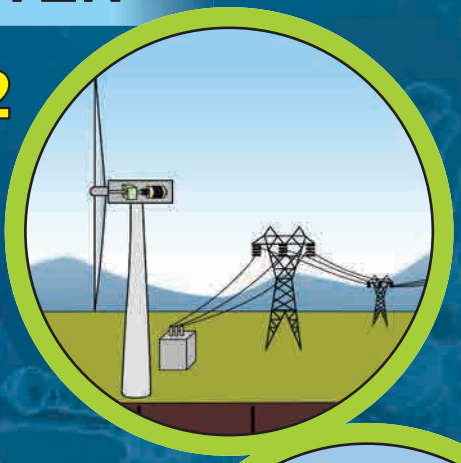

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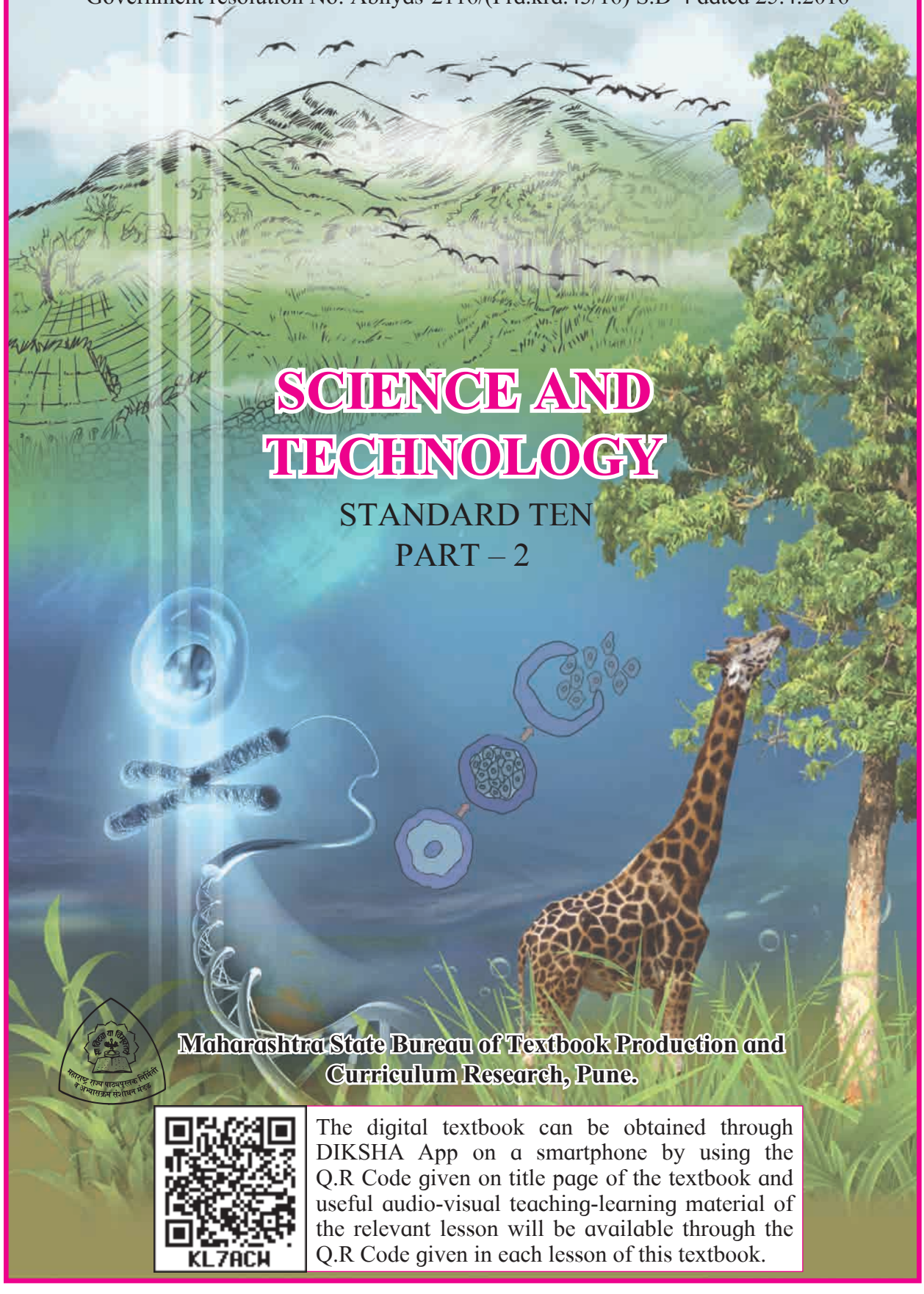

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The Constitution of India

Preamble

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC and to secure to all its citizens:

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the unity and integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.

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NATIONAL ANTHEM

Jana-gana-mana-adhināyaka jaya hē
Bhārata-bhāgya-vidhātā,

Panjāba-Sindhu-Gujarāta-Marāthā
Drāvida-Utkala-Banga

Vindhya-Himāchala-Yamunā-Gangā
uchchala-jaladhi-taranga

Tava subha nāmē jāgē, tava subha āsisa māgē,
gāhē tava jaya-gāthā,

Jana-gana-mangala-dāyaka jaya hē
Bhārata-bhāgya-vidhātā,

Jaya hē, Jaya hē, Jaya hē,
Jaya jaya jaya, jaya hē.

PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

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Preface

Dear students

Welcome to Std X. We have great pleasure in offering you this Science and Technology textbook based on the new syllabus. From the primary level till today, you have studied science from various textbook. In this textbook, you will be able to study the fundamental concepts of science and technology from a different point of view through the medium of the different branches of Science.

The basic purpose of this textbook Science and Technology Part-2 can be said to be 'Understand and explain to others' the Science and Technology that relates to our everyday life. While studying the concepts, principles and theories in science, do make the effort to understand their connection with day to day affairs. While studying from this textbook, use the sections 'Can you recall?' and 'Can you tell?' for revision. You will learn science through the many activities given under the titles such as 'Observe and discuss.' and 'Try this' or 'Let's try this. Make sure that you perform all these activities. Activities like 'Use your brain power!', 'Research', 'Think about it' will stimulate your power of thinking.

Many experiments have been included in the textbook. Carry out these experiments yourself, following the given procedure and making your own observations. Ask your teachers, parents or classmates for help whenever you need it, interesting information, which reveals the science underlying the events we commonly observe and the technology developed on its basis, has been given in details in this textbook through several activities. In this world of rapidly developing technology, you have already become familiar with computers and smartphones. While studying the textbook, make full and proper use of the devices of information communication technology, which will make you studies easier. For more effective studies, you can avail additional audio-visual material for each chapter using the Q.R code through an App. This will definitely help you in your studies.

While carrying out the given activities and experiments, take all precautions with regard to handling apparatus, chemicals, etc. and encourage others to take the same precautions.

It is expected that while carrying out activities or observation involving plants and animals, you will also make efforts towards conservation of the environment. You must of course take all the care to avoid causing any harm or injury to them.

Do tell us about the parts that you like, as well as about the difficulties that you face as you read and study and understand this textbook.

Our west wishes for your academic progress.

(Dr. Sunil Magar)
Director
Maharashtra state Bureau of Textbook and Curriculum Research, Pune

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For Teachers

- The real objective of science education is to learn to be able to think about events that are happening around us, logically and with discretion.
- In view of the age group of Std IX students, it would be appropriate now, in the process of science education, to give freedom and scope to students' own curiosity about the events of the world, their propensity to go looking for the causes behind them and to their own initiative and capacity to take the lead.
- As experimentation is necessary to learn the skills of observation, logic, estimation, comparison and application of available data, which form a part of science education, deliberate efforts must be made to develop these skills while dealing with laboratory experiments give in the textbook. All observations that the students have noted should be accepted and then they should be helped to achieve that the expected results.
- These two years in middle school lay the foundation of higher education in Science. Hence, it is our duty and responsibility to enrich and enhance the student's interest in science. You all will of course always actively pursue the objective of developing their creativity and imbuing them with a scientific temper.
- You can use 'Let's recall' to review the previous knowledge for a lesson and 'Can you tell?' to introduce a topic by eliciting all the knowledge that the students already have about it from their own reading or experience. You may of course use any of your own activities or questions for this purpose. Activities given under 'Try this' and 'Let's try this' help to explain the content of the lesson. The former are for students to do themselves and the latter are those that you are expected to demonstrate. 'Use your brain power!' is meant for application of previous knowledge as well as the new lesson, and 'Always remember' gives important suggestions/information or values. 'Research', 'Find out', 'Do you know?' ' Introduction to scientists' and 'Institutes at work' are meant to give some information about the world outside the textbook and to develop the habit of doing independent reference work to obtain additional information.
- This textbook is not meant for reading and explaining in the classroom but guiding students to learn the methods of gaining knowledge by carrying out the given activities. An informal atmosphere in the classroom is required to achieve the aims of this textbook. All students should be encouraged to participate in discussions, experiments and activities. Special efforts should be made to organize presentations or report-reading in the class based on students activities and projects, besides observing of Science Day and other relevant occasions/days.
- The science and technology content of the textbook has been complemented with Information Communication Technology. These activities are to be conducted under your guidance along with the learning of various new scientific concepts.

Front and back covers : Pictures of various activities, experiments and concepts in the book.

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Competency Statements Std X

The students are expected to achieve the following competency level after studying the text book Science and Technology II

The Living World.

* To analyze the scientific information about heredity and state opinions about new hybrid species.
* To understand evolution theories or living and state there characteristics.
* To explain reproductive systems of plants and animals.
* To state importance of cell science by collection of information of cell on utility and various medical facilities.
* To understand production processes of various biotic factors by experiments and prove them scientifically.
* To collect and analyze useful data by observing diversity of animals through different tools.
* To describe animals in the surroundings on scientific basis and classify them.
* To develop awareness of hobbies like watching the things and their conservation.
* To present documentary on animals.
* To collect useful and scientific information on human reproductive system and explain effects on society.
* To eradicate superstitions and rigid customs prevailing in society.

Natural resources and disaster management

* To explain role of environmental guard by conservation of environment, various laws and rules.
* To adapt scientific life style in the role of environmental guard.
* Get attention of society towards negligence towards conservation of environment.
* To plan and implement programs about conservation of environmental.
* To play self-role in disaster management considering international understanding, help and to-getherness.

Diet and Nutrition

* To set up the experiments, projects in our environmental in small scale considering advantages and disadvantages of Biotechnology.
* To aware farmers and components of society by various graphs of Biotechnology.
* To take feedback of comparative study of progress of Biotechnology in India and the other countries.
* To find out various problems regarding conservation of ecosystems.
* To collect data on conservation of ecosystem and to take a distinct role to awake the society.
* To change one's lifestyle by taking into account the various aspects and effects which endanger social health.
* To spread the roles of government and non-government organizations to nurture social health.

Energy

* By considering the serious consequences of the energy crisis, adopt proper lifestyle and motivating others to decide their lifestyle accordingly.
* Explain the steps involved in the process of generation of electrical energy.
* To analyze the correlation of electricity generation processes and environment.
* Knows the importance of green energy and saves energy in daily life.

Information communication Technology.

* Use of Information communication Technology in daily life.
* Exchange of knowledge about science and Technology with the help of internet.
* Awareness about the proper use of information communication technology.
* Based on the information gathering, with various types of information related to science and Technology. To predict it. Ability of prediction on the basis of science and technology data collected form internet.
* To understand dangers (cybercrimes) while using information communication technology and take precautions against them.
* Effective use of various systems developed through information communication technology in daily life.

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CONTENT

Academic Planning

Two separate books have been prepared for Science and technology. Science and technology part 2 contains ten chapters mainly related to Biology, Environment, Microbiology, Biotechnology. While thinking about science and technology, it is expected that an integrated approach will be taken while teaching and a connection will be made between different components of science and technology. In previous standards, we have studied various topics in science and technology together. For technical case two separate books science and technology part 1 and part 2 have been prepared, but it is necessary that an integrated perspective be taken while teaching.

Out of the ten chapters included in textbook science and technology part 2, the first five chapters are expected to be taught in the first five session while the next five chapters in the second session. At the end of a session, a written examination for 40 marks and a practical examination for ten marks should be conducted. Exercises and projects have been given an the end of every chapters in the text book.

In view of evaluation, representative questions similar to those in the activity sheets of language books are given in exercises. You may make similar other questions for your use. The students should be evaluated based on these questions detailed information above to this will be given in separate evaluation scheme.

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1. Heredity and Evolution

- Heredity and Hereditary Changes
- Evolution
- Darwin's Theory of Natural Selection
- Speciation
- Transcription, Translation & Translocation
- Evidences of Evolution
- Lamarckism
- Human Evolution

Can you recall?

1. Which component of the cellular nucleus of living organisms carries hereditary characters?
2. What do we call to the process of transfer of physical and mental characters from parents to the progeny?
3. Which are the components the DNA molecule?

Heredity and hereditary changes

You know that here dity is the transfer of biological characters from one generation to another via genes. Johann Gregor Mendel is pioneer of the modern genetics. Around the period of 1886, it took a long time for him to understand the conclusions of his research about heredity. In 1901, the reasons behind the sudden changes were understood due to the mutational theory of Hugo de Vries. Meanwhile in 1902, Walter and Sutton observed the paired chromosomes in the cells of grasshopper; until then it was not known to anyone. Research started in the direction of finding the nature of genetic material when it was proved that genes are carried via chromosomes. Through which 1944, trio of scientists Ostwald Avery, Mclyn McCarthy and Colin MacLeod proved that except viruses, all living organisms have DNA as genetic material.

In 1961, the French geneticists Francois Jacob and Jack Monad proposed a model for process of protein synthesis with the help of DNA in bacterial cells. It helped to uncover the genetic codes hidden in DNA. Thereby, the technique of recombinant DNA technology emerged which has vast scope in the field of genetic engineering.

The science of heredity is useful for diagnosis, treatment and prevention of hereditary disorders, production of hybrid varieties of animals and plants and in industrial processes in which microbes are used.

Transcription, Translation and Translocation

Can you tell?

1. Sketch and explain the structure of DNA and various types of RNA.
2. Explain the meaning of genetic disorders and give names of some disorders.

With the help of RNA, the genes present in the form of DNA participate in the functioning of cell and thereby control the structure and functioning of the body. Information about protein synthesis is stored in the DNA and synthesis of appropriate proteins as per requirement is necessary for body. These proteins are synthesized by DNA through the RNA. This is called as 'Central Dogma'. mRNA is produced as per the sequence of nucleotides on DNA. Only one of the two strands of DNA is used in this process. The sequence of nucleotides in mRNA being produced is always complementary to the DNA strand used for synthesis. Besides, there is uracil in RNA instead of thymine of DNA. This process of RNA synthesis is called as 'transcription'.

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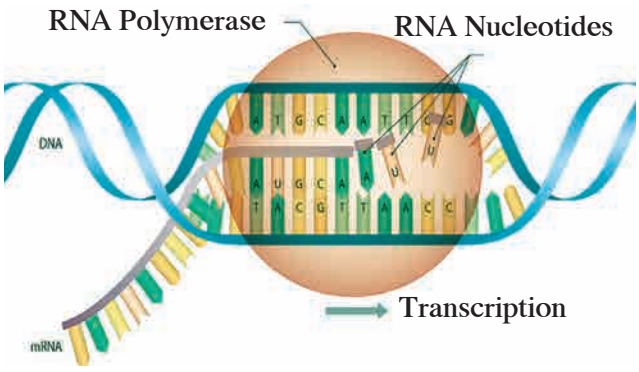
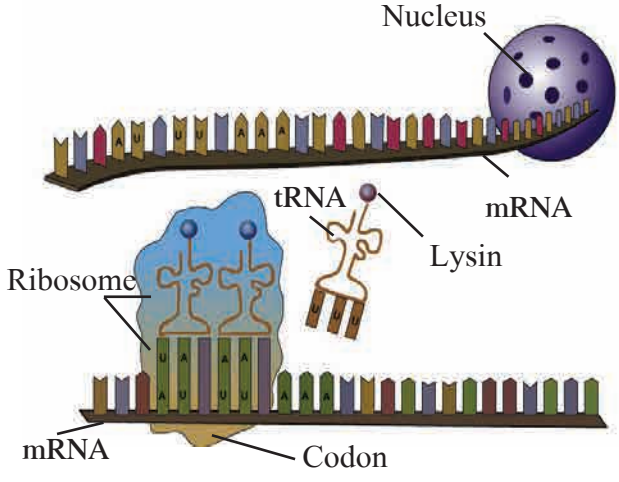
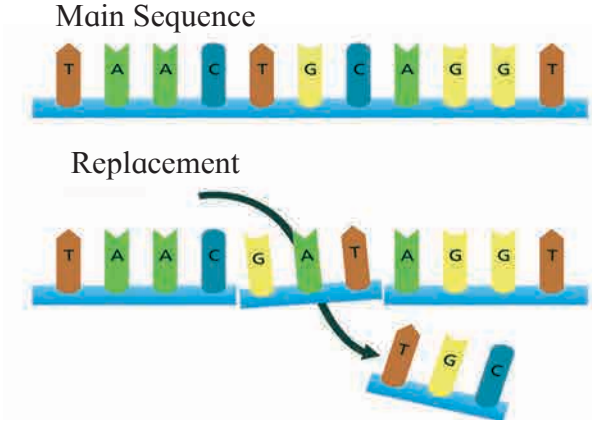


1.1 Transcription



1.2 Translation & Translocation



1.3 Mutation

` The mRNA formed in nucleus comes in cytoplasm. It brings in the coded message from DNA. The message contains the codes for amino acids. The code for each amino acid consists of three nucleotides. It is called as 'triplet codon'.

Dr Har Govind Khorana, a scientist of Indian origin has made an important contribution in discovery of triplet codons for 20 amino acids. For this work, he has been awarded with the Nobel Prize in 1968, along with two other scientists.

Each mRNA is made up of thousands of triplet codons. As per the message on mRNA, amino acids are supplied by the tRNA. For this purpose, tRNA has 'anticodon' having complementary sequence to the codon on mRNA. This is called as 'translation'. The amino acids brought in by tRNA are bonded together by peptide bonds with the help of rRNA. During this process, the ribosome keeps on moving from one end of mRNA to other end by the distance of one triplet codon. This is called as 'translocation'. Such many chains come together to form complex proteins. These proteins control various functions in the body of living organisms and their appearance too.

Living organisms can produce new individuals like themselves due to genes only and some of those genes are transmitted to the next generation without any changes. Due to this, some of the characters of parents are transmitted to their offsprings. However, sometimes sudden changes occur in those genes. Sometimes, any nucleotide of the gene changes its position that causes a minor change which is nothing but the 'mutation'.

Some mutations may be minor but some may be considerable. Ex. Mutation may cause the genetic disorders like sickle cell anemia. This is a everlasting process and it is one of the proof for Darwin's theory of natural selection.

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Can you recall?

1. What is the function of the appendix of our digestive system?
2. Are our wisdom teeth really useful for chewing the food?
3. Why did the huge animals like dinosaur become extinct?
4. Why are many species of animals and birds getting extinct?

Evolution

Evolution is the gradual change occurring in living organisms over a long duration. This is a very slow-going process through which development of organisms is achieved. All the stages in changes occurred in various components ranging from stars and planets in space to the biosphere present on the Earth should be included in the study of evolution. Formation of new species due to changes in specific characters of several generations of living organisms as a response to natural selection, is called as evolution.

3.5 billion years ago, life had been non existent on the Earth. At the beginning, there may have been only simple elements in the ocean on the Earth and simple type of organic and inorganic compounds may have been formed from those. Complex compounds like proteins and nucleic acids may have formed over the long period from those simple compounds. First primitive type of cells may have been formed from the mixture of different types of organic and inorganic compounds. Number of those cells may have increased at the cost of surrounding chemicals. There may had been some differences among those cells and according to the principle of natural selection, some may have shown good growth and some may have perished which could not adjust with the surrounding.

At present, crores of species of plants and animals with huge diversity regarding shape and complexity are present on the Earth. Animal diversity ranges from the unicellular *Amoeba* and *Paramoecium* to man and giant whale. The plant diversity consists of various species ranging from unicellular *Chlorella* to the huge banyan tree. The life exists on Earth everywhere from equator to both the poles. Organisms are present at all the places like air, water, land, rock, etc. Humans have shown curiosity about origin of life and reasons for such a great diversity in life present on the Earth since ancient period. Different theories about origin and evolution of life have been proposed till today of which theory of 'Gradual development of living organisms is accepted.

Internet is my friend

Collect the information from internet about Big-Bang theory related with the formation of stars and planets and present it in your class.

A peek into History

Many philosophers and religious scholars have written their views about formation of life. There seems to be a thorough discussion over the formation of Universe, in various cultures like Indian, Chinese, Roman, Greek, etc. Various cultures have noted different type of information about planets, stars, the 'panchmahabhuta', living organisms, etc. in the form of poetry, stories and religious / sacred books.

Theory of Evolution:

According to this theory, first living material (protoplasm) has been formed in ocean. In due course of time, unicellular organism was formed. Gradually, changes occurred in the unicellular organisms from which larger and more complex organisms were formed. All those changes were slow and gradual. Duration of all these changes is at must 300 crore years. Changes and development in living organisms had been all round and multi-dimensional and this led to evolution of different types of organisms. Hence, this overall process is called as evolution which is organizational. Progressive development of plants and animals from the ancestors having different structural and functional organization is called evolution.

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Evidences of evolution

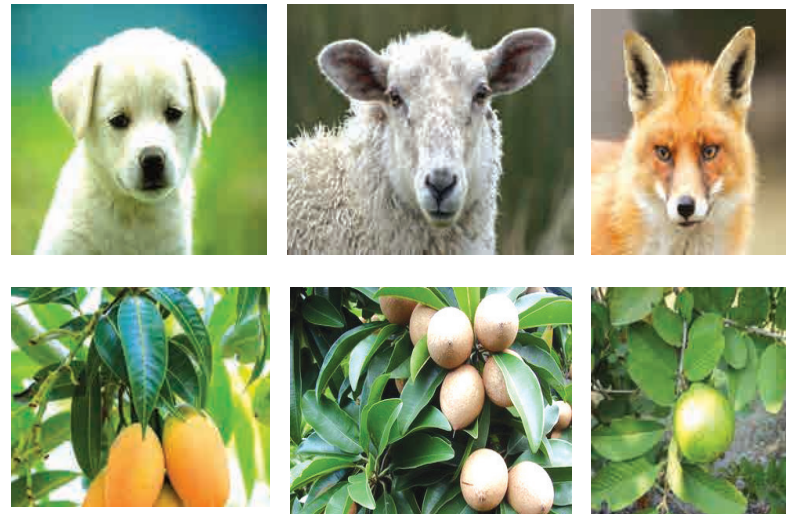
Collective thinking upon all above mentioned theories implies that evolution is everlasting process of changes. However, it needs proof to prove it. Following are various proofs available in support of the theories mentioned above.

1. Morphological Evidences

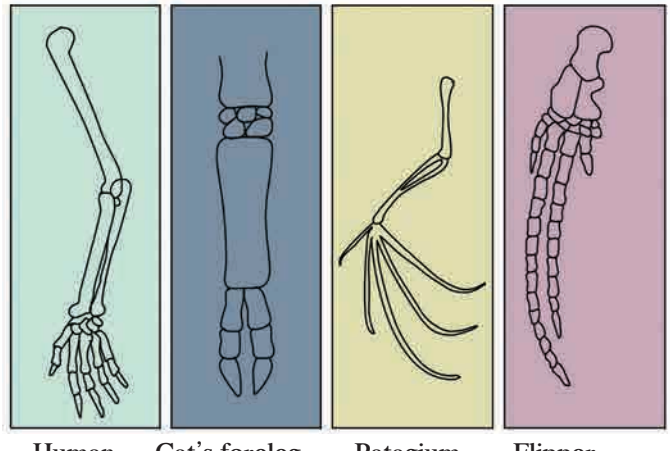
Try this

Observe the following images and note the similarities between given animal images and plant images.

Various similarities like structure of mouth, position of eyes, structure of nostrils and ear pinnae and thickly distributed hairs on body are seen in animals whereas similarities in characters like leaf shape, leaf venation, leaf petiole, etc. occur in case of plants. This indicates that there are some similarities in those groups and hence it proves that their origin must be same and must have common ancestors



1.4 Morphological evidences



Human hand | Cat's foreleg | Patagium of Bat | Flipper of Whale

1.5 Structure of bones

2. Anatomical Evidances

If you carefully observe the pictures, there doesn't seem any superficial similarity between human hand, cat's foreleg, flipper of whale and patagium of bat. Similarly, use of each of those structures is different in respective animals. However, there is similarity in structure of bones and bony joints in organs of each of those animals. This similarity indicates that those animals may have common ancestor.

Can you tell?

1. Which are the different organs in body of organisms?
2. Is each of the organs useful to organism?

Use of ICT :

Collect the information of geological dating and Present it classroom.

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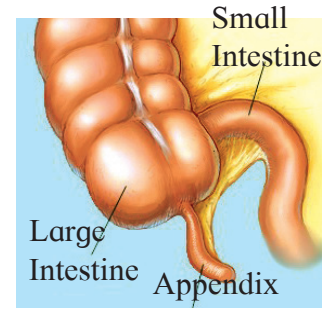
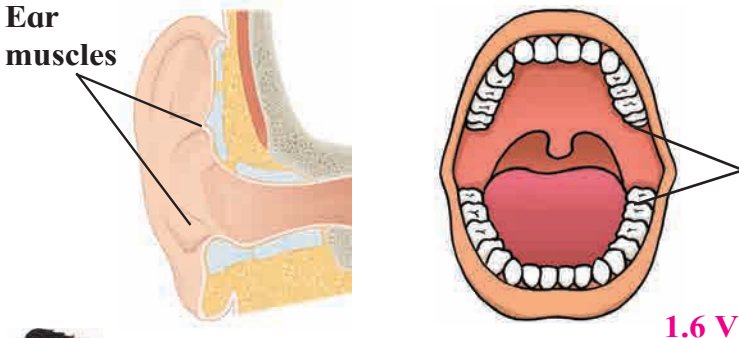
3. Vestigial Organs

Degenerated or underdeveloped useless organs of organisms are called as vestigial organs. In living organisms, sudden development of new tissues or organs for living in changing environment is not possible. Instead, existing organs undergo gradual changes. Mostly, a specific structure in the body is useful under certain situation. However, same structure under different situation may become useless or even harmful. Such structure begins to degenerate under such situation as per the principle of natural selection. It takes thousands of years for a structure to disappear. Such organs are seen in different phases of disappearance in different animals. Such organ, though non-functional in certain organism, it may be functional in other organisms i.e. it is not vestigial in other organisms.

Appendix, which is useless to human, is useful and fully functional organ in ruminants. Similarly, muscles of ear pinna, which are useless to human, are useful in monkeys for movement of ear pinna. Various vestigial organs like tail-bone (coccyx), wisdom teeth, and body hairs are present in body of human being.





1.6 Vestigial organs

Observe and discuss. Observe the following pictures.

1.7 Some fossils

Use of ICT

Find how the vestigial organs in certain animals are functional in others. Present the information in your class and send it to others.

4. Paleontological Evidences

A question may arise in your mind that which organisms existed millions of years ago? How can we tell this? Now this secrete has been hidden in the Earth. Large number of organisms get buried due to disasters like flood, earthquake, volcano, etc. Remnants and impressions of such organisms remain preserved underground. These are called as fossils. Study of fossils is an important aspect of study of evolution.

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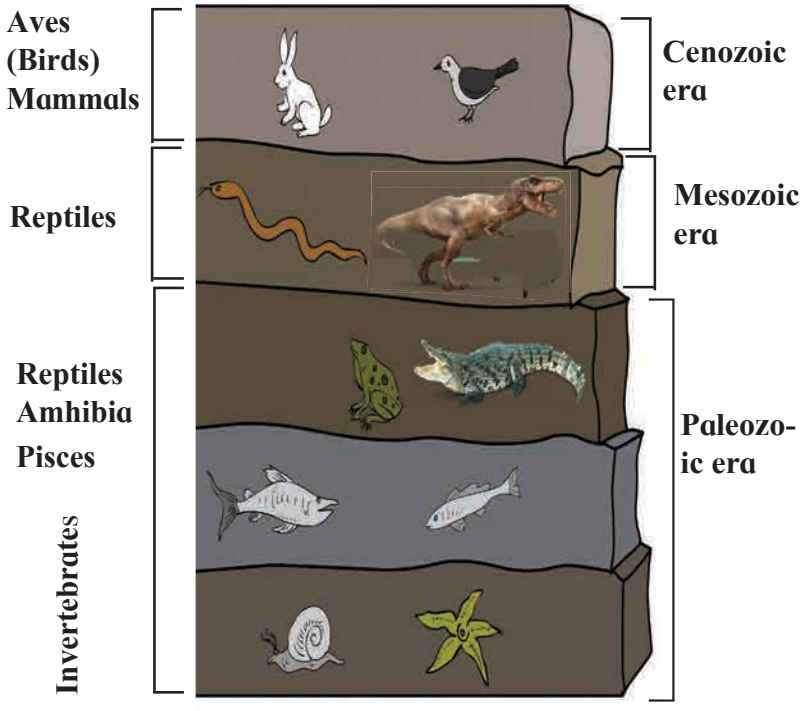
Carbon consumption of animals and plants stops after death and since then, only the decaying process of C-14 occurs continuously. In case of dead bodies of plants and animals, instead of remaining constant, the ratio between C-14 and C-12 changes continuously as C-12 is non-radioactive. The time passed since the death of a plant or animal can be calculated by measuring the radioactivity of C-14 and ratio of C-14 to C-12 present in their body. This is 'carbon dating' method. It is used in paleontology and anthropology for determining the age of human fossils and manuscripts. Once the age of fossil been determined by such technique, it becomes easy to deduce the information about other erstwhile organisms. It seems that vertebrates have been slowly originated from invertebrates.



1.8 Structure of ground level and fossils

Intoduction to Scientists

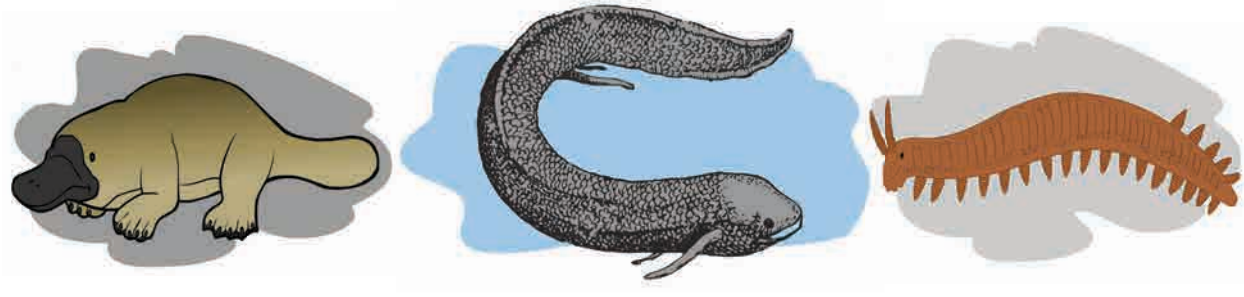
Carbon dating method is based upon the radioactive decay of naturally occurring C-14 and it is developed by Willard Libby.

He has been awarded with Nobel Prize (1960) for this invention. The age of the materials determined by this method are published in the journal 'Radio Carbon'

5. Connecting Links

Observe and discuss.

Observe the following pictures and discuss the characters observed.



Duckbill Platipus | Lungfish | Peripatus

1.9 Some animals with special charactristics

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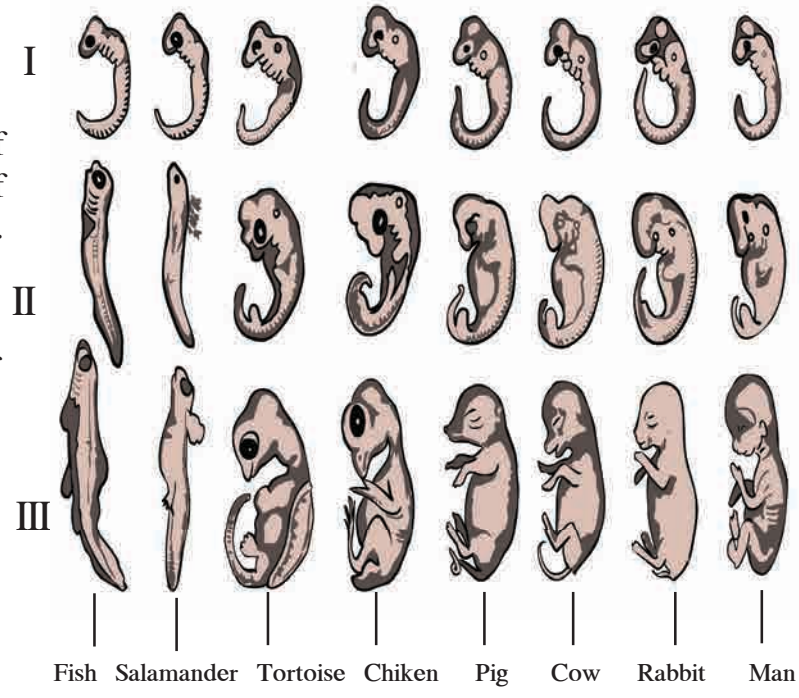
Some plants and animals show some morphological characters by which they can be related to two different groups; hence they are called as 'connecting links'. Ex. In *Peripatus*, characters like segmented body, thin cuticle, and parapodia-like organs are present. Similarly, these animals show tracheal respiration and open circulatory system similar to arthropods. This indicates that *Peripatus* is connecting link between annelida and arthropoda. Similarly, duck billed platypus lays eggs like reptiles but shows relationship with mammals too due to presence of mammary glands and hairs. Lung fish performs respiration with lungs irrespective of being fish. These examples indicate that mammals are evolved from reptiles and amphibians from fishes.

Observe and discuss.

Carefully observe the stages of embryonic development of some animals shown in fig. 1.10

6. Embryological Evidences:

Comparative study of embryonic developmental stages of various vertebrates given in the picture shows that all embryos show extreme similarities during initial stages and those similarities decrease gradually. Similarities in initial stages indicate the common origin of all these animals.



1.10 Embryos during different stages

Darwin's theory of natural selection

Charles Darwin had collected innumerable specimens of plants and animals and depending upon the observations of those specimens; he published the theory of natural selection which preaches the survival of fittest. For this purpose, Darwin had published a book titled **'Origin of Species'**. While explaining the concept, Darwin says that all the organisms reproduce prolifically. All the organisms compete with each other in a life--threatening manner. In this competition, only those organisms sustain which show the modifications essential for winning the competition. However, besides this, natural selection also plays important role because nature selects only those organisms which are fit to live and the rest perish. Sustaining and selected organisms can perform reproduction and thereby give rise to the new species with their own specific characters. Darwin's theory of natural selection was widely accepted for long duration. However, some objections were raised against the theory. Some of the main objections are-

1. Natural selection is not the only factor responsible for evolution.
2. Darwin did not mention any explanation about useful and useless modifications.
3. There is no explanation about slow changes and abrupt changes.

Irrespective of all these objections, Darwin's work on evolution has been a milestone.

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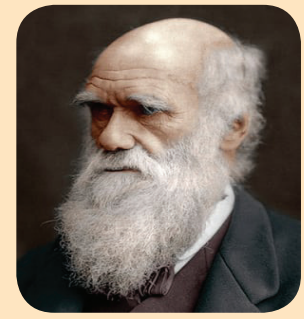
Introduction to Scientists

Charles Robert Darwin (1809-1882)

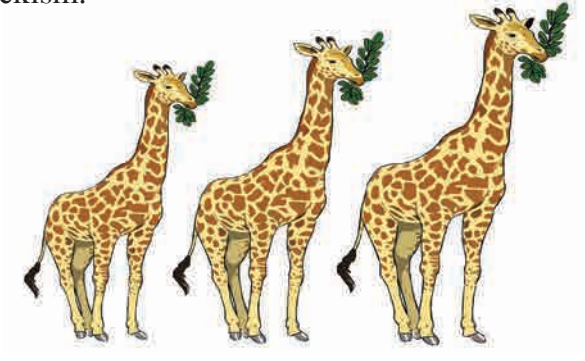


This English biologist proposed the theory of evolution. He showed that all the species of living organisms have been gradually evolved over the period of thousands of years from common ancestor. He proposed that principle of natural selection is responsible for this evolution.

Lamarckism

Jean-Baptiste Lamarck proposed that morphological changes occurring in living organisms are responsible for evolution and the reason behind those morphological changes is activities or laziness of that organism. He called this concept as principle of 'use or disuse of organs'.

Further, he said that the neck of giraffe has become too long due to browsing on leaves of tall plants by extending their neck for several generations; similarly, shoulders of the ironsmith have become very strong due to frequent hammering movements. Wings of birds like ostrich and emu have become weak due to no use. Legs of the birds like swan and duck have become useful for swimming due to living in water and snakes have lost their legs by modifications in their body for burrowing habit. All these examples are types of 'acquired characters' and are transferred from one to another generation. This is called as theory of inheritance of acquired characters or Lamarckism.



1.11 Giraffe

Development of organs due to specific activities or their degeneration due to no use at all was widely accepted but transfer of those characters from generation to generation was rejected. Because it had been verified many times that modifications brought in us are not transferred to next generation and thereby Lamarck's theory was disproved.

The living orgaism can transfer the characters which it has aquired, to the next generation. This is called ancestry of aquired characters.

Introduction to Scientists

Jean-Baptiste Lamarck (1744-1829)

Lamarck proposed that the activities of the organisms are responsible for their evolution. This French naturalist proposed that each animal or plant undergo some changes in its life span and those changes are transferred to the next generation and such changes occur in next subsequent generations too.

Internet is my friend

Collect the pictures and information of various species of monkeys from internet.

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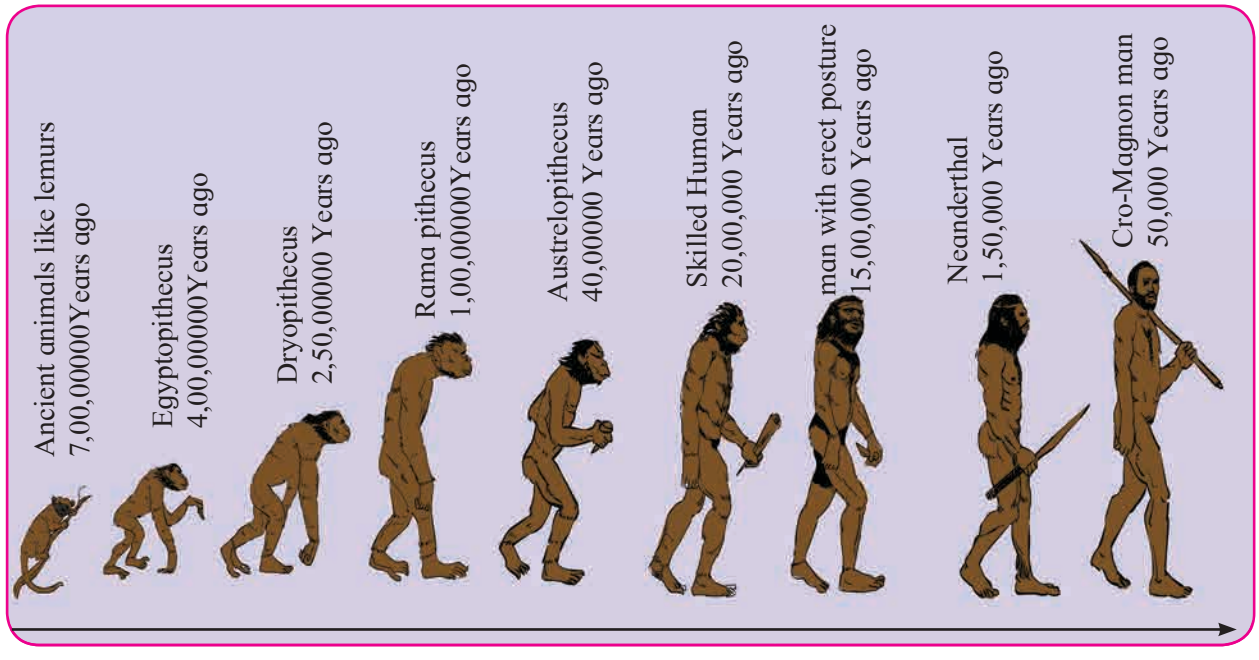
Speciation

Formation of new species of plants and animals is the effect of evolution. Species is the group of organisms that can produce fertile individuals through natural reproduction. Each species grows in specific geographical conditions. Their food, habitat, reproductive ability and period is different. However, genetic variation is responsible for formation of new species from earlier one. Besides, geographical and reproductive changes are also responsible. Similarly, geographical or reproductive isolation also leads to speciation

Human Evolution

The biodiversity that is known today has been said to be formed from very simple unicellular organism due to evolution. In this evolution, origin of human evolution can be shown as per the picture given below. Last dinosaurs disappeared approximately seven crore years ago. At that time, monkey-like animals are said to be evolved from some ancestors who were more or less similar to the modern lemurs. Tail of these monkey-like animals of Africa is said to be disappeared about 4 crore years ago. They developed due to enlargement in brain their hands were also improved and thus ape-like animals were evolved. Meanwhile, these ape-like animals reached the South and North-East Asia and finally evolved into gibbon and orangutan.

Remaining ape-like animals stayed in Africa and from them, gorilla and chimpanzee evolved about 2.5 crore years ago. Evolution of some of the 2 crore year old species of apes seems to be occurred in different way. They had to use their hands more for eating food and other work.



1.12 Journey of human

Those apes started to live on land as the forests started to decline due to dry environment. Their lumbar bones developed in such a way that they started to stand in erect posture in grasslands and thereby their hands became available for use, anytime. These first human--like animals with erect posture which were using their hands have evolved about 2 crore years ago.

First record of human-like animal is with us in the form of 'Ramapithecus' ape from East Africa. Afterwards, this ape grown up in size and became more intelligent and thus the ape of South Africa evolved about 40 lakh years ago.

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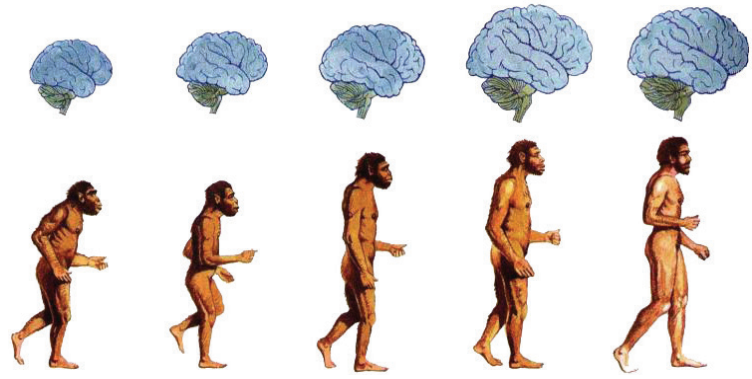
The morphology of these human-like animals started to appear like to be the member of the genus *Homo*, about 20 lakh years ago and thus skilled human developed. About 15 lakh years ago, human walking with erect posture was evolved. It may have existed in China and Indonesia of Asian continent.



1.13 Development of human brain

Evolution of upright man continued in the direction of developing its brain for the period of about 1 lakh years and meanwhile it discovered the fire. Brain of 50 thousand year old man had been sufficiently evolved to the extent that it could be considered as member of the class- wise-man (*Homo sapiens*).

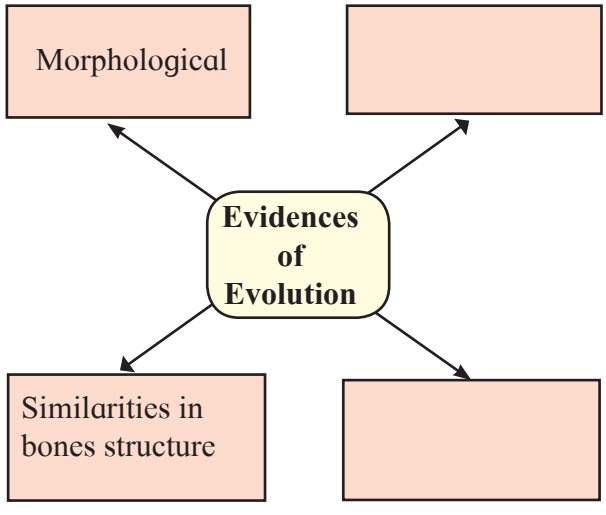
Neanderthal man can be considered as the first example of wise-man. The Cro-Magnon man evolved about 50 thousand years ago and afterwards, this evolution had been faster than the earlier.

1.14 Neanderthal man

About 10 thousand years ago, wise-man started to practice the agriculture. It started to rear the cattle-herds and established the cities. Cultural development took place. Art of writing was invented about 5000 years ago and thus the history had been started. Modern sciences emerged about 400 years ago and industrial society was established about 200 years ago and now we have reached at this stage, and still we are searching the details of roots of human ancestry.

Exercise

1. Complete the following diagram.



2. Read the following statements and justify same in your own words with the help of suitable examples.

a. Human evolution began approximately 7 crore years ago.
b. Geographical and reproductive isolation of organisms gradually leads to speciation.
c. Study of fossils is an important aspect of study of evolution.
d. There is evidences of fatal science among chordates.

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3. Complete the statements by choosing correct options from bracket.

(Gene, Mutation, Translocation, Transcription, Gradual development, Appendix)

a. The causality behind the sudden changes was understood due to -- -- principle of Hugo de Vries.

b. The proof for the fact that protein synthesis occurs through -- --- was given by George Beadle and Edward Tatum.

c. Transfer of information from molecule of DNA to mRNA is called as -- -- -- process.

d. Evolution means -- -- -- --.

e. Vestigial organ -- -- -- present in human body is proof of evolution.

4. Write short notes based upon the information known to you.

a. Lamarckism

b. Darwin's theory of natural selection.

c. Embryology.

d. Evolution.

e. Connecting link.

5. Define heredity. Explain the mechanism of hereditary changes.

6. Define vestigial organs. Write names of some vestigial organs in human body and write the names of those animals in whom same organs are functional.

7. Answer the following questions.

a. How are the hereditary changes responsible for evolution?

b. Explain the process of formation of complex proteins.

c. Explain the theory of evolution and mention the proof supporting it.

d. Explain with suitable examples importance of anatomical evidences in evolution.

e. Define fossil. Explain importance of fossils as proof of evolution.

f. Write evolutionary history of modern man.

Project :

1. Make a presentation on human evolution using various computer softwares and arrange a group disscussion over it in the class room.
2. Read the book – 'Pruthvivar Manus Uparach' written by Late Dr. Sureshchandra Nadkarni and note your opinion on evolution.

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2. Life Processes in living organisms Part -1

- Living Organisms & Life Processes
- Living Organisms & Energy Production
- Some Nutrients & Energy Efficiency
- Cell Division- A Life Process

Can you recall?

1. How are the food stuffs and their nutrient contents useful for body?
2. What is the importance of balanced diet for body?
3. Which different functions are performed by muscles in body?
4. What is the importance of digestive juices in digestive system?
5. Which system is in action for removal of waste materials produced in human body?
6. What is the role of circulatory system in energy production?
7. How are the various processes occurring in human body controlled? In how many ways ?

Living Organisms and Life Processes

Various organ-systems are continuously performing their functions in human body. Along with the various systems like digestive, respiratory, circulatory, excretory and control systems, different external and internal organs are performing their functions independently but through a complete co-ordination. This overall system is in action in more or less same way in all the organisms. Those are in need of continuous source of energy for this purpose. Carbohydrates, fats and lipids are the main sources of this energy and it is harvested by the mitochondria present in each cell. It is not like that only foodstuff is sufficient for energy production but oxygen is also necessary. All these i.e. food stuffs and oxygen are transported up to the cell via circulatory system. Besides, it is coordinated by the control system of the body. i.e. each life process contributes in its own way in the process of energy production. Functioning of all these life processes also requires the energy.

Human and other animals consume the fruits and vegetables. Plants are autotrophs. They prepare their own food. They utilize some of the food for themselves whereas remaining is stored in various parts like fruits, leaves, stem, roots, etc. We consume all these various plant materials and obtain different nutrients like carbohydrates, fats, proteins, vitamins, minerals, etc. Which food materials do we consume to obtain these nutrients?

We obtain the carbohydrates from milk, fruits, jaggary, cane sugar, vegetables, potatoes, sweet potatoes, sweet meats and cereals like wheat, maize, ragi, jowar, millet, rice, etc. We get 4Kcal energy per gram of carbohydrates. Let us study the way by which this energy is obtained.

Many players are seen consuming some food stuffs during breaks of the game.

Use your brain power Why may be the players consuming these food stuffs?

Can you recall? 1. What is respiration? How does it occur?

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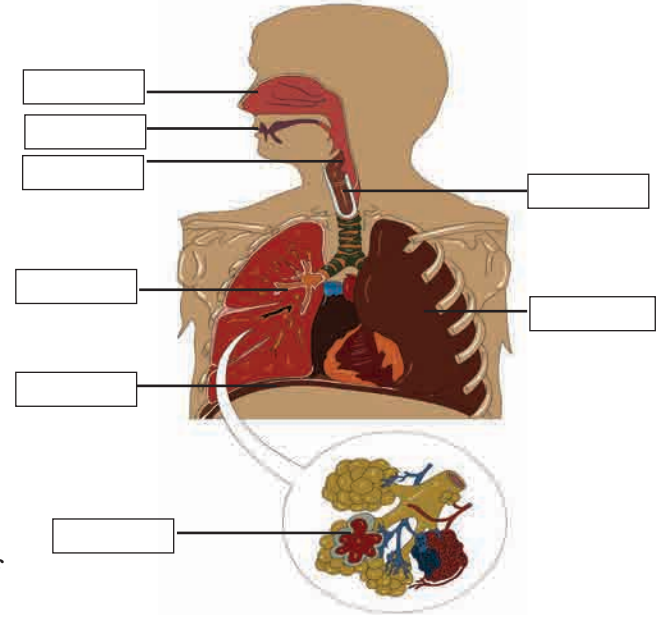
Observe

Observe and Label the diagram given beside.

In living organisms, respiration occurs at two levels as body and cellular level. Oxygen and carbon dioxide are exchanged between body and surrounding in case of respiration occurring at body level. In case of respiration at cellular level, foodstuffs are oxidized either with or without help of oxygen.



2.1 Human respiratry system

Can you tell?

1. How many atoms of C, H and O are respectively present in a molecule of glucose?
2. Which types of chemical bonds are present between all these atoms?
3. In terms of Chemistry what happens actually when a molecule is oxidized?

Carbohydrates of the food that we consume everyday are mainly utilized for production of energy required for daily need. This energy is obtained in the form of ATP. For this purpose, glucose, a type of carbohydrates is oxidized step by step in the cells. This is called as cellular respiration. Cellular respiration occurs among the living organisms by two methods. Those two methods are aerobic respiration (oxygen is involved) and anaerobic respiration (oxygen is not involved). In aerobic respiration, glucose is oxidized in three steps.

1. Glycolysis

Process of glycolysis occurs in cytoplasm. A molecule of glucose is oxidized step by step in this process and two molecules of each i.e. pyruvic acid, ATP, $NADH_2$ and water are formed.

Molecules of pyruvic acid formed in this process are converted into molecules of Acetyl-Coenzyme-A. Two molecules of $NADH_2$ and two molecules of CO_2 are released during this process.

2. Tricarboxylic acid cycle

Both molecules of acetyl-CoA enter the mitochondria. Cyclic chain of reactions called as tricarboxylic acid cycle is operated on it in the mitochondria. Acetyl part of acetyl-CoA is completely oxidized through this cyclical process and molecules CO_2, H_2O, $NADH_2$, $FADH_2$ are derived.

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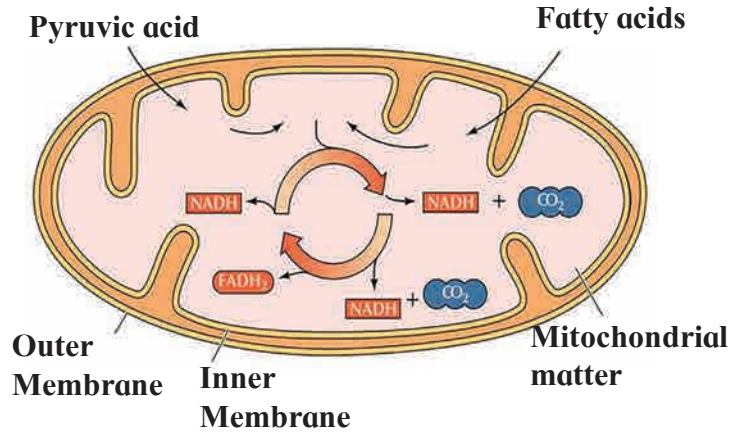
3. Electron transfer chain reaction

Molecules of $NADH_2$ and $FADH_2$ formed during all above processes participate in electron transfer chain reaction. Due to this, 3 molecules of ATP are obtained from each $NADH_2$ molecule and 2 molecules of ATP from each $FADH_2$ molecule. Besides ATP, water molecules are also formed in this reaction. Electron transfer chain reaction is operated in mitochondria only.

Thus, a molecule of glucose is completely oxidized in aerobic respiration and molecules of CO_2 and H_2O are produced along with energy.



2.2 Mitochondria and Tri-carboxylic acid cycle

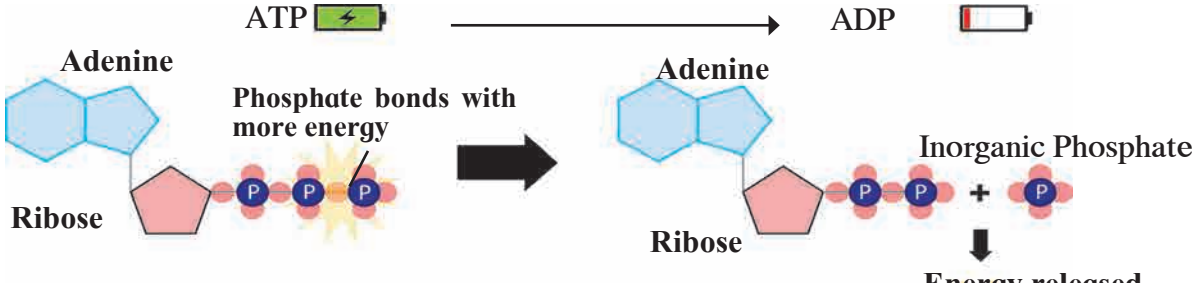
Always Remember.

$NADH_2$ - Nicotinamide Adenine dinucleotide

$FADH_2$ - Flavin adenine dinucleotide

Both enzymes are formed in the cells and used in cellular respiration.

ATP: Adenosine triphosphate is energy-rich molecule and energy is stored in the bonds by which phosphate groups are attached to each other. These molecules are stored in the cells as per need. Chemically, ATP is triphosphate molecule formed from adenosine ribonucleoside. It contains a nitrogenous compound-adenine, pentose sugar- ribose and three phosphate groups. As per the need, energy is derived by breaking the phosphate bond of ATP; hence ATP is called as 'energy currency' of the cell.



3.3 ATP: Energy Currency

If there is insufficient amount of carbohydrates in body due to exceptional conditions like fasting and hunger, then lipids and proteins are used for energy production. In case of lipids, they are converted into fatty acids whereas proteins into amino acids. Fatty acids and amino acids are converted into acetyl-CoA and energy is obtained through complete oxidation of acetyl-CoA by the process of Krebs cycle in mitochondria.

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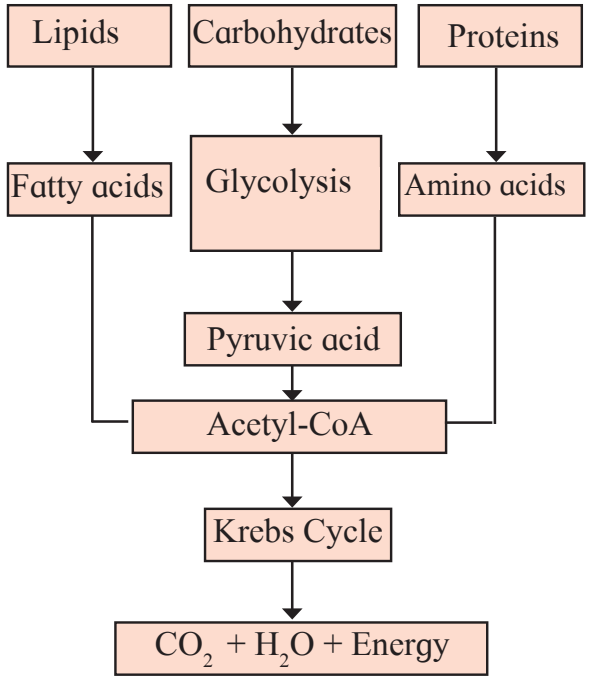
Introduction To Scientists

Process of glycolysis was discovered by three scientists Gustav Embden, Otto Meyerhof, and Jacob Parnas along with their colleagues. For this purpose, they performed experiments on muscles. Hence, glycolysis is also called as Embden-Meyerhof-Parnas pathway (EMP pathway).

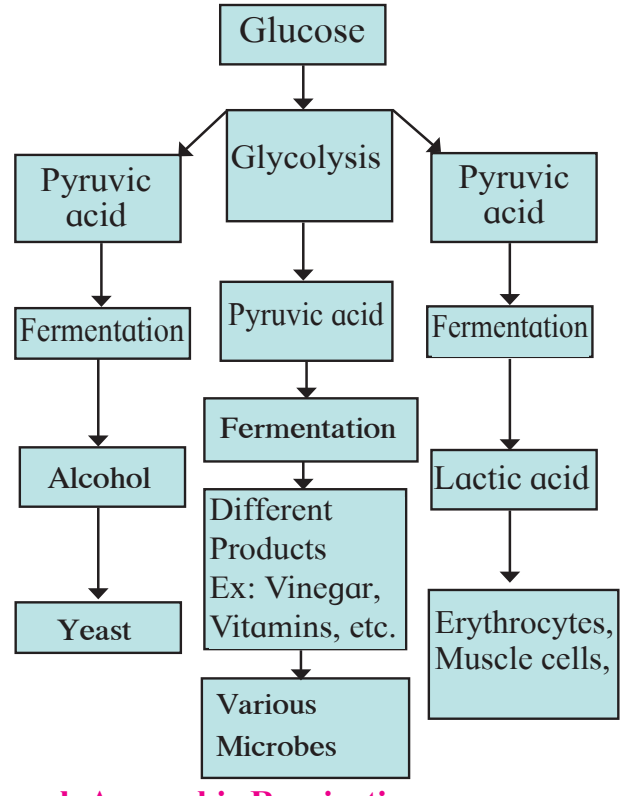
The cyclical reactions of tricarboxylic acid cycle were discovered by Sir Hans Kreb. Hence, this cyclical process is also called as Kreb's cycle. He has been awarded the Nobel Prize in 1953 for this discovery.

Sir Hans Kreb (1900-1981)

Process of energy production through aerobic respiration of carbohydrates, proteins and Fats.



aneerobic respiration in living organisms/ cells



Energy Production in Microorganisms through Anaerobic Respiration

Some organisms cannot live in presence of oxygen. Ex. Many bacteria. Such living organisms have to perform anaerobic respiration for energy production. Glycolysis and fermentation are two steps of anaerobic respiration. Glucose is incompletely oxidized and less amount of energy is obtained in this type of respiration. Pyruvic acid produced through glycolysis is converted into other organic acids or alcohol with the help of some enzymes in this process. This is called as fermentation. Some higher plants, animals and aerobic microorganisms also perform anaerobic respiration instead of aerobic respiration if there is depletion in oxygen level in the surrounding.

Ex. Seeds perform anaerobic respiration if the soil is submerged under water during germination. Similarly, our muscle cells also perform anaerobic respiration while performing the exercise. Due to this, less amount of energy is produced in our body and lactic acid accumulates due to which we feel tired.

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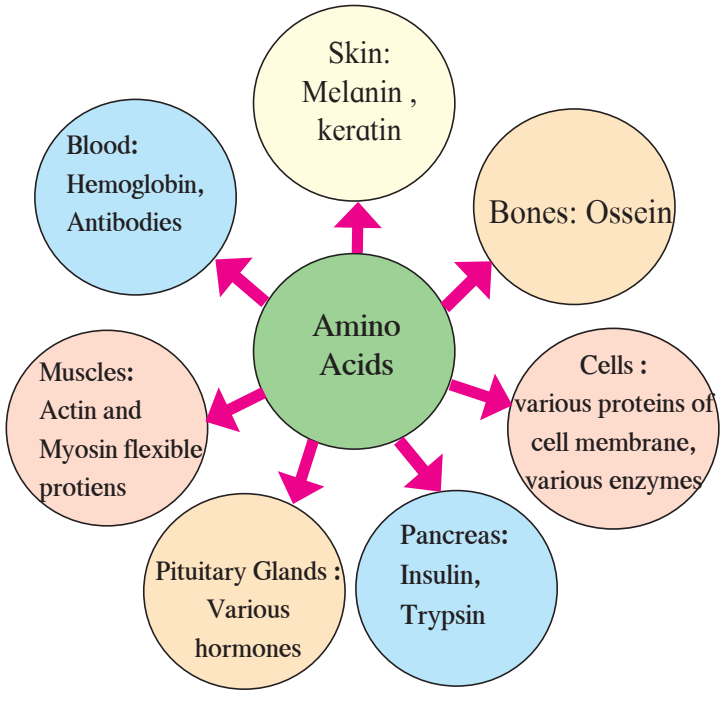
Can you tell?

1. Which type of cellular respiration performs complete oxidation of glucose?
2. Which cell organelle is necessary for complete oxidation of glucose?

Energy from different food components

Excess of the carbohydrates are stored in liver and muscles in the form of glycogen. What is the source of proteins? What are they made up of?

Proteins are the macromolecules formed by bonding together many amino acids. Proteins of animal origin are called as 'first class' proteins. We get 4 Kcal of energy per gram of proteins. Amino acids are obtained after digestion of proteins. Those amino acids are absorbed in the body and transported up to each organ and cell via blood. From these amino acids, organs and cells produce various proteins necessary for themselves and the whole body. Those examples are given in the following diagram.



2.4 Proteins and different amino acids obtained

Always remember

Excess of amino acids obtained from proteins are not stored in the body. They are broken down and the ammonia formed is eliminated out of the body. If necessary, excess of proteins are converted into other useful substances like glucose through the process of *gluconeogenesis*.

Plants produce the necessary amino acids from minerals *denovo* and thereby produce different proteins. An enzyme RUBISCO present in the plant chloroplasts is most abundant protein found in nature.

Can you recall?

From where do we obtain the lipids?

The substances formed by specific chemical bond between fatty acids and alcohol are called as lipids. Digestion of lipids consumed by us is nothing but their conversion into fatty acids and alcohol. Fatty acids are absorbed up and distributed everywhere within the body. From those fatty acids, different cells produce various substances necessary to themselves. Ex. the molecules called as phospho lipids which are essential for producing plasma membrane are formed from fatty acids. Besides, fatty acids are used for producing hormones like progesterone, estrogen, testosterone, aldosterone, etc. and the covering around the axons of nerve cells. We get 9 KCal of energy per gram of lipids. Excess of lipids are stored in adipose connective tissue in the body.

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Think:

1. Many times, you cannot eat hot food due to inflammation / ulceration in mouth.
2. Some persons experience difficulty in night vision since their childhood or adolescence.

Vitamins are a group of heterogeneous compounds of which, each is essential for proper operation of various processes in the body. There are main six types of vitamins, e.g. A, B, C, D, E and K. Out of these, A, D, E and K are fat-soluble whereas B and C are water-soluble. We have seen that, $FADH_2$ and $NADH_2$ are produced in the processes like glycolysis and Krebs cycle. Vitamins like riboflavin (Vitamin B_2) and nicotinamide (Vitamin B_5) respectively are necessary for their production.

Use your brain power

1. Many times, we experience dryness in mouth.
2. Oral rehydration solution (Salt-sugar-water) is frequently given to persons experiencing loose motions.
3. We sweat during summer and heavy exercise.

There is about 65 – 70% water in our body. Each cell contains 70% water weight by weight. Blood-plasma also contains 90% of water. Functioning of cells and thereby whole body disturbs even if there is a little loss of water from the body. Hence, water is an essential nutrient.

Along with all above mentioned nutrients, fibers are also essential nutrients. In fact, we cannot digest the fibers. However, they help in the digestion of other substances and egestion of undigested substances. We obtain the fibers from leafy vegetables, fruits, cereals, etc.

Internet is my friend

Collect information

1. What are symptoms of diseases like night blindness, rickets, beriberi, neuritis, pellagra, anemia, scurvy?
2. What do you mean by coenzymes?
3. Find the full forms of FAD, FMN, NAD, NADP.
4. How much quantity of each vitamin is required every day?

Cell Division: An Essential Life Process

Can you tell?

1. What happens to the cells of injured tissue?
2. Whether new cells are formed during healing of wound?
3. Do the plants get injured when do we pluck the flowers? How are those wounds healed?
4. How does the growth of any living organism occur? Does the number of cells in their body increase? If yes, how?
5. How the new individual of a species is formed from existing one of same species?

Cell division is one of the very important properties of cells and living organisms. Due to this property only, a new organism is formed from existing one, a multicellular organism grows up and emaciated body can be restored.

There are two types of cell division as mitosis and meiosis. Mitosis occurs in somatic cells and stem cells of the body whereas meiosis occurs in germ cells. Before study of cell division, we should know the structural organization of cell that we have studied earlier. Each cell has a nucleus. Besides, other cell organelles are also present. Let us study the cell division with the help of this information.

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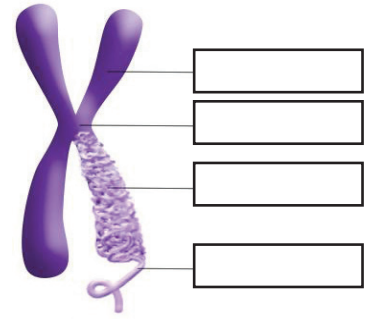
Before any type of cell division, the cell doubles up its chromosome number present in its nucleus i.e. if chromosome number is 2n, it is doubled up to 4n.

Can you recall? What is the shape of chromosome? Give its names in the figure.

A pair of each type of chromosome is present in 2n condition whereas single chromosome of each type is present in n condition and their structure is like the one shown in figure given beside.



2.5 Chromosome

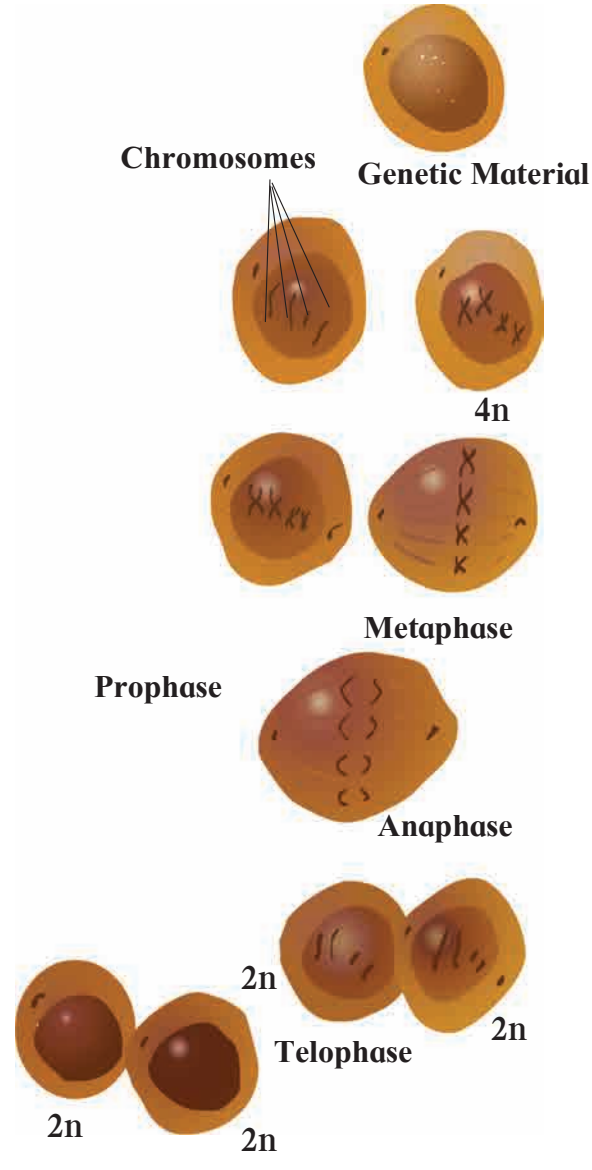
Mitosis

Somatic cells and stem cells divide by mitosis. Mitosis is completed through two main steps. Those two steps are karyokinesis (nuclear division) and cytokinesis (cytoplasmic division). Karyokinesis is completed through four steps.

A. Prophase : In prophase, condensation of basically thin thread-like chromosomes starts. Due to this, they become short and thick and they start to appear along with their pairs of sister chromatids. Centrioles duplicate and each centriole moves to opposite poles of the cells. Nuclear membrane and nucleolus start to disappear.

B. Metaphase : Nuclear membrane completely disappears in metaphase. Chromosomes complete their condensation and become clearly visible along with their sister chromatids. All chromosomes are arranged parallel to equatorial plane (central plane) of the cell. Special type of flexible protein fibers (spindle fibers) are formed between centromere of each chromosome and both centrioles.

C. Anaphase : In anaphase, centromeres split and thereby sister chromatids of each chromosome separate and they are pulled apart in opposite directions with the help of spindle fibers. Separated sister chromatids are called as daughter chromosomes. Chromosomes being pulled appear like bunch of bananas. In this way, each set of chromosomes reach at two opposite poles of the cell.



2.6 Mitosis

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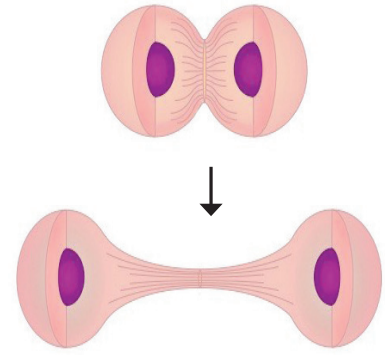
D. Telophase : The chromosomes which have reached at opposite poles of the cell now start to decondense due to which they again become thread-like thin and invisible. Nuclear membrane is formed around each set of chromosomes reached at poles. Thus, two daughter nuclei are formed in a cell. Nucleolus also appears in each daughter nucleus. Spindle fibers completely disappear.

In this way, karyokinesis completes and cytokinesis begins.

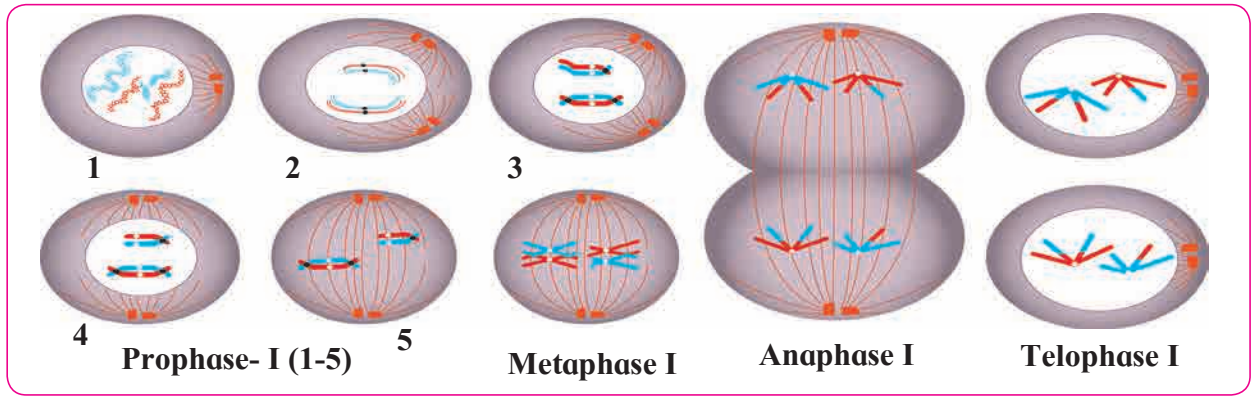
The cytoplasm divides by cytokinesis and two new cells are formed which are called as daughter cells. In this process, a notch is formed at the equatorial plane of the cell which deepens gradually and thereby two new cells are formed. However, in case of plant cells, instead of the notch, a cell plate is formed exactly along midline of the cell and thus cytokinesis is completed.



2.7 Cytokinesis

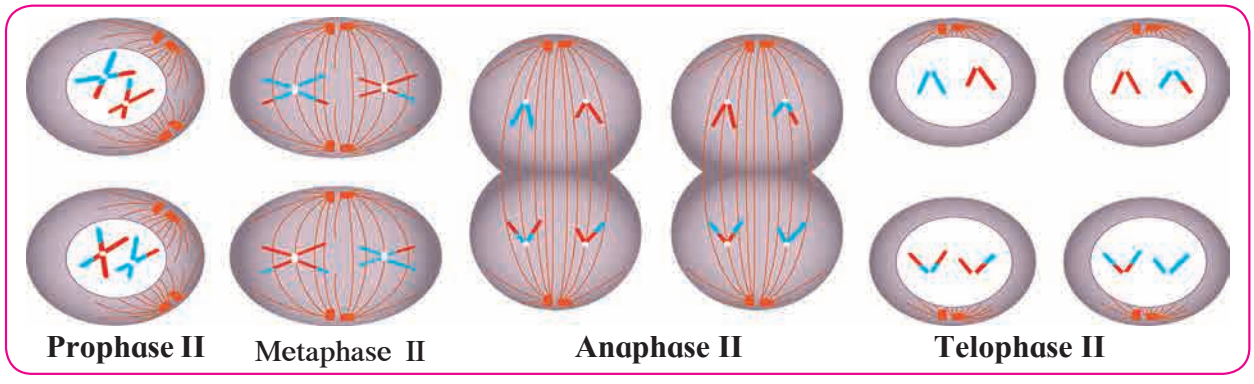
Mitosis is essential for growth of the body. Besides, it is necessary for restoration of emaciated body, wound healing, formation of blood cells, etc.

Meiosis:



2.8 Meiosis Part-I

Meiosis is completed through two stages. Those two stages are meiosis-I and meiosis-II. In meiosis-I, recombination / crossing over occur between homologous chromosomes and thereafter those homologous chromosomes (Not sister chromatids) are divided into two groups and thus two haploid cells are formed.



2.9 Meiosis Part -II

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Meiosis-II is just like mitosis. In this stage, the two haploid daughter cells formed in meiosis-I undergo division by separation of recombined sister chromatids and four haploid daughter cells are formed. Process of gamete production and spore formation occurs by meiosis. In this type of cell division, four haploid (n) daughter cells are formed from one diploid (2n) cell. During this cell division, crossing over occurs between the homologous chromosomes and thereby genetic recombination occurs. Due to this, all the four daughter cells are genetically different from parent cell and from each other too.

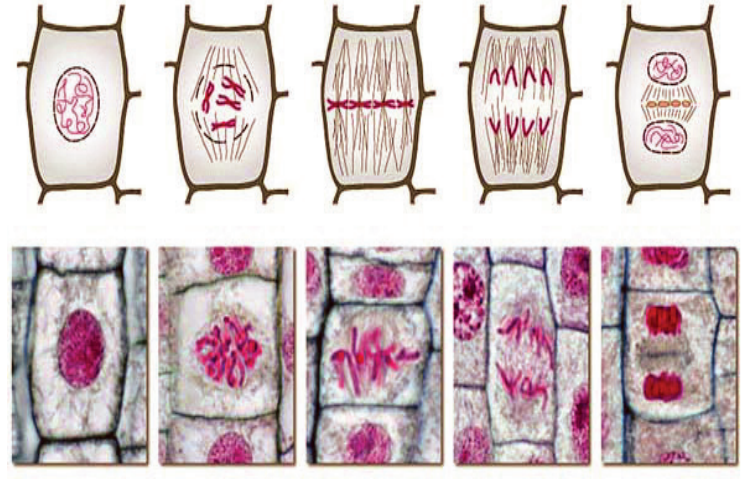
Try this

Apparatus : Conical flask, glass slides, cover slips, forceps, compound microscope, watch glass, etc.
Materials : a medium sized onion , iodine solution, etc.

Procedure : Take a medium sized onion. Keep it in a conical flask filled with water in such a way that the roots of onion will be in contact with water. Observe the roots of onion after 4 – 5 days. Cut the tips of some of the roots and put them in a watch glass. Pour some drops of iodine in watch glass. Take one of the root tip on glass slide press it with the help of forceps. Add 1 – 2 drops of water and carefully place cover slip over it in such a way that air will not be trapped between. Observe the prepared glass slide under the compound microscope. Which phase of cells division did you observe? Sketch its figure.
Various phases of cell division occurring in root tips of onion are shown in the following figure. Which one of those could you see in the slide?

Use your brain power

1. What do you mean by diploid (2n) cell?
2. What do you mean by haploid (n) cell?
3. What do you mean by homologous chromosomes?
4. Whether the gametes are diploid or haploid? Why?
5. How are the haploid cells formed?
6. What is the importance of haploid cells?



2.10 Phases of mitosis in onion root tip

Use of ICT

Collect videos and photographs of different life processes in living organisms. Prepare a presentation and present it on the occassion of science exhibition

Books are my friend

Read different Encyclopedias of technical terms in biology and anatomy and other reference books.

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Exercise

1. Fill in the blanks and explain the statements.

a. After complete oxidation of a glucose molecules, ---- --- --- number of ATP molecules are formed.

b. At the end of glycolysis, ---- --- -- molecules are obtained.

c. Genetic recombination occurs in -- -- -- phase of prophase of meiosis-I.

d. All chromosomes are arranged parallel to equatorial plane of cell in -- -- -- phase of mitosis.

e. For formation of plasma membrane, --- --- --- molecules are necessary.

f. Our muscle cells perform -- -- -- type of respiration during exercise.

2. Write definitions.

a. Nutrition. b. Nutrients

c. Proteins. d. Cellular respiration

e. Aerobic respiration.

f. Glycolysis.

3. Distinguish between

a. Glycolysis and TCA cycle.

b. Mitosis and meiosis.

c. Aerobic and anaerobic respiration.

4. Give scientific reasons.

a. Oxygen is necessary for complete oxidation of glucose.

b. Fibers are one of the important nutrients.

c. Cell division is one of the important properties of cells and organisms.

d. Sometimes, higher plants and animals too perform anaerobic respiration.

e. Kreb's cycle is also known as citric acid cycle.

5. Answer in detail.

a. Explain the glycolysis in detail.

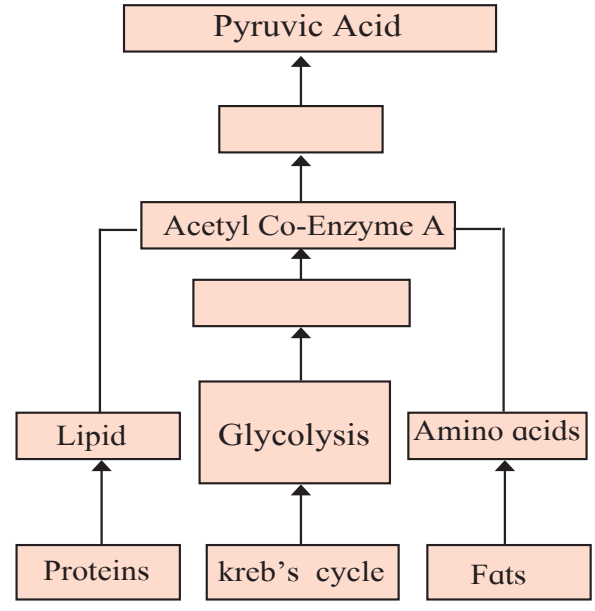
b. With the help of suitable diagrams, explain the mitosis in detail.

c. With the help of suitable diagrams, explain the five stages of prophase-I of meiosis.

d. How all the life processes contribute to the growth and development of the body?

e. Explain the Kreb's cycle with reaction.

5. How energy is formed from oxidation of carbohydrates, fats and proteins? Correct the diagram given below.



Project :

With the help of information collected from internet, prepare the slides of various stages of mitosis and observe under the compound microscope.

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3. Life Processes in Living Organisms Part – 2

- **Reproduction: Asexual and Sexual reproduction.**
- **Reproduction and modern technology**
- **Reproductive health**
- **Population Explosion**

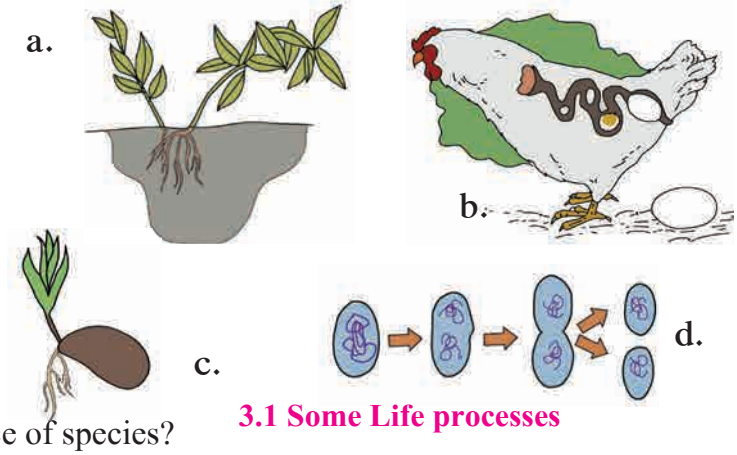
Can you recall?

1. Which are the important life processes in living organisms?
2. Which life processes are essential for production of energy required by body?
3. Which are main types of cell-division? What are the differences?
4. What is the role of chromosomes in cell-division?

We have studied various life processes in previous classes. All those life processes i.e. nutrition, respiration, excretion, sensation & response (control & co-ordination), etc. are essential to each living organism to remain alive. Besides these life processes, one more life process occurs in living organisms; it is reproduction. However, reproduction does not help the organism to remain alive but it helps to maintain the continuity of the species of that organism.

Observe

Observe the pictures and tell the life process which you identified.



3.1 Some Life processes

Can you tell?

1. What do we mean by maintenance of species?
2. Whether the new organism is genetically exactly similar to earlier one that has produced it?
3. Who determines whether the two organism of a species will be exactly similar or not?
4. What is the relationship between the cell division and formation of new organism of same species by earlier existing organism?

Formation of new organism of same species by earlier existing organism is called as reproduction. Reproduction is one of the various important characters of living organisms. It is also one of the various reasons responsible for evolution of each species. In living organisms, reproduction occurs mainly by two methods. Those two methods are- asexual and sexual reproduction.

Asexual reproduction

Process of formation of new organism by an organism of same species without involvement of gametes is called as asexual reproduction. As this reproduction does not involve union of two different gametes, the new organism has exact genetic similarity with the reproducing organism. This is uniparental reproduction and it occurs by mitotic cell division. Absence of genetic recombination is a drawback whereas fast process is advance of this reproductive method.

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A. Asexual reproduction in unicellular organisms

1. Binary Fission

Try this

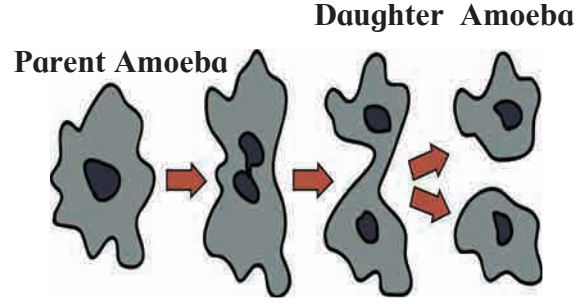
Activity 1 : Take a conical flask and collect the water in it from a pond having stagnant water and aquatic plants. Add some wheat grains and aquatic plants to it. Keep it for 3 – 4 days so that wheat grains & plants will decompose. Early in the morning on fourth day, take a glass slide and put a drop of that water over it. Carefully, put a cover-slip on that drop and observe under compound microscope.

You will be able to see many paramecia performing the binary fission.

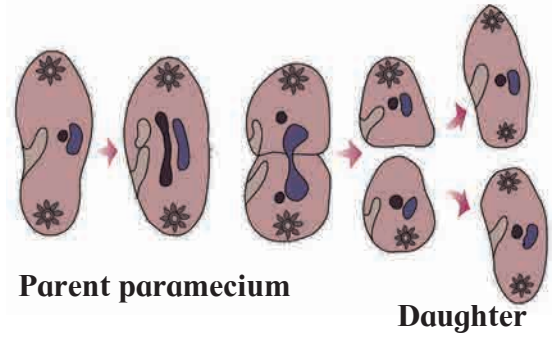
Prokaryotes (Bacteria), Protists (*Amoeba*, *Paramoecium*, *Euglena*, etc.) and eukaryotic cell-organelle like mitochondria and chloroplasts perform asexual reproduction by binary fission. In this process, the parent cell divides to form two similar daughter cells. Binary fission occurs either by mitosis or amitosis.

Axis of fission / division is different in different protists. Ex.: Amoeba divides in any plane due to lack of specific shape; hence it is called as 'simple binary fission'. Paramoecium divides by 'transverse binary fission' whereas Euglena by 'longitudinal binary fission'.

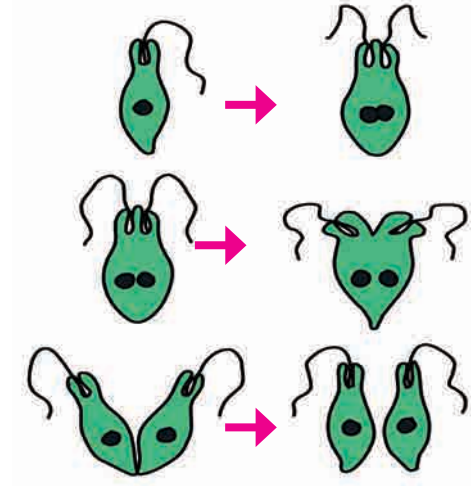
Binary fission is usually performed by living organisms during favorable conditions i.e. availability of abundant food material.



3.2 Simple binary fission: *Amoeba*



3.3 Transverse binary fission : Paramecium



3.4 Longitudinal binary fission: *Euglena*

2. Multiple Fission

Asexual reproduction by multiple fission is performed by Amoeba and other similar protists. Amoeba stops the formation of pseudopodia and thereby movements whenever there is lack of food or any other type of adverse condition. It becomes rounded and forms protective covering around plasma membrane. Such encysted Amoeba or any other protist is called as 'Cyst'.

Many nuclei are formed by repeated nuclear divisions in the cyst. It is followed by cytoplasmic division and thus, many amoebulae are formed. They remain encysted till there are adverse conditions. Cyst breaks open on arrival of favorable conditions and many amoebulae are released.

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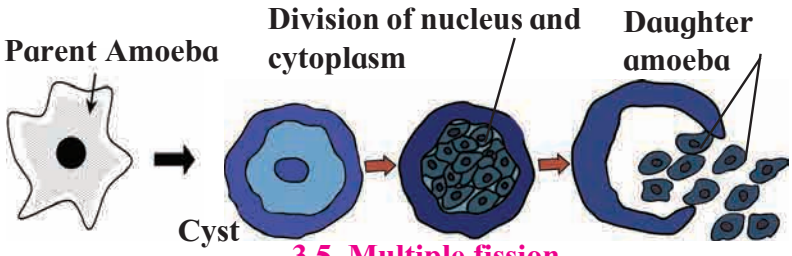


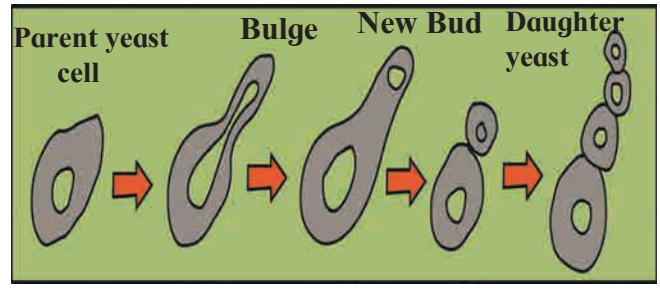
3.5 Multiple fission

Use your brain power

Does the parent cell exist after asexual reproduction- fission?

3. Budding:

Activity 2 : Bring the active dry yeast powder from market. Take 50 ml lukewarm water in a conical flask. Add 5 gm of active dry yeast powder and 10 gm table sugar to that water and mix well the mixture. Keep the flask in warm place and after an hour take a drop of that mixture on a clean glass slide. Put a cover-glass on that drop and observe it under the compound microscope.



3.6 Budding

You will see the yeast cells performing budding i.e. a small bud coming out of many parent cells. Asexual reproduction occurs by budding in yeast- a unicellular fungus. Yeast cell produces two daughter nuclei by mitotic division, so as to reproduce by budding. This yeast cell is called as parent cell. A small bulge appears on the surface of parent cell. This bulge is actually a bud. One of the two daughter nuclei enters this bud. After sufficient growth, bud separates from the parent cell and starts to live independently as a daughter yeast cell.

B. Asexual reproduction in Multicellular organisms

1. Fragmentation:

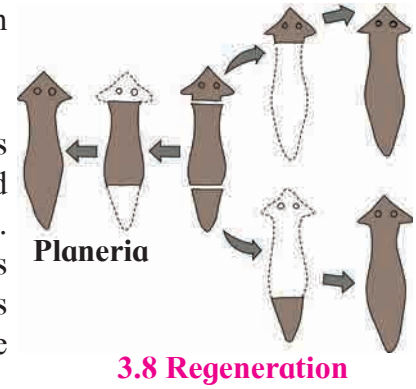
This type of asexual reproduction occurs in multicellular organisms. In this type of reproduction, the body of parent organism breaks up into many fragments and each fragment starts to live as an independent new organism. This type of reproduction occurs in algae like *Spirogyra*, and sponges like *Sycon*.

3.7 Fragmentation

Whenever there is plenty of water and nutrients are available to Spirogyra, its filaments grow up very fast and break up into many small fragments. Each fragment starts to live independently as a new Spirogyra fiber.If the body of Sycon breaks up accidentally into many fragments, each fragment develops into new Sycon.

2. Regeneration

You may know that the wall lizard breaks up and discards some part of its tail in emergency. Discarded part is regenerated after a period. This is an example of limited regeneration. However, under certain situations, an animal- Planaria breaks up its body into two parts and thereafter each part regenerates remaining part of the body and thus two new Planaria are formed. This is called as regeneration.



3.8 Regeneration

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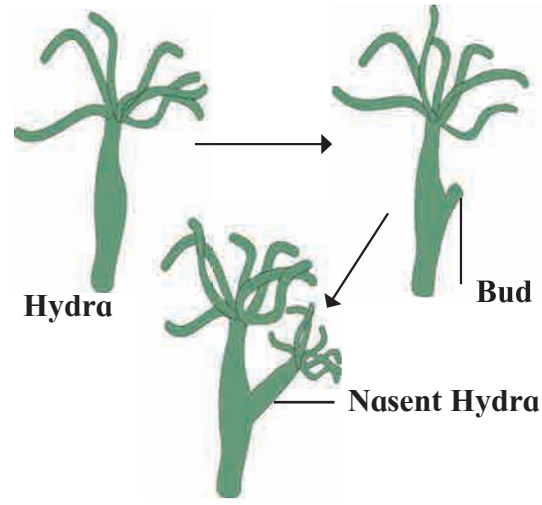
3. Budding

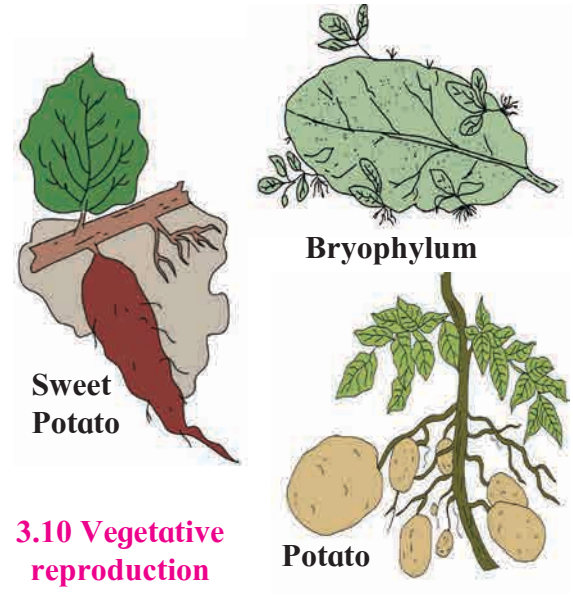
In case of *Hydra*, under favorable conditions, at specific part of its body, an outgrowth is formed by repeated divisions of regenerative cells of body wall. This outgrowth is called as bud. Bud grows up progressively and finally forms a small hydra. Dermal layers and digestive cavity of the budding hydra are in continuity with those of parent hydra. Parent hydra supplies nutrition to the budding hydra. Budding hydra separates from parent hydra and starts to lead an independent life when it grows up and becomes able to lead an independent life.



3.9 Budding

4. Vegetative Propagation

Reproduction in plants with the help of vegetative parts like root, stem, leaf and bud is called as vegetative reproduction. Vegetative propagation in potatoes is preformed with the help of 'eyes' present on tuber whereas in *Bryophyllum* it is performed with the help of buds present on leaf margin. In case of plants like sugarcane & grasses, vegetative propagation occurs with the help of buds present on nodes. Plants like carrot and radish perform vegetative propagation with the help of roots.



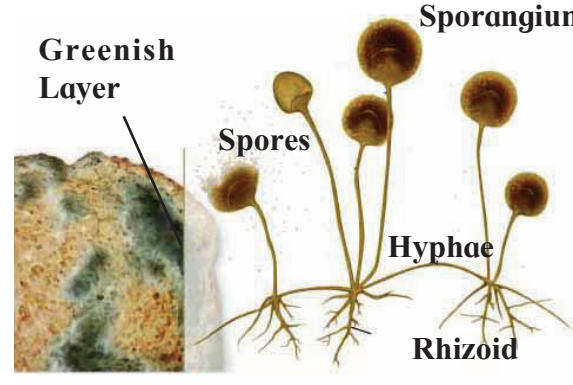
3.10 Vegetative reproduction

5. Spore Formation

Try this

Take a piece of wet bread or 'bhakari' and keep it in humid place. Fungus will grow on it within 2 – 3 days. Observe the fungus under compound microscope and draw its diagram.

Fungi like *Mucor* have filamantous body. They have sporangia. Once the spores are formed, sporangia burst and spores are released. Spores germinate in moist and warm place and new fungal colony is formed.



3.11 Spore formation

Sexual Reproduction

Sexual reproduction always occurs with the help of two germ cells. Female gamete and male gamete are those two germ cells. Two main processes occur in the sexual reproduction.

1. Gamete formation: Gametes are formed by the meiosis. In meiosis, chromosome number is reduced to half; hence haploid gametes are formed.

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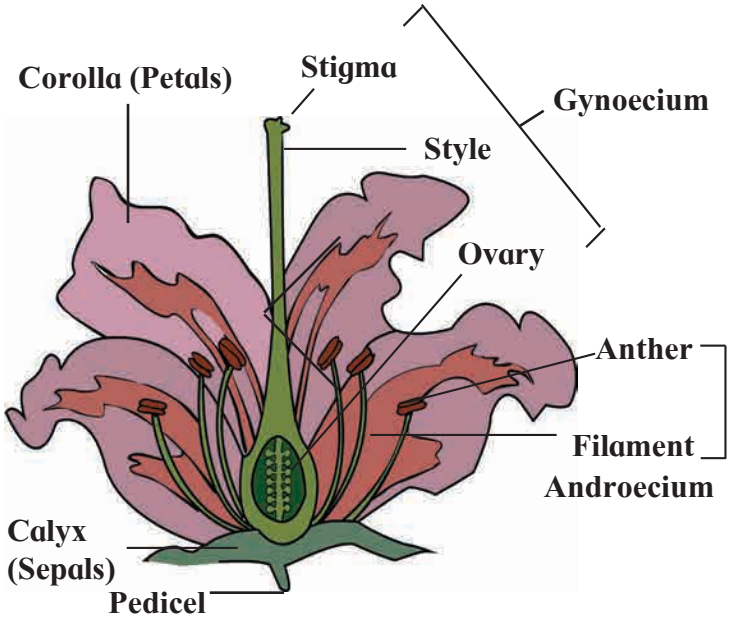
2. **Fertilization:** A diploid zygote is formed in this process by union of haploid male and female gametes. The zygote divides by mitosis and embryo is formed. The embryo develops to form new individual.

Two parents i.e. male parent and female parent are involved in this type of reproduction. Fusion of male gamete of male parent and female gamete of female parent occurs. Due to this, new individual always has the recombined genes of both the parents. Hence, the new individual shows similarities with the parents for some characters and has some characters different than both parents. Diversity in living organisms occurs due to genetic variation. Genetic variation helps the organisms to adjust with the changing environment and thereby to maintain their existence. Due to this, plants and animals can save themselves from being extinct.

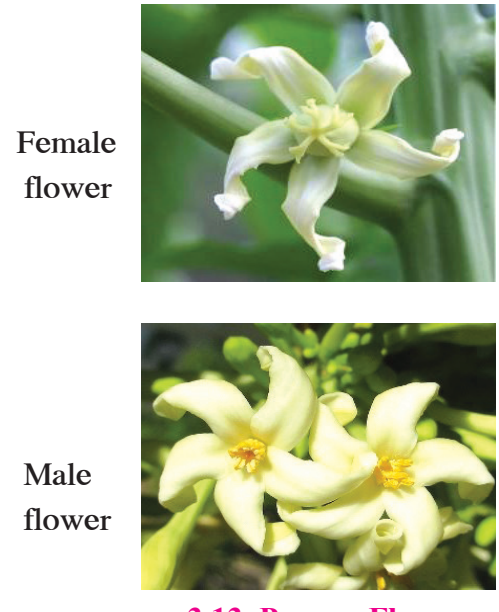
1. What would have been happened if the male and female gametes had been diploid?
2. What would have been happened if any of the cells in nature had not been divided by meiosis?

A. Sexual reproduction in plants

Flower is structural unit of sexual reproduction in plants. It consists of four floral whorls as calyx, corolla, androecium and gynaecium; arranged in sequence from outside to inside. Androecium and gynoecium are called 'essential whorls' because they perform the function of reproduction whereas calyx and corolla are called as 'accessory whorls' because they are responsible for protection of inner whorls. Members of calyx are called as 'sepals' and they are green colored. Members of corolla are called as 'petals' and they are variously colored.



3.12 Parts of flower



3.13 Papaya Flower

A flower is called as 'bisexual' if both whorls i.e. androecium and gynoecium are present in the same flower. Ex. *Hibiscus*. A flower is called as 'unisexual' if any one of the abovementioned two whorls is present in the flower. If only androecium is present, it is 'male flower' and if only gynoecium is present, flower is 'female flower'. Ex. Papaya.

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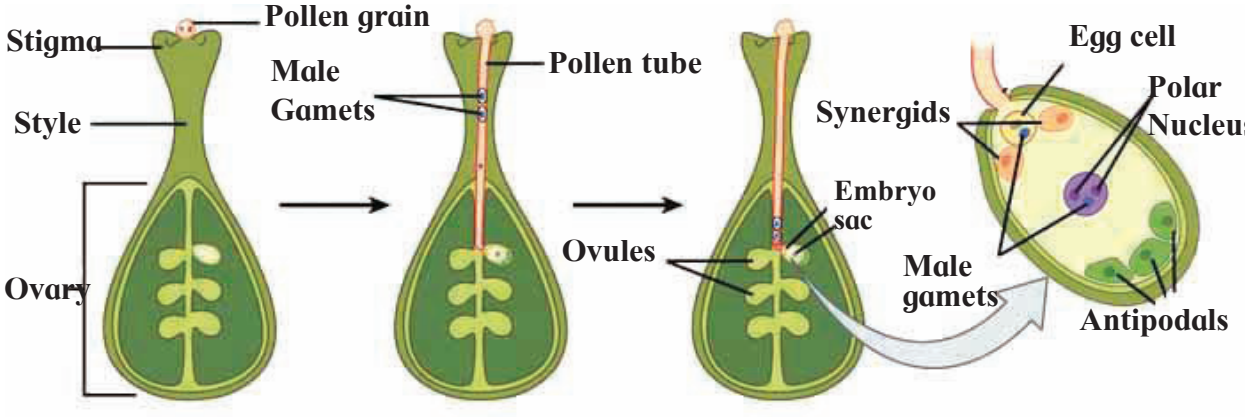
Many flowers have the stalk for support, called as 'pedicel' and such flowers are called as 'pedicellate' whereas flower without stalk is called as 'sessile'.

Androecium is male whorl and its members are called as stamens. Gynaecium is female whorl and its membranes are called as carpels.

Members of gynaecium are called as carpels. These may be separate or united. Ovary is present at the basal end of each carpel. A hollow 'style' comes up from the ovary. Stigma is present at the tip of style. Ovary contains one or many ovules. Embryo sac is formed in each ovule by meiosis. Each embryo sac consists of a haploid egg cell and two haploid polar nuclei.

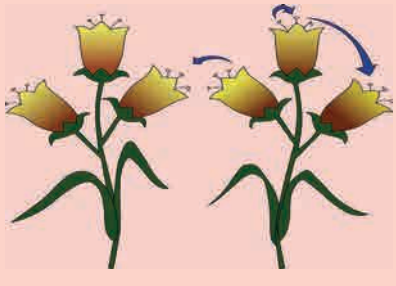
Pollen grains from anther are transferred to the stigma. This is called as pollination.

Pollination occurs with the help of abiotic agents (wind, water) and biotic agents (insects and other animals). Stigma becomes sticky during pollination Pollens germinate when they fall upon such sticky stigma i.e. a long pollen tube and two male gametes are formed. The pollen tube carries male gametes. Pollen tube reaches the embryo sac via style. Tip of the pollen tube bursts and two male gametes are released in embryo sac. One male gamete unites with the egg cell to form zygote. This is fertilization. Second male gamete unites with two polar nuclei and endosperm is formed. As two nuclei participate in this process, it is called as double fertilization.



3.14 Double fertilization in angiosperms

Do you know?



When pollination involves only one flower or two flowers borne on same plant, it is called as self-pollination whereas if it involves two flowers borne on two plants of same species, it is cross-pollination. While discovering the new high yielding and resistant varieties of plants, scientists bring about the pollination with the help of brush.

Use of ICT	Make an video album of pollination and show it in the class.

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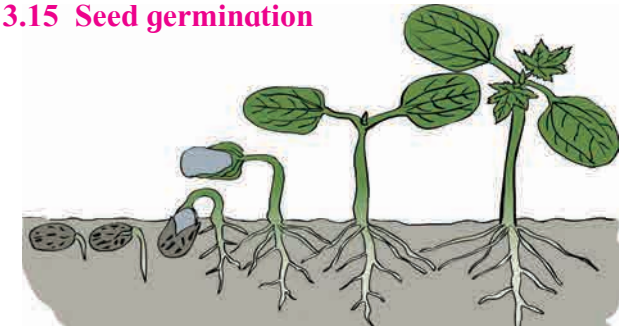
Try this

Take a suitable glass vessel like conical flask or beaker. Add some garden soil in it and sow some pulse grains in it in such a way that you can observe them through glass. Water it every day and record the changes.



3.15 Seed germination

Ovule develops into seed and ovary into fruit after fertilization. Seeds fall upon the ground when fruits break up and they germinate in the soil under favorable conditions. Zygote develops at the cost of food stored in endosperm of seed and thus a new plantlet is formed. This is called as seed germination.

B. Sexual reproduction in human being

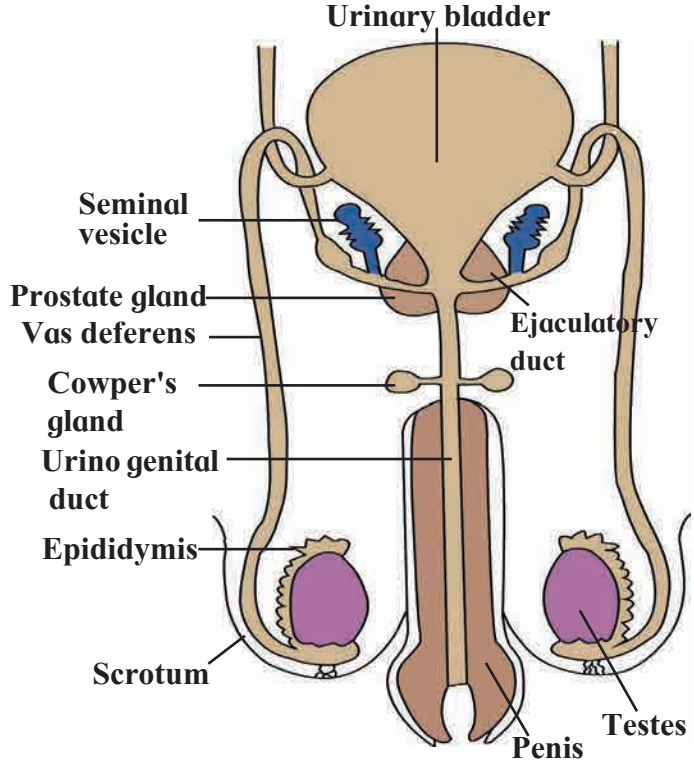
Can you recall?

1. Which different hormones control the functions of human reproductive system through chemical coordination?
2. Which hormones are responsible for changes in human body occurring during on set of sexual maturity?
3. Why has the Government of India enacted the law to fix the minimum age of marriage as 18 in girls and 21 in boys?

We have studied in the chapter of heredity and variation that men have XY sex-chromosomes and women have XX sex-chromosomes. Reproductive system with specific organs develops in the body of men and women due to these sex-chromosomes only. X-chromosome is present in men and women whereas Y-chromosome is present in men only. Now we shall study the structure and functions of human reproductive system.

Human male reproductive system

Male reproductive system of humans consists of testes, various ducts and glands. Testes are present in the scrotum, outside the abdominal cavity. Testes contain numerous seminiferous tubules. Germinal epithelium present in the tubules divide by meiosis to produce sperms. Those sperms are sent forward through various tubules. Sequence of those tubules is as- rete testes, vas eferens, epididymis, vas deferens, ejaculatory duct and urinogenital duct. As the sperms are pushed forwards from one duct to next, they become mature and able to fertilize the ovum.



3.16 Male reproductive system of human

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Seminal vesicles secrete their secretion in ejaculatory ducts whereas prostate glands and Cowper's glands secrete their secretions in urinogenital duct. Semen is formed of sperms and secretions of all these glands. Semen is ejaculated out through penis. All the organs of male reproductive system are paired except urinogenital duct, penis & scrotum.

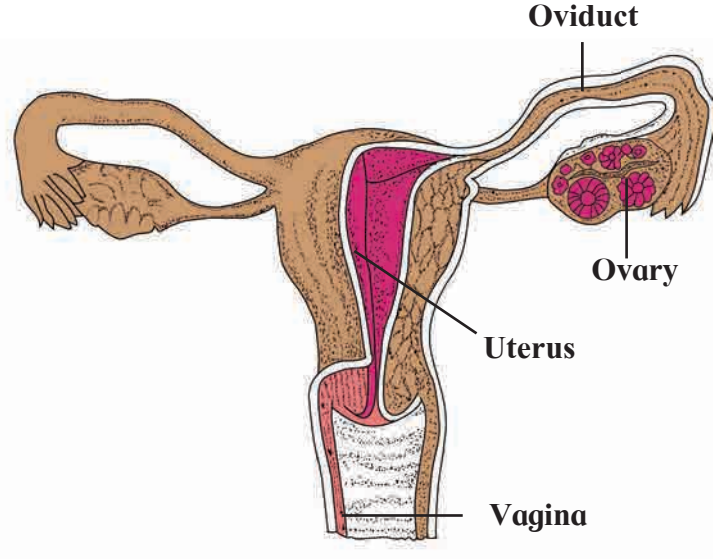
Surprising Facts

1. Length of each epididymis is about 6 meters.
2. Length of a sperm is about 60 micrometers.
3. Such a small sperm has to cross the distance of approximately 6.5 meter while passing out of male reproductive system.
4. Sperm needs large amount of energy. For this purpose, fructose is present in the semen.

Human female reproductive system

All organs of female reproductive system are in abdominal cavity. It includes a pair of ovaries, a pair of oviducts, single uterus and a vagina. Besides, a pair of bulbo-urethral gland is also present.

Generally, every month, an ovum is released in abdominal cavity alternately from each ovary. Free end of oviduct is funnel-like. An opening is present at the center of it. Oocyte enters the oviduct through that opening. Cilia are present on inner surface of oviduct. These cilia push the oocyte towards uterus.



3.17 Human female reproductive system

Gamete Formation

Both gametes i.e. sperm and ovum are formed by meiosis. Sperms are produced in testes of men from beginning of maturation (puberty) till death. However, in case of women, at the time of birth, there are 2 – 4 million immature oocytes in the ovary of female fetus. An oocyte matures and is released from ovary every month from the beginning of maturity up to the age of menopause (approximately 45 years of age). Menopause is the stoppage of functioning of female reproductive system. At the age of about 45 – 50 years, secretion of hormones controlling the functions of female reproductive system either stops of becomes irregular. This causes the menopause.

Fertilization

Formation of zygote by union of sperm and ovum is called as fertilization. Fertilization is internal in humans. Semen is ejaculated in vagina during copulation. Sperms, in the numbers of few millions start their journey by the route of vagina – uterus – oviduct. One of those few million sperms fertilize the only ovum present in the oviduct.

From the age of puberty up the menopause (from 10 – 17 years of age up to 45 – 50 years), an ovum is released every month from the ovary. i.e. out of 2 – 4 million ova, approximately only 400 oocytes are released up to the age of menopause. Remaining oocytes undergo degeneration.

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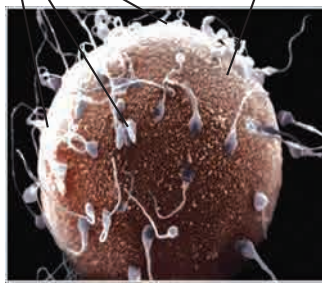
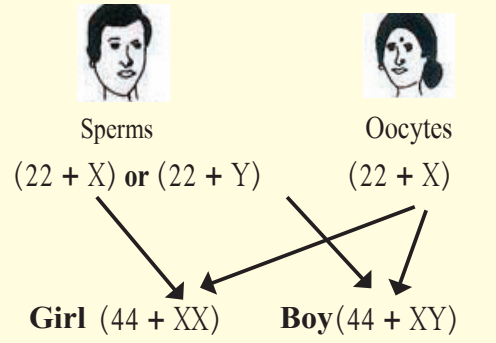


3.18 Fertilization

Oocytes released from ovaries during last few months nearing the age of menopause are 40 – 50 years old. Their ability of division has been diminished till now. Due to this, they cannot complete meiotic division properly. If such oocytes are fertilized, the newborns produced from them may be with some abnormalities like Down's syndrome.

Do you know?

1. The chromosome number in germ cells producing the gametes are diploid i.e. 2n. It includes 22 pairs of autosomes and 1 pair of sex-chromosomes i.e. (44 + XX or 44 + XY). These germ cells divide by meiosis. Due to this, gametes contain only haploid (n) number of chromosomes i.e. (22 + X or 22 + Y). Two types of sperms are produced as (22 + X) or (22 + Y) whereas oocytes are produced of only one type as (22 + X).

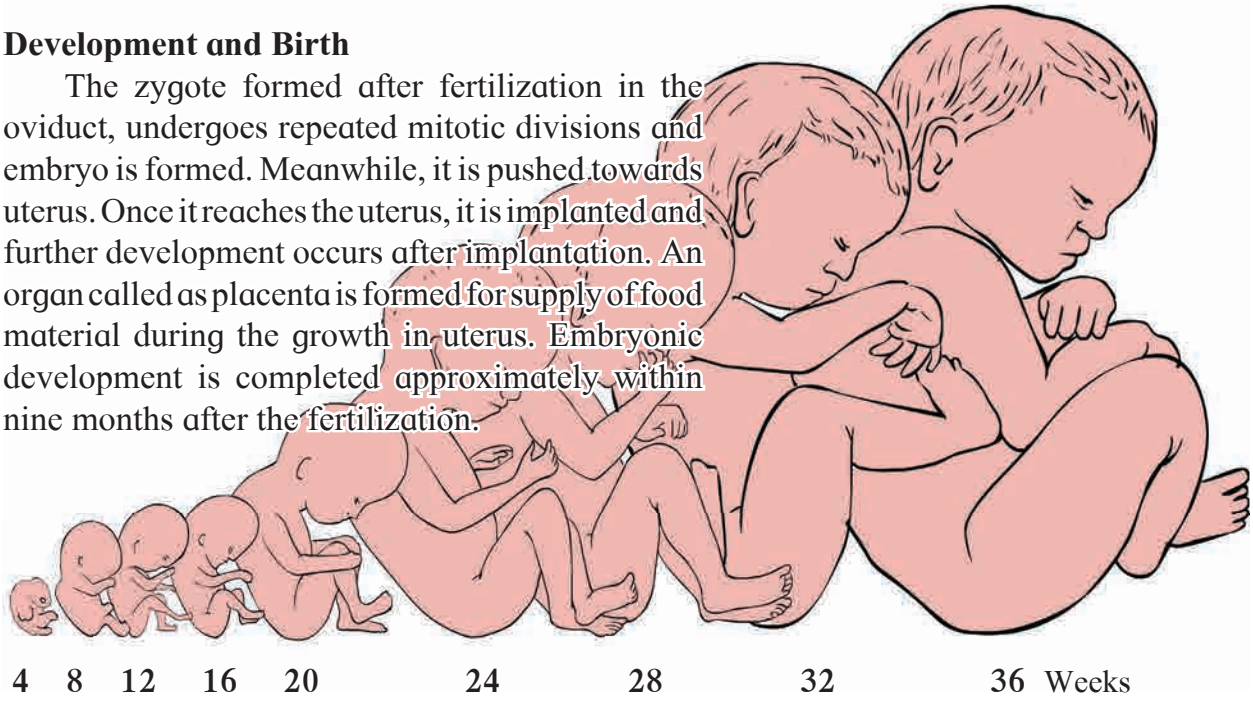


3.19 Sex determination in human being

2. Both, sperms and oocytes are produced by meiosis. In case of sperms, process of meiotic division is completed before the sperms leave male reproductive tract. However, in case of oocytes, process of meiotic division completes after ovulation; during fertilization in oviduct.

Development and Birth

The zygote formed after fertilization in the oviduct, undergoes repeated mitotic divisions and embryo is formed. Meanwhile, it is pushed towards uterus. Once it reaches the uterus, it is implanted and further development occurs after implantation. An organ called as placenta is formed for supply of food material during the growth in uterus. Embryonic development is completed approximately within nine months after the fertilization.



3.20 Growth of an embryo

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Always remember

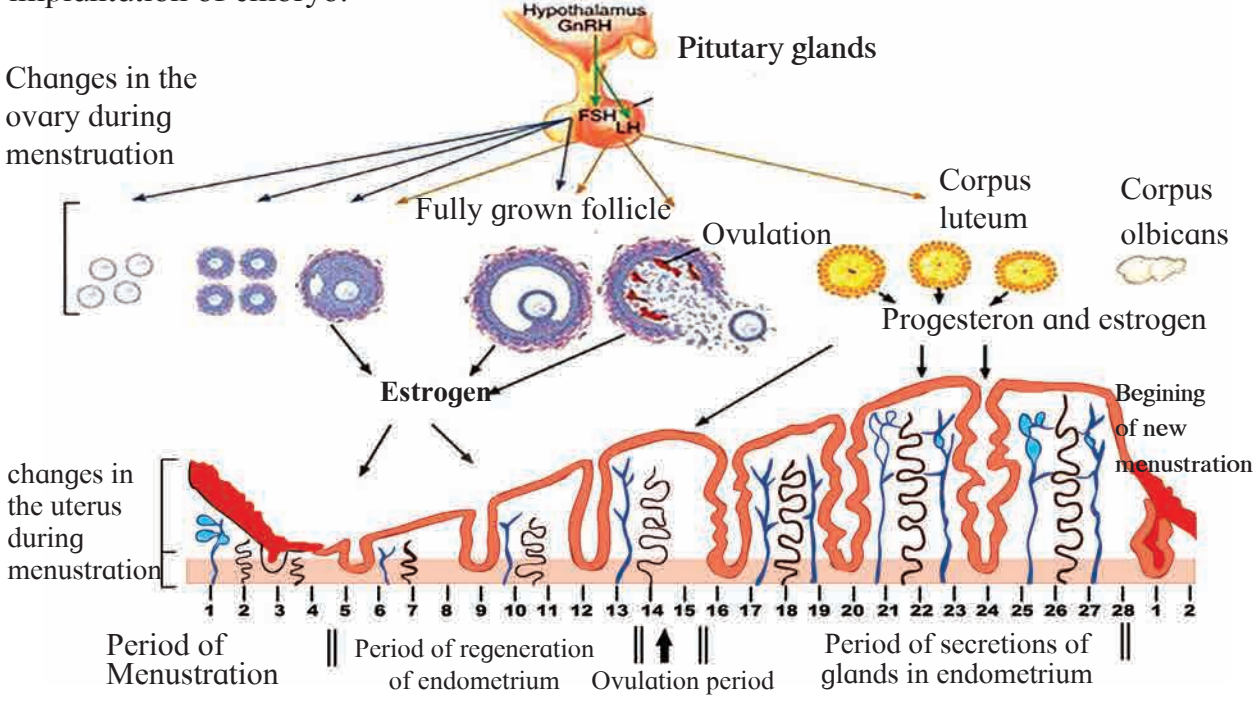
The man is totally responsible, whether the couple will have a boy or a girl child. During zygote formation, man contributes either X or Y chromosome to the next generation But females transfer only X-sex chromosome to the next generation. At the time of fertilization, if X-chromosomes comes from male, the child will be a girl and if Y-chromosomecomes then the child will be a boy. **Thinking of this, is it right to consider the mother responsible for a girl child? We all must take efforts to stop female foeticide.**

Can you tell?

1. Which hormone is released from pituitary of mother once the fetal development is completed?
2. Under the effect of that hormone, which organ of the female reproductive system starts to contract and thereby birth process (Parturition) is facilitated?

Menstrual Cycle:

Female reproductive system undergoes some changes at puberty and those changes repeat at the interval of every 28 – 30 days. These repetitive changes are called as menstrual cycle. Menstrual cycle is a natural process, controlled by four hormones. Those four hormones are follicle stimulating hormone (FSH), luteinizing hormone (LH), estrogen and progesterone. One of the several follicles in the ovary starts to develop along with the oocyte present in it, under the effect of follicle stimulating hormone. This developing follicle secretes estrogen. Endometrium of the uterus starts to develop (during first cycle) or regenerate (during subsequent cycles) under the effect of estrogen. Meanwhile, developing follicle completes its development. It bursts under the effect of luteinizing hormone and oocyte is released. This is called as ovulation. Remaining tissue of the burst follicle forms the corpus luteum. Corpus luteum starts to secrete progesterone. Endometrial glands secrete their secretion under the effect of progesterone. Such endometrium is ready for implantation of embryo.



3.21 Menustral cycle

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If oocyte is not fertilized within 24 hours, corpus luteum becomes inactive and transforms into corpus albicans. Due to this, secretion of estrogen and progesterone stops completely. Endometrium starts to degenerate in absence of these two hormones. Tissues of degenerating endometrium and unfertilized ovum are discarded out through vagina. This is accompanied with continuous bleeding. Bleeding continues approximately for five days. This is called as menstruation.

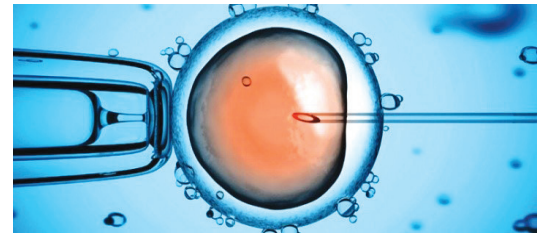
Unless the oocyte is fertilized and embryo is implanted, this process is repeated every month. If the embryo is implanted, repetition of this cycle is temporarily stopped till the parturition and thereafter period of breast feeding. Menstrual cycle is a natural process and the women experience severe pains during this period. Severe weakness is felt due to heavy bleeding. There is higher possibility of infections too during this overall period. Due to all such reasons, there is need of rest along with special personal hygiene.

Reproduction and Modern Technology

Many couples cannot have children due to various reasons. In case of women, irregularity in menstrual cycle, difficulties in oocyte production, obstacles in the oviduct, difficulties in implantation in uterus and many other reasons are responsible for this. Absence of sperms in the semen, slow movement of sperms, anomalies in the sperms are the reasons in case of males. But now with the help of advanced medical techniques like IVF, Surrogacy, Sperm bank the childless couples can have a child.

In Vitro Fertilization (IVF)

In this technique, fertilization is brought about in the test-tube and the embryo formed is implanted in uterus of woman at appropriate time. IVF technique is used for having the child in case of those childless couples who have problems like less sperm count, obstacles in oviduct, etc.



3.22 Fertilization in a test tube

Surrogacy

Some women have problems in implantation of embryo in uterus. Such women can take the help of the modern remedial technique called as surrogacy. In this technique, oocyte is collected from the ovary of the woman having problem in implantation in uterus. That oocyte is fertilized in test-tube with the help of sperms collected from her husband. The embryo formed from such fertilization is implanted in the uterus of some other woman having normal uterus. Such a woman, in whose uterus the embryo is implanted, is called as surrogate mother.

3.23 Surrogacy

Sperm Bank/ Semen Bank

There are various problems in sperm production as mentioned above, in case of many men. So as to have the children in case of such couples, new concept of sperm bank has been introduced. This concept is similar to blood bank. Semen ejaculated by the desired men is collected after their thorough physical and medical check-up and stored in the sperm bank.

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As per the wish of needful couple, oocyte of woman of the concerned couple is fertilized by IVF technique using the semen from sperm bank. Resultant embryo is implanted in the uterus of same woman. Name of the semen donor is strictly kept secret as per the law.

Twins

Two embryos develop simultaneously in the same uterus and thus two offsprings are delivered simultaneously. Such offsprings are called as twins. Many couples have twins. There are two main types of twins as- monozygotic twins and dizygotic twins.

Monozygotic twins are formed from single embryo. During early period of embryonic development (within 8 days of zygote formation), cells of that embryo divide into two groups.

3.24 Twin girls: age 18 months

Those two groups develop as two separate embryos and thus monozygotic twins are formed. Such twins are genetically exactly similar to each other. Due to this, such twins are exactly similar in their appearance and their gender is also same i.e. both will be either boys or girls.

In case of monozygotic twins, if the embryonic cells are divided into two groups 8 days after the zygote formation; there is high possibility of formation of conjoined twins (Siamese twins). Such twins are born with some parts of body joined to each other. Some organs are common in such twins.

Occasionally, two oocytes are released from the ovary of woman and both oocytes are fertilized by two separate sperms and thus two zygotes are formed. Two embryos are formed from those two zygotes and both of those embryos are separately implanted in the uterus and thus dizygotic twins are delivered after complete development. Such twins are genetically different and may be same of different by gender.

Internet is my friend

You may have read that sometimes a woman may deliver more than two offsprings at a time. Collect more information from internet about reasons for such incidences.

Reproductive health

A person's state of being physical, mental and social strongness is called as health. In our country, there seems to be lack of awareness regarding reproductive health due to various reasons like social customs, traditions, illiteracy, shyness, etc. Especially, there seems to be indifference towards the reproductive health of women.

Occurrence of menstrual cycle is related with reproductive and overall health of women. Now a day, women are working at par with men. Due to this, they have to stay outdoors for whole day. Bleeding occurs during menstrual cycle. Due to this, private organs (genitals) need to be maintained clean time to time, otherwise, problems regarding reproductive health may arise. Some problems regarding reproductive health may arise in men too. It is essential to maintain the cleanliness of their genitals.

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Among the various sexual diseases, syphilis and gonorrhea occur on large scale. Both of these diseases are caused by bacteria. Occurrence of chancre (patches) on various parts of body including genitals, rash, fever, inflammation of joints, alopecia, etc. are the symptoms of syphilis. Painful and burning sensation during urination, oozing of pus through penis and vagina, inflammation of urinary tract, anus, throat, eyes, etc. are symptoms of gonorrhea.

Do you know?

Population Explosion

Excessive growth of population within short duration is called as population explosion. You may have realized from the table given besides about fast population growth of India. We have to face various problems like unemployment, decreasing per capita income and increasing loan, stress on natural resources, etc. There is only one solution for all such problems and it is population control. Family planning is essential for this.

Year	Population
1901	238396327
1911	252093390
1921	251321213
1931	278977238
1941	318660580
1951	358142161
1961	439234771
1971	548159652
1981	683329097
1991	846421039
2001	1028610328
2011	1210854977

Get information

Visit a public health center nearby your place and collect the information through an interview of health officer about meaning and various methods of family planning.

Exercise

1. Complete the following chart.

Asexual reproduction	Sexual reproduction
1. Reproduction that occurs with the help of somatic cells is called as asexual reproduction.	1. ....
2	2. Male and female parent are necessary for sexual reproduction.
3. This reproduction occurs with the help of mitosis only.	3. ....
4.	4. New individual formed by this method is genetically different from parents.
5. Asexual reproduction occurs in different individuals by various methods like binary fission, multiple fission, budding, fragmentation, regeneration, vegetative propagation, spore production, etc.	5. ....

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2. Fill in the blanks.

a. In humans, sperm production occurs in the organ ----------.

b. In humans, ------ chromosome is responsible for maleness.

c. In male and female reproductive system of human, ---------- gland is same.

d. Implantation of embryo occurs in ------

e. ---------- type of reproduction occurs without fusion of gametes.

f. Body breaks up into several fragments and each fragment starts to live as a new individual. This is -- -- -- -- -- -- -- type of reproduction.

g. Pollen grains are formed by -- ----- -- -- -- division in locules of anthers.

3. Complete the paragraph with the help of words given in the bracket.

(Luteinizing hormone, endometrium of uterus, follicle stimulating hormone, estrogen, progesterone, corpus luteum)

Growth of follicles present in the ovary occurs under the effect of ----- This follicle secretes estrogen. -- --- - -- -- -- grows / regenerates under the effect of estrogen. Under the effect of --- ---, fully grown up follicle bursts, ovulation occurs and -- --- -- -- is formed from remaining part of follicle. It secrets --- --- -- -- and --- --- -- -- --. Under the effect of these hormones, glands of -- -- -- -- are activated and it becomes ready for implantation.

4. Answer the following questions in short.

a. Explain with examples types of asexal reproduction in unicellular organism.

b. Explain the concept of IVF.

c. Which precautions will you follow to maintain the reproductive health?

d. What is menstrual cycle? Describe it in brief.

5. In case of sexual reproduction, newborn show similarities about characters. Explain this statement with suitable examples.

6. Sketch the labeled diagrams.

a. Human male reproductive system.

b. Human female reproductive system.

c. Flower with its sexual reproductive organs.

d. Menstrual cycle.

7. Give the names.

a. Hormones related with male reproductive system.

b. Hormones secreted by ovary of female reproductive system.

c. Types of twins.

d. Any two sexual diseases.

e. Methods of family planning.

8. Gender of child is determined by the male partner of couple. Explain with reasons whether this statement is true or false.

9. Explain asexual reproduction in plants.

10. Modern techniques like surrogate mother, sperm bank and IVF technique will help the human beings. Justify this statement.

11. Explain sexual reproduction in plants.

Activity :

1. Collect the official data about present and a decade old population of various Asian countries and plot a graph of that data. With the help of it, draw your conclusions about demographic changes.

2. With the help of your teacher, compose and present a road show to increase the awareness about prenatal gender detection and gender bias.

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4. Environmental management

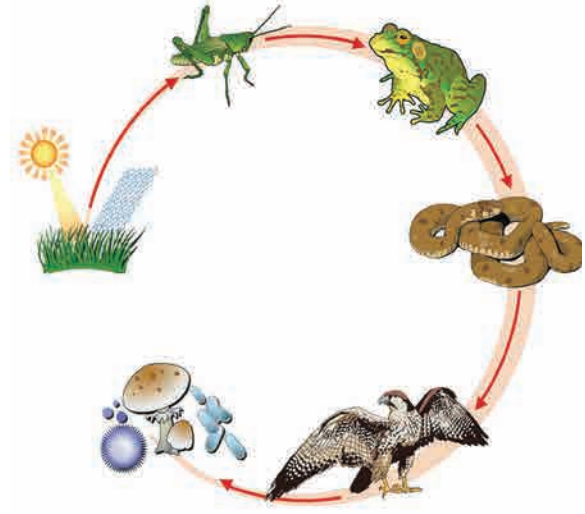
- Ecosystem – A review
- Environment Conservation
- Biodiversity hotspots
- Environment and Eco-system
- Environment management

Can you recall?

1. What is ecosystem? Which are its different components?
2. Which are the types of consumers? What are the criteria for their classification?
3. What may be the relationship between lake and birds on tree?
4. What is difference between food chain and food web?

Think and Answer

1. Write the name and category of each of the component shown in picture.
2. What is necessary to convert this picture into food web? Why?



4.1 Foodchain

Ecosystem A review

Ecosystem is formed by biotic and abiotic factors and their interactions with each other. Each factor plays very important role in the ecosystem. Producers like plants are important. Herbivores like deer, goats, sheep, cattle, horses, camels, etc. feeding upon producers are also important. Predators like lion and tiger which prevent the overpopulation of herbivores are also equally important. A question may arise in our mind that whether the caterpillars found in nature, organisms present in filthy places, termites, insects present in dung, are really useful? However, those organisms are also important though they are dirty. They are responsible for cleaning the environment.

It means that our existence is due to these factors present around us. Hence, we should care for these factors.

Think:

If fallen foliage in forest, dead trees, and carcasses in and around villages had not been decomposed for years……

Discuss

'Jivo Jivasya Jivanam'

Can you recall?

1. Which are different trophic levels in food chain?
2. What is energy pyramid?

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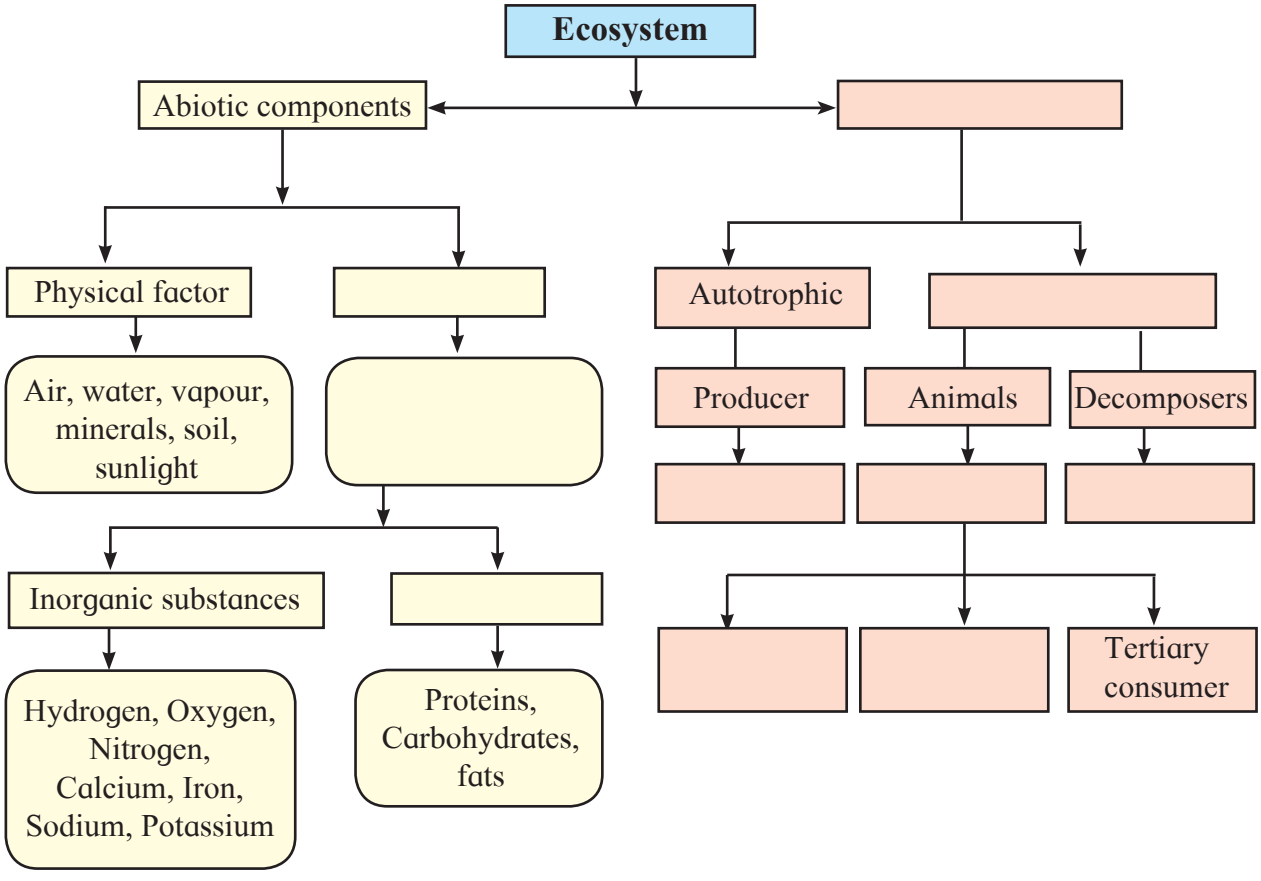
Lets Think

A bird building nest on a tree feed upon the fishes in nearby pond. Whether this bird is part of both i.e. tree as well as pond ecosystem?

Complete the chart

Fill up the blank boxes and display the completed chart in classroom.



Paddy is cultivated on large scale in various states of South India. Paddy fields are frequently attacked by grasshoppers. Similarly, frogs are also present in large number in the mud of paddy fields, to feed upon grasshoppers and snakes are also present therein to feed upon their favourite food- frogs.

However, if frog population declines all of a sudden,

Lets Think

1. What will be the effect on paddy crop?
2. Number of which consumers will decline and which will increase?
3. What will be overall effect on that ecosystem?

Can you tell?

1. What is environment?
2. What is included in environment?

Relationship between Environment and Ecosystem

Environment is a broad concept. Physical, chemical and biological factors affecting the living organisms in any possible way is collectively called as environment. In short, environment is the condition in surrounding. It includes many biotic, abiotic, natural and artificial factors. There are two main types of environment. One is natural environment and other is artificial environment.

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Natural environment consists of air, atmosphere, water, land, living organisms, etc. Continuous interactions occur between biotic and abiotic factors. Their interactions are very important. Artificial environment is also affecting the natural environment directly or indirectly. Basically, environment consists of two basic factors- 1. Biotic factors, 2. Abiotic factors. The science that deals with the study of interactions between biotic and abiotic factors of the environment is called as ecology. Basic functional unit used to study the ecology is called as ecosystem.

Environment consists of many ecosystems. We have studied some ecosystems in earlier classes. A small pond is an ecosystem whereas the Earth is largest ecosystem. In brief, biotic and abiotic factors occupying a definite geographical area and their interactions collectively constitute the ecosystem.

Can you recall?

Which cycles are operated in environment? What is their importance?

Environmental balance is maintained through continuous operation of various natural cycles like water cycle, carbon cycle, gaseous cycles like nitrogen cycle, oxygen cycle, etc. Environmental balance is also maintained due to various food chains of ecosystem.

Human existence is totally impossible without the existence of nature. Hence, it is basic responsibility of human being to preserve the nature without disturbing its balance. It is said that we have got this Earth planet on lease from our future generations and not as an ancestral property from our ancestors. Hence we should not forget to conserve it for ourselves and for future generations.

Environmental Conservation

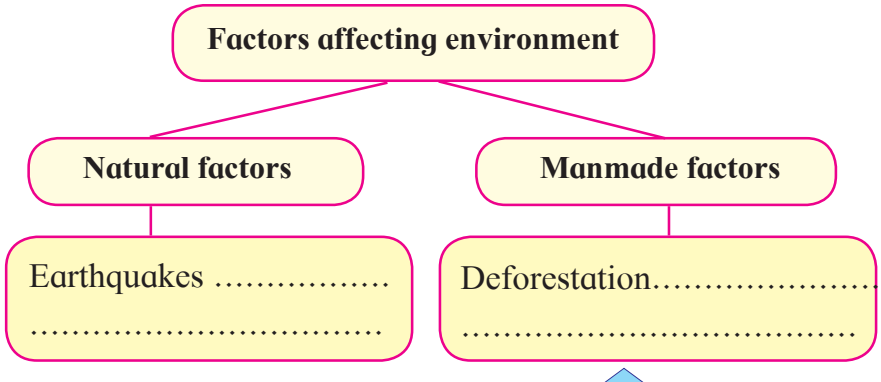
Can you tell?

1. Which factors affect the environment? How?
2. What will happen if number of consumers in environment goes on increasing gradually?
3. What will be the effect of industry established on river bank on the river ecosystem?

When some natural factors of environment and some artificial polluted factors harm the environment, it creates imbalance between various factors of the environment and ultimately affects the existence of biotic factors.

Observe and fill the information

Observe the environment around you. Complete the following flow chart.



"The Earth is sufficient to satisfy everyone's need but not the greed."
- Mahatma Gandhi

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At present, many environmental problems have been arisen due to effect of various natural and artificial factors on the Earth. Environmental pollution is one of those main factors. Generally, contamination of any material is its pollution. Unnecessary and unacceptable change in the surrounding environment due to natural events or human activities is called as environmental pollution. i.e. Direct or indirect changes in physical, chemical and biological properties of air, water and soil which will be harmful to human and other living beings is environmental pollution. Various reasons like population explosion, fast industrialization, and indiscriminate use of natural resources, deforestation, and unplanned urbanization are responsible for environmental pollution.

Can you recall?

1. Which are the types of pollution?
2. What do we mean by natural and artificial pollution?

4.2 Fog and pollution in city- A problem

Pollution is a broad concept. Various types of pollutions like that of air, water, sound, soil, thermal, light, pollution occur around us. Ultimate adverse effect of all these is on existence of all the living organisms and out of this, environmental conservation has become the need of hour.

We have studied the air pollution, water pollution and soil pollution in detail in earlier classes. Based on that, complete the following chart.

Complete the Chart

	Air pollution	Water pollution	Soil pollution
Compo-nents	**Gases :** CO_2, CO, Hydro-carbons, Sulfur, NOx, hydrogen sulphides, etc. **Solid** : dust, ash, carbon, lead, asbestos, etc.		
Source		Industrial wastes, Domestic waste, sewage, Chemicals discharged from Industries, pesticides used in agriculture.	
Effect			Soil erosion, retarded growth of plants/ crops, Nutritional deficiency etc.
Control Measure			

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Do you know?

Radioactive pollution: Radioactive pollution can occur due to two reasons as natural and artificial. UV and IR radiations are natural radiations whereas X-rays and radiations from atomic energy plants are artificial radiations. Chernobyl, Windscale, and Three Miles Island mishaps are the major mishaps of the world till present. Thousands of people have been affected for long term due to these accidents. Some of the effects of radiations are as follows-

1. Cancerous ulceration occurs due to higher radiations of X-rays.
2. Tissues in the body are destroyed.
3. Genetic changes occur.
4. Vision is adversely affected.

Use your brain power

Why is it said that pollution control is important?

Need of environmental conservation

General public is not aware about the rules of environment conservation. There should be large scale participation of the people in environment conservation. It will be possible to answer the environmental problems only if environmental protection-conservation becomes an effective public movement. For this purpose, values like positive attitude and affection towards environment, knowledge about it, etc. should be inculcated among the children since their childhood. This will help to make the future generations more aware about environmental conservation and protection. So as to achieve this, it is necessary to increase the awareness through education.

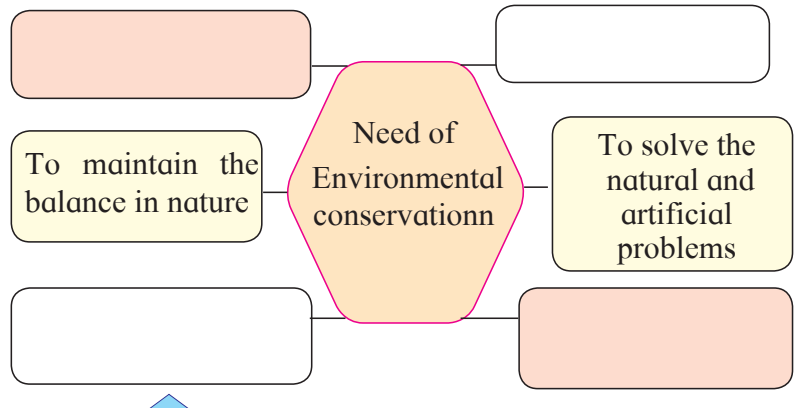
Today, all the developed, developing and underdeveloped countries have accepted the responsibility of environmental protection. Their efforts are in that direction. They have defined the future plans about environmental protection and have constituted the necessary laws.

A peek into the history

In 1972, United Nations Environment Program (UNEP) has been established in a conference arranged on human and environment in which environmental problems were discussed. Afterwards, in India, a separate environmental department had been established after through discussion on environmental problems. Ministry of environment and forests is involved in planning, inducting and increasing awareness about environment and forest through various programs since 1985.

Complete the Chart

Now a day, we are observing the environmental degradation everywhere. Complete the flow chart given besides with the help of environment.



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Environmental Conservation. Our social respocibility

Since existence of human, there is interrelationship between human and environment. Human stepped on the Earth long after formation of Earth. On the Earth, human being proved its superiority as compared to other animals with the help of characters like intelligence, memory, imaginary ability, etc. Human established domination over the nature. Human utilized all the natural resources as much as possible. In an attempt to live a satisfactory life, human kept on snatching form the nature as much as possible and this lead to increase in problems. From this entire scenario, we can understand that human has crucial role in maintaining the environmental balance. If human has disturbed the environmental balance, then human itself only can conserve and improve the quality of nature. Many times, general public is unknown that its activities are harmful to environment and thereby unknowingly many activities happen.

Search How do butterflies contribute to environmental balance?

Do You Know?

Laws enacted about environmental conservation:

Forest Conservation Act, 1980.

The land reserved for forest conservation has been prohibited to use for any other purpose by this law. Ex. Permission of central government is compulsory for mining activities. Any person who disobeys this law is entitled to imprisonment for 15 days.

Environmental Conservation Act, 1986.

Purpose of this act is to control the pollution and punish the persons or institutes harming the environment. Any person or factory is prohibited by this act from releasing the pollutants in atmosphere beyond a permissible limit. The person breaching this rule is entitled for either five year imprisonment or fine up to Rs. 1 lakh. National Green Tribunal has been established in 2010 for effective implementation of environment related laws.

Let's Discuss

Collect the information about Chipko Movement and discuss between two groups of your class about its importance in present situation.

Internet is my friend

1. Sound Pollution (Control & Prevention) Rule, 2000.
2. Biomedical Waste (Management & Handling) Rule, 1998.
3. E-waste (Management & Handling) Rule, 2011.

Always remember

As per wildlife protection Act 1972

As per clause 49 A, trading of rare animals has been completely banned.

As per clause 49 B, use of articles prepared from skin or organs of wild animals has been banned.

As per clause 49 C, disclosure of the stock of artifacts made form rare wild animals is compulsory.

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The big story of a small man

Jadav Molai Payeng is a highly capable person born in a nomadic tribe of Assam. Born in 1963, he is working as a forest worker since the age of 16 years. Once, large number of snakes died in the flood of Brahmaputra River flowing by the village. As a preventive measure, Molai planted 20 bamboo plantlets. In 1979, the local Social Forestry Department began a social aforestation project on 200 hectares of land. 'Molai' was one of the few forest workers who were looking after that project. Molai continued to plant the trees even after completion of the project. As a result of his continuous work of planting and caring for the trees, the barren area witnessed the forest cover over the 1360 acres.

Today, this jungle in Kokilamukh of Jorhat district of Assam is the result of the hard work for 30 years. He has been awarded with the prestigious 'Padmashree' award by government of India for this unparallel work. Now, it is well known as 'Molai Jungle'. Many people come together to destroy the forest, **but a single person, if determined, can establish a new forest!**

Environmental Conservation and Biodiversity

Most harmful effect of the environmental pollution occurs on the living organisms. Have you seen some examples of this in your area? Our living world had been richly diverse. It consisted of varieties of plants and animals. However, we are not able to see some specific animals about which we had listened from our earlier generations. Who is responsible for this?

Biodiversity is the richness of living organisms in nature due to presence of varieties of organisms, ecosystems and genetic variations within a species. Biodiversity occurs at three different levels.

Genetic Diversity

Occurrence of diversity among the organisms of same species is genetic diversity. Ex. Each human being is different from other. Possibility of wiping out the species arises if there is decrease in the diversity within the species whose members involve in sexual reproduction.

Species Diversity

Innumerable species of organisms occur in the nature. This is called as species diversity. Species diversity includes various types of plants, animals and microbes.

Ecosystem Diversity

Many ecosystems are present in each region. Ecosystem is formed through the interaction between plants, animals, their habitat and changes in the environment. Each ecosystem has its own characteristic animals, plants, microbes and abiotic factors. Ecosystems are also of two types are natural and artificial.

There should be positive attitude of human being towards the environment for welfare of entire living world. For this purpose, following roles are important. You can be a conservator, organizer, guide, plant-friend, etc. Describe about the role you wish to perform and your plans for that role.

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4.3 Sacred grove

Sacred Groves

The forest conserved in the name of god and considered to be sacred is called as sacred grove. These are in fact 'sanctuaries' conserved by the society and not by the government forest department. As it has been conserved in the name of god, it has special protection. These clusters of thick forests are present not only in Western Ghats of India but in the entire country.

More than 13000 sacred groves have been reported in India. Where are such sacred groves in Maharashtra? Make a list and visit with your teachers.

Enlist and discuss

Some symbols are given below. Find the meaning of those symbols in relation to environment conservation. Make a list of other such symbols.

Stick here a symbol known to you.

How can biodiversity be conserved?

1. Protecting the rare species of organisms.
2. Establishing national parks and sanctuaries.
3. Declaring some regions as 'bioreserves'.
4. Projects for conservation of special species.
5. Conserving all plants and animals.
6. Observing the rules.
7. Maintaining record of traditional knowledge.

Till now, we have studied the rules and regulations about environmental conservation and protection, in this lesson. Many people in the society are voluntarily coming together to perform this noble work. Many institutes at state, national and international level are involved in this work.

Voluntary Organizations

1. Bombay Natural History Society, Mumbai.
2. CPR environment group, New Chennai.
3. Gandhi Peace Foundation, Environment Cell, Delhi.
4. Chipko Centre, Tehri Garhwal.
5. Centre for Environment Education, Ahmadabad.
6. Kerala Science Literature Council, Trivandrum.
7. Indian Agro Industries Foundation, Pune.
8. Vikram Sarabhai Community Science Centre, Ahmadabad.

International Environment Organizations

1. International Union for Conservation of Nature (IUCN), Gland VD, Switzerland.
2. Intergovernmental Panel on Climate Change (IPCC), Geneva.
3. United Nations Environment Program, Geneva.
4. World Wildlife Fund, New York.
5. Bird Life International, Cambridge.
6. Green Climate Fund, Songdo, S. Korea

Green Peace is world's largest organization engaged in environmental activities. More thant 25 lakh people from 26 different countries are members of this organization. Collect more information about the work of above mentioned organizations.

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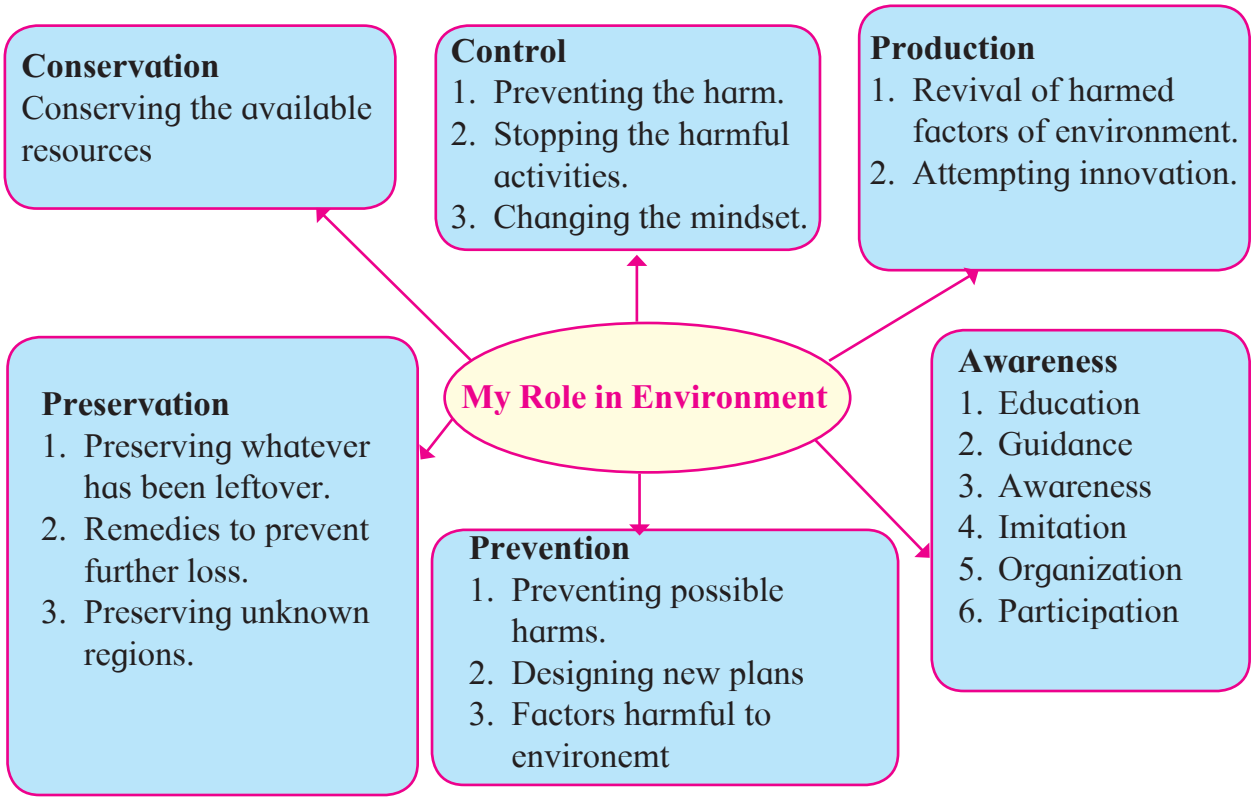
Think and Answer

Attempts at various levels are performed for conserving environment. Role of the person is defined as per these levels. Some roles are given below. Which role would you like to per form? Why ?



Hotspots of Biodiversity

34 highly sensitive biodiversity spots are reported all over the world. Such areas had once occupied 15.7% area of the Earth. At present, 86% of the sensitive areas are already destroyed. Presently, only 2.3% area of the Earth has been left over with sensitive spots. It includes 1,50,000 plant species which are 50% of the world count.

As far as India is considered, out of 135 species of animals, 85 species are found in the jungles of eastern region. About 1,500 endemic plant species are found in western ghat. Out of the total plant species in the entire world, 50,000 are endemic. Collect more information about locations of these hotspots present in the world.

Three Endangered Heritage Places of the Country

The Western Ghat spread over the states of Gujarat, Maharashtra, Goa, Tamilnadu and Kerala has been endangered due to mining industry and search for natural gas. Habitats of Asiatic lion and wild bison of this region have been under threat.

Manas sanctuary of the Assam is under threat due to dams and indiscriminate use of water. Tiger and rhino of that region are under threat.

Sunderban sanctuary of West Bengal is reserved for tigers. However, the tiger population and overall local environment is seriously challenged by dams, deforestation, excessive fishing, trenches dug for same, etc.

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Recall a little

Collect the names of extinct birds and animals of India and tell those names to others.

Classification of Threatened Species

1. Endangered Species

Either number of these organisms is declined or their habitat is shrunk to such an extent that they can be extinct in near future if conservative measures are not implemented. Exampl, Lion tailed monkey, lesser florican.

2. Rare Species

Number of these organisms is considerably declined. Organisms of these species being endemic may become extinct very fast. Example, Red panda, Musk deer.

3. Vulnerable Species

Number of these organisms is extremely less and continues to decline. Continuous decline in their number is worrisome reason. Example, Tiger, Lion.

4. Indeterminate Species

These organisms appear to be endangered but due to their some behavioural habits (like shyness) there is no definite and substantial information. Example, Giant squirrel (Shekhru).

4.4 Lion-tailed Monkey

4.5 Red Panda

Specialty of the Day

22nd May: World Biodiversity Day

Survey the plants and animals in your area. Maintain a record about their characteristics.

Do you know?

International Union for Conservation of Nature (IUCN) prepares the 'Red List' that contains the names of endangered species from different countries. Pink pages of this book contain the names of endangered species while green pages contain the names of previously endangered but presently safe species.

Always remember

Always Remember

Let us remember…. Let us behave accordingly……

1. Destroying a plant is to destroy everything.
2. Practice afforestation to conserve environment.
3. Forest is Wealth.
4. Environmental protection is value education.
5. Provident use of paper is prevention of deforestation.
6. To practice the environmental protection is to development of human society.
7. Pure air, pure water is key to healthy life.

Think

World Wildlife Fund (WWF) published a survey in 2008. According to it, about 30% of animal species have become extinct over the period of 35 years (1975 – 2005). What will happen in future if this continues as it is?

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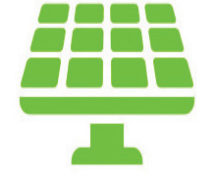
Exercise

1. **Reorganize the following food chain. Describe the ecosystem to which it belongs.** Grasshopper – Snake – Paddy field – Eagle – Frog.
2. **Explain the statement-'we have got this Earth planet on lease from our future generations and not as an ancestral property from our ancestors.'**
3. **Write short notes.**
   a. Environmental Conservation.
   b. Chipko Movement of Bishnoi.
   c. Biodiversity.
   d. Sacred Groves.
   e. Disaster and its management.
4. **How will you justify that overcoming the pollution is a powerful way of environmental management?**
5. **Which projects will you run in relation to environmental conservation? How?**
6. **Answer the following.**
   a. Write the factors affecting environment.
   b. Why does the human beings have important place in environment?
   c. Write the types and examples of biodiversity.
   d. How the biodiversity can be conserved?
   e. What do we learn from the story of Jadav Molai Peyang?
   f. Write the names of biodiversity hot spots.
   f. Which are the reasons for endangering the many species of plants and animals? How can we save those?
7. **What are the meanings of following symbols? Write your role accordingly?**





Project:

Make a presentation on pollution of Ganga and Yamuna Rivers and effects of air pollution on Tajmahal.

KYD6YE

-: A Pledge for Life :-

I am aware that the diversity on the Earth is for the existence of me, my family and the entire mankind. I am aware about the responsibility of conserving and protecting the rich diversity. I am aware about the fast declining number of wildlife, plants and animals. I am accepting the responsibility of judicious use of natural resources and management of biodiversity.

I pledge for adopting the following principles for happy and satisfactory life of all organisms on the Earth.

I will always try for conservation and sustainable management of natural resources.
I will make the change that I am expecting.
I will be committed for safety of entire life on the Earth.
I will educate the people about benefits of conservation and co-existance.

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5. Towards Green Energy

- **Use of various energy sources**
- **Generation of electrical energy**
- **Process of generation of electricity and environment**

Can you recall?

1. What is Energy?
2. What are different types of Energy?
3. What are different forms of Energy?

Let's Discuss

Make a list of the work that we do in our day to day life using energy. Which forms of energy do we use to do this work? Discuss with your friends.

Energy and use of energy

In modern civilization, energy has become a primary need along with food, cloth and shelter. We need energy in different forms for diverse types of works. The energy that we need may be in the form of mechanical energy, chemical energy,sound energy, light energy or heat energy. How do we get these different forms of energy?

Make a table Make a table based on forms of energy and corresponding devices.

We know that energy can be converted from one form to another. Different sources of energy are used to the different forms of energy necessory for us. In previous standards we have learnt about energy, sources of energy and various concepts related to them. Here we will learn about various sources that are now used for the generation of elecrical energy, the methods that are used for this, the scientific principles that are used there, the advantages and disadvantages of these methods and also what is meant by green energy.

Can you tell?

1. Where do we use electrical energy in our day-to-day life?
2. How Electric energy is produced ?

Generation of electrical energy

Most of the electric power plants are based on the principle of electromagnetic induction invented by Michael Faraday. According to this principle, whenever magnetic field around a conductor changes, a potential difference is generated across the conductor.

The field around a conductor can be changed in two ways. If a conductor is stationary and magnet is rotating, the field around the conductor changes or if a magnet is stationary, but the conductor is moving then also the field around the conductor will change. Thus, in both these cases, a potential difference is created across the conductor. (Figure 5.1). The electrical power generating machine based on this principle is called electric generator.

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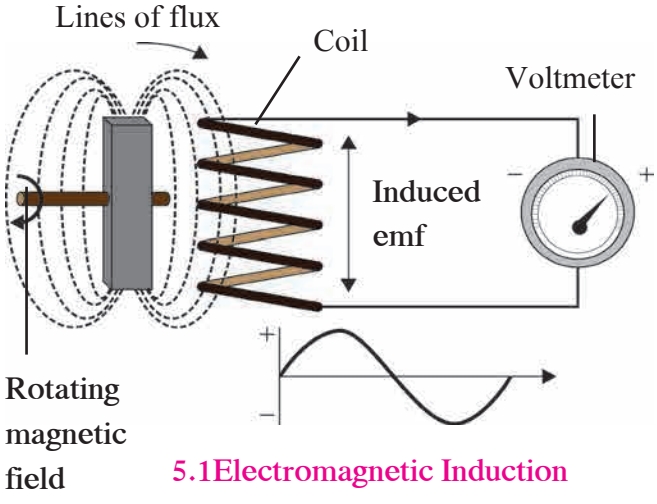
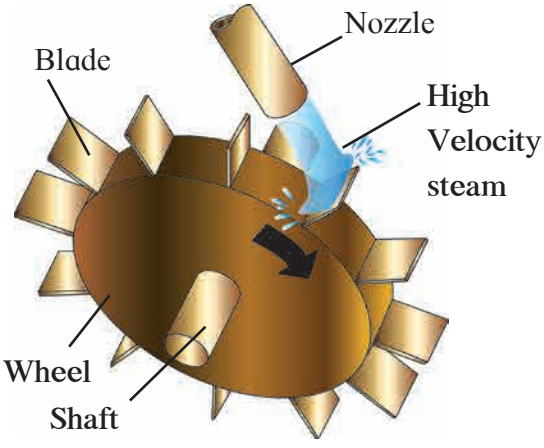
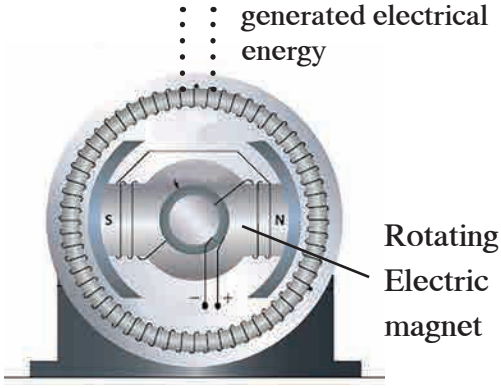
Such large generators are used in commercial power generation plants. Turbine is used to rotate the magnet in the generator. A turbine has blades .When a flow of liquid or gas is directed on the blades of the turbine, it rotates (see Figure 5.2). because of the kinetic energy of the flow.This turbine is connected to electric generator. Thus the magnet in electric generator starts rotating and electric energy is produced (Fig.5.3)



5.1Electromagnetic Induction



5.2 Steam turbine



5.3 Schematic of electric generator

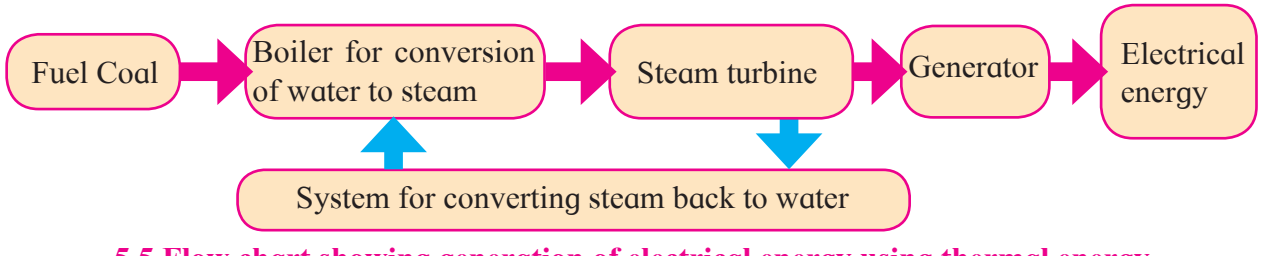
This method of electric energy generation can be represented as below.

Thus, to generate electricity based on the principle of electromagnetic induction, we need a generator. To rotate the generator we need a turbine and to drive the turbine, we need an energy source. Based on which type of energy source is used to rotate the turbine, there are different types of power generating stations. The design of the turbine used in different types of power stations is also different.

5.4 Flow chart showing generation of electrical energy

Thermal energy based electric power station

In this the turbine is rotated using steam. Water is heated in a boiler. Using the thermal energy released due to burning of coal. Steam of very high temperature and pressure is generated. The energy in the steam drives the turbine. Thus, the generator connected to the turbine rotates and electrical energy is produced. The steam is converted back into water and the water is re-circulated to the boiler.This is shown in flow chart in fig 5.5



5.5 Flow chart showing generation of electrical energy using thermal energy

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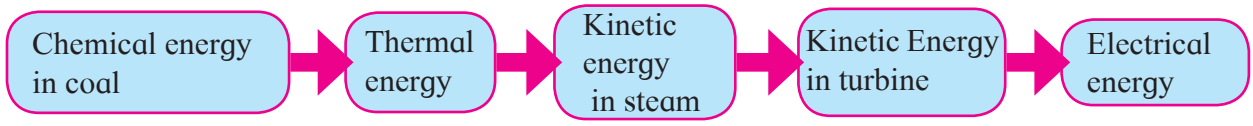
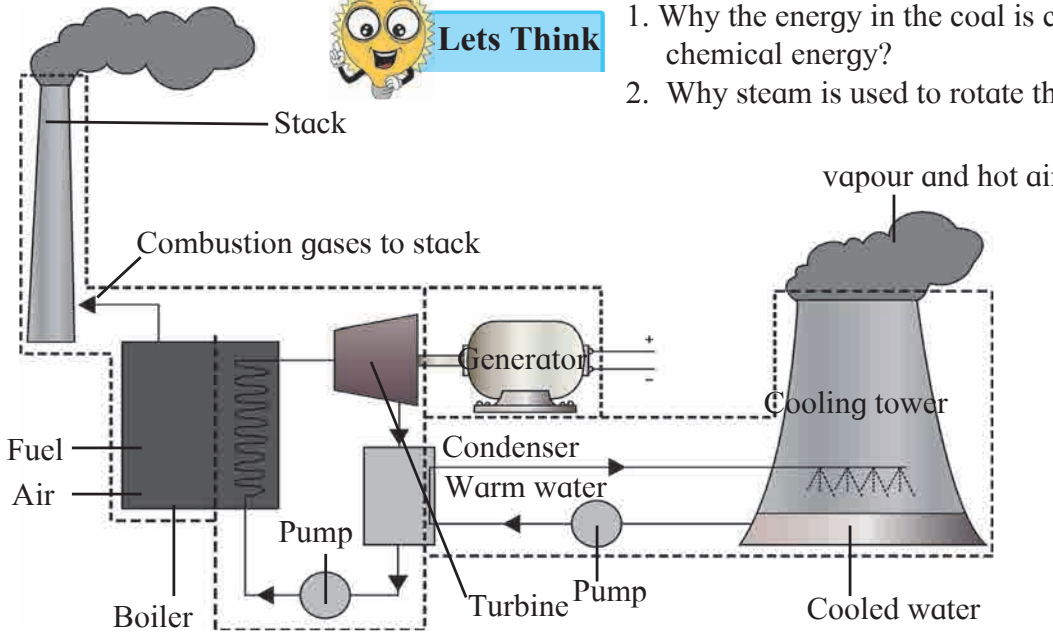
Since thermal energy is used here to generate electrical energy, such power plants are called thermal power plants. In thermal power plants, the chemical energy in the coal is converted into electrical energy through several steps which are shown in figure 5.6.



5.6 Energy transformation in thermal power plant

Lets Think

1. Why the energy in the coal is called as chemical energy?
2. Why steam is used to rotate the turbine?



5.7 Schematics of Thermal : power plant

If you see a thermal power station, you will observe two types of towers there. What are they? If you observe the schematic of the thermal power station in Figure 5.7 , you will get answer to this question.

Compare the schematic of the thermal power station with the block diagram above and you will understand how the boiler, turbine, generator and the condenser are arranged in the power station.

After combustion of fuel (here, coal) in the boiler, the emitted gases are released to the atmosphere through very high tower. Once the turbine is rotated using the steam at high temperature and high pressure, steam temperature and pressure decreases. This steam is converted back to water by taking out heat from it (i.e by cooling it) . This is done in the condenser using water in the cooling tower. The water in cooling tower is circulated through the condenser. Heat energy in the steam is given to the water and the steam condenses back to water. The heat absorbed by the water is then released to atmosphere through vapour and heated air through cooling tower. Although, thermal power generation is a major way of electricity generation today, it suffers from certain problems

Use of ICT

Prepare a presentation about thermal power plant using computerized presentation, animation, video,pictures,etc. Send it to others and upload on You Tube.

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Problems

1. Air pollution due to burning of coal: Burning of coal results in emission of gases like carbon dioxide, sulphur oxide and nitrogen oxide which are harmful to the health.
2. Along with the emission of gases due to burning of coal, soot particles are also released into the environment. This may cause serious health problems related to the respiratory system.

Do you know?

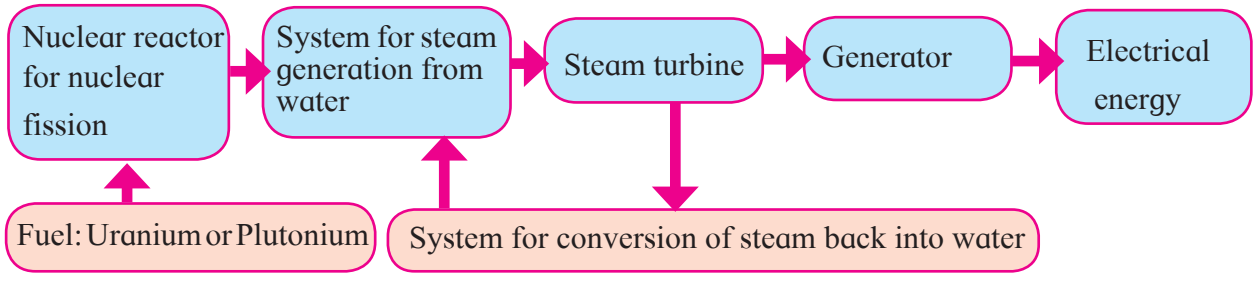
Some major thermal power plants in India and their capacity

Place	State	Capacity (MW)
Vindhyanagar	Madhya Pradesh	4760
Mundra	Gujarath	4,620
Mundra	Gujarath	4,000
Tamnaar	Chhattisagarh	3,400
Chandrapur	Maharashtra	3,340

3. The reserves of fuel used in this method i.e. coal are limited. Therefore, in future, there will be limitations on the availability of the coal.

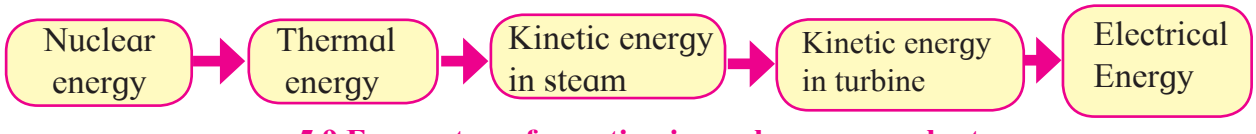
Power plant based on Nuclear Energy

In the power plant based on nuclear energy also , steam turbine is used to rotate the generator. However, here, the energy released by fission of nuclei of atoms like Uranium or Plutonium is used to generate the steam of high temperature and high pressure. The energy in the steam rotates the turbine, which in turn drives the generator producing electricity. The flow chart of nuclear power plant is shown in fig 5.8 .



5.8 Nuclear power plant

Thus, here nuclear energy is converted into thermal energy, thermal energy is converted into kinetic energy of steam, kinetic energy of steam is converted into kinetic energy of turbine and finally the kinetic energy of the turbine is converted into electrical energy .The step-by-step transformation of energy is shown in figure 5.5.



5.9 Energy transformation in nuclear power plant

Can you tell? How does nuclear fission take place?

When neutron is bombarded on atom of Uranium - 235 , it absorbs the neutron and converts into its isotope Uranium - 236. Uranium - 236 being extremely unstable converts into atoms of Barium and Krypton through a process of fission releasing three neutrons and 200 MeV energy. The three neutrons generated in this process cause fission of three other Uranium - 235 atoms releasing more energy.

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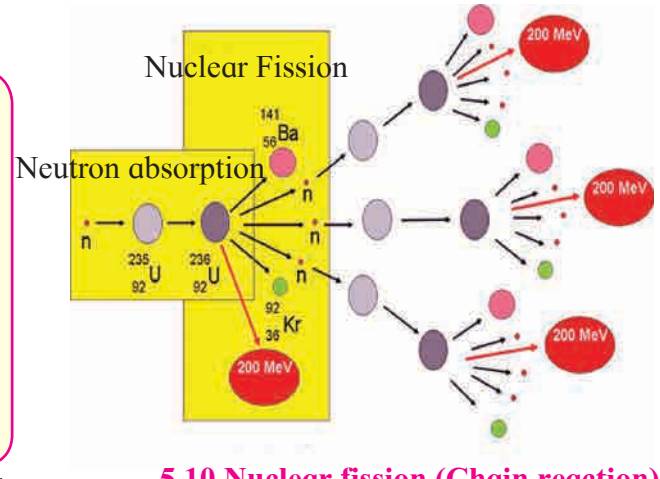
The neutrons released in this reactionrelease more energy through fission of more uranium nuclei. This process of fission of U ranium -235 atoms continnues and is called the chain reaction. In nuclear power plants, a controlled chain reaction results in release of thermal energy, which is used for electric energy generation.

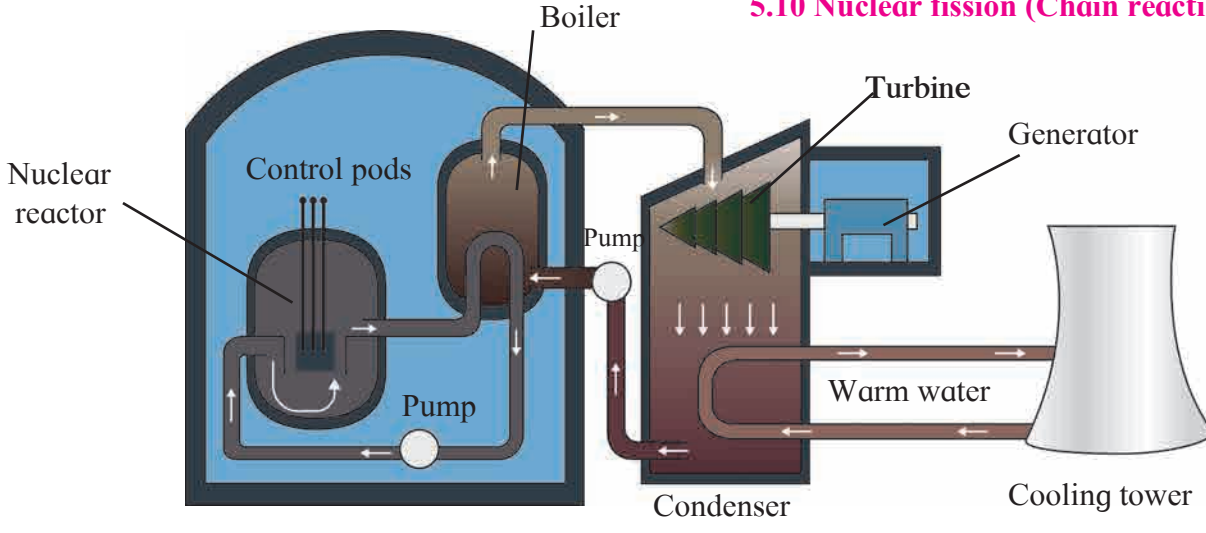
Internet is my friend

Complete the following table for some important nuclear power plants in india.

Place	State	Capacity (MW)
Kudankulam	.....	.....
Tarapur	.....	.....
Ravatabhata	.....	.....
kaiga	.....	.....



5.10 Nuclear fission (Chain reaction)



5.11 Schematic of nuclear power plant

A nuclear power plant does not use fossil fuel like coal. Therefore, problems like air pollution do not arise. Also, if sufficient nuclear fuel is available, this can be a good source of electrical energy. However, there are few problems associated with nuclear power generation.

Problems:

1. The products after fission of nuclear fuel are also radioactive and emit harmful radiations. The products are called as nuclear waste. How to dispose the nuclear waste safely is a big challenge before the scientists.
2. An accident in nuclear power plant can be very fatal. This is because the accident may result in release of very harmful radiations.

Compare

Observe the schematic of thermal power plant and the nuclear power plant. Discuss what are the similarities and differences between the two?

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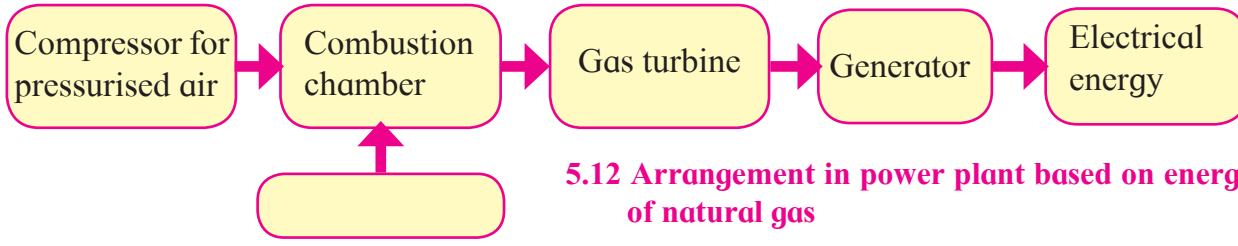
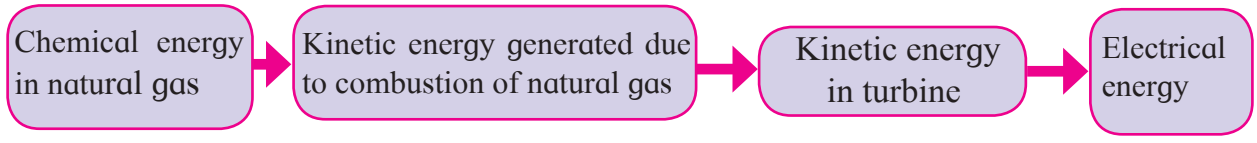
Power generation plant based on energy of natural gas

In this plant, the turbine is run by a gas at very high temperature and pressure generated by combustion of natural gas. A flow chart showing various stages in the power generation plant based on natural gas energy is shown in figure 5.12.



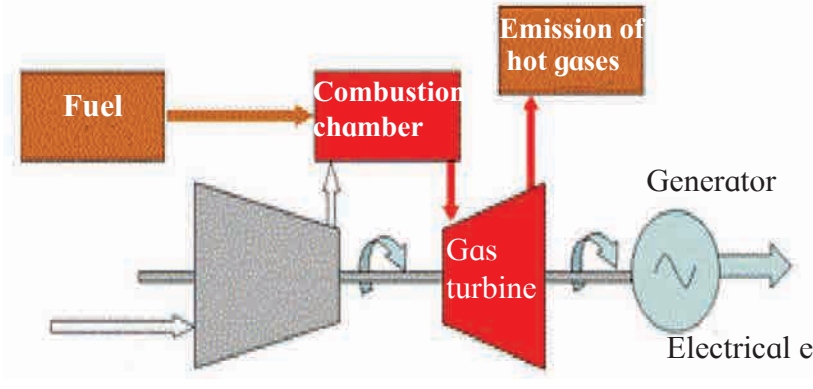
5.12 Arrangement in power plant based on energy of natural gas

There are three main sections in this type of plant. Pressurised air is introduced into the combustion chamber using a compressor. In the combustion chamber the natural gas burns in presence of the air. The gas at very high temperature and pressure generated in this chamber runs the turbine. The turbine then drives the generator to produce electricity. Step-by-step transformation of energy in this plant is shown in fig 5.13.



5.13 Transformation of energy in power plant using energy of natural gas

The efficiency of this type of power generation plant is higher than that of power generation plant based on coal. Moreover, since the natural gas does not contain sulphur, burning of natural gas results in less pollution. The schematic of power plant based on natural gas is given in fiure 5.14.



Lets Think

Which electricity generation process is ecofriendly and which not?

5.14 Schematic of power plant based on natural gas

Some natural gas based power plants and their capacity

Place	State	Capacity(MW)
Samaralkota	Andhra Pradesh	2620
Anjanvel	Maharashtra	2,220
Bavanaa	Delhi	1,500
Kondapalli	Andhra Pradesh	1466

Always remember

Though use of energy is unavoidable in our day to day life, it is necessary to use it carefully and only in the required amount.

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Electric energy generation and environment

Electricity generation based on fossil fuels like coal, natural gas and nuclear fuels like uranium and plutonium are not environment friendly. It means, that if electrical energy is generated using these fuels, it can lead to environmental degradation.

1. We have seen that burning of fossil fuels like coal, and natural gas leads to emission of certain gases and soot particles. This results in air pollution. Incomplete combustion of fuels leads to formation of carbon monoxide. It adversly affects our health. Increase in percentage of carbon dioxide in the air due to burning of fuels affects environment severely. The phenomena of global warming is an example of this. Nitrogen dioxide generated due to burning of fuels like coal, diesel, petrol, etc. lead to problems like acid-rain. Soot particles generated due to incomplete burning of fossil fuel cause air pollution. It can lead to problems related to respiratory system, like asthama.
2. It took millions of years for formation of fossil fuels like coal, crude oils and natural gases (LPG and CNG). Also, the reserves of these fuels are limited. They are going to deplete in future. It is said that with the current speed of their use, the coal reserves in the world would last for another about 200 years or so and the natural gas reserves for about 200-300 years.
3. We have also discussed above about the problems in use of nuclear energy like the disposal of nuclear waste and possibility of disaster due to accident in nuclear power plant.

Considering all these points, it can be said that the energy generation from fossil fuels and nuclear fuels are not environment friendly.

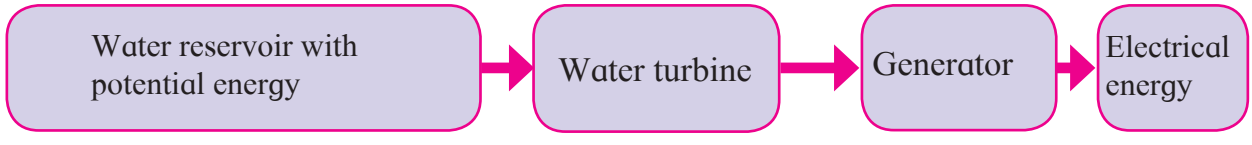
Towards environment friendly energy…..towards green energy:

There are other ways of electricity production which avoids above problems. Electricity generation from water reservoir, wind, Sunlight, biofuels etc are the examples of such methods. The energy sources used in such options i.e. water--reservoir, wind, sunlight, biofuel are never-ending i.e are perpetual. Moreover, use of these sources do not lead to environmental problems discusses above. Therefore, electricity generation through these sources can be called environment friendly. We can also call the energy generated by these processes as green energy. Looking at the problems in electricity generation using fuels like coal, natural gas and nuclear fuels, the world is now heading towards environment friendly energy i.e. green energy.

Hydroelectric Energy

Kinetic energy in flowing water or the potential energy in water reservoir is a conventional source of energy. In hydroelectric power plant, the potential energy in water stored in dam is converted into kinetic energy of water. Fast flowing is brought from the dam to the turbine at the bottom of the dam. The kinetic energy of the flowing water drives the turbine. The turbine in turn drives the generator to generate electricity.

The block diagram showing different components of hydroelectric power plant is shown in figure 5.15



5.15 Different Stages in hydroelectric power plant

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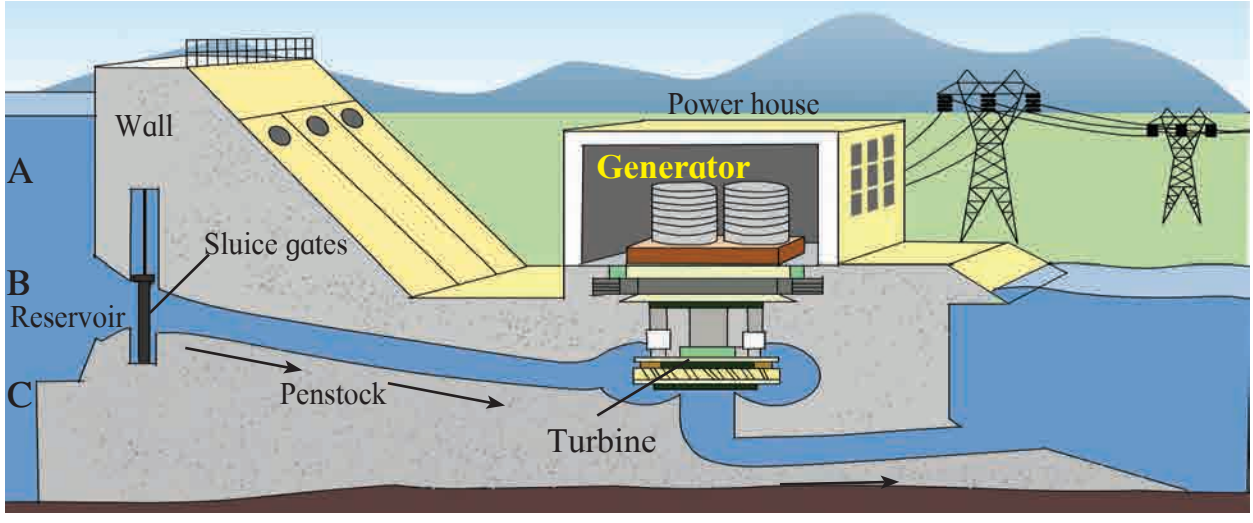
Electricity generation using wind-energy

Potential energy in water → Kinetic energy in flowing water → Kinetic energy in turbine → Electrical energy

5.16 Energy Transformation in hydroelectric powerplant

The schematic of hydroelectric plant is shown in Figure 5.17. Water from about middle of the total height of the dam is taken to the turbine, as shown by point B in the diagram.



5.17 Schematic of Hydroelectric plant

Use your brain power

1. With reference to point B, potential energy of how much water reservoir in the dam will be converted into kinetic energy?
2. What will be the effect on electricity generation, if the channel taking water to turbine starts at point A?
3. What will be the effect on electricity generation, if the channel taking water to turbine starts at point C?

Since no fuel is burnt in hydroelectric plant, no air pollution due to combustion of fuel results. However, considering the issues like forced migration of large community, submerging of forests and fertile land, adverse effect on living creatures in the river, it has always been a point of debate whether the hydroelectricity is environment friendly or not. What is your opinion about it?

Advantages of hydroelectric power generation

1. Since no fuel is burnt in hydroelectric power generation, there is no pollution resulting from combustion of fuels.
2. If there is sufficient water storage in the dam, it is possible to generate electricity as and when necessary.
3. Although water reservoir is used for power generation, it can be replenished during rainy season leading to uninterrupted power generation.

Problems associated with hydroelectric power plant

1. The back-water due to storage of water in dam may submerge villages or towns in that area. This leads to the problems of re-habitation of the displaced population. Moreover, this can also submerge forests as well as fertile land.
2. The obstruction of the flow of river water may have adverse effect on living world in the river.

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Do you know?

Some major hydroelectric plants in India and their capacity (MW)

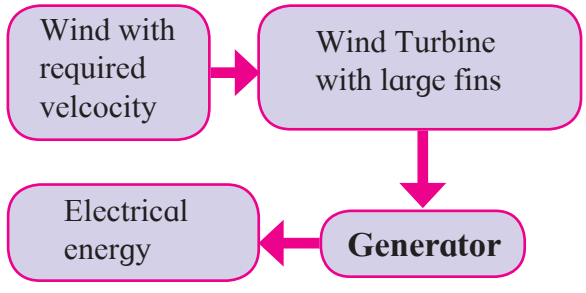
Place	State	Capacity (MW)
Tehari	Uttarakhanda	2400
Koyana	Maharashtra	1960
Srishailam	Andhra Pradesh	1670
Nathpa Zakri	Himachal Pradesh	1500

5.18 Koyana Dam

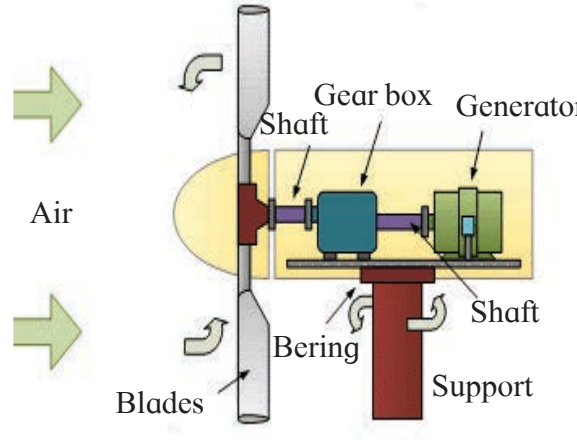
Find out

What is lake tapping? Why it takes place?

The kinetic energy in wind has been used since long for lifting of water, for driving floor mill etc. The wind energy can also be used for electricity generation. The machine which converts the kinetic energy of wind to electrical energy is called wind-turbine. As the wind strikes the blades of the turbine, the blades rotate. The axel of the turbine is connected to electric generator through a gear-box. The function of the gear-box is to increase the rotations per unit time. Thus, the rotating blades drive the turbine and the turbine in turn drives the generator to generate electricity. Various stages in the wind-energy generation system can be shown in figure 5.19 and schematics of a wind mill is shown in figure 5.20.



5.19 Stages in electric generator using wind energy



5.20 Schematic of wind mill

The energy conversion process is shown in figure 5.21.

5.21Transformation of energy in an electric generator using wind energy

Wind turbines with capacity right from less than 1 kW to about 7 MW (7000 kW) are commercially available. Depending on the wind velocity available at the site of installation, wind-turbine with specific capacity is selected. The wind velocity at specific location depends on many geographical factors.

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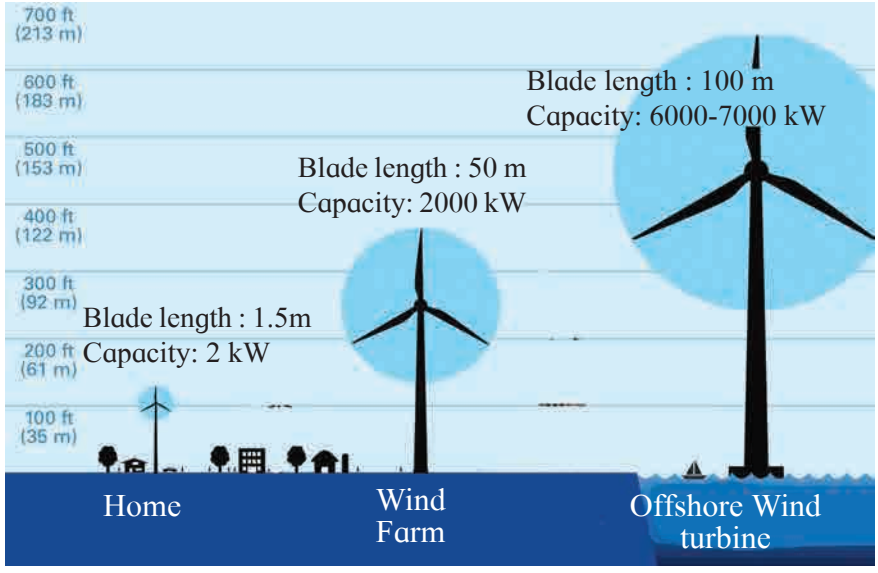
Wind velocity is usually high on sea shores and that environment is appropriate for installation of wind turbine.Wind-energy is a clean energy source. However, the wind-velocity necessary for wind-energy generation is not available everywhere. In that sense, use of wind-energy is limited.



5.22 Wind turbines of different capacities

Get information

Get information about major wind-power stations in India and their capacity. Make a table of their location, state and their power generation capacity in MW.

Electric Energy generation using solar energy

Using the energy in the Sunlight, electric energy can be generated in two ways:

1. In all the above methods of electricity generation we have studied, the electric generator is driven by using some source of energy and electricity is generated by making use of the principle of electromagnetic induction. However, electrical energy can be generated directly from solar radiation without using generator and without using the principle of electromagnetic induction. This happens in solar photovoltaic cells. Solar photovoltaic cells convert the solar energy directly into electrical energy.
2. In the second method, the energy in solar radiation is converted into thermal energy first. Then a turbine-generator system is driven using that thermal energy to generate electricity.

1.Solar photovoltaic cell

Solar photovoltaic cell converts the solar radiation energy directly into electrical energy. This is called solar photovoltaic effect. The electrical energy generated through this energy transformation process is DC in nature. These solar cells are made of a special type of material called semiconductor (e.g. silicon). A silicon solar cell of dimension 1 cm^2 generates current of about 30 mA and potential difference of about 0.5 V. Thus, a silicon solar cell of dimension 100 cm^2 will generate about 3 A (30 mA/cm^2 X 100 cm^2=3000 mA= 3 A) current and 0.5 V. Remember taht the potential difference available from a solar cell is independent of its area.

Energy in Sunlight —(Photovoltaic effect)→ **DC Electric power**

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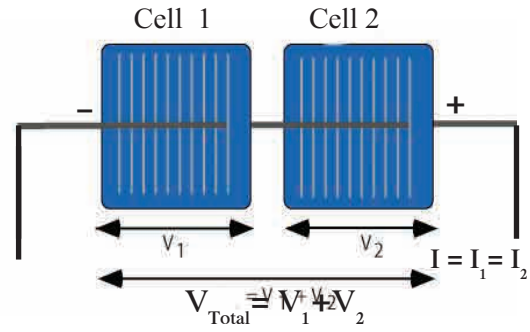
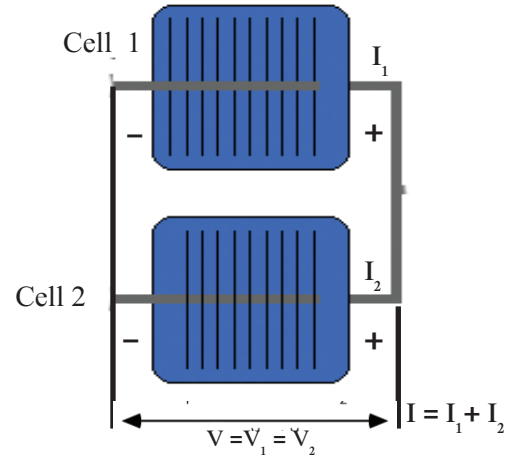
If two solar cells are connected in series as shown in figure 5.23, the potential difference obtained from this combination is addition of the potential differences of individual solar cells. However, the current generated from this combination is equal to the current from an individual cell. It means that when solar cells are connected in series, currents from the individual cells are not added. Similarlyas shown in figure 5.24, if two solar cells are connected in parallel, the current generated from this combination is the summation of the currents from an individual solar cells. However, the potential difference obtained from this combination is the same as the potential difference obtained from individual cell. Thus, if two solar cells are connected in parallel, the potential differences from the two cells are not added.

In this way, by connecting many solar cells in series and in parallel solar panels generating required current and potential difference are made. See Figure 5.25. For example, if 36 solar cells, each of size 100 cm^2 are connected in series in a solar panel, it will give potential difference of 18 V and current of 3 A. Many such panels are connected together to generate electricity on larger scale. A good solar cell can have an efficiency of around 15%. It means that if a solar panel receives power of 100 watt from solar radiation, the electrical power output from the panel will be 15 watt.

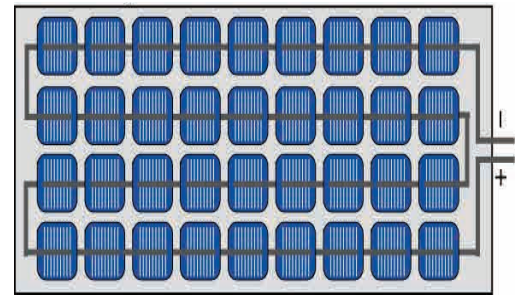
Many solar panels are connected in series and in parallel to generate required current and potential difference. As shown in Figure 5.26, solar cell is the basic unit in solar electric plant . Many solar cells come together to form a solar panel. Many solar panels connected in series form a solar strings, and, many solar strings connected in parallel form a solar array. As we can obtain as much electrical power as needed, they are used in applications which need marginal power (e.g. calculators that run on solar energy) to power station of MW capacity.



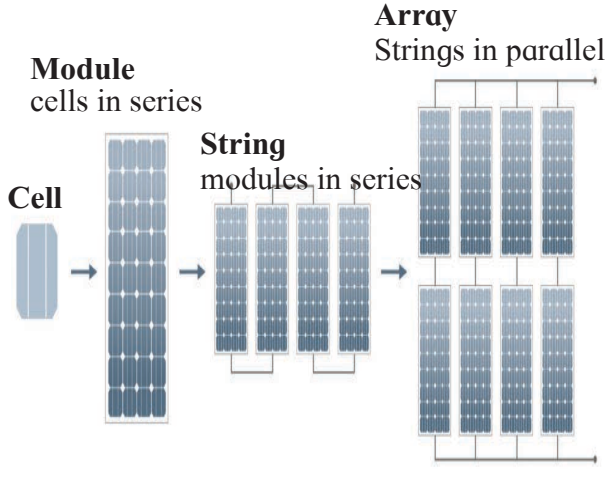
5. 23 Solar cells in series



5.24 Solar cells in parallel



5.25 A solar panel made from 36 solar cells



5.26 Solar cell to solar array

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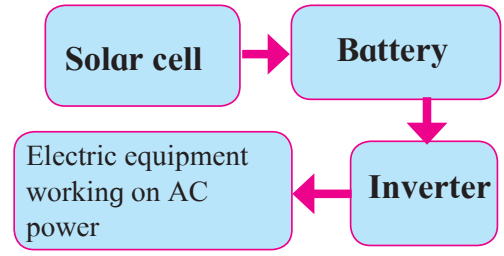
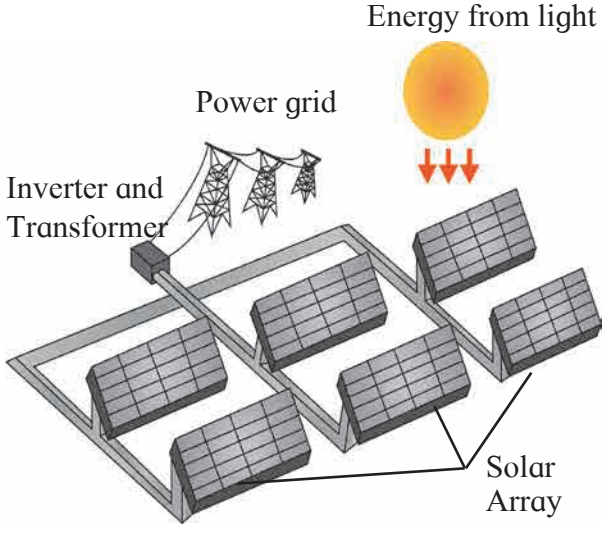
The power available from the solar cells is DC. So, in applications which need DC power , e.g. electric lights based on Light Emitting Diodes, the energy can be directly used. However, since the energy from solar cell is available only in presence of sunlight, the energy has to be stored in batteries for use at later time.

However, most of the equipment in domestic as well as industrial use run on AC power. In such case, the DC solar power must be converted to AC power using an electronic device called inverter(Figure 5.27).



5.27 Conversion of energy generated by cells to AC form by using inverter



5.28 Schematic of solar photovoltaic station

We have seen that many solar panels can be connected together to generate whatever energy we need. As shown in Figure 5.28, the DC power generated from these panels is first converted into AC power. A transformer transforms the voltage and current levels of the generated power and then it is fed into the electricity distribution network. Figure 5.28 is a schematic diagram of solar photovoltaic power station.

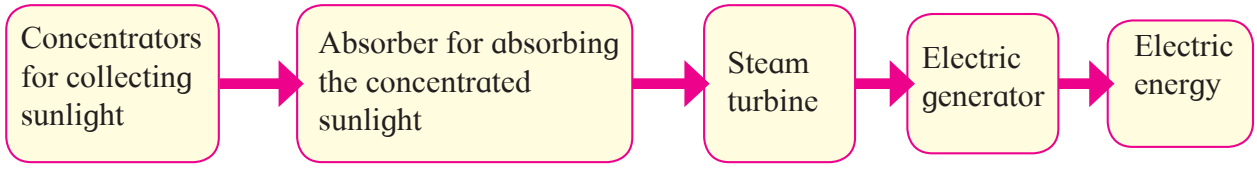
In this way, electricity is generated without any fuel combustion and so without any air pollution. However, since the energy is generated using solar radiation, solar cells can generate electricity during day-time only.

Find out

Gather information about major solar photovoltaic power generating plants and their capacity in India.

Solar Thermal power plant

We have seen that thermal energy generated from coal and nuclear fuel can be used to generate electricity. Thermal energy can also be generated from solar radiation and can be used for electricity production. Different stages in such solar thermal power plant are as shown in figure 5.29



5.29 Different stages in solar thermal power plant

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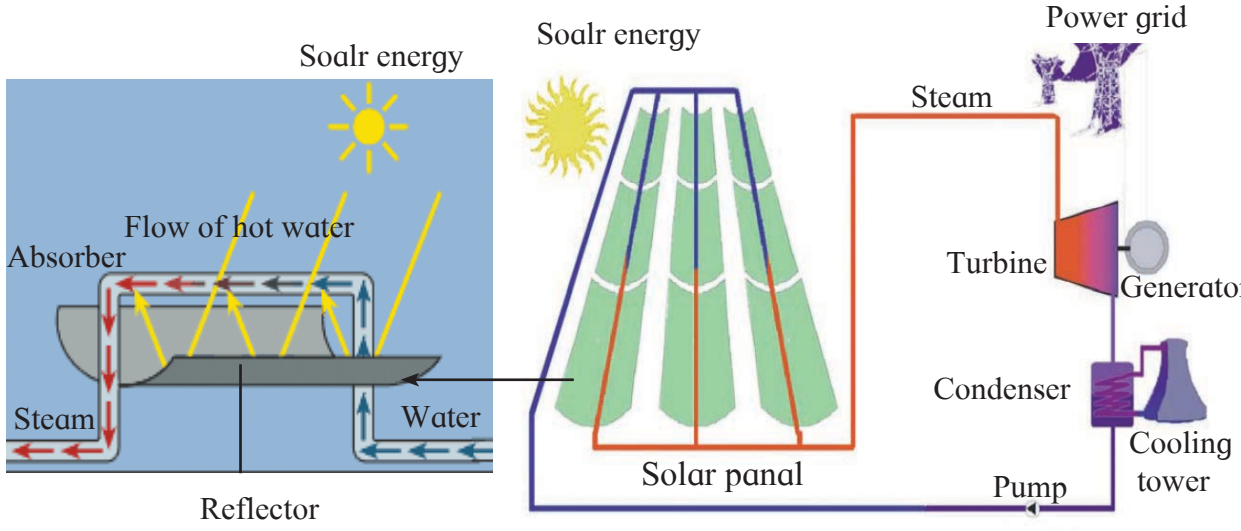
As shown in Figure 5.30 , many reflectors reflect and concentrate solar radiation on absorbers. There solar energy is converted into heat energy. Using this heat energy steam is generated to drive the turbine and generator.



5.29 Schematic o fsolar thermal power plant

Do you know?

Energy sources use for electrical power generation in the world.

Souces	World (%)	India (%)
Coal	41	60
Natural Gas	22	08
Hydroelectric	16	14
Nuclear energy	11	02
Petrolium	04	0.3
Renewable sources (wind, solar etc)	06	15.7
Total	**100**	**100**

Exercise

1. **Remake the table taking into account relation between entries in three columns.**

I	II	III
Coal	Potential energy	Wind electricity plant
Uranium	Kinetic Energy	Hydro electric plant
Water Reservoir	Nuclear Energy	Thermal plant
Wind	Thermal Energy	Nuclear power plant

2. **Which fuel is used in thermal power plant? What are the problems associated with this type of power generation?**
3. **Other than thermal power plant, which power plants use thermal energy for power generation? In what different ways is the thermal energy obtained?**
4. **Which type/types of power generation involve maximum number of steps of energy conversion? In which power generation is the number minimum?**

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5. Solve the following crossword puzzle.

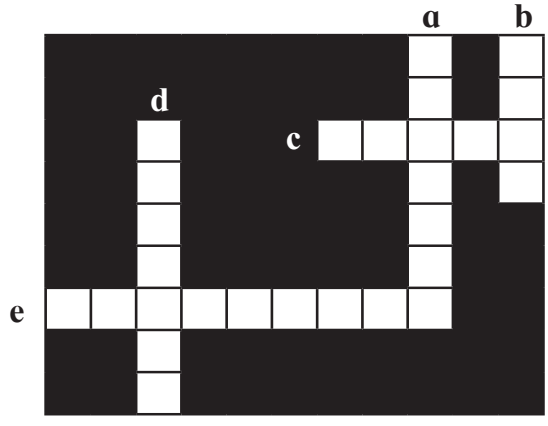
a. Maximum energy generation in india is done using..... energy.

b. ..... energy is a renewable source of energy

c.Solar energy can be called.... energy.

d .... energy of wind is used in wind mills.

e. ..... energy of water in dams is used for generation of electricity.



6. Explain the differance.

a. Conventional and Non-conventional Sources of energy.

b Thermal electricity generation and solar thermal electricity generation.

7. What is meant by green energy? Which energy sources can be called as green energy sources and why? Give exampls.

8. Explain the following sentences.

a. Energy obtained from fossil fuels is not green energy.

b. Saving energy is the need of the hour.

9. Answer the following questions.

a. How can we get the required amount of energy by connecting solar panels?

b. What are the advantages and limitations of solar energy?

10. Explain with diagram step-by-step energy conversion in

a. Thermal power plant

b. Nuclear Power Plant

c. Solar thermal power plant

d. Hydroelectric power plant

11. Give scientific reasons

a. The construction of turbine is different for different types of power plants.

b. It is absolutely necessary to control the fission reaction in nuclear power plants.

c. Hydroelectric energy, solar energy and wind energy are called renewable energies.

d. It is possible to produce energy from mW to MW using solar photovoltaic cells.

12. Draw a schematic diagram of solar thermal electric energy generation.

13. Give your opinion about whether hydro electric plants are environment friendly or not?

14. Draw neat and labelled diagrams.

a. Energy transformation in solar thermal electric energy generation.

b. One solar panel produces a potential difference of 18 V and current of 3A. Discribe how you can obtain a potential difference of 72 Volts and current of 9 A with a solar array using solar panels. You can use sign of a battery for a solar panel.

15. Write short note on

Electrical energy generation and environment.

Project :

1.Gather information about solar light, solar water heating system and solar cooker.

2.Gather information about a power plant near your locality by vising the plant.

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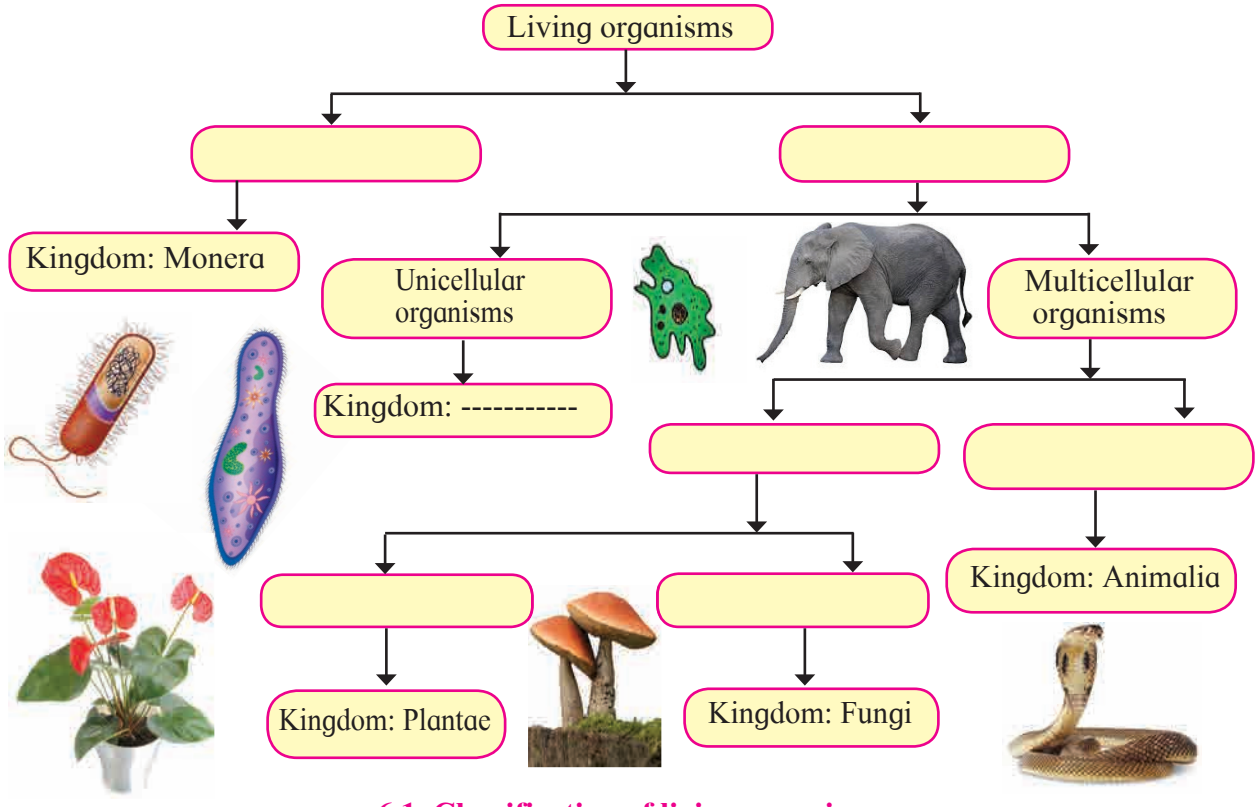
6. Animal Classification

- **History of animal classification**
- **New (method) system of animal classification.**
- **Kigdom- Animalia.**

Can you recall? Which criteria are used for classification of organisms?

You have studied the classification of living organisms in earlier classes. The living organisms present around us are mainly plants and animals. We have studied the criteria of their classification. With the help of that, complete the following chart.



6.1 Classification of living organisms

Can you recall? How the plants are classified?

We have studied the plants classification in last year. It helped us to understand the diversity of plants around us.

You must be looking varieties of animals around you. Some animals are too small whereas some are too big. Some animals are terrestrial where as some are aquatic. Some animals crawl on land, some swim in water whereas some fly in air. Some animals have scales on skin whereas some have feathers or hairs. In this way, there is huge diversity among the animals too. According to recent studies, estimated number of animal species on earth is approximately 7 millions. It is impossible to study each and every species. However, if groups and sub-groups of animals are formed depending upon the similarities & differences, it will make it very easy to study such vast variety of animals.

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Formation of groups and sub-groups of animals depending upon similarities and differences among animals is called as animal classification.

History of animal classification

Time to time, different scientists have tried to classify the animals. Greek philosopher Aristotle was the first to perform the animal classification. Aristotle classified the animals according to the criteria like body size, habits and habitats. Further, as per the new developments in sciences, references were changed and thereby the criteria of animal classification too. Classification proposed by Aristotle is known as 'Artificial method'. Besides Aristotle, artificial method of classification was followed by Theophrastus, Pliny, John Ray, Linnaeus, etc. Later on, 'Natural system of classification' was followed. Natural system of classification was based on various criteria like body organization, types of cells, chromosomes, bio-chemical properties, etc. By the time, system of classification based on evolution was also brought into practice. It was used by Dobzhansky and Meyer. Recently, Carl Woese has also proposed the animal classification

Benefits of animal classification

1. Study of animals becomes convenient.
2. Study of few animals from a group helps to understand about that entire animal group.
3. It gives idea about animal evolution.
4. Animals can be easily identified with great accuracy.
5. It helps to understand the relationship of animals with other living organisms.
6. It helps to understand the habitat of each animal and it's exact role in the nature.
7. It helps to understand various adaptations shown by animals.

Traditional method of animal classification

Traditionally, depending upon presence or absence of the notochord, the animal kingdom has been divided into two groups- **Non-chordates and Chordates.**

A. Non-Chordates : Characters of non-chordate animals are as follows

1. Body is not supported by rod-like notochord.
2. Pharyngeal gill-slits are absent.
3. Nerve cord; if present, it is on ventral side. It is solid & paired.
4. Heart, if present, it is on dorsal side.

Non-chordates are classified / divided into ten phyla. Those phyla are- Protozoa, Porifera, Coelentarata / Cnidaria, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Hemichordata

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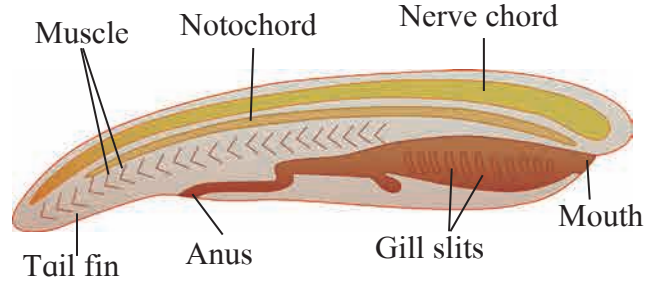
Chordates : Characters of chordates are as follows

1. Body is supported by notochord.
2. Pharyngeal gill-slits or lungs are present for respiration.
3. Nerve cord is present on dorsal side of body. It is hollow.
4. Heart is present on ventral side of body.

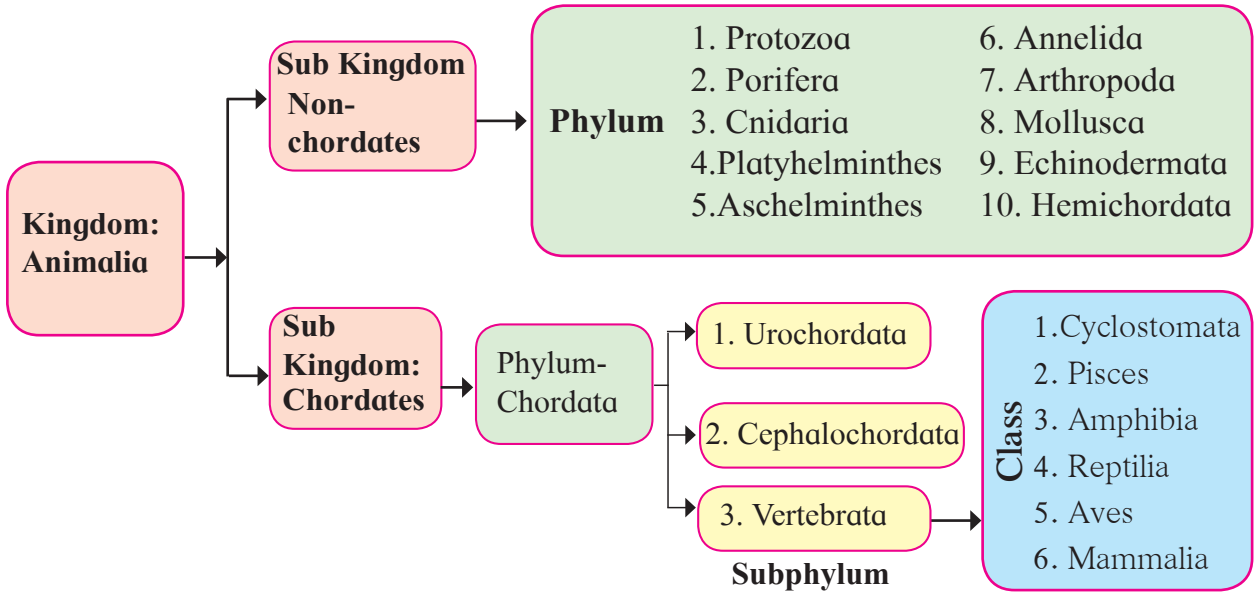
Notochord is a long rod like supporting structure present on dorsal side of animal body. It keeps the nerve tissue isolated from remaining body.



6.2 Charactristics of Chordates

Do you know?

All chordate animals are grouped together in a single phylum and the name of phylum is same i.e. Phylum- Chordata. This phylum has been divided into three subphyla as- Urochordata, Cephalochordata & Vertebrata. Sub-phylum Vertebrata has been further divided into six classes as- Class: Cyclostomata, Class: Pisces, Class: Amphibia, Class: Reptilia, Class: Aves and Class: Mammalia.



6.3 Conventional System of Animal Classification

This system of animal classification was in practice till now. However, now a days, new system of classification is followed. We will study this new system of animal classification in brief.

At present, according to the five kingdom classification system of Robert Whittaker, all multicellular animals are included in Kingdom: Animalia. This system of classification is based upon some criteria like Body organization, Body symmetry, Body cavity, Germinal layers, Segmentation, etc.

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Criteria for new system of classification

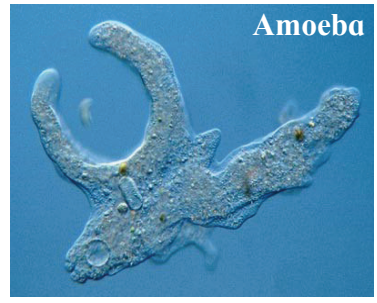
A. Grades of organization

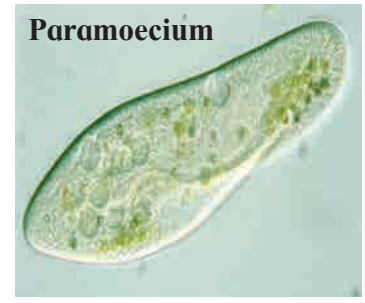
Body of animals is made up of cells. In case of multicellular animals, many cells are performing different functions in their body while in unicellular animals, as their body is made up of single cell; all functions are performed by same cell only. Body organization of unicellular animals is referred as 'Protoplasmic grade' organization.

In case of multicellular animals, if tissues are not formed, their body organization is called as 'Cellular grade organization'. Ex. Phylum-Porifera.

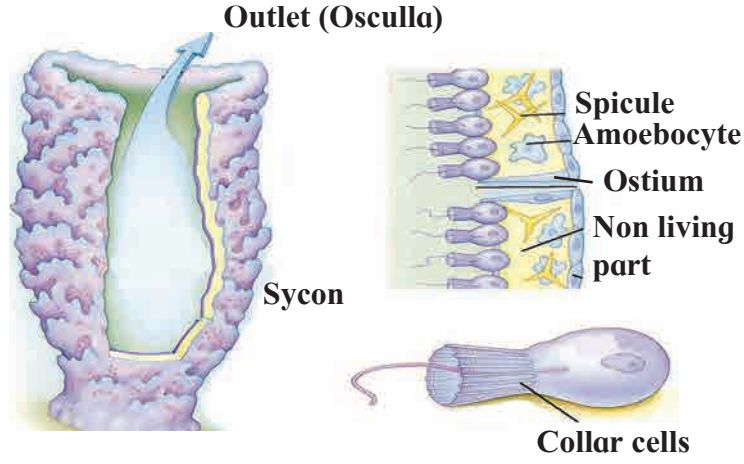
In case of some animals, cells come together to form tissues with the help of which all the body functions are performed. Such animals show 'Cell - tissue grade' organization. Ex. Animals from phylum- Cnidaria.

Flat worms show 'Tissue-Organ grade' organization. In this type of organization, tissues are organized to form some organs. However, complete organ-systems are not formed.

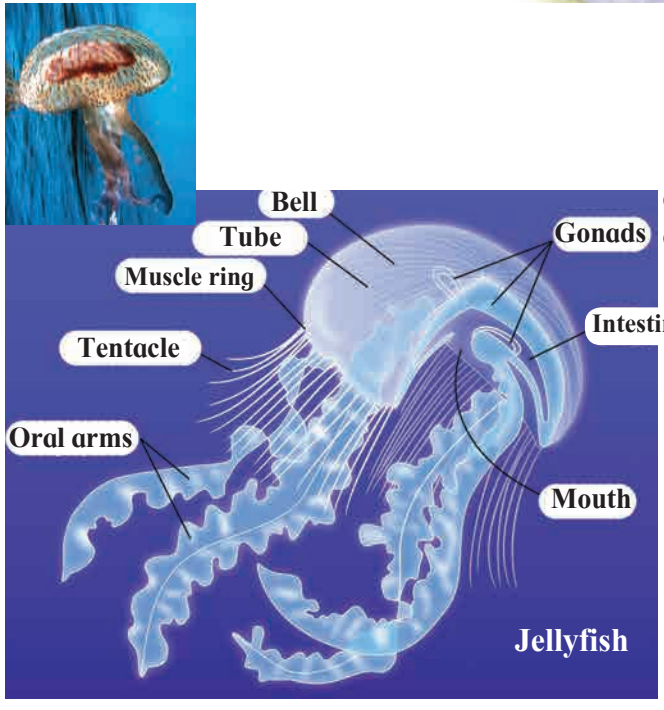




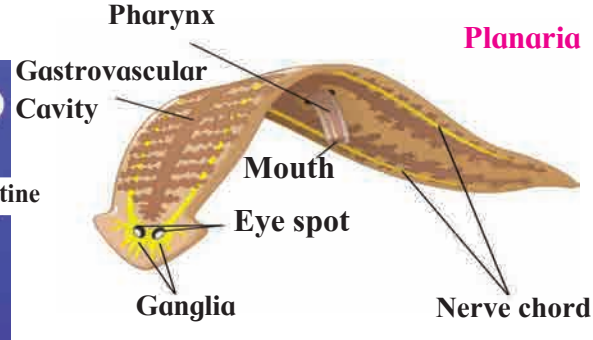
6.4 Some animals with Protoplasmic-grade organization.



6.5 Cellular grade organization



6.6 Cell -Tissue grade organization



6.7 Tissue -Organ grade organization

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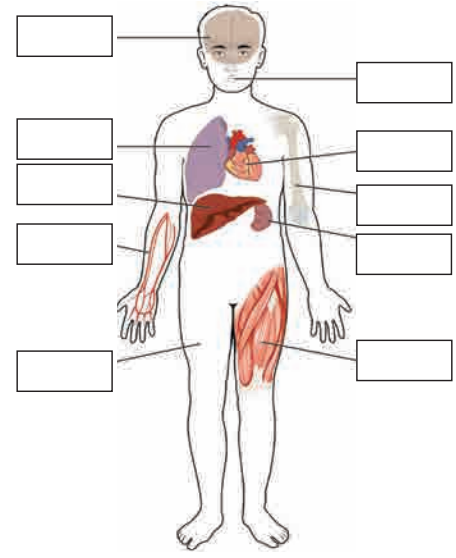
Observe

Body organization of human has been shown in the following figure. Use appropriate labels in that figure. Which organs are present in human body?



6.8 Organ- System grade of organization

Besides the four types of body organizations mentioned above, Remaining all animals show 'Organ-system grade organization' in which different organs are joined together to form organ-system that performs specific functions. Ex. Crab, Frog, Human, etc.

B. Body Symmetry

Take the pictures of human body and Amoeba and try to take an imaginary section through specific plane of their bodies so as to get two equal halves.

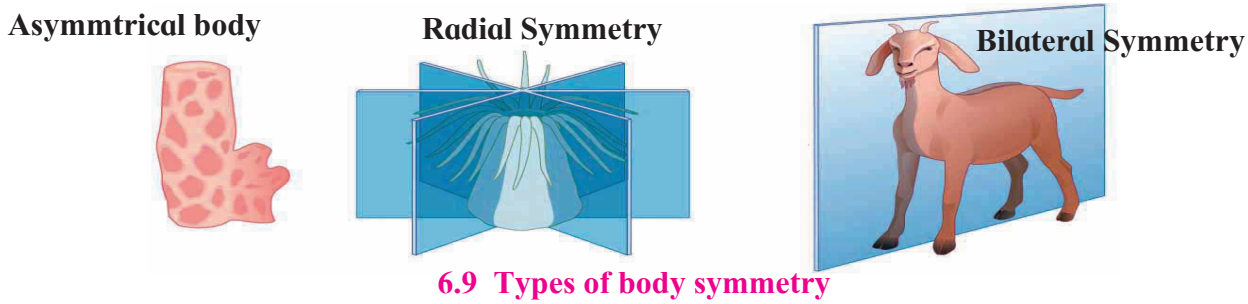
What did you observe?

In imaginary sense, if body of any animal is cut through imaginary axis of body, it may or may not produce two equal halves. Depending upon this property, there are different types of animal bodies.

Asymmetrical Body : In case of such body, there is no any such imaginary axis of the body through which we can get two equal halves. Ex. *Amoeba, Paramoecium,* some sponges.

Radial symmetry : In this type of body, if imaginary cut passes through central axis but any plane of body, it gives two equal halves. Ex. Star fish. In case of this animal, there are five different planes passing through central axis of body through which we can get two equal halves.

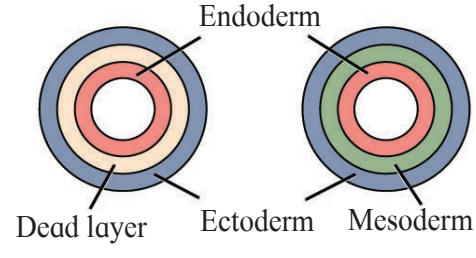
Bilateral symmetry: In this type of body, there is only one such imaginary axis of body through which we can get two equal halves. Ex. Insects, fishes, frog, birds, human, etc.



6.9 Types of body symmetry

C. Germ Layers: Diploblastic and triploblastic

In case of multicellular animals, germ layers are formed during initial period of their embryonic development and from those germ layers only, different tissues are formed in the body. In case of some animals, only two germ layers [Endoderm & ectoderm] are formed. Ex.: All Cnidarians. In most of all the remaining animals, three germ layers are formed i.e. mesoderm besides endoderm & ectoderm.



6.10 Diploblastic and triploblastic

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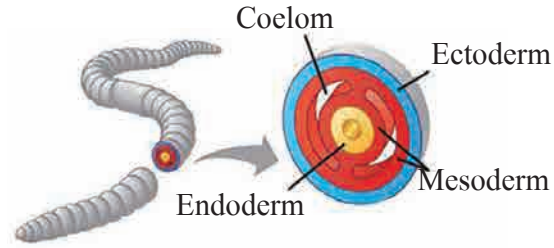
D. Body cavity (Coelom)

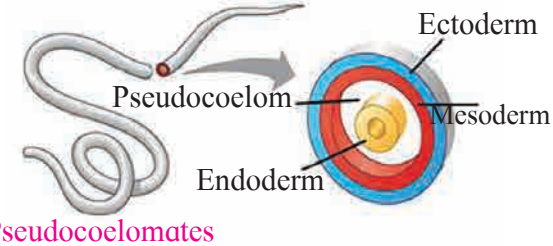
Cavity between the body and internal organs is called as body cavity/coelom. In case of multicellular animals, during initial period of their embryonic development, body cavity is formed from either mesoderm or gut. Such type of body cavity is present in animals of phylum Annelida and all phyla coming after Annelida. Such animals are called as eucoelomate (animals with true body cavity). Body cavity is absent in case of animals from phyla Porifera, Cnidaria and Platyhelminthes. Such animals are called as acoelomate. In case of animals from phylum Aschelminthes, they have body cavity but it is not formed by the above mentioned two ways. Hence those animals are called as pseudocoelomates.

E. Body Segmentation

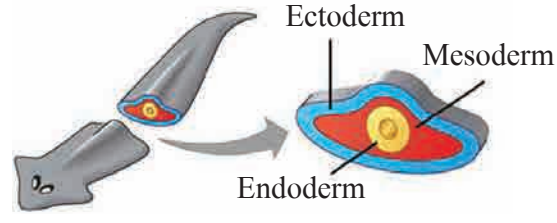
If the body of animals is divided into small, similar units, then such body is called as segmented body and each small unit is called as segment. Ex. Animals like earthworm from phylum Annelida.



Eucoelomates

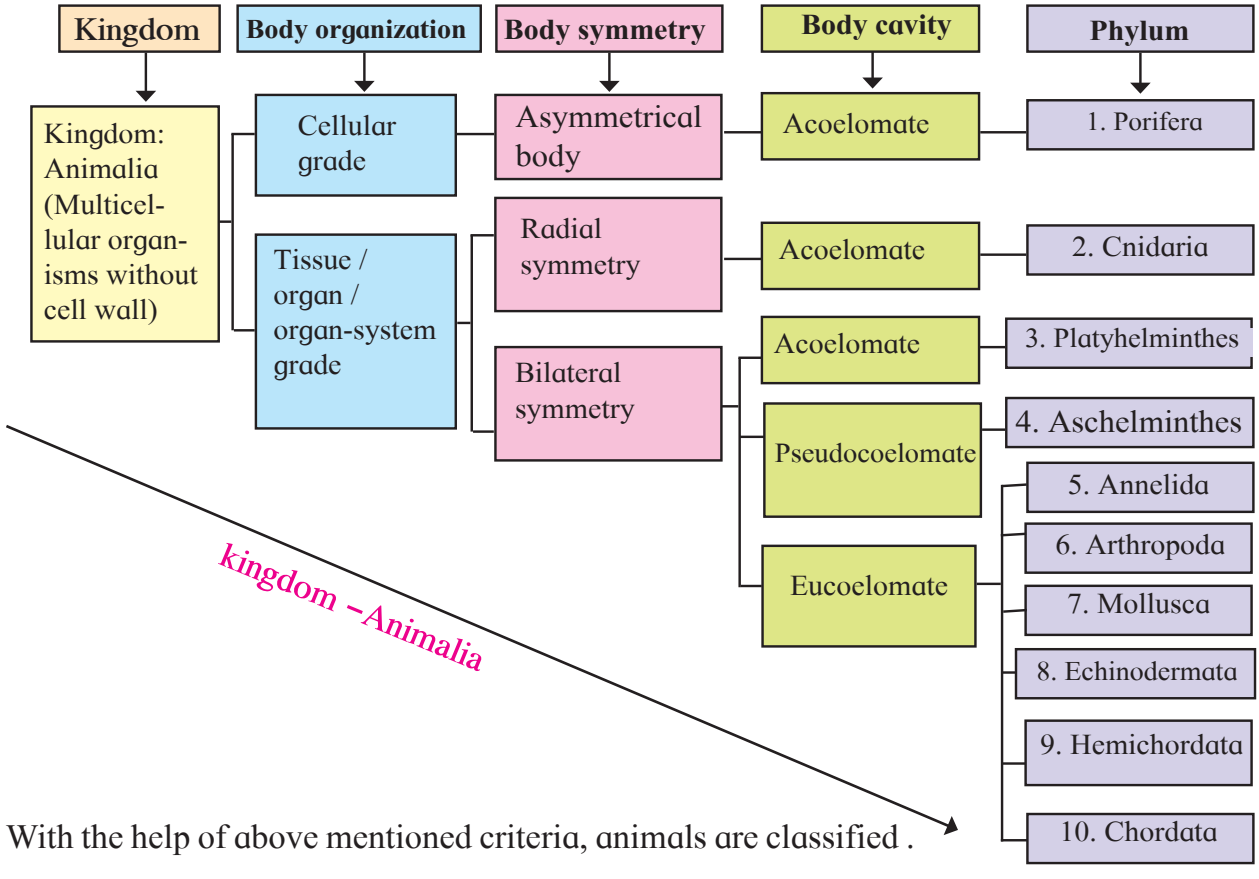


Pseudocoelomates



Acoelomates

6.11 Animal types as per body cavity



kingdom – Animalia

With the help of above mentioned criteria, animals are classified .

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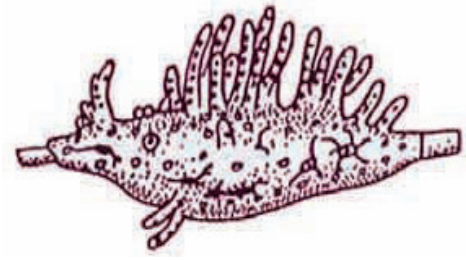
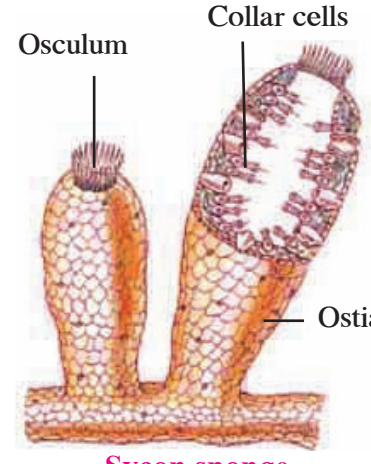
Phylum- Porifera

1. These animals are with simplest body plan and are called as 'Sponges'. They bear numerous pores on their body. Those pores are called as 'Ostia' and 'Oscula'.
2. These are aquatic animals. Most of them are marine and few are fresh water dwellers.
3. Most of the animals have asymmetrical body.
4. These animals have special types of cells- collar cells.
5. These animals are always attached to substratum, hence do not show locomotion. Hence, they are referred as sedentary animals.
6. Their spongy body is supported by spicules or spongin fibres. Spicules are made up of calcium carbonate or silica.
7. These animals feed upon small organisms taken in their body along with water. Water is taken in through ostia and given out through oscula.
8. These animals reproduce by budding, an asexual method and / or by sexual method. Besides, they have good ability of regeneration.

   Examples: *Sycon, Euspongia* (Bath sponge), *Hyalonema, Euplectella*, etc.



Spongila



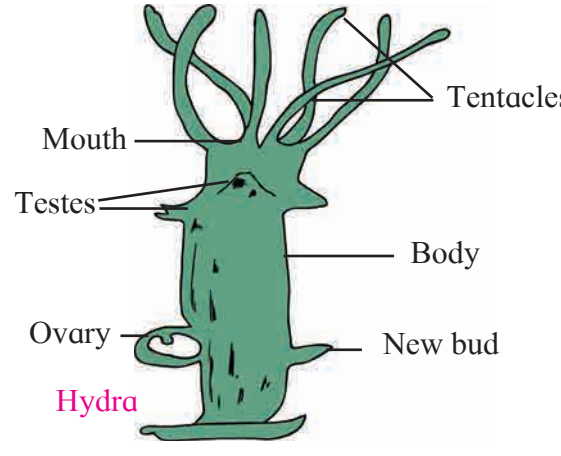
Sycon sponge

6.12 Animals in Porifera phylum

Phylum - Coelenterata/Cnidaria

1. Body of these animals is cylindrical or umbrella-like. If it is cylindrical, it is called as 'Polyp' and if it is umbrella like called as 'Medusa'.
2. Most of these animals are marine. Only few are fresh-water dwellers.
3. Body of these animals is radially symmetrical & diploblastic.
4. Cnidoblast bearing tentacles are present around the mouth. Tentacles are useful for capturing the prey whereas cnidoblasts inject the toxin in the body of prey. Those are useful for protection too.

   Examples: *Hydra, Adamsia* (Sea anemone), *Physalia* (Portuguese- man-of war), *Aurelia* (Jelly fish), Corals, etc.



Coral

Tentacles

Sea anemone

6.13 Animals in Cnidaria phylum

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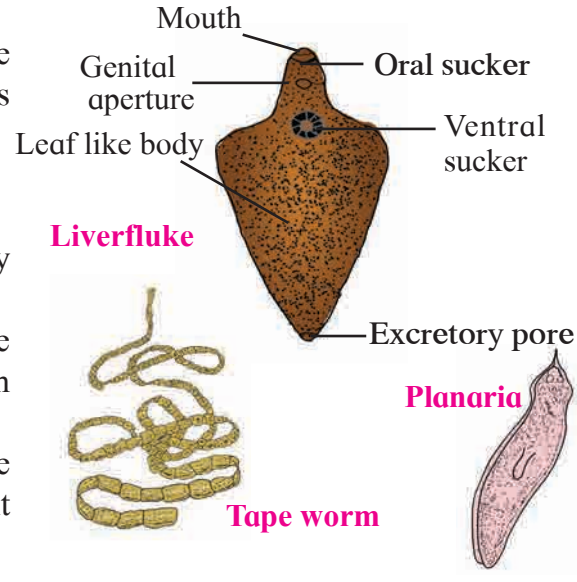
Do you know?

Bath sponge: This is black coloured and somewhat round-shaped animal. Its body is mainly made up of fibers of a protein- spongin and due to this, they have good water-holding capacity. It was used for bathing during old days. Besides, it was also used for manufacturing of pillows and cushions. These were also used as wetting material for sticking postal stamps and counting the currency notes.

Phylum - Platyhelminthes

1. Body of these animals is slender & flat like a leaf or strip. Hence, they are called as 'flatworms'.
2. Most of these animals are endoparasites. Few are free-living & aquatic.
3. Body is acoelomate & bilaterally symmetrical.
4. These are triploblastic i.e. their body is made up of three germ layers- endoderm, ectoderm & mesoderm.
5. These animals are hermaphrodite i.e. male and female reproductive systems are present in the same animal body.
   Examples: Planaria, Liverfluke, Tapeworm, etc.



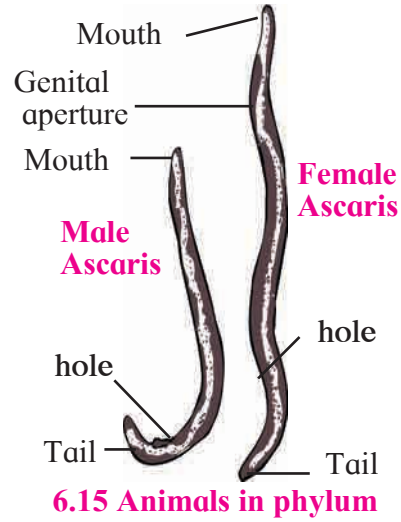
6.14 Animals in phylum Platyhelminthes

Surprising information

Coral reefs are present in ocean. These reefs are actually colonies of specific cnidarians. A precious stone called 'Coral' (पोवळा) and the coral powder (प्रवाळ भस्म) used in ayurveda is derived from these reefs. Collect more information about these corals from internet.

Phylum- Aschelminthes

1. Body of these animals is long thread-like or cylindrical. Hence, they are called as round worms.
2. These animals are either free living or endoparasites. Free living animals are either aquatic or terrestrial.
3. Body of these animals is triploblastic and pseudocoelomate.
4. Body of these animals is non-segmented and covered with tough cuticle.
5. These animals are unisexual.
   Examples: *Ascaris* (Intestinal worm), Filarial worm, *Loa loa* (Eye worm), etc.



6.15 Animals in phylum Ascheminthes

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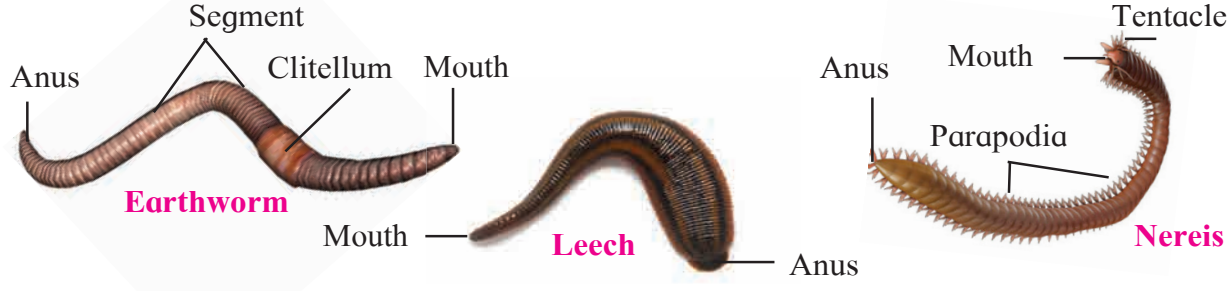
Internet is my friend

Collect the Information

1. How does the infection of tapeworm in man, liverfluke in grazing animals like goat and sheep occur and what are their preventive measures?
2. How does the infection of round worms like Ascaris, filiarial worm & plant nematodes occur and what are their preventive measures and treatment?

Phylum - Annelida

1. Body of these animals is long, cylindrical & metamerically segmented.
2. Most of the animals are free-living, but few are ectoparasites. Free-living animals may be marine or fresh water dwellers or terrestrial.
3. These animals are triploblastic, bilaterally symmetrical and eucoelomate.
4. They have setae or parapodia or suckers for locomotion.
5. Their body is covered with special cuticle.
6. These animals are either hermaphrodite or unisexual.
   Examples: Earthworm, Leech, *Nereis*, etc.



6.16 Animals in phylum Annelida

Get Information

1. Why is earthworm called as friend of farmers?
2. How may be the leech used in ayurvedic system of treatment?

Phylum- Arthropoda

1. These animals have jointed appendages. Hence they are called as arthropods.
2. Planet Earth has highest number of animals from this phylum. Hence, this is largest phylum with highly successful animals in animal kingdom.
3. These animals are found in all types of habitats ranging from deepest oceans to highest mountains.
4. Body of these animals is triploblastic, eucoelomate, bilaterally symmetrical and segmented.
5. Chitinous exoskeleton is present around their body.
6. These animals are unisexual.
   Examples: Crab, spider, scorpion, millipede, centipede, cockroach, butterfly, honey bee, etc

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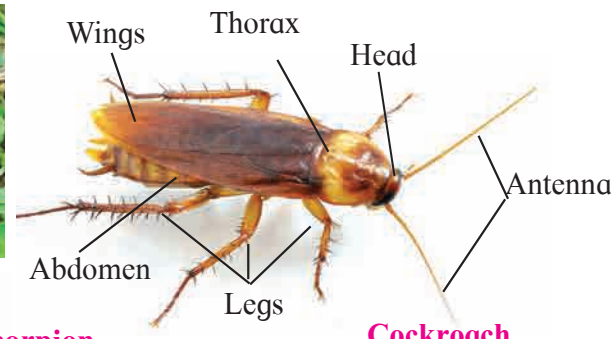
Find out

What is chitin?

Centipede



Cockroach

Butterfly

Scorpion

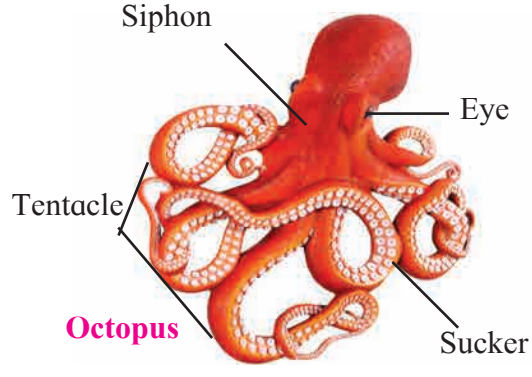
6.17 Animals in phylum Arthropoda

Lets Think

1. What types of benefit & harm occur to human from animals of phylum- Arthropoda?
2. Which are the animals from phylum Arthropoda those have shortest & longest lifespan?
3. Why has it been said that only insects directly compete with humans for food?

Phylum- Mollusca

1. Body of these animals is soft and slimy. Hence they are referred as mollusc.
2. This is second largest phylum in animal kingdom.
3. These animals are aquatic or terrestrial. Most of the aquatic molluscs are marine, but few are fresh water dwellers too.
4. Body of these animals is triploblastic, eucoelomate, non-segmented and soft. Except animals like snail, their body shows bilateral symmetry. Their body is divided into three divisions like head, foot and visceral mass.
5. Visceral mass is covered with mantle. This mantle secretes a hard, calcareous shell. This shell may be external or internal or even absent in some cases.
6. These animals are unisexual.
   Examples: Bivalve, Snail, Octopus, etc.



Octopus

Bivalve

Snail

6.18 Animals in phylum Mollusca

Surprising Information!

1. Octopus is most clever animal among all non-chordates. It can change its colour.
2. It can perform three types of locomotions like swimming, creeping & walking.

Books are my friend

Collect the information about pearl production from bivalves by reading appropriate books.

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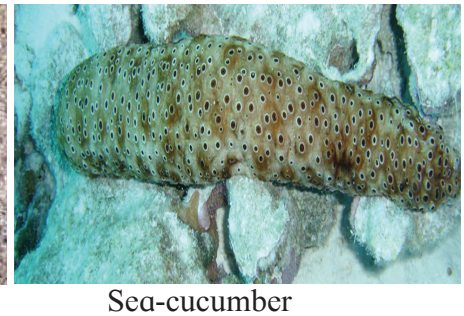
Phylum- Echinodermata

1. Calcareous spines are present on the body of these animals; hence they are called as echinoderms.
2. These animals are found only in ocean.
3. Their body is triploblastic, eucoelomate. And it is radially symmetrical in adult stage. However, they show bilateral symmetry in larval stage.
4. They perform locomotion with the help of tube-feet. Tube feet are also useful for capturing the prey. Some animals are sedentary.
5. They have skeleton made up of calcareous spines and / or ossicles (plates).
6. These animals have good ability of regeneration.
7. These animals are mostly unisexual.

   Examples: Star fish, sea-urchin, brittle star, sea-cucumber, etc.

Star fish



Sea-cucumber

Sea-urchin

6.19 Animals in phylum Echinodermata

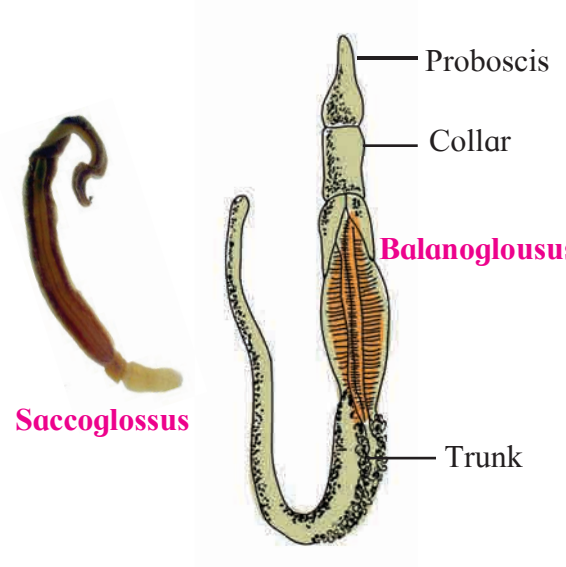
Do you know?

In certain situations, star fish can break apart its body parts and regenerate those later on.

Phylum- Hemichordata

1. Body of these animals is divided into three parts as proboscis, collar & trunk.
2. Notochord is present in proboscis region only. Hence, they are called as hemichordates.
3. These animals are also called as 'acorn worms'.
4. These are marine animals, live in burrows in sand.
5. They have one to many pharyngeal gill slits.
6. They are unisexual or some may be hermaphrodite.

   Ex.: *Balanoglossus, Saccoglossus.*



6.20 Animals in phylum Hemichordata

Through the view point of evolution, *Balanoglossus* is considered as connecting link between non-chordates and chordates. This animal shows the characters of both the groups.

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Phylum- Chordata

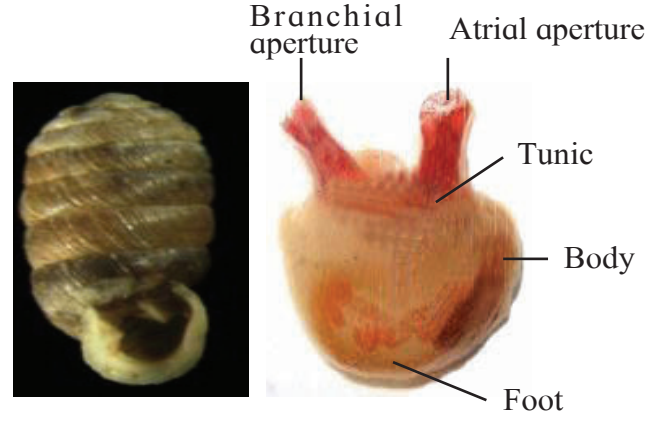
These animals have supporting notochord in their body. All chordates are included in the same phylum. The phylum Chordata is classified in to three subphyla. Following are important characters of phylum Chordata

1. Notochord is present in the body during at least any developmental stage.
2. Pharyngeal gill slits are present in the body during at least any developmental stage.
3. Single, tubular spinal cord is present on dorsal side of body.
4. Heart is present on ventral side of body.

A. Sub phylum - Urochordata

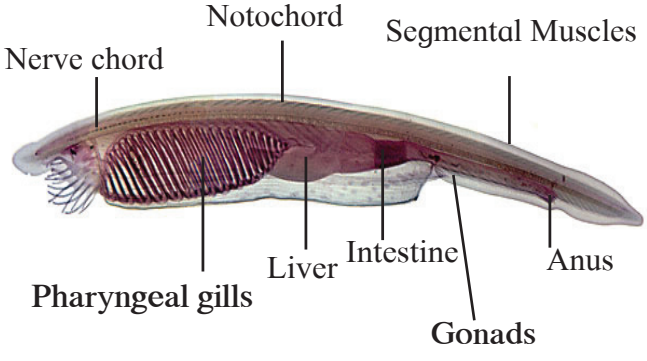
1. These are marine animals.
2. Their body is covered by skin-like test or tunic.
3. Larvae of these animals are freely swimming and notochord is present in only tail region of larvae. Hence, they are called as Urochordata.
4. Larvae metamorphose into adults after settling down at bottom of the sea.
5. Generally, these animals are hermaphrodite.

   Examples: *Herdmania, Doliolum, Oikopleura,* etc.



Doliolum **Herdmania**

6.21 Animals in Sub- phylum Urochordata



6.21 Animals in Sub- phylum Cephalochordata

B. Sub phylum -Cephalochordata

1. These are small, fish-like, marine animals.
2. Notochord is present throughout the body length.
3. Pharynx is very large and contains gill-slits.
4. These animals are unisexual.

   Ex.: *Amphioxus*.

C. Sub phylum -Vertebrata/Craniata

1. In these animals, notochord is replaced by vertebral column.
2. In these animals, head is well developed.
3. Brain is protected by cranium.
4. Endoskeleton is either cartilaginous or bony.
5. Some chordates are jaw-less (Agnatha) whereas some are with jaws (Gnathostomata).

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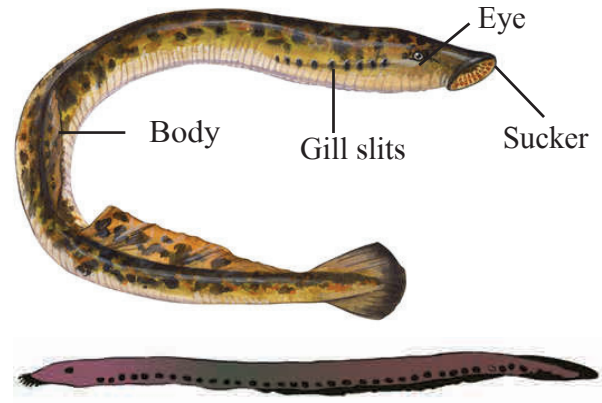
Subphylum- Vertebrata is divided into six classes as follows-

a. Class- Cyclostomata

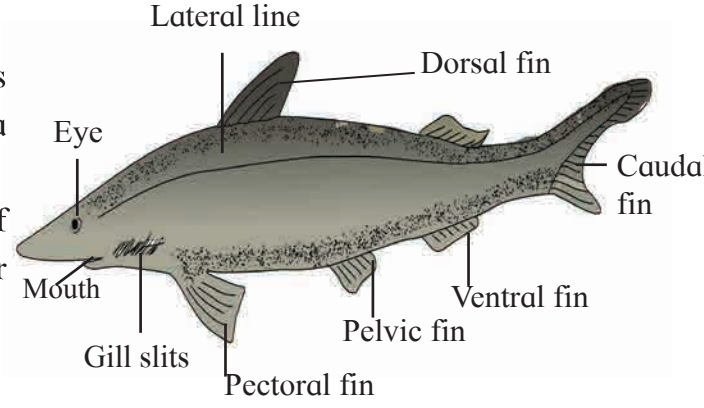
1. These animals have jaw-less mouth provided with sucker.
2. Their skin is soft and without any scale.
3. Paired appendages are absent.
4. Endoskeleton is cartilaginous.
5. Most of the animals are ectoparasites.
   Examples: Petromyzon, Myxine, etc.



6.23 : Class Cyclostomata-Petromyzon

b. Class- Pisces

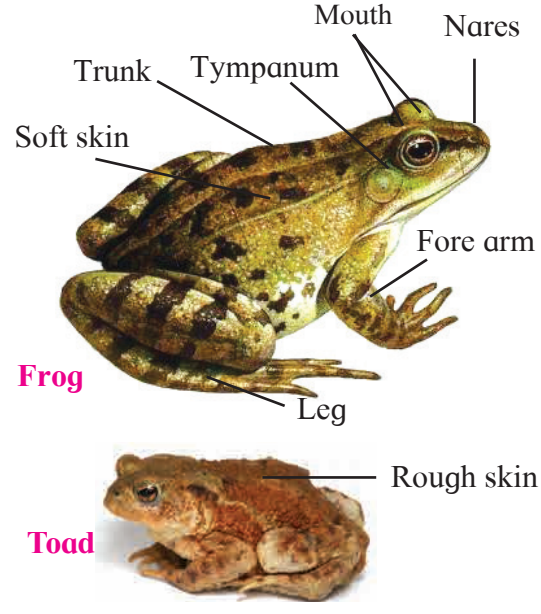
1. These are cold blooded (Poikilotherms) aquatic animals living in marine and fresh waters.
2. Body is spindle shaped to minimize water-resistance.
3. They have paired & un-paired fins for swimming. Tail fin is useful as a steering organ during swimming.
4. Exoskeleton is in the form of scales & endoskeleton is either cartilaginous or bony.
5. Respiration occurs with gills.
   Examples.: Rohu, Pomfret, Sea horse, Shark, Electric ray, Sting ray, etc.



6.24 Class Pisces : Scoliodon (Dog fish)

c. Class- Amphibia

1. These animals are strictly aquatic during larval life and perform only aquatic respiration whereas they can live in water as well as on land during adult life and can perform aquatic as well as aerial respiration.
2. They have two pairs of appendages. Digits are without claws.
3. Exoskeleton is absent. Skin is without any derivative and usually kept moist for respiration.
4. External ear is absent but tympanum is present.
5. Neck is absent. Eyes are prominent with eye lids.
   Ex.: Frog, Toad, Salamander, etc.



6.25 Class Amphibia: Frog and Toad

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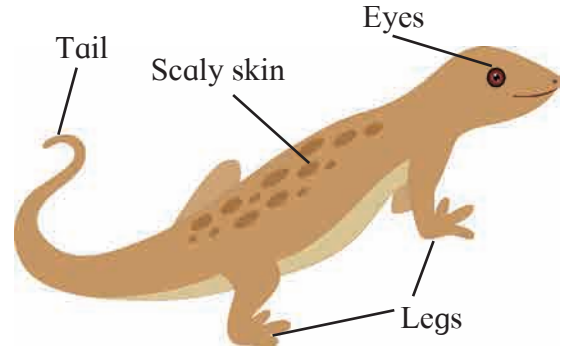
d. Class- Reptilia

1. According to the course of animal evolution, these are first true terrestrial animals with creeping movement.
2. These are cold blooded (poikilotherms) animals.
3. They creep on the land as their body cannot be lifted up.
4. Their skin is dry and scaly.
5. Neck is present between head & trunk.
6. External ear is absent.
7. Digits are provided with claws.

   Examples: Tortoise, Lizard, Snake, etc.

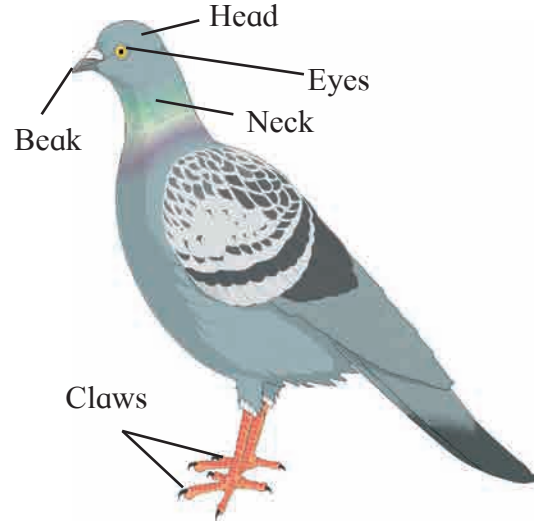


6.26 Class-Reptilia : Wall lizard

e. Class- Aves

1. These vertebrates are completely adapted for aerial life.
2. These are warm blooded (Homeotherms) i.e. they can maintain their body temperature constant.
3. Their body is spindle-shaped to minimize air resistance during flight.
4. Forelimbs are modified into wings. Digits are covered with scales and bear claws.
5. Exoskeleton is present in the form of feathers.
6. Neck is present between head and trunk.
7. Jaws are modified into beak.

   Examples: Peacock, Parrot, Pigeon, Duck, Penguin, etc

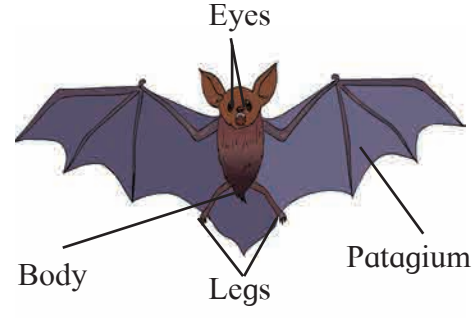


6.27 Class- Aves: Pigeon

f. Class- Mammalia

1. Presence of mammary glands is typical character of mammalia.
2. These animals are warm blooded.
3. Body is divided into head, neck, trunk and tail.
4. Digits are provided with nails, claws, or hooves.
5. Exoskeleton is in the form of hairs or fur.

   Examples: Elephant, Human, Kangaroo, Dolphin, Bat, etc.



6.28 Class-Mammalia: Bat

Use your brain power

1. Animals like ghariyal & crocodile live in water as well as on land. Are they amphibians or reptiles?
2. Animals like whale, walrus live in water (ocean). Whether they are included in pisces or mammalia?

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Use of Information Technology

Prepare the presentation of animal classification using video clips downloaded from internet.

Books are My Friends

Read the book- The Animal Kingdom: Libbie Hyman and some other similar books.

Always remember

Varieties of animals are found in our surroundings. We should be cautious about not causing any harm to animals during their studies and observations.

Exercise

1. Identify me.

a. I am diploblastic & acoelomate. Which phylum do I belong to?

b. My body is radially symmetrical. Water vascular system is present in my body. I am referred as fish though I am not. What is my name?

c. I live in your small intestine. Pseudocoelom is present in my thread like body. In which phylum will you include me?

d. Though I am multicellular, there are no tissues in my body. What is the name of my phylum?

2. Write the characters of each of the following animals with the help of classification chart.

Bath sponge, grasshopper, rohu, penguin, frog, lizard, elephant, jellyfish.

3. Write in brief about progressive changes in animal classification.

4. What is the exact difference between grades of organization and symmetry? explain win examples.

5. Answer in brief.

a. Give scientific classification of shark upto class.

b. Write four distinguishing characters of phylum- Echinodermata.

c. Distinguish between butterfly and bat with the help of four distinguishing properties.

d. To which phylum does Cockroach belong? Justify your answer with scientific reasons.

6. Give scientific reasons.

a. Though tortoise lives on land as well as in water, it cannot be included in class- Amphibia.

b. Our body irritates if it comes in contact with jelly fish.

c. All vertebrates are chordates but all chordates are not vertebrates.

d. Balanoglossus is connecting link between non-chordates & chordates.

e. Body temperature of reptiles in not constant.

7. Answer the following questions by choosing correct option.

a. Which special cells are present in the body of sponges (Porifera)?
1. Collar cells. 2. Cnidoblasts.
3. Germ cells. 4. Ectodermal cells.

b. Which of the following animals' body shows bilateral symmetry?
1. Star fish. 2. Jelly fish.
3. Earthworm. 4. Sponge.

c. Which of the following animals can regenerate it's broken body part?
1. Cockroach. 2. Frog.
3. Sparrow. 4. Star fish.

d. Bat is included in which class?
1. Amphibia. 2. Reptilia.
3. Aves. 4. Mammalia.

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8. Complete the following chart.

Body cavity	Germ Layer	Phylum
Absent	----------	Porifera
Absent	Triploblastic	----------
Pseudocoelom	----------	Aschel-minthes.
Present	----------	Arthropoda

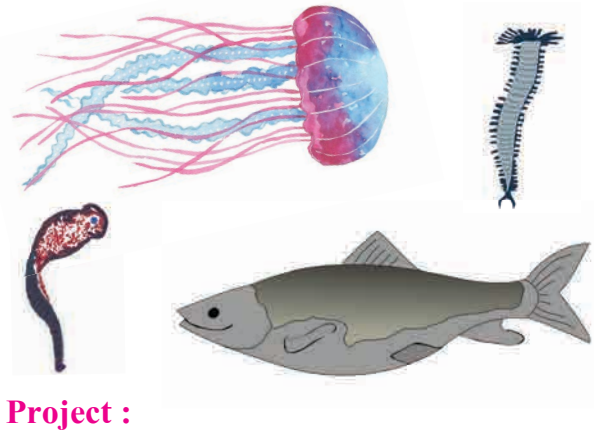
9. Complete the following chart.

Type	Character	Example
Cyclostomata		
	Gill respiration	
Amphibia		
		Whale
	Poikilotherms	

10. Sketch, labell and classify

Hydra, Jellyfish, Planaria, Round worm, Butterfly, Earthworm, Octopus, Star fish, Shark, Frog, Wall lizard, Pigeon.

11. Label the following.



Project :

In each week, on a specific day of your convenience, observe the animals present around your school & residence. Perform this activity for six months. Keep datewise record of your observations. After the observation period of six months, analyze your observations with respect to seasons. With the help of your teacher, classify the reported animals.

KYVY2P

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7. Introduction to Microbiology

- **Applied Microbiology**
- **Industrial Microbiology**
- **Products**

Can you recall?

1. Which different microbes are useful to us?
2. Which different products can be produced with the help of microbes?

Applied Microbiology

Branch of biology in which study of the enzymes related to some prokaryotes and eukaryotic microbes, proteins, applied genetics, molecular biology, etc. is performed; is called as applied microbiology. This study is used for the society and various products like food and medicines are produced on large scale with the help of microorganisms.

Industrial microbiology

This science is related to commercial use of microbes in which various economic, social and environment related processes and products are included. Various microbial processes useful for this purpose are carried out.

Industrial Microbiology: main features

A. Various productions with the help of fermentation process. Ex. Bread, cheese, wine, row material for chemicals, enzymes, nutrients, medicines, etc.
B. Use of microbes for garbage management and pollution control.

Can you recall?

We use the fermentation process while conversion of milk into yoghurt. Which microbes are useful for this process?

Products

A. Dairy Products

Since ancient days, milk is converted into various products for its preservation purpose. Ex. Cheese, butter, cream, kefir, yoghurt, etc. Water content and acidity of the milk changes during formation of these products and texture, taste and flavour is improved.

These processes are performed on large scale with more skill. For production of most of the milk products, bacteria in milk itself are used; only cheese is produced with the help of fungi. Basic process for production of yoghurt, cheese and cream is same. Milk is pasteurized at the beginning to destroy unwanted microbes. It is then fermented with the help of lactobacilli. In this process, lactose sugar of the milk is converted into lactic acid and milk proteins are coagulated with the help of lactic acid. Besides, compounds with taste and flavour are also formed. Ex. Diacetyl has the flavour of butter.

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2. Yoghurt Products

Yoghurt is a milk product produced with the help of lactobacilli (inoculant). For maintaining the protein content, condensed milk powder is mixed with milk to be fermented for industrial production of yoghurt. Milk is boiled and once it cools to warm temperature, bacterial strains of Streptococcus thermophilus and Lactobacillus delbrueckii are added to it in 1:1 proportion. Lactic acid is formed due to Streptococcus that makes the proteins to gel out that gives dense consistency to the yoghurt.

Acetaldehyde like compounds are formed due to lactobacilli that gives characteristic taste to the yoghurt. Now a day, various fruit juices are mixed with yoghurt to impart different flavours. Ex. Strawberry yoghurt, banana yoghurt, etc. Shelf life of yoghurt and its probiotic properties can be improved by pasteurization.

3. Butter

Two types of butter like sweet cream and cultured are produced on large scale. Microbes are used for production of cultured variety.

4. Cheese production

Cheese is produced on large scale from the abundantly available cow milk all over the world. First, chemical and microbiological tests of milk are performed. Some colours and microbes like Lactobacillus lactis, Lactobacillus cremoris, and Streptococcus thermophilus are mixed with milk. It imparts sourness to the milk. After this, to impart the dense texture, whey (water in yoghurt) needs to be removed.

An enzyme, rennet obtained from alimentary canal of cattle was being traditionally used earlier. However, an enzyme protease obtained from fungi is used at present to produce vegetarian cheese.

7.1 Cheese and Butter

The whey is separated from yoghurt (which has some other uses). Then, process of production of cheese is started through steps like cutting the solid yoghurt into pieces, washing, rubbing, salting, and mixing of essential microbes, pigments and flavours. Then, cheese is pressed and cut in to pieces and stored for ripening.

Lets think

1. Which different types of cheese are used in western food like pizza, burger, sandwich, etc?
2. What is difference between those types of cheese?

Do you know?

During industrial production of milk products, strict cleanliness and sterilization is essential as bacteria can be attacked by viruses. Hence, virus-resistant varieties of bacteria are developed. Recently, use of mutant varieties of bacteria has been increased. Artificially, some strains are developed that will help to avoid unnecessary steps / materials.

Freshly prepared cheese is always soft e.g. cottage cheese, cream cheese, mozzarella cheese. On storing for 3 to 12 months, semi-hard cheddar cheese is formed whereas after ripening for 12 – 18 months, very hard cheese called parmesan cheese is formed.

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Can you tell? What for probiotic food is famous?

Probiotics

These are also milk products, but contain active bacteria e.g. *Lactobacillus, Acidophilus, Lactobacillus casei, Bifidobacterium bifidum,* etc. These microbes maintain the balance of intestinal microorganisms i.e. increase the population of microbes helping the digestion and decrease the population of harmful microbes (ex. *Clostridium*). Probiotic products are available in various forms like yoghurt, kefir, sauerkraut (pickle of cabbage), dark chocolate, miso soup, pickles, oils, corn syrup, artificial sweeteners, microalgae (Sea food like *Spirulina, Chlorella*, Blue green algae, etc.).

Why the probiotics have developed much importance in recent days? These products form the colonies of useful microbes in alimentary canal and control other microbes and their metabolic activities, improve resistance and lower the ill-effects of harmful substances formed during metabolic activities. Useful microbes become inactive due to antibiotics; probiotics make them active again.

Nowaday, probiotics are used for treatment of diarrhoea and treatment of poultry also.

7.2 Probiotics

Use your brain power In the earlier class, you had prepared the solution of dry yeast for observation of yeast. Which substance is prepared by its use on commercial basis?

Bread

Different types of breads are produced from flour of cereals. Dough is formed by mixing of baker's yeast – *Saccharomyces cerevisiae*, water, salt and other necessary materials with flour. Due to fermentation of carbohydrates by yeast, sugar is converted in to carbondioxide (CO_2) and ethanol. Dough rises up due to CO_2 and the bread becomes spongy.

Compressed yeast is used in commercial bakery industry. It is available in dry, granular form for domestic use. Yeast produced for commercial use contains various useful contents like carbohydrates, fats, proteins, various vitamins, and minerals. Due to this, bread and other products produced with the help of yeast become nutritive. Ingredients like vinegar, soya sauce and monosodium glutamate (ajinomoto) that are used in presently popular chinese food are produced by microbial fermentation.

Vinegar Production

Vinegar is used in each country of the world to impart sour taste to food materials and for preservation of pickles, sauce, ketch-up, chutneys, etc. Chemically, vinegar is 4% acetic acid (CH_3COOH).

Ethanol, an alcohol is obtained by fermentation of carbon compounds like fruit juices, maple syrup, sugar molasses, starch of the roots; with the help of yeast *Saccharomyces cerevisiae*.

7.3 Vinegar

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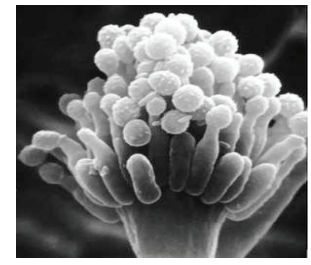
Mixture of bacterial strains like *Acetobacter* and *Glucanobacter* is mixed with ethanol for its microbial degradation. Acetic acid and other by-products are obtained through it. Acetic acid is separated from mixture by rarefaction. Acetic acid is bleached with the help of potassium ferrocynide. Then, it is pasteurized. Finally, very small quantity of SO_2 gas is mixed to produce vinegar.



7.4 *Aspergillus oryzae*

Soya sauce is produced by fermentation of the mixture of flour of wheat or rice and soyabean with the help of the fungus *Aspergillus oryzae*.

Production of beverages

Sr. No.	Fruit	Microbe used	Role of microbe	Name of beverage
1	*Caffea arabica*	*Lactobacillus brevis*	Separating seeds from fruit	Coffee
2	*Theobroma cacao*	*Candida, Hansenula, Pichia,Saccharomyces.*	Separating seeds from fruit	Cocoa
3	Grapes	*Saccharomyces cerevisiae*	Fermentation of juice	Wine
4.	Apple	*Saccharomyces cerevisiae*	Fermentation of juice	Cider

Saccharomyces cerevisiae

Fruit and seeds of coffee

Cocoa seeds

7.5 Some ingradients of beverages production

Can you tell?

1. Which functions are performed by enzymes secreted in human digestive system?
2. Give names of some such enzymes.

Microbial Enzymes

Now a day, instead of chemical catalysts, microbial enzymes are used in chemical industry. These enzymes are active at low temperature, pH and pressure; due to which energy is saved and erosion-proof instruments are also not necessary. Enzymes carry out specific processes; hence unnecessary by-products are not formed due to which expenses on purification are minimised.

In case of microbial enzymatic reactions, elimination and decomposition of waste material is avoided and enzymes can be reused. Hence, such enzymes are eco-friendly. Some examples of microbial enzymes are oxido-reductases, transferases, hydrolases, lyases, isomerases, ligases, etc.

Process of dirt / muck removal occurs at low temperature too due to mixing of enzymes with detergents. Glucose and fructose syrup can be obtained from corn flour by action of enzymes obtained from bacilli and streptomyces. Microbial enzymes are used in various industries like cheese, plant extracts, textile, leather, paper, etc.

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Use your brain power

Food materials like cold drinks, ice creams, cakes, juices are available in various colours and flavours. Whether these colours and flavours are really derived from fruits?

Search

Read the ingredients and their proportion printed on bottles of cold drinks and juices and wrappers of ice creams. Find out the natural and artificial ingredients. Wheat or rice flour is inoculated with Aspergillus.

Organic acids used in various commercial products and microbes useful for the same

Source	Microbe	Amino acid	Use
Sugar and beet molasses, ammonia salt	*Brevibacterium, Corynobacterium*	L-glutamic acid	Production of monosodium glutamate (Ajinomoto)
Sugar molasses, salt	*Aspergillus niger*	Citric acid	Drinks, toffees, chocolate production
Glucose, corn steep liquor	*Aspergillus niger*	Gluconic acid	Production of minerals used as supplement for calcium and iron
Molasses, corn steep liquor	*Lactobacillus delbrueckii*	Lactic acid	Source of nitrogen, production of vitamins.
Molasses, corn steep liquor	*Aspergillus itaconius*	Itaconic acid	Paper, textile, plastic industry, gum production

7.6 *Aspergilus niger*

What is the xanthan gum that imparts thickness to your favourite ice creams, puddings, chocolates, milk shakes, chocolate drinks, instant soups, etc.? This gum is obtained by fermentation of starch and molasses with the help of *Xanthomonas* species. It is variously useful due to properties like solubility in hot and cold water, high density, etc. It is used for production of pigments, fertilizers, weedicides, textile pigments, tooth pastes, high quality paper, etc.

Substances obtained by microbial processing and their roles

Substances obtained by microbial processing	Roles
Citirc, Malic and Lactic acid	To impart acidity
Glutamic acid, Lysine, Tryptophan	Protein binding
Nycin and natamycin	Microbial restrictor
Ascorbic acid (Vit. C), B_{12}, B_2	Antioxidants, vitamins.
Beta carotene, lycopenes, xanthenes, lutein	Edible colours
Polysaccharides, glycolipids	Emulsifiers
Vanillin, Ethyl butyrate (fruit flavour), peppermint flavour, essence of various fruits and flowers	Essence
Xylitol, aspartame	Artificial sweetener (low calorie)

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Can you recall?

1. What do you mean by antibiotic?
2. Which precautions should be taken about their consumption?

Antibiotics

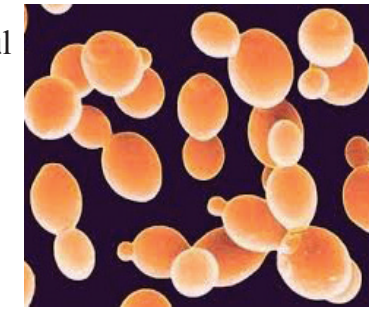
Many diseases of human and other animals have been controlled due to antibiotics obtained from different types of bacteria and fungi. Antibiotics like penicillin, cephalosporins, monobactam, bacitracin, erythromycin, gentamycin, neomycin, streptomycin, tetracyclins, vancomycin, etc. are used against various strains of gram positive and gram negative bacteria. Rifamycin is effective against tuberculosis.
in etc.

Can you tell?

1. Which different materials are decomposed in biogas plant?
2. Which useful materials are obtained through it? Which is the fuel out of those?
3. Decomposition occurs through which organisms?

Microbes and Fuels

1. Gaseous fuel- methane can be obtained by microbial anaerobic decomposition of urban agricultural and industrial waste.
2. Ethanol, an alcohol is a clean (smokeless) fuel obtained during fermentation of molasses by the yeast- Saccharomyces.
3. Hydrogen gas is considered to be the fuel of future. Hydrogen gas is released during bio-photolysis of water in which bacteria perform the photoreduction.



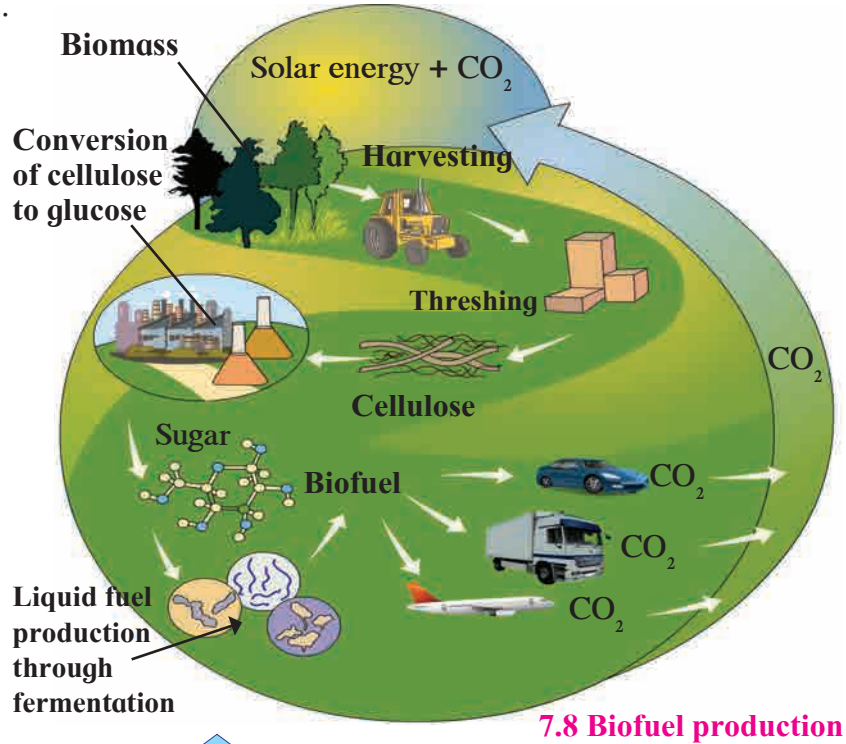
7.7 Saccharomyces yeast

Similar to fuels, various industrial chemicals are also produced through microbial process. Ex. various alcohols, acetone, organic acids, fatty acids, polysaccharides, that are useful as raw materials in chemical industry. Some of these are useful as raw materials for plastic and food products.

Observe

Observe the fig. 7.7.
Discuss about bio-fuel.

Bio-fuel : Biofuel is important among the renewable source of good energy. These fuels are available in solid (coal, dung, crop residue), liquid (vegetable oils, alcohol), gaseous (gobar gas, coal gas) forms. These fuels are easily available and in plenty of quantity. These are reliable fuels of the future.



7.8 Biofuel production

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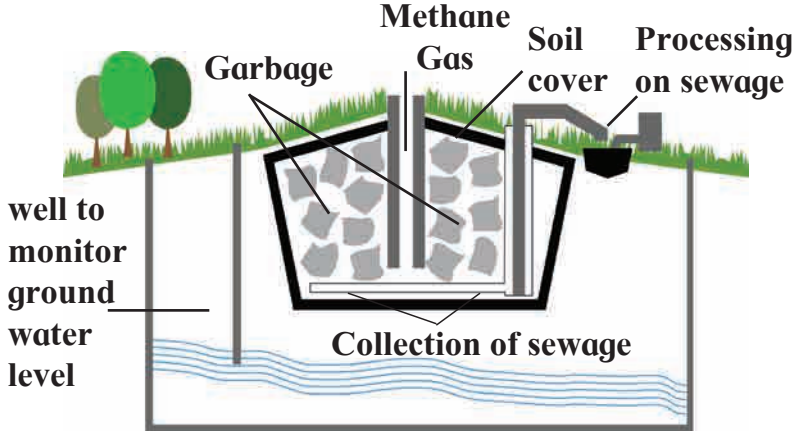
Microbial Pollution Control

Solids wastes, sewage and various pollutants are ever increasing with increase in pollution. Along with it, ever increasing diseases and degradation of environment are the world-wide problems. Especially, cities in densely populated countries like India are affected with these problems. Life of the future generations will be difficult if these problems are not solved at right time and to right extent. Let us see the role of microbes in environment.

You already know that microbes are used for disposal of solid waste through biogas plant and compost production. How urban waste that is accumulated in terms of tonnes, may be disposed off ?

Lets Think

1. Why is it asked to segregate wet and dry waste in each home?
2. What is done with the segregated waste?
3. Which is most appropriate method of disposal of dry waste?



7.9 Modern landfill site

Land-filling sites

Degradable waste being accumulated in urban areas is used for this purpose. Large pits are dug in open spaces far away from the residential area and those pits are lined with plastic sheets as a precaution against pollution of soil due to leaching of toxic and harmful materials.

Compressed waste is dumped in the pit. It is covered with layers of soil, saw dust, leafy waste and specific biochemicals. Bioreactors are mixed at some places. Microbes present in soil and other top layers decompose the waste. Completely filled pit is sealed with soil slurry. Best quality compost is formed after few days. Such land filling sites can be reused after removal of compost.

Observe

Observe the garbage vans of grampanchayat and municipality. Nowaday, there is facility of decreasing the volume of garbage by compaction in those vans. Explain the advantages of this activity.

Sewage Management

In villages, domestic sewage is disposed off either in nearby soil or in biogas plant. However, in cities, sewage needs to be carried to processing unit and acted upon by microbial processes.

Microbes which can decompose any compound as well as destroy the pathogens of cholera, typhoid, etc. are mixed with sewage. They release methane and CO_2 by decomposition of the carbon compounds present in sewage. Phenol oxidizing bacteria decompose the xenobiotic chemicals present in sewage.

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The sludge that settles down in this process can again be used as fertilizer. Water released after microbial treatment is environmentally safe. Microbes are used for bioremediation of environment polluted due to sewage.

Collect Information

1. Which materials should not be present in garbage for its proper microbial decomposition?
2. How the sewage generated in your house orapartment is disposed off ?

Clean Technology

Human being has made a very fast progress in technology. However, environmental pollution is also increasing with same speed. Let us see the ways of control over air-, soil- and water pollution with the help of microbes.

Microbes have natural ability of decomposing the manmade chemicals. Hydrocarbons and other chemicals are transformed with the help of these abilities.

1. Some microbes remove the sulphur from fuels.

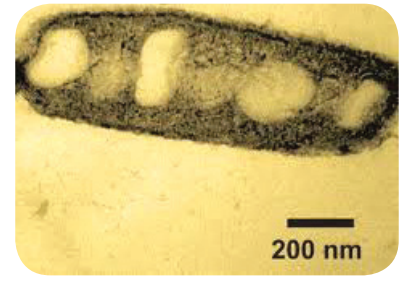
2. Metals like copper, iron, uranium, zinc, etc. leach into environment from low quality metalloids. These are converted into compounds before leaching, with the help of thiobacilli and sulphobacilli.

Can you tell?

You must have seen or read the news of dead fishes or oily water accumulating at the sea coasts. Why does this happen?

Spilling of petroleum oil occurs in ocean due to various reasons. This oil may prove fatal and toxic to aquatic organisms. It is not easy to remove the oil layer from surface of water by mechanical method. However, bacteria like *Pseudomonas* spp. and *Alcanovorax borkumensis* have the ability to destroy the pyridines and other chemicals. Hence, these bacteria are used to clear the oil spills. These are called as hydrocarbonoclastic bacteria (HCB). HCB decompose the hydrocarbons and bring about the reaction of carbon with oxygen. CO_2 and water is formed in this process.

Plastic bottles are formed from the chemical substance PET (Polyethylene Terephthalate Polyester). Now a day, most of the urban garbage consists of plastic. It has been observed that species like Vibrio, Ideonella sakaiensis can decompose the PET. Similarly, species of fungi like *Actinomycetes, Streptomyces, Nocardia, Actinoplanes* have ability of decomposing rubber from garbage.



7.10 *Alcanovorax borkumensis*

7.11 *Pseudomonas*

7.12 *Acidobacillus*

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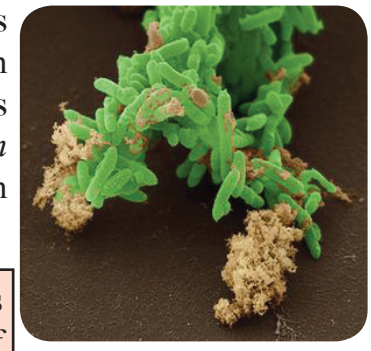
Sulphuric acid is present in the acid rain and materials coming out of mines. You know that erosion of metals present in statues, bridges and buildings occurs due to it. Sulphuric acid is source of energy for some species of bacteria like *Acidophillium* spp. and *Acidobacillus ferroxidens*. Hence, these bacteria can control the soil pollution occurring due to acid rain.



7.13 *Geobacter*

Internet is My Friend

Collect pictures of various useful microbes. Display chart of their information in classroom.

Water soluble salts of uranium are present in the wastes produced during electroplating and in effluent released in environment from the atomic energy plant. *Geobacter* convert these salts of uranium into insoluble salts and thereby prevent those salts from mixing with ground water sources.

Microbes and Farming

Can you tell?

How the bacteria present in soil and root nodules of leguminous plants are useful?

Microbial Inoculants

Some microbes-containing inoculants are produced by process of fermentation. These inoculants are sprayed on seeds before sowing and some of the inoculants are released into plants. Microbes in the inoculants help in plant growth by supplying nutrients. They improve the quality of vegetarian food. Solution containing *Azotobacter* and artificial nitrogenase is used in organic farming.

Soil pollution occurring due to chemical fertilizers is prevented due to use of these solutions. Fluoroacetamide-like chemicals are mixed with soil due to use of chemical pesticides in agriculture. These prove to be harmful to other plants and animals as well as cause skin diseases to human. These pesticides in the soil can be destroyed with the help of microbes.

Always Remember

Plastic being used for storing the garbage is biodegradable polylactic acid. Such material should be used as per need only and environment should be saved.

Bioinsecticides

Bacterial and fungal toxins which can destroy pests and pathogens can be directly integrated into plants with the help of biotechnology. Being toxic to insects, they do not consume the plants. Similar to bacteria, some species of fungi and viruses are useful as pesticides. Spinosad, a by-product of fermentation is a biopesticide.

7.14 Caterpillar feeding on leaf

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Exercise

1. Rewrite the following statements using correct of the options and explain the completed statements.

(gluconic acid, coagulation, amino acid, acetic acid, clostridium, lactobacilli)

a. Process of -- -- -- -- of milk proteins occurs due to lactic acid.

b. Harmful bacteria in like -- -- -- in the intestine are destroyed due to probiotics.

c. Chemically, vinegar is -- -- --.

d. Salts which can be used as supplement of calcium and iron are obtained from -------- acid.

2. Match the pairs

'A' group	'B' group
a. Xylitol	1. Pigment
b. Citric acid	2. To impart sweetness
c. Lycopene	3. Microbial restrictor
d. Nycin	4. Protein binding emulsifier
	5. To impart acidity

3. Answer the following.

a. Which fuels can be obtained by microbial processes? Why is it necessary to increase the use of such fuels?

b. How can the oil spills of rivers and oceans be cleaned?

c. How can the soil polluted by acid rain be made fertile again?

d. Explain the importance of biopesticides in or ganic farming.

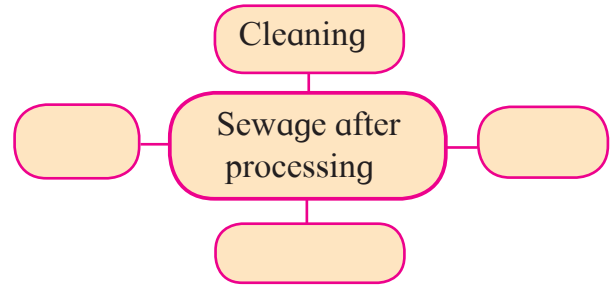
e. Which are the reasons for increasing the popularity of probiotic products?

f. How the bread and other products produced using baker's yeast are nutritious?

g. Which precautions are necessary for proper decomposition of domestic waste?

h. Why is it necessary to ban the use of plastic bags?

4. Complete the following conceptual picture.



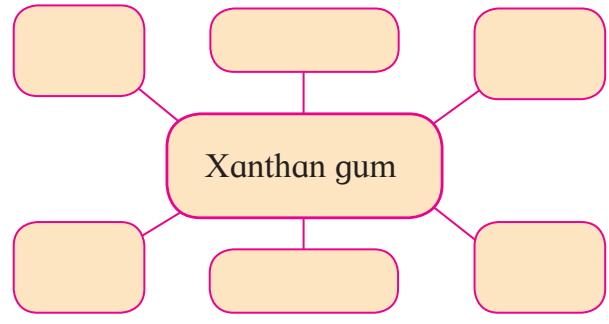
5. Give scientific reasons.

a. Use of mutant strains has been increased in industrial microbiology.

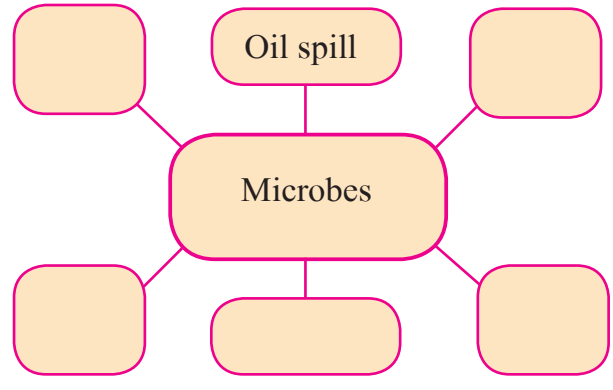
b. Enzymes obtained by microbial process are mixed with detergents.

c. Microbial enzymes are used instead of chemical catalysts in chemical industry.

6. Complete the following conceptual picture with respect to uses.



7. Complete the following conceptual picture related to environmental management.



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8. Answer the following.

a. What is role of microbes in compost production?

b. What are the benefits of mixing ethanol with petrol and diesel?

c. Which plants are cultivated to obtain the fuel?

d. Which fuels are obtained from biomass?

e. How does the bread become spongy?

Project :

1. Find the ways to implement the zero garbage system at domestic level.
2. Which are the microbes that destroy the chemical pesticides in soil?
3. Collect more information about reasons for avoiding the use of chemical pesticides.

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8. Cell Biology and Biotechnology

- Cell Biology (Cytology)
- Biotechnology and Its Applications
- Stem Cells
- Important Stages in Development of Agriculture

Can you Recall

1. What is cell?
2. What is tissue? Which are the functions of tissue?
3. Which technique in relation to tissues have you studied in earlier classes?
4. Which are the various processes in tissue culture?

We have studied the plant production by technique of tissue culture in the last class. Stem cells are used for that purpose. Whether such stem cells are present in animals?

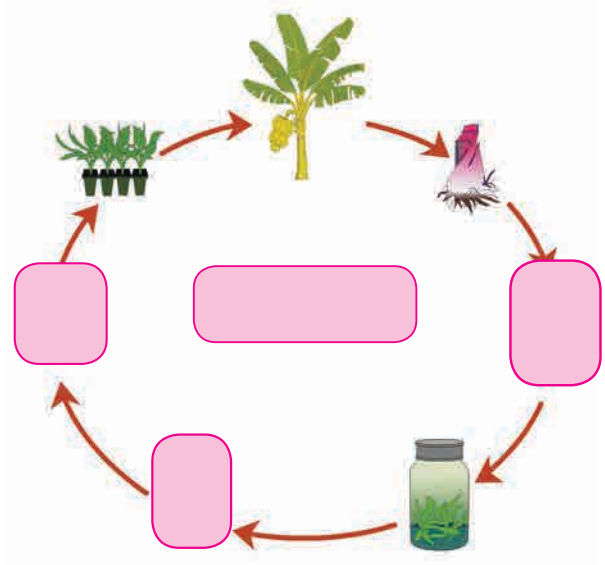
Observe

Assign names in the figure given below. Explain the various stages those are kept blank.

Cytology

Earlier, we have studied the structure, types and organelles of the cell. This is called as cell biology / cytology. Besides above mentioned points, it includes the study of cell division and many other aspects of the cell.

There are revolutionary changes in the field of human health due to cell biology. Research institutes specially dedicated for research on cells are established at Pune and Bengaluru, India. National Center for Cell Science (http://www.nccs.res.in) at Pune and 'Instem' (http://www.instem.res.in) at Bengaluru are involved in valuable research.



8.1 Diagram

Visit both the websites mentioned above and with the help of your teacher, try to understand the research undergoing in those institutes.

Stem Cells

These are special types of cells present in the body of multicellular organisms. These cells give rise to all other types of cells present in the boy of multicellular organisms. Similarly, these cells play an important role in wound healing.

We had studied the stem cells of plants in the previous class. Now, we shall study the stem cells in animals, particularly in human beings.

New organism is formed from the zygote that is formed by union of male and female gamete. At the earliest stage of development, organism is in the form of a mass of cells. All the cells in that mass are almost alike. Those cells are called as stem cells.

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During further development, these cells form any type of cell, different types of tissues and perform different functions in the body. This is the differentiation of stem cells. However, once the tissues are formed, the cells in those tissues, at the most, can form same types of cells only. This is the case in each part of the body. However, stem cells are present for longer duration in some parts of the body.

Stem cells are present in the umbilical cord by which the fetus is joined to the uterus of the mother. Stem cells are also present in the blastocyst stage of embryonic development. Stem cells are present in red bone marrow and adipose connective tissue of adult human beings. It has become possible to produce different types of tissues and the degenerated part of any organ with the help of these stem cells.

Stem Cell Preservation

For the purpose of preservation, stem cell samples are carefully collected from sources like cord blood, red bone marrow or embryo (blastocyst) and are kept in small, sterile vials. Those vials are kept in liquid nitrogen at -135^{0}C to -190^{0}C.

Use your brain Just like the grafting in plants, is the organ transplantation possible in humans?

Stem cell research

In biotechnology, stem cell research is a revolutionary event after cloning. This technique has the potential of bringing about the fundamental changes in the medical science.

Depending upon source, stem cells are of two types as embryonic stem cells and adult stem cells.

Embryonic stem cells

Division of the zygote starts and thereby it is converted into embryo. Cells of embryo undergo repeated mitotic divisions. Cell differentiation starts from 14th day of conception. Cells of different organs like osteocytes (bone cells), hepatocytes (liver cells), and neurons are formed due to differentiation. Embryonic cells before differentiation are called as embryonic stem cells. 220 different types of cells in human body are formed from single type cells i.e. embryonic stem cells. Thus, stem cells are primary type of undifferentiated cells with self-multiplying ability and they are parent cells of all types of human cells. This property of stem cells is called as pleuripotency. It has been found that if these stem cells are collected well before the beginning of differentiation on 14th day i.e. during 5th – 7th day and cultured with certain biochemical stimulus in laboratory, as per the stimulus, they can transform themselves into desired type of cells, thereby tissues and finally into organs.

Adult stem cells

Stem cells can be obtained from the body of adult person too. There are three main sources of stem cells in the body of adult persons. Stem cells can be obtained from red bone marrow, adipose connective tissue and blood. Besides, stem cells can be obtained from cord blood immediate after birth.

Uses of Stem Cells

1. Regenerative Therapy

A. Cell Therapy: Stem cells are used to replace the dead cells in case of conditions like diabetes, myocardial infarction, Alzheimer's disease, Parkinson's disease, etc.

B. To produce blood cells required in conditions like anemia, thalassaemia, leukemia, etc.

2. Organ Transplantation: In case of failure of organs like kidney and liver, those can be produced with the help of stem cells and transplanted.

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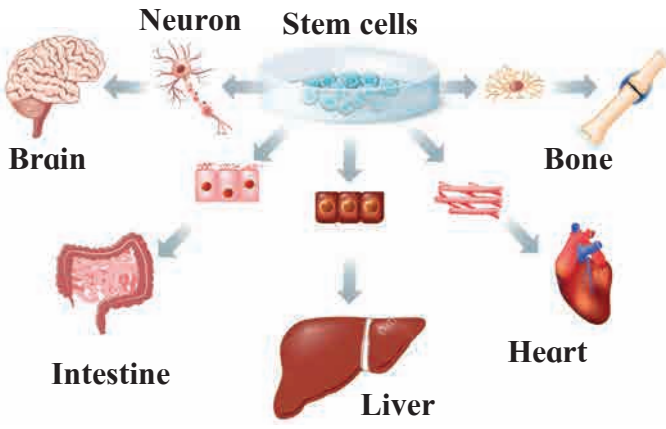
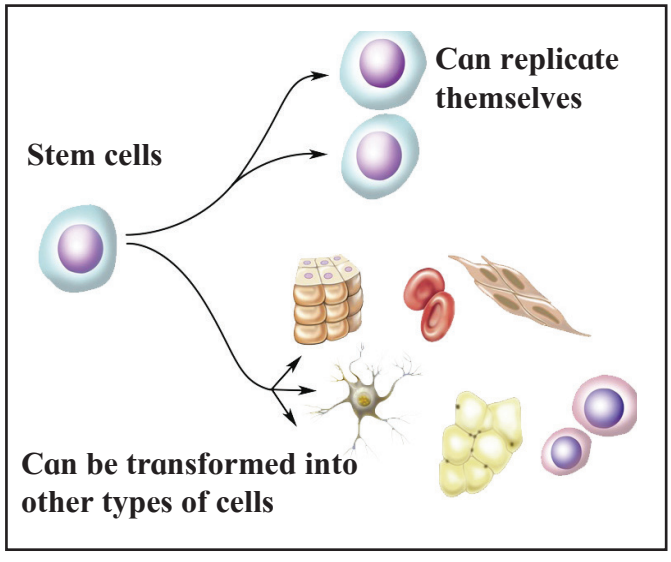
Observe

Discuss about stem cells and organ transplantation in the class with the help of figures given below.



8.2 Stem cells and organs



8.3 Stem cells theropy

Organ transplantation

Various organs in the human body either become less efficient or completely functionless due to various reasons like aging, accidents, infections, disorders, etc. Life of such person becomes difficult or even fatality may occur under such conditions. However, if a person gets the necessary organ under such conditions, its life can be saved.

Availability of donor is an important requirement in organ transplantation. Each person has a pair of kidneys. As the process of excretion can occur with the help of single kidney, person can donate another one. Similarly, skin from certain parts of the body can also be donated.

Various factors like blood group, diseases, disorders, age, etc. of the donor and recipient need to be paid attention during transplantation.

However, other organs cannot be donated during life time. Organs like liver, heart, eyes can be donated after death only. This has lead to the emergence of concepts like posthumous (after death) donation of body and organs.

Organ and Body Donation: Human bodies are disposed off after death as per traditional customs. However due to progress in science, it has been realized that many organs remain functional for certain period even after death occurrs under specific conditions. Concepts like organ donation and body donation have emerged recently after realization that such organs can be used to save the life of other needful persons. A liberal view behind the concept of organ and body donation is that after death, our body should be useful to other needful persons so that their miserable life would become comfortable. Awareness about these concepts is increasing in our country and people are voluntarily donating their bodies.

Life of many people can be saved by organ and body donation. Blinds can regain the vision. Life of many people can be rendered comfortable by donation of organs like liver, kidneys, heart, heart valves, skin, etc. Similarly, body can be made available for research in medical studies. Many government and social organizations are working towards increasing the awareness about body donation.

Internet is my friend

Visit the websites- http://www.who.int/transplantation/organ/en/ & www.organindia.org/approaching-the-transplant/ and collect more information about 'brain dead', organ donation and body donation.

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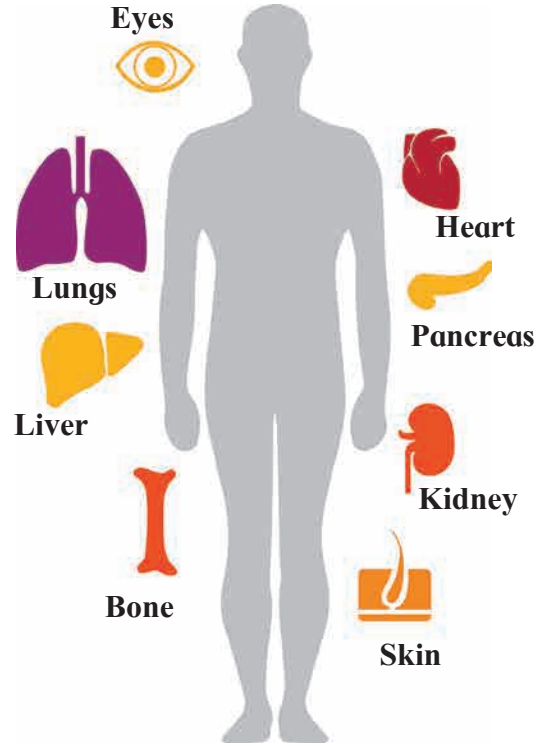
Always Remember

Organ donation and transplantation is under the control of 'Transplantation human organs act, 1994' and subsequent amendments of 2009, 2011 and 2014 so that overall process would be transparent and any person would not be cheated.

Recall A Little

1. What is biotechnology?
2. In which various fields, the biotechnology has been useful?
3. What the impact of biotechnology on agriculture and other related fields?



8.4 Organs that can be donated

Biotechnology

We have studied in the earlier class that biotechnology is bringing about artificial genetic changes and hybridization in organisms for human welfare. Various branches of science like cytology, biochemistry, molecular biology, and genetic engineering are included in biotechnology. There is considerable progress mainly in the field of agriculture and pharmacy due to biotechnology. New experiments are being performed for improving the agricultural yield. In pharmacy, experiments for production of antibodies, vitamins, and hormones like insulin have been successful. High-class varieties of crops have been developed through the technique of tissue-culture.

Biotechnology includes following main areas

1. Use of various abilities of microbes like yoghurt production from milk and alcohol from molasses.
2. Use of productivity of the cells. Ex. – Production of antibiotics and vaccines, etc. with the help of specific cells.
3. Use of bio-molecules like DNA and proteins in human welfare.
4. Development of plants, animals and products of desired quality by gene manipulation. Production of human growth hormone with the help of genetically modified bacteria.
5. Use of genetic and non-genetic technique. Non-genetic biotechnology involves use of either cell or tissue. Ex. Tissue culture, production of hybrid seeds, etc.

Benefits of Biotechnology

1. It has become possible to increase the per hectare yield irrespective of the limitations of crop-land area.
2. Expenses on disease control have minimized since development of resistant varieties.
3. Due to development of fast fruit setting varieties, yield per annum has been increased.
4. Development of stress resistant varieties which can withstand variable temperature, water-stress, changing fertility of soil, etc. has become possible.

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Development of Biotechnology in India

Government of India had established the National Biotechnology Board in 1982. This board was transformed into department of biotechnology under the ministry of science and technology, in 1986. Various institutes in India are working under the control of this department of biotechnology. It includes National Institute of Immunology, National Facility for Animal Tissue and Cell Culture, National Centre for Cell Science, National Brain Research Centre, Central Institute of Medicinal and Aromatic Plants. There are facilities of higher education and research in these institutes from where thousands of students have pursued Ph.D. degrees and are contributing to the progress of country in the field of biotechnology.

Commercial Applications of Biotechnology:

1. Crop Biotechnology: Biotechnology is used in agricultural field to improve yield and variety.

a. Hybrid Seeds: Genes of two different crops are recombined to form hybrids of various crops. This is especially useful for fruits.

b Genetically Modified Crops: Crops developed with desired characters by integrating foreign gene with their genome are called as genetically modified crops. High yielding varieties with resistance to diseases, alkalinity, weeds other stresses like cold and drought.

BT Cotton: A gene had been isolated from the bacterium Bacillus thuringiensis and integrated with the gene of cotton. Due to this, the toxin which is fatal for bollworm was produced in leaves and bolls of cotton. If bollworm feeds on leaves, the toxin destroys its alimentary canal and the bollworm dies.

BT Brinjal: BT Brinjal variety is developed by using the gene isolated from Bacillus thuringiensis. This improved variety of brinjal kills the pest in same way as the BT cotton does.

Golden Rice: A gene synthesizing the vitamin A (Beta carotene) has been introduced in this variety of rice. As compared to the normal variety, this variety which has been developed in 2005 contains 23 times more amount of beta carotene.

Herbicide tolerant plants: Weeds always affect the growth of main crop. If herbicides are used to destroy the weeds, it affects the main crop too. Due to this, Herbicide tolerant plants varieties of crops are being developed. Due to this, it has become possible to selectively destroy the weeds.

8.5 Some crops

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c. Biofertilizers

Due to use of biofertilizers instead of chemical fertilizers, nitrogen fixation and phosphate solubilization abilities of the plants are improved. Mainly the bacteria like *Rhizobium, Azotobacter, Nostoc, Anabaena* and plants like *Azolla* are used as biofertilizers.

In the last year, we have studied the tissue culture. Genetic improvement of the plants has become possible due to tissue culture and besides, those characters inherited to next generation.

8.6 Azolla

Make a list and discuss

Give five examples of each of the fruiting and flowering plants developed through tissue culture and metion their benefits.

2. Animal Husbandry

Two main methods as artificial insemination and embryo transfer are used in animal husbandry. It helps to improve both, the quantity and quality of animal products. Ex. Milk, meat, wool, etc. Similarly, animals with more strength have been developed for hard work.

USE OF ICT

Collect information about various hybrid varieties of animals. What are their benefits? Make a presentation of various pictures and videos.

3. Human Health

Diagnosis and treatment of the diseases are two important aspects of the human health management. Biotechnology helps to identify the role of gene, if any, in disease of a person. Diagnosis of diabetes and heart diseases has become possible even before the onset of symptoms, with the help of biotechnology. Diagnosis of the diseases like AIDS, dengue can be done within few minutes. Hence, treatment can be done at the earliest.

Various medicines are used for the treatment of diseases. Ex. The hormone insulin is used in treatment of diabetes. Earlier, insulin was being collected from the pancreas of horses. However, nowadays, due to biotechnology, insulin can be prepared with the help of bacteria. For this purpose, human insulin gene has been inserted into the genome of bacteria. Various vaccines and antibiotics are also produced in the same way.

a. Vaccines and Vaccination: Vaccine is the 'antigen' containing material given to acquire either permanent or temporary immunity against a specific pathogen or disease. Traditionally, vaccines were prepared with the help of pathogens. Completely or partially killed pathogens were used as vaccines. However, due to this, there were chances of contracting the disease in case of some persons. Hence, as an alternative, scientists tried to artificially produce vaccines with the help of biotechnology. For this purpose, scientists produced the antigen in laboratory with the help of gene isolated from the pathogen and used it as vaccine. Thus, safer vaccines are being produced.

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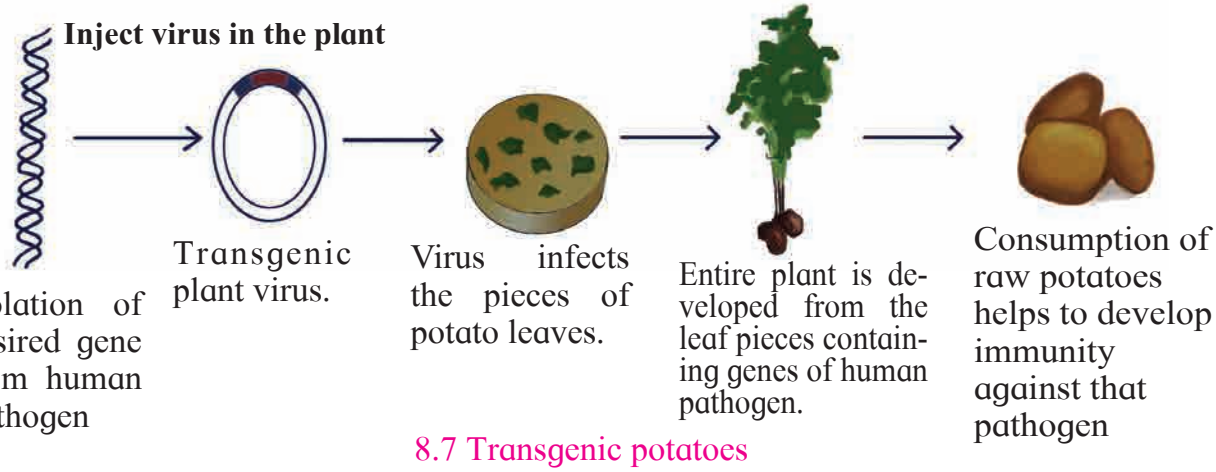
Now, proteins which act as antigen are injected in pure form instead of injecting the killed or semi-killed pathogens. These proteins keep the persons away from the diseases by keeping the immune system active. Thus, injecting the antigens is safest way in vaccination. Vaccines produced with the help of biotechnology are more thermo-stable and remain active for longer duration. Ex. Vaccines of polio, hepatitis,

Edible Vaccines: Work on production of edible vaccines is in progress and presently, potatoes are being produced with the help of biotechnology. These potatoes are called as transgenic potatoes. These potatoes will act against bacteria like *Vibrio cholerae, Escherichia coli.* Consumption of these raw potatoes generates the immunity against cholera and the disease caused due to *E. coli.* What will happen if these potatoes are cooked for consumption?



8.7 Transgenic potatoes

b. Treatment: Biotechnology is useful for production of hormones like insulin, somatotropin and blood clotting factors.

c. Interferon: This is a group of small sized protein molecule used in treatment of viral diseases. These are produced in blood. However, nowadays, with the help of biotechnology, transgenic E. coli are used for production of interferon.

d. Gene therapy: Gene therapy to treat genetic disorders in somatic cells has become possible due to biotechnology. Ex. Phenylketonuria (PKT) arises due to genetic changes in hepatocytes (liver cells). It has become possible to treat it with gene therapy. This method is called as somatic cell gene therapy. All the cells except sperms and ova in the body are called as somatic cells

Do you know ?

Indian Institute of Science has developed a transgenic variety of tobacco. If cattles feed upon leaves of this plant, they do not contract a viral disease- rinderpest.

e. Cloning: Production of replica of any cell or organ or entire organism is called cloning.

i. Reproductive cloning: A clone can be produced by fusion of a nucleus of somatic cell with the enucleated ovum of anybody. Thus, there is no need of sperm to produce the new organism.

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Internet My Friend Collect more information about the Human Genome Project, one of the important projects in the world

ii. Therapeutic cloning

Stem cells can be derived from the cell formed in laboratory by the union of somatic cell nucleus with the enucleated egg cell. Various diseases can be treated with the help of these stem cells.

* Similar to cells, genes can also be cloned and millions of copies of same gene can be produced. Those can be used for gene therapy and other purposes.
* Controlling the inheritance of hereditary diseases, continuation of generations, enhancing the specific tendency may become possible due to cloning tech nique. However, there is world-wide opposition to human cloning on various issues.

4. Industrial Products / White Biotechnology

Various industrial chemicals can be produced through less expensive processes. Example: Alcohol production from sugar molasses with the help of transgenic yeast.

5. Environment and Biotechnology

It has become possible to solve environment related various problems with the help of biotechnology.

Microbial techniques are already in use for treatment on sewage and solid waste. Sewage is rich in organic matter. If such sewage is released in natural water bodies like rivers, the organic matter in it gets oxidized with the help of dissolved oxygen. Due to this, level of dissolved oxygen in water decreases, adversely affecting the aquatic life. As a remedy on this, sewage should be released in to rivers only after oxidation with the help of microbial technique.

See the proteins produced by biotechnology and the names of diseases they are used against-

1.	Insulin	Diabetes
2.	Somatostatin	Dwarfism
3.	Erythropoietin	Anemia
4.	Factor VIII	Hemophilia
5.	Interleukin	Cancer
6.	Interferon	Viral infection

Peeking into History

A sheep 'Dolly' was born in Scotland by cloning technique on 5th July 1996. Nucleus from the udder cell of sheep of 'Finn Dorset' variety had been introduced into enucleated ovum of Scottish sheep. Then, the ovum was allowed to develop in the uterus of Scottish sheep and thereby the 'Dolly' had been born. It was showing the characters as per the chromosomes in nucleus and any character of Scottish sheep was not visible.

Dolly (Clone)

i. Microbes are useful on large scale while production of compost by treatment on solid organic waste material.
ii. Bio-remediation, biopesticides, biofertilizers, biosensors, etc, are some new concepts in biotechnological methods.

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Bioremediation means either absorption or destruction of toxic chemicals and harmful pollutants with the help of plants and microorganisms. If plants are used for this purpose, it called as 'phyto-remediation'. Some examples of bioremediation are as follows-

* The *Pseudomonas* bacteria are useful for cleaning the hydrocarbon and oil pollutants from soil and water.
* The fern *Pteris vitata* can absorb the arsenic from the soil.
* Genetically modified variety of Indian mustard can absorb selenium from soil.
* Sunflower can absorb uranium and arsenic.
* The bacterium *Deinococcus radiodurans* is highly radiation resistant organism. It has been genetically modified and used to absorb the radiations from radioactive debris.
* Grasses like alfalfa, clover and rye are used in phyto-remediation.

5. **Food Biotechnology:** Food items like bread, cheese, wine, beer, yoghurt, vinegar are produced with the help of microorganisms. These food items are probably the oldest ones produced with the help of biotechnology.
6. **DNA fingerprinting:** DNA sequence of each person is unique as that of the fingerprints. Due to this, identity of any person can be established with the help of its available DNA. This is called as DNA fingerprinting. It is mainly useful in forensic sciences. Identity of the criminal can be established with the help of any part of its body found at the site of crime. Similarly, identity of father of any child can be established. This research is performed in Center for DNA fingerprinting and Diagnostics, Hyderabad.

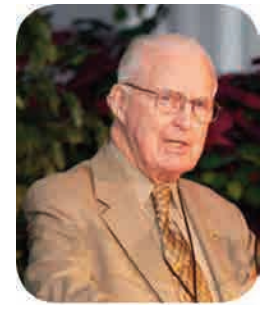
Cleaning of Oil Spillage in Oceans: If oil spillage occurs, it adversely affects the marine life. Now, cleaning the ocean without any harm to environment in cheaper way has become possible with the help of oil-digesting and fast multiplying bacteria. India born American citizen and scientist Dr. Anand Mohan Chakravarti had for the first time suggested the use of such microbes. Naturally, the credit for this discovery goes to him.

Important stages in agricultural develoment

Green revolution

Problems of population explosion were started to appear at the beginning of 20th century. Almost all the countries, especially underdeveloped and developing countries had been badly affected by the effects of poor quality and quantity of food. Various methods applied for harvesting maximum yield from minimum land are collectively called as green revolution.


Dr.M.S Swaminathan


Dr. Norman Borlog

Improvised dwarf varieties of wheat and rice, proper use of fertilizers and pesticides and water management has led to the increased production of food grains and thereby large population had been saved from hunger. Dr. Norman Borlaug (USA) and Dr. M. S. Swaminathan (India) have valuable contribution in green revolution.

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Various research institutes and laboratories are engaged in development of new varieties of various crops through research. Ex. Indian Agricultural Research Institute (IARI), New Delhi, National Citrus Research Institute, Nagpur and allied branches, Indian Institute of Sciences, National Pomegranate Research Institute, Solapur.

Collect Information

Which new species of the rice have been developed in India?

Internet is My Friend

Collect the information and make the chart about the work of various state and national-level institutes related with biotechnology.

White revolution

Various parts of India were rich in milk and milk products. However, those products were not sufficient to meet the needs of far-flung regions. Dr. Verghese Kurien proved through the cooperative movement and use of biotechnology that Dairy cannot be allied but it will be a mainstream business. He put the cooperative dairy movement of Anand, Gujarat at all time high status.

While achieving the self-sufficiency in dairy business, various experiments were performed for quality control, newer dairy products and their preservation. Why people from all over the world are again preferring the local wild varieties?

8.8 Milk processing and milk products

Blue revolution

Production of various useful aquatic organisms with the help of water is called as blue revolution. Farm ponds and the fishes are very common in East Asian countries. However, people are not only thinking of cultivating the fishes and shrimps but other aquatic plants and animals too. Government of India has vowed to increase the production by encouraging the people for pisciculture by launching the program 'Nil-Kranti Mission-2016' (NKM-16). 50% to 100% subsidies are offered in this case.

Marine and fresh water fishery is possible on large scale. Fresh water fishes like rohu, catla and other fishery products like shrimp and lobsters are being cultured on large scale

8.9 Pisciculture : Prawns

Fertilizers

Two types of fertilizers are used in agriculture. One of those is organic manure and others are chemical fertilizers. Water holding capacity of the soil improves with soil conservation due to use of manures.

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Upper layer of the soil essential in agriculture is formed due to humus formation. Various essential elements like N, P, K can be available to crops due to earthworms and fungi. In soil-less farming i.e. hydroponics, liquid chemical fertilizers are used. However, there are more harmful effects of liberal use of chemical fertilizers. It includes decrease in fertility of soil.

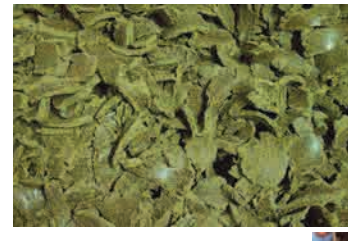
8.10 Fertilizers and Insecticides

Insecticides

Though the natural immunity of plants can prevent the infections, use of insecticides is not under control. Irrespective of the natural friends of farmers like frogs and insectivorous birds, pesticides are used on large scale for increase in yield. Pesticides are in fact a type of poison. This poison enters the food-web through water and food and its bio-magnification occurs. Various pesticides like DDT, malathion, chloropyriphos, etc. have been proved to be dangerous.

Organic farming

Now a days, organic farming and organic products have become buzzwords. Organic products are being available and demand for them is ever-increasing.



Oil cake

Chemical fertilizers and pesticides have been used on large scale. These poisonous chemicals reached the human body through food and water and their adverse harmful effects on human and environment became apparent.

Vermiculture

8.11 Oil cake and Vermiculture

Various problems like soil fertility and pest infestation have become serious. So as to overcome these problems, farmers are opting for organic farming. It includes complete ban on chemical fertilizers and pesticides and use of local, sturdy varieties and thereby maintaining natural balance. Definitely, this is a welcome decision.

8.12 Apiculture

Apiculture

You must have seen the bee hive. Worst method of harvesting / collecting the honey from these hives is driving away the bees by smoking the hive with burning torch and then cutting the hive into pieces. This method causes the destruction of hive and large scale death of bees. However, it is easy to collect the honey without destroying the hive and bees, if artificial bee boxes are used.

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Cultivation of Medicinal Plants

India has been gifted with a great biodiversity. Indian citizens have established the humble and strong relation with the nature. We have a great tradition of ayurveda that cures the diseases with the help of natural sources.

8.13 Adhatoda vasica (Adulsa) and Melia azadiracta (Neem)

Try this

Bring a packet of 'Balghuti' from ayurveda shop. Learn the information about each component in it. Collect information about various other medicines and prepare the chart as shown below.

Local Name of plant	Name of active ingredient	Uses
Adulsa	Vasicine present the leaves	Cough

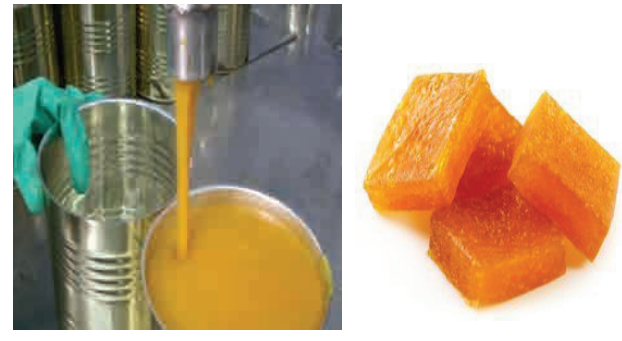
During earlier days, medicinal plants were collected from the forest. However, due to depletion in forest area, medicinal plants are becoming rare. Hence, medicinal plants are being cultivated.

Make a list and discuss

Which fruit processing industries you observe in your surrounding ? What is their effect ?

Fruit Processing

We are daily using various products prepared from fruits. All are consuming the products like chocolates, juices, jams and jellies. All these products can be produced by processing on fruits. Fruits are perishable agro-produce. It needs the processing in such a way that it can be used throughout the year. Fruit processing includes various methods ranging from storage in cold storage to drying, salting, air tight packing, preparing murabba, evaporating, etc.



8.14 Mango processing Unit

Exercise

1. Fill in the blanks and complete the statements.

a. Methods like artificial insemination and embryo transplant are mainly used for --

b. -- -- -- -- is the revolutionary event in biotechnology after cloning.

c. The disease related with the synthesis of insulin is --- --- ---.

d. Government of India has encouraged the -- -- --- -- for improving the productivity by launching NKM-16.

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2. Match the pairs.

a. Interferon	1. Diabetes
b. Factor	2. Dwarfness
c. Somatostatin	3. Viral infection
d. Interleukin	4. Cancer
	5. Hemophilia

3. Rewrite the following wrong statements after corrections.

a. Changes in genes of the cells are brought about in non-genetic technique.

b. Gene from *Bacillus thuringiensis* is introduced into soyabean.

4. Write short notes.

a. Biotechnology: Professional uses.

b. Importance of medicinal plants.

5. Answer the following questions in your own words.

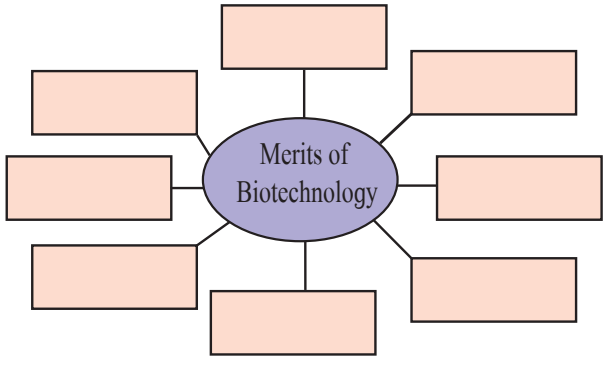
a. Which products produced through biotechnology do you use in your daily life?

b. Which precautions will you take during spraying of pesticides?

c. Why some of the organs in human body are most valuable?

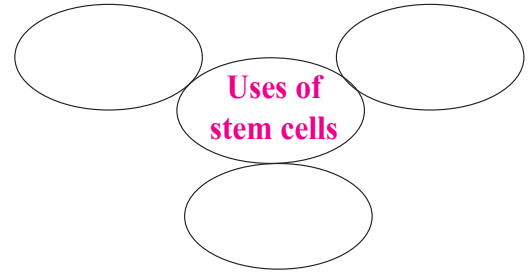
d. Explain the importance of fruit-processing in human life?

e. Explain the meaning of vaccination.



6. Complete the following chart.

7. Write the correct answer in blank circles.



8. Identify and complete the following correlations.

a. Insulin : Diabetes :: Interleukin : -- -- --

b. Interferon : -- :: Erythropoietin : Anemia.

c. ------- : Dwarfness :: Factor VIII : Hemophilia.

d. White revolution : Dairy :: Blue revolution : -- -- -- --.

9. Write a comparative note on usefulness and harmfulness of biotechnology.

Projects:

1. Visit the organic manuring projects nearby your place and collect more information.
2. What will you do to increase public awareness about organ donation in your area?
3. Collect information about 'green corridor'. Make a news-collection about it.

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9. Social health

- Social Health
- Stress Management
- Factors endangering the social health

Lets Think

Elders always instruct you to get out of the home to interact with relatives and others and play outdoor games but not to spend time continuously with television, phone and internet

Why the children of your age are instructed same in each home? Our lifestyle has been changed to some extent in this age of technology. Each person is busy with own daily routine work and favorite job only. How much is it scientifically correct?

Earlier, we have studied the importance of physical health, cleanliness and staying healthy. However, the concept of health does not end with it only.

Try this

Classify your classmates into following groups depending upon the observation for a week.

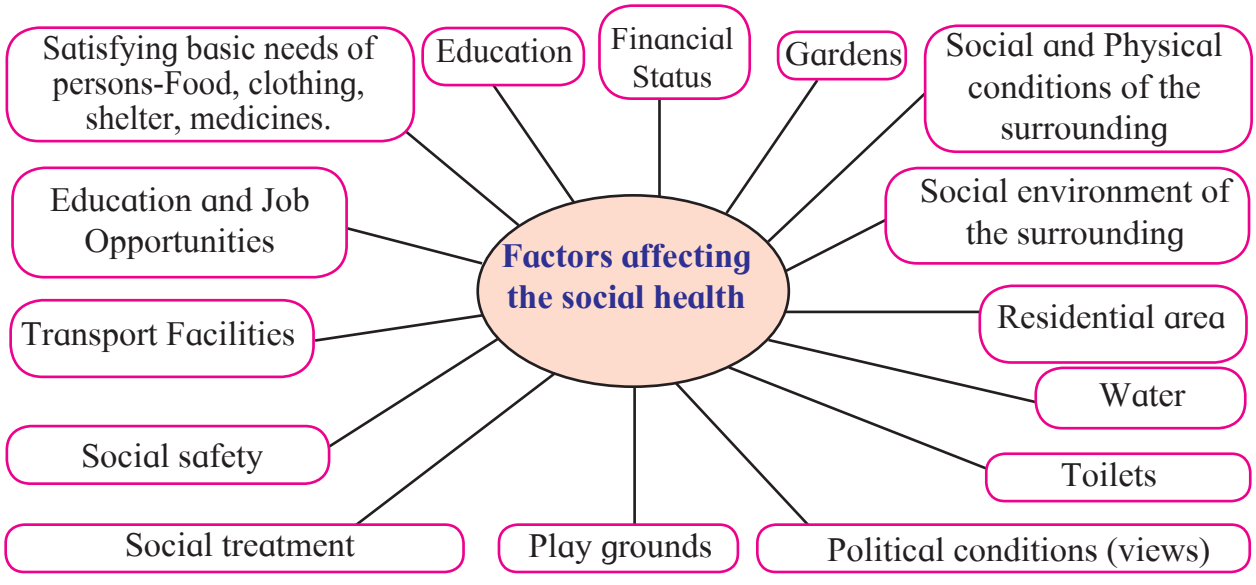
1. Highly interactive. 2. Occasionally interactive. 3. Non-interactive

Make a list of the friends of each of the above three group members and also mention the group to which you belong.

Social health

Obeserve and Discuss

Observe the following chart. Discuss about the relationship of various factors shown therein with the social health.



9.1 Factors affecting the social health

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Out of the various aspects of social health, we thought about only one in the above mentioned activity. Social health is the ability of a person to establish relationship with other persons. Ability to change one's own behavior according to changing social conditions is an important characteristic of social health. Various factors like strong personality, having large number of friends and relatives, proper use of time during loneliness and with peer-group, trust in others, respect and acceptance for others are important for good social health. We have seen that various factors affect the social health.

Factors disturbing the social health

Mental Stress

Competition has increased in opportunities for education, employment and business due to increase in population. Children are facing the problems of loneliness and mental stress due to reasons like nuclear family and parents staying outdoors due to job.

There are many bindings on girls and excessive freedom for boys in some families. Boys enjoy the concession from their domestic duties where as girls have compulsion for the same on the pretext that 'should be used to it'. Do you see the advertisements about increasing awareness on avoiding the discrimination between girls and boys or sister and brother in same family on choice for fresh/left-over food, learning medium? In society too, adolescent girls have to unnecessarily face the problems like teasing and molestation. Girls are facing the problem of stress due to such gender inequality.

9.2 Mental Stress

Now a days, everyone has to face the stress due to ever increasing disorder, crime and violence. At the same time, people looking at this as 'fast and easy way of making money' may become scapegoats and become part of such system. This is the deadly effect of social illness.

Addiction

Peer-group influence is stronger in case of adolescents. Adolescents always prefer the company of friends and follow their good or bad habits instead of following advice of parents and teachers. Children in their early age try upon tobacco, cigarette, gutkha, alcoholic drinks, drugs, etc. due to either peer--group pressure or symbol of high standard living or as an imitation of elders. However, it may lead to addiction to such deadly substances. Temporarily intoxicating drugs of plant origin and some chemicals may permanently damage the human nervous system, muscle system, heart, etc. Earlier, we have studied the carcinogenic effect of tobacco containing substances on mouth and lungs.

9.3 Addiction control

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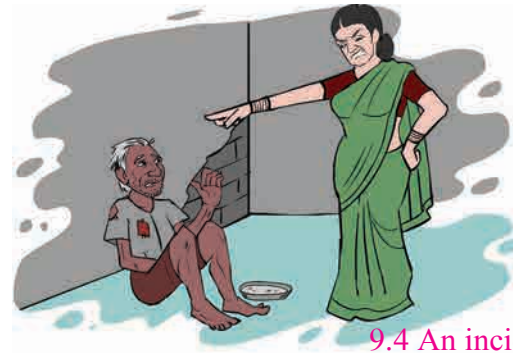
Incurable disease

Factors like ignorance towards the people with incurable diseases like AIDS, T. B., leprosy and mental disorders as well as old persons leads to increase in old age homes and such factors also may cause harm to social health.

Think Whether the incidence shown in the following picture is rational? Express your opinion.



9.4 An incidence

Can you tell ?

Have you ever seen the persons inebriated with drugs or liquor loitering on dirty places? Whether such a pitiful condition of most intelligent human being is acceptable?

You must have read the news about many deaths due to poisonous liquor. Why does it happen?

Liquor is produced from alcohol obtained through fermentation of substances. However, if this process is performed in a wrong way, poisonous liquor is produced and proves fatal for many at a time. Efficiency of nervous system (especially brain) and liver as well as lifespan of person decreases due to alcoholism. Brain development in adolescents is hindered due to alcoholism and thereby ability of memorization and learning becomes slow. Addictive person cannot think rationally. Due to this, the person has to face the social, mental and familial illness along with physical illness.

Communication Media and excessive use of Modern Technology

Two caricatures presenting the situations of the year 1998 and 2017 about playing on playground are given below. Observe those caricatures. Express your opinion about arising of such different situations

Observe

9.5 Different Situations

Compare Distribute the 24 hours of your daily routine as per various duties you have observed. Make two categories as time spent on your health and time spent on other responsibilities and compare both the categories.

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Now a days, excessive, unnecessary and irrational use of modern technology and communication media is becoming a sensitive issue through the view point of social health. Persons spending the time with cell phones for several hours are usually unaware of the surrounding. This is also a sort of addiction and leading to endangering of the social health.

Various physical problems like tiredness, headache, insomnia, forgetfulness, tinnitus, joint pains and problems in vision may arise due to radiation of cell phones. More serious fact is those radiations penetrate the bones of children more effectively than the bones of adults. Persons continuously using the computers and internet become solitary. They cannot establish harmonious relations with relatives and other members of the society. Habitually, they become self-centered and thereby they may develop problems like autism and selfishness. They become less sensitive towards others. Chronic effect of such tendency is that they are not ready to help others in need and he nce they also do not get it in need.

Recall a little

1. Do you recall the sudden closing of any cartoon serial of foreign origin being telecast on television?
2. Explain details on happenings about blue whale game.

Children who watch the cartoon films may imitate the characters of those films. Tendency and behavior of the children who play the games like virtual war and car races (especially deliberately brought about virtual accidents in games) gradually become negative. Some games available on cell phones and computers are extremely time-consuming and also cause economic losses, to lose concentration on some essential subjects and may also prove fatal.

Along with some useful purpose, huge information available on internet is used for viewing some inappropriate videos too. However, there is a governmental regulation over such media. Website, movies and cartoon films inappropriate for children are banned by the government.

- Why is there increase in news of death by drowning in ocean, falling in deep valleys or under trains during catching the cell phone selfie?
- There is increasing competition to upload the videos of road accidents instead of helping the victims. What is the mentality of such people?
- Why are the video-clips of parents threatening or hitting the children not studying as per their wish or domestic helpers beating the children are very common on social media nowadays?

9.6 Boy using cell phone while eating

9.7 Selfie on Road

Obeserve

Observe the above images Is it rational? Why?

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Person indulging in such destructive and unnatural activities is usually under stress and such activities are bursting of stress. Medical science has declared such activities as mental illness.

Person indulging in selfie is not aware about the world around and the risks. This is called as selfiecide. Persons indulging in domestic violence, sending messages to others before committing suicide or those who send the video clips of suicidal act are mentally ill and they do so to win the sympathy.

9.8 Pedestrian making a video-clip of the accident scene

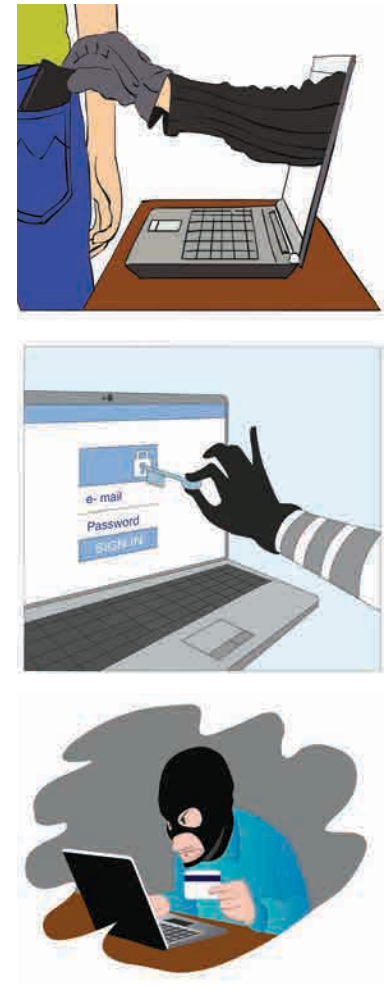
Hence, make the constructive use of communication media like television, phone, and internet for essential needs and entertainment only but do not go into the clutches by spending hours with those media.

Internet My Friend

Visit the website www.cyberswachhtakendra.gov.in

Cyber crimes

- Banks continuously spread the message on mobile phones about not to disclose the aadhar / PAN / credit card / debit card number and other personal information if demanded by any person.
- Do not disclose your PIN to anyone while withdrawing cash from ATM machine or purchasing through card payment. Why such instructions are given?
- Consumers are deceived by showing superior items on websites but actually selling the items of either inferior quality or impaired ones.
- Bank transactions are done using PIN without the knowledge of consumers.
- Confidential information about government, institutes and companies is obtained from internet with the help of computer programs or other ideas and misused. This is called as hacking of information.
- Nowadays, crimes like opening a fake account on Facebook and displaying false information and thereby teasing the girls or exploiting them financially.
- Misuse or illegal sale of the written literature, software, photos, videos, music, etc. of others by obtaining from internet is called as piracy.



9.9 Cheating of Consumers

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- Electronic media is also misused by sending derogatory messages, spreading vulgar pictures and inflammatory statements.
- Exchange of information through media like email, Facebook and Whatsapp occurs very fast. However, our personal information and phone numbers are automatically spread and thereby reaches the unwanted persons which leads to malpractices like incoming of unnecessary messages. Some of such messages either impair of shut down the mobiles and computers.

All the above mentioned incidences are examples of cyber crime. Committing such crimes is also a mental illness. Later on, the criminal also has to face the mental stress. 'Cyber crime unit' has been newly launched in police department. Cyber crime experts collect the details, investigate the cyber crime and thereby find the criminal with the help of internet.

Do You Know

IT Act-2000: This act has been enacted since 17th October 2000 and been amended in 2008. Person committing the cyber crime has to face the punishment like imprisonment for 3 years of fine up to 5 lakh. Maharashtra is at forefront in controlling the cybercrimes and it has been proved to be a first state to start a separate cyber crime unit.

Stress management

Have you seen the loudly laughing citizens in morning in public gardens? Name of this newly popularized concept is 'laughter club'. These people relieve their mental stress by laughing loudly.

9.10 Laughter Club

Various ways of expression like establishing communication with friends, peers, cousins, teachers and more importantly parents, noting down our feelings, expressing our feeling with near and dear ones help us to relieve the stress.

Fostering the hobbies like material collection, photography, reading, cooking, sculpturing, drawing, rangoli, dancing, etc. help us to properly utilize the free hours. By diverting the energy and mind towards the positive thinking, negative thoughts are automatically neutralized.

Can you tell ?

Why do you wait for periods of music, P.T., drawing in the classroom?

Learning and listening to the music, singing keeps us happy and drives away the stress. Music has the power of changing the mindset. Importance of outdoor games is unparallel. There are various benefits of sports like it causes physical exercise, improves discipline, interaction and tendency of unity, loneliness is driven away and person becomes more social.

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Regular exercising, massaging, visiting the spa too help to relive the stress. Yoga is not limited for asanas and pranayam but it includes discipline, balanced and good food, and meditation also. Deep breathing, yogic sleep, yogasanas, etc. are good for health. Meditation helps to improve the ability of concentration. It imparts positivity in our temperament. Meditation helps the students to improve concentration in their studies. Deliberate inculcation of characters like time management, planning of our own duties and decision power is nothing but cultivating the socially strong and ideal personality.

Always Remember

Nature is closest friend of human being. Hobbies like gardening, bird watching, lingering in nature, rearing domestic animal, etc. helps to create positive mindset, improves confidence. Social health can be maintained by keeping ourselves aware about happenings around us, neutralizing the negative thoughts (ex. revenge), etc.

We have all the ways to manage our stress. However, if those are not successful due to certain reasons, it leads to some more serious problems like depression and frustration. Medical advice, counselling and psychotherapy are available for such persons. Similarly, many NGOs also provide helping hand. Let us see the information about some of those.

1. Unified Movement against Tobacco.

This movement has been started by 45 different well-known organizations like WHO, Tata trust, etc. This movement is active for controlling the tobacco consumption and providing guidance to activists against tobacco.

2. Salaam Mumbai Foundation

This organization runs programs in various schools in Mumbai to inpower the children living in slum area in the field of education, sports, arts and busines. This organization encourages the children to take education by helping them to improve their health and lifestyle. This trust has made some districts in Maharashtra completely tobacco-free through hard work. Since the year 2002 theis organiration is working with various school in urban and rural area for making the society tobacco-free. This programme is being implemented with the help of Government in about 200 schools in Mumbai and 14000 schools in the rest of Maharashtra. The oath of freedom from tobacco is taken in every school as per the Government letter.

9.11 Counselling

Government Schemes

Phone number / helpline numbers are published in newspaper to help the children in distress or facing any type of problem. Children contact the helpline to narrate their problems. Proper help and guidelines are offered to children.

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Exercise

1. Fill in the blanks with appropriate word.

a. Laughter club is a remedy to drive away -- -- -- --.

b. Alcohol consumption mainly affects -- -- -- -- system.

c. The act -- -- -- -- is to curb the cyber crimes.

2. Answer the following.

a. Which factors affect the social health?

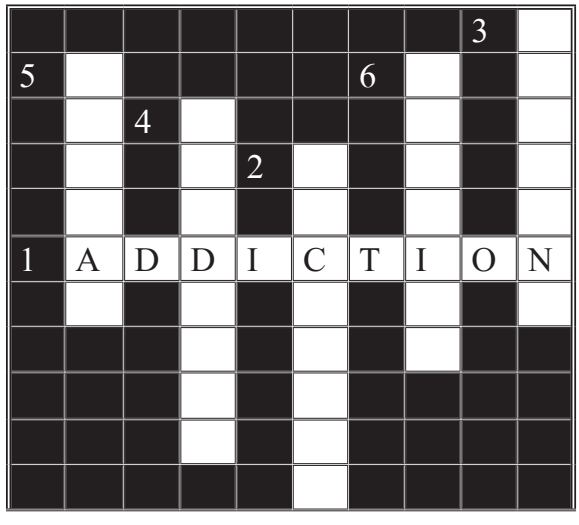
b. Which changes occur in persons continuously using internet and mobile phones?

c. Which problems do the common man faces due to incidences of cyber crime?

d. Explain the importance of good communication with others.

3. Solve the following cross-word

1. Continuous consumption of alcoholic and tobacco-materials.
2. This app may cause the cyber crimes.
3. A remedy to resolve stress.
4. Requirement for stress free life.
5. Various factors affect -- -- -- health.
6. Art of preparing food items.



4. Which are various ways to minimize stress?

5. Give three examples of each.

a. Hobbies to reduce stress.

b. Diseases endangering the social health.

c. Physical problems arising due to excessive use of mobile phones.

d. Activities under the jurisdiction of cyber crime laws.

6. What will you do? Why?

a. You are spending more time in internet/mobile games, phone, etc.

b. Child of your neighbor is addicted to tobacco chewing.

c. Your sister has become incommunicative. She prefers to remain alone.

d. You have to use free space around your home for good purpose.

e. Your friend has developed the hobby of snapping selfies.

f. Your brother studying in XII has developed the stress.

7. What type of changes occurs in a home having chronically ill old person? How will you help to maintain good atmosphere?

Project:

Enlist various factors affecting the social health in your residential area. Decide the necessary changes to correct the situation and implement those changes.

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10. Disaster Management

- Disaster
- Types of disaster
- Effect of disaster
- Effect/ Impact of disaster
- Disaster management
- The nature and extent of disaster
- First aid and emergency action
- Mock drill

Can you recall?

1. What is disaster?
2. Which disasters have you experienced in your area?
3. What are the effects of that disaster on local and surrounding conditions?

Disaster

Variously dangerous events occur many times in the environment. Those are called as disasters. Some of the main natural disasters are floods, wet and dry famine, cyclones, earthquakes, volcanoes, etc. These are 'all of a sudden' troubles to the mankind. Such events cause sudden changes in the environment and thereby cause the damage to it. Environment is also damaged due to use of natural resources for our development. This leads to sudden disasters, unexpected to human. These can be called as man-made disasters.

United Nations has defined the disaster as 'the sudden event that leads to the huge loss of life and property. Words like 'huge' and 'sudden' are important in the definition. As the disaster occurs suddenly, it cannot be predicted. Hence, precautions are not possible. Huge losses to the property occur in the area of disaster. There are long term effects on society due to incidences of life and property loss. Various areas of life like economic, social, cultural, political, law and administration, etc. are affected by it. The life in the area of disaster disturbs totally. There is loss to life and property of the people in distress.

Earlier, we have studied various types of disasters and the measures to be taken. None of the different disasters are similar. Period of each disaster is not same. Some disasters are short term where as some are long term. Reasons behind each disaster are also different. Depending upon the nature of disaster, it can be determined that which component of the environment will be affected more.

Can you tell? Which are two main types of disasters?

Earlier, we have studied the effects of various types of disasters and the precautionary measures to be taken in case any disaster happens. We can classify the disasters in other ways too; like catastrophic disasters. Ex. Cyclones in Odisha, catastrophic earthquakes of Gujarat and Latur, frequently buzzing cyclones in coastal Andhra Pradesh, etc. which lead to total chaos, huge loss of life and property in respective region. However, irrespective of all these, life has always returned to normal within short time. Disasters making the impact for long duration are those whose after-effects are either severe or severity increases with time. Ex. Famine, various problems of crop, strikes of workers, rising levels of oceans, desertification, etc.

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Let's Discuss

Observe the following images. Whether the places of disasters are known to you? Discuss the effects of these disasters on public life. How it could have been saved from these disasters? Discuss with your friends in the class-room.




10.1 Some Disasters (Courtacy: Lokmat Library, Aurangabad)

Internet is my friend

Search for the video clips of disasters. Discuss in your class about effects of disasters and remedies over it.

Can you tell?

How can disasters be classified depending upon various criteria?

Types of Disasters

(Geophysical)

- Geological — Ex. Earth quake, volcano, tsunami, land-slides, land-fall, erosion, alkalization, flooding, etc.
- Atmospharic — Ex. Hot and cold waves, snow-storms, snow fall, cyclones, hail storm, drought, flood, meteorite, sun spots, etc.

(Biological)

- Plant — Ex. Forest fire, fungal dis-ease spreading (Blister), weed, (aquatic, carrot grass, common grass)
- Animal — Infectious viruses, bacteria (cholera, malaria, hepatitis, plague), insects, bite of poisonous animals,etc.

(Man Made)

- Unknown — poisonous gases. Atomic test. Unplanned action Accident..
- International — War, fire, bomb blast, forced migration, terrorism, rapes, child labour.

Can you recall?

1. Which are the destructive effects of flood?
2. Which are the effects of dry famine?
3. Which are the destructive effects of earthquake?
4. What is forest fire? What is its effect on environment?

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Effects of disaster

We have understood the serious effects of disaster with the help of above-mentioned questions. Collapsing of bridges, flooding of coastal villages, shortage of food are some of the problems of floods. Collapsing of houses, developing cracks in land are some of the effects of earthquake. Disasters like forest fire and drought also adversely affect the environment. However, what is exact nature of these disasters? Whether there are any changes in nature before the occurrence of disasters? For how long the effects occur after the occurrence of disaster? How? It needs to be think over all these aspects. This helps us to understand the nature and gravity of the disaster.

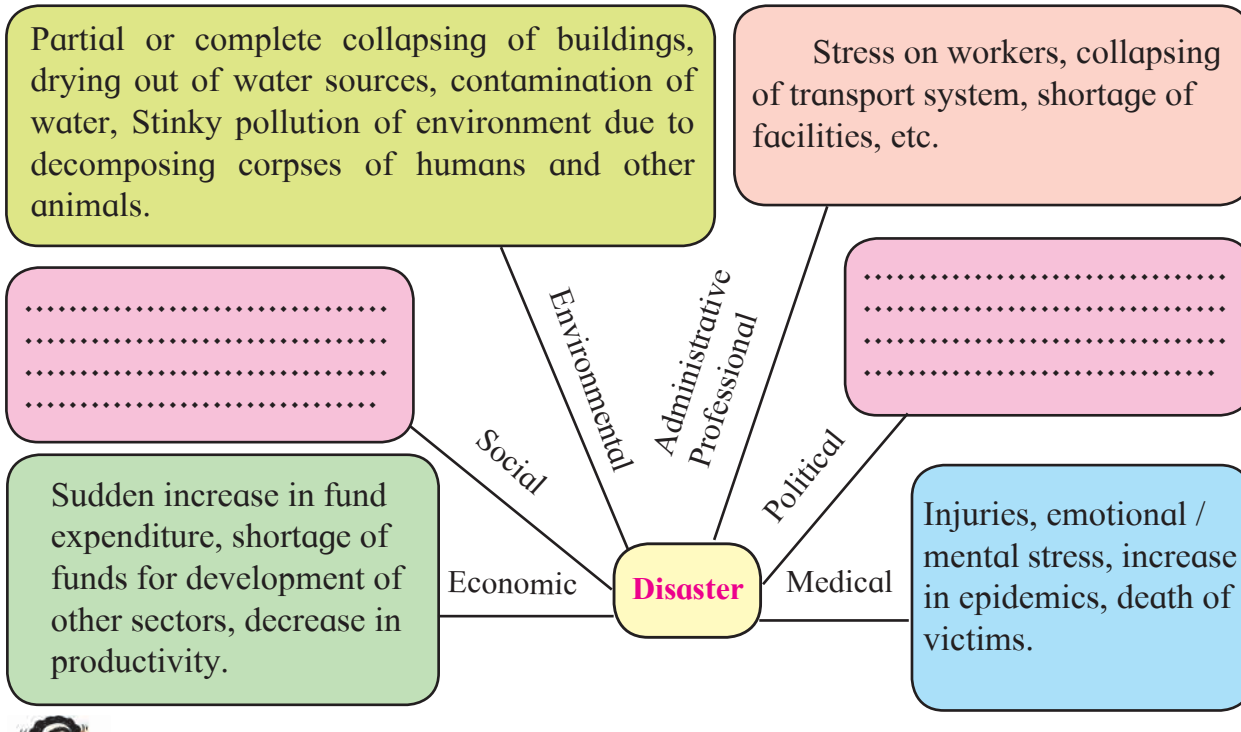
Disasters definitely affect the economy of the nation. That effect is always relative to disaster and economy i.e. if any port is destroyed, there are long lasting effects on economy due to huge expenses on its reconstruction. An effect of disaster on social leadership is that if local leadership is not strong enough, citizen become confused. It affects their participation in rescue and rehabilitation activities. Administrative problems arise during the disaster. If local governing bodies are affected by disasters, related departments cannot answer the problems of disaster efficiently. All the concerned departments are affected by disaster and thereby entire system collapses.

Complete the chart

Different problems occurs with disasters. in the concept map different effects are mentioned. Read it and fill the blank places.

Lets Think

What will be the effect on yourself and surrounding, if any accident-like disaster occurs during the sports on playground or in school?



Use your brain power

Depending upon above information, explain the various effects of the disaster of railway accident.

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Nature and scope of disaster

Taking in to consideration the scope of disaster, some of the important facts must be thought over, as follows

1. Pre-disaster phase
2. Warning phase
3. Emergency phase
4. Rehabilitation phase
5. Recovery phase
6. Reconstruction phase

Lets Think

Explain the nature and scope of the disaster of flood with the help of six points given beside.

Taking into consideration the nature and scope of disaster, only three aspects of disaster are important for common citizens.

1. Phase of emergency: Important character of this phase is that maximum lives can be saved by quick actions during this phase only. Various actions like search and rescue operations, medical assistance, first aid, restoring communication services, removing the people from affected area are expected in this phase. Gravity of disaster can be estimated in this phase only.

2. Transitional Phase: Rehabilitation work is started in this phase, after the subsidence of any type of disaster. It includes clearing of debris, restoring water supply, repairing roads, etc. so that it will help to bring normalcy in public life. Rehabilitation of the victims is important aspect of this phase. Generally, different institutes offer the monetary and other type of help to such people. It helps to soothe the mental stress at the earliest if these victims are offered with the permanent mean of earning livelihood and this is true rehabilitation.

3. Reconstruction Phase: This is highly complicated phase. This phase begins in transitional phase. People reconstruct their buildings and facilities like roads and water supply are restored. Farming practices are restarted. However, it takes long time for reconstruction.

Planet Earth has experienced many natural disasters. Listening to the description of those disasters brings numbness to the mind. Most of the disasters and related unprecedented situations have been occurred in the Asian continent and region of Pacific Ocean. Huge loss to the life and the planet Earth has been occurred due to such disasters. Generally, such conditions of natural imbalance have been arisen due to greed of economic progress of human being.

In reality, old problems of several years have become fierce. Ex. Increasing population, its increasing needs emerging problems out of it are now at the extreme end. Such disasters have been increased after the world war-II. Condition of instability arises in the country due to various reasons like economic inequality, racial and religious differences, etc. Incidences like terrorism, abduction, social differences have been a routine now.

Production and use of harmful chemicals is under ban in developed countries. However, production of either same or those chemicals which can wipe out the human race is common in developing and poor countries.

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Do you know?

In 2014, there had been a huge land slide in the village Malin, Tal. Ambegaon, Dist. Pune. Following is the image of the school reconstructed after the disaster.

Another such threat to human being is from the atomic energy plants. Ex. Radiation leakage occurred after a blast in atomic energy plant at Chernobyl, Russia. Its ill-effects are still experienced in the region. This atomic energy plant was only used for electricity generation. Now a day, many countries are equipped with atomic energy. Out of this, risk of radiation leakage is increasing due to carelessness. Hence, importance of disaster management has become the foremost need of almost all the nations. In fact, it is most necessary for citizens of all countries, because they are the main sufferers in any type of disaster. Hence, direct participation of citizens in disaster management is highly necessary. Similarly, disaster management schemes should be changed with respect to location, time and nature of the disaster. It should not be restricted for a particular period. Overall, there may be any type of disaster, it should be overcome. Concept of disaster management has been arisen out of this only.

Disaster management

Disaster may be minor or major, short--time or long-time, it should be overcome and effective disaster management is necessary for it. There is close relationship between disaster management and public participation. Disaster management is either prevention of disasters or making arrangements to face it or at least achieve the abilities to face it.

Disaster is a very fast process, in fact it is accident. What shall we do in such situation? How can we protect ourselves, our belongings and animals?

In case of disaster management, there should be an attempt to minimize the losses. Disasters are never planned but losses due it can be prevented in a planned manner.

Objectives of disasters management

1. Disposal of human life suffered by human being during the calamity and release of the people.
2. Supply of essential commodities of the people to reduce the effect of disaster.
3. The restore the human life in the region by creating reconciliation in disaster.
4. Rehabitant disaster victims.
5. Considering protective measure in disaster, such disaster will not reach in future and slop take care to reduce their intensity.

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Disaster management is achieving or time to time improving the ability to face the disasters through scientific and careful observations and analysis of data. For example, preparing the action plan through study of various aspects like preventive measures, rehabilitation and reconstruction and executing that plan is nothing but the management of disaster. Disaster management can be divided into two parts.

Pre-disaster management

This includes the complete preparation and planning to face any type of disaster. For that purpose..

a. Identifying the pro-disaster areas.
b. Collecting the information about intensity of disaster and probable sites of disasters through predictive intensity maps and hazard maps respectively.
c. Getting special training for disaster management.
d. Increasing awareness about disaster management among the general public through training programmes, mass media, and etc. Post-disaster management

Post-disaster management

1. Providing all types of necessary help to victims of disasters.
2. Participation of preferably local peoples saved from the disaster in arranging the help to victims.
3. Quick establishment of help centre. Different types of disasters need different types of control centres.
4. Categorization of the help material received from control centre, delivering the material to victims and continuous review of the help.
5. Being always prepared for disaster rescue.

Observe

Observe the disaster cycle given below and explain each aspect of the disaster of earthquake.

Preparation: Plan is prepared to minimize the destruction in any disaster, if occurs.

Redemption: Plan for minimizing the damage to the society and country.

Preparedness: A plan is chalked out so as to get the quick response from general public and administration.

Impact of disaster: Intensity of various aspects of disaster and disaster management are reviewed.

Responce : Responce to the disaster is to be given immediately after the incidence. This factor is followed by the disaster strike in this cycle.

Resurgence : Resurgence is an imporatnt link between emergency measures and national progerss. Resurrection is a stage used for the welfare and rehabilition of the nation.

Restoration: This is an important link between measures after disaster and national development. This step is useful for progress of nation and rehabilitation.

Main aspects of disaster management cycle

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Try this

Which factors will you consider while designing the pre-disaster management plan for your school / home?

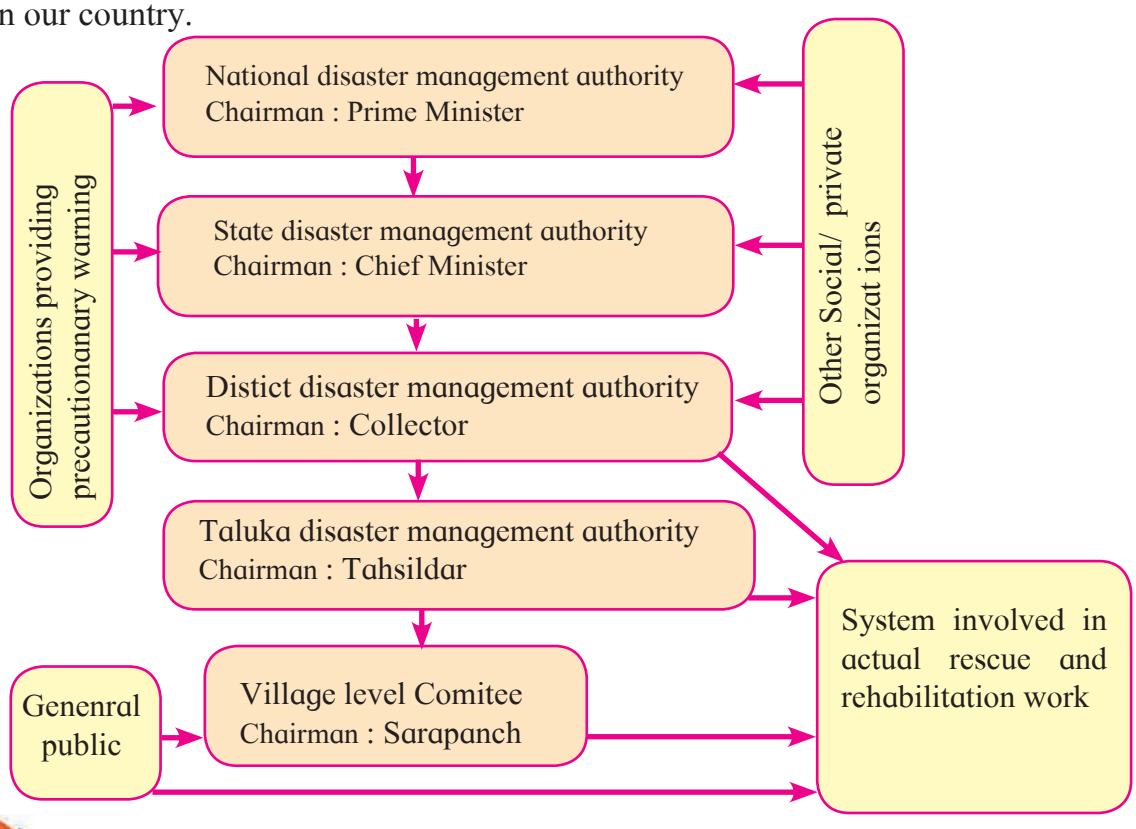
Prepare a survey report with the help of your teacher.

Always remember

Though avoidance of natural disaster is impossible, loss out of it can be minimized. However man-made disasters can be avoided. Helping each other in the crisis of disaster is our ethical responsibility.

Structure of Disaster Management Authority

In case of disaster, an authority has been established at the level of government. Following flow chart indicates the function of control and coordination under the disaster management from national to village level. Disaster Management Act, 2005 has been passed in our country.



Get information

Visit the district collector or Taluka Tehasildar office and collect the information about disaster management.

District Disaster Management Authority:

At the district level, district collector is responsible for disaster management and implementation of rehabilitation schemes. Collector is planning, coordinating and controlling the implementation of rehabilitation programme, gives out necessary instructions and reviews the entire system. District collector is also responsible for designing the schemes for each district, separately for each type of disaster and getting those sanctioned from state-level authorities.

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District-wise Disaster Control Unit:

District control unit is established immediately either after the impact of disaster or getting intimation about it. It reviews about various aspects of disaster, keeps continuous contact with various agencies like army, air force, navy, telecommunication department, paramilitary forces, etc. for getting help. It is also responsible for coordinating with various voluntary organizations for their help in disaster management.

Internet is my friend

Find out more about the activities international organizations that work for disaster management.

1. United Nations Disaster Relief Organization
2. United Nations Centre for Human Settlements
3. Asian Disaster Reduction Centre.
4. Asian Disaster Preparedness Centre.
5. World Health Organization.
6. United Nations Educational, Scientific and Cultural Organization.

Who Does What?

National Disaster Response Force has been established as per the Disaster management Act, 2005. Divisions of this force are working in army. Overall, 12 divisions are working in the country. Its headquarter is in Delhi and it is in action all over the country with the help of army. In Maharashtra, National Disaster Response Force is in action through State Reserve Police Force. Personnel of this force have substantial contribution in rescue work in disasters like cyclones, cliff-sliding, building collapse, etc. Website: http://www.ndrf.gov.in

Can you tell?

1. What is first aid?
2. How can we offer first aid to victims of any disaster?

First Aid and Emergency Action:

You have studied in earlier classes about the types of first aid to be offered to the persons injured in disasters. Use of this knowledge is useful for offering the help to classmates or people around you facing any disaster and injured there in.

Sometimes, we have to face the disaster due to our own unawareness. Some symbols given beside are seen used around us. Those symbols can be ignored. Such symbols are useful to avoid the mishaps.

10.2 Signs

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Lets Think

Following are some pictures of disasters. Which precautions would you take during those disasters?

A B C

10.2 Various disasters

Observe

Give the reference of following pictures and explain importance of each of those in disaster management. Which are other such activities?

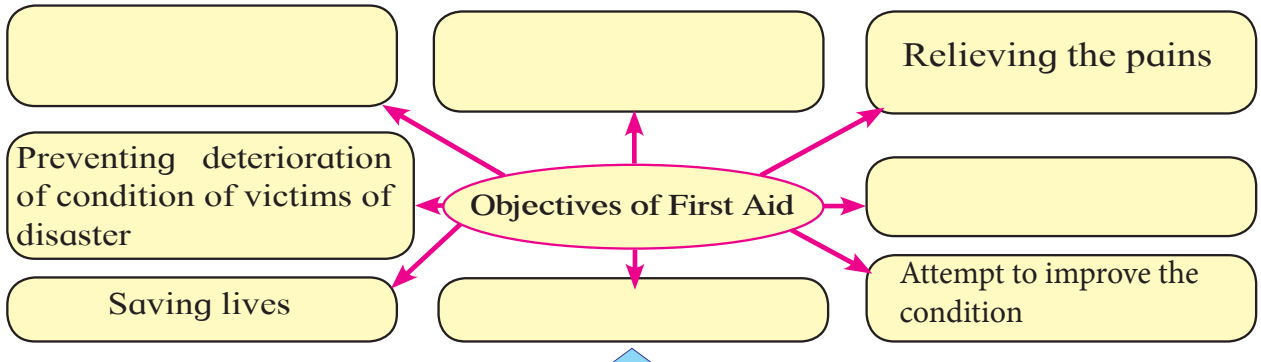
a b c d e f

10.4 Various activities

In emergency condition, various transportation methods like cradle method, carrying on back, carrying on two hands are to be followed. Those methods depend upon the condition of victim. We face different types of major or minor disasters in our daily life. Varieties of disasters like accidents, stampede, injuries in fighting, electric shock, burns, heat shock, snake bite, dog bite, fire due to electric short circuit, epidemic of any disease, etc. happen around us. Victims of disaster need to be offered some primary help before actual medical treatment. First aid is useful in such circumstances.

Complete the chart

complete the chart as per the objectives of Firs taid.



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First Aid Kit

It is essential to have material necessary for first aid with us. That material is available in the first aid kit. You can also prepare a first aid kit. It is also important to use whatever the material available in the given condition for first aid.

Get information

Meet the medical officer / doctor from your village and collect information about providing the first aid.

The necessary material in first aid box

1. Bandage strips of different size
2. Wound gauze.
3. Triangular and circular bandage.
4. Medicated cotton
5. Hand gloves
6. Clean and dry cloth pieces.
7. Soap
8. Antiseptic (Dettol/ Sarlon)
9. Safety pins
10. Blade
11. Small pins
12. Needle
13. Band aid
14. Torch
15. Scissor
16. Thermometer
17. Petroleum jelly

Can you tell?

Whether there had been mock drill by fire fighters under the disaster management scheme in your school? Which techniques did you see during the drill?

Mock Drill

It is a practice to check the preparedness of facing the disaster as early as possible. Virtual / Apparent situation of disaster is created to check the reaction time for any type of disaster. Trained personnel observe their responsibilities to check execution of plan designed for disaster redressal. This helps to check the efficacy of the system prepared for disaster redressal.

Mock drill is arranged on disaster of fire in various schools by the fire fighters. It includes the demonstrations like extinguishing the fire, rescuing the people trapped at higher floors of buildings, rescuing the persons whose clothing have catched the fire, etc. Such activities are also arranged by police force and voluntary organizations.

Objectives of Mock Drill

1. Evaluating the response to the disaster.
2. Improving the coordination between various departments of disaster control.
3. Identification of own abilities.
4. Improving the ability of quick response to disaster.
5. Checking the competency of the planned actions.
6. Identifying the possible errors and risks.

Internet is my friend

Watch the video clip of fire fighting mock drill on you tube and send to your friends and relatives.

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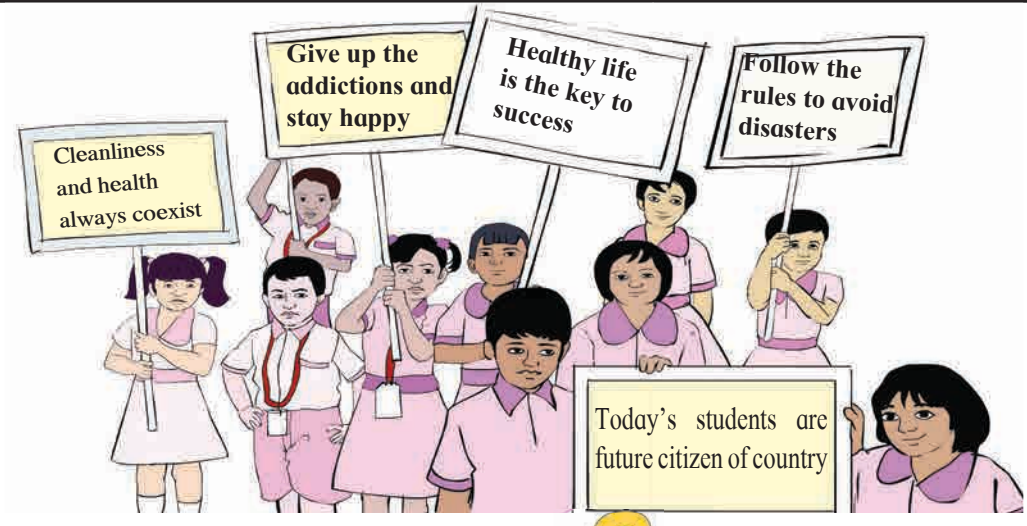
Always remember

1. Do not chaos and push each other while using staircase in the school.
2. Remind important help-lines and use as per need. Ex. Police 100, Fire fighting force 101, Disaster Control Unit 108, Ambulance 102, etc.
3. Follow the traffic rules. Look at left and right sides while crossing the road and ensure that any vehicle in not passing by.
4. Do not touch any unclaimed object. Do not spread rumors.
5. Do not make chaos at the crowded places.



Exercise

1. Complete the table.

(Motor accident, land sliding, forest fire, theft, riot, war, epidemic, drought, locust attack, financial crisis, flood, famine)

Disaster	Symptoms	Effects	Remedy

2. Write notes.

a. Disaster management Authority

b. Nature of disaster management

c. Mock drill

d. Disaster Management Act, 2005

3. Answer the following questions.

a. Explain the role of district disaster control unit after occurrence of any disaster.

b. Give the reasons for increase in human disasters after the World War-II.

c. Which are the objectives of disaster management?

d. Why is it essential to get the training of first aid?

e. Which different methods are used for transportation of patients? Why?

4. On the basis of the structure of disaster-management authority, form the same for your school.

5. Write down the reasons, effects and remedial measures taken for any two disasters experienced by you.

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6. **Which different aspects of disaster management would you check for your school? Why?**

7. **Identify the type of disaster.**

a. Terrorism
b. Soil erosion
c. Hepatitis
d. Forest fire
e. Famine
f. Theft

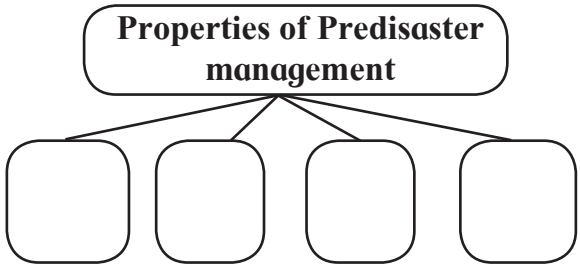
8. **Some symbols are given below. Explain those symbols. Which disasters may occur if those symbols are ignored?**

9. **Explain that why is it said like that?**

A] Mock drill is useful

B] Effective disaster management makes us well prepared for future.

10. **Complete the following chart.**



11. **Following are the pictures of some disasters. How will be your pre- and post-disaster management in case you face any of those disasters?**

a.

b.

c.

d.

Project:

1. Demonstrate the activities shown on page no. 106 of std. IX textbook in front of the students of other classes. Make a video clip and send it to others.
2. Form a group of students from your school to demonstrate the mock drill and demonstrate it in the school.

KZXH9A

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