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Class 9 | Physic

01 Motion

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Atoms, molecules, planets, stars and galaxies are all in motion. We often perceive an object to be in motion when its position changes with time.
An object may appear to be moving for one person and stationary for some other. For the passengers in a moving bus, the roadside trees appear to be moving backwards. A person standing on the road–side perceives the bus along with the passengers as moving. However, a passenger inside the bus sees his fellow passengers to be at rest.

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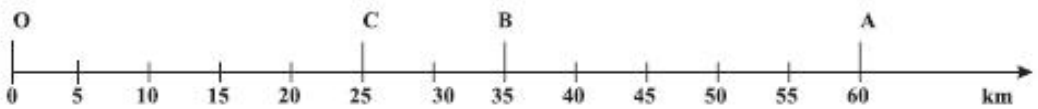
02. MOTION ALONG A STRAIGHT LINE

Assume the motion of an object moving along a straight path. The object starts its journey from O which is treated as its reference point (Fig.). Let A, B and C represent the position of the object at different instants. At first, the object moves through C and B and reaches A. Then it moves back along the same path and reaches C through B.



Positions of an object on a straight line path

The total path length covered by the object is OA + AC, that is 60 km + 35 km = 95 km. This is the distance covered by the object.
The shortest distance measured from the initial to the final position of an object is known as the displacement.

03. UNIFORM AND NON- UNIFORM MOTION

Assume an object moving along a straight line. Let it travel 9 m in the first second, 9 m more in the next second, 9 m in the third second and 9 m in the fourth second. In this case, the object covers 9 m in each second. As the object covers equal distances in equal intervals of time, it is said to be in uniform motion.

Example 1 An object travels 60 m in 4 s and then another 60 m in 2 s. What is the average speed of the object?

Solution Total distance travelled by the object = 60 m + 60 m = 120 m

Total time taken = 4 s + 2 s = 6 s

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

$$= \frac{120\ \text{m}}{6\ \text{s}}$$

Therefore, the average speed of the object is 20 m s^{-1}.

SPEED WITH DIRECTION

Velocity is the speed of an object moving in a definite direction. The velocity of an object can be uniform or variable. It can be changed by changing the object's speed, direction of motion or both. When an object is moving along a straight line at a variable speed, we can express the magnitude of its rate of motion in terms of average velocity. It is calculated in the same way as we calculate average speed.

In case the velocity of the object is changing at a uniform rate, then average velocity is given by the arithmetic mean of initial velocity and final velocity for a given period of time. That is,

$$\text{Average velocity} = \frac{\in ial\ velocity + final\ velocity}{2}$$

$$\text{Mathematically, } v_{av} = \frac{u + v}{2}$$

where vav is the average velocity, u is the initial velocity and v is the final velocity of the object.

Speed and velocity have the same units, that is, m s^{-1} or m/s.

04. Rate of Change of Velocity

During uniform motion of an object along a straight line, the velocity remains constant with time. In this case, the change in velocity of the object for any time interval is zero.

However, in non-uniform motion, velocity varies with time. It has different values at different instants and at different points of the path. Thus, the change in velocity of the object during any time interval is not zero.

This kind of motion is known as accelerated motion. The acceleration is taken to be positive if it is in the direction of velocity and negative when it is opposite to the direction of velocity. The SI unit of acceleration is m s^{-2}.

To describe the motion of an object, we can use line graphs. In this case, line graphs show dependence of one physical quantity, such as distance or velocity, on another quantity, such as time.

05. DISTANCE–TIME GRAPHS

The change in the position of an object with time can be represented on the distance-time graph adopting a convenient scale of choice. In this graph, time is taken along the x–axis and distance is taken along the y-axis. Distance-time graphs can be employed under various conditions where objects move with uniform speed, non-uniform speed, remain at rest etc.

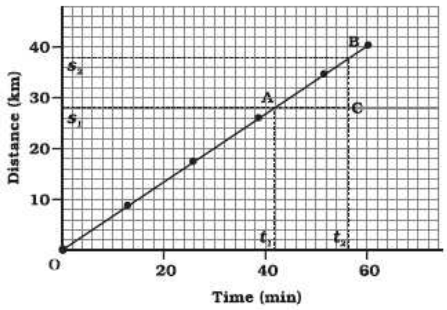


Fig. Distance-time graph of an object moving with uniform speed

We know that when an object travels equal distances in equal intervals of time, it moves with uniform speed. This shows that the distance travelled by the object is directly proportional to time taken. Thus, for uniform speed, a graph of distance travelled against time is a straight line, as shown in Fig. The portion OB of the graph shows that the distance is increasing at a uniform rate. Note that, you can also use the term uniform velocity in place of uniform speed if you take the magnitude of displacement equal to the distance travelled by the object along the *y*-axis.

We can use the distance-time graph to determine the speed of an object. To do so, consider a small part AB of the distance-time graph shown in Fig. Draw a line parallel to the *x*-axis from point A and another line parallel to the *y*-axis from point B. These two lines meet each other at point C to form a triangle ABC. Now, on the graph, AC denotes the time interval $(t_2 - t_1)$ while BC corresponds to the distance $(s_2 - s_1)$. We can see from the graph that as the object moves from the point A to B, it covers a distance $(s_2 - s_1)$ in time $t_2 - t_1$). The speed, v of the object, therefore can be represented as

$$v = \frac{s_2 - s_1}{t_2 - t_1} \qquad \text{...(i)}$$

We can also plot the distance-time graph for accelerated motion. Table shows the distance travelled by a car in a time interval of two seconds.

Equations of Uniformly Accelerated Motion

There are three equations for the motion of those bodies which travel with a uniform acceleration.

(i) **First Equation of Motion :**

The first equation of motion is : $v = u + at$. It gives the velocity acquired by a body in time t.

The equation $v = u + at$ is known as the first equation of motion and it is used to find out the velocity $'v'$ acquired by a body in time $'t'$, the body having an initial velocity $'u'$ and a uniform acceleration $'a'$.

(ii) **Second Equation of Motion :**

The second equation of motion is : $s = ut + \frac{1}{2}at^2$. It gives the distance travelled by a body in time t.

(iii) Third Equation of Motion

The third equation of motion is : $v^2 = u^2 + 2as$. It gives the velocity acquired by abody in travelling a distance s.

To solve the problems on motion we should remember that :

(a) if a body starts from rest, its initial velocity, $u = 0$

(b) if a body comes to rest (it stops), its final velocity, $v = 0$

(c) if a body moves with uniform velocity, its acceleration, $a = 0$

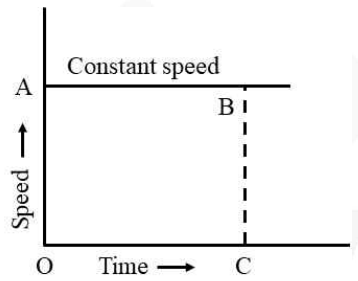
06. Speed-Time Graphs (Or Velocity-Time Graphs)

We can have three types of speed-time graphs for a moving body. These three cases are :

(i) When the speed of the body remains constant (and there is no acceleration)

(ii) When the speed of the body changes at a uniform rate (there is uniform acceleration)

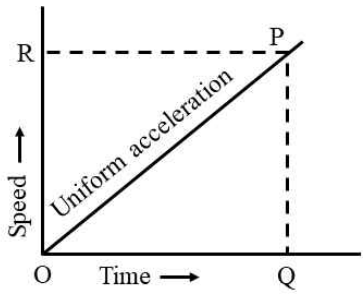
(iii) When the speed of the body changes in a non-uniform way (there is non-uniform acceleration)



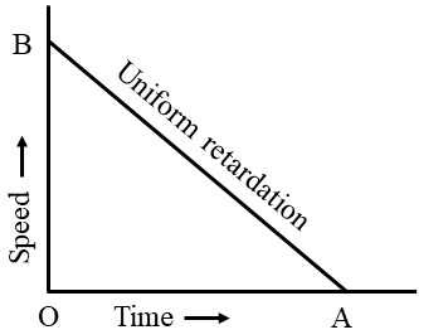
If the speed-time graph of a body is a straight line parallel to the time axis, then the speed of the body is constant (or uniform).

07. Speed-Time Graphs when Speed Changes at a Uniform Rate (Uniform Acceleration)

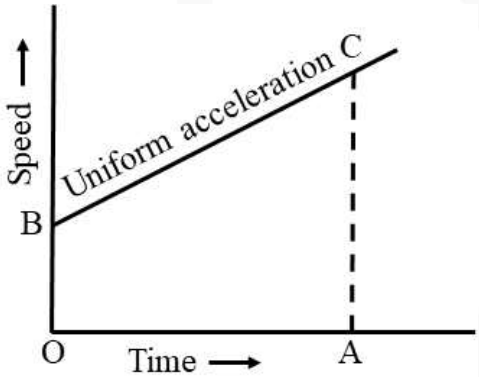
The speed-time graph for a uniformly changing speed (or uniform acceleration) will be a straight line.



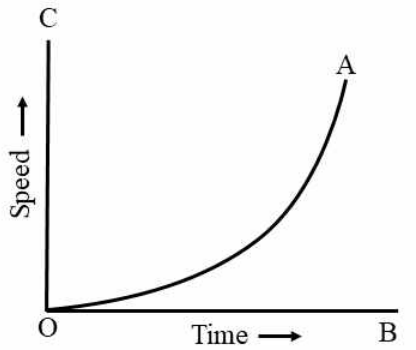
We can find out the value of acceleration from the speed-time graph of a moving body. The slope of a speed-time graph of a moving body gives its acceleration.
The distance travelled by a moving body in a given time can also be calculated from its speed-time graph.
In a speed-time graph of a body, a straight line sloping upwards shows uniform acceleration, in a speed-time graph of a body, a straight line sloping downwards indicates uniform retardation. We will now discuss the speed-time graph of a body whose initial speed is not zero.



Speed-Time Graph when the Initial Speed of the Body is Not Zero



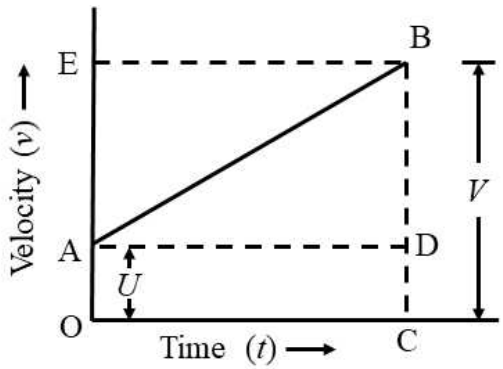
08. Speed-Time Graph when Speed Changes at a Non-Uniform Rate (Non-Uniform Acceleration)



09. Derive The Equations of Motion by Graphical Method

The three equations of motion : $v = u + at$; $s = ut + \frac{1}{2}at^2$ and $v^2 = u^2 + 2as$ can be derived with the help of graphs as described below.

(i) **To Derive $v = u + at$ by Graphical Method**



Now, Initial velocity of the body, $u = OA$

And, Final velocity of the body, $v = BC$

But from the graph $BC = BD + DC$

Therefore, $v = BD + DC$

Again $DC = OA$

So, $v = BD + OA$

Now, From equation (i), $OA = u$

So, $v = BD + u$

We should find out the value of BD now. We known that the slope of a velocity-time graph is equal to acceleration, a.

Acceleration, a = slope of line AB

or $a = \frac{BD}{AD}$

$a = \frac{BD}{t}$

$BD = at$

$v = at + u$

$v = u + at$

(ii) **To Derive $s = ut + \frac{1}{2}at^2$ by Graphical Method**

Distance travelled = Area of figure $OABC$

= Area of rectangle $OADC$ + Area of triangle ABD

We will now find out the area of the rectangle $OADC$ and the area of the triangle ABD.

(a) Area of rectangle $OADC = OA \times OC$

$= u \times t$

$= ut$

(b) rea of triangle $ABD = \frac{1}{2} \times$ Area of rectangle $AEBD$

$$= \frac{1}{2} \times AD \times BD$$

$$= \frac{1}{2} \times t \times at \qquad \text{(because } AD = t \text{ and } BD = at\text{)}$$

$$= \frac{1}{2} at^2$$

So, Distance travelled, s = Area of rectangle $OADC$ + Area of triangle ABD

or $$s = ut + \frac{1}{2} at^2$$

This is the second equation of motion. It has been derived here by the graphical method.

(iii) **To Derive $v^2 = u^2 + 2as$ by Graphical Method**

Distance travelled, $s = \dfrac{(Sum\ of\ parallel\ sides) \times Height}{2}$

or $$s = \frac{(OA + CB) \times OC}{2}$$

Now, $OA + CB = u + v$ and $OC = t$. Putting these values in the above relation, we get :

$$s = \frac{(u + v) \times t}{2}$$

Thus, $v = u + at$ (First equation of motion)

And, $at = v - u$

So, $t = \dfrac{(v - u)}{a}$

Now, putting this value of t equation above, we get :

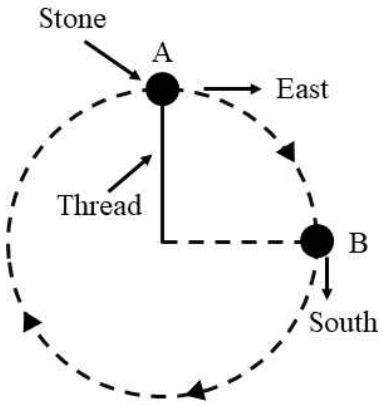
$$s = \frac{(u + v) \times (v - u)}{2a}$$

or $2as = v^2 - u^2$ [because $(v + u) \times (v - u) = v^2 - u^2$]

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

09. Uniform Circular Motion

When a body (or an object) moves in a circle, it is called circular motion.
When a body (or object) moves along a circular path, then its direction of motion (or direction of speed) keeps changing continuously. Since the velocity changes (due to continuous change in direction), therefore, the motion along a circular path is said to be accelerated.
When a body moves in a circular path with uniform speed (constant speed), its motion is called uniform circular motion.



A stone tied to a thread moving with uniform circular motion.

Circular motion is acceleration even though the speed of the body remains constant. Thus, the motion in a circle with constant speed is an example of accelerated motion. A force is needed to produce circular motion. The force which is needed to make an object travel in a circular path is called centripetal force.

CBSE Pattern
Exercise (1)

(Q 1 to 2) Very Short Type

1. Change the speed of 6 m/s into km/h?

2. What is the other name of negative acceleration?

(Q 3 to 5) Short Answer Type

3. What type of motion, uniform or non-uniform, is exhibited by a freely falling body?

4. A tortoise moves a distance of 100 metress in 15 minutes. What is the average speed of tortoise in km/h?

5. If a bus travelling at 20 m/s is subjected to a steady deceleration of 5 m/s^2, how long will it take to come to rest?

(Q 6 to 8) Multiple Choice

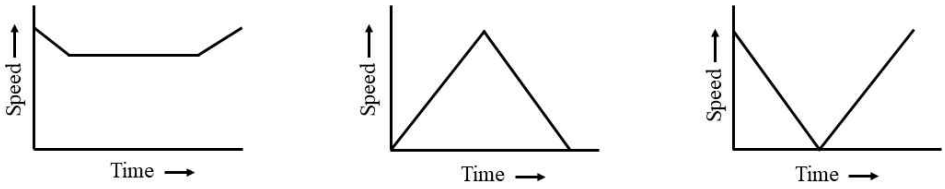
6. A particle is moving in a circular path of radius r. The displacement after half a circle would be :
   (a) 0
   (b) πr
   (c) $2r$
   (d) $2\pi r$

7. The speed of a moving object is determined to be 0.06 m/s. This speed is equal to :
   (a) 2.16 km/h
   (b) 1.08 km/h
   (c) 0.216 km/h
   (d) 0.0216 km/h

8. A bus moving along a straight line at 20 m/s undergoes an acceleration of 4 m/s^2. After 2 seconds, its speed will be :
   (a) 8 m/s
   (b) 12 m/s
   (c) 16 m/s
   (d) 28 m/s

(Q 9 to 10) High Order Thinking Skills

9. Three speed-time graphs are given below :



(a) (b) (c)

Which graph represents the case of :

(a) a cricket ball thrown vertically upwards and returning to the hands of the thrower?

(b) a trolley decelerating to a constant speed and then accelerating uniformly?

10. A car is travelling along the road at 8 m s^{-1}. It accelerates at 1 m s^{-2} for a distance of 18 m. How fast is it then travelling?

Answer & Solution

Q1
21.6 km/h

Q2
Retardation (or Deceleration)

Q3
Uniformely accelerated motion with increasing velocity if no friction of air. Because 'g' is constant.

Q4
0.4 km/h

Q5
4 s

Q6
(c)

Q7
(c)

Q8
(d)

Q9
(i) c

Q10
10 m s^{-1}

CLASS 9

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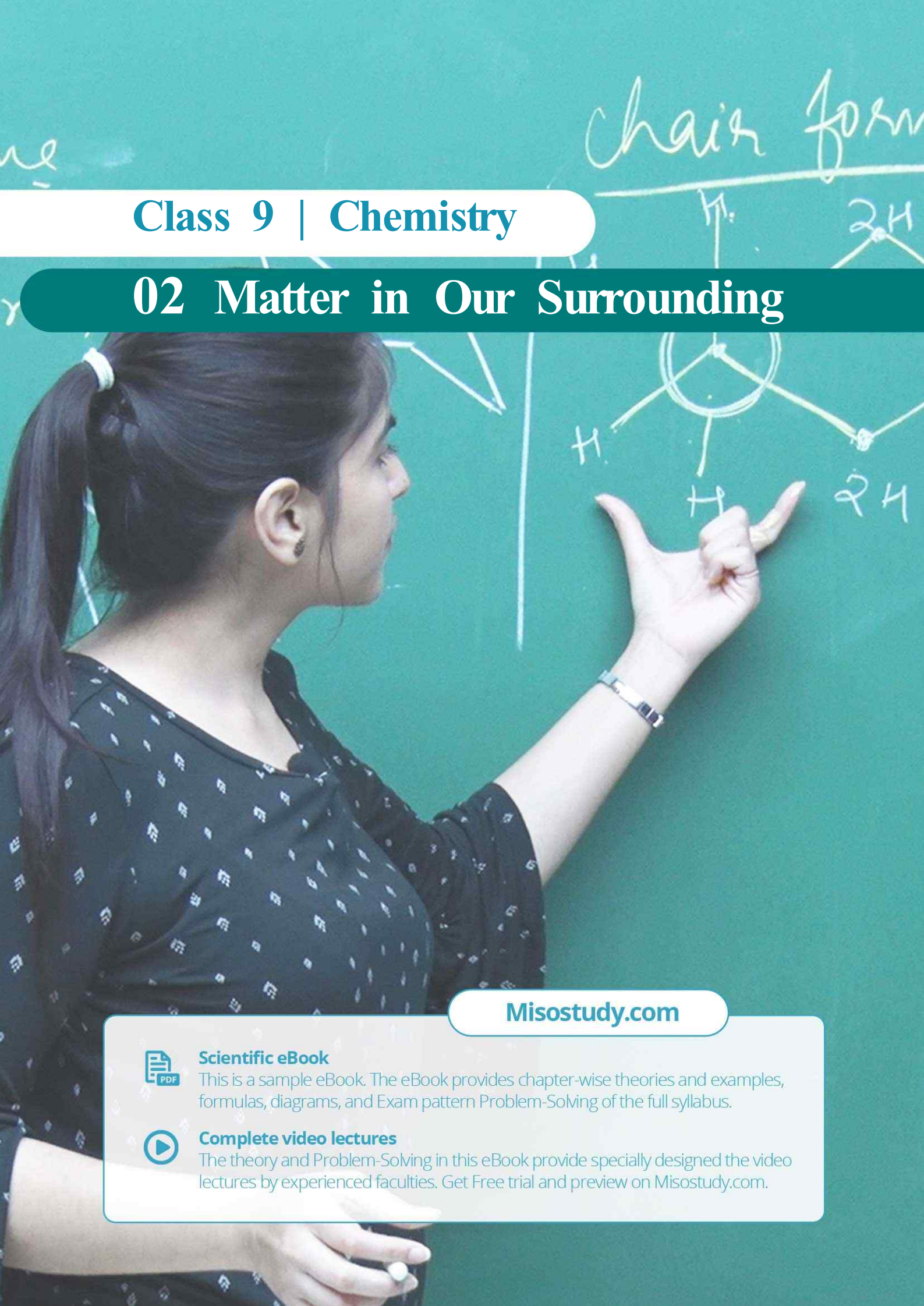

Class 9 | Chemistry

02 Matter in Our Surrounding

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Anything which occupies space and has mass is called matter. Modern day scientists classify matter in two ways : on the basis of its physical properties and on the basis of its chemical properties. On the basis of physical properties matter is classified as solids, liquids and gases. And on the basis of chemical properties, matter is classified as elements, compounds and mixtures.

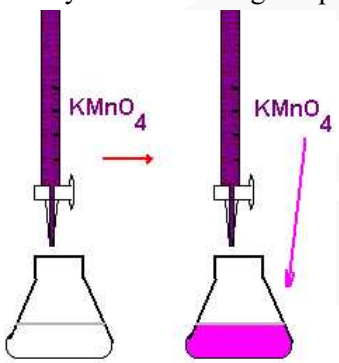
01. Matter is made of particles

Everything around us is made of tiny pieces or particles.

Evidence for Particles in Matter

(i) **Dissolving a Solid in Liquid**

we will first study the dissolving of potassium permanganate in water.



Actually, on dissolving, the particles of potassium permanganate into the spaces between the particles of the water. Since the particles of potassium permanganate and particles of water spread into each other and mix up on their own, it is concluded that ´they are moving' or ´they are in motion If the particles were not moving the colours could not spread throughout the beaker on its own. This movement of different particles among each other (on their own), so that they become mixed uniformly, is called diffusion. We will now discuss the case of sugar dissolving in water. when sugar is added to water and stirred, it dissolves quickly. The sugar seems to disappear. These sugar particles go into the spaces between the particles of water, and mix with them.

(ii) **Mixing of Two Gases**

The process of diffusion give us two conclusions about the nature of matter :

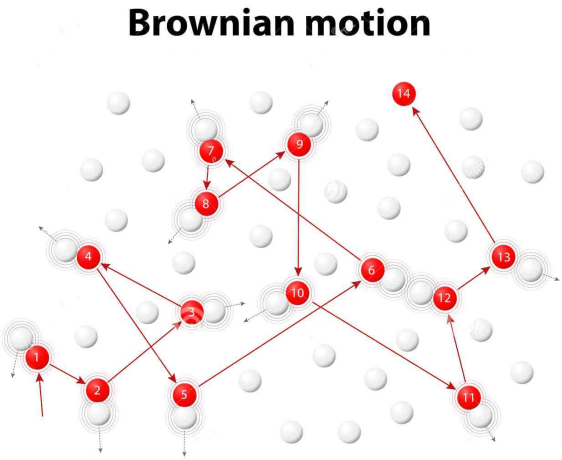
(a) that matter is made up of tiny particles, and

(b) that the particles of matter are constantly moving.

(iii) **Movement of pollen Grains in Water**

The best evidence for the existence and movement of particles in liquids was given by Robert Brown in 1827. Robert Brown suspended extremely small pollen grains in water. On looking through the microscope. it was found that the pollen grains were moving rapidly throughout water in a very irregular way (or zig-zag way) It was also observed that warmer the water, faster the pollen grains move on the surface of water. The pollen grains move on the surface of water because they are constantly being hit by the fast

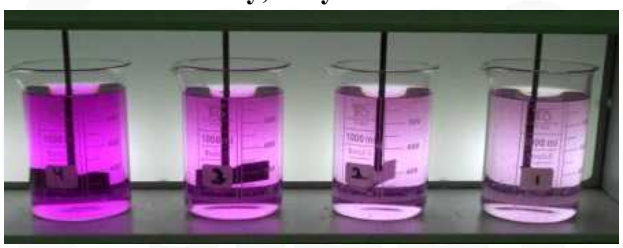
(iv) moving particles of water. The random motion of visible particles (pollen grains) caused by the much smaller invisible particles of water is an example of Brownian motion (after the name if the scientist Robert Brown who first observed this phenomenon. The zig-zag movement of the small particles suspended in a liquid (or gas) is called Brownian motion.)



Characteristics of Particles of Matter

The important characteristics of particles of matter (like atoms or molecules are the following:

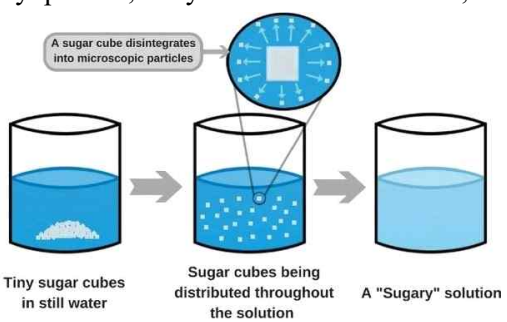
(i) **The particles of matter are very, very small**



From this observation we conclude that each potassium permanganate crystal itself must be made up of millions of small particles which keep on spreading and imparting colours to more and more of water (on dilution.)

(ii) **The particles of matter have spaces between them**

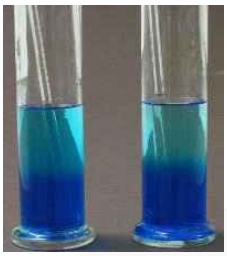
The fact that there is no change in volume on dissolving sugar in water tells us that there are spaces between the particles of water. And these spaces accommodate the sugar particles. This also gives us another conclusion that the particles (or molecules) in water are not tightly packed, they are somewhat loose, having spaces between them.



(iii) **The particles of matter are constantly moving**

The best evidence that particles of matter constantly moving comes from the studies of diffusion and brownian motion

(a) When we light (or burn) an incense stick (*agarbatti*) in one corner of room, its fragrance (pleasant smell) spreads in the whole corner of a room, quickly. When a few crystals of copper sulphate are placed at the bottom of a beaker (or a gas jar) containing water then water in the whole beaker turns blue slowly, thus, the spreading of blue colours of copper sulphate crystals in water is due to the movement of both, copper sulphate particles as well as water particles.



(iv) **The particles of matter attract each other**

There are some forces of attraction between the particles of matter which bind them together.

02. Classification of matter as solids, liquids and gases

On the basis of physical states all the matter can be classified into three groups: solids, and liquids Gases. for example :

(a) Sugar, sand, sand, iron, wood, rocks, minerals and ice are solids,
(b) Water, milk, oil, kerosene, petrol, and alcohol, are liquids, and
(c) Air, oxygen, dioxide and steam are gases.

Properties of solids

- Solids have a fixed shape and a fixed volume.
- Solids cannot be compressed much.
- solids have high densities. They are heavy.
- Solids do not fill their container completely
- Solids do not flow

Properties of Liquids

- Liquids have a fixed volume but they have no fixed shape Liquids take the shape of the common gases. the vessel in which they are placed
- Like solids, liquids cannot be compress
- Liquids have moderate to high densities. They are usually less dense than solid.
- Liquid do not fill their container completely.
- Liquid generally flow easily.

Properties of Gases

- Gases have neither a fixed shape nor a fixed volume Gases acquire the shape and volume of the vessel in which they are kept.
- Gases can be compressed easily (into a small volume).
- Gases have very low densities. They are very, very light. A gas is much lighter then the same volume of a solid or a liquid
- Gases fill their container completely.
- Gases flow easily.

03. Diffusion

The spreading out and mixing of a substance with another substance due to the motion of its particles is called diffusion.

Diffusion in Gases

- The smell of food being cooked in the kitchen in the reaches us even from a considerable distance
- The fragrance of burning incense stick (or agarbatti) spreads all around due to the diffusion of its smoke into the air.
- The smell of perfume due to diffusion of perfume vapours into air.

Diffusion in Liquids

- The spreading of purple colour of potassium permanganate into water, on its own, is due to the diffusion of potassium permanganate particles into water
- The spreading of blue colour of copper sulphate into water, on its own is due to the diffusion of copper sulphate particles into water.
- The spreading of ink water, on its own, is due to the diffusion of ink particles into water.
- The carbon dioxide gas and oxygen gas present in air (or atmosphere) diffuse into water (of pond, lakes, rivers and sea) and dissolve in it.

Diffusion in Solids

Diffusion in solids is a very, very slow process.

- If two metal block are bound together tightly and kept undisturbed for a few year then the particles of one metal are found to have diffused into the other metal.

04. The common unit of temperature and si unit of temperature

$$0^{\circ}C=273K$$

The relation between kelvin scale and Celsius scale of temperature can be written as :

Temp. on Kelvin scale = Temp. on Celsius + 273

05. Change of state of matter

We can change the physical state of matter in two ways:
(a) By changing the temperature, and
(b) By changing the pressure.

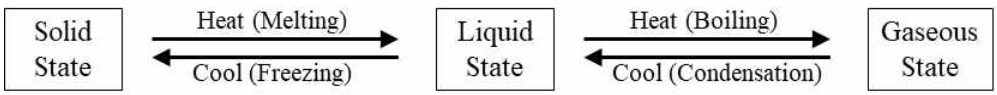
06. Effect of change of temperature

(i) **Solid to Liquid Change : Melting** The process in which a solid substance changes into a liquid on heating, is called melting (or fusion). The temperature at which a solid substance melts and changes into a liquid at atmospheric pressure, is called melting point of the substance. Different solids have different melting point for example, the melting point of ice is $0^{\circ}C$; the melting point of wax is $63^{\circ}C$; whereas the melting point of iron is $1535^{\circ}C$. the melting point of a solid is a measure of the force of attraction between its particles (atoms or molecules).

(ii) **Liquid to Gas Change : Boiling (or Vaporisation)**The process in which a liquid substance changes into a gas rapidly on heating, is called boiling. the temperature at which a liquid boils and changes rapidly into a gas at atmospheric pressure is called boiling point of the liquid. Different liquid have different boiling point. For example the boiling point af alcohol is $78^{\circ}C$, the boiling point of water $100^{\circ}C$,
whereas the boiling point of mercury is $357^{\circ}C$ the boiling point of a liquid is a measure of the force of attraction between its particles.

(iii) **Gas to Liquid Change : Condensation** The process of changing a gas (or vapour) to a liquid by cooling is called condensation.

(iv) **Liquid to Solid Change : Freezing** The process of changing a liquid into a solid by cooling is called freezing For example, when water is cooled it gets converted into a solid called ice this is called freezing. of water freezing means solidification. Please note that freezing is the reverse of melting.



07. Latent heat

The heat energy which has to be supplied to change the state of a substance is called its latent heat. Latent heat does not raise (or increase) the temperature. The latent heat which we supply is used up in overcoming the forces of attraction between the particles of a substance during the change of state.
Latent heat is of two type:
(a) Latent heat of fusion and
(b) Latent heat of vaporisation.

08. Sublimation

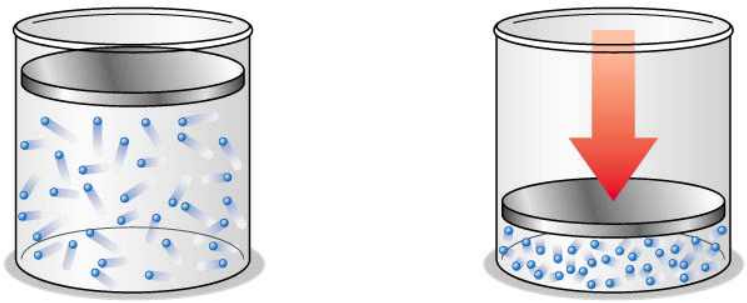
The changing of a solid directly into vapours on heating, and of vapours into solid on cooling, is known as sublimation.

$$\text{Solid} \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}} \text{Vapour (or Gas)}$$

Please note that :
(a) the changing of a solid directly into vapour (or gas) is called sublimation and
(b) the changing of vapour (or gas) directly into solid is also called sublimation
The common substances which undergo sublimation are : Ammonium chloride, Iodine, Camphor, Naphthalene and anthracene. Solid carbon dioxide (or dry ice) sublimes to form carbon dioxide gas.

09. Effect of change of pressure

The physical state of matter can also be changed by changing the pressure.
Gases can be Liquefied by Applying Pressure And Lowering Temperature



(a) (b)

10. Evaporation

The process of a liquid changing into vapour (or gas) even below its boiling point is called evaporation.

Factors Affecting Evaporation
The evaporation of a liquid depends mainly on the following factors:

- **Temperature :** The rate of evaporation increasing the temperature of the liquid
- **Surface Area of the Liquid :** The rate of evaporation increases on increasing the surface area of the liquid
- **Humidity of Air :** When the humidity of air is low, then the rate of evaporation is high and water evaporates more readily. when the humidity of air of is high then rate of evaporation is low, and water evaporates very slowly.
- **Wind Speed :** The rate of evaporation of a liquid increases with increasing wind speed.

Cooling Caused by Evaporation : The cooling caused by evaporation is based on the fact that when a liquid evaporates, it draws (or takes) the latent heat of vaporisation from anything which it touches. losing heat, this anything gets cooled,

- If we put a little of spirit (ether or petrol) at the back of our hand wave it around the spirit evaporates rapidly and our hand feels very cold.
- During hot summer days, water is usually kept in an earthen pot (called pitcher or matka) to keep it cool.
- Perspiration (or sweating) is our body s method of maintaining a constant temperature.
- We should wear cotton clothes in hot summer days to keep cool and comfortable.

Two More States of Matter : Plasma and Bose-Einstein Condensate

Scientist now say that there are actually five states of matter : Solid Liquid, Gas, Plasma and bose-Einstein Condensate.

CBSE Pattern
Exercise (1)

(Q 1 to 2) One Mark

1. What is the chemical name of dry ice?

2. If the fish is being fried in a neighbouring home, we can smell it sitting in our own home. Name the process which brings this smell to us.

(Q 3 to 5) Two Marks

3. What do you understand by the term 'latent heat'? What are the two types of latent heat?

4. Which contain more heat, 1 kg of water at 100°C or 1 kg of steam at 100°C? Give reason for your answer.

5. Why does our palm feel cold when we put some acetone (or perfume) on it?

(Q 6 to 7) Three Marks

6.
   (a) What are the two ways in which the physical states of matter can be changed?
   (b) Draw the 'states of matter triangle' to show the interconversion of states of matter.
   (c) How can the evaporation of a liquid be made faster?

7.
   (a) What is meant by 'diffusion'? Give one example of diffusion in gases.
   (b) Why do gases diffuse very fast?
   (c) Name two gases of air which dissolve in water by diffusion. What is the importance of this process in nature?

8. When extremely small particles X derived from the anther of a flower were suspended in a liquid Y and observed through a microscope, it was found that the particles X were moving throughout the liquid in a very zig-zag way. It was also observed that warmer the liquid Y, faster the particles X moved on its surface.
   (a) What could particles X be?
   (b) What do you think liquid Y is?
   (c) What is the zig-zag movement of X known as?
   (d) What is causing the zig-zag movement of particles X?
   (e) Name the scientist who discovered this phenomenon.
   (f) What does this experiment tell us about the nature of liquid Y?

(Q 9 to 10) Five Marks

9. There are four substances W, X, Y, Z. The substances W is dark violet solid having diatomic molecules. A solution of W in alcohol is used as a common antiseptic C. The substance X is a white solid which is recovered from sea water on large scale. The substance Y is a white solid which is insoluble in water and used in the form of small balls for safe storage of woollen clothes. The substances Z is a yet another white solid used in dry cells.
   (a) Name (i) W (ii) X (iii) Y (iv) X
   (b) Out of W, X, Y, and Z, which substance/substances can undergo sublimation?
   (c) Which substance is organic in nature?
   (d) What is the name of substance C?
   (e) Which substance belongs to halogen family?

10. When water is cooled to a temperature x, it gets converted into ice at temperature x by a process called P. And when ice at temperature x is warmed, it gets re-converted into water at the same temperature x in a process called Q.
   (a) What is the value of temperature x in kelvin?
   (b) What is the process P known as?
   (c) What is the name of energy released during the process P?
   (d) What is the process Q known as?
   (e) What is the name of the energy absorbed during the process Q?

Answer & Solution

1. Carbon dioxide, CO_2

2. Diffusion

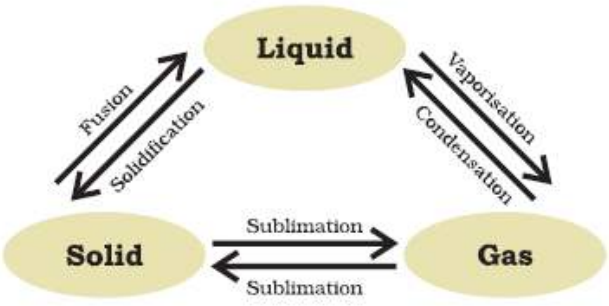
3. The heat required to convert a solid into a liquid or vapour, or a liquid into a vapour, without change of temperature. The two types of latent heats are:
   - Latent heat of fusion
   - Latent heat of vaporisation

4. 1 Kg of heat at 100 degree celsius contains more heat because of the following relationship:
   Water at 100°C + Heat $\rightleftarrows$ Steam at 100°C

5. The acetone has low boiling point and thus it gets evaporated immediately by absorbing heat from the palm making us feel cold.

6. (a) Temperature, Pressure

   (b)



   (c) Evaporation can be made faster by following ways:
   - Increasing temperature
   - Increasing surface area

- Decreasing humidity in the surrounding area
- Increasing the speed of wind

7.

(a) The spreading out and mixing of a substance with another, due to the motion of the particles is known as diffusion. Example: The smell of the perfume spreads due to the diffusion of perfume vapours in the air.
(b) Particles move very quickly in all the directions.
(c) O_2 and CO_2, both are dissolved in water which is required by marine animals and plants, respectively, for their survival.

8.

(a) Pollen Grains
(b) Water
(c) Brownian Motion
(d) The fast moving water particles are constantly hitting particles X, causing them to move in a zig-zag manner.
(e) Robert brown
(f) The liquid Y is made up of very small particles which are constantly moving.

9.

(a) (i) Iodine, (ii) Sodium Chloride, (iii) Naphthalene, (iv) Ammonium Chloride
(b) W, Y, Z
(c) Y
(d) Tincture of Iodine
(e) W

10.

(a) 273K
(b) Freezing
(c) Latent Heat of Freezing
(d) Melting Latent Heat of Fusion

CLASS 9

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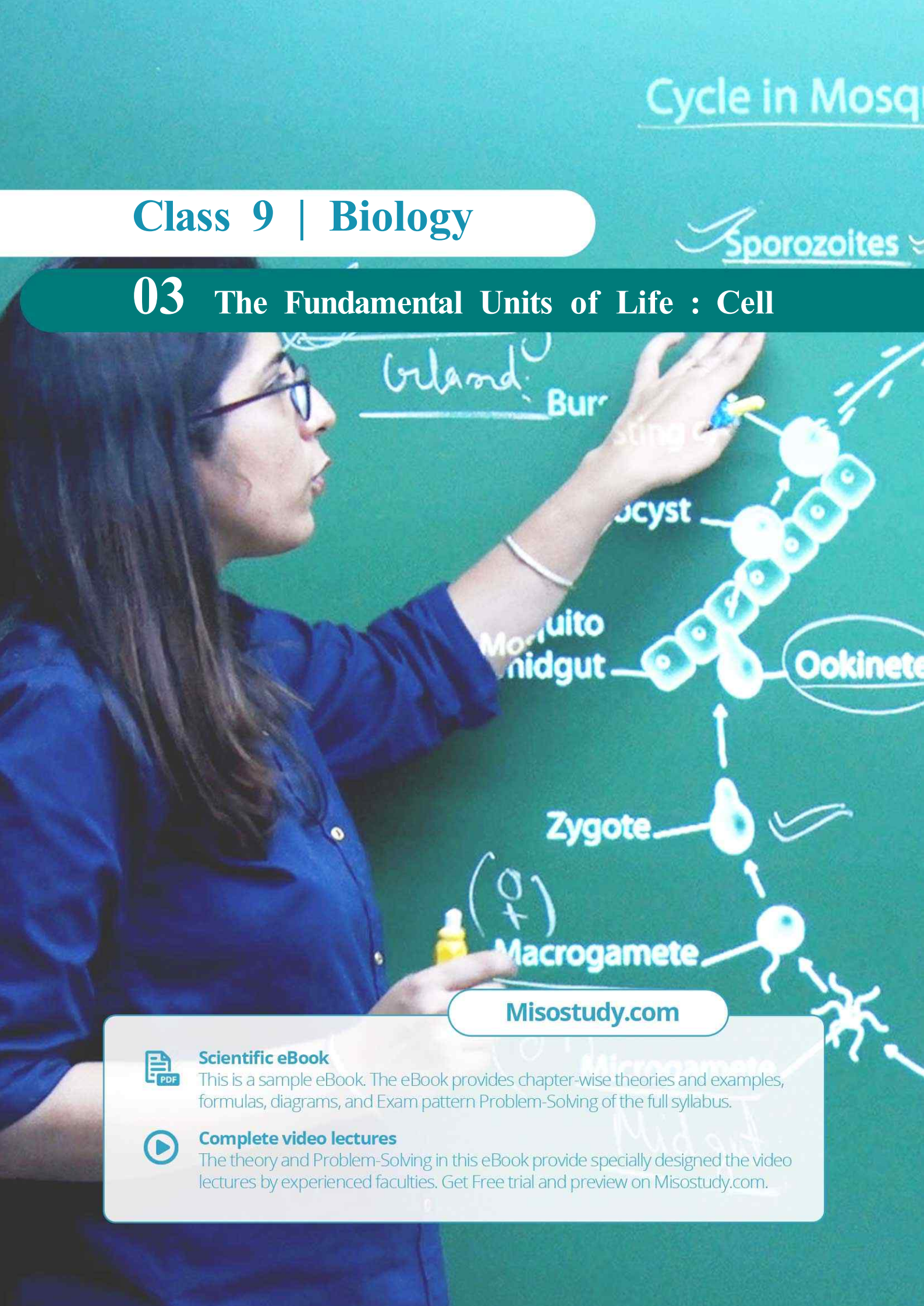
Class 9 | Biology

03 The Fundamental Units of Life : Cell



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01. What is The Living Being Made Up of ?

(a) **Cell is termed as the structural unit of life as it** provides structure to our body.
(b) **Cell is considered as the functional** unit of life as all the functions of the body take place at cell level.

Discovery of Cell :

(a) Discovered by Robert Hooke in 1665 in cork resembling the structure of honeycomb consisting of many little compartments in self designed microscope. Cork is a substance which is obtained from the bark of a tree.
(b) Robert Brown in 1831 discovered the nucleus in the cell.

02. Discovery of Cell

(i) Discovered by Robert Hooke in 1665 in cork resembling the structure of honeycomb onsisting of many little compartments in self designed microscope. Cork is a substance which is obtained from the bark of a tree.
(ii) Robert Brown in 1831 discovered the nucleus in the cell.

Cell Theory : Given by **Jacob Matthias Schleiden** (18-04-1881), a German botanist, first proposed the idea that all plants consist of cells. A year later, in 1839, **Theodor Schwann** (18-10-1882), a German zoologist, independently asserted that all animals and plants are made up of cell. Cell theory states that:

All living organisms are composed of cells.

- Cell is the fundamental unit of life.
- All new cells come from pre-existing cells.

Types of Organisms on the Basis of Number of Cells

There are two kinds of organisms on the basis of cells:

Different between unicellular and multicellular organisms.

Unicellular Organisms	Multicellular Organisms
• An unicellular organisms is represented by a single cell.	• A multicellular organisms consists of large number of cells.
• All activities of the organisms are performed by a single cell.	• A single cell performs one or few activities of the organisms.
• There is no division of labour as the single cell perform all life activities.	• Cells are specialised to perform different functions of the body so that there is a division of labour within cells.
• Reproduction consumes a single cell.	• Only some cells of the body called germ cells take part in reproduction. Other cells (somatic cells) remain intact.
• The life span of an individual is short.	• The life span of an individual is long.

Shape and Size of Cells

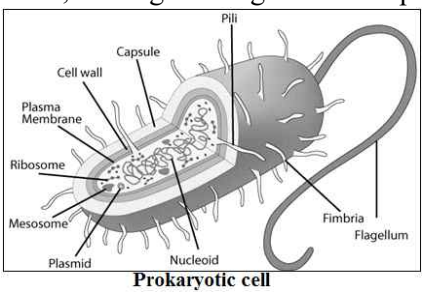
(a) Cells vary in shape and size. They may be oval, spherical, rectangular, spindle shaped, or totally irregular like the nerve cell.
(b) The size of cell also varies in different organisms. Most of the cells are microscopic in size like red blood cells (RBC) while some cells are fairly large like nerve cells

03. Types of Cells

The cells can be categorized in two types:

(i) **Prokaryotic cell :**

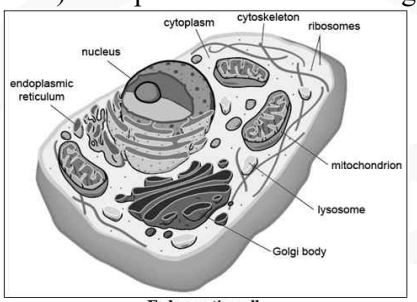
Prokaryotic cells are cells in which true nucleus is absent. They are primitive and incomplete cells. Prokaryotes are always unicellular organisms. For example, archaebacteria, bacteria, blue green algae are all prokaryotes.



Prokaryotic cell

(ii) **Eukaryotic Cell**

Eukaryotic cells are the cells in which true nucleus is present. They are advanced and complete cells. Eukaryotes include all living organisms (both unicellular and multicellular organisms) except bacteria and blue green algae.



Eukaryotic cell

Prokaryotic cell	Eukaryotic cell
• Size of a cell generally small (1-10mm).	• Size of a cell is generally large (5-100mm.)
• Nucleus is absent (Nuclear region or nucleoid is not surrounded by a nuclear membrane).	• Nucleus is present (Nuclear material is surrounded by a nuclear membrane).
• It contains single chromosome.	• It contains more than one chromosome.
• Nucleolus is absent.	• Nucleolus is present.
• Membrane bound cell organelles are absent.	• Membrane bound cell organelles such as mitochondria, plastids, endoplasmic reticulum, Golgi apparatus, lysosmes, peroxisomes, etc., are present.
• Cell division takes place by fission or budding (no mitosis).	• Cell division occurs by mitotic or meiotic cell division.

04. Cell Shape

The basic shape of eukaryotic cell is spherical, but the shape of cell is ultimately determined by the specific function of the cell. Thus, the shape of the cell may be **variable** (*i.e.*, frequently changing its shape) or **fixed.** Variable or irregular shape occurs in *Amoeba* and

white blood cells or leucocytes. Fixed shape of cell occurs in most plants and animals (including *Euglena* and *Paramecium.*) In unicellular organisms, the cell shape is maintained by tough plasma membrane (e.g. *Paramecium*) and exoskeleton (e.g., *Elphidium* or *Polystomella*). In multicellular organisms, the shape of a cell depends mainly on its functional adaptation and partly on the surface tension, viscosity of the protoplasm, the mechanical action exerted by adioning cell and rigidity of the cell membrane (*e.g.,* presence of rigid cell wall in plant cells). Thus, cell may have diverse shapes such as **polyhedral** (with 8,12 or 14 sides), **spherical** (e.g., eggs of many animals),spindle-shaped (e.g., smooth muscle fibre), elongated (e.g., nerve cell), **branched** (e.g., chromatophores or pigment cells of skin), discoidal (e.g., erythrocytes or red blood cells) and so on

05. Cell Size

The size of cells varies from the very small cells of bacteria (0.2 to 5.0 µm) to the very large eggs of the ostrich (18 cm).

06. Structure of Cell

Cell is generally composed of three basic components:

(i) **Cell membrane or Plasma Membrane:**

Plasma membrane is the covering of the cell that separates the contents of the cell from its external environment. It is a living part of the cell and is present in cells of plants, animals and microorganisms.

It is very thin, delicate, elastic and selectively permeable membrane.

It is composed of lipid and protein.

Function :

As it is selectively permeable membrane, it allows the flow of limited substances in and out of the cell.

Diffusion

(a) The spontaneous movement of a substance from region of high concentration to the region of low concentration is called diffusion

(b) Some substances like carbon dioxide or oxygen can move across the cell membrane by a process called diffusion. Cell also obtains nutrition from the environment.

Osmosis

(a) The movements of water molecules through selectively permeable membrane along the concentration gradient is called osmosis.

(b) Plant cell tend to obtain water through osmosis.

Hypotonic or Hypertonic or Isotonic Solution

What happened to cell in sugar or salt solution?

Name of the Solution	Condition	Result
Hypotonic solution	Medium surrounding cell has higher water concentration that cell.	Cell will gain water by osmosis and likey to swell up.
Isotonic solution	Medium has exactly same water concentration as the cell.	Water crosses the cell membrane in both directions. Cell will stay the same size.
Hypertonic solution	Medium has lower concentration of water than the cell.	Water crosses the cell in both directions, but more water leaves the cell than enters it.

Mediated Transport

Plasma membrane acts as an effective barrier to the free diffusion of most molecules of biological significance. Yet , it is essential that some materials enter and leave the cell. Nutrients such as sugars and materials of growth such as amino acids must enter the cell, and the wastes of metabolism must be thrown out. Such molecules are moved across the membrane by special proteins called transport **proteins** or **permeases.**

Endocytosis

Endocytosis is the ingestion of material by the cell through the plasma membrane. It is a collective term that describes three similar processes: **phagocytosis** (''cell eating), **potocytosis** (cell drinking) and **receptor – mediated endocytosis** These processes are pathways to specifically internalize solid particles, small molecules and ion, and macromolecules, respectively. All of them require energy, so they may be regarded as different form of active transport.

Exocytosis

Just as materials can be brought into a cell by invagination and formation of a vesicle, the membrane of a vesicle can fuse with the plasma membrane and extrude its contents to the surrounding medium. This process is called cell **vomiting** or **exocytosis.**
Exocytosis occurs in various cells to 1. remove undigested residues of substance completely across a cellular barrier. For example, a substance (*e.g.*, IgA or immunoglobulin/ antibody) may be picked up on one side of the wall of blood vessel by phagocytosis, moved across the cell, and released by exocytosis.

Cell Wall :

Cell wall is non-living, thick and freely permeable covering made up of cellulose.
It is present in eukaryotic plant cells and in prokaryotic cells.

Functions :

(a) It determines the shape and rigidity to the plant cell.
(b) It protects the plasma membrane.
(c) It prevents desiccation or dryness in cell.
(d) It helps in the transport of various substances in and out of the cell.

Plasmolysis

When a living plant cell loses water through osmosis, there is a shrinkage or contraction of the protoplasm away from the cell wall This phenomenon is called **plasmolysis**

(ii) **Nucleus :**

Nucleus is dense and spherical organelle. Nucleus is bounded by two membranes, both forming nuclear envelope. Nuclear envelope contains many pores known as nuclear pores. The fluid which present inside the nucleus is called nucleoplasm.

Nucleus contains chromosomes and chromosomes contain genes which are the centres of genetic information.

Difference Between Nucleus and Nucleoid.

Nucleus	Nucleoid
• It has larger in size.	• It is comparatively smaller in size.
• It has a covering of double membrane envelope.	• A covering membrane is absent. It lies free in the cytoplasm.
• Nucleolus is present in it.	• Nucleolus is absent in it.
• Its DNA is associated with histone proteins to form chromatin.	• In it histones are absent. DNA of a nucleoid is often naked.

Functions :

(a) Nucleus controls all the metabolic activities of the cell.

(b) It regulates the cell cycle.

(c) Nucleus is the storehouse of genes. It is concerned with the transmission of hereditary traits from the parent to offspring.

(iii) **Ncytoplasm :**

It is a jelly-like, viscous, colourless semi-fluid substance that occurs between the plasma membrane and the nuclear membrane.

Functions :

(a) Protoplasm acts as a store of vital chemicals like amino acids, proteins, sugars, vitamins, etc.

(b) It is the site of certain metabolic reactions, like glycolysis, synthesis of fatty acids, nucleotides, etc.

Difference Between Organs and Organelles.

Organs	Organelles
• They are found in multicellular organisms.	• They are found in all eukaryotic cells.
• They are large sized or macroscopic.	• They are very small sized, either microscopic or submicroscopic.
• They may be external or internal to the body of an organisms.	• They are mostly internal (*i.e.,* intracellular).
• The organs are formed of tissues, tissues comprise of cells and cells are formed of organelles.	• An organelle is made up of micromolecules and macromolecules.
• Organs coordinate to form organ system, while organ systems form the body of an organisms.	• Organelles coordinate to produce the cell.

07. Cell Organelles

Inside the cell there are different parts performing different activities to keep the cell alive an functionable. These part are called Cell organelles. They are explained below:

(i) **Golgi Apparatus :** Golgi apparatus consists of a set of membrane bound, fluid filled vesicles, vacuoles and flattened cisternae (closed sacks). Cisternae are usually arranged parallel to each other.

Functions :

(a) Its main function is to store, modify, package and dispatch the substances.

(b) It is also involved in the synthesis of cell wall, plasma membrane and lysosomes.

(ii) **Endoplasmic Reticulum :** It is a membranous network of tube like structures extending from nuclear membrane to plasma membrane. It is absent in prokaryotic cells and matured RBCs of mammals. There are two types of endoplasmic reticulum:

- Rough Endoplasmic Reticulum (RER): Here ribosomes are present on the surface for the synthesis of proteins.
- Smooth Endoplasmic Reticulum (SER): Here ribosomes are absent and is meant for secreting lipids.

Functions :

(a) It gives internal support to cell.

(b) It helps in transport of various substances from nuclear membrane to plasma membrane or vice versa.

(c) RER helps in synthesis and transportation of proteins.

(d) SER helps in synthesis and transportation of lipids.

(iii) **Ribosomes :** These are extremely small, dense and spherical bodies which occur freely in the matrix (cytosol) or remain attached to the endoplasmic reticulum.

These are made up of ribonucleic acid (RNA) and proteins.

Functions :

They play a major role in the synthesis of proteins.

(iv) **Mitochondria :** They are small rod-shaped organelles. It is a double membrane structure with outer membrane being smooth and porous whereas inner membrane being thrown into a number of folds called cristae. They contain their own DNA and ribosomes. They are absent in bacteria and red blood cells of mammals.

Functions:

- They are the sites of cellular respiration, hence provide energy for the vital activities of living cells.
- They store energy releases during reactions, in the form of ATP (Energy currency of the cell). Therefore, they are also called 'power house' of the cell.

(v) **Centrosome and Centrioles :** Centrosome is found only in eukaryotic animal cells. It is not bounded by any membrane but consists of centrioles. Centroles are hollow cylindrical structures arranged at right angle to each other and made up of microtubules.

Functions:

Centrioles help in cell division and also help in the formation of cilia and flagella.

(vi) **Plastids:** Plastids are present in most of the plant cells and absent in animal cells. They are usually spherical or discoidal in shaped and double membrane bound organelles. They also have their own DNA and ribosomes. Plastids are of three types:

(a) **Chloroplasts :** These are the green coloured plastids containing chlorophyll. Chloroplasts aid in the manufacture food by the process of photosynthesis.

(b) **Chromoplasts :** These are the colourful plastids (except green colour).

(c) **Leucoplasts :** These are the colourless plastids.

Difference Between Leucoplasts and Chromoplasts (Nongreen Plastids)

Mitochondria	Chloroplasts
• They are colourless.	• They range from brownish to reddish n colour.
• They are cylindrical or ounded in shape.	• They are irregular in shape.
• They are found in unexposed cells.	• They are found in both exposed and unexposed cells.
• They can change to other type of plastids.	• They do not change into other types of plastids.
• They take part in storage of zood, e.g., amyloplasts (carbohydrates), elaioplasts (lipids), aleuroplasts (proteins).	• They provide colour to organs to attract pollination and disseminators.

Difference Between Chloroplasts and Chromoplasts.

Chloroplasts	Chromoplasts
• They are green plastids.	• They are non-green coloured plastids.
• They ontain chlorophylls and carotenoids	• Chlorophylls are absent. Only carotenids are present.
• Lamellae are present.	• Lamellae are absent.
• Chloroplasts are sites of photosynthesis.	• They add colour to the organs (*e.g.,* flowers, fruits) for attracting animals to perform pollination and fruit dispersal.

Functions :

- Chloroplasts trap solar energy and utilise it to manufacture food for the plant.
- Chromoplasts impart various colours to flowers to attract insects for pollination.
- Lecuoplasts help in the storage of food in the form of starch, proteins and fats.

Mitochondria	Chloroplasts
• They occur in the cells of the aerobic organisms (plants and animals) with the exception of mammalin RBcs.	• They occur in the cells of green photosynthetic parts (*e.g.,* leaves) of plants
• They are colourless.	• They are green in colour.
• The shape is rod-like or sausage-shaped.	• They are generally dis-like in outline.
• Inner membrane of each mitochondria is thrown into folds called cristae.	• Their inner membrane forms flattened sacs called thylakoids or lamellae.
• They liberate energy	• They trap solar energy and convert it into chemical energy.
• They perform oxidation of food.	• They synthesize food by photosynthesis.
• They perform oxidation of food.	• They synthesize food by hotosynthesis.
• They consume O_2 and liberate CO_2.	• They consume CO_2 and liberate O_2.

(i) **Lysosomes :**

Lysosomes are small, spherical, sac like structures which contain several digestive enzymes enclosed in a membrane.

They are found in eukaryotic cells mostly in animals. 0

Functions :

- Lysosomes help in digestion of foreign substances and worn-out cell organelles.
- They provide protection against bacteria and virus.
- They help to keep the cell clean.
- During the disturbance in cellular metabolism, for example when the cell gets damaged, Lysosomes may burst and the enzymes digest their own cell. Therefore, lysosomes are also known as **suicide bags** of a cell
- They provide turgidity and rigidity to the plant cell.

(ii) **Vacuoles :**

Vacuoles are liquid/solid filled and membrane bound organelles.

In plant cells, vacuoles are large and permanent. In animal cells, vacuoles are small In size and temporary.

In mature plant cell, It occupies 90% space of cell volume.

Due to its size, other organelles, including nucleus shift towards plasma membrane.

Function :

- They help to maintain the osmotic pressure in a cell.
- They provide turgidity and rigidity to the plant cell.

(iii) **Plastids :**

Nature and occurrence. Plastids occur in most plant cells and are absent in animals cells. Like the mitochondria, the plastids also have their own genome (i.e., DNA) ribosome. They are self-replicating organelles like the mitochondria, i.e., they have the power to divide. Plastids are of following three types :

(a) Chromoplasts. Coloured plastids (except green colour).

(b) Chloroplasts. Green-coloured plastids.

(c) Leucoplasts. The colourless plastids.

Function :

- Chloroplasts trap solar energy and utilise it to manufacture food for the plant.
- Chromoplasts impart various colours to flowers to attract insects for pollination.
- Lecuoplasts help in the storage of food in the form of starch, proteins and fats.

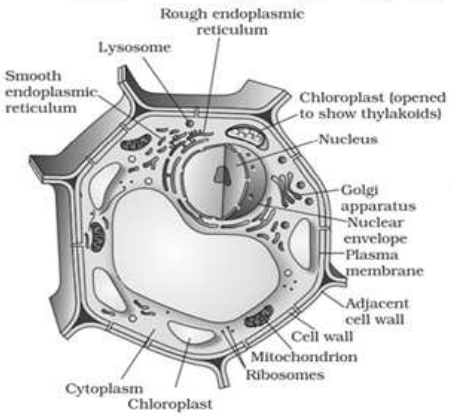
Peroxiomes : They are small and spherical organelles containing powerful oxidative enzymes. They are bounded by a single membrane. They are found in kidney and liver cells.

Function : They are specialized to carry out some oxidative reactions, such as detoxification or removal of toxic substances form cell.

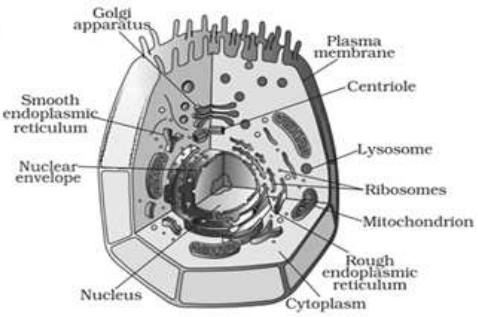
Difference Between Animal Cell and Plant Cell:

S.No.	Animal cell	Plant cell
•	Animal cells are generally small in size.	Plant cells are larger than animal cells.
•	Cell wall is absent.	Plasma membrane of plant cell is surrounded by a rigid cell wall of cellulose.
•	Plastids are absent except in case of protozoan Euglena.	Plastids are present.
•	Here vacuoles are many, small and temporary.	They have a permanent and large central sap vacuole.
•	They have centrosome and centrioles.	They lack centrosome and centrioles.

Structure of Plant Cell and Animal Cell :



Plant cell



Animal cell

CBSE Pattern
Exercise (1)

(Q 1 to 3) One Mark

1. State two important functions of nucleus.

2. Which organelles is called factory of ribosomes

3. What is plasmolysis

(Q 4 to 6) Two Marks

4. What are lysosomes termed as suicide bags of cell

5. Name any cell organelles which is non membranous

6. Why do plant cell posses large sized vacuole

(Q 7 to 8) Three Marks

7. How is prokaryotic cell differ from eukaryotic cell

8. Differentiat between unicellular and multicellular organism

(Q 9 to 10) Five Marks

9. Draw a well labeled diagram of plant cell

10.
   (a) What are genes. what is difference between genes and chromosome.
   (b) Why is the inner membrane of mitochondria folded.

Answer & Solution

Q1.

(i) The nucleus controls all metabolic activities of the cell. If the nucleus is removed from a cell, the protoplasm ultimately dries up and dies.

(ii) It regulates the cell cycle.

Q2. Nucleolus is called factory of ribosomes

Q3. When a living plants cell loses water through osmosis. there is a shrinkage or contraction of the protoplasm away from the cell wall This phenomenon is called **plasmolysis.**

Q4. During breakdown of cell structure, when the cell gets damaged, lysosomes may burst and the enzymes eat up their own cells. Therefore, lysosomes are also known as **suicide bags** of a cell

Q5. Nonmembranous organelles do not contain a definite boundary for organelles. On that account, these organelles do not possess fluid-filled cavities. All organelles in prokaryotes are nonmembranous. Ribosomes, nucleoid, centrioles, cilia, flagella, and components of the cytoplasm like microtubules, microfilaments, and intermediate filaments are nonmembranous organelles

Q6. Plant cells have large sized vacuoles because these ghelp the cell in maintaining stiffness while it withstands all the environmental conditions. They store food materials, water required by the plant. Over a period of time the excretory products accumulated will break down in the vacuole. Vacuoles maintain the shape of the cell constantly without getting disturbed by the availability of the water to the plant. Hence, plants have larger vacuoles.
Animals can move f10rom place to place in search of food, water and others while plants cannot.

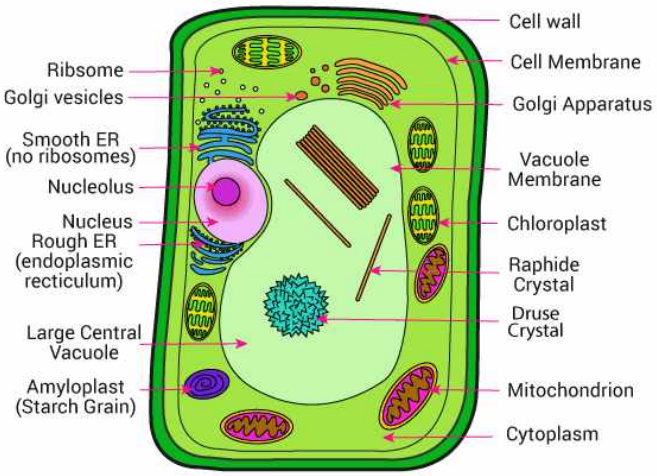
Q7. **Differences between prokaryotic cells and eukaryotic cells.**

Prokaryotic cell	*Eukaryotic cell*
(i) Size of a cell is generally small (1—10 mm).	(i) Size of a cell is generally large (5—100 mm.)
(ii) Nucleus is absent (Nuclear region or nucleoid is not surrounded by a nuclear membrane.)	(ii) Nucleas is present (Nuclear material is surrounded by a nuclear membrane.)
(iii) It contains single chromosome.	(iii) It contains more than one chromosome.
(iv) Nucleolus is absent.	(iv) Nucleolus is present
(v) Membrane bond cell organelles are absent.	(v) Membrane. bond cell organelles such as mitochondria, plastids, endoplasmic reticulum, Golgi apparatus. lysosomes, peroxisomes, etc., are present
(vi) Cell division takes place by fission or budding (no mitosis)	(vi) Cell division, occurs by mitotic or meiotic cell division.

Q8. **Differences between unicellular and multicellular organisms.**

Unicellular organisms	*Multicellular organisms*
(i) An unicellular organisms is represented by a single cell.	(i) A multicellular organism consists of large number of cells.
(ii) All activities of the organisms are performed by a single cell.	(ii) A single cell performs one or few activities of the organisms.
(iii) There is no division of labour as the single cell perform all life activities.	(iii) Cells are specialized to perform different functions of the body so that there is a division of labour within cells.
(iv) Reproduction consumes a single cell.	(iv) Only some cells of the body called germs cells take part in reproduction. Other cells (somatic cells) remain intact.
(v) The life span of an individual is short.	(v) The life span of an individual is long.

Q9.



Q10.(a)

A gene is a section of DNA which is involved in carrying information for a particular trait. They are functional units of heredity and are made of DNA. Genes are responsible for the hereditary and this is the reason why we all have similar characteristics of both the parents like the pigmentation of the eye, hair color, etc. There are about 29 to 30 thousands of genes in every cell of the human body. The term gene was first coined in the year 1909 by a Danish botanist Wilhelm Johannsen.

Chromosomes

Chromosomes are thread-like structures merged together and are made of proteins and a single molecule of deoxyribonucleic acid – DNA. They are mainly found inside the nucleus of both animal and plant cells. They are passed to offspring from their parents, over generations. The term chromosome is derived from the Ancient Greek word meaning coloured body. Every human cell contains 46 or 23 pairs of chromosomes These chromosomes play an important role in cell division process and ensure that DNA molecules are copied and distributed evenly.

Gene	Chromosome
(i) Gene is located on the chromosome	(i) Chromosomes are the packed structure of a DNA with proteins
(ii) Genes are not visible under the microscope.	(ii) Chromosomes are visible under the microscope
(iii) A single gene is a locus on a chromosome.	(iii) A single chromosome comprises of many genes.
(iv) Genes are composed of either DNA or RNA	(iv) Chromosomes are composed of DNA, histones, and RNA.
(v) Gene mutations are small.	(v) Chromosomal mutations are relatively large.
(vi) Gene mutations lead to point mutations and frameshift mutations: insertions and deletions	(vi) Chromosomal mutations lead to chromosomal abnormalities such as deletion, duplication, rearrangement and inversion of genes.

(b) The folding of the inner membrane increases the surface area inside the organelle. Since many of the chemical reactions happen on the inner membrane, reactions to occur

CLASS 9

CBSE

MATHEMATICS

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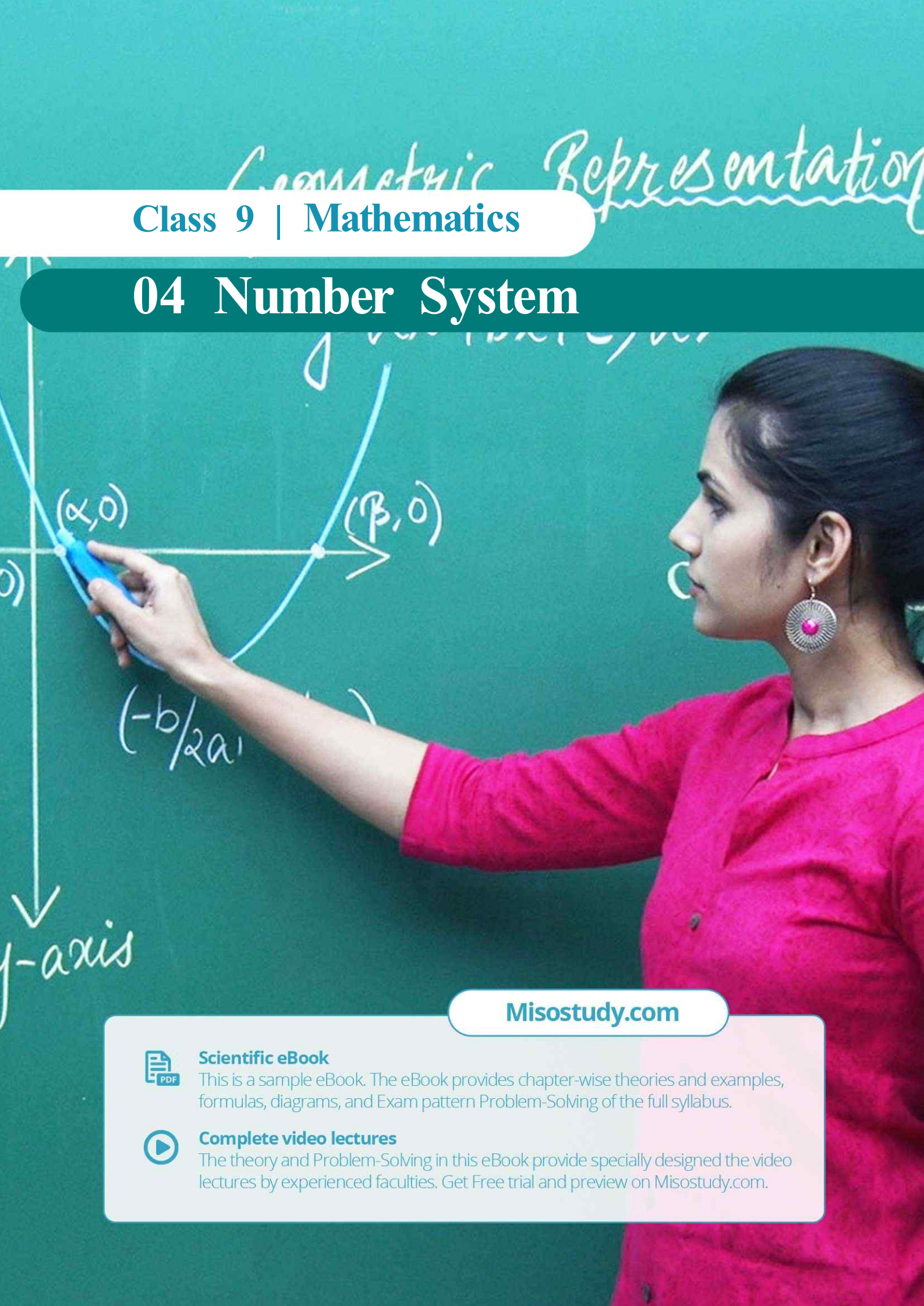
Class 9 | Mathematics
04 Number System
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(β,0)
(-b/2a)
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01. Decimal Representation of Rational Numbers

A rational number is a number which can be expressed in the form $\frac{m}{n}$, where m and n are both integers and $n \neq 0$. A rational number $\frac{m}{n}$ is said to be in its lowest terms, if $n \in N$ and m and n have no common factor other than 1. For example, $\frac{2}{3}, \frac{7}{4}, \frac{12}{5}$ etc are rational numbers in their lowest terms, whereas $\frac{22}{32}$ is not in its lowest terms.

A rational number $\frac{m}{n}$ is positive rational number if m and n are of the same sign. If m and n are such that one of them is positive and another one is negative, then the rational number $\frac{m}{n}$ is negative.

Note Every integer m is also a rational number, as it can be written as $\frac{m}{1}$.

Example Find the decimal expansions of $\frac{10}{3}, \frac{7}{8}$ and $\frac{1}{7}$.

Solution

$$
\begin{array}{r|l}
3 & 3.333\ldots \\
\hline
 & 10 \\
 & 9 \\
\hline
 & 10 \\
 & 9 \\
\hline
 & 10 \\
 & 9 \\
\hline
 & 10 \\
 & 9 \\
\hline
 & 1
\end{array}
\qquad
\begin{array}{r|l}
8 & 0.875 \\
\hline
 & 7.0 \\
 & 64 \\
\hline
 & 60 \\
 & 56 \\
\hline
 & 40 \\
 & 40 \\
\hline
 & 0
\end{array}
\qquad
\begin{array}{r|l}
7 & 0.142857\ldots \\
\hline
 & 1.0 \\
 & 7 \\
\hline
 & 30 \\
 & 28 \\
\hline
 & 20 \\
 & 14 \\
\hline
 & 60 \\
 & 56 \\
\hline
 & 40 \\
 & 35 \\
\hline
 & 50 \\
 & 49 \\
\hline
 & 1
\end{array}
$$

Remainders : 1, 1, 1, 1, 1…
Divisor : 3

Remainders : 6, 4, 0
Divisor : 8

Remainders : 3, 2, 6, 4, 5, 1, 3, 2, 6, 4, 5, 1,...
Divisor : 7

Here,

(i) The remainders either become 0 after a certain stage, or start repeating themselves.

(ii) The number of entries in the repeating string of remainders is less than the divisor (in $\frac{10}{3}$ one number repeats itself and the divisor is 3, in $\frac{1}{7}$ there are six entries 326451 in the repeating string of remainders and 7 is the divisor.)

(iii) If the remainders repeats, then we get a repeating block of digits in the quotient (for $\frac{10}{3}$, 3 repeats in the quotient and for $\frac{1}{7}$, we get the repeating block 142857 in the quotient).
Although we have noticed this pattern using only the examples above, its is true for all rationals of the form $\frac{p}{q}(q \neq 0)$. On division of p by q, two main things happen – either the remainder becomes zero or never becomes zero and we get a repeating string of remainders.

Case (i) The remainder becomes zero

In the example of $\frac{7}{8}$, we found that the remainder becomes zero after some steps and the decimal expansion of $\frac{7}{8} = 0.875$. Other examples are $\frac{1}{2} = 0.5, \frac{639}{250} = 2.556$. In all these cases, the decimal expansion terminates or ends after a finite number of steps. We call the decimal expansion of such numbers *terminating*.

Case (ii) The remainder never becomes zero

In the examples of $\frac{10}{3}$ and $\frac{1}{7}$, we notice that the remainders repeat after a certain stage forcing the decimal expansion to go on for ever. In other words, we have a repeating block of digits in the quotient. We say that this expansion is non-terminating recurring. For example, $\frac{10}{3} = 3.3333...$ and $\frac{1}{7} = 0.142857142857142857...$

Remark The usual way of showing that 3 repeats in the quotient of $\frac{10}{3}$ is to write it as $3.\overline{3}$. Similarly, since the block of digits 142857 repeats in the quotient of $\frac{1}{7}$, we write $\frac{1}{7}$ as $0.\overline{142857}$, where the bar above the digits indicates the block of digits that repeats. Also $3.57272...$ can be written as $3.5\overline{72}$. So, all these examples give us *non-terminating recurring* (*repeating*) decimal expansions.
Thus, we see that the decimal expansion of rational numbers have only two choices: either they are terminating or non-terminating recurring.

02. Conversion of Decimal Numbers into Rational Numbers of the Form $\frac{m}{n}$

We shall learn how to convert a given decimal number into an equivalent rational number in the form $\frac{p}{q}$.

We shall divide it into-two parts.

(i) When the decimal number is of terminating nature.

(ii) When the decimal representation is of non-terminating nature.

Conversion of a Terminating Decimal Number to the From $\frac{p}{q}$

In order to convert a rational number having finite number of digits after the decimal point, we follow the following steps :

Step I *Obtain the rational number.*

Step II *Determine the number of digits in its decimal part.*

Step III *Remove decimal point from the numerator. Write 1 in the denominator and put as many zeros on the right side of 1 as the number of digits in the decimal part of the given rational number.*

Step IV *Find a common divisor of the numerator and denominator and express the rational number to lowest terms by dividing its numerator and denominator by the common divisor.*

Example Express each of the following decimal numbers in the form $\frac{p}{q}$:

(i) 15.75 (ii) 8.0025 (iii) –25.6875

Solution

(i) We have,

$$15.75 = \frac{1575}{100} = \frac{1575 \div 25}{100 \div 25} = \frac{63}{4}$$

(ii) We have,

$$8.0025 = \frac{80025}{10000} = \frac{80025 \div 25}{10000 \div 25} = \frac{3201}{400}$$

(iii) We have,

$$-25.6875 = \frac{-256875}{10000} = \frac{-256875 \div 625}{1000 \div 625} = \frac{-411}{16}$$

Conversion of a Pure Recurring Decimal to the Form $\frac{p}{q}$

In a non-terminating repeating decimal, there are two types of decimal representations.

(i) A decimal in which all the digits after the decimal point are repeated. These types of decimal are known as pure recurring decimals.

For Example : $0.\overline{6}, 0.\overline{16}, 0.\overline{123}$ are pure recurring decimals.

(ii) A decimal in which at least one of the digits after the decimal point is not repeated and then some digit or digits are repeated. This type of decimals are known as *mixed recurring decimals*.

For Example : $2.1\overline{6}, 0.3\overline{5}, 0.7\overline{85}$ are mixed recurring decimals.

In order to convert a pure recurring decimal to the form $\frac{p}{q}$, we follow the following steps :

Step I *Obtain the repeating decimal and put it equal to x (say).*

Step II *Write the number in decimal form by removing bar from the top of repeating digits and listing repeating digits at least twice.*

For Example, write $x = 0.\overline{8}$ as $x = 0.888...$ and $x = 0.1\overline{4}$ *as* $x = 0.141414...$

Step III *Determine the number of digits having bar on their heads.*

Step IV *If the repeating decimal has 1 place repetition, multiply by 10; a two place repetition, multiply by 100; a three place repetition, multiply by 1000 and so on.*

Step V *Subtract the number in step II from the number obtained in step IV.*

Step VI *Divide both sides of the equation by the coefficient of x.*

Step VII *Write the rational number in its simplest form.*

Example Express the following decimal in the form $\frac{p}{q}$:

$0.\overline{35}$

Solution Let $x = 0.\overline{35}$

$\Rightarrow x = 0.353535 \ldots$ ...(i)

Here, we have two repeating digits after the decimal point. So, we multiply sides of (i) by $10^2 = 100$ to get

$10x = 35.3535 \ldots$ ...(ii)

Subtracting (i) from (ii), we get

$100x - x = (35.3535 \ldots) - (0.3535 \ldots)$

$\Rightarrow 99x = 35$

$\Rightarrow x = \frac{35}{99}$

Hence, $0.\overline{35} = \frac{35}{99}$

Conversion of a Mixed Recurring Decimal to the Form $\frac{p}{q}$

While converting a recurring decimal that has one or more digits before the repeating digits,, it is necessary to isolate the repeating digits.

In order to convert a mixed recurring decimal to the form $\frac{p}{q}$, we follow the following steps:

Step I *Obtain the mixed recurring decimal and write it equal to x (say).*

Step II *Determine the number of digits after the decimal point which do not have bar on them. Let there be n digits without bar just after the decimal point.*

Step III *Multiply both sides of x by* 10^n *so that only the repeating decimal is on the right side of the decimal point.*

Step IV *Use the method of converting pure recurring decimal to the form* $\frac{p}{q}$ *and obtain the value of x.*

Example Express the following decimals in the form $\frac{p}{q}$.

$0.00\overline{352}$

Solution Let $x = 0.00\overline{352}$

Clearly, there are three digits on the right side of the decimal point which are without bar. so, we multiply both sides of x by $10^3 = 1000$ so that only the repeating decimal is left on the right side of the decimal point.

$$\therefore \quad 1000x = 3.\overline{52}$$
$$\Rightarrow \quad 1000x = 3 + 0.52$$
$$\Rightarrow \quad 1000x = 3 + \frac{52}{99}$$
$$\Rightarrow \quad 1000x = \frac{3 \times 99 + 52}{99}$$
$$\Rightarrow \quad 1000x = \frac{297 + 52}{99} \Rightarrow 1000x = \frac{349}{99} \Rightarrow x = \frac{349}{99000}$$

03. Irrational Numbers

Irrational Numbers

A number is an irrational number, if it has a non-terminating and non-repeating decimal representation.

We have seen that a number in terminating decimal form or in a non-terminating but repeating decimal form can always be written in the form $\frac{p}{q}$, where p, q are integers such that $q \neq 0$. It follows from this that an irrational number cannot be written in the form $\frac{p}{q}$, where p and q are both integers and $q \neq 0$.

Example *Prove that $\sqrt{3}$ is an irrational number.*

Solution We find the square root of $\sqrt{3}$ by long division method.

	1.732050807
1	3.00 00 00 00 00 00 00 00 1
27	200 189
343	1100 1029
3462	7100 6924
346405	1760000 1732025
34641008	279750000 277128064
3464101607	26219360000 24248711249
	1970648751

$\therefore \quad \sqrt{3} = 1.732050807 \ldots$

We observe that the decimal representation of $\sqrt{3}$ is neither terminating nor repeating. Hence, $\sqrt{3}$ is an irrational number.

Remark *$\sqrt{n}$ is not a rational number, if n is not a perfect square.*

Example *Find three different irrational numbers between the rational numbers $\frac{5}{7}$ and $\frac{9}{11}$.*

Solution We have,

$$a = \frac{5}{7} = 0.\overline{714285} \text{ and } b = \frac{9}{11} = 0.\overline{81}$$

We observe that in the first decimal place a has digit 7 and b has digit 8, therefore $a < b$. In the second decimal place a has digit 1. So, if we consider irrational numbers

$x = 0.72072007200072000072...$

$y = 0.73073007300073000073...$

$z = 0.74074007400074000074...$

We find that

$a < x < y < z < b$

Hence, x, y and z are required irrational numbers.

04. Representing Irrational Numbers on the Number Line

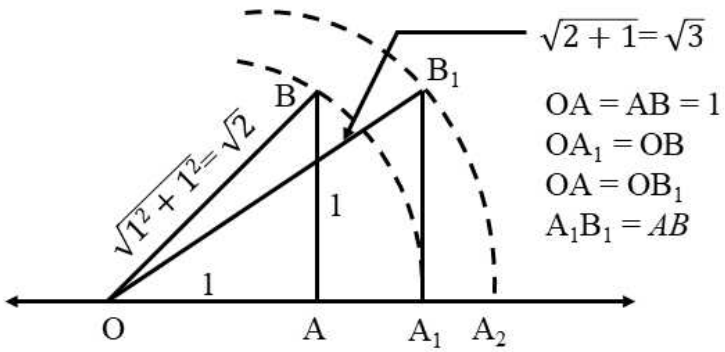
Draw a number line and mark a point O, representing zero, on it. suppose point A represents 1 as shown in Fig. Then, $OA = 1$. Now, draw a right triangle OAB such that $AB = OA = 1$. By pythagoras theorem, we have

$OB^2 = OA^2 + AB^2$

$\Rightarrow \quad OB^2 = 1^2 + 1^2$

$\Rightarrow \quad OB^2 = 1 + 1 = 2$

$\Rightarrow \quad OB = \sqrt{2}$



Now, draw a circle with centre O and radius OB, We find that the circle cuts the number line at A_1.

Clearly, $OA_1 = OB$ = radius of the circle = $\sqrt{2}$

Thus, A_1 represents $\sqrt{2}$ on the number line.

But, we have seen that $\sqrt{2}$ is not a rational number. Thus, we find that there is a point on the number which is not a rational number.

Now, draw a right triangle OA_1B_1 such that $A_1B_1 = AB = 1$.

Again, by Pythagoras theorem, we have

$$OB_1^2 = OA_1^2 + A_1B_1^2$$

$$\Rightarrow \quad OB_1^2 = (\sqrt{2})^2 + 1^2$$

$$\Rightarrow \quad OB_1^2 = 3$$

$$\Rightarrow \quad OB_1 = \sqrt{3}$$

Now, draw a circle with centre O and radius $OB_1 = \sqrt{3}$. This circle cuts the number line at A_2 as shown in Fig.

Clearly, $OA_2 = OB_1 = \sqrt{3}$

Thus, A_2 represents $\sqrt{3}$ on the number line.

Also, A_2 is a point on the number line not representing a rational number.

Continuing in this manner, we can show that there are many other points on the number line representing $\sqrt{5}, \sqrt{6}, \sqrt{7}, \sqrt{8}$, etc. which are not rational numbers. In fact, such numbers are irrational numbers.

05. Real Numbers and Real Number Line

Existence of Square Root of a Positive Real Number

For any positive real number x, we have

$$\sqrt{\left(\frac{x+1}{2}\right)^2 - \left(\frac{x-1}{2}\right)^2} = \sqrt{\frac{x^2+2x+1}{4} - \frac{x^2-2x+1}{4}} = \sqrt{\frac{4x}{4}} = \sqrt{x}$$

Therefore, to find the positive square root of a positive real number, we may follow the following algorithm.

Algorithm

Step I *Obtain the positive real number x (say).*

Step II *Draw a line and mark a point A on it.*

Step III *Mark a point B on the line such that AB = x units.*

Step IV *From point B mark a distance of 1 unit and mark the new point as C.*

Step V *Find the mid-point of AC and mark the point as O.*

Step VI *Draw a circle with centre O and radius OC.*

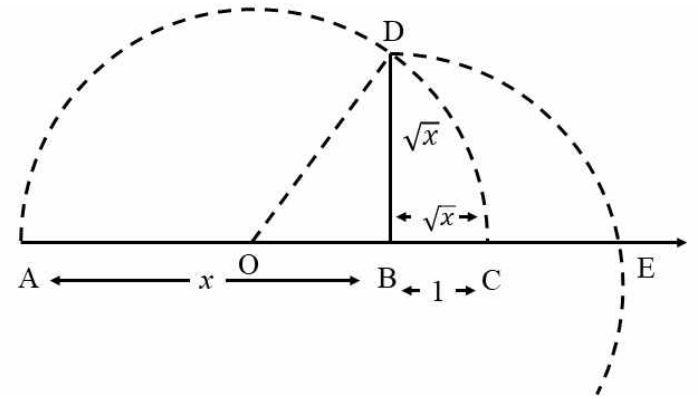
Step VII *Draw a line perpendicular to AC passing through B and intersecting the semi-circle at D. Length BD is equal to* $\sqrt{x}$.

Justification : We have,

$AB = x$ units and $BC = 1$ unit.

$$\therefore \quad AC = (x + 1) \text{ units}$$

$$\Rightarrow \quad OA = OC = \frac{x+1}{2} \text{ units}$$



$\Rightarrow$ $OD = \frac{x+1}{2}$ units $[\because OA = OC = OD]$

Now, $OB = AB - OA = x - \frac{x+1}{2} = \frac{x-1}{2}$

Using Pythagoras Theorem in ΔOBD, we obtain

$OD^2 = OB^2 + BD^2$

$\Rightarrow$ $BD^2 = OD^2 - OB^2$

$\Rightarrow$ $BD^2 = \left(\frac{x+1}{2}\right)^2 - \left(\frac{x-1}{2}\right)^2$

$\Rightarrow$ $BD = \sqrt{\frac{(x^2+2x+1)-(x^2-2x+1)}{4}} = \sqrt{\frac{4x}{4}} = \sqrt{x}$

This shows that $\sqrt{x}$ exists for all real numbers $x > 0$.

Algorithm

In order to find the position of $\sqrt{x}$ on the number line, we consider BC as the number line, with B as the origin to represent zero. Since $BC = 1$ so, C represents 1. Now, mark points C_1, C_2, C_3,... such that $CC_1 = BC = 1$, $C_1C_2 = BC = 1$; $C_2C_3 = BC = 1$ and so on. Clearly, C_1, C_2, C_3,... represent 2,3,4,... respectively.

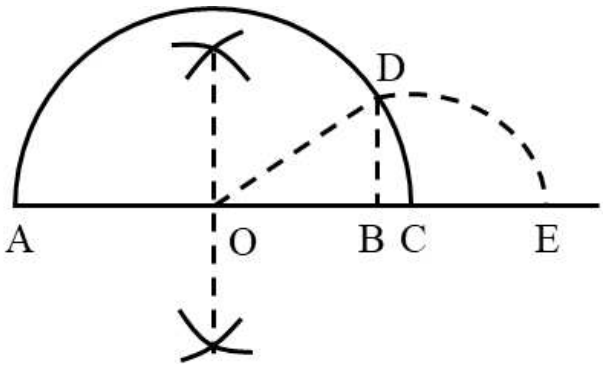
Now, draw an arc with centre at B and radius equal to BD. Suppose this arc cuts the number line BC with B as the origin at E. Then, $BE = \sqrt{x}$. Consequently, E will represent $\sqrt{x}$.

Example *Represent* $\sqrt{9.3}$ *on the number line.*

Solution In order to represent $\sqrt{9.3}$ on number line, we follow the following steps :

Step I *Draw a line and mark a point A on it.*

Step II *Mark a point B on the line drawn in step I such that AB = 9.3 cm.*



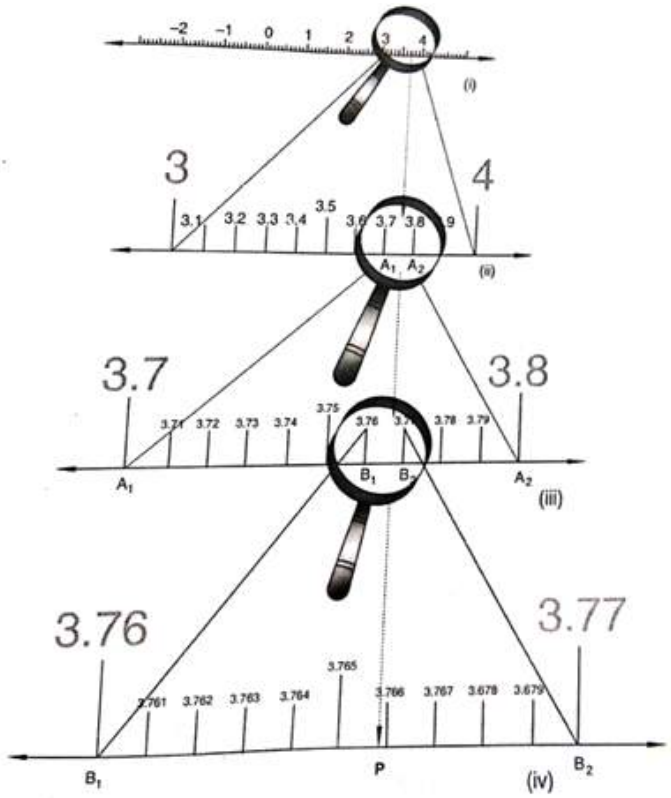
Step III *Mark a point C on AB produced such that BC = 1 unit.*

Step IV *Find mid-point of AC. Let the mid-point be O.*

Step V *Taking O as the centre and OC = OA as radius draw a semi-circle. Also, draw a line passing through B perpendicular to OB. Suppose it cuts the semi-circle at D.*

Step VI *Taking B as the centre and BD as radius draw an arc cutting OC produced at E. Point E so obtained represent* $\sqrt{9.3}$.

Suppose we want to visualise the representation of 3.765 on the number line. We observe that 3.765 lies between 3 and 4. So, let us look closely at the portion of the number line between 3 and 4. We divide this portion into 10 equal parts and mark each point of division as shown in Fig.



The first mark to the right of 3 will represent 3.1, the second 3.2 and so on. to see this clearly, we magnify this portion by taking a magnifying glass and look at the portion between 3 and 4. Though magnifying glass this portion between 3 and 4 will look like what we see in Fig. As 3.765 lies between 3.7 and 3.8. So, let us mark 3.7 as A_1 and 3.8 as A_2 and focus on the portion A_1 A_2 of the number line. Now, we imagine that the portion A_1 A_2 of the number line has been divided into ten equal parts. The first mark on the right of A_1 (representing 3.7) will represent 3.71, the next 3.72, and so on. As we may find some difficulty in observing these points of division between 3.7 and 3.8. Therefore, to have a clear view of the same, we magnify this portion as shown in Fig. As 3.765 lies between 3.76 and 3.77. So, we identify points representing 3.76 and 3.74 and mark them as B_1 and B_2 respectively as shown in Fig.

Since 3.765 lies between 3.76 and 3.77. So, let us now focus on the portion B_1 B_2 of the number line (Fig.) and imagine that it has been divided into ten equal parts. Let us magnify this portion to have clear view of this portion. The first mark on the right of 3.76 will represent 3.761, the next one represent 3.762, and so on. Clearly, 3.765 is the fifth mark in these subdivisions as shown in Fig. and is represented by point P on the number line.

This process of visualisation of numbers on the number line, through a magnifying glass, is known as the process of successive magnification. Thus it is possible to visualise the position (or representation) of a real number with a terminating decimal expansion on the number line by successive magnification. Let us now try to visualise the position (or representation) of a real number with a non-terminating recurring decimal expansion on the number line.

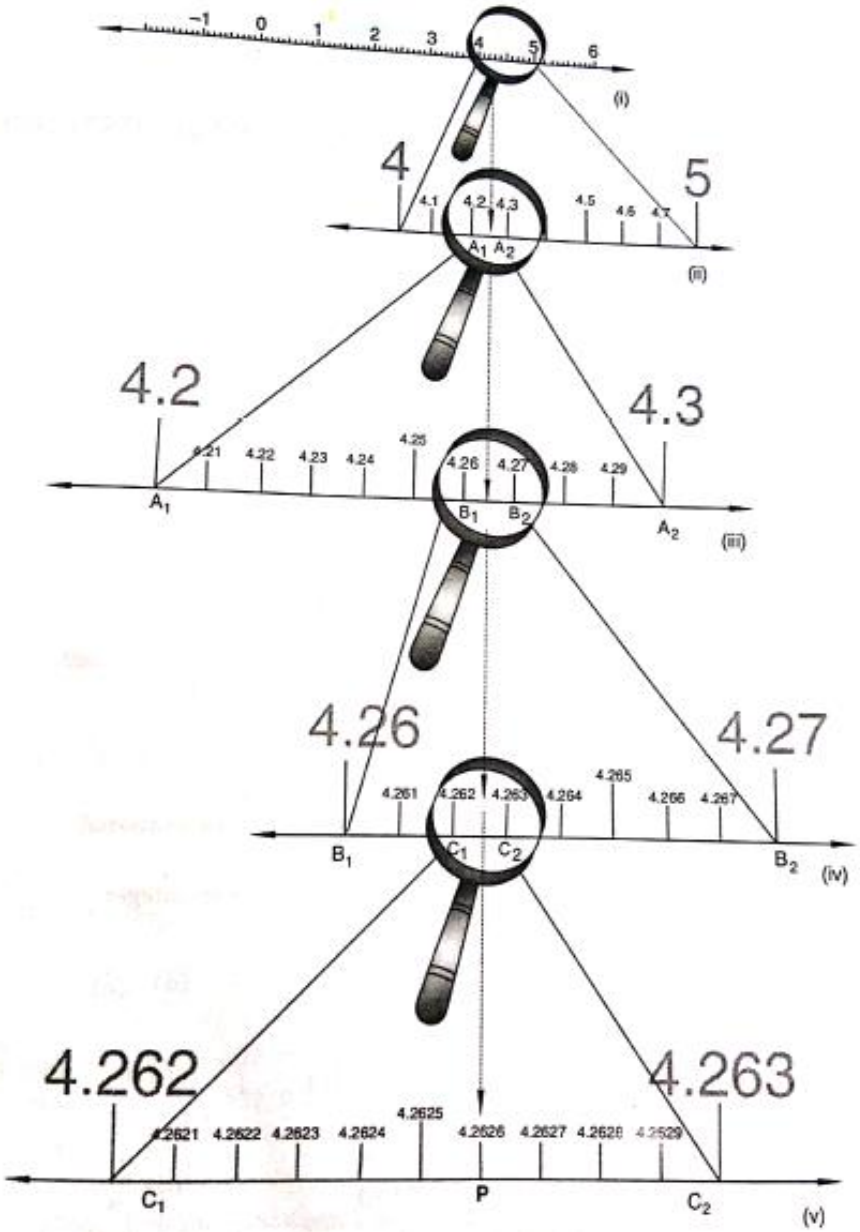
Suppose we wish to visualise the representation (or position) of $4.\overline{26}$ (upto 4 decimal places, i.e. upto 4.2626) on the number line. We observe that 4.2626 is located somewhere between 4 and 5 on the number line. So, let us look at the portion of the number line between 4 and 5. We divide this portion into 10 equal parts and mark each point of division as shown in Fig. The first mark to the right of 4 will represent 4.1, the next 4.2 and so on. To see this clearly, we magnify this portion of the number line by taking a magnifying glass and look at the portion between 4 and 5. through magnifying glass this portion will look like what we see in Fig. We observe that 4.2626 lies between 4.2 and 4.3. So, we mark these points as A_1 and A_2 respectively as shown in Fig. As 4.26 lies between 4.2 and 4.3. So, let us focus on the portion A_1 A_2 of the number line. We imagine that the portion A_1 A_2 has been divided into ten equal parts. The first mark on the fight side of A_1 will represent 4.21, the number 4.22, and so on.

To see this clearly, we magnify this portion. Through magnifying glass this portion will look like what we see in Fig. Now, 4.262 lies between 4.26 and 4.27.

So, let us mark 4.26 as B_1 and 4.27 as B_2 and focus on the portion B_1 B_2 of the number line. Let us imagine that the portion B_1 B_2 has been divided into ten equal parts. The first mark on the right side of B_1 (representing 4.26) will represent 4.261, then next 4.262, and so on.

To have clear view of these points of division, we magnify this portion as shown in Fig. As 4.2626 lies between 4.262 and 4.263. So, we mark the points representing 4.262 and 4.263 as C_1 and C_2 respectively.

We imagine that the portion C_1 C_2 of the number line has been divided into ten equal parts. The first mark on the right side of C_1 (representing 4.262) will represent 4.2621, then next 4.2622, and so on. clearly, sixth point will represent 4.2626 as shown in Fig. and marked as point P.



It is evident from the above discussion on visulalisation of real numbers on number line that every real number is represented by a unique point on the number line and every point on the number line represents a unique real number. That is why number line is also known as real number line or simply real line.

CBSE Pattern
Exercise (1)

(Q 1 to 3) One Mark

1. State whether the following statements are true or false. Justify your answers.
   (i) Every irrational number is a real number.
   (ii) Every point on the number line is of the form $\sqrt{m}$, where m is a natural number
   (iii) Every real number is an irrational number

2. State whether the following statements are true or false. Give reasons for your answers.
   (i) Every natural number is a whole number.
   (ii) Every integer is a whole number.
   (iii) Every rational number is a whole number.

3. Show that 3.142678 is a rational number. In other words, express 3.142678 in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$.

(Q 4 to 7) Two Marks

4. Find five rational numbers between $\frac{3}{5}$ and $\frac{4}{5}$.

5. Show that $1.272727... = 1.\overline{27}$ can be expressed in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$.

6. Rationalise the denominator of $\frac{1}{2+\sqrt{3}}$.

7. Visualise $4.\overline{26}$ on the number line, up to 4 decimal places.

(Q 8 to 10) Four Marks

8. Look at several examples of rational numbers in the form $\frac{p}{q}$ $(q \neq 0)$, where p and q are integers with no common factors other than 1 and having terminating decimal representations (expansions). Can you guess what property q must satisfy?

9. Represent $\sqrt{9.3}$ on the number line.

10. Find :

(i) $9^{\frac{3}{2}}$

(ii) $32^{\frac{2}{5}}$

(iii) $16^{\frac{3}{4}}$

(iv) $125^{\frac{-1}{3}}$

Answer & Solution

Q1

(i) True

Because all rational numbers and all irrational numbers form the group (collection) of real numbers.

(ii) False

Because negative numbers cannot be the square root of any natural number.

(iii) False

Because rational numbers are also a part of real numbers.

Q2

(i) True

$\because$ The collection of all natural numbers and 0 is called whole numbers.

(ii) False

$\because$ Negative integers are not whole numbers.

(iii) False

$\because$ Rational numbers are of the form p/q $\neq$ 0 and q does not divide p completely that are not whole numbers.

Q3

We have $3.142678 = \frac{3142678}{1000000}$, and hence is a rational number.

Now, let us consider the case when the decimal expansion is non-terminating recurring.

Q4

Since, we need to find five rational numbers, therefore, multiply numerator and denominator by 6.

$$\therefore \frac{3}{5} = \frac{3\times6}{5\times6} = \frac{18}{30} \text{ and } \frac{4}{5} = \frac{4\times6}{5\times6} = \frac{24}{30}$$

$\therefore$ Five rational numbers between $\frac{3}{5}$ and $\frac{4}{5}$

are $\frac{19}{30}, \frac{20}{30}, \frac{21}{30}, \frac{22}{30}, \frac{23}{30}$.

Q5

Let x = 1.272727... Since two digits are repeating, we multiply x by 100 to get

$100x = 127.2727...$

So, $100x = 126 + 1.272727... = 126 + x$

Therefore, $100x - x = 126$, i.e., $99x = 126$

i.e. $x = \frac{126}{99} = \frac{14}{11}$

You can check the reverse that $\frac{14}{11} = 1.\overline{27}$.

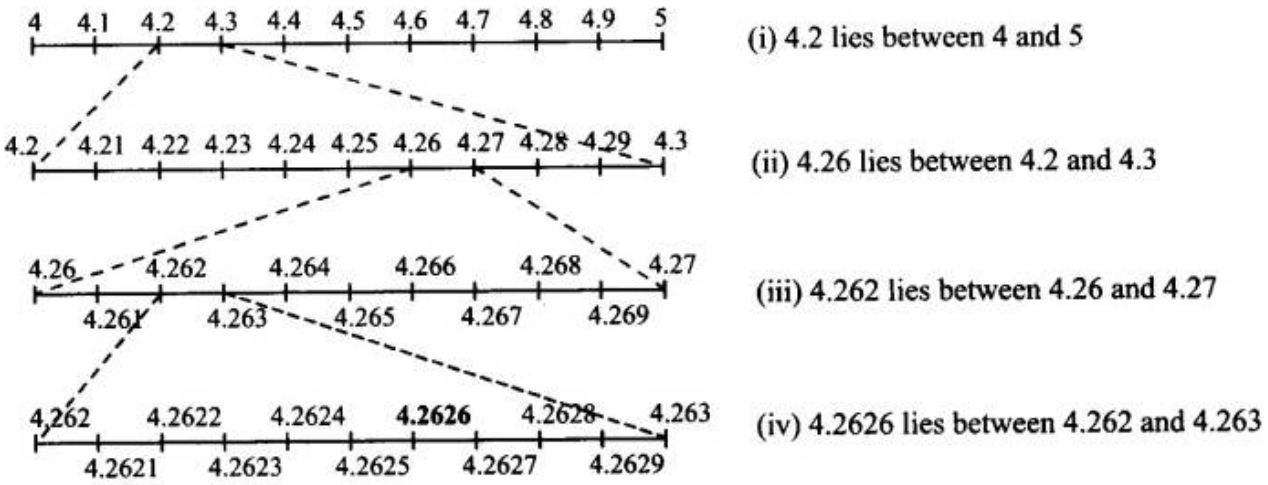
Q6

We use the identity $(a+\sqrt{b})(a-\sqrt{b}) = a^2 - b$. Multiply and divide $\frac{1}{2+\sqrt{3}}$ by $2-\sqrt{3}$ to get

$\frac{1}{2+\sqrt{3}} \times \frac{2-\sqrt{3}}{2-\sqrt{3}} = \frac{2-\sqrt{3}}{4-3} = 2-\sqrt{3}$.

Q7

$4.\overline{26}$ or 4.2626 lies between 4 and 5.



Q8

Let us look decimal expansion of the following terminating rational numbers :

$\frac{3}{2} = \frac{3\times5}{2\times5} = 1.5$ [Denominator = 2 = 2^1]

$\frac{1}{5} = \frac{1\times2}{5\times2} = \frac{2}{10} = 0.2$ [Denominator = 5 = 5^1]

$\frac{7}{8} = \frac{7\times125}{8\times125} = \frac{875}{1000} = 0.875$ [Denominator = 8 = 2^3]

$\frac{8}{125} = \frac{8\times8}{125\times8} = \frac{64}{1000} = 0.064$ [Denominator = 125 = 5^3]

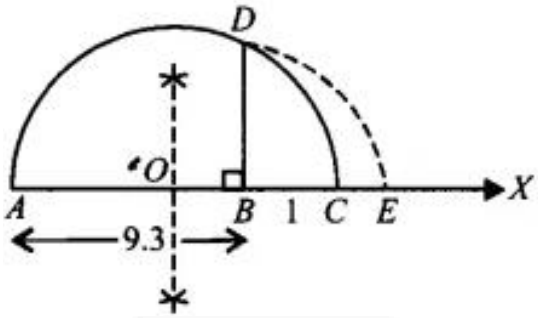
$\frac{13}{20} = \frac{13\times5}{20\times5} = \frac{65}{100} = 0.65$ [Denominator = 20 = $2^2 \times 5^1$]

$\frac{17}{16} = \frac{17\times625}{16\times625} = \frac{10625}{10000} = 1.0625$ [Denominator = 16 = 2^4]

We observe that the prime factorisation of q (i.e. denominator) has only powers of 2 or powers of 5 or powers of both.

Q9

Draw a line segment $AB = 9.3$ units and extend it to C such that $BC = 1$ unit.
Find mid point of AC and mark it as O.
Draw a semicircle taking O as centre and AO as radius. Draw $BD \perp AC$.



Draw an arc taking B as centre and BD as radius meeting AC produced at E such that $BE = BD = \sqrt{9.3}$ units.

Q10

(i) $9 = 3 \times 3 = 3^2$

$\therefore (9)^{3/2} = (3^2)^{3/2} = 3^{2\times 3/2} = 3^3 = 27$

$[(a^m)^n = a^{mn}]$

(ii) $32 = 2 \times 2 \times 2 \times 2 \times 2 = 2^5$

$\therefore (32)^{2/5} = (2^5)^{2/5} = 2^{5\times 2/5} = 2^2 = 4$

$[(a^m)^n = a^{mn}]$

(iii) $16 = 2 \times 2 \times 2 \times 2 = 2^4$

$\therefore (16)^{3/4} = (2^4)^{3/4} = 2^{4\times 3/4} = 2^3 = 8$

$[(a^m)^n = a^{mn}]$

(iv) $125 = 5 \times 5 \times 5 = 5^3$

$\therefore (125)^{-1/3} = (5^3)^{-1/3} = 5^{3\times(-1/3)} = 5^{-1}$

$= \frac{1}{5} [a^{-n} \quad \frac{1}{a^n}]$

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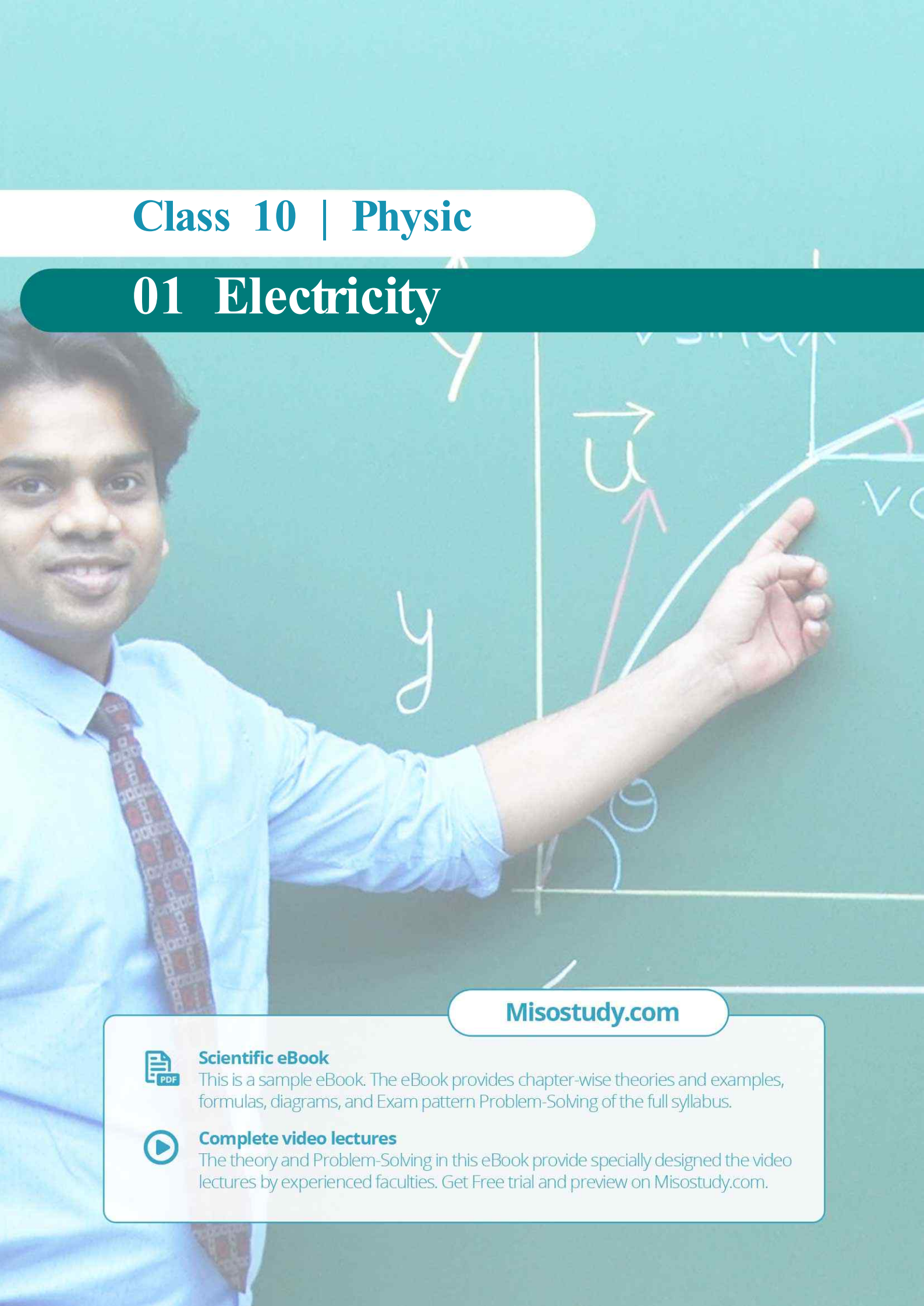
Class 10 | Physic

01 Electricity



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Electricity is an important source of energy

01. Types of Electric Charges

There are two types of electric charges : *positive* charge and *negative* charge. Important property of electric charges.

(i) Opposite charges (or Unlike charges) attract each other.

(ii) Similar charges (or Like charges) repel each other.

The SI unit of electric charge is coulomb which is denoted by the latter C.

A Proton possesses a positive charge of 1.6×10^{-19} C whereas an electron possesses a negative charge of 1.6×10^{-19} C.

The SI unit of electric charge 'coulomb' (C) is equivalent to the charge contained in 6.25×10^{18} electrons.

02. Electric Potential

The electric potential (or potential) at a point in an electric field is defined as the work done in moving a unit positive charge from infinity to that point.

03. Electric Potential

The potential difference between two points in an electric circuit is defined as the amount of work done in moving a unit charge from one point to the other point.

$$\text{Potential difference} = \frac{\text{Work done}}{\text{Quantity of charge moved}}$$

04. Electric Current

It is the potential difference between the ends of the wire which makes the electric charges (or current) to flow in the wire.

The electric current is a flow of electric charges (called electrons) in a conductor such as a metal wire.

$$\text{Current,} \quad I = \frac{Q}{t}$$

The SI unit of electric current is ampere.

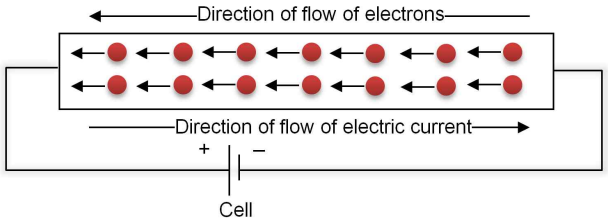
When 1 coulomb of charge flows through any cross-section of a conductor in 1 second, the electric current flowing through it si said to the 1 ampere.

Current is measured by an instrument called ammeter. Ammeter is always connected in *series* with the circuit in which the current is to be measured.

An ammeter should have very low resistance.

05. How the Current Flows in a Wire

Electric current is a flow of electrons in a metal wire (or conductor).



6. OHM'S Law

At constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its ends. The ratio of potential difference applied between the ends of a conductor and the current flowing through it is a constant quantity called resistance.

We have just seen that : $\frac{V}{I} = R$

or $V = I \times R$

or $\frac{V}{R} = I$

So, Current, $I = \frac{V}{R}$

(i) the current is directly proportional to potential difference, and
(ii) the current is inversely proportional to resistance.

If the potential difference across the ends of a conductor is doubled, the current flowing through it also gets doubled, and if the potential difference is halved, the current also gets halved.

07. Factors Affecting the Resistance of a Conductor

The electrical resistance of a conductor (or a wire) depends on the following factors :
(i) Length of the conductor,
(ii) Area of cross-section of the conductor (or thickness of the conductor),
(iii) Nature of the material of the conductor, and
(iv) Temperature of the conductor.

We will now describe how the resistance depends on these factors.

08. Resistivity

It has been found by experiments that :
(i) The resistance of a given conductor is directly proportional to its length, That is :

$R \propto l$

(ii) The resistance of a given conductor is inversely proportional to its area of cross-section. That is :

$$R \propto \frac{1}{A}$$

By combining the relations both equation, we get :

$$R \propto \frac{l}{A}$$

or

$$R = \frac{\rho \times l}{A}$$

09. Combination of Resistances (Or Resistors)

The resistances can be combined in two ways : (*i*) in series, and (*ii*) in parallel.
When two (or more) resistances are connected end to end consecutively, they are said to be connected in series.
When two (or more) resistances are connected between the same two points, they are said to be connected in parallel.

10. Resistances (Or Resistors) in Series

The combined resistance of any number of resistances connected in series is equal to the sum of the individual resistances. If a number of resistances R_1, R_2, R_3..... etc., are connected in series, then their combined resistance R is given by : $R = R_1 + R_2 + R_3 + ...$

11. Resistances (Or Resistors) in Parallel

The reciprocal of the combined resistance of a number of resistances connected in parallel is equal to the sum of the reciprocals of all the individual resistances. If a number of resistances R_1, R_2, R_3..... etc., are connected in parallel, then their combined resistance R is given by the formula :

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$

When a number of resistances are connected in parallel then their combined resistance is less than the smallest individual resistance.

12. Electric Power

Electric power is the electrical work done per unit time.

$$\text{Power} = \frac{\text{Work done}}{\text{Time taken}}$$

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

13. Unit of Power

The SI unit of electric power is watt. The power of 1 watt is a rate of working of 1 joule per second.

$$1 \text{ watt} = \frac{1 \text{ joule}}{1 \text{ second}}$$

Electric power is the rate at which electrical energy is consumed. When an electrical appliance consumes electrical energy at the rate of 1 joule per second, its power is said to be 1 watt. The rate at which electrical work is done or the rate at which electrical energy is consumed, is called electric power.

14. Heating Effect of Current

When an electric current is passed through a high resistance wire, like nichrome wire, the resistance wire becomes very hot and produces heat. This is called the heating effect of current.

15. Applications of the Heating Effect of Current

(i) The heating effect of current is utilised in the working of electrical heating appliances such as electric iron, electric kettle, electric toaster, electric oven, room heaters, water heaters.

(ii) The heating effect of electric current is utilised in electric bulbs (electric lamps) for producing light.
Tungsten metal is used for making the filaments of electric bulbs because it has a very high melting point.
The electric bulb is filled with a chemically unreactive gas like argon or nitrogen (or a mixture of both).

(iii) The heating effect of electric current is utilised in electric fuse for protecting household wiring and electrical appliances.

CBSE Pattern
Exercise (1)

(Q 1 to 2) Very Short Type

1. Give the law of combination of resistances in series.

2. Two resistances X and Y are connected turn by turn:
   (i) in parallel
   (ii) in series.
   In which case the resultant resistance will be less than either of the individual resistances?

(Q 3 to 5) Short Answer Type

3. A battery of 9 V is connected in series with resistors of 0.2 Ω, 0.3 Ω, 0.4 Ω, 0.5 Ω and 12 Ω. How much current would flow through the 12 Ω resistor?

4. Two resistors, with resistances 5 Ω and 10 Ω respectively are to be connected to a battery of emf 6 V so as to obtain :
   (i) minimum current flowing
   (ii) maximum current flowing

5. A 4 Ω coil and a 2 Ω coil are connected in parallel. What is their combined resistance? A total current of 3 A passes through the coils. What current passes through the 2 Ω coil?

(Q 6 to 7) Multiple Choice

6. If two resistor of 25 Ω and 15 Ω are joined together in series and then placed in parallel with a 40 Ω resistor, the effective resistance of the combination is :
   (a) 0.1 Ω
   (b) 10 Ω
   (c) 20 Ω
   (d) 40 Ω

7. A wire of resistance R_1 is cut into five equal pieces. These five pieces of wire are then connected in parallel. If the resultant resistance of this combination be R_2, then the ratio $\frac{R_1}{R_2}$ is :
   (a) $\frac{1}{25}$
   (b) $\frac{1}{5}$
   (c) 5
   (d) 25

(Q 8 to 10) High Order Thinking Skills

8. Two resistances when connected in parallel give resultant value of 2 ohm; when connected in series the value becomes 9 ohm. Calculate the value of each resistance.

9. What will be the current drawn by an electric bulb of 40 W when it is connected to a source of 220 V?

10. An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be :

Answer & Solution

Q1
The combined resistance of any number of resistances connected in series is equal to the sum of the individual resistances. If a number of resistances R_1, R_2, R_3..... etc., are connected in series, then their combined resistance R is given by : $R = R_1 + R_2 + R_3 + ...$

Q2
When they are in parallel combination.

Q3
The current flow is .67 A.

Q4
For minimum current flow in series – For maximum current flow in parallel.
.4 A, 1.8 A.

Q5
$\frac{4}{3}\Omega$ and 2 A.

Q6
20 Ω

Q7
(d) Hint. Resistance of one piece of wire will be $\frac{R_1}{5}$. And

$$\frac{1}{R_2} = \frac{5}{R_1} + \frac{5}{R_1} + \frac{5}{R_1} + \frac{5}{R_1} + \frac{5}{R_1} = \frac{25}{R_1}$$

Q8
3 Ω and 6 Ω.

Q9

In this case we have been given power P and voltage V, so the formula to be used for calculating the current will be :

$$P = V \times I$$

Here, Power, $P = 40$ watts

Voltage, $V = 220$ volts

And, Current, I = ? (To be calculated)

Now, putting these values in the above formula, we get :

$$40 = 220 \times I$$

$$I = \frac{40}{220}$$

$$= \frac{2}{11}$$

Thus, Current, $I = 0.18$ ampere

Q10

In the first case :

Power, $P = 100$ W

Potential difference, $V = 220$ V

And, Resistance, R = ? (To be calculated)

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

So, $100 = \frac{(220)^2}{R}$

And $R = \frac{220 \times 220}{100} = 484\ \Omega$

This resistance of 484 Ω of the bulb will remain unchanged. *In the second case* :

Power, P = ? (To be calculated)

Potential difference, $V = 110$ V

And, Resistance, $R = 484\ \Omega$ (Calculated above)

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

$$P = \frac{(110)^2}{484} = \frac{110 \times 110}{484} = 25 \text{ W}$$

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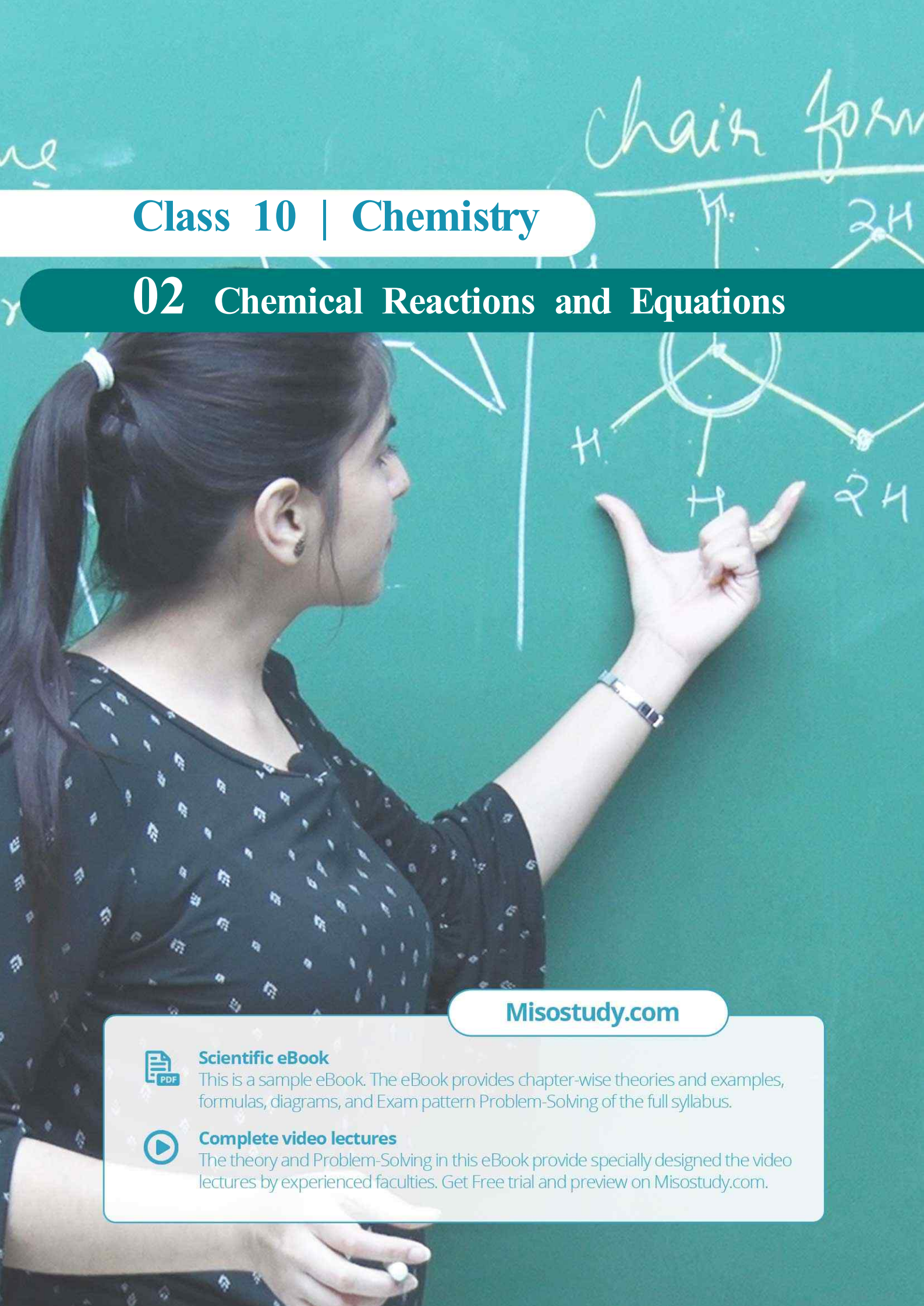

Class 10 | Chemistry

02 Chemical Reactions and Equations

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Chemical reactions are the processes in which new substances with new properties are formed. during a chemical reaction, atoms of one element do not change into those pf another element. only a rearrangement of atoms takes place in a chemical reaction.

(i) The substances which take part in a chemical reaction are called reactants.

(ii) The new substances produced as a result of chemical reaction are called products.

When a magnesium ribbon is heated, it burns in air with a dazzling white flame to form a white powder called magnesium oxide. Actually, on heating, magnesium combines with oxygen present in air to form magnesium oxide :

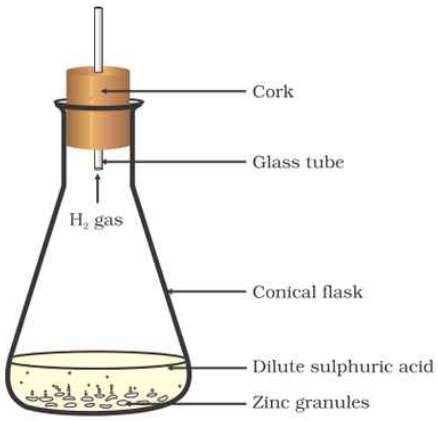
$$\underset{\text{(As ribbon)}}{\text{Magnesium}} + \underset{\text{(From air)}}{\text{Oxygen}} \xrightarrow{\text{Heat}} \underset{\text{(White power)}}{\text{Magnesium Oxide}}$$

The burning of magnesium in air to form magnesium oxide is an example of a chemical reaction. Souring of milk (when left at room temperature during summer), Formation of curd from milk, Cooking of food Digestion of food in our body, Process of respiration, Fermentation of grapes, Rusting of iron (when left exposed to humid atmosphere), Burning of fuels (like wood, coal, kerosene, petrol and LPG,) burning of candle wax, and Ripening of fruits, are all chemical changes which involve chemical reactions.

01. Characteristics of Chemical Reactions

The important characteristic of chemical reactions are :

(i) **Evolution of a Gas :** The chemical reaction between zinc and dilute sulphuric acid is characterised by the evolution of hydrogen gas.



(ii) **Formation of a Precipitate :** When formed the chemical reaction between potassium iodide and lead nitrate is characterised by the formation of a yellow precipitate of lead iodide.

(iii) **Change in colour :** When citric acid reacts with potassium permanganate solution, then the purple colour of potassium permanganate solution disappears (it becomes colourless). the chemical reaction between citric acid and purple coloured potassium permanganate solution is characterised by a change in colour from purple to colourless.

(iv) **Change in Temperature :** The chemical reaction between quicklime and water form slaked lime is characterised by a change in temperature (which is rise in temperature) the reaction between quicklime and water to form slaked lime is an exothermic reaction (which means heat producing reaction).

(v) **Change in State :** When wax is burned (in the form of a wax candle) then water and carbon dioxide are formed

02. Chemical Equations

The method of representing a chemical reaction with the help of symbols and formulae of the substances involved in it is known as a chemical equation.

$$\underbrace{Zn + H_2SO_4}_{\text{Reactants}} \longrightarrow \underbrace{ZnSO_4 + H_2}_{\text{Products}}$$

Balanced and Unbalanced Chemical Equations

A balanced chemical equation has an equal number of atoms of different elements in the reactants and products.

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

Let us count the number of atoms of all the elements in the reactants and products separately.

	In reactants	*In reactants*
No. of Zn atoms	1	1
No. of H atoms	2	2
No. of S atoms	1	1
No. of O atoms	4	4

We find that the reactants contain 1 zinc atom and products also contain 1 zinc atom. Reactants contain 2 hydrogen atoms and products also contain 2 hydrogen atoms, Similarly reactants contain 1 sulphur atom and products also contain 1 sulphur atom. and finally, reactants contain 4 oxygen atoms and the products also contain 4 oxygen atoms. Thus, there is an equal number of atoms of different elements in the reactants and products, so the above chemical equation is a balanced equation Since the number of atoms of various elements in reactants and products is equal we can say that a balanced chemical equation has equal masses of various elements in reactants and products.

An unbalanced chemical equation has unequal number of atoms of one or more elements in the reactants and products.

Balancing of Chemical Equations

The number of making the number of different types of atoms equal on both the sides of an equation is called balancing of equation.

$$H_2 + O_2 \longrightarrow H_2O$$

	In reactants	In product
No. of H atoms :	2	2
No. of O atoms :	2	1

	In reactants	In product
No. of H atoms :	2	4
No. of O atoms :	2	2

$$H_2 + O_2 \longrightarrow 2H_2O$$

	In reactants	In product
No. of H atoms :	4	4
No. of O atoms :	2	2

This chemical equation contains an equal number of atoms of hydrogen and oxygen on both sides, so this is a balanced equation.

To make equations more informative

(i) by indicating the "physical states" of the reactants and products.
(ii) by indicating the "heat changes" taking placed in the reaction.
(iii) by indicating the "conditions" under which the reaction takes place.

zinc metal reacts with dilute sulphuric acid to form zinc sulphate solution and hydrogen gas. This can be Written as :

$$Zn + H_2SO \longrightarrow ZnSO_4 + H_2$$

Here, zinc metal is a solid so we writes Zn(s)
Dilute sulphuric acid is an aqueous solution, so we write H_2SO_4 (aq)
Zinc sulphate is also an aqueous solution, so we write $ZnSO_4$(aq)
and hydrogen is a gas which is written as H_2(g)
The above equation can now be written as :

$$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

Those reactions in which heat is evolved are know as exothermic reactions. for example, when carbon burns in oxygen to form carbon dioxide, a lot of heat is produced in this reaction :

$$\underset{\text{Carbon}}{C(s)} + \underset{\text{Oxygen}}{O_2\ (g)} \longrightarrow \underset{\text{Carbon dioxide}}{CO_2(g)} + \text{Heat}$$

Those reactions in which heat is absorbed are known as endothermic reactions. For example, when nitrogen and oxygen are heated to a very high temperature (of about 3000°C) They combine to form nitrogen monoxide =, and a lot of heat is absorbed in this reaction :

$$\underset{\text{Nitrogen}}{N_2\ (g)} + \underset{\text{Oxygen}}{O_2(g)} + \text{Heat} \longrightarrow \underset{\text{Nitrogen monoxide}}{2NO(g)}$$

03. Types of Chemical Reactions

(i) **Combination Reactions :** Those reactions in which two or more substances combine to form a single substance, are called combination reactions.
Example magnesium and oxygen combine when heated to form magnesium oxide :

$$\underset{\text{Magnesium}}{2Mg\ (s)} + \underset{\text{Oxygen}}{O_2\ (g)} \xrightarrow{\text{Combination}} \underset{\text{Magnesium oxide}}{2H_2O\ (s)}$$

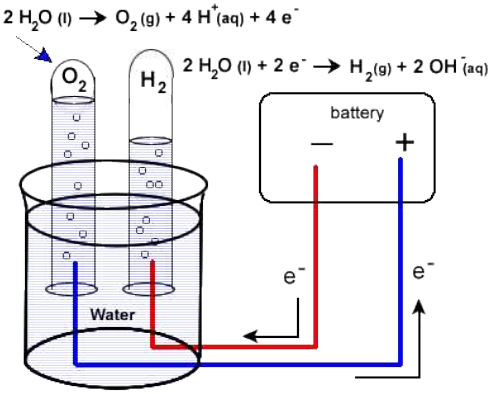
(ii) **Decomposition Reactions :** Those reactions in which a compound splits up into two or more simpler substances are known as decomposition reactions.
Example : when calcium carbonate is heated it decomposes to give calcium oxide and carbon dioxide :

$$\underset{\text{Calcium carbonate (Limestone)}}{CaCO_3(s)} \xrightarrow[\text{(Decomposition)}]{\text{Heat}} \underset{\text{Calcium oxide (Lime)}}{CaO(s)} + \underset{\text{Carbon dioxide}}{CO_2(g)}$$

Example : when electric current is passed through acidified water, it decompose to give hydrogen gas and oxygen gas. This reaction can be represented as :

$$\underset{\text{Water}}{2H_2O(l)} \xrightarrow[\text{(Decomposition)}]{\text{Electricity}} \underset{\text{Hydrogen}}{2H_2(g)} + \underset{\text{Oxygen}}{O_2(g)}$$

We can carry out the electrolysis of water as follows :



(iii) **Displacement Reactions :** Those reactions in which one element take the place of another element in a compound are known as displacement reaction.

Example when a strip of zinc metal is placed in copper sulphate solution, then zinc sulphate solution and cooper are obtained :

$CuSO_4(aq)$	+	Zn(s)			$ZnSO_4(aq)$	+	Cu(s)
Copper sulphate		Zinc	→		Zinc Sulphate		Copper
(Blue solution)		(Silvery-white)			(Colourless solution)		(Red-brown)

(iv) **Double displacement reactions :**

Example when silver nitrate solution is added to sodium chloride solution then a white precipitate of silver chloride is formed along with sodium nitrate solution :

$AgNO_3(aq)$	+	NaCI(aq)			AgCI(s)	+	$NaNO_3(aq)$
Silver nitrate		Sodium chloride	→		Silver chloride		Sodium nitrate
					(white ppt.)		

(v) **Oxidation and Reduction Reactions :**

Oxidation :

- The addition of oxygen to a substance is called oxidation.
- The removal of hydrogen from a substance is also called oxidation

Reduction :

- The addition of hydrogen to a substance is called reduction.
- The removal of oxygen from a substance is also called reduction.

Oxidising agent :

- The substance which gives oxygen for oxidation is called an oxidising agent.
- The substance which removes hydrogen is also called and oxidising agent.

Reducing agent :

- The substance which given hydrogen for reduction is called a reducing agent.
- The substance which removes oxygen is called a reducing agent.

The oxidation and reduction reactions are also called redox reactions (in the name 'redox' the term 'red' stands fir 'reduction' and 'ox' stands for oxidation). we will now give some examples of oxidation and reduction reactions.

Example when copper oxide is heated with hydrogen, then copper metal and water are formed :

$$\underset{\text{Copper oxide}}{CuO} + \underset{\text{hydrogen}}{H_2} \xrightarrow{\text{Heat}} \underset{\text{copper}}{Cu} + \underset{\text{water}}{H_2O}$$

- In this reaction, CuO is changing into Cu. that is oxygen is being removed from copper oxide. Now by definition removal of oxygen from a substance is called reduction, so we can say that copper oxide is being reduced to copper.
- In this reaction H_2 is changing into H_2O that is oxygen is being added to hydrogen. Now by definition addition of oxygen to a substance is called oxidation, so we can say that hydrogen is being oxidised to water.

04. Effects of Oxidation Reactions in Everyday Life

- Corrosion of metals ,and
- Rancidity of food.

Corrosion : Corrosion id the process in which metals are eaten up gradually by the action of air moisture or a chemical (such as an acid) on their surface. corrosion is caused mainly by the oxidation of metals by the oxygen of air. Rusting of iron metal is the most common form of corrosion.

Rancidity : The condition produced by aerial oxidation of fats and oils in foods marked by unpleasant smell and taste is called rancidity. Rancidity spoils the food materials prepared in fats and oils which have been kept for a considerable time and make them unfit for eating.

CBSE Pattern
Exercise (1)

(Q 1 to 3) One Mark

1. State whether the following statement is true or false:
   A chemical equation can be balanced easily by altering the formula of a reactant or product.

2. What type of reaction is represented by the digestion of food in our body?

3. What is wrong with the following chemical equation?
   $Mg + O \rightarrow MgO$
   Correct and balance it.

(Q 4 to 5) Two Marks

4. Given one example of a decomposition reaction which is carried out:
   (a) with electricity
   (b) by applying heat

5. What type of chemical reactions are represented by the following equations?
   (a) $A + BC \rightarrow AC + B$
   (b) $X \rightarrow Y + Z$
   (c) $PQ + RS \rightarrow PS + RQ$
   (d) $A_2O_3 + 2B \rightarrow B_2O_3 + 2A$

(Q 6 to 7) Three Marks

6.
   (a) What is meant by a chemical reaction? Explain with the help of an example.
   (b) Give one example each of a chemical reaction characterised by:
   - evolution of gas
   - change in colour
   - formation of a precipitate
   - change in temperature

7.
   (a) Define a combination reaction.
   (b) Give one example of a combination reaction which is also exothermic.
   (c) Give one example of a combination reaction which is also endothermic.

(Q 8 to 10) Five Marks

8. Translate the following statements into chemical equations and then balance the equations:
   (a) Hydrogen sulphide gas burns in air to give water and sulphur dioxide.
   (b) Phosphorus burns in oxygen to give phosphorus pentoxide.
   (c) Carbon disulphide burns in air to give carbon dioxide and sulphur dioxide
   (d) Aluminium metal replaces iron from ferric oxide, Fe_2O_3, giving aluminium oxide and iron.

(e) Barium chloride reacts with zinc sulphate to give zinc chloride and barium sulphate.

9.
(a) What is a redox reaction ? Explain with an example.
(b) When a magnesium ribbon burns in air with a dazzling flame and forms a white ash, is magnesium oxidised or reduced ? Why ?
(c) In the reaction represented by the equation :
$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$
- name the substance oxidised.
- name the oxidising agent.
- name the substance reduced.
- name the reducing agent.

10. A red-brown metal X forms a salt XSO_4. When hydrogen sulphide gas is passed through an aqueous solution of XSO_4, then a black precipitate of XS is formed along with sulphuric acid solution.
(a) What could the salt XSO_4 be ?
(b) What is the colour of salt XSO_4 ?
(c) Name the black precipitate XS.
(d) By using the formula of the salt obtained in (a) above, write an equation of the reaction which takes place when hydrogen sulphide gas is passed through its aqueous solution.
(e) What type of chemical reaction takes place in this case ?

Answer & Solution

1. Carbon dioxide, CO_2

2. Diffusion

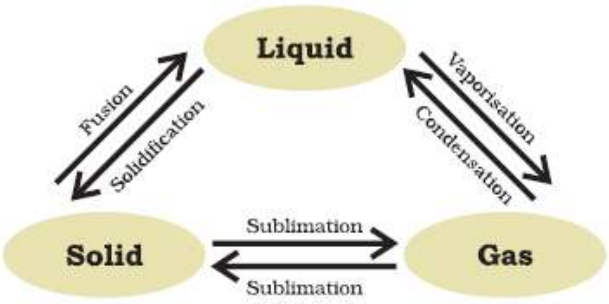
3. The heat required to convert a solid into a liquid or vapour, or a liquid into a vapour, without change of temperature. The two types of latent heats are:
   - Latent heat of fusion
   - Latent heat of vaporisation

4. 1 Kg of heat at 100 degree celsius contains more heat because of the following relationship:
   Water at 100°C + Heat $\rightleftarrows$ Steam at 100°C

5. The acetone has low boiling point and thus it gets evaporated immediately by absorbing heat from the palm making us feel cold.

6.
   (a) Temperature, Pressure

   (b)



   (c) Evaporation can be made faster by following ways:
   - Increasing temperature
   - Increasing surface area

- Decreasing humidity in the surrounding area
- Increasing the speed of wind

7.

(a) The spreading out and mixing of a substance with another, due to the motion of the particles is known as diffusion. Example: The smell of the perfume spreads due to the diffusion of perfume vapours in the air.
(b) Particles move very quickly in all the directions.
(c) O_2 and CO_2, both are dissolved in water which is required by marine animals and plants, respectively, for their survival.

8.

(a) Pollen Grains
(b) Water
(c) Brownian Motion
(d) The fast moving water particles are constantly hitting particles X, causing them to move in a zig-zag manner.
(e) Robert brown
(f) The liquid Y is made up of very small particles which are constantly moving.

9.

(a) (i) Iodine, (ii) Sodium Chloride, (iii) Naphthalene, (iv) Ammonium Chloride
(b) W, Y, Z
(c) Y
(d) Tincture of Iodine
(e) W

10.

(a) 273K
(b) Freezing
(c) Latent Heat of Freezing
(d) Melting Latent Heat of Fusion

CLASS 10

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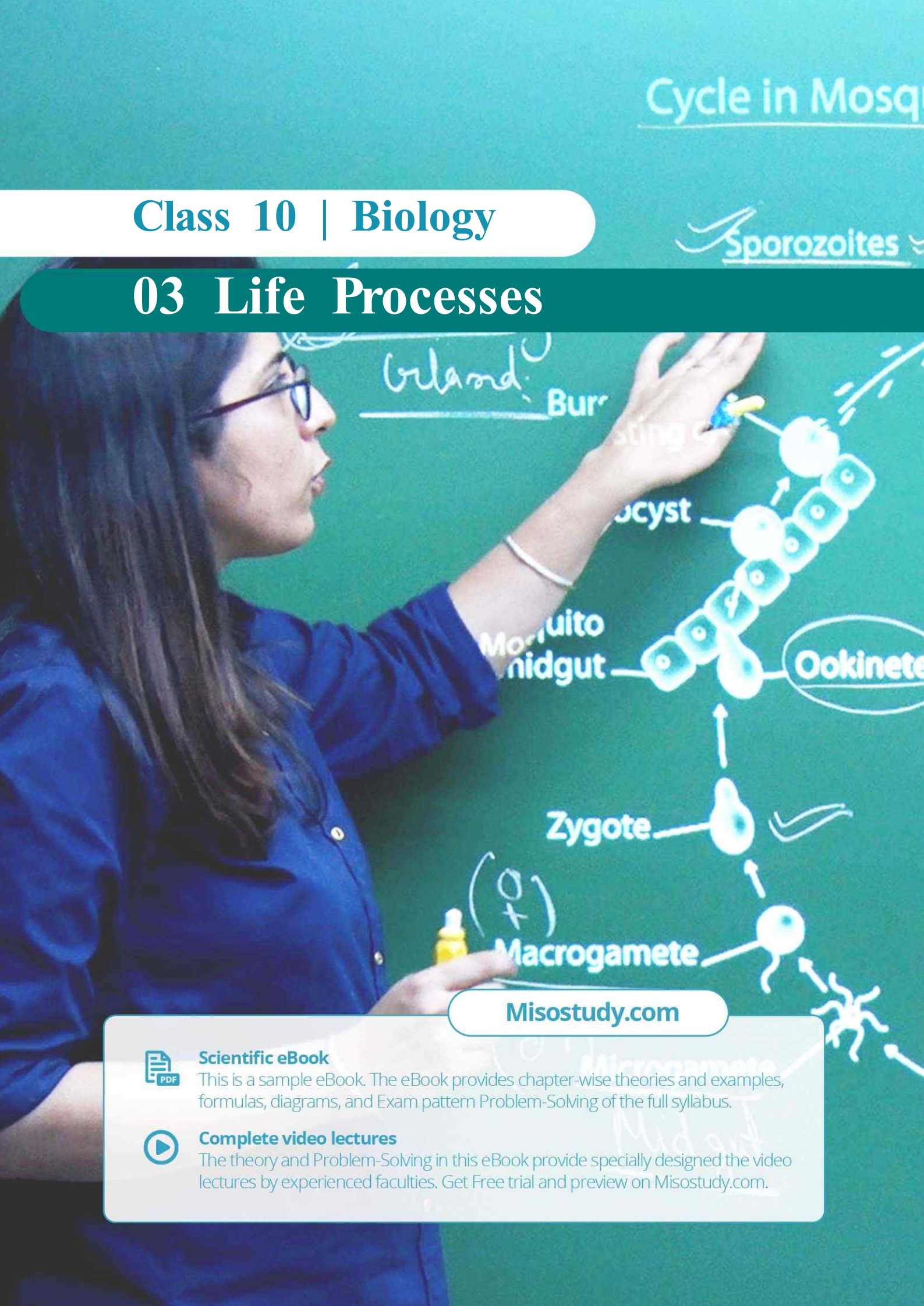
Class 10 | Biology

03 Life Processes



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01. Introduction

All the plants and animals (including human beings) are alive or living things. The most important criterion to decide wether something is alive (or not) is the movement. All the living things (which are alive) move by themselves without any external help. The movement in most of the animals are fast and can be observed easily but the movements in plants are usually slow and observed with difficulty. Animals can move from one place to another or they can move their body parts. The plants are fixed in the soil at a place, so they cannot move like animals from place to place. The plants can only move parts of their body such as leaves, flowers, shoots and roots. The plant parts move towards a stimulus such as sunlight, gravity or water, etc. Non-living things (which are not alive cannot move by themselves. The characteristics of living things are as follows :

- Living things can move by themselves.
- Living things need food, air and water.
- Living things can grow.
- Living things can respond to changes around them. They are sensitive.
- Living things respire (release energy from food).
- Living things excrete (get ride of waste materials from their body).
- Living things can reproduce. They can have young ones.

02. What are Life Processes

The basic functions performed by living organisms to maintain their life on this earth are called life processes. The basic life processes common to all the living organisms are Nutrition and Respiration; Transport and Excretion; Control and coordination (Response to stimuli); Growth; Movement and Reproduction.

03. Energy is Need for The Life Processes

Food is a kind of fuel which provides energy to all the living organisms. The energy required by an organisms comes from the food that the organism eats.

04. Nutrition

Food is an organic substance. The simplest food is glucose. It is also called simple sugar. A more complex food starch. Starch is made from glucose. The general name of substances like glucose (sugar) and starch is `Carbohydrates are the most common foods for getting energy. Fats and proteins are also foods. (A wider definition of food, however, also includes mineral salts, vitamins and water which are essential for the normal growth and development of an organism). The process of talking in food (consuming food) and utilising it is called nutrition. A nutrient can be defined as a substance which an organism obtains from its surroundings and uses it as source of energy or for the biosynthesis of its body constituents (like tissues and organs). For example carbohydrate and fats are the nutrients. Nutrition is a process of

intake of nutrients (like carbohydrates. fats, proteins, minerals, vitamins and water) by organism as well as the utilisation of these nutrients by the organism.

05. Modes of Nutrition

There are mainly two modes of nutrition :

(i) **Autotrophic Mode of Nutrition :** Autotrophic nutrition is that mode of nutrition in which an organism make (or synthesizes) its own food from the simple inorganic materials like carbon dioxide and water present in the surroundings (with the help of sunlight energy). The green plants have an autotrophic mode of nutrition. The autotrophic bacteria also obtain their food by the autotrophic mode of nutrition. Those organisms which can make their own food from carbon dioxide and water are called autotrophs. All the green plants are autotrophs The autotrophic organisms (or autotrophs) contain the green pigment called chlorophyll which is capable of trapping sunlight energy.

(ii) **Heterotrophic Mode of Nutrition :** Heterotrophic nutrition is that mode of nutrition in which an organism cannot make (or synthesize) its own food from simple inorganic materials like carbon dioxide and water, and depends on other organisms for its food. All the animals have a heterotrophic mode of nutrition. Most bacteria and fungi also have heterotrophic mode of nutrition. Those organisms which cannot make their own food from inorganic substances like carbon dioxide and water, and depend on other organisms for their food are called heterotrophs. All the animals are heterotrophs The non-green plants (like yeast) are also heterotrophs.

Types of Heterotrophic Nutrition

A heterotrophic organism (or heterotroph) can obtain its food from other organisms in three ways. So, the heterotrophic made of nutrition is of three types:

(a) **Saprotrophic Nutrition (or Saprophytic) :** Saprotrophic nutrition is that nutrition in which an organism its food decaying organic matter of dead plants, dead animals and rotten bread, etc. Saprophytes are the organisms which obtain their food from dead plants (like rotten leaves), dead and decaying rotten bread

(b) **Parasitic Nutrition :** The parasitic nutrition is that nutrition in which an organism derives its food from the body of another living organism (called its host) without killing it. A parasite is an organism (plant or animal) which feeds on another living organism called its host.

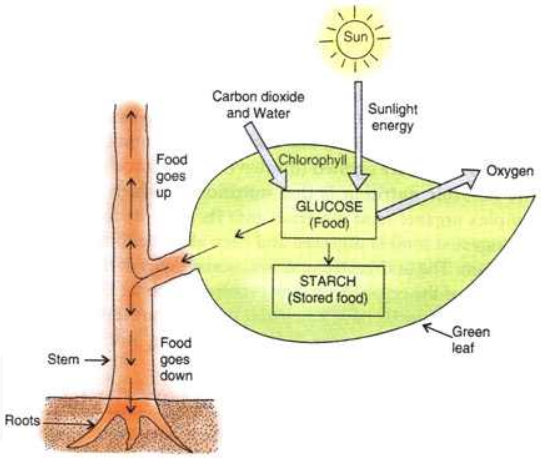
(c) **Holozoic Nutrition :** The holozoic nutrition is that nutriation in which an organism take the complex organic food materials into its body by the process of ingestion, the ingested food is digested and then absorbed into the body cells of the organism.

06. Nutrition in Plants

The process by which green plants make their own food (like glucose) from carbon dioxide and water by sunlight energy in the presence of chlorophyll, is called photosynthesis

$$\underset{\text{Carbon dioxide (From air)}}{6CO_2} + \underset{\text{Water (From Soil)}}{6H_2O} + \underset{\text{(From sun)}}{\text{Light energy}} \xrightarrow[\text{(Photosynthesis)}]{\text{Chlorophyll}} \underset{\text{Glucose (A food)}}{C_6H_{12}O6} + \underset{\text{Oxygen}}{6O_2}$$

The process of photosynthesis takes place in the green leaves of a plant



The extra glucose is changed into another food called starch. This starch is stored in the leaves of the plant. The green plants convert sunlight energy into chemical energy by making carbohydrates (foods).

The photosynthesis takes place in the following three steps :

(i) Absorption of sunlight energy by chlorophyll.

(ii) Conversion of light energy into chemical energy, and splitting of water into hydrogen and oxygen by light energy.

(iii) Reduction of carbon dioxide by hydrogen to form carbohydrate like glucose by utilising the chemical energy (obtained by the transformation of light energy).

Condition Necessary for Photosynthesis

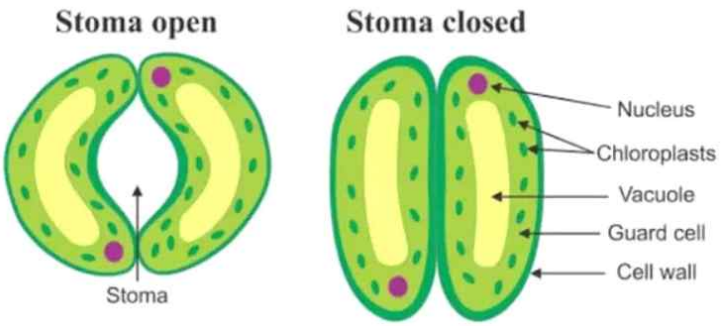
- Sunlight,
- Chlorophyll,
- Carbon dioxide, and
- Water.

Raw Materials for Photosynthesis

The raw materials for photosynthesis are :

- Carbon dioxide, and
- Water.

The green plants take carbon dioxide from air for photosynthesis. The carbon dioxide gas enters the leaves of the plant through the stomata present on their surface.

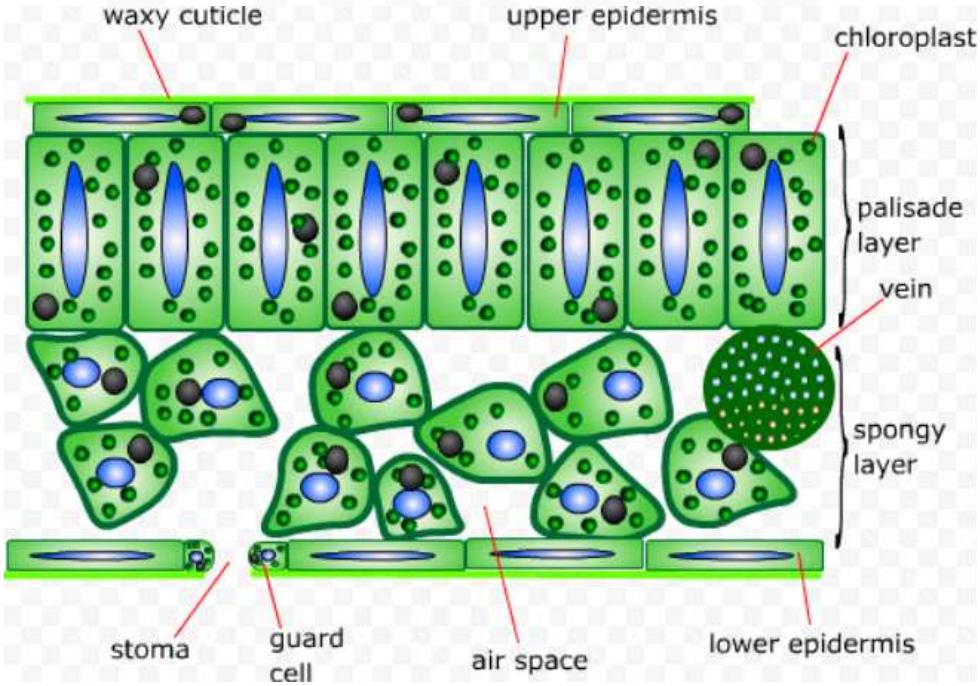


How the Plants Obtain Water for Photosynthesis

The water required by the plants for photosynthesis is absorbed by the roots of the plants from the soil through the process of osmosis. The water absorbed by the roots of the plants is transported upward through the xylem vessels to the leaves where it reaches the photosynthetic cells and utilised in photosynthesis. The plants take materials like nitrogen, phosphorus, iron and magnesium, etc., from the soil.

Site of Photosynthesis : Chloroplasts

Photosynthesis occurs in the organelles called choroplasts present in the photosynthesis cells (or mesophyll cells) of green plants. The site of photosynthesis in a cell of the leaf are chloroplasts.



07. Nutrition in Animals

Animals Obtain Their Food From Plants or Other Animals

Animals obtain their food from plants or other animals (which they eat). We (human beings)

are also animals. We obtain the food like wheat, rice. pulses (*dal*), fruits and vegetables from plants.

All the animals can be divided into three groups on the basis of their food habits (or eating habits). These are :

(a) **Herbivores :** Those animals which eat only plants are called herbivores. Goat, Cow, Buffalo, Sheep, Horse, Deer, Camel, Ass, Ox, Elephant, Monkey

(b) **Carnivores :** Those animals which eat only other animals as food are called carnivores. Those animals which eat only the meat (or flesh) of other animals are called carnivores

(c) **Omnivores :** Those animals which eat both, plants and animals, are called omnivores. Some of the example of omnivores are : Man (Human beings), Dog, Crow, Sparrow, Bear, Mynan, and Ant.

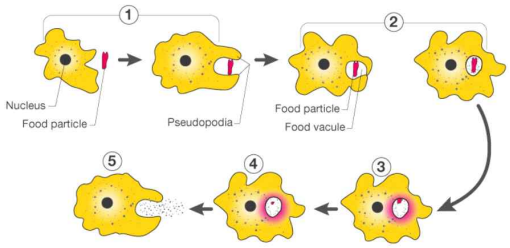
08. Different Steps in The Process of Nutrition in Animals

- **Ingestion :** The process of taking food into body is called ingestion.
- **Digestion :** The process in which the food containing large, insoluble molecules is broken down into small, water soluble molecules (which can be absorbed by the body) is called digestion. Most animals use both, physical and chemical methods for digesting (breaking up) the large food molecules. Physical methods include chewing and grinding the food in mouth and chemical methods include the addition of digestive juices (enzymes) to food by the body itself.
- **Absorption :** The process in which the digested food passes through the intestinal wall into blood stream is called absorption.
- **Assimilation :** The process in which the absorbed food is taken in by body cells used for energy, growth and repair, is called assimilation.
- **Egestion :** The process in which the undigested food is removed from the body is called egestion.

09. Nutrition in Amoeba

Amoeba is a unicellular animal. The mode of nutrition in Amoeba is holozoic. The process of obtaining food by Amoeba is called phagocytosis The various steps involved in the nutrition of Amoeba are : ingestion, digestion, absorption, assimilation, and egestion.

- **Ingestion :** Amoeba has no mouth or a fixed place for the ingestion of food (intake of food). Amoeba ingests food by using its pseudopodia.



- **Digestion :** In amoeba, food is digested in the food vacuole by digestive enzymes. The enzymes from surrounding cytoplasm enter into the food vacuole and break down the food into small and soluble molecules by chemical reactions
- **Absorption :** The digested food present in the food vacuole of Amoeba is absorbed directly into the cytoplasm of Amoeba cell by diffusion.
- **Assimilation :** A part of the food absorbed in Amoeba cell is used to obtain energy through respiration. The remaining part of absorbed food is used to make the parts of Amoeba cell which lead to the growth of Amoeba.
- **Egestion :** Amoeba has no fixed place (like anus) for removing the undigested part of food. When a considerable amount of undigested food collects inside Amoeba, then its cells membrane suddenly ruptures at any place and the undigested food is thrown out of the body of Amoeba.

10. Nutrition in Human Beings (Human Digestive System)

The human digestive system consists of the alimentary canal and its associated glands. The various organs of the human digestive system in sequence are : Mouth, Oesophagus (or Food pipe), Stomach, Small intestine and Large intestine. The glands which are associated with the human digestive system and form a part of the human digestive system are : Salivary gland, Liver and Pancreas

- **Ingestion :** The human beings have a special organ for the ingestion of food. It is called mouth. The food is put into the mouth with the help of hands.
- **Digestion :** The mouth cavity (or buccal cavity) contains teeth, tongue, and salivary glands. The teeth cut the food into small pieces, chew and grind it. So, the teeth help in physical digestion. The salivary glands in our mouth produce saliva. Our tongue helps in mixing this saliva with food. Saliva is a watery liquid so it wets the food in our mouth. The salivary glands help in chemical digestion by secreting enzymes. The human saliva contains an enzyme called salivary amylase which digests the starch present in food into sugar. Thus, the digestion of starch (carbohydrate) begins in the mouth itself. The slightly digested food in the mouth is swallowed by the tongue and goes down the food pipe called oesophagus

The contraction and expansion movement of the walls of food pipe is called peristaltic movement. The peristaltic movement of food pipe (or oesophagus) pushes the slightly digested food into the stomach The stomach is a J-shaped present on the left side of the abdomen The food is further digested in the stomach. The stomach wall contains three tubular glands in its walls. The gland present in the walls of the stomach secrete gastric juice. The gastric juice contains three substances : hydrochloric acid, the enzyme pepsin and mucus. In the acidic medium, the enzyme pepsin beings the digestion of proteins present in food to form smaller molecules. Another function of hydrochloric acid is that it kills any bacteria which may enter the stomach with food. The mucus helps to protect the stomach wall from its own secretion of hydrochloric acid. From the stomach, the partially digested food enters the small

intestine. The small intestine in human beings is the site of complete digestion of food (like carbohydrates, proteins and fasts).

(a) The small intestine receives the secretions of two glands **:** liver and pancreas. Liver secretes bile. Bile is a greenish yellow liquid made in the liver which is normally stored in the gall bladder. Bile is alkaline, and contains salts which help to emulsify or break the fats (or lipids) present in the food. Thus, bile performs two function : (1) makes the acidic food coming from the stomach alkaline so that pancreatic enzymes can act on it, and (2) bile salt break the fats present in the food into small globules making it easy for the enzymes to act and digest them. Pancreas is a large gland which lies parallel to and beneath the stomach Pancreas secretes pancreatic juice which contains digestive enzymes like pancreatic proteins and the enzyme lipase breaks down the emulsified fats.

(b) The walls of small intestine contain glands which secrete intestinal juice. : The intestinal juice contains a number of enzymes which complete the digestion of complex carbohydrates into glucose proteins into amino acids and fats into fatty acids and glycerol. Glucose, amino acids, fatty acids and glycerol are small, water soluble molecules.

- **Absorption :** After digestion, the molecules of food become so small that they can pass through the walls of the small intestine (which contain blood capillaries) and go into our blood. blood. This is called obsorption. The small intestine is the main region for the absorption of digested food. The presence of villi gives the inner walls of the small intestine a very large surface area. And the large surface area of small intestine helps in the rapid absorption of digested food. The digested food which is absorbed through the walls of the small intestine, goes into our blood.
- **Assimilation :** The blood carries digested and dissolved food all the parts of the body where it becomes assimilated as part of the cells. This assimilated food is used by the body cells for obtaining energy as well as for growth and repair of the body.
- **Egestion :** A part of the food which we eat cannot be digested by our body. This undigested food cannot be absorbed in the small intestine. So, the undigested food passed from the small intestine into a wider tube called large intestine (it is called large intestine because it is a quite wider tube). The walls of large intestine absorb most of the water from the undigested food (which the help of villi). Due to this, the undigested part of food becomes almost solid. The last part of the large intestine called `rectum` stores this undigested food for some time. And when we go to the toilet, then this undigested food is passed out (or egested) from our body through anus as faeces or `stool` The act of expelling the faeces is called egestion or defection.

11. Dental Caries

The hard, outer covering of a tooth is called enamel Tooth enamel is the hardest material in our body. The formation of small cavities (or holes) in the teeth due to the action of acid – forming bacteria and improper dental care is called dental caries. If the teeth are not cleaned regularly, they become covered with a sticky, yellowish layer of food particles and bacteria cells called `dental plaque`

12. Respiration

The assimilated food is used mainly for two purposes :
(i) Assimilated food is used as a fuel to get energy for various life processes, and
(ii) Assimilated food is used as a material for the growth and repair of the body.
The process of releasing energy from is called respiration The process of respiration oxygen (of air) into the cells, using it for releasing energy by burning food, and then eliminating the waste products (carbon dioxide and water) from the body.

Food + Oxygen ⟶ Carbon dioxide + Water + Energy

(a) **Breathing and Respiration**
The mechanism by which organisms obtain oxygen from the air and release carbon dioxide is called breathing. Respiration is a more complex process. Respiration includes breathing as well as the oxidation of food in the cells of the organism to release energy.

(b) **How Energy Released During Respiration is Stored**
The energy produced during respiration is stored in the form of ATP molecules in the cells of the body ADP is a substance called Adenosine Di-Phosphate. The molecules of ADP are present in a cell. ADP has low energy content. ATP is a substance called Adenosine Tri-Phosphate. ATP has high energy content.

- The energy released during respiration is used to make ATP molecules from ADP and inorganic phosphate.

ADP (Low energy) + Phosphate + Energy (From respiration) ⟶ ATP (High energy)

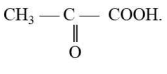
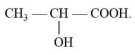
- When the cell needs energy, then ATP can be broken down using water to release energy. Thus :

ATP ⟶ ADP + Phosphate + Energy (For use in cells)

The energy equivalent to 30.5 kJ/ mole is released in this process. The energy stored in ATP used by the body cells for various purposes like contraction of muscles, conduction of nerve impulses, synthesis of proteins, and many other activities related to the functioning of cells

An Important Discussion

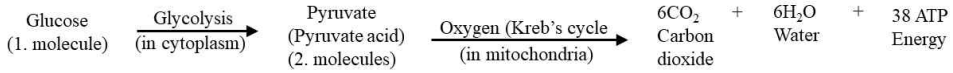
- Glucose is $C_6H_{12}O_6$. It is a six carbon atom compound. It is the simple food which is oxidised in the cells of organisms during respiration.
- The oxidation of glucose to pyruvic acid (or pyruvate) is called glycolysis. It occurs in the cytoplasm of a cell and not in mitochondria. The oxidation of glucose to pyruvic acid does not require oxygen. One molecule of glucose on glycolysis produces two molecules of pyruvic acid

- Pyruvic acid is a three carbon atom compound. It is also called pyruvate. The formula of pyruvic acid or pyruvate is  It is a ketonic carboxylic acid.
- The fate of pyruvate formed during respiration depends on whether oxygen is present in the cells or not. If oxygen is present in the cells, then pyruvate is completely oxidised to carbon dioxide and water, and a lot of energy is produced (in the form of ATP). If, however, oxygen is not present in the cells (that is, in the absence of oxygen), pyruvate is converted to either' ethanol and carbon dioxide` or `lactic acid`
- Lactic acid is also a three carbon atom compound. It is also called lactate acid or lactate is  It is a hydroxy carboxylic acid.

13. Types of Respiration

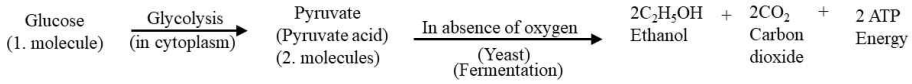
We have two types of respiration : aerobic respiration and anaerobic respiration.

(a) **Aerobic Respiration :** The respiration which uses oxygen is called aerobic respiration. Aerobic respiration produces a considerable amount of energy for use by the organism which gets stored in the ATP molecules.



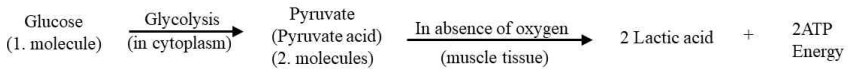
Please note that during aerobic respiration (shown above), 1 molecule of glucose (food) produces 38 energy – rich ATP molecules Mitochondria are the sites of aerobic respiration in the cells

(b) **Anaerobic Respiration :** The respiration which takes place without oxygen is called anaerobic respiration. In anaerobic respiration, the micro – organisms like yeast break down glucose (food) into ethanol and carbon dioxide, and release energy.



Please note that

(c) during anaerobic respiration (shown above), 1 molecule of glucose (food) produces only 2 energy- rich ATP molecules. Anaerobic respiration takes place in our muscles during vigorous physical exercise when oxygen gets used up faster in the muscle cells than can be supplied by the blood



The sudden build up of lactic acid in our muscle during vigorous physical activity can cause muscular `cramps` We can get relief from cramps in muscles caused by heavy exercise by taking a hot water bath or a massage.

Differences between Aerobic and Anaerobic Respiration

Aerobic respiration	Anaerobic respiration
• Aerobic respiration takes place in the presence of oxygen • Complete breakdown of food occurs in aerobic respiration • The end products in aerobic respiration are carbon dioxide and water. • Aerobic respiration produces a considerable amount of energy.	• Anaerobic respiration place in the absence of oxygen. • Partial breakdown of food occurs in anaerobic respiration. • The end products in anaerobic respiration may be ethanol and carbon dioxide (as in animal muscles). • Much less energy is produced in anaerobic respiration.

14. Respiration in Plants

The respiration in plants differs from that in animals in three respects :

(i) All the parts of a plant (like root, stem and leaves) perform respiration individually. On the other hand, an animal performs respiration as a single unit.

(ii) During respiration in plants, there is a little transport of respiratory gases from one part of the plant to the other. On the other hand, respiratory gases are usually transported over long distances inside an animal during respiration.

(iii) The respiration in plants occurs at a slow rate. On the other hand, the respiration in animals occurs at a much faster rate.

Plants get Oxygen by Diffusion

(a) **Respiration in Roots :** Air is present in- between the particles of soil The roots of a plant take the oxygen required for respiration from the air present in- between the soil particles by the process of diffusion. The extensions of the epidermal cells of a root are called root hair. The root hair are in contact with the air in the soil. Oxygen (from air in the soil particles) diffuses into root hairs and reaches all the other cells of the root respiration.

(b) **Respiration in Stems :** The stems of herbaceous plants (or herbs) have stomata. So, the exchange of respiratory gases in the stems of herbaceous plants take place through stomata. In woody stems, the bark (outer covering of stem) has lenticels for gaseous exchange

(c) **Respiration in Leaves** Oxygen from air diffuses into a leaf through stomata and reaches all the cells where it is used in respiration. in leaves occurs during the day time as well as at night. On the other hand, photosynthesis occurs only during the day time

- During day time, when photosynthesis occurs, oxygen is produced. The leaves use some of the this oxygen for respiration and the rest of oxygen diffuses out into air. Again, during day time, carbon dioxide produced by respiration is all used up in photosynthesis by leaves. The net gas exchange in leaves during day time is : O_2 diffuses out ; CO_2 diffuses in
- At nigh time when no photosynthesis occurs and hence no oxygen is produced the net gas exchange in leaves at night : O_2 diffuses in ; CO_2 diffuses out.

15. Respiration in Animals

Different animals have different modes of respiration. For example :

(i) In simple unicellular animals like Amoeba, respiration take place by the simple diffusion of gases through the cell membrane. Most of the animals have, specific organs for respiration

(ii) The animals like earth worms which live in the soil use their skin to absorb oxygen from air and remove carbon dioxide. So, the respiratory organ in the earthworm is the skin.

(iii) The aquatic animals like fish, prawns and mussels have gills as the respiratory organs which extract oxygen dissolved in water and take away carbon dioxide from the body.

(iv) In the insects like grasshopper, cockroach, housefly and a mosquito, the tiny holes called spiracles on their body and the air tubes called tracheae are the respiratory organs

(v) The respiratory organs of the land animals such as man (humans), birds, lizard, dog, and frog, etc., are the lungs. (Frogs, however, breathe both by lungs and skin).

Respiration in Human

The process by which energy is released from food in our body is called respiration. The function of respiratory system is to breathe in oxygen for respiration (producing energy from food), and to breathe out carbon dioxide produced by respiration. Breathing is the process by which air in oxygen is taken inside the body of an organism and air rich in carbon dioxide is expelled from the body. The taking in of air rich in oxygen into the body during breathing is called *inhalation* giving our (or expelling) the air rich in carbon dioxide is *exhalation*` A breath means` one inhalation plus one exhalation`

(a) **reathing in :** When we breathe in (or inhale), then two things happen at the same time : (i) the muscles between the ribs contract causing the rib cage to move upward and outward, and (ii) the diaphragm contracts and move downward The upward and outward movement of rib cage, as well as the downward movement of diaphragm, both increase the space in the chest cavity and make it larger As the chest cavity becomes larger, air is sucked in from outside into the lungs. The lungs get filled up with air and expand

(b) **Breathing out :** When we breathe our (or exhale), even then two things happen at the same time : (i) the muscles between the ribs relax causing the rip cage to move downward and inward, and (ii) the diaphragm relaxes and move upward. The downward and inward movement of rib cage, as well as the upward movement of diaphragm, both decrease the space in chest cavity and make it smaller as the chest cavity becomes smaller, air is pushed out from the lungs.

Respiration in Plants

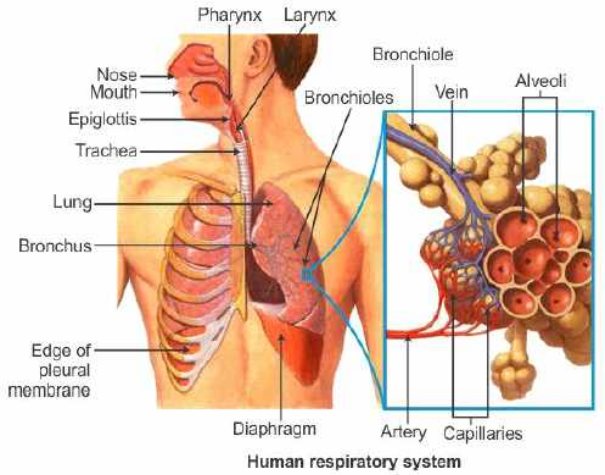
- All parts of a plant perform respiration.
- Plants exchange gases by diffusion through the stomata.
- Oxygen from the air diffuses into a leaf and reaches all the cells for respiration.
- Carbon dioxide produced during respiration is released into the air through the stomata.
- In plants, respiration occurs during the day as well as during the night.
- During the day, oxygen produced during photosynthesis is used for respiration and the extra amount of oxygen is given out through the stomata.
- The roots of plants take up oxygen from the air present between the roots and soil particles.
- In stems, the exchange of gases occurs through either the stomata or lenticels.

Respiration in Animals

Different animals have evolved different respiratory organs:

Human Respiratory System

The respiratory system in human beings consists of the nose, pharynx, larynx, trachea, bronchi and lungs.



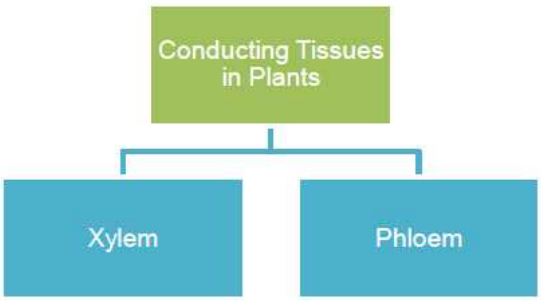
Human respiratory system

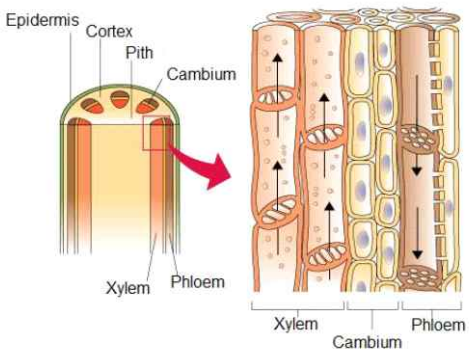
- Air is taken in through the nostrils.
- Hairs present in the nostrils prevent the entry of dust particles inside the nose.
- Nostrils further continue into the nasal cavity.
- Nostrils humidify the air passing through it.
- There is a bony plate called the palate, which separates the oral cavity from the nasal cavity.
- Nasal cavity opens into the pharynx.
- The pharynx is a muscular chamber acting as a common passage for the windpipe or trachea and the food pipe or oesophagus.
- It is connected to the larynx through a slit-like opening called the glottis.
- The larynx is also called the voice-box or Adam's apple.
- The larynx connects the pharynx to the trachea.
- The trachea shows the presence of cartilaginous rings.
- The cartilaginous rings provide flexibility thus, facilitating continuous air flow.
- The inner wall of the trachea is lined by a mucous membrane consisting of ciliated columnar. epithelium.

- The trachea divides into two branches or tubes called bronchi, one of which enters the right lung and the other enters the left lung.
- The bronchi have cartilaginous rings for distention.
- Each bronchus divides into fine secondary bronchi. These bronchi further divide into finer tertiary bronchi. In the lungs, each bronchus finally divides into finer and smaller branches called bronchioles.
- The bronchioles further divide to form smaller terminal bronchioles.
- The bronchioles divide repeatedly to form a cluster of tiny air chambers called air sacs or alveoli.
- Alveoli have thin and moist walls which enable gaseous diffusion with blood capillaries.
- The lungs are a pair of spongy and elastic respiratory organs protected by a bony rib cage.
- The base of the lungs rests on the diaphragm.
- Each lung is covered by two membranes. The inner membrane is called the inner or visceral pleura and the outer membrane is called the outer or parietal pleura.
- The diaphragm is a curved, musculo-fibrous sheath which separates the thoracic cavity from the abdominal cavity.
- The diaphragm plays a major role during respiration.
- The intercostal muscles found between the ribs and the radial muscles of the diaphragm bring about the breathing movements.
- When we breathe in, the ribs are pulled upwards and the diaphragm becomes flat which results in an increase in the volume of lungs.
- When we breathe out, the ribs come back to their normal position, the diaphragm is relaxed, lungs attain their normal size and air is expelled out of the body through the nostrils.

16. Transportation in Plants

- Transportation in plants is the process by which a substance, absorbed or synthesised in one part of the plant, is transported to the other parts of the plant.
- Substances transported by the transport system are water, mineral and food prepared by plants.





(i) **Xylem**

- It conducts water upwards in a plant.
- Xylem also provides strength to the stem and helps the plant to stand upright.
- It is located in the centre of the plant body.
- Xylem mainly consists of tracheids and vessels.

Mechanism of Transport of Water and Minerals

(a)

- Water enters the root hair through osmosis, and mineral ions enter the root cells by active transport.
- Both water and minerals move upward from cell to cell through the cortex of the root by osmosis.
- From the cortex, water and minerals are brought to the xylem.
- The sap which contains water and dissolved minerals move upwards from the root cells to xylem. The upward movement of sap is called the ascent of sap.
- The xylem vessels of the roots are in continuation with the xylem vessels of the stem.

(b)

- Transpiration is the loss of water in the form of water vapour from the aerial parts of a plant.
- It occurs through openings called stomata.
- Water loss through evaporation lowers the concentration of water inside the mesophyll cells.
- Due to this, water enters mesophyll cells from neighbouring xylem vessels through osmosis.
- As water evaporates from the leaves, a suction force is created. This force helps to draw more water up through the stem which causes the roots to absorb more water from the soil.
- Higher the rate of transpiration, greater the rate of absorption of water and solutes from the soil.
- Transpiration also helps in maintaining the temperature of the plant body.

(ii) **Phloem**

- It conducts manufactured food from the leaves to different parts of the plant.
- The food in the phloem can move in the upward and downward directions.
- Phloem mainly consists of sieve tube cells and companion cells.
- Sieve tubes are living cells of the phloem. They contain cytoplasm but no nucleus.
- The end walls of the cells form sieve plates.
- Sieve plates have small pores in them which allow food to pass through the phloem.
- Each sieve tube cell has a companion cell next to it.

Mechanism of Transport of Water and Minerals

- Food synthesised during photosynthesis is loaded into sieve tubes by utilising ATP.
- The presence of food inside the phloem develops the concentration gradient for water. Thus, water enters the phloem by osmosis.
- Osmosis develops high pressure inside the phloem which transports the food from the phloem to plant parts where the concentration of food is less.
- This process is called translocation.
- In spring, the sugar stored in the root or stem tissues is transported to the buds.

17. Blood

Blood is a red coloured liquid which circulates in our body. Blood is red because it contains a red pigment called haemoglobin in its red cells. Blood is a connective tissue. Blood consists of four things : plasma, red blood corpuscles, white blood corpuscles, and platelets. Thus, the main components of blood are :

Blood is a liquid (or fluid matrix) called plasma with red cells, white cells and platelets in it

(i) **Plasma :** The liquid part (or fluid part) of blood is called plasma.

(ii) **Red Blood Cells :** Red blood cells carry oxygen from the lungs to all the cells of the body. It is actually the haemoglobin present in the red blood cells which carries oxygen in the body. Red blood cells do not nuclei. Each red blood cell lives for about four months.

(iii) **White Blood Cells :** White blood cells fight infection and protect us from diseases This is because white blood cells help to fight against germs and other foreign bodies which cause diseases. White blood cells are called soldiers of the body.

(iv) **Platelets :** Platelets help in the coagulation of blood (or clotting of blood) in a cut or wound.

Functions of Blood

- Blood carries oxygen from the lungs to different part of the body.
- Blood carries carbon dioxide from the body cells to the lungs for breathing out.
- Blood carries digested food from the small intestine to all the part of the body.
- Blood carries hormones from the endocrine glands to different organs of the body (where they are needed).
- Blood carries a waste product called urea from the liver to the kidneys for excretion in urine

- Blood protects the body from diseases. This is because white blood cells kill the bacteria and other germs which cause diseases.
- Blood regulates the body temperature. This is because the blood capillaries in our skin help to keep our body temperature constant at about 37°C

Transport in Humans

The main transport system in human beings (or man) is the `blood circulatory system. The human blood circulatory system consists of the heart (the organ which pumps and receives the blood) and the blood vessels (or tubes) through which the blood flows in the body.

In blood circulatory system, the blood flows through three types of blood vessels :

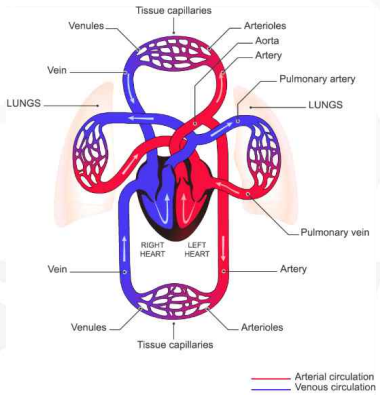
(i) arteries,
(ii) veins, and
(iii) capillaries

In addition to the blood circulatory system for the transport in human beings, there is another system called lymphatic system which also helps in the human body. The liquid which circulates and carries materials in the lymphatic system is called lymph. Thus, in human beings, the various substances are transported through two liquid called `blood` and `lymph`

18. Human Circulatory System

The various organs of the circulatory system in humans are : Heart, Arteries, Veins and Capillaries. The heart is roughly triangular in shape. It is made of special muscle called cardiac muscle. The size of our heart is about the same our `clenched fist`. The heart has four compartments called `chambers` inside it The upper two chambers of heart are called atria (Singular atrium), and the lower two chambers of heart are called ventricles. The two atria receive blood from the two main veins. And the two ventricles transport blood to the entire body and the lungs. The left atrium is connected to the left ventricle through a valve V_1 Similarly, the right atrium is connected to the right ventricle through another valve V_2 These valves prevent the backflow of blood into atria when the ventricles contract to pump blood out of the heart to the rest of the body. This is because when the ventricles contract, the valves V_1 and V_2 close automatically so that the blood may not go back into atria. The job of heart is to pump blood around our body. All the atria and ventricles of the heart contract and relax (expand) at appropriate times and make the heart behave like a pumps. Sine ventricles have to pump blood into various organs with high pressure, they have thicker walls than atria. A sheath of tissue called `pericardium` protects the muscular heart The chambers of the heart are separated by a partition called by a partition called septum. The arteries veins and capillaries are a kind of thin pipes (or tubes) through which blood flows in the Arteries are the thick walled blood vessels which carry blood from the heart to all the parts of the body. Arteries are the thick walled blood vessels which carry blood from the heart to all the parts of the body. Arteries have thick walls because blood emerges from the heart under high pressure. Arteries are found in the whole of our body. The main artery (called aorta) is connected to the left ventricle of the heart through a valve V_3 The main artery carries oxygenated blood from the

left ventricle to all the parts of the body (except the lungs). Another artery called pulmonary artery is connected to the right ventricle of the heart through another valve V_4 The pulmonary artery carries deoxygenated blood from the right ventricle to the lungs. The capillaries are thin walled and extremely narrow tubes or blood vessels which connect arteries to veins. The exchange of various materials like oxygen, food, carbon dioxide, etc., between the blood and the body cells takes place through capillaries. Veins are the thin walled blood vessels which carry blood which carry blood from all the parts of the body back to the heart.
Veins do not need thick walls because the blood flowing them is no longer under high pressure. Veins have valves in them which allow the blood in them to flow in only one direction (towards the heart). The valves prevent the backflow of blood in veins. Veins are also found in the whole of our body. The pulmonary vein is connected to the left atrium of the heart The pulmonary vein carries oxygenated blood from lungs back to the heart. There is also a main vein (called vena cava). The blood from all the parts of the body (except lungs), back to the heart. Please not that the main different between an artery and a vein is that an artery carries blood from the heart to the body organs whereas a vein carries blood from the body organs back to the heart. The blood carrying oxygen in it is called oxygen in it is called oxygenated blood. The blood having no oxygen in it called deoxygenated blood. The heart non-stop all the time.



A circulatory system in which the blood travels twice through the heart in one complete cycle of the body is called double circulation. In the human circulatory system the pathway of blood from the heart to the lungs and back to the heart is called pulmonary circulation ; and the pathway of blood from the heart to the rest of the body and back to the heart is called the systemic circulation. The amphibians (like frogs) and reptiles (like lizards) have a three-chambered heart (which consists of two atria and one ventricle). The fish has a two-chamberd heart (which consists of one atrium and one ventricle).
Heart Beats : One complete contraction and relaxation of the heart is called a heart beat. The heart usually beats about 70 to 72 times in a minute when we are resting.

Pulse : The expansion of an artery each time the blood is forced into it, is called pulse the pulse rate of an adult person while resting is 70 to 72 per minute.
Blood Pressure : The pressure at which blood is pumped around the body by the heart is called blood pressure. The blood pressure of a person is always expressed in the form of two values called `systolic pressure` and diastolic pressure The maximum pressure at which the blood leaves the heat through the main artery (aorta) during contraction phase, is called the systolic pressure. The minimum pressure in the arteries during the relaxation phase of heart is called the diastolic pressure. The normal blood pressure values are :

- Systolic pressure : 120mm Hg
- Diastolic pressure : 80mm Hg
- This is usually written as 120/80

High blood pressure is called hypertension

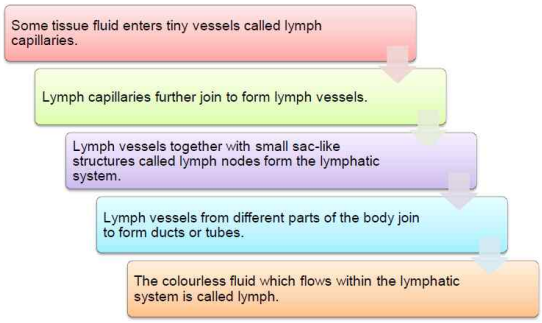
How to Measure Blood Pressure

Blood pressure is measured by using an instrument called sphygmomanometer

19. Lymphatic System

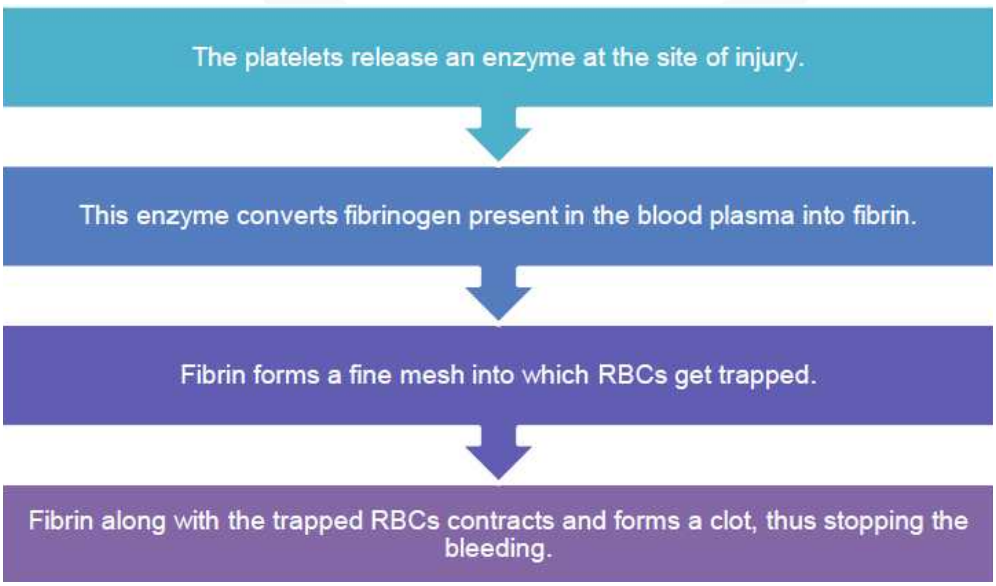
Lymph and Lymphatic System

- As the blood flows through capillaries, the water, dissolved substances and a few white blood cells
- pass through the capillary walls into the spaces between the cells, i.e. intercellular spaces. This fluid is called **tissue fluid**.
- White blood cells in the lymph protect the body against diseases.
- The lymphatic system carries excessive tissue fluid back to the blood.



Clotting of Blood (Coagulation)

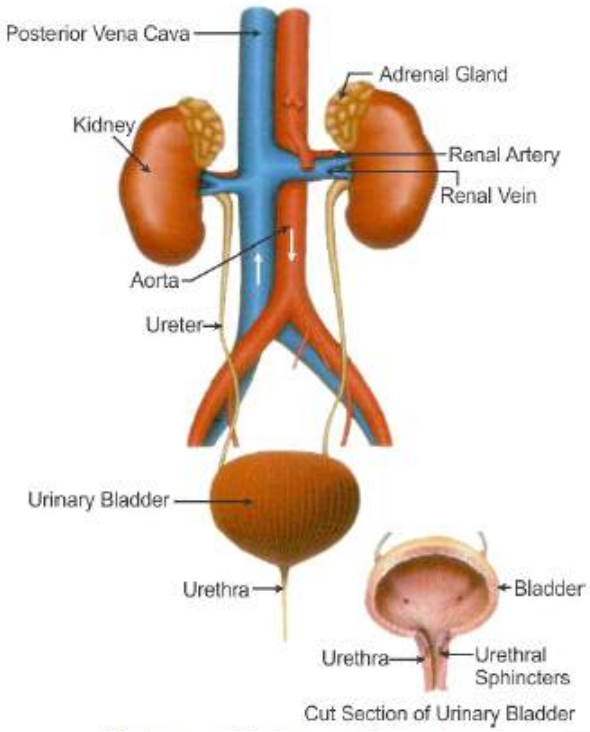
- When a blood vessel is cut, blood escapes from it. Soon a clot is formed on the wound, and the flow is stopped.
- Blood clotting is a complex process:



20. Excretion

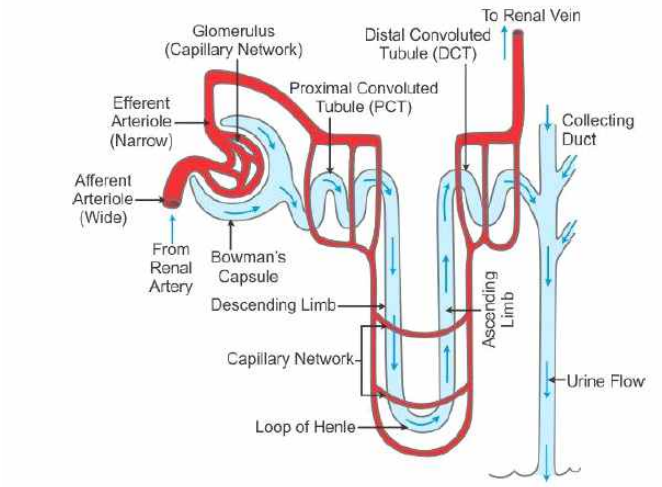
(i) Excretion is the removal of harmful and unwanted substances, especially nitrogenous wastes, from the body.

(ii) The human urinary system consists of -



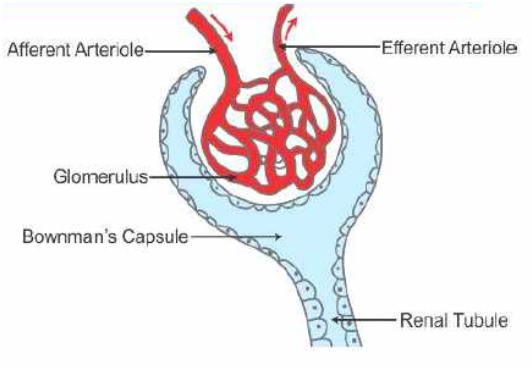
Pair of kidneys	• Dark red, bean-shaped, 10 cm long, 6 cm wide. • The right side of the kidney is slightly lower in position due to the presence of the liver.
Pair of ureters	• Ureters are tube-like structures which arise from the notch, i.e. the hilum of each kidney. • The ureters connect behind with the urinary bladder. • The ureters carry the urine produced to the urinary bladder
Urinary bladder	• Muscular sac-like structure. • It stores urine temporarily. • Its opening is guarded by muscular sphincters. • The sphincters open at the time of micturition (urination).
Urethra	• Short muscular tube which expels urine out of the body. • The urethra is long in males and is very short in females. • The opening is guarded by sphincters which open at the time of urination

Uriniferous Tubule



Uriniferous Tubule

- Each kidney is composed of an enormous number of uriniferous tubules.
- They are also known as nephrons, renal tubules or kidney tubules.
- Uriniferous tubules are the structural and functional units of the kidney.



Malpighian Tubule

- Each nephron has a Malpighian body and body of tubules.
- Malpighian body is nothing but a cup-shaped Bowman's capsule. In its up-shaped depression, a tuft of blood capillaries called glomerulus is situated.
- The body of tubules contains proximal convoluted tubule (PCT), loop of Henle and distal convoluted tubule (DCT).
- DCT opens into the collecting duct.

Note :

Approximately 2 million uriniferous tubules are present in both the kidneys.
Each single uriniferous tubule is 4 to 5 cm long.
The great length of the uriniferous tubule provides a large surface area for the reabsorption
of usable substances such as water.
Blood flow through the kidneys per minute = 1 litre
Glomerular filtrate produced in 24 hours = 160 litre
Urine produced from the glomerular filtrate after reabsorption per day = 1.2 litre

Formation of Urine :

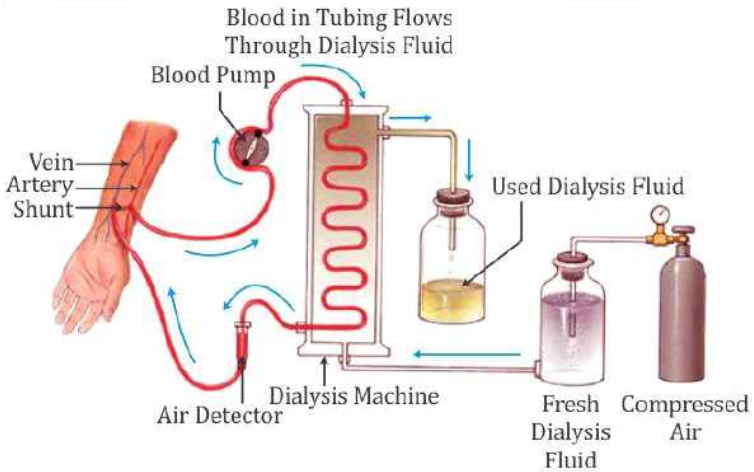
The process of urine formation occurs in two major steps.

Ultrafiltration	Reabsorption
• The efferent arteriole is narrower than the afferent arteriole which develops a hydrostatic pressure on the blood. • Thus, the blood flows through the glomerulus with a great pressure. • Due to the pressure, the liquid part of the blood filters out from the glomerulus and passes into the Bowman's capsule. • The glomerular filtrate consists of water, urea, salts, glucose and other plasma solutes. • Blood corpuscles, proteins and other large molecules remain behind in the glomerulus. • Therefore, the blood carried away by the efferent arteriole is relatively thick.	• The glomerular filtrate entering the renal tubule contains many useful substances. • Hence, as the filtrate passes down the tubule, water and other substances required by the body are reabsorbed. • Potassium ions and certain substances such as penicillin are passed into the forming urine through the distal convoluted tubule (DCT). • The cells of the walls of DCT are involved in bringing potassium ions and other substances back into the renal tubule; hence, this process is known as tubular secretion.

Urine Excretion

- The filtrate left after reabsorption and tubular secretion is called urine.
- The urine passes from the collecting duct into the pelvis of the kidney. From there it is sent to the urinary bladder through the ureters.
- By relaxing the sphincters present at the opening of the urethra, the urine is expelled from the body. This process is known as micturition or urination.

Artificial Kidney



- If one kidney is damaged or removed, then the other kidney alone can fulfil excretory needs.
- However, the failure of both the kidneys allows urea and other wastes to accumulate in the blood.

- Such a patient undergoes dialysis.
- In dialysis, an artificial kidney is used.
- The artificial kidney contains tubes with a semi-permeable lining.
- These tubes are suspended in a tank filled with a dialysing solution.
- This fluid contains water and glucose in concentrations similar to those in blood.
- The patient's blood is led from the radial artery through the tubes of the artificial kidney where excess salts and urea are removed.
- The purified blood is returned through a vein in the same arm.
- The function of dialysis is similar to the function of the kidney, but the only difference is there is no reabsorption during dialysis.

Excretion in Plants

- Plants also produce several waste products during their life processes.
- The major waste products are water, carbon dioxide and oxygen produced during respiration and photosynthesis.
- These wastes are excreted through the stomata and lenticels.
- Plants store some waste products in leaves which fall off.
- Wastes such as gums and resins are stored in the old xylem.

CBSE Pattern
Exercise (1)

(Q 1 to 3) One Mark

1. Into how may groups organisms can be classified?

2. Name the structures through which amoeba capture food.

3. What is the range of normal systolic and diastolic blood pressure.?

(Q 4 to 6) Two Marks

4. Write one function each of the following component of the transport system in human beings:
   - Blood vessels
   - Blood platelets
   - Lymph
   - Heart.

5. What is difference between breathing and respiration?

6. Although bile juice has no digestive enzyme, it is still considered to be very important during digestion of food. Give two reasons.

(Q 7 to 8) Three Marks

7. Name the various digestive glands associated with human digestive system, also give the name of secretion of these glands along with their functions.

8. Why the medium becomes acidic in mouth? What is the ill effect of the acidic medium? How this can be prevented?

(Q 9 to 10) Five Marks

9.
   (a) Draw the diagram of human heart and label the following:
      - part which receive deoxygenated blood from vena cava.
      - part which send deoxygenated blood to lung through pulmonary artery.
      - part which receives oxygenated blood from lungs.
      - part which sends oxygenated blood to all parts of the body through aorta.

   (b) What does the blood consist?

   (c) Write two functions of blood.

10. Describe the process of digestion of food in man.

Answer & Solution

Q1.
Two groups :
(a) Autotrophs and
(b) Heterotrophs.

Q2.
Pseudopodia.

Q3.
Systolic−120 mm of H.g Diastolic −80 mm of H.g

Q4.
(a) **Blood vessels :** Arteries are the vessels which transport blood from heart to various organs of the body while veins bring blood from various organs of the body back to the heart.
(b) **Blood platelets :** Help in clotting of blood by releasing platelet factor at the site of injury:
(c) **Lymph :** Transports fat and bring back extracellular fluid into circulation.
(d) **Heart :** It pumps oxygenated blood to various organs of the body and deoxygenated blood to lungs for oxygenation.

Q5.
Differences between breathing and respiration:

Breathing	Respiration
• The mechanism by which an organism obtains oxygen from th environment and release carbon dioxide is termed breathing.	• In involves the mechanism of exchange of gases−O_2 and O_2.
• Breathing is a physical process.	• Oxidation of food occurs in the cells resulting in release of energy which is utilised for carrying out various functions.

Q6

(i) Bile salts break fats into smaller globules (Emulsification) and thus increase the efficiency of enzyme action.

(ii) Bile is alkaline in nature. It neutralises the acidic chyme and provides alkaline pH for enzymes secreted by pancreas.

Q7.

The various digestive glands associated with human digestive system are:

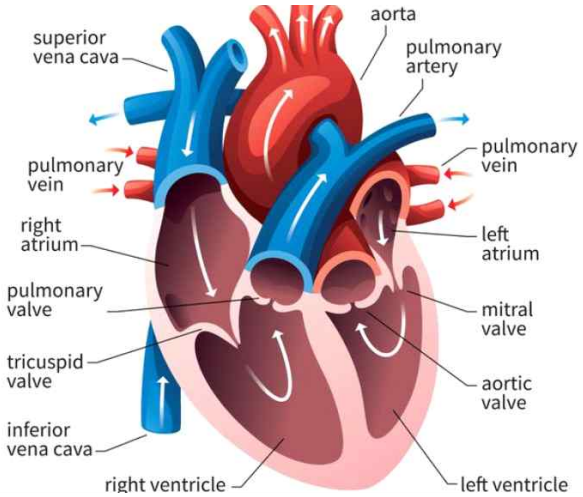
Glands	*Secretion*	*Function of secretion*
• Salivary glands	Saliva which contains enzyme ptyalin/salivary amylase.	Ptyalin digests starch and converts it to sugar maltose. Mucus present in saliva makes the food slipery so that it can be easily swallowed.
• Gastric glands	HCl and Pepsin	HCl makes the food acidic and pepsin digests protein.
• Liver	Bile juice	Emulsifies fat and bicarbonates present in it turn the acidic food into alkaline.
• Pancreas	Pancreatic juice. It contains enzyme trypsin, lipase and amylase.	Trypsin digest protein. Lipase digest fat and amylase digest starch.
• Intestinal glands	succus entericus	Completes the digestion of starch. protein and fat.

Q8.

The medium in the mouth becomes acidic when bacteria acting on sugars produce acids. The bacterial cells together with food particles stick to the tooth to form dental plaque. As causes tooth decay duet to gradual softening of tooth enamel. It can be prevented by brushing the teeth after each meal.

Q9.

(a)



- Right atrium receives deoxygenated blood from vena cava.
- Right ventricle pumps deoxygenated blood to lungs through pulmonary artery.
- Left atrium receives oxygenated blood from lungs.
- Left ventricle sends blood to all parts of body through aorta.

(b) Blood consists of plasma in which three types of blood cells WBC, RBC and platelets are found. Blood is a type of connective tissue.

(c)

- Transport of nutrients.
- Transport of hormones.
- Transport of excretory products (urea) to kidney for excretion.
- Transport of gases.

Q10.

Process of digestion starts in mouth

CLASS 10

CBSE

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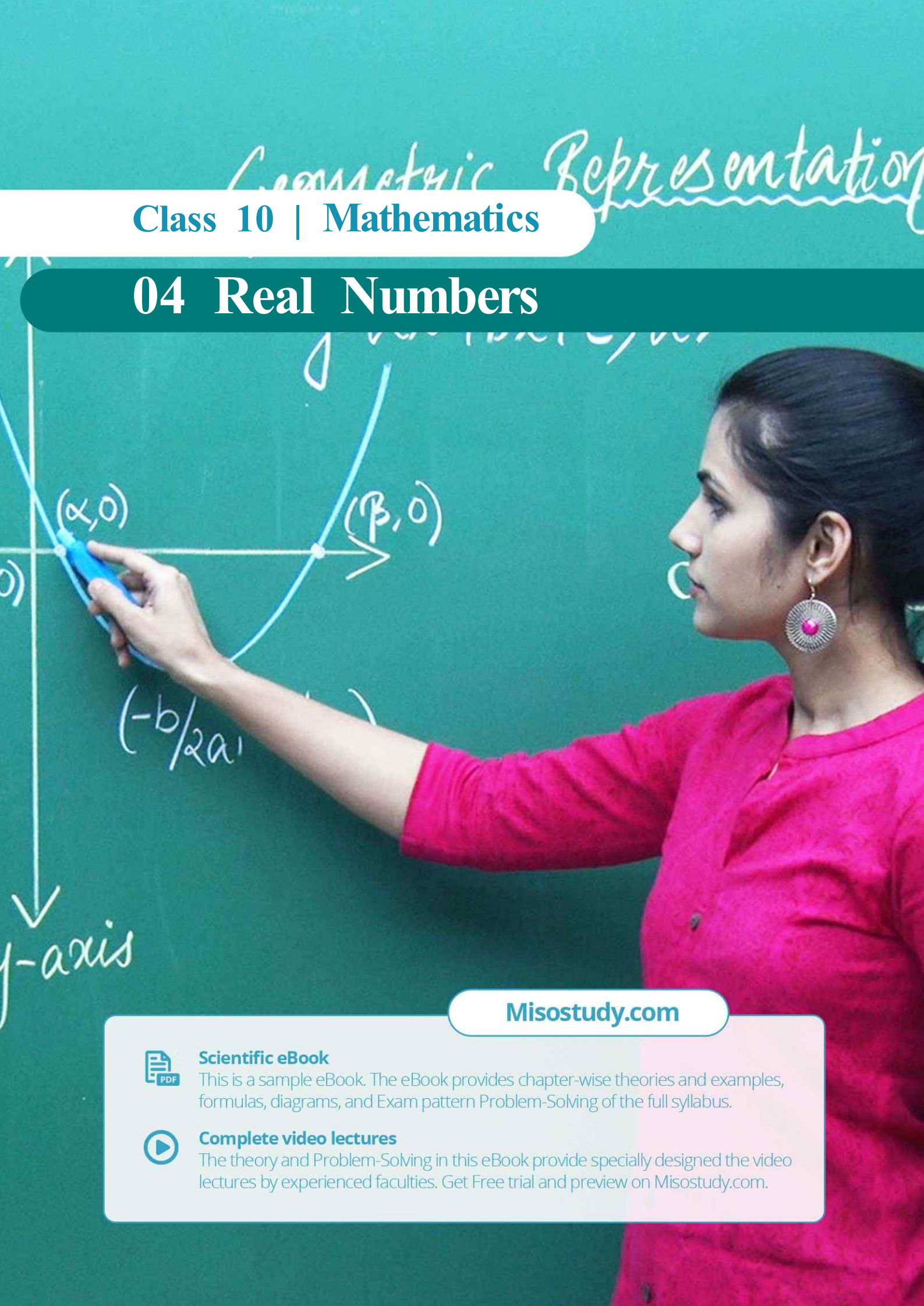

Class 10 | Mathematics

04 Real Numbers

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01. Euclid's Division Lemma

Euclid's Division Lemma : Let a and b be any two positive integers. Then, there exist unique integers q and r such that

$$a = bq + r,\ 0 \le r < b$$

If $b \mid a$, then $r = 0$. Otherwise, r satisfies the stronger inequality $0 < r < b$.

Remark I *The above Lemma is nothing but a restatement of the long division process we have been doing all these years, and that the integers q and r are called the quotient and remainder, respectively.*

Remark II *The above Lemma has been stated for positive integers only. But, it can be extended to all integers as stated below :*
Let a and b any two integers with $b \neq 0$. Then, there exist unique integers q and r such that

$$a = bq + r, \text{ where } 0 \le < |b|$$

Remark III

(i) *When a positive integer is divided by 2, the remainder is either 0 or 1. So, any positive integer is of the form $2m$, $2m + 1$ for some interger m.*

(ii) *When any positive integer is divided by 3, the remainder is 0 or 1 or 2. So, any positive integer can be written in the form $3m$, $3m + 2$ for some integer m.*

(iii) *When a positive integer is divided by 4, the remainder can be 0 or 1 or 2 or 3. So, any positive integer is of the form $4q$ or, $4q + 1$ or, $4q + 3$.*

Example *Show that any positive odd integer is of the form $4q + 1$ or $4q + 3$, where q is some integer.*

Solution Let a be any odd positive integer and $b = 4$. By division Lemma there exists integers q and r such that

$$a = 4q + r, \text{ where } 0 \le r < 4$$

$$\Rightarrow \quad a = 4q \text{ or, } a = 4q + 1 \text{ or, } a = 4q + 2 \text{ or, } a = 4q + 3 \quad [\because\ 0 \le r < 4 \Rightarrow r = 0,1,2,3]$$

$$\Rightarrow \quad a = 4q + 1 \text{ or, } a = 4q + 3 \quad [\because\ a \text{ is an odd integer } \therefore\ a \neq 4q,\ a \neq 4q + 2]$$

Hence, any odd integer is of the form $4q + 1$ or, $4q + 3$.

02. Euclid's Division Algorithm

In order tlo compute the *HCF* of two positive intgers, say a and b, with $a > b$ we may follow the following steps :

Step I *Apply Euclid's division lemma to a and b and obtain whole numbers q_1 and r_1 such that $a = bq_1 + r_1$, $0 \le r_1 < b$.*

Step II *If $r_1 = 0$, b is the HCF of a and b*

Step III *If $r_1 \neq 0$, apply Euclid's division lemma to b and r_1 and obtain two whole numbers q_1 and r_2 such that $b = q_1r_1 + r_2$.*

Step IV *If $r_2 = 0$, then r_2 is the HCF of a and b.*

Step V *If $r_2 \neq 0$, then apply Euclid's division lemma to r_1 and r_2 and continue the above*

process till the remainder r_n is zero. The divisor at this stage i.e. r_{n-1}, or the non-zero remainder at the previous stage, is the HCF of a and b.

Example *Use Euclid's division algorithm to find the HCF of* 4052 *and* 12576.

Solution Given integers are 4052 and 12576 such that 12576 > 4052. Applying Euclid's division lemma to 12576 and 4052, we get

$$12576 = 4052 \times 3 + 420 \quad ...(i)$$

$$\begin{array}{r} 3 \\ \therefore\ 4052\overline{)12576} \\ \underline{12156} \\ 420 \end{array}$$

Since the remainder 420 ≠ 0. So, we apply the division lemma to 4052 and 420, to get

$$4052 = 420 \times 9 + 272 \quad ...(ii)$$

$$\begin{array}{r} 9 \\ \therefore\ 420\overline{)4052} \\ \underline{3780} \\ 272 \end{array}$$

We consider the new divisor 420 and the new remainder 272 and apply division lemma to get

$$420 = 272 \times 1 + 148 \quad ...(iii)$$

$$\begin{array}{r} 1 \\ \therefore\ 272\overline{)420} \\ \underline{272} \\ 148 \end{array}$$

Let us now consider the new divisor 272 and the new remainder 148 and apply division lemma to get

$$272 = 148 \times 1 + 124 \quad ...(iv)$$

$$\begin{array}{r} 1 \\ \therefore\ 148\overline{)420} \\ \underline{148} \\ 124 \end{array}$$

We consider now the new divisor 148 and the new remainder 124 and apply division lemma to get

$$148 = 124 \times 1 + 24 \quad ...(v)$$

$$\begin{array}{r} 1 \\ \therefore\ 124\overline{)148} \\ \underline{124} \\ 24 \end{array}$$

We consider now the new divisor 124 and the new remainder 24 and apply division lemma to get

We consider the new divisor 24 and the new remainder 4 and apply division lemma to get

$24 = 4 \times 6 + 0$ ...(vii)

$$\left[\begin{array}{l} \quad\;\; 6 \\ \because\; 4\overline{)\,24} \\ \quad\;\; \underline{24} \\ \quad\;\; 0 \end{array}\right]$$

We observed that the remainder at this stage is zero. Therefore, the divisor at this stage i.e. 4 (or the remainder at the earlier stage) is the HCF of 4052 and 12576.

Example *Any contingent of 616 members is to march behind on army band of 32 members in a parade. The two groups are to march in the same number of columns. What is the maximum number of columns in which they can march*?

Solution The maximum number of columns is the HCF of 616 and 32. In order to find the HCF of 616 and 32, let us apply Euclid's division lemma to 616 and 32 to get

$616 = 32 \times 19 + 8$

Let us now take the divisor 32 as dividend and remainder 8 as divisor and apply Euclid's division lemma to get

$32 = 8 \times 4 + 0$

Since, the remainder at this stage is 0. Therefore, the last divisor i.e. 8 is the HCF of 616 and 32.

Hence, the maximum number of columns in which they can march is 8.

03. The Fundamental Theorem Arithmetic

Result **Fundamental Theorem of Arithmetic :** *Every composite number can be expressed (factorised) as a product of primes, and this factorization is unique except for the order in which the prime factors occur.*

Result *Let p be a prime number and a be a positive integer. If p divides a^2, then p divides a.*

Example *Prove that there is no natural number for which 4^n ends with the digit zero.*

Solution We know that any positive integer ending with the digit zero is divisible by 5 and so its prime factorization must contain the prime 5.

$4^n = (2^2)^n = 2^{2n}$

$\Rightarrow$ The only prime in the factorization of 4^n is 2.

$\Rightarrow$ There is no other primes in the factorization of $4^n = 2^{2n}$.

[By uniqueness of the Fundamental Theorem of Arithmetic]

$\Rightarrow$ 5 does not occur in the prime factorization of 4^n for any n.

$\Rightarrow$ 4^n does not end with the digit zero for any natural number n.

04. Some Applications of the Fundamental Theorem of Arithmetic

(i) Finding HCF and LCM of Positive Integers

In order to find the HCF and LCM of two or more positive integers, we may use the following algorithm.

Algorithm

Step I *Factorize each of the given positive integers and express them as a product of powers of primes in ascending order of magnitudes of primes.*

Step II *To find the HCF, identify common prime factors and find the smallest (least) exponent of these common factor, Now raise these common prime factors to their smallest exponents and multiply them to get the HCF.*

To find the LCM, list all prime factors (once only) occuring in the prime factorisation of the given positive integers.

For each of these factors, find the greatest exponent and raise each prime factor to the greatest exponent and multiply them to get the LCM.

Remark *To find the LCM of two positive integers a and b, we can also use the following result, if we have already found the HCF.*

$HCF \times LCM = a \times b.$

Example *Find the HCF nd LCM of 144, 180 and 192 by prime factorisation method.*

Solution Using the factor tree for the prime factorisation of 144, 180 and 192, we have

$144 = 2^4 \times 3^2$, $180 = 2^2 \times 3^2 \times 5$ and $192 = 2^6 \times 3$

To find the HCF, we list the common prime factors and their smallest exponenets in 144, 180 and 192 as follows :

Common prime factors	*Least exponents*
2	2
3	1

$\therefore$ $HCF = 2^2 \times 3^1 = 12$

To find the LCM, we list all prime factors of 144, 180, 192 and their greatest exponents as follows :

Prime factors of 144, 180 *and* 192	*Greatest exponents*
2	6
3	2
5	1

$\therefore$ $LCM = 2^6 \times 3^2 \times 5^1 = 64 \times 9 \times 5 = 2880$

(ii) Proving Irrationality of Numbers

Example *Prove that* $\sqrt{3}$ *is an irrational number.*

Solution Let us assume on the contrary that $\sqrt{3}$ is a rational number. Then, there exist positive integers a and b such that

$\sqrt{3} = \frac{a}{b}$, where a and b are co-prime i.e. their HCF is 1.

Solution Now,

$$\sqrt{3} = \frac{a}{b}$$

$\Rightarrow \quad 3 = \frac{a^2}{b^2}$

$\Rightarrow \quad 3b^2 = a^2$

$\Rightarrow \quad 3 \mid a^2 \qquad [\because\ 3 \mid 3b^2]$

$\Rightarrow \quad 3 \mid a \qquad$ ...(i)

$\Rightarrow \quad a = 3c$ for some integer c

$\Rightarrow \quad a^2 = 9c^2$

$\Rightarrow \quad 3b^2 = 9c^2 \qquad [\because\ a^2 = 3b^2]$

$\Rightarrow \quad b^2 = 3c^2$

$\Rightarrow \quad 3 \mid b^2 \qquad [\because\ 3 \mid 3c^2]$

$\Rightarrow \quad 3 \mid b \qquad$ ...(ii)

From (i) and (ii), we observe that a and b have at least 3 as a common factor. But this contradicts the fact that a are co-prime. this means that our assumption is not correct.

Hence, $\sqrt{3}$ is an irrational number.

Example *Prove that* $5-\sqrt{3}$ *is an irrational number.*

Solution Let us assume on the contrary that $5-\sqrt{3}$ is rational. Then, there exist co-prime positive integers a and b such that

$$5-\sqrt{3} = \frac{a}{b}$$

$\Rightarrow \quad 5-\frac{a}{b} = \sqrt{3}$

$\Rightarrow \quad \frac{5b-a}{b} = \sqrt{3}$

$\Rightarrow \quad \sqrt{3}$ is rational $[\because\ a,b$ are integers $\therefore\ \frac{5b-a}{b}$ is a rational number$]$

This contradicts the fact $\sqrt{3}$ is irrational. So, our assumption is incorrect.

Hence, $5-\sqrt{3}$ is an irrational number.

(iii) Determining the Nature of the Decimal Expansions of Rational Numbers

Result *Let x be a rational number whose decimal expansion terminates. Then, x can expressed in the form $\frac{p}{q}$, where p and q are co-primes, and the prime factorisation of q is of the form $2^m \times 5^n$, where m, n are non-negative integers.*

Result *Let $x = \frac{p}{q}$ be a rational number, such that the prime factorisation of q is of the form $2^m \times 5^n$, where m, n are non-negative integers. Then, x has a decimal expansion which terminates after k places of decimals, where k is the larger of m and n.*

Result *Let $x = \frac{p}{q}$ be a rational number, such that the prime factorisation of q is not of the form $2^m \times 5^n$, where m, n are non-negative integers. Then, x has a decimal expansion which is non-terminating repeating.*

Example *Without actually performing the long division, state whether the following rational number will have terminating decimal expansion or a non-terminating repeating decimal expansion. Also, find the number of places of decimals after which the decimal expansion terminates :* $\frac{13}{3125}$.

Solution We have,

$$\frac{13}{3125} = \frac{13}{2^0 \times 5^5}$$

This shows that the prime factorisation of the denominator of $\frac{13}{3125}$ is of the form $2^m \times 5^n$. hence, it has terminating decimal expansion which terminates after 5 places of decimals.

Example What can you say about the prime factorisations of the denominators of the following rationals :

(i) 34.12345 (ii) $34.\overline{5678}$

Solution

(i) Since 34.12345 has terminating decimal expansion. So, its denominator is of the form $2^m \times 5^n$, where m, n are non-negative integers.

(ii) Since $34.\overline{5678}$ has non-terminating repeating decimal expansion. So, its denominator has factors other than 2 or 5.

CBSE Pattern
Exercise (1)

(Q 1 to 2) One Mark

1. Use Euclid's division algorithm to find the HCF of : 196 and 38220

2. Find the LCM and HCF of the following pair of integers and verify that LCM × HCF = product of the two numbers. 510 and 92.

(Q 3 to 6) Two Marks

3. Given that HCF (306, 657) = 9, find LCM (306, 657).

4. Prove that the following are irrational : $6 + \sqrt{2}$

5. Without actually performing the long division, state whether the following rational number will have a terminating decimal expansion or a non-terminating repeating decimal expansion: $\frac{23}{2^3 5^2}$.

6. Without actually performing the long division, state whether the following rational number will have a terminating decimal expansion or a non-terminating repeating decimal expansion: $\frac{77}{210}$

(Q 7 to 10) Four Marks

7. Use Euclid's division lemma to show that the cube of any positive integer is of the form $9m$, $9m + 1$ or $9m + 8$.

8. Prove that $\sqrt{5}$ is irrational.

9. The following real number have decimal expansions as given below. Decide whether it is rational or not. If it is rational, and of the form $\frac{p}{q}$, what can you say about the prime factors of q? 43.123456789.

10. The following real number have decimal expansions as given below. Decide whether it is rational or not. If it is rational, and of the form $\frac{p}{q}$, what can you say about the prime factors of q? 0.120120012000120000...

Answer & Solution

Q1

Since 38220 > 196, we apply the division lemma to 38220 and 196 to obtain

38220 = 196 × 195 + 0.

Since the remainder is zero, the process stops. Since the divisor at this stage is 196, Therefore, HCF of 196 and 38220 is 196.

Q2

510 and 92

510 = 2 × 3 × 5 × 17

92 = 2 × 2 × 23

HCF = 2

LCM = 2 × 2 × 3 × 5 × 17 × 23 = 23460

Product of the two numbers = 510 × 92 = 46920

HCF × LCM = 2 × 23460

= 46920

Hence, product of two numbers = HCF × LCM

Q3

We know that, LCM × HCF = Product of two numbers

∴ LCM × HCF = 306 × 657

$$\text{LCM} = \frac{306 \times 657}{\text{HCF}} = \frac{306 \times 657}{9}$$

LCM–22338

Q4

Let $6 + \sqrt{2}$ be rational.

Therefore, we can find two integers a, b ($b \neq 0$) such that

$$6 + \sqrt{2} = \frac{a}{b}$$

$$\sqrt{2} = \frac{a}{b} - 6$$

since a and b are integers, $\frac{a}{b} - 6$ is also rational and hence, $\sqrt{2}$ should be rational. This

contradicts the fact that $\sqrt{2}$ is irrational. Therefore, our assumption is false and hence, $6+\sqrt{2}$ is irrational.

Q5

$\frac{23}{2^3 \times 5^2}$

The denominator is of the form $2^m \times 5^n$.

Hence, the decimal expansion of $\frac{23}{2^3 \times 5^2}$ is terminating.

Q6

$\frac{77}{210} = \frac{11 \times 7}{30 \times 7} = \frac{11}{30}$

$30 = 2 \times 3 \times 5$

since the denominator is not of the form $2^m \times 5^n$, and it also has 3 as its factors, the decimal expansion of $\frac{77}{210}$ is non-terminating repeating.

Q7

Let a be any positive integer and $b = 3$

$a = 3q + r$, where $q \geq 0$ and $0 \leq r < 3$

$\therefore\ a = 3q$ or $3q + 1$ or $3q + 2$

Therefore, every number can be represented as these three forms.

There are three cases.

Case I When $a = 3q$,

$a^3 = (3q)^3 = 27q^3 = 9(3q^3) = 9m$,

Where m is an integer such that $m = 3q^3$

Case II When $a = 3q + 1$

$a^3 = (3q + 1)^3$

$a^3 = 27q^3 + 27q^3 + 9q + 1$

$a^3 = 9(3q^3 + 3q^2 + q) + 1$

$a^3 = 9m + 1$

Where m is an integer such that $m = (3q^3 + 3q^2 + q)$

Case III When $a = 3q + 2$,

$a^3 = (3q^3 + 2)^3$

$a^3 = 27q^3 + 54q^2 + 36q + 8$

$a^3 = 9(3q^3 + 6q^2 + 4q) + 8$

$a^3 = 9m + 8$

Where m is an integer such that $m = (3q^3 + 6q^2 + 4q)$

Therefore, the cube of any positive integer is of the form $9m$, $9m + 1$, or $9m + 8$.

Q8

Let $\sqrt{5}$ is a rational number.

Therefore, we can find two integers a, $b(b \neq 0)$ such that $\sqrt{5} = \frac{a}{b}$

Let a and b have a common factor other than 1. Then we can divide them by the common factor, and assume that a and b are co-prime.

$a = \sqrt{5}$
$a^2 = 5b^2$
Therefore, a^2 is divisible by 5 and it can be said that a is divisible by 5.
Let $a = 5k$, where k is an integer
$(5k)^2 = 5b^2$
$b^2 = 5k^2$ This means that b^2 is divisible by 5 and hence, b is divisible by 5.
This implies that a and b have 5 as a common factor.
And this is a contradiction to the fact that a and b are co-prime.

Hence, $\sqrt{5}$ cannot be expressed as $\frac{p}{q}$ or it can be said that $\sqrt{5}$ is irrational.

Q9

Since this number has a terminating decimal expansion, it is a rational number of the form $\frac{p}{q}$ and q is of the form $2'' \times 5''$ i.e., the prime factors of q will be either 2 or 5 or both.

Q10
The decimal expansion is neither terminating nor recurring. Therefore, the given number is an irrational number.

CBSE Exam Pattern Exercise
Objective Questions (1)

1. the decimal expansion of number $\frac{441}{2^2 \times 5^3 \times 7}$ has
   (a) a terminating decimal
   (b) non-terminating but repeating
   (c) non-terminating non-repeating
   (d) terminating after two decimal places

2. n^2-1 is divisible by 8, if n is
   (a) an integer
   (b) a natural number
   (c) an odd integer
   (d) an even integer

3. The HCF of 95 and 152 is
   (a) 57
   (b) 1
   (c) 19
   (d) 38

4. If two positive integers a and b are written as $a = x^3y^2$ and $b = xy^3$; x,y are prime numbers, then HCF = (a,b) is _____.
   (a) xy
   (b) xy^2
   (c) x^3y^3
   (d) x^2y^2

5. The decimal expansion of the rational number $\frac{33}{2^2 \times 5}$ will terminate after
   (a) one decimal place
   (b) two decimal places
   (c) three decimal places
   (d) more than 3 decimal places

6. If the sum of LCM and HCF of two numbers is 1260 and their LCM is 900 more than their HCF, then the product of two numbers is_____.
   (a) 203400
   (b) 194400
   (c) 198400
   (d) 205400

7. If $a = 2^3 \times 3$, $b = 2 \times 3 \times 5$, $c = 3^n \times 5$ and LCM $(a,b,c) = 2^3 \times 3^2 \times 5$, then n = _____.
   (a) 1
   (b) 2
   (c) 3
   (d) 4

8. The largest number which divides 70 and 125, leaving remainders 5 and 8, respectively is
   (a) 13
   (b) 65
   (c) 875
   (d) 1750

9. If the LCM of a and 18 is 36 and the HCF of a and 18 is 2, then a = _____.
   (a) 2
   (b) 3
   (c) 4
   (d) 1

10. If the HCF of 65 and 117 is expressible in the form $65m - 117$, then the value of m is_____.
   (a) 4
   (b) 2
   (c) 1
   (d) 3

Answer & Solutions

1. (a)

$\frac{441}{2^3 \times 5^3 \times 7} \quad \frac{63}{}$ (on simplification)

$= \frac{63}{2^3 \times 5^3}$

Since the denominator only contains the power of 2 and 5

$\therefore \frac{441}{2^3 \times 5^3 \times 7}$, on simplification gives a terminating decimal expansion

2. (c)

Let $a = n^2 - 1$

Here n can be even or add

case1:- n = even ie $n = 2k$ where r is only integer

$a = (2k)^2 - 1$

$a = 4k^2 - 1$

when $R = -1$, $4(-1)^2 - 1 = 3$, not divisible by 8.

when $R = 0$, $4(0)^2 - 1 = -1$, not divisible by 8.

case2:- n = odd, $n = 2k + 1$, where R is any integer

$a = (2R + 1)^2 - 1$

$a = 4k^2 + 1 + 4k - 2$ [using $(a + b)^2$]

$a = 4k^2 + 4k$

When $R = -1$; $a = 3(-1)^2 + 4(-1)$

$= 4 - 4 = O$ which is divisible by 8

When, $R = O$; $a = 4(0)^2 + 4(0) = O$ which is divisible by 8.

When, $R = 1$; $a = 4(1)^2 + 4(1) = 8$ which is divisible by 8.

$\Rightarrow$ n is an odd numbers.

3. (c)

HCF (95,152)

By using Euclid's division lemma

$a = bq + r$; $0 \leq r \leq b$

where a = dividend; b = divisor ; q = quotient ; r = semainde

$152 = 95 \times 1 + 57$

$95 = 57 \times 1 + 38$

$57 = 38 \times 1 + 19$

$38 = 19 \times 2 + 0$

HCF (a,b) = $x\ y^2$

4. (b)
a = $x^3 y^2$; b = xy^3
HCF = The lowest of indices of x and y
HCF (a,b) = $x\ y^2$

5. (b)
$\frac{33}{2^2 \times 5}$
on simplifying the denominator
$\frac{33}{2^2 \times 5} = \frac{33}{4 \times 5} = \frac{33}{20} = 1.65$
$\therefore$ It terminates ofter 2 decimal places.

6. (b)
According to the question,
LCM + HCF = 1260 (1)
also, LCM is 900 more than their HCF
$\Rightarrow$ HCF + 900 LCM (2)
Substitute (2) in (1)
HCF + 900 + HCF = 1260
2 HCF = 1260 – 900
HCF = 180
Put HCF = 180 I (2)
LCM = 180 + 900 = 1080
Since the product of LCM and HCF of true numbers is equal to the product of numbers.
$\Rightarrow$ Product of numbers = 180 × 1080 = 194400

7. (b)
a = $2^3 \times 3$; b = $2 \times 3 \times 5$; C = $3^n \times 5$
LCM(a,b,c) = $2^3 \times 3^2 \times 5$
Also, LCM = Highest indices of 2,3 and 5.
$\Rightarrow$ n = 2

8. (a)
To find the largest numbers which divides 70 and 125 leaving the semainder 5 and 8 respectively, We will subtract 5 from 70 and 8 from 125 then we will compute the HCF of the resuet obtained after substation.
70 – 5 = 65 ; 125 – 8 = 117
65 = 13 × 5
117 = 13 × 3^2
HCF (65, 117) = 13
$\therefore$ 13 is the largest number which divides 70 & 125 leaving the semainder 5 and 8 respective

9. (c)

Product of number = LMC × HCF of the numbers.

$18 \times a = 36 \times 2$

$a = \frac{236 \times 2}{18}$

$a = 4$

10. (b)

HCF (65,117)

$65 = 13 \times 5$; $117 = 13 \times 3^2$

HCF(65, 117) = 13

65 = 117 = 13 as HCF (65, 117) is expressible as 65m – 117

65m = 13 + 117

65m = 130

$m = \frac{130}{65} = 2 \Rightarrow m = 2$