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Welcome to a transformative learning journey with **QuestPix**. This module is meticulously designed to provide a comprehensive, integrated approach to mastering complex subjects, offering a clear and structured pathway that empowers learners to gain profound depth in their chosen field.

The **QuestPix** module is intuitively divided into chapters, each dedicated to a specific topic. Every chapter begins with a detailed explanation of core concepts, laying a robust foundation for your learning. To further solidify understanding, you'll find dedicated sections of **QuestPix Concept Explorers**, carefully crafted exercises that reinforce learned concepts and sharpen critical thinking.

At **QuestPix**, we understand that thorough preparation for examinations is key. To ensure learners are exceptionally well-equipped, we have included three distinct sets of exercises at the end of every chapter:

Our Unique Exercise Sets

- 1. QuestPix Foundational Drills:** This exercise set is specifically designed to align with typical school examination formats. It covers a variety of commonly seen problems, including multi-choice questions, short-answer questions, long-answer questions, and case-based scenarios. These drills are perfect for cementing your understanding of core concepts and building confidence for standard classroom assessments.
- 2. QuestPix Elevate Exercises:** Aimed at stimulating deeper understanding and critical analysis, these **QuestPix** exercises go beyond basic recall. They are tailored to prepare students for prestigious national and international competitions, such as the International Mathematics Olympiad (IMO), International Olympiad of Mathematics (IOM), International Junior Science Olympiad (IJSO), and the Indian Olympiad Qualifier in Mathematics (IOQM). Engage with these challenges to truly master the subject.
- 3. QuestPix Competitive Edge Practice:** The third exercise introduces a selection of previous year problems from key competitive examinations. These solved problems help students familiarize themselves with diverse exam formats and difficulty levels, ensuring they are well-prepared for real-world tests and high-stakes competitions.

QuestPix is not just about rote memorization. It nurtures a deeper understanding of the subject matter while also training you to approach problems from various perspectives. Whether you are preparing for a school exam, an Olympiad, or any competitive test, this **QuestPix** module provides the resources and exercises to guide you through every stage of your preparation.

Our aim is to help you build superior conceptual understanding, enhance your problem-solving abilities, and develop the critical thinking skills that are indispensable for academic and professional success.

In conclusion, this **QuestPix** module serves as your dedicated companion on a journey of academic excellence. Whether you are aiming for a top-tier competitive score or simply looking to sharpen your problem-solving skills, this module offers the tools and guidance you need to achieve your goals. So, dive in, challenge yourself, and savor the process of learning and growth with **QuestPix**.

Wishing you success on your educational journey with QuestPix!



MOTION

Physics

It is the branch of science in which we observe, measure and describe nature and natural phenomena.

Mechanics

It is the branch of physics which deals with the study of object in the condition of rest or motion. It is divided into two parts.

(I) Statics

(II) Dynamics

(I) **Statics:** It deals with the study of objects at rest or in equilibrium, even when they are under the action of several forces.

(II) **Dynamics:** Dynamics is also divided into two parts.

(i) **Kinematics:** It deals with the study of motion of objects without considering the cause of motion.

Example: Equations of motion

(ii) **Kinetics:** It deals with the study of motion of objects with considering the cause of motion.

Example: Newton's laws of motion

Rest and Motion

Motion is a combined property of the object and the observer. There is no meaning of rest or motion without the observer. Nothing is in absolute rest or in absolute motion.

An object is said to be in motion with respect to an observer, if its position changes with respect to that observer. It may happen by both ways either observer moves or object moves.

Rest: An object is said to be at rest if it does not change its position with respect to its surroundings with the passage of time.

Example: The chair, black board, table in the class room are at rest with respect to the students.

Motion: A body is said to be in motion if its position changes continuously with respect to the surroundings (or with respect to an observer) with the passage of time.

Example: A car moving on the road will be in motion with respect to the person standing on the road.

Note: Rest and motion are relative terms, there is nothing like absolute motion or rest.

Example: A train is moving on the track, the passengers are seated, will be stationary with respect to each other but in moving condition with respect to station.

Therefore, all the motions are relative. There is nothing like absolute motion.

To study the motion of an object, following points are essential:

Concept of a Point Object

In mechanics while studying the motion of an object, sometimes its dimensions are not important and the object may be treated as a point object without much error. When the size of the object is much less in comparison to the distance covered by the object then the object is considered as a point object.

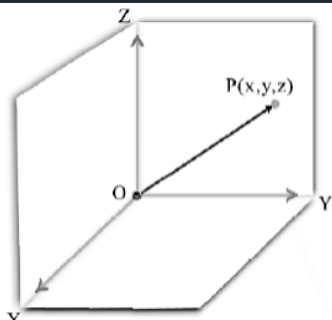
Example: Earth can be considered as a point object for studying its motion around the sun. Because length of the path covered by the earth in one revolution is very large in comparison to the size of earth, so earth can be considered as a point object.

Frame of Reference

A fixed point or a fixed object with respect to which the given body changes its position is known as reference point/origin. To locate the position of object we need a frame of reference.

A convenient way to set up a frame of reference is to choose three mutually perpendicular axes and name them x-y-z axis. The co-ordinates (x, y, z) of the particle then specify the position of object with respect to that frame. If any one or more co-ordinates change with time, then we say that the object is moving with respect to this frame.





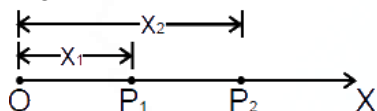
Motion in one, two and three dimensions

As position of the object may change with time due to change in one or two or all the three co-ordinates, so we have classified motion as follows:

- (i) **Motion in 1-D:** If only one of the three co-ordinates specifying the position of object changes with respect to time then its motion is known as 1D motion. In such a case the object moves along a straight line. This motion is also known as rectilinear or linear motion.

Example:

- (I) Motion of train along straight railway track
- (II) An object falling freely under gravity
- (II) When a particle moves from P_1 to P_2 along a Straight-line path only the x-co-ordinate changes



- (ii) **Motion in 2-D:** If two of the three co-ordinates specifying the position of object changes with respect to time, then the motion of object is called two dimensional. In such a motion the object moves in a plane.

Example:

- (I) Motion of queen on carom board
 - (II) An insect crawling on the floor of the room
 - (III) Motion of object in horizontal and vertical circles
 - (IV) Motion of planets around the sun
 - (V) A car moving along a zig-zag path on a level road
- (iii) **Motion in 3-D:** If all the three co-ordinates specifying the position of object changes with respect to time, then the motion of object is called 3-D. In such a motion the object moves in space.

Example:

- (I) A bird flying in the sky (also kite)
- (II) Random motion of gas molecules
- (III) Motion of an airplane in space

Types of Motion

Linear motion (or translatory motion)

When an object moves in straight line then motion is called as linear motion.

Example: The motion of a car moving on straight road, a running person, a stone being dropped, motion of a train on a straight track

Rotational motion

Motion of a body around a fixed axis is called rotational motion.

Example: The motion of an electric fan, motion of earth about its own axis

Oscillatory motion

The to and fro periodic motion of a body around a fix point is called oscillatory motion.

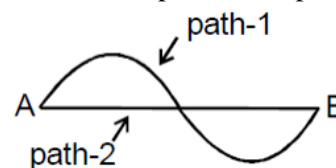
Example: The motion of a simple pendulum, a body suspended from a spring

Distance and Displacement

Distance: It is the actual length of path covered by a moving particle. It is a scalar quantity. Its S.I. unit is metre (m).

Displacement: It is the shortest distance between the initial and final position of the particle. It is a vector quantity. Its S.I. unit is metre (m).

Example: Consider a body moving from a point A to a point B along the path shown in figure. Then total length of path covered is called distance (path-1). While the length of straight line AB in the direction from A to B is called displacement (path-2).





Note:

If a body travels in such a way that it comes back to its starting position, then the displacement is zero. However, distance travelled is never zero in case of moving body.

Some important points

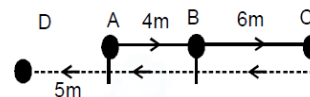
- (I) When an object moves towards right from origin, its displacement is considered as positive.
- (II) When an object moves towards left from origin, its displacement considered as negative.
- (III) When an object remains stationary or it moves first towards right and then an equal distance towards left, its displacement is zero.
- (IV) Shifting origin causes no change in displacement.
- (V) If body moves along the circumference of the circle of radius r then distance travelled by it is given by $2\pi r$ and displacement is given by zero, for one complete revolution.

Difference between distance and displacement

Distance		Displacement
1.	Distance is the length of the path actually travelled by a body in any direction.	Displacement is the shortest path between the initial and the final positions of a body in the direction of the point of the final position.
2	Distance between two given points depends upon the path chosen.	Displacement between two points is measured by the straight path between the points.
3	Distance is always positive.	Displacement may be positive as well as negative and even zero.
4.	Distance is a scalar quantity.	Displacement is a vector quantity.
5	Distance will never decrease.	Displacement may decrease.

Example 1:

A body starts from A and moves according to given figure. The body retraces the path after C then reaches to D. Find distance and displacement for each path.

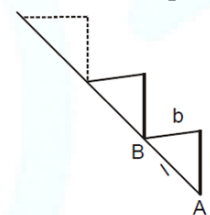


Solution:

Path	Distance	Displacement
AB	4m	4m
ABC	10m	10m
ABCB	16m	4m
ABCA	20m	0m
ABCAD	25m	-5m

Example 2:

There are n steps each of dimension b & h if a man climbs n steps what is his displacement and distance.



Solution: By Pythagoras theorem $AB = \sqrt{b^2 + h^2}$

Similarly for each step, Displacement $= \sqrt{b^2 + h^2}$

So that total displacement $n \times \sqrt{b^2 + h^2}$

Distance $= n(b + h)$

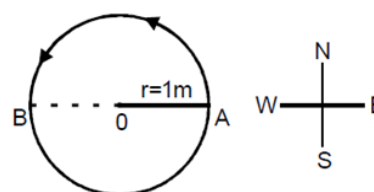
Example 3:

A person moves in a circular path centered at O of radius 1 m. He starts from A and reaches diametrically opposite point B. Then find :

- (a) distance between A and B
- (b) displacement between A and B

Solution.

- (a) Distance = Length of actual circular path from A to B = Half the circumference





$$\text{i.e Distance} = \frac{2\pi r}{2} = \pi r$$

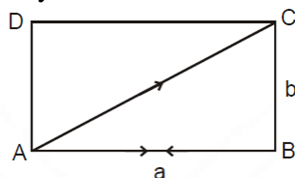
$$\text{as } r = 1 \text{ m}$$

$$\therefore \text{Distance} = \pi \text{ m}$$

$$\begin{aligned} \text{(b) Displacement} &= 2r \text{ along west.} \\ &= 2 \text{ m along west} \end{aligned}$$

Example 4:

Body moves from A to B and come back then goes to point C. Find distance and displacement of the journey.

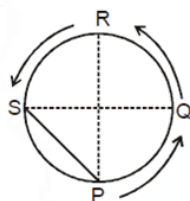
**Solution:**

$$\text{Distance} = AB + BA + AC = a + a + \sqrt{a^2 + b^2} = 2a + \sqrt{a^2 + b^2}$$

$$\text{Displacement } AC = \sqrt{a^2 + b^2}$$

Example 5:

A body moves on three quarters of a circle of radius r . Find the displacement and distance travelled by it.

**Solution.**

The body starts from P reaches to S passing through Q and R.

$$\text{(a) Displacement} = \sqrt{r^2 + r^2} = r\sqrt{2}$$

$$\text{(b) Distance} = \frac{3}{4} \times 2\pi r = \frac{3\pi r}{2}$$

FUNDAMENTAL UNLOCKED- (FU#1)

- Q.1** A stone is thrown vertically upwards and after ascending a height 'h' it comes back to the hands of the thrower. What is the total distance covered?
- Q.2** What is the value of distance & displacement when body travel in the straight-line path?
- Q.3** Is absolute rest possible or not?

Q.4 An object moves in circular path of radius r . Find the distance and displacement for two complete revolutions.

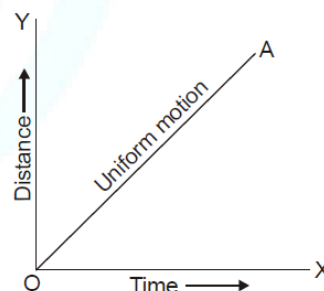
Q.5 A body moves 6 m north, 8 m east and 10 m vertically upwards. Find the resultant displacement of the body from initial position.

Q.6 A man goes 10 m towards North, then 20 m towards east. Find the displacement of the body from its initial position.

Q.7 An athlete completes one round of a circular track of radius 2 m in 40 sec. Find his displacement at the end of 2 min 20 sec.

Uniform and Non-Uniform Motion**Uniform Motion:**

A body has a uniform motion if it travels equal distances in equal intervals of time, no matter how small these time intervals may be. For example, a car running at a constant speed say, 10 metre per second, will cover equal distances of 10 metre every second, so its motion will be uniform. Please note that the distance-time graph for uniform motion is a straight line (as shown in the figure).

**Non-Uniform Motion**

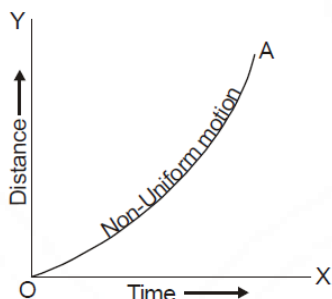
A body has a non-uniform motion if it travels unequal distances in equal intervals of time. For example, if we drop a ball from the roof of a building, we will find that it covers unequal distances in equal intervals of time. It covers 4.9 metre in the 1st second, 14.7 metre in the 2nd second, 24.5 metre in the 3rd second, and so on.

Thus, a freely falling ball covers smaller distance in the initial '1 second' interval and larger distance in the later '1 second' interval. From this discussion, we conclude that the motion of a freely falling body is an example of non-uniform motion. The motion of a





train starting from the railway station is also an example of non-uniform motion. This is because when the train starts from a station, it moves a very small distance in the 'first' second. The train moves a little more distance in the '2nd' second and so on. And when the train approaches the next station, the distance travelled by it per second decreases.



Please note that the distance-time graph for a body having non-uniform motion is a curved line (as shown in the figure). Thus, in order to find out whether a body has uniform motion or non-uniform motion, we should draw the distance-time graph for it. If the distance time graph is a straight line, the motion will be uniform and if the distance-time graph is a curved line, the motion will be non-uniform. It should be noted that non-uniform motion is also called accelerated motion or decelerated motion.

Speed and Velocity

Speed

The distance travelled by a body in unit time is called its speed. Therefore,

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} \text{ or } s = \frac{d}{t}.$$

- Speed is a scalar quantity.
- Speed depends on the path.
- Speed gives no idea about the direction of motion of the object.
- Speed can never be negative in motion, it is taken positive. At rest, it is zero.
- **Unit :** C.G.S. System - centimeter/second (cm/s) S.I. System - metre/second (m/s).

Types of Speed

(1) **Uniform Speed (or Constant Speed):** When an object covers equal distances in equal intervals of time, it is said to move with uniform speed.

Example: A car moves 10 m in every one second so its motion is uniform.

(2) **Non-Uniform Speed (or Variable Speed):** If a body covers unequal distances in equal intervals of time, its motion is said to be non-uniform.

Example: Vehicle starting from rest, the motion of a freely falling body etc.

(3) **Average Speed:** For an object moving with variable speed, it is the total distance travelled by the object divided by the total time taken to cover that distance.

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

Case-1: Let initial speed of an object is v_1 , final speed is v_2 and acceleration is constant, then

$$\text{Average speed} = \frac{v_1 + v_2}{2}$$

Case-2: A body covers a distance s_1 in time t_1 , s_2 in time t_2 and s_3 in time t_3 .

$$\text{Then, average speed, } V_{av} = \frac{s_1 + s_2 + s_3}{t_1 + t_2 + t_3}$$

Case-3: A body travels with speed v_1 for a time t_1 , v_2 for time t_2 and v_3 for the time t_3 .

$$\text{Then, average speed, } V_{av} = \frac{v_1 t_1 + v_2 t_2 + v_3 t_3}{t_1 + t_2 + t_3}$$

$$\therefore s_1 = v_1 t_1, s_2 = v_2 t_2 \text{ and } s_3 = v_3 t_3$$

$$\text{If } t_1 = t_2 = t_3 = t$$

$$V_{av} = \frac{t(v_1 + v_2 + v_3)}{3t}$$

$$V_{av} = \frac{(v_1 + v_2 + v_3)}{3}$$

Case-4: A body covers distance s_1 with speed v_1 , s_2 with speed v_2 and s_3 with speed v_3 .

$$\text{Then, average speed, } V_{avg} = \frac{(s_1 + s_2 + s_3)}{\frac{s_1}{v_1} + \frac{s_2}{v_2} + \frac{s_3}{v_3}}$$

$$\therefore t_1 = \frac{s_1}{v_1}, t_2 = \frac{s_2}{v_2}, t_3 = \frac{s_3}{v_3}$$

Case-5: A boy goes from home to school with speed v_1 and come back to home with speed v_2 . Here distance covered by the boy is same.





Time taken by the boy, from home to school,

$$t_1 = \frac{s}{v_1}$$

Time taken by the boy, from school to home,

$$t_2 = \frac{s}{v_2}$$

Then, average speed,

$$V_{av} = \frac{s + s}{t_1 + t_2} = \frac{2s}{\frac{s}{v_1} + \frac{s}{v_2}}$$

$$V_{av} = \frac{2v_1 v_2}{v_1 + v_2}$$

Case-6: If an object covered $\frac{1}{3}$ rd distance with speed

u , next $\frac{1}{3}$ rd with speed v and last $\frac{1}{3}$ rd

distance with speed w then,

$$V_{avg} = \frac{3uvw}{uv + vw + wu}$$

Instantaneous speed

The speed of object at a particular instant is called instantaneous speed. (The limiting value of average speed when the time interval approaches zero). Thus,

$$\text{Instantaneous speed} = \lim_{\Delta t \rightarrow 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$$

- Speedometer of the vehicle measures its instantaneous speed.
- In uniform motion of a particle, the instantaneous speed is equal to its average speed.

Velocity

It is defined as the rate of change of displacement.

Therefore, $\text{velocity} = \frac{\text{displacement}}{\text{time}}$ or it is the distance travelled in unit time in a given direction.

$$\text{velocity} = \frac{\text{distance travelled in a given direction}}{\text{time taken}}$$

- Velocity can be negative, positive or zero.
- The direction of average velocity is same as that of the total displacement.
- If average velocity for a journey is positive, it may have a negative instantaneous velocity at some point of time during the journey and vice-versa.

- **Unit:** C.G.S. System - centimeter/second (cm/s)
S.I. System - metre/second (m/s).

Note:

- To convert m/s into km/h, we multiply given quantity by 18/5.
- To convert km/h into m/s, we multiply given quantity by 5/18.

Types of Velocity

(I) Uniform Velocity (or Constant Velocity): If a body covers equal distances in equal intervals of time in a given direction, then it is said to be moving with constant velocity.

(II) Non-Uniform Velocity (or Variable Velocity):

When a body does not cover equal distances in equal intervals of time, in a given direction (in this case speed is not constant), then it is known as non uniform velocity.

In uniform circular motion speed is constant but velocity is not constant.

(III) Average Velocity: It is defined as the ratio of total displacement to the total time taken for this displacement. It is denoted by \vec{v}_{av} or \vec{v} . It is a vector quantity.

$$\therefore \text{Average velocity} = \frac{\text{Total displacement}}{\text{Total time}}$$

$$\text{i.e. } \vec{v} = \frac{\vec{s}}{t}$$

It is a vector quantity and its direction is in the direction of displacement.

(IV) Instantaneous velocity: The velocity of an object at a particular instant of time is called instantaneous velocity. It is equal to the limiting value of average velocity of the object when the time interval approaches zero.

$$\text{Instantaneous velocity } \vec{v} = \lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{s}}{\Delta t} = \frac{d\vec{s}}{dt}$$

It is a vector quantity.

Note:

- In straight line motion, if displacement is positive then \vec{v} is positive.
- If displacement is negative, then \vec{v} is also negative.



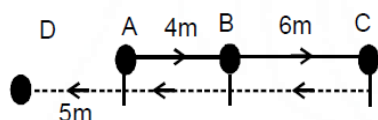


Difference between Speed and Velocity

	Speed	Velocity
1.	It is rate of change of position of an object.	It is rate of change of position of an object in a specific direction.
2.	Speed = $\frac{\text{distance}}{\text{time}}$	Velocity = $\frac{\text{displacement}}{\text{time}}$
3.	It is a scalar quantity.	It is a vector quantity.
4.	Speed will always be positive.	It will be positive or negative depending on the direction of motion.
5.	For moving body, it will never be zero.	It may be zero.

Example 6:

A body starts from A and moves according to given figure. Time for each interval is: $t_{AB} = 2\text{s}$, $t_{BC} = 3\text{s}$, $t_{CB} = 2\text{s}$, $t_{BA} = 3\text{s}$, $t_{AD} = 4\text{s}$. Find the distance, displacement, speed and velocity for each path.



Solution:

Path	Distance	Displacement	Speed	Velocity
AB	4m	4m	$4/2$ m/s	$4/2$ m/s
ABC	10m	10m	$10/5$ m/s	$10/5$ m/s
ABCB	16m	4m	$16/7$ m/s	$4/7$ m/s
ABCA	20m	0m	$20/10$ m/s	$0/10$ m/s
ABCAD	25m	-5m	$25/14$ m/s	$-5/14$ m/s

Example 7:

When the average speed of an object is equal to the magnitude of its average velocity? Give reason.

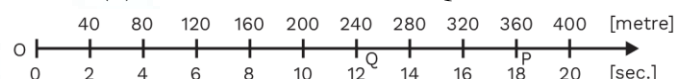
Solution: As average speed = $\frac{\text{Total distance}}{\text{Time}}$

$$\text{also, average velocity} = \frac{\text{Total displacement}}{\text{Total time}}$$

When an object moves along a straight line or in the same direction, its total path length is equal to the magnitude of its displacement. Hence, average speed is equal to the magnitude of its average velocity.

Example 8:

A car is moving along x-axis, as shown in figure. It moves from O to P in 18 s and returns from P to Q in 6 second. What is the average velocity and average speed of the car in going from (i) O to P and (ii) from O to P and back to Q?



Solution:

(i)

$$\text{Average velocity} = \frac{\text{Displacement}}{\text{time interval}} = \frac{360\text{m}}{18} = 20 \text{ ms}^{-1}$$

$$\text{Average speed} = \frac{\text{path length}}{\text{time interval}} = \frac{360\text{m}}{18} = 20 \text{ ms}^{-1}$$

(ii) From O to P and back to Q

$$\text{Average velocity} = \frac{\text{Displacement}}{\text{time interval}}$$

$$= \frac{OQ}{18+6} = \frac{240\text{m}}{24} = 10 \text{ ms}^{-1}$$

$$\text{Average speed} = \frac{\text{path length}}{\text{time interval}}$$

$$= \frac{OP + PQ}{18+6} = \frac{360+120}{24} = 20 \text{ ms}^{-1}$$

Example 9:

A car covers the 1st half of the distance between two places at a speed of 40 km h^{-1} and the 2nd half with 60 km h^{-1} . What is the average speed of the car?

Solution:

Suppose the total distance covered is $2S$.

Then time taken to cover the distance 'S' with speed 40 km/h ,

$$t_1 = \frac{S}{40} \text{ h}$$





Time taken to cover the next distance 'S' with speed 60 km/hr.

$$t_2 = \frac{S}{60} \text{ h}$$

$$V_{av} = \frac{\text{total distance}}{\text{total time}} = \frac{S+S}{\left(\frac{S}{40} + \frac{S}{60}\right)}$$

$$V_{av} = \frac{2S}{\left(\frac{3S+2S}{120}\right)} = \frac{2S}{5S} \times 120 \Rightarrow V_{av} = 48 \text{ km/h}$$

Example 10:

A non-stop bus goes from one station to another station with a speed of 54 km/h. The same bus returns from the second station to the first station with a speed of 36 km/h. Find the average speed of the bus for the entire journey.

Solution:

Suppose the distance between the stations is S. Time taken in reaching from one station to another station,

$$t_1 = \frac{S}{54} \text{ h}$$

Time taken in returning back,

$$t_2 = \frac{S}{36} \text{ h}$$

Total Time

$$t = t_1 + t_2 \quad ; \quad t = \frac{S}{54} + \frac{S}{36} = \frac{2S+3S}{108} = \frac{5S}{108} \text{ h}$$

$$\text{Average speed } V_{av} = \frac{\text{Total distance}}{\text{Total time}}$$

$$V_{av} = \frac{2S}{\frac{5S}{108}} \times 108 \Rightarrow V_{av} = \frac{216}{5} = 43.2 \text{ km/h}$$

FUNDAMENTAL UNLOCKED- (FU#2)

- Q.1** Can a body have a constant velocity but a varying speed?
- Q.2** Are the magnitudes of average velocity and average speed equal?
- Q.3** Under what condition is the average velocity equal to instantaneous velocity?
- Q.4** A body travels with a speed of v_1 from A to B and returns with a speed of v_2 from B to A. Derive an expression for the average speed of the body. What will be the average velocity of the body?

Q.5 Define the instantaneous speed.

Q.6 Light travels at a speed of $3 \times 10^8 \text{ m s}^{-1}$. How long does light take to reach the earth from the sun, which is $1.5 \times 10^{11} \text{ m}$ away?

Q.7 A train travels with a speed of 60 km h^{-1} from station A to station B and returns with a speed of 80 km h^{-1} from station B to station A. Find the average speed and average velocity.

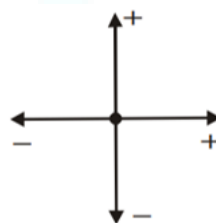
Acceleration and Equations of Motion

Acceleration

Mostly the velocity of a moving object changes either in magnitude or in direction or in both. The body is then said to have acceleration. So it is the rate of change of velocity i.e. change in velocity in unit time is said to be acceleration. It is a vector quantity.

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

$$a = \frac{v-u}{t} = \frac{\text{final velocity} - \text{initial velocity}}{\text{time}}$$



Sign convention for acceleration

- It is a vector quantity. Its direction is same as that of change in velocity and not of the velocity.
- It is NOT the rate of change of speed. For example, when a body moving with constant speed along a circular path, there is no change in its speed but there is a change in velocity as its direction is changing continuously at every point. Thus, there must be some acceleration of the body.
- A change in velocity occurs when (i) only its direction changes, e.g. uniform circular motion. (ii) only its magnitude changes. e.g. a ball dropped from a certain height under gravity (iii) both magnitude as well as direction changes, e.g. a projectile motion. In all these cases, there must be some acceleration present in the motion.





- Whenever velocity and acceleration are in same direction, the velocity of a particle increases. Such motion is called accelerated motion. Such an acceleration for numericals is usually taken 'positive acceleration'.
- Whenever velocity and acceleration are in opposite direction, the velocity of a particle decreases. Such motion is called retarded motion. Such an acceleration for numericals is usually taken 'negative acceleration' and also called 'retardation' or 'deceleration'.

Unit of Acceleration: C.G.S. System - centimetre/(second)² (cm/s²);
S.I. system - metre/(second)² (m/s²).

Uniform Acceleration (Uniformly Accelerated Motion): If a body travels in a straight line and its velocity increases in equal amounts in equal intervals of time. Its motion is known as uniformly accelerated motion.

Example:

- Motion of a freely falling body is an example of uniformly accelerated motion (or motion of a body under the gravitational pull of the earth)
- Motion of a bicycle going down the slope of a road when the rider is not pedaling and wind resistance is negligible

Non-Uniform Acceleration: If during motion of a body its velocity increases by unequal amounts in equal intervals of time, then its motion is known as non uniform accelerated motion.

Example:

- Car moving in a crowded street.
- Motion of a train leaving or entering the platform.

Types of Acceleration

Positive acceleration: If the velocity of an object increases with respect to time in the same direction, the object has a positive acceleration.

Negative acceleration (retardation): If the velocity of a body decreases with respect to time in the same direction, the body has a negative acceleration or it is said to be retarding.

Example: A train slows down, so its acceleration will be negative.

Equations of uniformly accelerated motion

There are three equations of uniformly accelerated motion. They show the relation between initial velocity u , final velocity v , acceleration a , time t and displacement s .

(I) 1st Equation of Motion: Consider a body moving with initial velocity u and its velocity changes from u to v in time t . Then

$$\text{acceleration} = \frac{\text{Final velocity} - \text{Initial velocity}}{\text{Time taken}}$$

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

$$\text{So } at = v - u \text{ and } v = u + at$$

(II) 2nd Equation Motion:

We know

Distance covered = (average velocity) \times (Time)

$$\text{or } S = \frac{u + v}{2} t$$

But $v = u + at$

Substituting the value of v in the equation above, we have

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

$$\text{or } s = \left(\frac{2u + at}{2} \right) t = \left(u + \frac{at}{2} \right) t$$

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

(III) 3rd Equation of motion:

We know that $v = u + at$

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

Distance travelled = (average velocity) \times (time)

$$S = \frac{v + u}{2} t$$

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





or $S = \frac{v^2 - u^2}{2a}$

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

(IV) Distance covered in n^{th} second

Distance travelled in n^{th} second = Distance travelled in n sec – Distance travelled in $(n-1)$ sec.

So, $S_{n^{\text{th}}} = S_n - S_{(n-1)} \dots\dots\dots(i)$

$$= \left(un + \frac{1}{2}an^2 \right) - \left[u(n-1) + \frac{1}{2}a(n-1)^2 \right]$$

We have, $S_{n^{\text{th}}} = u + \frac{a}{2}(2n-1)$

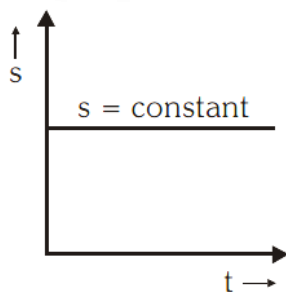
Graphs in Motion

Usually distance-time, displacement-time, speed-time, velocity-time, acceleration-time graphs are used in understanding motion.

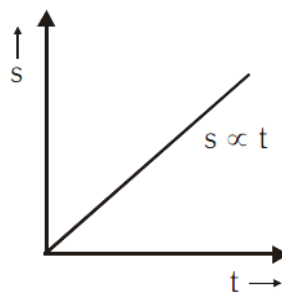
Distance-time Graph

Here, distance is taken on y-axis and time is taken on x-axis.

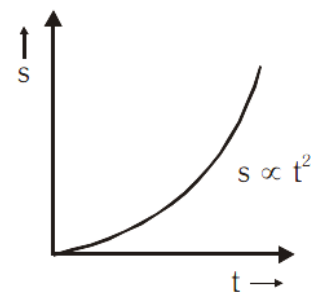
Distance-time graph is always positive, it is always increasing never decreasing.



A body at rest
($s = \text{constant}$)
($v = 0$)



A body in uniform motion
($s = v \times t$)

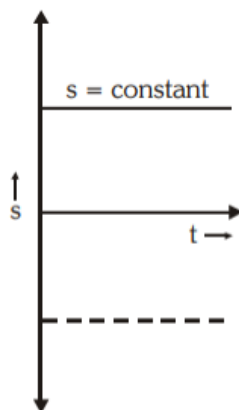


A body in uniformly accelerated motion
($s = ut + \frac{1}{2}at^2$)

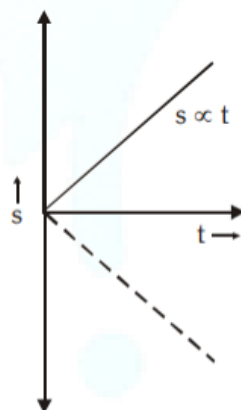
Displacement-time Graph

Here, displacement is taken on y-axis and time is taken on x-axis.

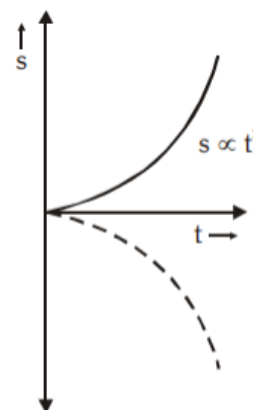
Displacement-time graph can be positive or negative, it can be increasing or decreasing.



A body at rest
($s = \text{constant}$)
($v = 0$)



A body in uniform motion
($s = v \times t$)



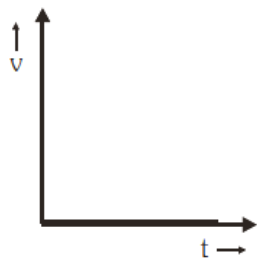
A body in uniformly accelerated motion
($s = ut + \frac{1}{2}at^2$)



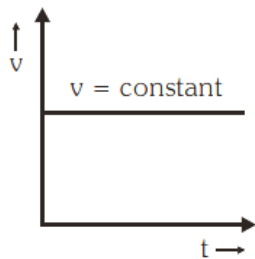


Speed-time Graph

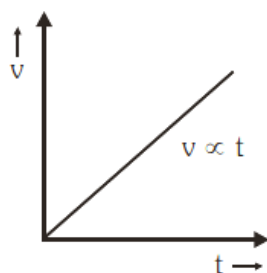
Here, speed is taken on y-axis and time is taken on x-axis. Speed-time graph is always positive, it can be increasing or decreasing.



A body at rest
($v = 0$)



A body in uniform motion
($v = \text{constant}$)

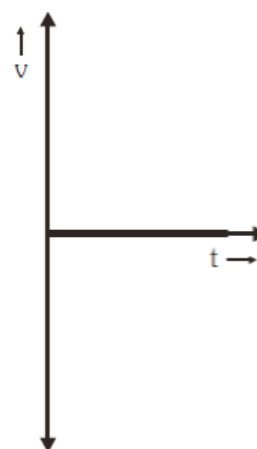


A body in uniformly accelerated motion
($v = u + at$)

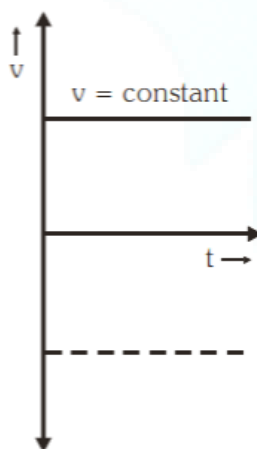
Velocity-time Graph

Here, velocity is taken on y-axis and time is taken on x-axis.

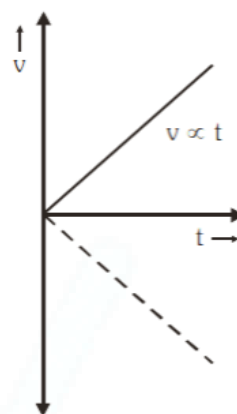
Velocity-time graph can be positive or negative, it can be increasing or decreasing.



A body at rest
($v = 0$)



A body in uniform motion
($v = \text{constant}$)

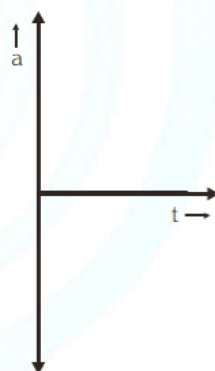


A body in uniformly accelerated motion
($v = u + at$)

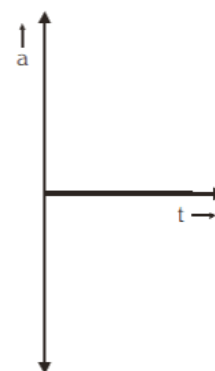
Acceleration-time Graph

Here, acceleration is taken on y-axis and time is taken on x-axis.

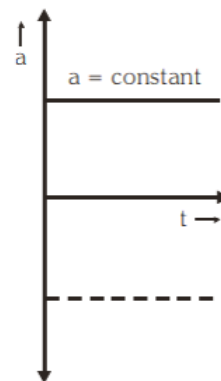
Acceleration-time graph can be positive or negative, it can be increasing or decreasing.



A body at rest
($a = 0$)



A body in uniform motion
($a = 0$)



A body in uniformly accelerated motion
($a = \text{constant}$)





Significance of Graphs in Motion

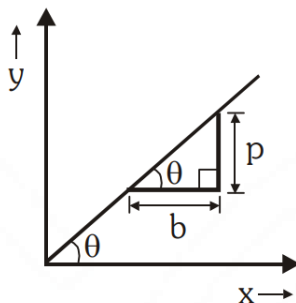
(I) Slope of a graph = $\tan \theta = \frac{\text{perpendicular}}{\text{base}} = \frac{p}{b}$ see

adjoining graph)

More the value of θ , more will be the value of slope.

Slope of a graph can be zero ($\theta = 0^\circ$), positive ($0^\circ < \theta < 90^\circ$), negative

($90^\circ < \theta < 180^\circ$) or even infinite ($\theta = 90^\circ$).

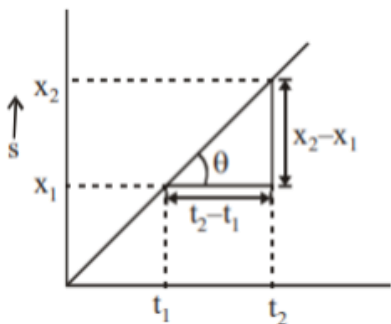
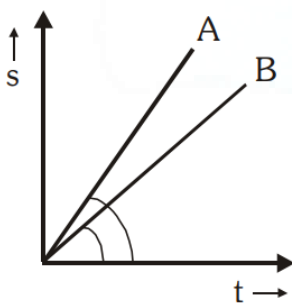


(II) Slope of distance-time graph gives speed.
Slope of displacement-time graph gives velocity.

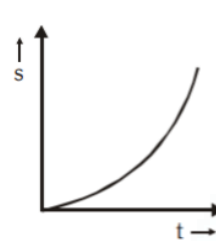
In the adjoining s-t graph, slope of A is more than slope of B, thus, $v_A > v_B$

From the s-t graph shown below, we can find the value of v.

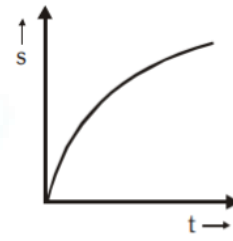
$$v = \frac{p}{b} = \frac{x_2 - x_1}{t_2 - t_1}$$



(III) In the following graphs, graph 1 represents accelerated motion i.e., v (i.e. slope) increasing with time. Graph 2 represents retarded motion i.e., v decreasing with time.



Graph 1
(v increasing with time)
accelerated motion



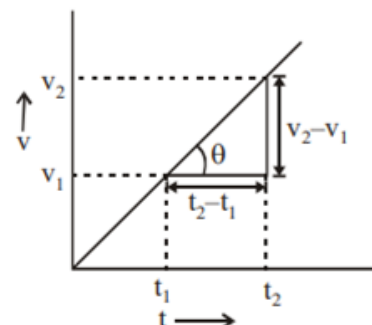
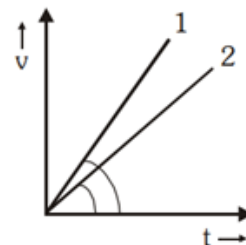
Graph 2
(v decreasing with time)
retarded motion

(IV) Slope of speed-time graph or velocity-time graph gives acceleration.

In the adjoining v-t graph, slope of 1 is more than slope of 2, thus, $a_1 > a_2$.

From the v-t graph shown below, we can find the value of a.

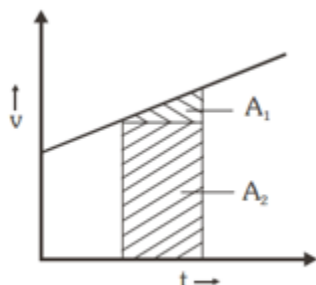
$$a = \frac{p}{b} = \frac{v_2 - v_1}{t_2 - t_1}$$



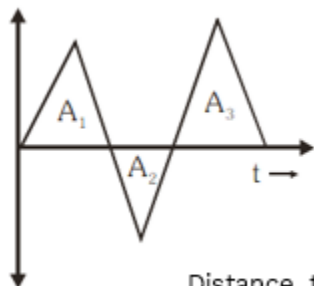
(V) Total area under the speed-time graph or velocity-time graph always gives total distance travelled by the body during a given time interval. We can also find displacement using a velocity-time graph which is as shown below:



The area under the acceleration-time graph gives change in velocity during a given time interval.



Distance travelled = $A_1 + A_2$

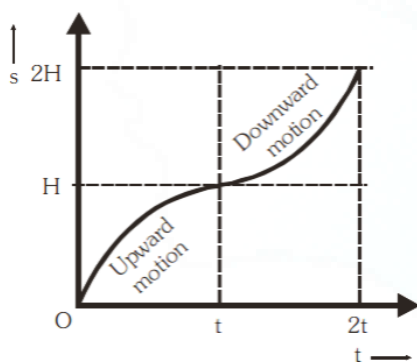


Distance travelled = $A_1 + A_2 + A_3$

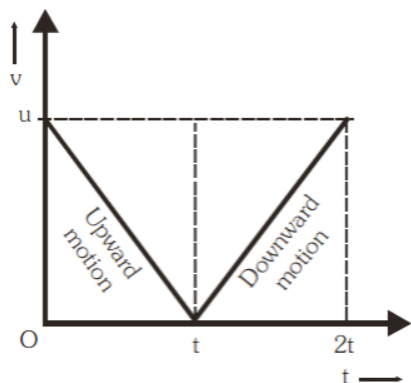
Displacement = $A_1 - A_2 + A_3$

Graphs of Motion Under Gravity

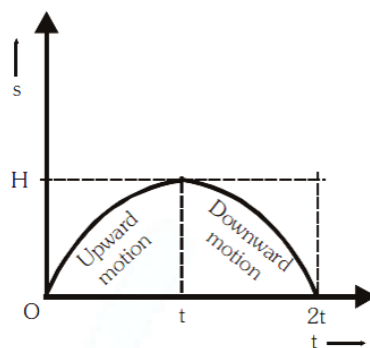
Upward motion of an object is a retarded motion, while downward motion is an accelerated motion.



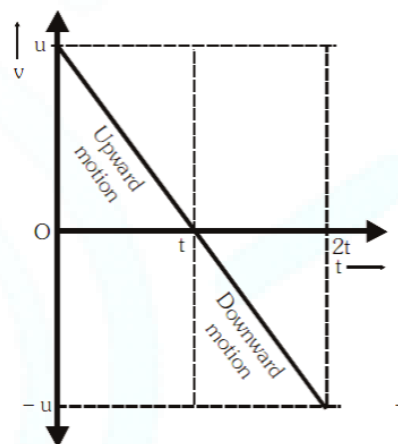
(a) Distance-time graph



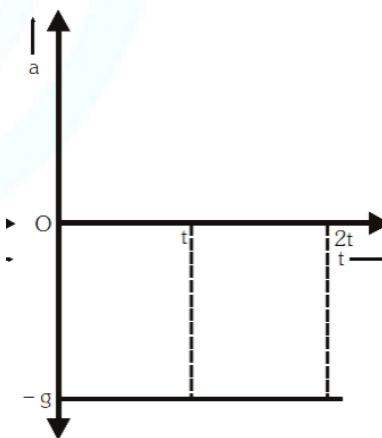
(b) Speed-time graph



(c) Displacement-time graph



(d) Velocity-time graph



(e) Acceleration-time graph

Graphical derivation of Equations of motion

(I) First Equation: $v = u + at$

It can be derived from $v - t$ graph, as shown in figure.

The slope of line PQ = acceleration

$$a = \frac{QR}{RP} = \frac{SP}{CO}$$

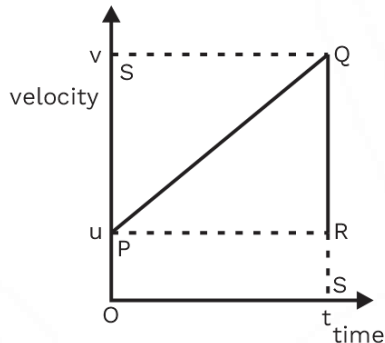


$$\therefore SP = v - u$$

$$\text{And } CO = t$$

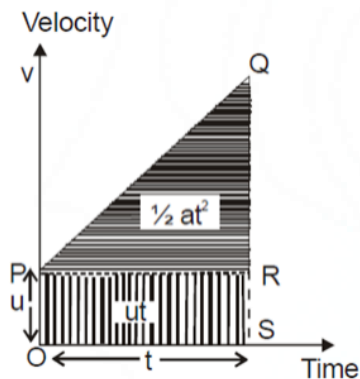
$$\text{So, } a = \frac{v - u}{t}$$

$$\text{or } v = u + at$$



(II) Second Equation: $s = ut + \frac{1}{2}at^2$

It can also be derived from $v - t$ graph as shown in figure.



From relation,

Distance covered = Area under $v - t$ graph

$S = \text{Area of trapezium OPQS}$

$= \text{Area of rectangle OPRS} + \text{Area of triangle PQR}$

$$= OP \times PR + \frac{RQ \times PR}{2} \quad \text{Putting values,}$$

$$s = u \times t + \frac{1}{2}(v - u) \times t \quad (\because RQ = v - u \text{ \& } PR = OS = t)$$

$$= u \times t + \frac{1}{2} at \times t \quad (\because v - u = at)$$

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

(III) Third Equation: $v^2 = u^2 + 2as$

From above graph

$$OP = u, SQ = v, OP + SQ = u + v$$

$$a = \frac{QR}{PR}$$

$$\text{Or } PR = \frac{QR}{a} = \frac{v - u}{a}$$

$s = \text{Area of trapezium}$

$$OPQS = \frac{OP + SQ}{2} \times PR$$

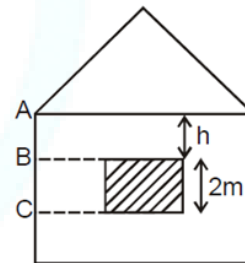
$$s = \frac{u + v}{2} \times \frac{v - u}{a} = \frac{v^2 - u^2}{2a} \quad \text{or } v^2 = u^2 + 2as$$

Example 11:

A stone drops from the edge of a roof. It passes a window 2 metre high in 0.1 second. How far is the roof above the top of the window?

Solution:

Let the distance between the top of the window and the roof be h . this problem can be solved in two stages.



- (a) For the journey across the window i.e., from B to C

Let, Velocity at B = u m/s

Distance travelled, $s = 2$ m

Time take, $t = 0.1$ s

Acceleration, $a = g = 9.8$ m/s²

Using the relationship,

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

$$2 = u \times 0.1 + \frac{1}{2} \times 9.8 \times (0.1)^2$$

$$2 = 0.1u + 4.9 \times 10^{-2}$$

$$\text{or } u = \frac{(2 - 0.049)}{0.1} = 19.51 \text{ m/s}$$

The velocity of the stone at the top of the window is 19.51 m/s.





- (b) For journey from roof to the top of the window i.e., from A to B

The velocity at the top of the window is the velocity of the stone at the end of falling through 'h'. So,

Initial velocity, $u = 0 \text{ m/s}$

Final velocity, $v = 19.51 \text{ m/s}$

Acceleration due to gravity, $g = 9.8 \text{ m/s}^2$

Then by using the equation, $v^2 - u^2 = 2gh$, one gets

$$(19.51)^2 - 0 = 2 \times 9.8 \times h$$

$$h = \frac{(19.51)^2}{19.6} \text{ m} = 19.42 \text{ m}$$

Thus, the roof is 19.42 m above from the upper end (top) of the window.

Example 12:

A ball is thrown vertically upwards with a velocity 'u'. Calculate the velocity with which it falls to the earth again.

Solution:

For a ball thrown vertically upwards,

Initial velocity = u, Final velocity = $v = 0$

For the vertically upward motion, the equation of motion is

$$v = u - gt$$

$$\text{So, } 0 = u - gt \text{ or } t = \frac{u}{g} \dots (i)$$

For the return journey, when the body falls vertically downwards, the equations of motion is

$$v = u + gt$$

Since, $u = 0$

$$\text{Hence } v = 0 + gt \text{ or } t = \frac{v}{g} \dots (ii)$$

From (i) and (ii),

Thus, the body falls back to the earth with the same velocity with which it was thrown vertically upwards.

Example 13:

A car is moving at a speed of 50 km/h after two seconds it is moving at 60 km/h. Calculate the acceleration of the car.

Solution: Here $u = 50 \text{ km/h} = 50 \times \frac{5}{18} \text{ m/s} = \frac{250}{18}$

$$\text{m/s and } v = 60 \text{ km/s} = 60 \times \frac{5}{18} = \frac{300}{18} \text{ m/s}$$

$$\text{Since } a = \frac{v - u}{t} = \frac{\frac{300}{18} - \frac{250}{18}}{2} = \frac{\frac{50}{18}}{2} = \frac{50}{36} = 1.39 \text{ m/s}^2$$

Example 14:

A car attains 54 km/h in 20 s after it starts. Find the acceleration of the car.

Solution:

$u = 0$ (as car starts from rest)

$$v = 54 \text{ km/h} = 54 \times \frac{5}{18} = 15 \text{ m/s}$$

$$\text{As, } a = \frac{v - u}{t} \therefore a = \frac{15 - 0}{20} = 0.75 \text{ m/s}^2$$

Example 15:

A ball is thrown vertically upwards with a velocity of 20 m/s. How high did the ball go? (Take $g = 9.8 \text{ m/s}^2$).

Solution:

$u = 20 \text{ m/s}$, $g = -9.8 \text{ m/s}^2$ (moving against gravity)

$s = ?$, $v = 0$ (at highest point)

$$v^2 - u^2 = 2gh$$

$$(0)^2 - (20)^2 = 2(-g)h$$

$$-400 = 2(-9.8)h \Rightarrow -400 = -19.6h$$

$$\frac{400}{19.6} = h \Rightarrow h = 20.4 \text{ m}$$

FUNDAMENTAL UNLOCKED- (FU#3)

- Q.1** Give an example of motion with acceleration $a = 0$ and velocity $v \neq 0$.
- Q.2** Is it possible to have velocity $v = 0$ and acceleration $a \neq 0$? If yes, give an example.
- Q.3** Define the term acceleration. Give its S.I. unit.
- Q.4** Derive the first equation of motion.
- Q.5** An object is thrown in upward direction with velocity u . Derive the expression for the maximum height attained by the object.
- Q.6** A body moving towards positive direction has an instantaneous velocity of 5 m s^{-1} and 3 seconds later it is 14 m s^{-1} . Find the acceleration of the body.



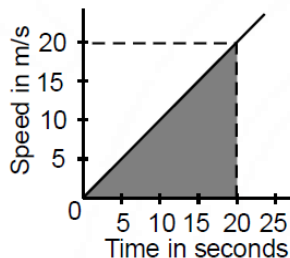


Q.7 A bullet moving with an initial velocity of 20 m s^{-1} , strikes a target and comes to rest after penetrating the target to a distance of 10 cm. Calculate the retardation caused by the target.

Q.8 A train starts from rest and accelerates uniformly at a rate of 2 m s^{-2} for 10 s. It then maintains a constant speed for 200 s. The brakes are then applied and the train is uniformly retarded and it comes to rest in 50 s. Find the maximum velocity reached.

Example 16:

Find the distance covered by a particle during the time interval $t = 0$ to $t = 20 \text{ s}$ for which the speed–time graph is shown in figure.



Solution:

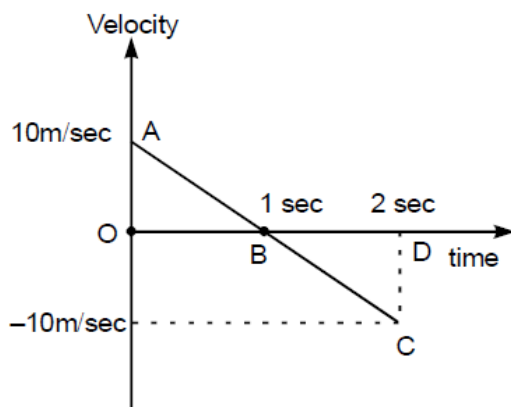
The distance covered in the time interval 0 to 20s is equal to the area of the shaded triangle. It is

$$\frac{1}{2} \times \text{Base} \times \text{Height}$$

$$= \frac{1}{2} \times (20\text{s}) \times (20\text{m/s}) = 200\text{m}$$

Example 17:

A ball is thrown vertically upwards with a velocity of 10 m/sec. It strikes the ground after 2 sec. Its velocity–time graph is as shown in figure below. Find the displacement of the ball in 2 second.



Solution:

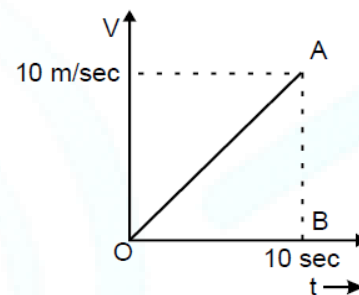
Displacement = Area under velocity–time curve along time axis = Area of triangle AOB + Area of triangle BDC

$$= \frac{1}{2} \times \text{OB} \times \text{AO} + \frac{1}{2} \times \text{BD} \times \text{CD} = \frac{1}{2} \times 10 \text{ sec} \times 10 \text{ m/sec} + \frac{1}{2} \times 1 \text{ sec} \times (-10 \text{ m/sec})$$

$$= 5\text{m} - 5\text{m} = 0\text{m}$$

Example 18:

Velocity–time curve for a body moving with constant acceleration is shown in the figure. Calculate the displacement of the body in 10 sec.



Solution:

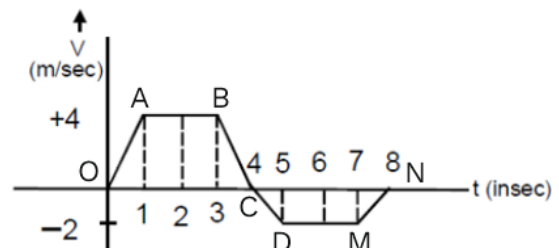
Displacement = Area under the velocity time curve along time axis = Area AOB

Now AOB is a triangle with base = 10 sec and height = 10 m/sec

$$\text{So Area} = \frac{1}{2} \times \text{Base} \times \text{Height}$$

$$= \frac{1}{2} \times 10 \text{ sec} \times 10 \text{ m/sec} = 5 \times 10 = 50\text{m}$$

Example 19: The velocity versus time graph of a linear motion is shown in figure. Find the distance from the origin in 8 second.



Solution: Distance in 8 second,

$$S = \text{Area of OABC} + \text{Area of CDMN}$$

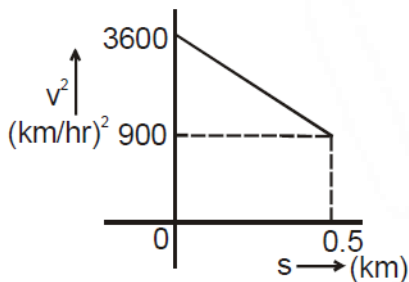
$$S = \frac{(2+4) \times 4}{2} + \frac{(2+4) \times 2}{2}$$

$$S = 18 \text{ m}$$



Example 20:

A graph between the square of the velocity of a particle and the distance is moved by the particle is shown in the figure. Find the acceleration of the particle in km/h^2 .

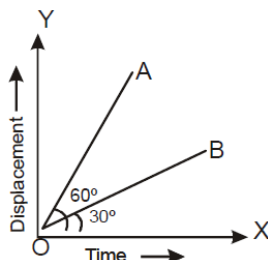


Solution: Given: $u^2 = 3600 \text{ (km/h)}^2$, $v^2 = 900 \text{ (km/h)}^2$, $s = 0.5 \text{ km}$. From III equation of motion,

$$v^2 = u^2 + 2as \Rightarrow a = \frac{v^2 - u^2}{2s} \Rightarrow a = \frac{(900) - (3600)}{2 \times 0.5} = -2700 \text{ km/h}^2$$

FUNDAMENTAL UNLOCKED- (FU#4)

- Q.1** If the displacement-time graph of a body is a straight line parallel to the time axis, what is the nature of motion of the body?
- Q.2** What does the slope of a displacement-time graph represent? Can displacement-time graph be parallel to the displacement axis? Give reason for your answer.
- Q.3** A ball starts from rest, rolls down an inclined plane and then moves on a horizontal ground. Neglecting friction, draw the v-t graph.
- Q.4** The position-time graph for two particles A and B is shown below. Line A and Line B are making angles 60° and 30° with the time axis. The ratio of velocities $v_A : v_B$ will be:



- Q.5** A ball is dropped from a height 'h' above the ground. It rebounds to a height $(h/2)$. Draw the v-t and s-t graph for the motion neglecting air resistance.

Free Fall (Motion Under Gravity)

Free fall is the motion of an object subject only to the influence of gravity. An object is in free fall as soon as it is dropped from rest, thrown downward or thrown upward.

Acceleration due to gravity: The constant acceleration of a freely falling body is called the acceleration

due to gravity. Its magnitude is denoted with the letter g. The value of g on the surface of Earth is nearly 9.8 m/s^2 .

Earth's gravity always pulls downward, so the acceleration (g) of an object in free fall is always downward and constant in magnitude, regardless of whether the object is moving up, down, or is at rest, and independent of its speed.

If the object is moving downward, the downward acceleration makes it speed up; if it is moving upward, the downward acceleration makes it slow down.

Equations of Motion of Freely Falling Body

There are two main assumptions in free fall:

- (i) Acceleration due to gravity (g) is constant throughout the motion and it acts vertically downwards.
- (ii) Air resistance is negligible.

For numericals, we can assume acceleration due to gravity as + g for downward while -g for upward motion.

Case I: An object thrown vertically upward and it returns after some time. Equations of motion are:

$$(I) v = u - gt \quad (II) h = ut - \frac{1}{2}gt^2$$

$$(III) v^2 = u^2 - 2gh$$

Time taken to reach maximum height:

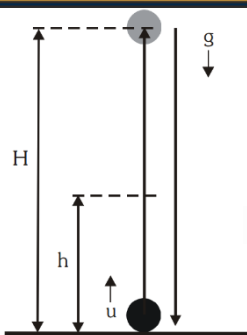
$$t = \frac{u}{g}$$

Total time of journey:

$$T = \frac{2u}{g}$$

Maximum height achieved by the object:

$$H = \frac{u^2}{2g}$$



The total distance covered, $s = 2H = 2\left(\frac{u^2}{2g}\right) = \frac{u^2}{g}$,

While, the total displacement is zero.

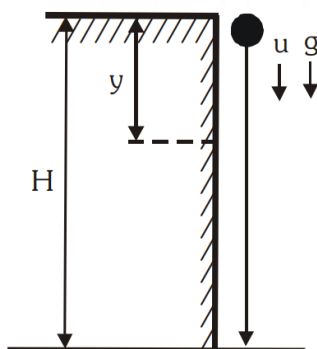
Case II : An object is thrown vertically downward from a certain height H.

Equations of motion are:

(I) $v = u + gt$

(II) $y = ut + \frac{1}{2}gt^2$

(III) $v^2 = u^2 + 2gy$



Velocity at ground: $v = \sqrt{u^2 + 2gH}$

Time taken to reach the ground: $H = ut + \frac{1}{2}gt^2$.

This is a quadratic equation that can be solved by factorisation or using quadratic formula.

If an object is dropped from certain height, its initial velocity is taken zero i.e., $u = 0$. In such case the equation. (i),(ii),(iii) will reduce to,

$$v = gt ; y = \frac{1}{2}gt^2 ; v^2 = 2gy$$

Velocity at ground: $v = \sqrt{2gH}$

Time taken to reach the ground: $t = \sqrt{\frac{2H}{g}}$.

Case III: An object thrown up from a certain height H or dropped from a rising balloon/helicopter. The initial velocity of a body dropped from a moving object is equal to the velocity of the moving object. Equation of motion are:

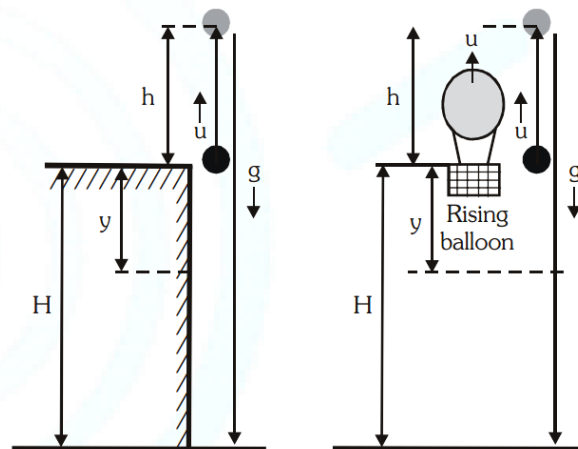
(i) $v = u - gt$

If v comes positive, it means that object is moving upwards. If v comes negative, it means that object is moving downwards.

(ii) $y = ut - \frac{1}{2}gt^2$

If y comes positive, it means that object is above the initial point. If y comes negative, it means that object is below the initial point.

(iii) $v^2 = u^2 - 2gy$



Velocity at ground: $v = \sqrt{u^2 + 2gH}$

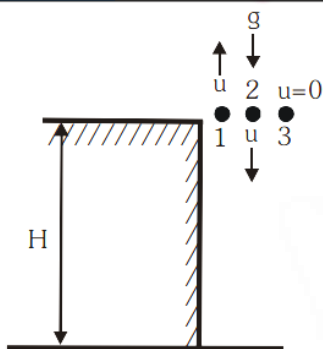
Time taken to reach the ground: $H = -ut + \frac{1}{2}gt^2$.

This is a quadratic equation that can be solved by factorisation or using quadratic formula.

Let three balls 1, 2, and 3 are allowed to fall under gravity from the

same height. Ball 1 is thrown vertically upward with speed u and it reaches the ground in time t_1 . Ball 2 is thrown vertically downward with the same speed u and it reaches the ground in time t_2 . Ball 3 is dropped (i.e., $u = 0$) from the same height and it reaches ground in time t_3 . Then, the relationship between t_1 , t_2 and t_3 is given by,

$$t_3 = \sqrt{t_1 t_2}$$

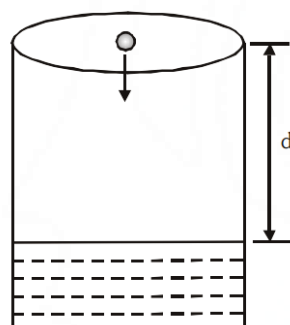


An object is dropped in a well of depth 'd' and the sound of splash in water is heard after a certain time T.

Downward motion of object: $t_1 = \sqrt{\frac{2d}{g}}$

Upward motion of sound: $t_2 = \frac{d}{v}$

$$T = t_1 + t_2 = \sqrt{\frac{2d}{g}} + \frac{d}{v}$$



Sign Conventions

- (i) g is taken as positive when it is acting in the same direction as that of motion and g is taken as negative when it is opposing the motion.
- (ii) Displacement measured upward from the point of projection is taken as positive, while displacement measured downward from the point of projection is taken as negative.
- (iii) Velocity measured away from the surface of earth (i.e. in upward direction) is taken as positive, while velocity measured towards the surface of the earth is taken as negative.

To solve numerical problems

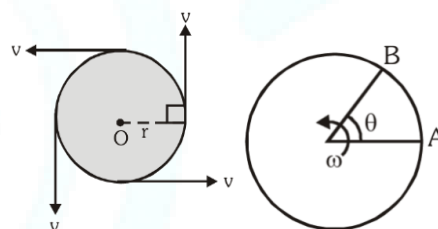
- (i) If a body is dropped from a height then its initial velocity $u = 0$ but has acceleration (acting). If a body starts from rest its initial velocity $u = 0$.

- (ii) If a body comes to rest, its final velocity $v = 0$ or, if a body reaches the highest point after being thrown upwards its final velocity $v = 0$ but has acceleration (acting).
- (iii) If a body moves with uniform velocity, its acceleration is zero i.e. $a = 0$.
- (iv) Motion of a body is called free fall if only force acting on it is gravity (i.e. earth's attraction).

Circular Motion

When a particle moves along a circular path, its motion is called circular motion. A circular motion is always a non-uniform motion i.e., accelerated motion because the direction of velocity changes continuously.

Velocity of a particle in circular motion is always tangential to the circular path i.e., velocity and radius are always \perp to each other.



Angular displacement (θ) : The angle described by particle moving along a circular path is called **angular displacement**.

S.I. unit of angular displacement is **radian**.

$$p \text{ radian} = 180^\circ, 1 \text{ radian} = 180^\circ/\pi = 57.3^\circ$$

You can use a formula to find radian from degrees or

$$\text{vice-versa which is given by, } \frac{R}{\pi} = \frac{D}{180}$$

Where, R is angle in radian, D is angle in degrees.

Angular velocity (ω): The rate of change of angular displacement is called angular velocity.

$$\omega = \frac{\theta}{t}$$

S.I. unit of ω : radian per second or rad s^{-1} .

Relation between angular velocity and linear speed: $v = r\omega$ (r = radius of circular path)

Angular acceleration (α): The rate of change of angular velocity is called angular acceleration.



$$\alpha = \frac{\omega_2 - \omega_1}{t}$$

S.I. unit of α : radian/(second)² or rad s⁻².

Relation between angular acceleration & linear (tangential) acceleration: $a_t = r\alpha$

Uniform circular motion: Motion of a particle along the circumference of a circle with a constant speed is called uniform circular motion.

In uniform circular motion, linear speed, v = constant; angular velocity, ω = constant;

angular acceleration, $\alpha = 0$.

Here, linear speed can also be found by formula,

$$v = \frac{2\pi r}{T} \quad (T = \text{time period of 1 revolution})$$

Also, angular velocity ω can be found using formula,

$$\omega = \frac{2\pi}{T}$$

If a particle is making N revolutions per minute (denoted as rpm), angular speed, $\omega = \frac{2\pi N}{60}$

Centripetal Acceleration - Uniform circular motion is always an accelerated motion. It has a radially inward acceleration called centripetal acceleration.

Formula for centripetal acceleration: $a_c = \frac{v^2}{r} = r\omega^2$

Centripetal acceleration (a_c) and velocity (v) are always perpendicular to each other.

Centripetal force

It is the radially inward force that is required to move an object along a circular path.

Formula for centripetal force:

$$F = ma_c = \frac{mv^2}{r} = mr\omega^2$$

Centripetal force is always supplied by a real force, the nature of which depends on the situation. While turning a motorcycle on a horizontal circular path, friction provides the necessary centripetal force. The electron moves in a circle around nucleus due to centripetal force provided by the electrostatic force of attraction between positive nucleus and negative electron. While whirling a stone tied with a string, the tension in the string provides the centripetal force. Earth revolves round the Sun due to the centripetal force provided by the gravitational force between the Earth and the Sun.

Example 21:

A fly wheel is making 120 revolutions/minute. Find the angular speed of the wheel.

Solution:

120 revolutions/ minute = 2 rev/s

Angular speed

$$= \frac{\text{angle in one revolution} \times \text{number of revolutions}}{t}$$

$$= 2\pi \times 2 = 4\pi \text{ rad/s}$$

Example 22:

A particle is moving with constant speed in a circular path. Find the ratio of average velocity to its instantaneous velocity when the particle describes an angle $\theta = \frac{\pi}{2}$.

Solution:

$$\theta, t = \frac{\theta}{\omega} = \frac{\theta R}{v} = \frac{\pi R}{2v}$$

$$\text{Average velocity} = \frac{\text{Total Displacement}}{\text{Total time}}$$

$$= \frac{\sqrt{2}R}{\pi R / 2v} = \frac{2\sqrt{2}}{\pi} v$$

Instantaneous velocity = v

The ratio of average velocity to its instantaneous velocity = $\frac{2\sqrt{2}}{\pi}$

Example 23:

Find the time period of meeting of minute hand and second hand of a clock.

Solution:

$$\omega_{\min} = \frac{2\pi}{60} \text{ rad/min}, \omega_{\sec} = \frac{2\pi}{1} \text{ rad/min}$$

$\theta_{\sec} - \theta_{\min} = 2\pi$ (for second and minute hand to meet again) $(\omega_{\sec} - \omega_{\min}) t = 2\pi$

$$2\pi(1 - 1/60) t = 2\pi \Rightarrow t = \frac{60}{59} \text{ min}$$

FUNDAMENTAL UNLOCKED- (FU#5)

- Q.1** Two bodies in circular paths of radii 1 : 3 take same time to complete their circles. Find the ratio of their linear speeds.
- Q.2** The wheel of a cycle of radius 25 cm is moving with a speed 20 ms⁻¹. Calculate the angular velocity of the wheel.
- Q.3** An aircraft completes a horizontal loop of radius 2 km with a uniform speed of 600 km h⁻¹. Find the angular velocity of the aircraft.





ANSWER KEY

FUNDAMENTAL UNLOCKED- (FU#1)

Q.1 Total distance covered = $2h$

Q.4 Displacement = 0

$$\text{Distance} = 2 \times 3.14 \times R$$

Q.5 $10\sqrt{2} \text{ m}$

Q.6 $\approx 22.4 \text{ m}$

Q.7 Displacement = 4 meter

FUNDAMENTAL UNLOCKED- (FU#2)

Q.4 Average velocity $V_{\text{avg.}} = \frac{2V_1V_2}{V_1 + V_2}$

Q.6 $t = 0.5 \times 10^3 \text{ sec.}$

Q.7 Avg. speed and Avg. velocity = $\frac{480}{7} \text{ km/h}$

FUNDAMENTAL UNLOCKED- (FU#3)

Q.6 $a = 3 \text{ m/s}^2$

Q.7 Retardation = 2000 m/s^2

Q.8 Maximum velocity = 17.69 m/s.

FUNDAMENTAL UNLOCKED- (FU#4)

Q.4 Ratio $V_A : V_B = 1 : 3$

FUNDAMENTAL UNLOCKED- (FU#5)

Q.1 The ratio of the linear speeds of the two bodies is $1 : 3$.

Q.2 Angular velocity = 80 rad/s

Q.3 Angular velocity = $\frac{1}{1200} \text{ rad/s}$





EXERCISE - I

Single Correct Type Questions

1. A body is said to be in motion if
 - (A) Its position with respect to surrounding objects remains same
 - (B) Its position with respect to surrounding objects keeps on changing
 - (C) Both (A) and (B)
 - (D) Neither (A) nor (B)
2. Distance is always
 - (A) shortest length between two points
 - (B) path covered by an object between two points
 - (C) product of length and time
 - (D) none of the above
3. Displacement
 - (A) is always positive
 - (B) is always negative
 - (C) may be positive as well as negative
 - (D) is neither positive nor negative
4. Which of the following is not a characteristic of displacement?
 - (A) Its magnitude is greater than or equal to the actual path length of the object.
 - (B) It has both magnitude and direction.
 - (C) It can be zero.
 - (D) None of these
5. S.I. unit of displacement is
 - (A) m
 - (B) ms^{-1}
 - (C) ms^{-2}
 - (D) none of these
6. In five minutes, distance between a pole and a car changes progressively. What is true about the car?
 - (A) Car is at rest
 - (B) Car is in motion
 - (C) Nothing can be said with this information
 - (D) None of the above
7. The rate of change of displacement is
 - (A) Speed
 - (B) Velocity
 - (C) Acceleration
 - (D) Retardation
8. Speed is never
 - (A) Zero
 - (B) Fraction
 - (C) Negative
 - (D) Positive
9. The motion of a body covering different distances in same intervals of time is said to be
 - (A) Zig-Zag
 - (B) Fast
 - (C) Slow
 - (D) Variable
10. Metre per second is not the unit of
 - (A) Displacement
 - (B) Velocity
 - (C) Speed
 - (D) None of them
11. In 10 minute, a car with speed of 60 kmh^{-1} travels a distance of
 - (A) 6 km
 - (B) 600 km
 - (C) 10 km
 - (D) 7 km
12. A particle covers equal distances in equal intervals of time, it is said to be moving with uniform
 - (A) Speed
 - (B) Velocity
 - (C) Acceleration
 - (D) Retardation
13. The SI unit of the average velocity is
 - (A) m/s
 - (B) km/s
 - (C) cm/s
 - (D) mm/s
14. S.I. Unit of speed is
 - (A) km h^{-1}
 - (B) cm s^{-1}
 - (C) h km^{-1}
 - (D) m s^{-1}
15. Average speed of a car is given as 50 km/h . In S.I. units, it can be expressed as
 - (A) 13.9 m/s
 - (B) 5 m/s
 - (C) 50 m/s
 - (D) 139 m/s
16. The value on converting km/h into m/s is
 - (A) 5/18
 - (B) 5/36
 - (C) 5/54
 - (D) 5/324



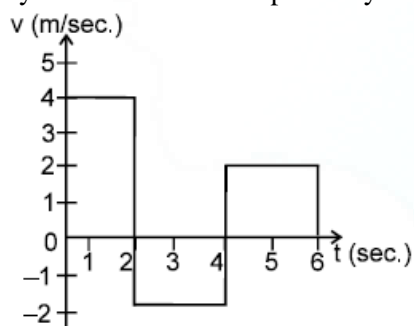
17. The brakes applied to a car produce a negative acceleration of 6 ms^{-2} . If the car stops after 2 seconds, the initial velocity of the car is
 (A) 6 ms^{-1} (B) 12 ms^{-1}
 (C) 24 ms^{-1} (D) Zero

18. A body is moving along a straight line at 20 ms^{-1} undergoes an acceleration of 4 ms^{-2} . After 2 s, its speed will be
 (A) 8 ms^{-1} (B) 12 ms^{-1}
 (C) 16 ms^{-1} (D) 28 ms^{-1}

19. A car increases its speed from 20 km h^{-1} to 50 km h^{-1} in 10 s. Its acceleration is
 (A) 30 ms^{-2} (B) 3 ms^{-1}
 (C) 18 ms^{-2} (D) 0.83 ms^{-2}

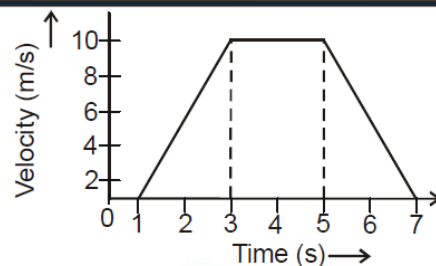
20. A body freely falling from rest has a velocity V after it falls through a height h . The distance it has to fall further for its velocity to become double is
 (A) $3h$ (B) $6h$ (C) $8h$ (D) $10h$

21. The velocity-time graph of a body moving in a straight line is shown in figure. The displacement and distance travelled by the body in 6 seconds are respectively



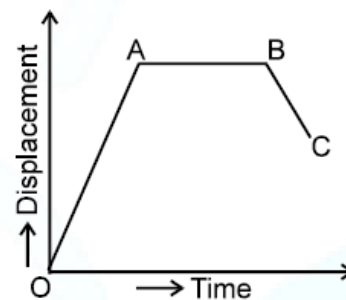
- (A) 8 m, 16 m (B) 16 m, 8 m
 (C) 16 m, 16 m (D) 8 m, 8 m

22. For the velocity-time graph shown in figure, what fraction is the distance covered by the body in the last two seconds of the total distance covered in all the seven seconds?



- (A) $1/2$ (B) $1/4$ (C) $1/3$ (D) $2/3$

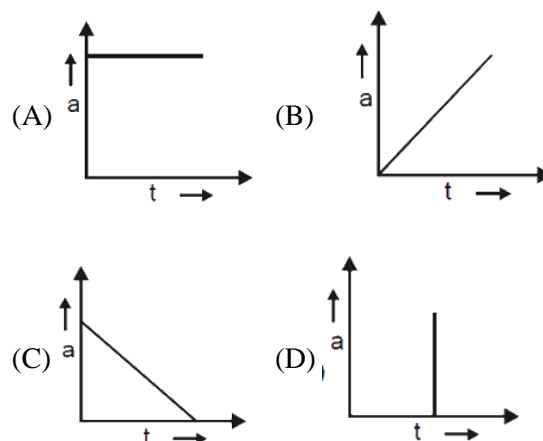
23. In figure, BC represents a body moving



- (A) Backward with uniform velocity
 (B) Forward with uniform velocity
 (C) Backward with non-uniform velocity
 (D) Forward with non-uniform velocity

24. Area of acceleration-time graph gives
 (A) Rate of change of velocity with the time
 (B) Rate of change of acceleration with time
 (C) Change in velocity
 (D) Change in acceleration

25. Which of the acceleration - time graph is not possible?



**Very Short Answer Type Questions**

1. An athlete completes one round of a circular track of diameter 200 m in 40 s. What will be the distance covered and the displacement at the end of 2 minutes 20 s?
2. Joseph jogs from one end A to the other end B of a straight 300 m road in 2 minutes 30 seconds and then turns around and jogs 100 m back to point C in another 1 minute. What are Joseph's average speeds and velocities in jogging (a) from A to B and (b) from A to C?
3. Nayan, while driving to school, computes the average speed for his trip to be 20 km h^{-1} . On his return trip along the same route, there is less traffic and the average speed is 30 km h^{-1} . What is the average speed for Nayan's trip?
4. What is the value of distance and displacement when body travel in the straight-line path?
5. Is absolute rest possible or not?
6. An object moves in circular path of radius r . Find the distance and displacement for two complete revolutions.
7. Can a body have a constant velocity but a varying speed?
8. Define the term acceleration. Give its S.I. unit.
9. Write differences between speed and velocity.
10. A train covers 80 km in 2 hours. Find its average speed in kmh^{-1} , m min^{-1} and ms^{-1} .

Short Answer Type Questions

1. A motorboat starting from rest on a lake accelerates in a straight line at a constant rate of 3.0 m s^{-2} for 8.0 s. How far does the boat travel during this time?
2. A driver of a car travelling at 52 km h^{-1} applies the brakes and accelerates uniformly in the opposite direction. The car stops in 5 s. Another driver going at 3 km h^{-1} in another car applies his brakes slowly and stops in 10 s. On

the same graph paper, plot the speed versus time graphs for the two cars. Which of the two cars travelled farther after the brakes were applied?

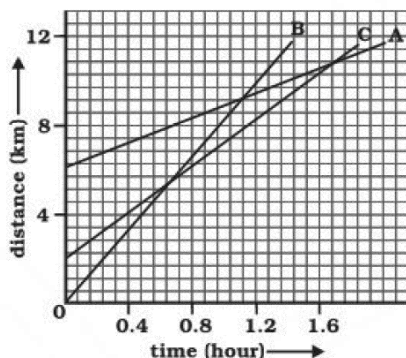
3. A stone is thrown vertically upwards and after ascending a height 'h' it comes back to the hands of the thrower. What is the total distance covered?
4. A body travels with a speed of v_1 from A to B and returns with a speed of v_2 from B to A. Derive an expression for the average speed of the body. What will be the average velocity of the body?
5. The speed of a magnetic audio tape is 4.5 cm/s . Find the length of the tape in a 60 minute cassette.
6. An object is thrown in upward direction with velocity u . Derive the expression for the maximum height attained by the object.
7. If the displacement-time graph of a body is a straight line parallel to the time axis, what is the nature of motion of the body?
8. Draw v - t graphs in the following cases: (a) uniform retardation (b) non uniform acceleration.
9. A stone is thrown vertically upward which takes time 't' to reach the maximum height 'h'. After next 't' seconds it reaches the ground from the maximum height. Draw (i) distance-time graph and (ii) displacement time graph for the motion of the stone.
10. A car travels from Bangalore to Mysore on a road that is 150 km long. If half the distance is covered at a speed of 60 km/h and the rest at 80 km/h . Find the average speed of the car.

Long Answer Type Questions

1. The given figure shows the distance-time graph of three objects A, B and C. Study the graph and answer the following questions:



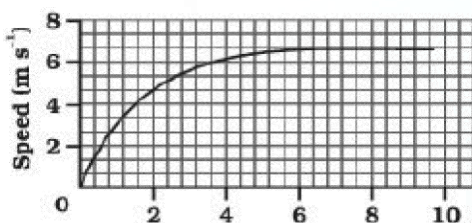
- Which of the three is travelling the fastest?
- Are all three ever at the same point on the road?
- How far has C travelled when B passes A?
- How far has B travelled by the time it passes C?



- A ball is gently dropped from a height of 20 m. If its velocity increases uniformly at the rate of 10 m s^{-2} , with what velocity will it strike the ground? After what time will it strike the ground?

- The speed-time graph for a car is shown in figure.

- Find how far the car travels in the first 4 seconds. Shade the area on the graph that represents the distance travelled by the car during the period.
- Which part of the graph represents uniform motion of the car?

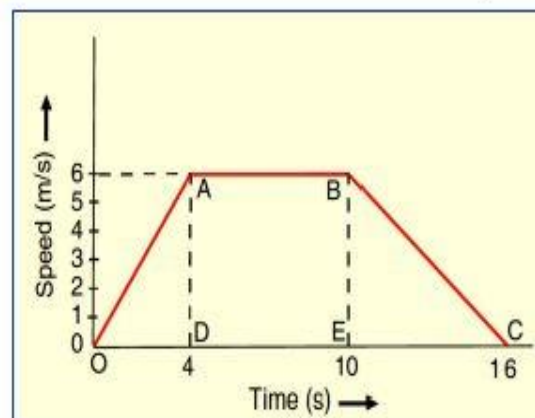


- State which of the following situations are possible and give an example for each of these:
 - an object with a constant acceleration but with zero velocity
 - an object moving in a certain direction with an acceleration in the perpendicular direction.
- An artificial satellite is moving in a circular orbit of radius 42250 km. Calculate its speed if it takes 24 hours to revolve around the earth.

- A particle moves along a straight line AB with constant acceleration. Its velocities are u and v at A and B, respectively. Show that its velocity at the mid-point of AB is .
- A boy standing near the edge of a cliff 125 m above a river throws a stone downward with a speed of 10 m/s. Find:
 - With what speed will the stone hit water?
 - How long will it take to descend?
- A stone is dropped from the top of a building 200 m high and at the same time another stone is projected vertically upward from the ground with a velocity of 50 ms^{-1} . Find where and when the two stones will meet.

Case Based Question

- Aditya started driving his car. He increases the speed till 4 seconds and then he kept his car in constant speed for 6 seconds. Then after he decreased the speed of the car upto another 6 seconds. After reaching at the starting place, he draws the speed-time graph of his 16 seconds driving as shown below:



- What type of motion is represented by OA?
- What type of motion is represented by BC?
- Find out the acceleration of the body in graph.
- Calculate the retardation of the body in graph.
- Find out the distance travelled by the body from A to B.



2. One day Rahul decided to go his office by his car. He is enjoying the driving along with listening the old songs. His car is moving along a straight road at a steady speed. On a particular moment, he notices that the car travels 150 m in 5 seconds.

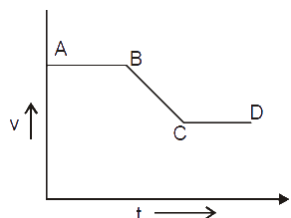


- (I) What is its average speed?
- (II) How far does it travel in 1 second?
- (III) How far does it travel in 6 seconds?
- (IV) How long does it take to travel 240 m?




EXERCISE - II
HOTS

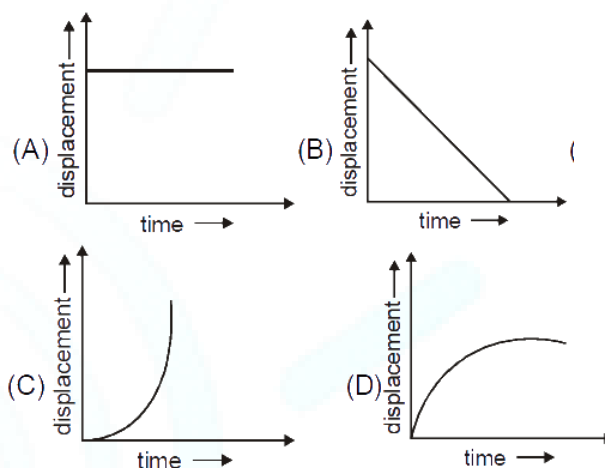
- A particle moves with a uniform velocity then
(A) The particle must be at rest.
(B) The particle moves along a curved path.
(C) The particle moves along a circle.
(D) The particle moves along a straight line.
- A quantity has value of -6.0 ms^{-1} . It may be the
(A) Speed of a particle
(B) Velocity of a particle
(C) Position of a particle
(D) Displacement of a particle
- The velocity of a bullet is reduced from 200 m/s to 100 m/s while travelling through a wooden block of thickness 10 cm. The retardation, assuming it to be uniform, will be
(A) $10 \times 10^4 \text{ m/s}^2$ (B) $1.2 \times 10^4 \text{ m/s}^2$
(C) $13.5 \times 10^4 \text{ m/s}^2$ (D) $15 \times 10^4 \text{ m/s}^2$
- A body starts falling from height 'h' and travels distance $h/2$ during the last second of motion. The time of travel (in sec.) is
(A) $\sqrt{2} - 1$ (B) $2 + \sqrt{2}$
(C) $\sqrt{2} + \sqrt{3}$ (D) $\sqrt{3} + 2$
- A stone is dropped from the top of a tower. Its velocity after it has fallen 20 m is
[Take $g = 10 \text{ ms}^{-2}$]
(A) 5 m s^{-1} (B) 10 m s^{-1}
(C) 15 m s^{-1} (D) 20 m s^{-1}
- An object undergoes an acceleration of 8 ms^{-2} starting from rest. Distance travelled in 1 sec is
(A) 2 m (B) 4 m (C) 6 m (D) 8 m
- Velocity - time graph shows that the body has constant velocity for part



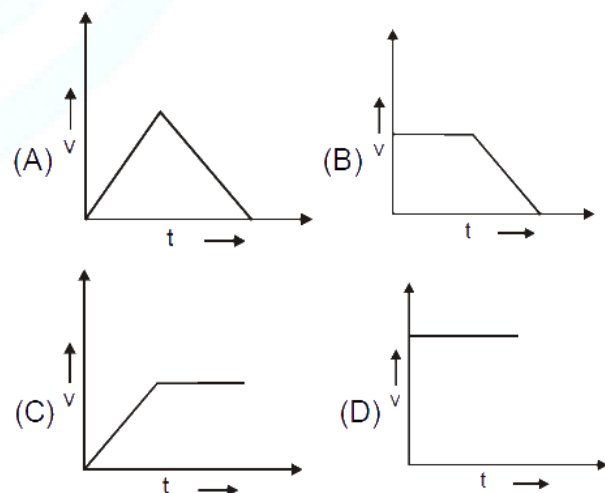
- (A) AB (B) BC
(C) CD (D) Both (A) and (C)

- In the above question acceleration is non-zero for which part of the graph?
(A) AB (B) BC
(C) CD (D) Both (A) and (C)

- Which of the figure corresponds to a case when body is moving with uniform velocity?



- Which of the figure corresponds to a case when body travels for a certain time with uniform acceleration and then with a uniform velocity for the rest of the time?



- A particle moving in a straight line covers half the distance with speed 3 m/s and the other half of the distance is covered in two equal time intervals with speed of 4.5 m/s and 7.5 m/s respectively. Then the average speed of particle during this motion is
(A) 4 m/s (B) 4.5 m/s (C) 5 m/s (D) 5.5 m/s





12. Particle has initial velocity 9 ms^{-1} due east and constant acceleration of 2 ms^{-2} due west. If the distance covered by it in fifth second of its motion

is $\frac{n}{10} \text{ m}$, then the value of 'n' is

- (A) 5 (B) 10 (C) 15 (D) 20

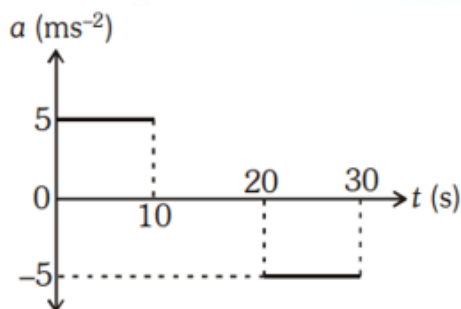
13. A car starts from rest and moves with constant acceleration. Then the ratio of the distance covered by it in the n^{th} second to that covered in n seconds is:

- (A) $\frac{2}{n^2} - \frac{1}{n}$ (B) $\frac{2}{n^2} + \frac{1}{n}$
(C) $\frac{2}{n} - \frac{1}{n^2}$ (D) $\frac{2}{n} + \frac{1}{n^2}$

14. A body A starts from rest with an acceleration a_1 . After 2s, another body B starts from rest with an acceleration a_2 . If they travel equal distances in 5th second after start of motion of A, the ratio of $a_1:a_2$ is:

- (A) 5:9 (B) 9:5 (C) 5:7 (D) 7:5

15. The acceleration of a cart started at $t = 0$, varies with time as shown in figure. The car starts from rest. Then the distance travelled by cart in 30 seconds is:



- (A) 100m (B) 1000m
(C) 1500m (D) 3000m

Assertion and Reason

In each of the following questions, a statement of Assertion is given and a corresponding statement of Reason is given just below it. Of the statements, given below, mark the correct answer as:

- (A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.
(C) Assertion is true but reason is false.
(D) Both Assertion and Reason are false.

1. **Assertion:** An object may acquire acceleration even if it is moving at a constant speed.

Reason: With change in the direction of motion, an object can acquire acceleration.

2. **Assertion:** The speedometer of a car measures the instantaneous speed of the car.

Reason: Average speed is equal to the total distance covered by an object divided by the total time taken.

3. **Assertion:** Displacement of an object may be zero even if the distance covered by it is not zero.

Reason: Displacement is the shortest distance between the initial and final position.

4. **Assertion:** The graph between two physical quantities P and Q is straight line, when P/Q is constant.

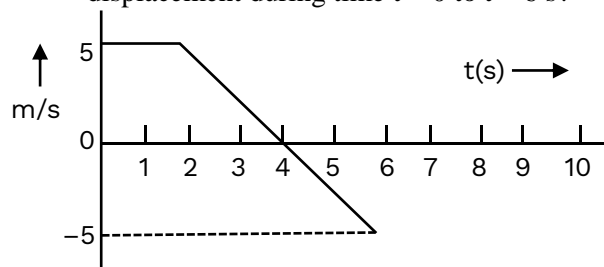
Reason: The straight line graph means that P is proportional to Q or P is equal to constant multiplied by Q.

5. **Assertion:** Velocity versus time graph of a particle in uniform motion along a straight path is a line parallel to the time axis.

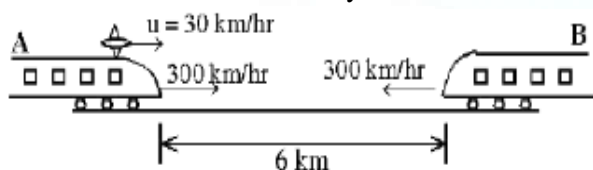
Reason: In uniform motion the velocity of a particle increases as the square of the time elapsed.

Numerical Type Questions

1. A velocity-time graph for a moving object is shown below. What would be the total displacement during time $t = 0$ to $t = 6 \text{ s}$?



2. A bullet of mass 10 g traveling horizontally with a velocity of 160 ms^{-1} strikes a stationary wooden block and comes to rest in 0.02 s. What is the distance of penetration of the bullet into the block will be ?
3. A ball hits a wall horizontally with a velocity of 6.0 ms^{-1} . After hitting wall it rebounds horizontally with a velocity of 4.4 ms^{-1} . If the ball remains in the contact of wall for 0.040 sec, what is the acceleration of ball ?
4. A girl swims in a swimming pool of length 100 m. She swims from one end to another end and reaches the starting point again in 2 minutes. What is average velocity of the swimmer ?
5. A car travels from one town to the other with average speed 20 km/hr. If the first half is travelled at average speed 30 km/hr, then what is the average speed of the car in the other half?
6. A bird is sitting on train A moving towards East with a velocity 300 km/hr. Another train B of same speed is moving in West direction on the same track. When the trains are 6 km apart, the bird starts flying with a velocity 30 km/hr with respect to ground towards B. After touching B, it returns back to A and continue repeating this process until the trains collide. In this process, the total distance travelled by the bird is



7. A person takes time 't' to go once around a circular path of diameter 2R. What would be speed (v) of this person?
8. A body covers half the distance with a speed of 20 m/s and the other half with 30 m/s. What is the average speed of the body during the whole journey?

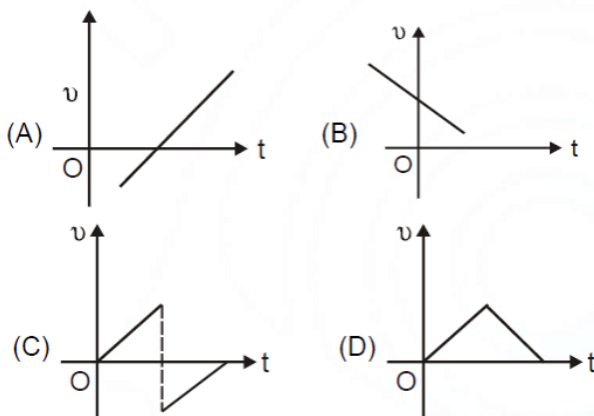
9. A boy running at an average speed of 4 km h^{-1} reaches school from his home in $\frac{1}{2}$ hour. What is the distance of the school from his home?
10. An object is moving with a velocity of 2 m s^{-1} . Its velocity changes at a uniform rate to 5 m s^{-1} . What is the average velocity of the object?
11. A marble rolling on a smooth floor has an initial velocity of 0.4 m/s. If the floor offers a retardation of 0.02 m/s^2 , calculate the time it will take to come to rest.
12. A car starts with velocity 10 m/s and accelerates at rate 5 m/s^2 . Find the final velocity when the car has travelled a distance 30 m.
13. A stone is vertically projected up with a velocity of 25 ms^{-1} . Find its time of descent. (Take $g = 10 \text{ ms}^{-2}$)
14. A body is dropped from a height of 2 m. If penetrates into the sand on the ground through a distance of 10 cm before coming to rest. What is the retardation of the body in the sand?
15. A balloon is ascending at the rate of 5 m/s at a height of 100 m above the ground when a packet is dropped from the balloon. After how much time does it reach the ground? ($g = 10 \text{ m/s}^2$)

EXERCISE - III

Previous Year Question

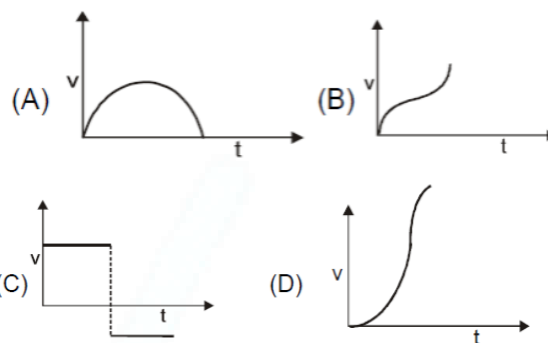
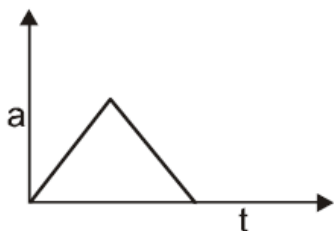
1. A student starts with a velocity 40 km/hr for school at 4 km away from his house. Due to closing of school he returns soon to his house with a velocity of 60 km/hr. His average velocity will be
 (A) zero (B) 10 km/hr
 (C) 48 km/hr (D) 50 km/hr

2. The velocity-time graph of a body falling from rest under gravity and rebounding from a solid surface is represented by

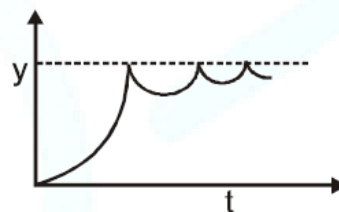


3. A bullet of mass 10 g traveling horizontally with a velocity of 160 ms^{-1} strikes a stationary wooden block and comes to rest in 0.02 s. The distance of penetration of the bullet into the block will be
 (A) 1.20 m (B) 1.60 m
 (C) 2.00 m (D) 2.40 m

4. The acceleration versus time graph of an object is as shown in figure. The corresponding velocity-time graph of the object is



5. The graph below describes the motion of a ball rebounding from a horizontal surface being released from a point above the surface.

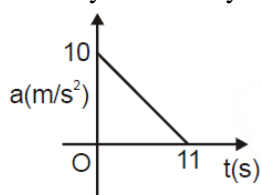


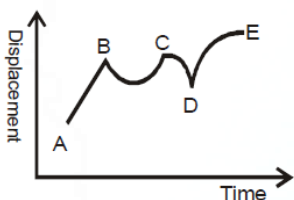
The quantity represented in the y-axis is the ball's

- (A) displacement (B) velocity
 (C) acceleration (D) momentum
6. Value of one Fermi is
 (A) 10^{-13} metre (B) 10^{-14} metre
 (C) 10^{-15} metre (D) 10^{-16} metre
7. A person takes time t to go once around a circular path of diameter $2R$. The speed (v) of this person would be:
 (A) $\frac{t}{2\pi R}$ (B) $\frac{2\pi R}{t}$ (C) $\frac{\pi R^2}{t}$ (D) $2\pi R \cdot t$
8. A body of mass 2 kg is moving on a smooth floor in straight line with a uniform velocity of 10 m/s. Resultant force acting on the body is
 (A) 20 N (B) 10 N (C) 2 N (D) zero
9. A body falling from rest describes distances S_1 , S_2 and S_3 in the first, second and third seconds of its fall. Then the ratio of $S_1 : S_2 : S_3$ is
 (A) 1 : 1 : 1 (B) 1 : 3 : 5
 (C) 1 : 2 : 3 (D) 1 : 4 : 9



10. A body starts from rest at time $t = 0$, the acceleration time graph is shown in figure. The maximum velocity attained by the body will be



- (A) 1110 m/s (B) 55 m/s
(C) 650 m/s (D) 550 m/s
11. A body covers half the distance with a speed of 20 m/s and the other half with 30 m/s. The average speed of the body during the whole journey is
(A) Zero (B) 24 m/s
(C) 25 m/s (D) None of the above
12. Correct relation is.....
(A) $v^2 = u^2 + 2a^2s^2$ (B) $v^2 = u^2 - 2a^2s^2$
(C) $v^2 = u^2 + 2as$ (D) $v^2 = u^2 + 2a^2s$
13. The figure given below shows the displacement plotted time for a particle. In which regions is the force acting on the particle zero?
- 
- The graph shows Displacement on the vertical axis and Time on the horizontal axis. The curve starts at point A, goes up linearly to point B, then curves down to point C, then goes up linearly to point D, and finally curves up to point E.
- (A) AB (B) BC (C) CD (D) DE
14. Two cars of unequal masses use similar tyres. If they are moving with same initial speed, the minimum stopping distance
(A) is smaller for the heavier car
(B) is same for both the cars
(C) is smaller for the lighter car
(D) depends on the volume of the car

15. A ball hits a wall horizontally with a velocity of 6.0 ms^{-1} . After hitting wall it rebounds horizontally with a velocity of 4.4 ms^{-1} . If the ball remains in the contact of wall for 0.040 sec, the acceleration of ball would be
(A) -260 m/s^2 (B) $+260 \text{ m/s}^2$
(C) -26 m/s^2 (D) $+26 \text{ m/s}^2$
16. If the length of pendulum executing simple harmonic motion is $\frac{g}{4\pi^2}$ metre then the time period of the pendulum is
(A) 2.5 sec (B) 1.5 sec
(C) 1 sec (D) 2 sec
17. The speed of a train decreases from 80 km/hour to 60 km/hour in 5 seconds. In this process, find out the acceleration of the train
(A) 2.22 m/sec^2 (B) -2.22 m/sec^2
(C) -1.11 m/sec^2 (D) 1.11 m/sec^2
18. A ball thrown vertically upward returns to the thrower after 6 s. The ball is 5 m below the highest point at $t = 2 \text{ s}$. The time at which the body will be at same position is (take $g = 10 \text{ m/s}^2$)
(A) 2.5 s (B) 3 s (C) 4 s (D) 5 s
19. A particle starts its motion from rest under the action of a constant force. If the distance covered in first 10 s is S_1 and that covered in first 20 s is S_2 then
(A) $S_2 = S_1$ (B) $S_2 = 2S_1$
(C) $S_2 = 3S_1$ (D) $S_2 = 4S_1$
20. A car travels 40 km at an average speed of 80 km/h and then travels 40 km at an average speed of 40 km/h. The average speed of the car for this 80 km trip is
(A) 40 km/h (B) 45 km/h
(C) 48 km/h (D) 53 km/h





ANSWER KEY

EXERCISE-I

Single Correct Type Questions

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	C	A	A	B	B	C	D	A	C	A	A	D	A
Que.	16	17	18	19	20	21	22	23	24	25					
Ans.	A	B	D	D	A	A	b	A	C	D					

Case Study Questions

Case 1

- (I) - OA represented is uniform acceleration (II) - BC represented is negative acceleration
 (III) - $a = 1.5 \text{ m/s}^2$ (IV) - Retardation = 1 m/s^2
 (V) - Distance = 36 m

Case 2

- (I) - Average speed $V_{av} = 30 \text{ m/s}$ (II) - Distance = 30 m/s
 (III) - Distance = 180 m/s (IV) - Time = 8 sec.

EXERCISE-II

HOTS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	B	D	B	D	B	D	B	B	C	A	A	C	A	B

Assertion and Reason

Que.	1	2	3	4	5										
Ans.	A	B	A	A	C										

Numerical Type Question

- Total displacement = 10 m
- Distance = 1.6 m
- Acceleration = -260 m/s^2
- Average velocity = 0 m/min
- Average speed = 24 km/h
- Total distance = 300 m
- Speed = $2\pi R t$
- $V_{av} = 24 \text{ m/s}$
- Distance = 2 km
- Average velocity = 4 m/s
- Time = 20 sec.
- Final velocity = 20 m/s
- Time $t = 2.5 \text{ sec.}$
- Retardation = 196 m/s^2
- Time = 5.05 sec.





EXERCISE-III

Previous Year Questions

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	C	B	D	A	C	B	D	B	B	D	C	A	B	A
Que.	16	17	18	19	20										
Ans.	C	C	C	D	D										





DPP

Daily Practice Problems

SUBJECT: PHYSICS**CLASS-9****DPP NO. 1****TOPIC: MOTION****Multiple Choices Questions:**

1. Distance covered by a body from velocity-time graph is
 - (A) Area under the graph
 - (B) Equal to the slope of the graph
 - (C) Is denoted by a line parallel to the time axis at any point on the distance axis
 - (D) Is denoted by a line parallel to the distance axis at any point on the time axis
2. The acceleration of a body from a velocity - time graph is
 - (A) Area under the graph
 - (B) Equal to the slope of the graph
 - (C) Is denoted by a line parallel to the time axis at any point on the distance axis
 - (D) Is denoted by a line parallel to the distance axis at any point on the time axis
3. An example of a body moving with constant speed but still accelerating is
 - (A) A body moving in a helical path with constant speed
 - (B) A body moving with constant speed on a straight road
 - (C) A body moving with constant speed in a circular path
 - (D) A body moving with constant speed on a straight railway track
4. SI Unit of measurement of acceleration is
 - (A) m/s^2
 - (B) m/s
 - (C) m
 - (D) m/hr
5. Formula to find the average velocity of a body is given by
 - (A) $V_{av} = (u + v)/2$
 - (B) $S_n = \{u + a/2(2n-1)\}$
 - (C) $S = u t + 1/2 a t^2$
 - (D) $V = u + at$
6. An object travels 20m in 5 sec and then another 40m in 5 se What is the average speed of the object?
 - (A) 2m/s
 - (B) 0 m/s
 - (C) 12m/s
 - (D) 6m/s
7. A farmer moves along the boundary of a square field of side 10 m in 40 sec. The magnitude of displacement of the farmer at the end of 2 minutes 20 seconds from his initial position is:
 - (A) 10 root 2 m
 - (B) 30m
 - (C) 10m
 - (D) 40m

8. A man travels a distance of 20 km from his home to office, and 10 km towards his house back. Then the displacement covered by the man in the whole trip is
(A) 30 Km (B) 10 Km (C) zero Km (D) 50 Km
9. Acceleration is a vector quantity, which indicates that its value
(A) Can be positive, negative or zero
(B) Is always positive
(C) Is always negative
(D) Is zero
10. Rate of change of displacement is called
(A) Velocity (B) deceleration (C) Speed (D) acceleration
11. 180° plane angle is equal to
(A) $\pi/2$ radian (B) π radian (C) 2π radian (D) none of these
12. Suppose a boy is enjoying a ride on a merry-go-round which is moving with a constant speed of 10 m/s. It implies that the boy is:
(A) At rest (B) Moving with no acceleration
(C) In accelerated motion (D) Moving with uniform velocity
13. $1 \text{ km/h} = \underline{\hspace{2cm}} \text{ m/s}$
(A) $3/50$ (B) $18/5$ (C) $50/3$ (D) $5/18$
14. Which of the following statement is correct regarding velocity and speed of a moving body?
(A) Velocity of a moving body is always higher than its speed
(B) Speed of a moving body is always higher than its velocity
(C) Speed of a moving body is its velocity in a given direction
(D) Velocity of a moving body is its speed in a given direction
15. If car A is at 40 km/h and car B is at 10 km/h in the opposite direction, what is the velocity of the car A relative to the car B?
(A) 40 km/h (B) 50 km/h (C) 10 km/h (D) 30 km/h
16. Which of the following is most likely not a case of uniform circular motion?
(A) Motion of the earth around the sun
(B) Motion of a toy train on a circular track
(C) Motion of a racing car on a circular track
(D) Motion of hours' hand on the dial of a clock

17. A man is moving with 36 kmph. The time of reaction is 0.9 seconds. On seeing an obstacle in the path, he applies brakes and decelerates at 5 m/s^2 , the total distance covered before he stops is:
(A) 19 m (B) 17 m (C) 16 m (D) 18 m
18. The numerical ratio of displacement to distance for a moving object is:
(A) Always less than 1 (B) Equal to 1 or less than 1
(C) Always more than 1 (D) Equal to 1 or more than one
19. A car goes from a town A to another town B with a speed of 40 km/h and returns back to the town A with a speed of 60 km/h. The average speed of the car during the complete journey is-
(A) 48 km/h (B) 50 km/h (C) zero (D) none of these
20. _____ describes how fast something is going, whereas, _____ describes how fast something is going in a certain direction.
(A) rate, velocity (B) rate, speed
(C) speed, velocity (D) speed, acceleration

Very short answer type Questions:

1. Which physical quantity corresponds to the rate of change of momentum?
2. Define one newton force.
3. What is the relationship between force and acceleration?
4. Name the principle on which a rocket works?
5. What is the force which produces an acceleration of 1 m/s^2 in a body of mass 1 kg.

Short answer type Questions:

1. To take the boat away from the bank of a river, the boatman pushes the bank with an oar. Why?
2. Why does a gunman get a jerk on firing a bullet?
3. Explain how a rocket works?
4. If a man jumps out from a boat, the boat moves backwards. Why?
5. How long will it take a force of 10 N to stop a mass of 2.5 kg which is moving at 20 m/s.

Long answer type Questions:

1. Explain, why a cricket player moves his hands backwards while catching a fast cricket ball.
2. State and explain Newton's second law of motion.
3. Explain why, when a fireman directs a powerful stream of water on a fire from a hose pipe, the hose pipe tends to go backwards.

Case based Study

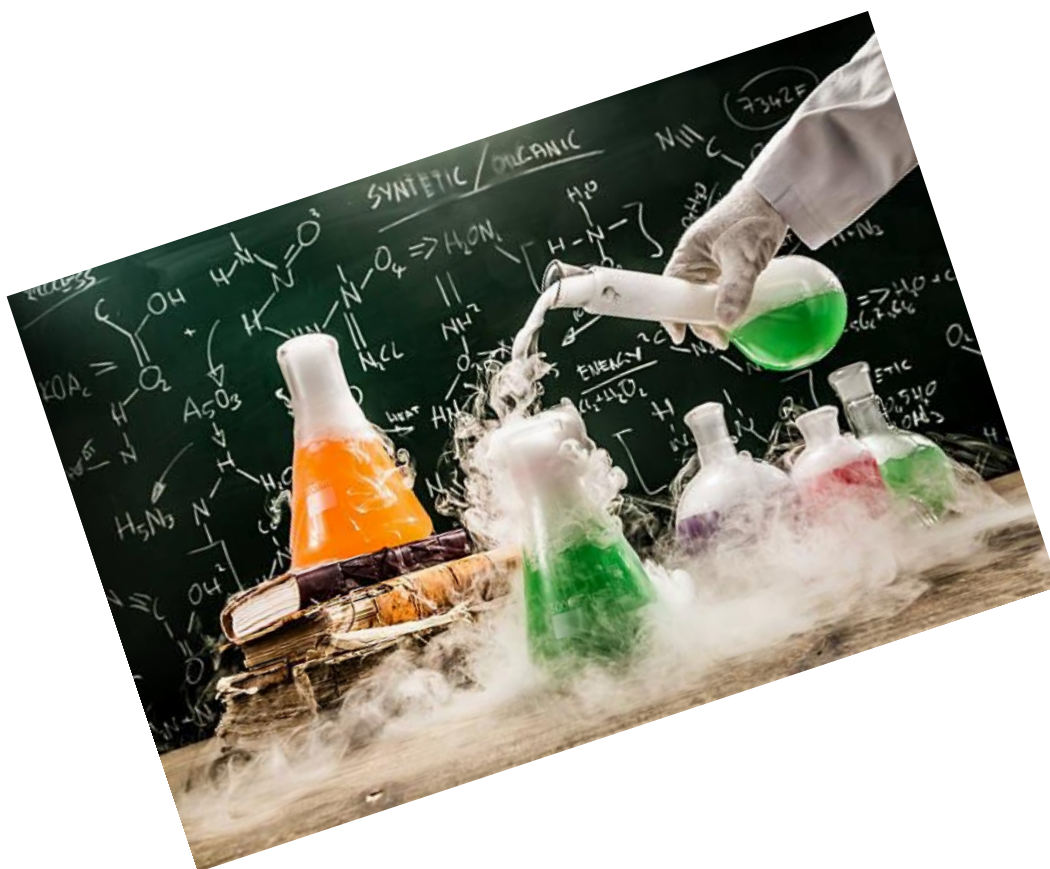
1. There is no atmosphere on the moon. This is because gas molecules need a certain amount of force of attraction to be retained on a heavenly body. The force of attraction of the moon is less than the required force, hence no atmosphere can exist.
 - (I) The value of g on moon is times that of earth
 (A) $1/3$ (B) $1/4$ (C) $1/5$ (D) $1/6$
 - (II) Mass of the moon is that of earth
 (A) more than (B) less than (C) equal to (D) can't say
 - (III) If the weight of an object is 60 kg f on earth then, its weight on moon is
 (A) 10 kg f (B) 20 kg f (C) 30 kg f (D) 40 kg f
2. Doctor has advised Deepak to do some exercise in order to lose his mass. He went to market and purchased a dumbbell of mass 100 kg and started doing the exercise regularly. In mean while he was selected by ISRO for Moon. He went to the moon along with his dumbbell. He experienced that doing exercise in moon is relatively easy as compared to earth.
 - (I) Why Mr. Deepak loved doing exercise in Moon?
 (A) Moon has good gym
 (B) Moon has no gravity
 (C) In moon, mass becomes lighter due to gravity
 (D) Earth has No gym.
 - (II) What is the weight of dumbbell in Earth?
 (A) 100 N (B) 980 N (C) 500 N (D) 340 N
 - (III) What is the weight of dumbbell in Moon?
 (A) 100 N (B) 980 N (C) 500 N (D) 163.33 N

ANSWER KEY										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	C	A	A	D	A	B	A	A
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	B	C	D	D	B	C	A	B	A	C

CLASS-IX

SAMPLE

CHEMISTRY



MATTER IN OUR SURROUNDINGS

Introduction

There are a large number of things around us which we see and feel. For example, we can see a book in front of us. A book occupies some space. The space occupied by the book is called its volume. If we pick up the book, we can also feel its weight. So, we conclude that the book has some mass. We cannot see the air around us, yet if we fill a balloon with air and then weigh it carefully, we will find that not only does air occupy space (bounded by the balloon), but it also has mass.

Things like a book and air are examples of matter. Other examples of matter are wood, cloth, paper, ice, steel, water, oil etc.

Thus, matter can be defined as follows -

“Anything that occupies space and has mass is called matter”.

Physical Nature of Matter

(A) Matter is made up of particles:

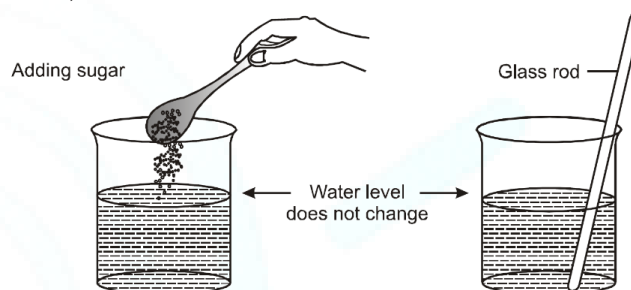
- (i) Everything around us is made up of many tiny particles.
- (ii) Particles which make up the matter are constantly moving.
- (iii) Particles which make up matter are atoms or molecules.
- (i) **Evidences for the presence of particles in matter:** Most of the evidences for the existence of particles in matter and their motion come from the experiments on diffusion and Brownian motion.

Evidence - 1

Dissolving a solid in a liquid: Take a beaker. Fill half of it with water. Mark the level of water in the beaker. Add some sugar to the water and dissolve it with the help of a glass rod. You will see that the sugar has disappeared, but there is no change in the level of water.

Conclusion: This can be explained by assuming that

matter is not continuous, rather it is made up of particles. Sugar contains a large number of separate particles. These particles when dissolved in water occupy the vacant spaces between the particles of water. That is why the water level in the beaker did not rise. Had sugar been continuous, like a block of wood, the water level in the beaker would have risen.

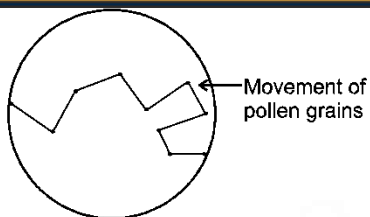


When a solid dissolves in a liquid, the volume of the liquid does not change

Experiment to show that matter is made of particles Evidence - 2

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).

Conclusion: Water is made up of tiny particles which are moving very fast (the water molecules themselves are invisible under the microscope because they are very, very small). The pollen grains move on the surface of water because they are constantly being hit by the fast moving particles of water. So, though the water particles (or water molecules) are too small to be seen, but their effect on the pollen grains can be seen clearly. 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 of the scientist Robert Brown who first observed this phenomenon.)



Movement of pollen grains

Brownian Motion : Zig-zag motion (in a very irregular way) of particles is known as brownian motion. Brownian motion can also be observed in gases. Sometimes, when a beam of light enters in a room, we can see tiny dust particles suspended in air which are moving rapidly in a very random way. This is an example of Brownian motion in gases. The tiny dust particles move here and there because they are constantly hit by the fast moving particles of air. The existence of Brownian motion gives two conclusions.

- Matter is made up of tiny particles.
- Particles of matter are constantly moving.

NOTE: Brownian motion increases on increasing the temperature, because of increase in the kinetic energy of particles of matter.

(B) Characteristics of Particles of Matter:

The important characteristics of particles of matter are the following:

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

(a) Experiment: Potassium permanganate is a purple coloured solid substance and water is a

liquid. We will take 2-3 crystals of potassium permanganate and dissolve them in 100 ml of water. Now we will take out 10 ml of this solution and put into another 90 ml of clear water. We will keep diluting the solution like this 5 to 8 times.

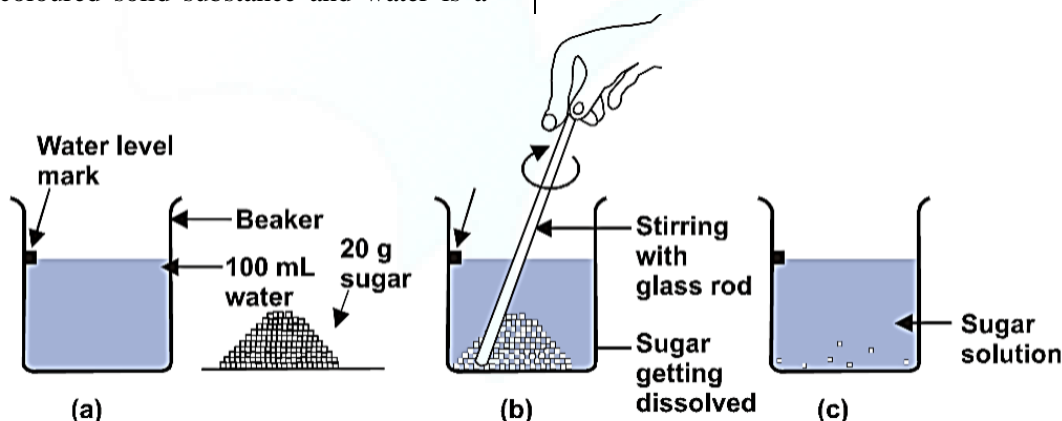


Just a few crystals of potassium permanganate can colour a huge volume of water

Conclusion: This experiment shows that just a few crystals of potassium permanganate can colour a large volume of water. It means a crystal of KMnO_4 is made up of millions of tiny particles. They keep dividing themselves into smaller and smaller particles.

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

(a) Experiment: We take about 100 ml of water in a beaker and mark the level of water. We will also take 20 g of sugar. Now we will dissolve the sugar by stirring and we get a sugar solution.



When we dissolve sugar in water, there is no change in the volume of water.

Conclusion: The level of sugar solution in the beaker is at the same mark where water level was initially in the beaker.

It shows that particles of sugar go into the spaces between various molecules of water due to which

there is no change in the volume. Thus, from this experiment it can be concluded that, the molecules in water are not tightly packed, they have spaces between them.



(iii) The particles of matter are constantly moving:

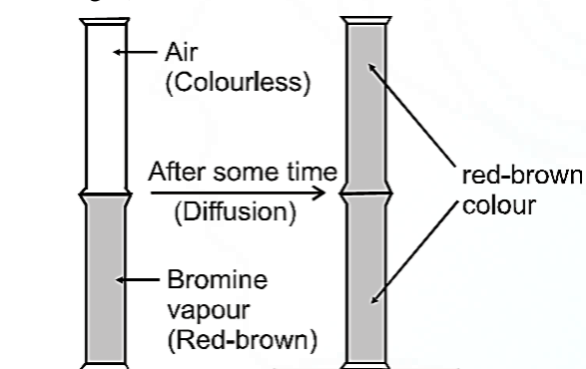
This property can be explained by diffusion.

Diffusion: “Intermixing of particles of two different types of matter on their own is called diffusion.” It is the phenomenon in which the movement of molecules or particles occur from their higher concentration towards their lower concentration.

e.g.: When a perfume bottle is opened in one corner of a room, its fragrance spreads in the whole room quickly. This happens because the particles of perfume move rapidly in all directions and mix with the moving particles of air in the room.

(a) Experiment: We take a gas jar full of bromine vapours and invert another gas jar containing air over it, then after some time, the red-brown vapours of bromine spread out into the upper gas jar containing air.

Conclusion: In this way, the upper gas jar which contains colourless air in it, also turns red-brown. The mixing is due to the diffusion of bromine vapours (or bromine gas) into air.



Diffusion of bromine vapour into air

(b) Experiment: To demonstrate that the Kinetic Energy of particles increases with increase in temperature.

Take two beakers. To one beaker add 100 mL of cold water and to the other beaker add 100 mL of hot water. Now add a crystal of potassium permanganate to both the beakers.

It is observed that purple colour of potassium permanganate starts spreading and after sometime the entire solution becomes purple. The rate of mixing is faster in case of hot water.

Conclusion: This experiment demonstrates that the particle of matter possess motion and that the kinetic energy of the particles increases with increase in temperature.

(c) Experiment: To understand different rates of diffusion by different substances.

Take two glasses filled with water. Put a drop of blue or red ink slowly and carefully along the sides of the first glass and honey in the same way in the second glass. Leave them undisturbed.

As the drop of ink trickles along the sides of the beaker, the blue colour of the ink starts diffusing in water, which appears like wavy blue streaks in water.

The honey drop continues travelling along the side of beaker and there is no visible diffusion of it in water.

The ink spreads evenly in the water in about two hours.

Conclusion:

- Rate of diffusion depends upon the nature of substances.
- More viscous substances which have particles with less kinetic energy takes more time to get diffused.

From these activities it is observed that when two different forms of matter are brought in contact, they intermix spontaneously. This intermixing is possible due to motion of the particles of matter and also due to the spaces between them. The intermixing takes place due to movement of particles of one form into the spaces between the particles of the other form of matter.

(iv) Particles of matter attract each other: There are some forces of attraction between the particles of matter which bind them together.

(a) Experiment: To demonstrate the strength of attractive forces between particles of different kinds of matter.

Play this game in the field. Make four groups and form human chains.



The first group should hold each other from the back and lock arms like Bihu dancers.

The second group should hold hands to form a human chain.

The third group should form a chain by touching each other with only their fingertips.

Now, the fourth group of students should run around and try to break the three human chains one by one into as many small groups as possible. It is observed that the third group was the easiest to break because they were weakly bonded with each other. If we consider each student as a particle of matter, then in the first group the particles held each other with the maximum force.

If particles are bonded tightly it is difficult to separate them.

Conclusion: Particles of matter attract each other.

(b) Experiment: To show that particles of different matter have different force of attraction.

Take a piece of iron wire, a piece of chalk and a rubber band.

Try to break them by hammering, cutting or stretching.

It is observed that the piece of iron wire is most difficult to break. This indicates that particles in iron wire are held by stronger force of attraction as compared to particles in piece of chalk or rubber band.

Conclusion: This shows that different kind of matter possess different forces of attraction.

(c) Experiment: To show that particles of matter attract each other.

Open a water tap, try breaking the stream of water with your fingers.

We can cut the stream of water.

Water molecules exert a force of attraction on each other, therefore as soon as we remove fingers, they will try to unite again and will remain together forming a continuous stream again.

Conclusion: Since energy is required to break crystals of matter into particles. It indicates that particles in matter are held together by some attractive forces, the strength of these attractive forces varies from one matter to another.

NOTE: The force of attraction between the particles of same substances is called **cohesive force**.

The force of attraction between the particles of different substances is called **adhesive force**.

(C) Classification of Matter

As the 'nature of the particles and physical forces between them determine the nature of the matter', so matter can be in different forms or states. Generally matter can be classified into five states as

1. Solid state 2. Liquid state
3. Gaseous state 4. Plasma state
5. Bose-Einstein Condensate (BEC)

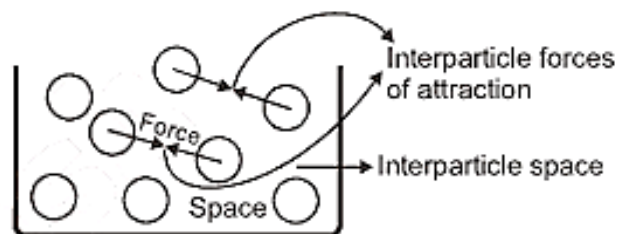
In ancient time, the distinction between different forms of matter was made on the basis of difference in the bulk properties as,

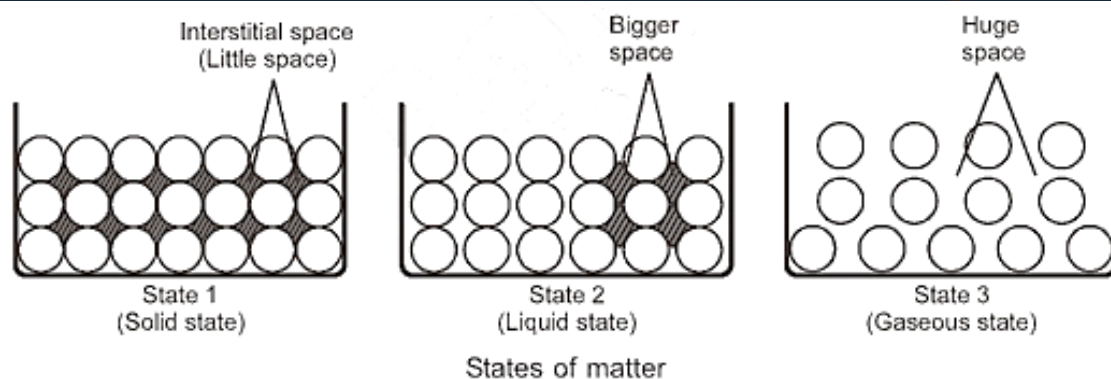
Solid is the state in which matter has a fixed shape and a fixed volume.

Liquid is the state in which matter has a fixed volume but its shape varies according to the shape of the container.

Gaseous state is the state in which matter neither has a fixed volume nor a fixed shape.

According to the modern classification, the matter is made up of particles (atoms or molecules) which are attracted towards each other through the interparticle forces known as 'interparticle forces of attraction' (which may also be called as 'interatomic', 'interionic' or 'intermolecular' forces of attraction). The empty space between these particles is known as 'interparticle space' ('interatomic space' or 'intermolecular space' or 'interstitial space').





The physical state of matter depends upon the net effect of the two factors.

- (i) Interparticle forces of attraction
- (ii) Kinetic energy

Interparticle forces between the particles tend to bring them closer to each other, whereas motion of the particles tends to move them apart.

As per **modern classification**, various forms of matter are

Solid state is the state which has maximum interparticle forces of attraction and therefore minimum interparticle spaces.

Liquid state is the state which has lesser interparticle forces of attraction than solids but more than the gaseous state.

Gaseous state is the state which has minimum interparticle forces of attraction and hence maximum interparticle spaces.

In addition to the above three basic forms of matter, modern classification states that those forms of matter which are not composed of molecules but are organised by different forces can also be considered in different states of matter, and hence, Plasma and Bose-Einstein Condensate are also considered as other states of matter.

NOTE :

Indian philosophers of ancient times also tried to classify the matter into five different states, that are air, earth, fire, sky and water and they named all these as 'Panch Tatva'.

In early times, there were two different views regarding the nature of matter, one view was based on the continuous structure and the other on particle structure.

(1) The Solid State:

Matter with **definite shape, boundaries and volume** is said to be in solid state. Attractive forces between the particles of solid state are very strong, so it needs high pressure to deform the solid state. The particles are not free to move from one place to another within the solid but they can vibrate about their mean positions. Compressibility of solid state is minimum in comparison to other states.

Characteristics of Solid State :

- (i) **Definite shape and volume** : Since the movement of particles in a solid is restricted, these particles can only vibrate about their mean positions. Therefore, the kinetic energy of the particles in a solid is very less and hence a solid has a definite or fixed shape. However, sugar and salt takes the shape of the vessel is an exception while the shape of individual sugar or salt crystal remains fixed.
- (ii) **Density** : Density of a solid is very high because particles of a solid are very closely packed and have strong intermolecular forces of attraction. Density is mass per unit volume of a substance.
- (iii) **Compressibility** : We can say solid have negligible compressibility because there is very little space between particles i.e., the volume of a solid cannot be increased or decreased by reducing or increasing pressure upon it. Compressibility shows the change in volume of a substance after altering the pressure on it.





However, a porous solid like a piece of bread or a sponge is an exception. It has spaces within, which make it easily compressible. The air within such a solid is expelled on compression.

(iv) **Rigidity** : Due to the packed arrangement of particles, solids have a rigid structure.

Exception - Rubber, it can change its shape on stretching but regains the same shape when excessive force is removed. If excessive force is applied, it breaks.

(v) **High mechanical strength** : Solids have high mechanical strength due to rigid packing of constituting particles.

(vi) **Diffusion (mixing ability)** : This is a process by which the particles of a substance may enter spontaneously into another substance. The movement of particles in a solid is restricted. Hence, a solid does not have the property of diffusion into other solids (without change in temperature)

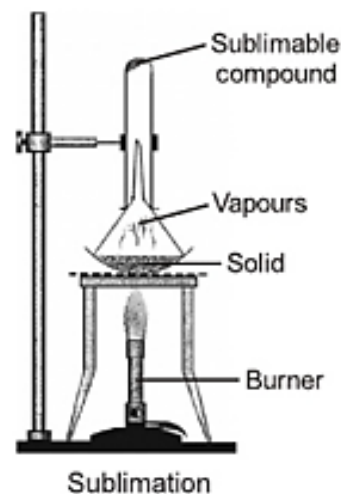
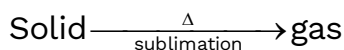
(vii) **Melting and Boiling points** : Solids have high melting and boiling points as there are high interparticle forces of attraction in solids. Large amount of energy needs to be given to overcome strong interparticle forces.

(viii) **Crystalline or geometrical structure** : In a solid, the constituent particles are arranged in a regular manner called lattice. Lattice is a three-dimensional arrangement of particles in the space. This explains why solids have a regular geometrical shape. Generally solids show crystalline structure.

(ix) **Sublimation** : Some solids change directly into vapours on heating without changing into liquid state. This phenomenon is called sublimation. The solid which undergoes sublimation to form vapour is called 'sublime'.

The solid obtained by cooling the vapours of a solid is called 'sublimate'.

For example Iodine, camphor, anthracene, naphthalene, ammonium chloride (NH_4Cl), dry ice etc.



(2) The Liquid State:

A state of matter in which **volume is fixed but shape is not fixed** is called liquid state. A liquid takes the shape of the vessel in which it is kept. Attractive forces among the particles of liquid are less in comparison to the solid state particles and more than the gaseous state particles. While interparticle space is quite large than that in solids but less than that in gases.

Characteristics of Liquid State :

(a) **Shape and volume** : A liquid has no definite shape but has a definite volume. A liquid attains the shape of the container in which it is kept. This is due to the fact that the liquid particles can slip over one another and finally settle down to take the shape of the container. Since the interparticle forces in liquids are of moderate level, hence it does not vary in volume.

(b) **Density** : The density of a liquid is lower than that of solids, while more than gases because the attractive forces in liquid molecules are in between the solids and gases.

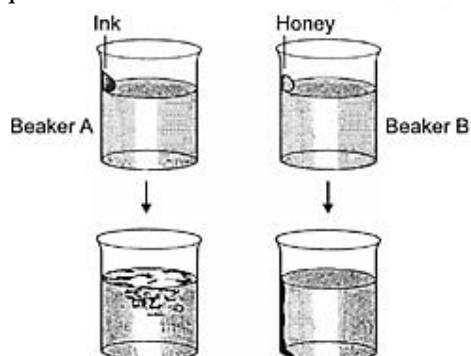
(c) **Compressibility** : A liquid shows compressibility upto a limited extent due to little interparticle spaces.

(d) **Fluidity** : A liquid shows fluidity i.e., it can flow due to kinetic energy of particles. This makes liquids non-rigid.



(e) **Mechanical strength** : Low mechanical strength is present in a liquid. it is just to maintain surface phenomenon.

(f) **Diffusion (mixing ability)** : A liquid shows fluidity and hence, it can diffuse. The less viscous liquids show more diffusion.



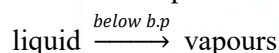
An ink drop diffuses faster in water than does a drop of honey because honey is more viscous than ink

(g) **Boiling point** : The boiling point of a liquid is generally less than that of a solid. This is because of less interparticle forces in them.

(h) **Freezing** : ‘Solidification’ of a liquid is called ‘Freezing’. It is the transformation of a liquid into the solid state.

Example - Water on freezing converts into ice.

(i) **Evaporation** : Conversion of matter from liquid state to vapours at any temperature below boiling point is called evaporation.



Explanation : Due to continuous motion, the liquid particles collide with one-another. When a liquid is exposed to air, collision between the air particles and the liquid particles takes place at surface. During these collisions, some particles of liquid get extra energy and overcome the interparticle forces of attraction. These highly energetic particles leave the surface and convert into vapours.

Examples of Evaporation

(a) **Liquid kept in open vessel** : In an open vessel, the liquid evaporates by itself because the particles of liquid absorb energy from its surroundings. After some time, it is observed that the quantity of liquid is lesser than before.

(b) **Hot milk or tea is easy to sip from saucer rather than cup** : Evaporation is a surface phenomenon, when we spread hot milk or tea in a saucer, it gets more space to evaporate thus leads to faster cooling.

(c) **Drying of clothes** : Wet clothes dry because they pick-up energy from the surroundings.

(d) **Sweating**: During summers, sweat on the skin evaporates by taking energy from the surroundings and body. This causes cooling and lowering of the body temperature.

Factors Affecting Rate of Evaporation

(a) **Surface area of the liquid** : Evaporation is a surface phenomenon. An increase in the surface area increases the rate of evaporation because more surface area provides more space for large number of particles to get evaporated. That is why an unfolded cloth dries faster than a folded one.

(b) **Temperature** : Higher the temperature, higher will be the number of active particles with high kinetic energy and hence more evaporation will be there.

(c) **Humidity** : Water vapours present in air cause humidity. Humidity decreases the rate of evaporation of water. So, wet clothes take a longer time to dry in the humid air; but they dry faster in the dry air.

(d) **Wind speed**: During evaporation, the air around the wet object becomes saturated with water vapours. As a result, rate of evaporation becomes slower. But with an increase in the speed of wind, the moist air is replaced by dry air. This results in faster rate of evaporation.

(e) **Nature of the liquid** : Lower the boiling point of a liquid, higher is its rate of evaporation.

Evaporation causes Cooling:

As evaporation is a surface phenomena i.e., in the evaporation process, the surface particles leave the surface by taking heat energy from the bulk of liquid and hence, the temperature of bulk of liquid decreases which causes cooling.

**(i) We Wear Cotton Clothes in Summer**

During summer, we perspire more because of the mechanism of our body which keeps us cool. During evaporation, the particles at the surface of liquid gain energy from the surroundings or body surface. The heat energy equal to latent heat of vaporisation, is absorbed from the body, leaving the body cool. Cotton, being a good absorber of water helps in absorbing sweat.

(ii) Pouring the acetone on our palm

If we pour some acetone or ether or nail polish remover on our palm then we feel cool because the energy needed for evaporation is taken from our palm. Hence, our palm feels cool.

(iii) Sprinkling of water on the open ground after a hot sunny day

The sprinkling of water on the open ground or roof after a hot sunny day causes the cooling of the surface of roof because the water evaporates by absorbing heat from the ground and the surrounding air. In this way the ground or roof becomes cool, and we feel comfortable.

(iv) Water droplets on the outer surface of a glass containing ice cold water

If we take some ice-cold water in a glass then we will observe water droplets on the outer surface of glass. The water vapour present in air on encountering glass of cold water, loses energy. So, water vapour gets converted to liquid state, which we see as water droplets.

(j) Boiling : Boiling is that phenomenon which occurs when the vapour pressure of the liquid becomes equal to the atmospheric pressure. On heating a liquid, vapours are formed over the liquid which exert some pressure on, the surface of liquid. This is known as vapour pressure. The temperature at which a liquid boils and changes rapidly into its vapours at atmospheric pressure i.e. when vapour pressure becomes equal to the atmospheric pressure is called the boiling

point of the liquid. Boiling point is affected by pressure. When atmospheric pressure is less, boiling point is less and vice-versa. (That is why, it is difficult to cook at hill stations without pressure cooker)

NOTE: The pressure exerted by the vapours in equilibrium with its liquid at a given temperature is called vapour pressure of that particular liquid. This is also called saturated vapour pressure. The magnitude of vapour pressure depends upon the following factors.

- Nature of liquid
- Temperature of liquid

Note: The numerical value of freezing point and melting point is same. Melting point of ice = Freezing point of water = 0°C (273.16 K).

Difference between evaporation and boiling

Evaporation	Boiling
(a) It is a spontaneous process that takes place at any temperature below the boiling point of the liquid.	(a) It occurs at a particular temperature i.e. at the boiling point of liquid. It is not a spontaneous process.
(b) it is a surface phenomenon i.e. evaporation takes place at surface of liquid only.	(b) It is a bulk phenomenon i.e. it occurs throughout the mass of the liquid with the formation of bubbles.

Notes:

- For a particular liquid at room temperature, the melting point of its solid state is lower than the room temperature but its boiling point is higher that is why it exists as liquid at room temperature.
- Rate of diffusion of solid particles into liquid is higher at higher temperature.
- Presence of impurities alters the melting points and boiling points of the pure substances.

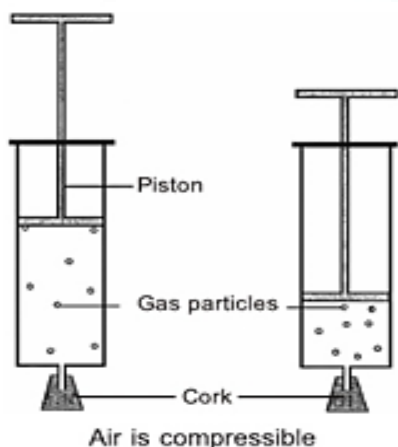


(3) The Gaseous State:

Substance with no fixed shape, size or volume is said to be in gaseous state. Attractive forces among gaseous particles are very less or weak. They occupy the whole space available to them. Molecules of gas move freely. When the fast moving particles hit the walls of the container, they exert a pressure which is known as gas pressure.

Characteristics of Gaseous State :

- (a) **Shape and volume :** A gas neither has a specific shape nor a specific volume. It acquires the shape and occupies the volume of the container.
- (b) **Density:** The density of a gas is lower than that of a solid or liquid, because its particles are very far from each other. Therefore, mass per unit volume i.e. density is very less.
- (c) **Compressibility :** A gas is highly compressible. This is due to large interparticle spaces which can be reduced by applying pressure. For example, LPG (used in home), O₂ (used in hospitals) & CNG (used In vehicles and homes), can be compressed and transported easily.



- (d) **Fluidity :** A gas shows the property of fluidity because gaseous particles can flow from a region of high concentration to lower concentration.
- (e) **Diffusion :** Due to very less interparticle forces of attraction and large interparticle spaces, gases readily intermix with each other without any external aid. This property of readily intermixing of particles is known as diffusion. With increase in temperature, rate of diffusion increases.

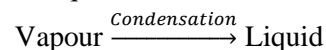
(f) **Melting and boiling point :** At normal atmospheric pressure, the melting and boiling points of a gas are below room temperature.

(g) **Effect of heating and cooling of a gas :** A gas generally expands and contracts respectively on heating and cooling. Actually, on heating, the gaseous particles gain energy and move apart from one another (due to very less interparticle forces of attraction) and on cooling they contract.

(h) **Liquefaction of a gas :** The conversion of a gas into liquid is called 'Liquefaction'. Liquefaction can be carried out either by decreasing temperature or by increasing pressure. Both methods (either decreasing temperature or increasing pressure) tend the gaseous particles to come closer by reducing their kinetic energy. During liquefaction, the interparticle forces of attraction increases while interparticle space decreases.

(i) **Pressure of a gas :** The gaseous molecules exert force on the walls of the container due to continuous movement and collisions with one-another and with the walls of the container. The pressure of gas is the force applied by a gas per unit area on the walls of container. The pressure of air at any location on the Earth is called atmospheric pressure. It is caused by the weight of the column of air above it.

(j) **Condensation:** The process of conversion of vapour into liquid state is called condensation.



Why do we see water droplets on the outer surface of a glass containing ice cold water? The water vapours present in air, on coming in contact with the cold glass of water, loses energy and gets converted to liquid state which we see as droplets.

Note: The numerical value of condensation point and boiling point is same.

Condensation point of water vapour = Boiling point of water = 100°C (373.16 K).

**Note :**

Attractive forces $-A_S > A_L > A_G$

Kinetic energy $-KE_S < KE_L < KE_G$ (Where, S = Solid, L = Liquid, G = Gas)

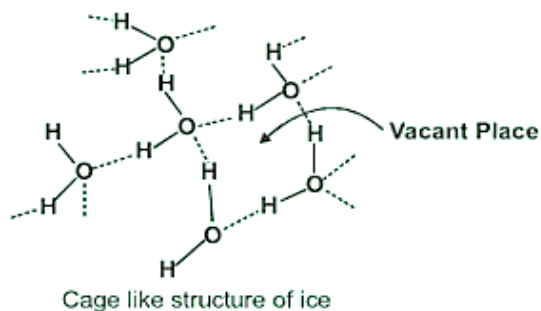
Density $-D_S > D_L > D_G$

Comparison between Solid, Liquid and Gas

Property	Solid	Liquid	Gas
1. Interparticle space	Very small	Larger (compared to solids)	Largest
2. Interparticle forces of attraction	Very strong	Weaker	Negligible
3. Density	High	Low	Very low
4. Arrangement of the particles	Fixed	Not fixed, particles can move freely within the bulk	Not fixed, particles can move freely throughout the available space
5. Energy of the particles	Low	High	Very high
5. Shape and volume	Definite shape and volume	No definite shape but has definite volume	No definite shape and volume
7. Compressibility	Very low (Negligible)	More (as compared to solids)	Highly Compressible
8. Melting and boiling points	Very high	Comparatively higher than gases	Low
9. Diffusion	Negligible	Comparatively higher than solids	Very high

Note :

- **Density of ice is less than water :** Due to the cage like structure of ice, molecules are not closely packed and vacant spaces are left. As ice melts, these molecules come closer and hence the density increases. As ice being less denser, it floats over the surface of water.
- **Density of water is maximum at 4°C :** As ice melts, molecules come closer and hence density increases upto 4°C. After that the kinetic energy of the molecules increases so they start moving away from each other and again density starts decreasing.

**(4) Plasma**

Plasma is a fourth phase of matter, apart from the traditional solids, liquids, and gases. It is a most common state of matter made from a gas that has lost its electrons from heat. In this state all the particles get highly activated and charged, so they make a pool of charged gaseous particles. The particles exist in super energetic and super



excited state.

Plasma was first identified as "radiant matter" by Sir William Crookes in 1879.

The majority (90%) of the matter in the universe is actually found in plasma state. All the stars are made of plasma and even the space between the stars is filled with a plasma.

Composition: Plasma may be formed by heating and ionizing a gas. It exists at temperatures starting at several thousand degrees Celsius, where they consist of free charged particles, usually in equal numbers, such as ions and electrons. It is a collection of charged particles that respond strongly and collectively to electromagnetic fields, taking the form of gas like clouds or ion beams.

- Plasma is different from a gas because it possesses unique properties.
- Plasma has neither a definite volume nor a definite shape.
- Free electrical charges (not bound to atoms or ions) cause plasma to be electrically conductive.

Types of Plasma

1. Space and astrophysics plasma

Sun, stars, solar wind, interstellar medium, charged air produced by lightning, intergalactic medium and interstellar nebulae.

2. Terrestrial plasma

Lightning, St. Elmo's fire, ionosphere, polar aurorae and most flames.

3. Artificially Produced Plasma.

Plasma display including TVs, rocket exhaust, electric arc, fluorescent lamps, neon sign bulbs, an arc welder or plasma torch.

(5) Bose - Einstein Condensate (B.E.C.)

It is also known as fifth state of matter. Physically, the BEC is just opposite to the plasma state. It is very rigid near absolute zero (0 K or -273.16°C) at this all molecular motion stops. They are super-unexcited and super-cold atoms.

When you get to a temperature near absolute zero, atoms begin to clump. The result of this clumping is the BEC. A group of atoms takes up the same place, creating a "super atom". There are no longer

thousands of separate atoms. They all take on the same qualities and for our purposes become one blob. It is a gaseous superfluid phase formed by atoms cooled to temperature very near to absolute zero. The first such condensate was produced by **Eric Cornell, Ketterle** and **Carl Wieman** in **1995**, using a gas of Rubidium atoms cooled at 170 nanokelvins (nK). Two other scientists, **Satyendra Bose** and **Albert Einstein**, had predicted it in 1920. They didn't have the equipment and facilities to make it happen in the 20s.

Example 1: What is the difference between fluidity and viscosity?

Solution: Fluidity means tendency to flow but viscosity refers to resistance to flow.

Example 2: Give reasons why the rate of diffusion of liquid in another liquid is greater than rate of diffusion of a solid in a liquid?

Solution: The kinetic energy of the particles of liquid is greater than the kinetic energy of the particle of solid.

Example 3: Arrange the following substances in increasing order of forces of attraction between the particles –water, sugar, oxygen.

Solution: Oxygen < Water < Sugar

Example 4: Give two reasons to justify why an iron almirah is solid at room temperature.

Solution: (i) Intermolecular forces are very large.
(ii) Intermolecular spaces, as well as, kinetic energy are very small.

Thus, the molecules are held very, very tightly, as a result, the iron almirah has a definite shape and definite volume, and hence, is a solid

FUNDAMENTAL UNLOCKED- (FU#1)

Q.1 Name two processes which provide the best evidence for the motion of particles of matter?

Q.2 A gas exerts pressure on the walls of the containers. Explain.

Interconversion of States of Matter

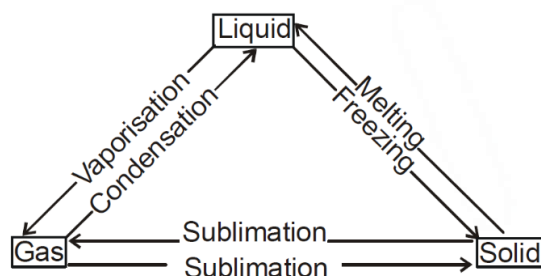
The phenomenon of change of matter from one state to another state and back to original state, by altering the conditions of temperature and pressure, is called



interconversion of states of matter.

The various states of matter can be interchanged into one another by altering the conditions of -

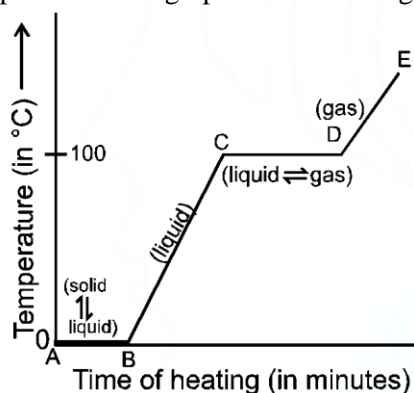
- (a) Temperature (b) Pressure.



Interconversion of states of matter

(a) Effect of Temperature :

We can show the change of temperature with time in the form of a temperature-time graph drawn by using the readings obtained in the experiment of conversion of ice to water and conversion of water to steam [Activity No 1 and 2]. Such a temperature-time graph is shown in figure.



Temperature Time Graph

We can understand the above graph by taking an example of water. In this graph at point A, we have all ice. As we heat it, the ice starts melting to form water but the temperature of ice and water mixture does not rise. It remains constant at 0°C (at line AB) during the melting of ice. At point B, all the ice has melted to form water. Thus, we have only water at point B.

Explanation: On increasing the temperature of solids, the kinetic energy (K.E.) of particles increases. Due to the increase in K.E., the particles start vibrating with greater speed. The energy supplied by heat overcomes the force of attraction between the particles. Then, the particles leave their fixed

positions and start moving freely and thus solid melts.

Latent Heat of Fusion: The amount of heat energy that is required to convert 1 kg of solid into liquid at atmospheric pressure and at its melting point is known as the latent heat of fusion. (In Greek 'Latent' means 'Hidden') Latent heat of fusion of ice = 3.34×10^5 J/kg.

Activity - 1

To study the change of state from ice to water.

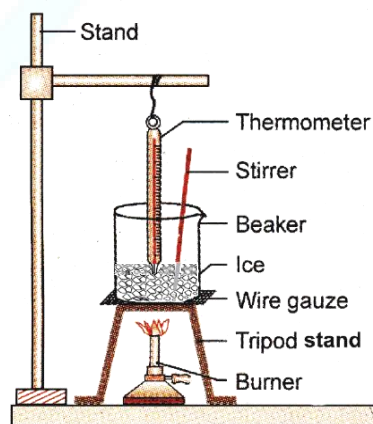
Materials required -

A 100 cc beaker, a thermometer (Celsius), a glass stirrer, a wire gauze, a tripod stand, a Bunsen burner, an iron stand, ice cubes.

Method -

Half fill the beaker with ice cubes and place it over a wire gauze and tripod stand. Suspend a Celsius thermometer from the iron stand, such that its bulb is touching the water level. Place a glass stirrer in the ice.

Record the temperature of ice. You will find it is 0°C (273 K). Now heat the beaker on a low Bunsen flame and continuously stir the contents of beaker. Record the temperature five to six times, till all the ice melts. You will observe that temperature throughout remains 0°C (273 K), till all the ice melts.



Change of state from ice to water

Now, on heating beyond point B, the temperature of water (formed from ice) starts rising as shown by the sloping line BC in the graph. When the temperature of water reaches its boiling point i.e; 100°C, water starts converting into steam. But during the process of boiling, temperature does not rise and thus constant temperature is observed (line CD). At point D all the water has boiled to form steam. Thus, we have only

steam at point D.

Explanation: When heat is supplied to water, particles start moving faster. At a certain temperature, a point is reached when the particles have enough energy to break the forces of attraction between the particles. At this temperature the liquid starts changing into gas.

Latent heat of vapourisation: The amount of heat which is required to convert 1 kg of the liquid (at its boiling point) to vapour without any change in temperature at one atmospheric pressure is known as latent heat of vapourisation. Latent heat of vapourisation of water = 22.5×10^5 J/kg.

Now on heating beyond point D, the temperature of steam rises as shown by the sloping line DE.

Activity - 2

To study the change of state from water to steam.

Materials required -

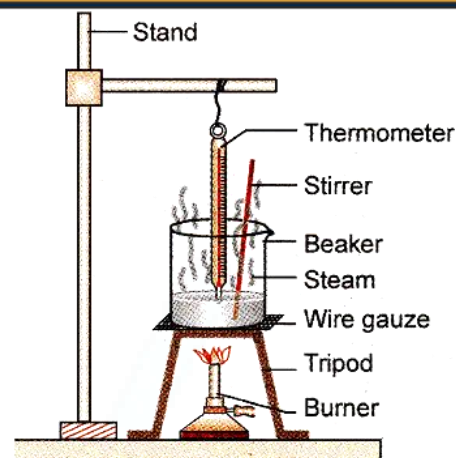
A 100 cc beaker, a thermometer (Celsius), a glass stirrer, a wire gauze, a tripod stand, a Bunsen burner, an iron stand, tap water.

Method -

Half fill the beaker with water and place it over a wire gauze and tripod stand. Suspend a Celsius thermometer from the iron stand, such that its bulb is touching the water level. Place a glass stirrer in the water.

Record the temperature of water. Heat the beaker on a low Bunsen flame and continuously stir the water with glass stirrer. Go on recording the temperature till water starts boiling. Allow the water to boil for few minutes and record its temperature.

You will notice that temperature of water rises till it starts boiling. The temperature of boiling water is 100°C (373 K). If we continue heating the water it changes into steam, but the temperature remains constant, i.e., 100°C (373 K).



Change of state from water to steam

Note: Particles of water at 0°C (273 K) have more energy as compared to particles in ice at the same temperature.

Note: Particles in steam, that is water vapour at 373 K have more energy than water at the same temperature. Because steam has absorbed extra energy in the form of latent heat of vapourisation.

Different units of measurements of temperature:

There are two main scales of temperature measurement. They are degree celsius ($^\circ\text{C}$) and kelvin (K) scale. Relation between the two is

$$T(\text{K}) = 273.15 + t(^{\circ}\text{C})$$

$$\text{As } 0^\circ\text{C} = (273.15 + 0) = 273.15 \text{ K}$$

$$100^\circ\text{C} = (273.15 + 100) = 373.15 \text{ K}$$

SI unit of temperature is kelvin (K).

Temperature is also measured in degree fahrenheit.

The relation between the degree celsius and fahrenheit temperature is

$$T = \frac{^{\circ}\text{C}}{5} = \frac{T^{\circ}\text{F} - 32}{9}$$

$$T^{\circ}\text{C} = \frac{5}{9}(T^{\circ}\text{F} - 32)$$

$$1^{\circ}\text{C} = 33.80^{\circ}\text{F}$$

Temperature at 0 K is called as absolute zero.

(b) Altering the Pressure on Matter:

The difference in various states of matter is due to the different intermolecular spaces between their particles. So, when a gas is compressed the intermolecular space between its particles decreases and ultimately it will be converted into liquid.



e.g.: Carbon dioxide (CO_2) is a gas under normal conditions of temperature and pressure. It can be liquefied by compressing it to a pressure 70 times more than atmospheric pressure.

Solid CO_2 is known as '**Dry ice**'. Solid CO_2 is extremely cold and it is used to 'deep freeze' food and to keep ice-cream cold.

Applying pressure and reducing temperature can liquefy gases.

Out of the two factors, the effect of temperature is more important. Because there is a certain minimum temperature above which the gases do not liquefy, provided how high pressure is applied. This characteristic temperature is known as the critical temperature of the gas.

Unit of pressure:

Atmosphere (atm) is a unit for measuring pressure exerted by a gas.

The S.I. unit of pressure is Pascal (Pa.)

$1 \text{ atm} = 1.01 \times 10^5 \text{ Pa}$.

Note:

The SI unit of mass is kilogram (kg).

The SI unit of volume is cubic meter (m^3).

The common unit of measuring volume is litre (L).

$1 \text{ L} = 1 \text{ dm}^3$

$1 \text{ L} = 1000 \text{ mL} = 1000 \text{ cm}^3$

$1 \text{ mL} = 1 \text{ cm}^3$

Every particle of matter exerts a special force to pull neighbouring particles towards itself, and this force is called as 'attraction force' but particles come closer only upto some extent. When they come very close a repulsive force operates on them which helps in retaining each particle's identity.

Example 5: Why is ice at 273 K more effective in cooling than water at the same temperature.

Solution: Ice at 273 K will absorb heat energy or latent heat from the medium to overcome the fusion to become water. Due to absorption of energy the temperature of surroundings gets lowered or cooling is caused. Since water is already present in a liquid state so it does not absorb energy from the surroundings. Thus, ice at 273 K causes more cooling than water at the same temperature.

Example 6: What produces more severe burns, boiling water or steam?

Solution: When water (liquid form) at 373 K is converted into steam at 373 K, it absorbs energy equal to latent heat of vaporisation ($22.6 \times 10^5 \text{ J/kg}$) from surroundings. Thus, steam (vapour form of water) at 373 K (100°C) have more energy than water at the same temperature and hence, steam produces more severe burns than boiling water.

FUNDAMENTAL UNLOCKED- (FU#2)

Q.1 At what temperature can water exist in all three states?

Q.2 What do you understand by the term latent heat?

Q.3 Name any two sublimable substances.

Q.4 Name and mention the temperature at which liquid changes into a gas at constant temperature.

Example 7: Out of water and petrol which is more volatile?

Solution: The petrol is more volatile than water because the force of attraction between the particles of petrol is less than water.

Example 8: Why do we feel cold after taking a hot bath?

Solution: The hot water takes heat from the body and evaporates. Thus, the body loses heat, and we feel cold.

Example 9: Why does ice floats on water?

Solution: Solids generally have higher density than liquids but ice, due to its specific structure has larger interparticle spaces and hence has lower density than liquid water. As a result, ice floats on water.

Example 10: Ice is at 273 K more effective in cooling, than water at the same temperature, why?

Solution: One kilogram of ice at 273 K, needs 3,36,000 J of heat energy in order to form water at 273 K. As ice can extract out large amount of heat energy on melting to form water at the same temperature, therefore, it is more effective in cooling.




FUNDAMENTAL UNLOCKED- (FU#3)

- Q.1** What is the difference between evaporation and boiling?
- Q.2** Why should wet clothes be spread while drying?

- Q.3** Why do we wear cotton clothes in summer?
- Q.4** Why do water droplets appear in a glass containing ice cold water?

ANSWER KEY
FUNDAMENTAL UNLOCKED- (FU#1)

- Q.1** Diffusion and Brownian motion are the two processes which provide best evidence for the motion of particles in matter.
- Q.2** A gas exerts pressure on the walls of the container because the particles of gas have the highest kinetic energy and they move randomly, they hit the walls of the container as well as each other. As a result, the gas particles exert pressure on the walls of the container.

FUNDAMENTAL UNLOCKED- (FU#2)

- Q.1** Water can coexist in all three states as 273.16 K at 611.2 Pa and is known as triple point of water.
- Q.2** Latent heat is the energy released or absorbed, by a body during a constant-temperature process. Two common forms of latent heat are latent heat of fusion (melting) and latent heat of vaporization (boiling). In both cases the change is endothermic, meaning that the system absorbs energy.
- Q.3** Camphor and Naphthalene balls are two examples of sublimable substance.
- Q.4** The temperature at which the liquid changes into gaseous state at atmospheric pressure is known as the boiling point. Boiling point of water is 100°C.

FUNDAMENTAL UNLOCKED- (FU#3)

- Q.1** The difference is boiling occurs in the bulk of the liquid, depending on the heat source. Whereas evaporation only takes place at the surface of the liquid. Boiling requires certain temperature at certain pressure, and continuous heating source, while evaporation works at any temperature and pressure
- Q.2** Spreading out clothes to dry them will give larger surface area to water for evaporation. Consequently, more water molecules would vanish in a shorter time and clothes will dry faster.
- Q.3** We wear cotton clothes during summer as cotton absorbs sweat from the body, exposing us to the atmosphere for easy evaporation. As we tend to sweat more during summer cotton fabric absorbs sweat and helps the body to cool down.
- Q.4** Sometimes we see water droplets on the outer surface of the glass containing ice-cold water this is because the water vapour present in air, on encountering the cold glass of water, loses energy and gets converted to liquid state, which we see as water droplets.





EXERCISE - I

Single Correct Type Questions

1. Which of the following is/are rigid(s)?
(A) Solids (B) Liquids
(C) Gases (D) Both (B) and (C)
2. Which of the following statements is/are correct?
(A) Intermolecular forces of attraction in solids are maximum
(B) Intermolecular forces of attraction in gases are minimum
(C) Intermolecular spaces in solids are minimum
(D) All of the above
3. What happens to the volume of the aqueous solution when small amount of sugar is dissolved in it?
(A) Volume increases
(B) Volume decreases
(C) Volume first increases then decreases
(D) No change in volume
4. Which of the following is not correct for gases?
(A) Gases have definite mass
(B) Gases have definite shape
(C) Gases have definite volume
(D) Both (B) and (C)
5. Which of the following is not an example of matter?
(A) Air (B) Feeling of cold
(C) Dust (D) None of these
6. Which of the following statements is/are correct?
(A) Interparticle spaces are maximum in the gaseous state of a substance
(B) Particles which constitute gas follow a zig-zag path
(C) Solid state is the most compact state of a substance
(D) All are correct
7. Which of the following statements does not go with the liquid state?
(A) Particles are loosely packed in the liquid state compared to solid state
(B) Fluidity is the maximum in the liquid state
(C) Kinetic energy of particles in liquid state are less than gas
(D) Liquids take up the shape of that container in which these are placed
8. Melting & freezing point of water
(A) are same
(B) have large difference between them
(C) have close difference between them
(D) None of these
9. The boiling point of alcohol is 78°C . What will be the temperature in Kelvin scale?
(A) 373 K (B) 351 K
(C) 375 K (D) 78 K
10. Latent heat of vaporisation of water is -
(A) $2.25 \times 10^2 \text{ J/kg}$ (B) $22.5 \times 10^5 \text{ J/kg}$
(C) $3.34 \times 10^5 \text{ J/kg}$ (D) $33.4 \times 10^2 \text{ J/kg}$
11. S.I. unit of temperature is -
(A) Kelvin (B) Celsius
(C) Both (D) None
12. In sublimation process
(A) solid changes into liquid
(B) liquid changes into gas
(C) solid changes directly into gas
(D) None of these
13. When a liquid starts boiling, the further heat energy which is supplied
(A) is lost to the surrounding as such
(B) increases the temperature of the liquid
(C) increases the kinetic energy of the liquid
(D) is absorbed as latent heat of vaporisation by the liquid



14. During evaporation of liquid
 - (A) the temperature of the surrounding falls
 - (B) the temperature of the surrounding rises
 - (C) the temperature of the surrounding remains unchanged
 - (D) all statements are wrong
15. On a humid day rate of evaporation
 - (A) is more
 - (B) is less
 - (C) initially more, later on less
 - (D) remains same
16. During evaporation, particles of a liquid change into vapours only
 - (A) from the surface
 - (B) from the bulk
 - (C) from both surface and bulk
 - (D) neither from surface nor from bulk
17. Rate of evaporation depends upon
 - (A) temperature (B) surface area
 - (C) humidity (D) All of these
18. In which phenomenon water changes into water vapour below its boiling point?
 - (A) Evaporation
 - (B) Condensation
 - (C) Boiling
 - (D) No such phenomena exists
19. During summer water kept in earthen pot becomes cool because of the phenomena -
 - (A) Diffusion
 - (B) Transpiration
 - (C) Osmosis
 - (D) Evaporation
20. Which of the following factors do not affect the rate of evaporation -
 - (A) Depth of liquid
 - (B) Humidity of surrounding air
 - (C) Temperature of liquid
 - (D) Surface area of liquid
21. The melting points of three solids A, B and C are 0°C , 4°C and 10°C respectively. What are the melting points in Fahrenheit scale respectively?
 - (A) 273°F , 277°F , 283°F
 - (B) 32°F , 36°F , 42°F
 - (C) 32°F , 39.2°F , 50°F
 - (D) 33.8°F , 37.8°F , 43.8°F
22. Four liquids A, B, C and D have their boiling points 100°C , 85°C , 56°C and 120°C respectively, the liquid with highest rate of evaporation is:
 - (A) D (B) C (C) B (D) A
23. From the given substances, identify the correct ratio of non-sublimable to sublimable components.
[Iodine, Camphor, Common salt, Dry ice, Blue vitriol, Napthalene]
 - (A) 2:1 (B) 1:2 (C) 1:5 (D) 1:1
24. While doing an experiment, student accidentally drops liquids A and B on back of the hand. Liquid A was giving more cooling sensation than B, which of the following conclusion can be drawn about liquid A and liquid B?
 - (A) The boiling point of A is higher than B
 - (B) The boiling point of liquid A and B are equal
 - (C) Liquid A has higher latent heat of vaporisation than liquid B
 - (D) Liquid A has lower latent heat of vaporisation than liquid B
25. Teacher was explaining the concept of diffusion to students A and B. He asked both of them to take 100mL of water in beaker. Student A heated the water at 50°C but student B maintained the water at room temperature they both added 5 drops of ink in it, what observations can be noted?
 - (A) Ink spreads faster in Student A beaker
 - (B) Ink spreads faster in Student B beaker
 - (C) Ink spreads with same rate in both beakers
 - (D) Ink settles down at bottom in beaker B and spreads evenly in beaker A

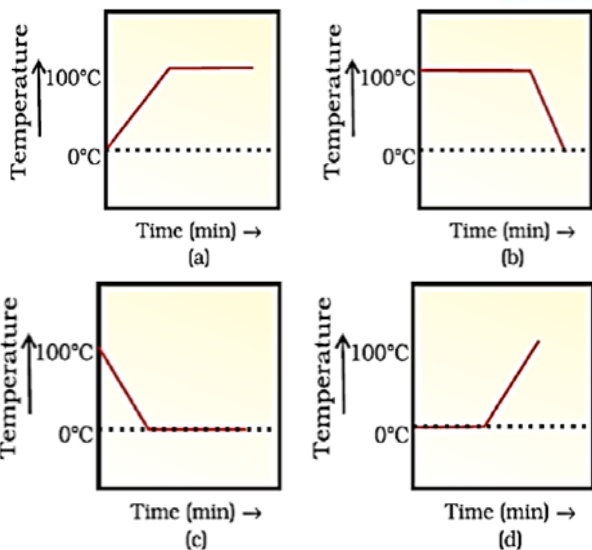


Very Short Answer Type Questions

- What is sublimation?
- What is the similarity between sponge and the gaseous state?
- Why do gases diffuse very fast?
- Arrange the following substances in the increasing order of interparticle forces.
Water, common salt, nitrogen
- When a solid melts, its temperature remains the same, so where does the heat energy go?
- Name the physical state of matter which can be easily compressed?
- What is plasma?
- Name the process by which a gas converts to liquid.
- Give two examples which undergo sublimation process?
- Name the process by which a liquid changes into vapour at any temperature.
- It is a hot summer day, Ravi and Deepak are wearing cotton and nylon clothes respectively. Who do you think would be more comfortable and why?
- Define diffusion. Give one example each of diffusion of (i) a solid into a liquid, (ii) a liquid into another liquid, (iii) a gas into a liquid and (iv) a gas into another gas.
- How is water kept in an earthen pot (Matka) become cool during summer?
- Why a desert cooler is more effective in summer?
- Comment on the following statements:
(a) Evaporation causes cooling.
(b) Rate of evaporation of an aqueous solution decreases with increase in humidity.
(c) Sponge though compressible is a solid.
- Define
(a) Latent heat of fusion
(b) Latent heat of vaporization.
- What is the difference between evaporation and boiling?
- Convert the following temperature into degree Celsius.
(a) 410 K (b) 643 K
- Why does our palm feel cold when we put some acetone, petrol or perfume on it?

Short Answer Type Questions

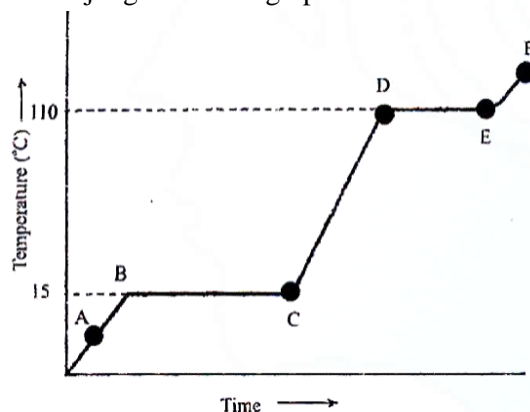
- A student heats a beaker containing ice and water. He measures the temperature of the content of the beaker as a function of time. Which of the following Fig. would correctly represent the result? Justify your choice.



Long Answer Type Questions

- Water as ice has a cooling effect, whereas water as steam may cause severe burns. Explain these observations.
- (a) Conversion of solid to vapour is called sublimation. Name the term used to denote the conversion of vapour to solid.
(b) Conversion of solid state to liquid state is called fusion; what is meant by latent heat of fusion?

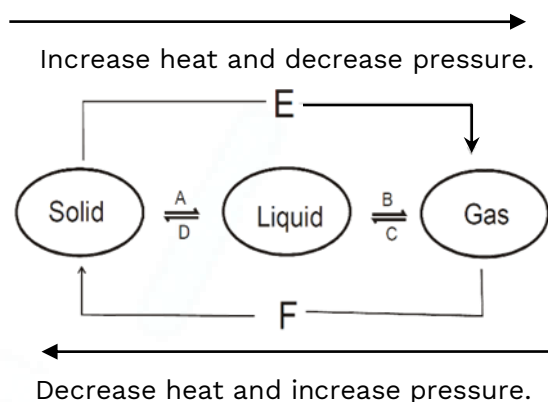
3. Give reasons-
 - (a) A gas fills completely the vessel in which it is kept.
 - (b) A gas exerts pressure on the walls of the container.
4. You are provided with a mixture of naphthalene and ammonium chloride by your teacher. Suggest an activity to separate them with well labelled diagram.
5. The graph shows the heating curve for a pure substance. The temperature rises with time as the substance is heated:
 - (a) What is the physical state of the substance at the points A, B, C, D, E and F?
 - (b) What is the melting point of the substance? What is its boiling point?
 - (c) What happens to the temperature during change of the state?
 - (d) The substance is not water. How can you judge from the graph?



6. Explain the factors affecting the rate of evaporation.
7. What are the characteristics of particles of matter?
8. Tabulate the difference between solid, liquid and gas with examples?

Case Based Question

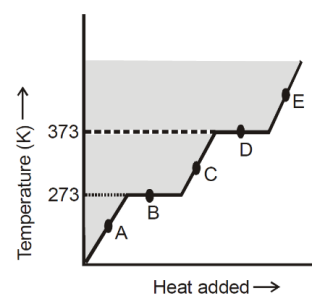
1. Name A, B, C, D, E and F in the following diagram showing change in their state:



Following diagram shows conversions of different states of matter observe it carefully and answer the following questions.

- (I) Name the process A, B, C, D.
- (II) What is the process E and F called?
- (III) Name some examples of substances that undergoes process E?
- (IV) What happens when gases are heated for thousands of $^{\circ}\text{C}$?
- (V) What are the conditions required for the process C?

2. The heating curve of a pure substance at one atmosphere pressure is shown in the following figure.



- (I) What is the physical state of the substance at points A, B, C, D and E.
- (II) What is the melting point of the substance?
- (III) What is the boiling point of the substance?
- (IV) What happens to the temperature when the substance is changing its state?
- (V) Can the given substance be ice at point A?



EXERCISE - II

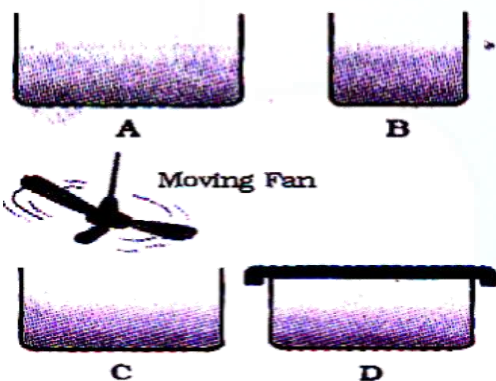
HOTS

1. The gradual mixing of one molecule of gas with the other based on their kinetic energy is called
- (A) Solubility (B) Diffusion
(C) Effusion (D) Dissolution

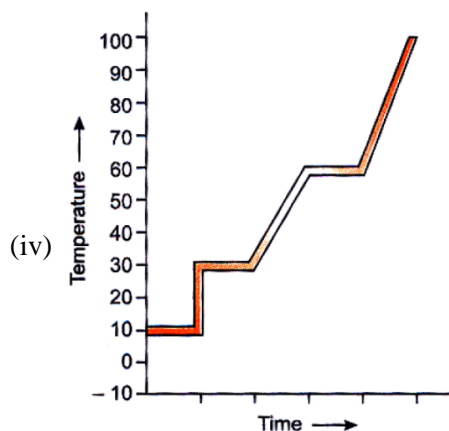
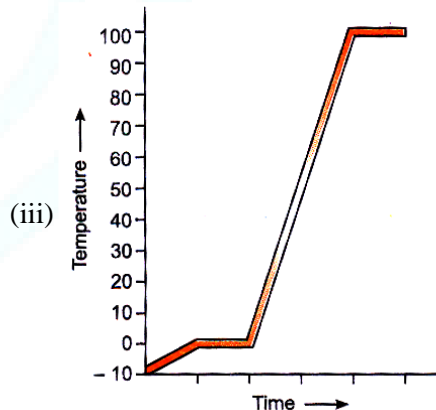
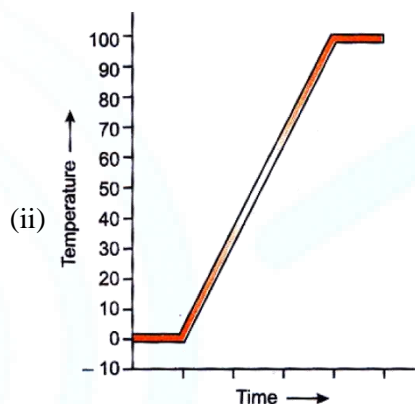
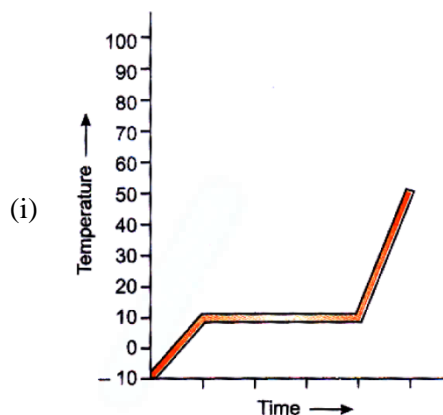
2. A gas confined in a rigid container is heated. Which of the following statements is true?
- (A) The pressure will increase.
(B) The number of moles of gas will increase.
(C) The volume will increase.
(D) The density will increase.

3. A gas jar filled with bromine gas (denser than air) was placed over a gas jar containing air. The gases were allowed to settle for four hours. What do we observe?
- (A) Bromine remains on the top.
(B) Bromine settles at the bottom.
(C) Bromine gets diffused in the air.
(D) Bromine starts moving towards the bottom.

4. Look at the figure and suggest in which of the vessel A, B, C or D the rate of evaporation will be the highest?



5. Ice at -10°C is heated slowly until the water formed starts boiling. The temperature time plot that will explain the changes correctly is represented as :



- (A) (i) and (iii) are correct
 (B) Both (ii) and (iv) are correct
 (C) only (iii) is correct
 (D) only (iv) is correct
6. Water can exist as a liquid at 100°C. To keep water in its liquid form even beyond 100°C, we should:
 (A) Increase the volume of the container
 (B) Decrease the pressure
 (C) Increase the pressure
 (D) Reduce the volume of the liquid
7. What is the temperature at which the density of water is the maximum?
 (A) 100°C (B) 0°C (C) -10°C (D) 4°C
8. Name the technique to separate salt from sea-water:
 (A) Centrifugation (B) Evaporation
 (C) Sublimation (D) All of these
9. Which of the following substance/s can sublime?
 (A) Camphor
 (B) Solid CO₂
 (C) Ammonium chloride
 (D) All of these
10. Which of them has maximum intermolecular forces
 (A) Liquid (B) Gas
 (C) Solid (D) None of these
11. Select the correct order of evaporation.
 (A) water > alcohol > kerosene oil > petrol
 (B) alcohol > petrol > water > kerosene oil
 (C) petrol > alcohol > water > kerosene oil
 (D) petrol > alcohol > kerosene oil > water
12. Physical state of water at 0°C is only
 (A) Solid
 (B) Liquid
 (C) Gas
 (D) Solid and liquid both

13. Water can be made to boil at 115°C by _____ its surface pressure.
 (A) Slowly decreasing
 (B) Keeping unchanged
 (C) Rapidly decreasing
 (D) Increasing
14. A thermometer is inserted into a beaker filled with ice at 0°C. The beaker is heated slowly. The temperature does not rise for some time. This is because -
 (A) ice is very cold
 (B) heat was used for changing ice at 0°C to water at 0°C
 (C) the density of water is more than ice
 (D) the density of water is less than the ice
15. The water boils when
 (A) Saturated vapour pressure of water becomes equal to the atmospheric pressure
 (B) Boiling point of water becomes more than atmospheric pressure
 (C) Saturated vapour pressure of water is less than atmospheric pressure
 (D) Vapour pressure of water becomes more than atmospheric pressure.

Assertion and Reason

- (A) A and R are correct and R is the correct explanation of A
 (B) A and R are correct, but R is not the correct explanation of A
 (C) A is true but R is false
 (D) Both A and R are false
1. **Assertion (A):** Carbonated drinks produce a hiss sound when opened.
Reason (R): Carbonated drinks are prepared by the diffusion of gas in water and when opened, the gases come out of the pressurized bottles causing a hissing sound.
2. **Assertion (A):** Smell of hot sizzling food reaches several meters away.
Reason (R): Particles of matter are continuously moving and at high temperature they have high kinetic energy.



3. **Assertion (A):** We sprinkled water on the road or open ground in summer.

Reason (R): Evaporation causes cooling by taking away heat from surroundings.

4. **Assertion (A):** In a state transition, composition of matter does not change.

Reason (R): State transition is a chemical change.

5. **Assertion (A):** It is easy to sip hot tea from a cup rather than a saucer.

Reason (R): Larger the surface area, less is the rate of evaporation.




EXERCISE - III
Previous Year Questions

1. Solids cannot be compressed because
(NSO Stage-I-2011)
(A) The constituent particles are closely packed
(B) The movement of the constituent particles is restricted
(C) The intermolecular attractive forces are very strong
(D) None of these
2. The energy required to change liquid water into water vapour at the same temperature is called latent heat of vaporization. What does this energy do? (NSO Stage-I-2012)
(A) It increases the average separation of the water molecules.
(B) It decreases the average speed of the water molecules.
(C) It raises the temperature of the air near the water.
(D) It splits the water molecules into their separate atoms.
3. Boiling point of water is
(NSO Stage-I-2013)
(A) 273K (B) 0K (C) 373K (D) 100K
4. The freezing and boiling points of a substance 'P' are -220°C and -185°C respectively. At which of the following range of temperatures will 'P' exist as a liquid?
(NSO Stage-I-2014)
(A) Between -175°C and -210°C
(B) Between -190°C and -225°C
(C) Between -200°C and -160°C
(D) Between -195°C and -215°C
5. How many free surfaces exists in case of solids
(NTSE Stage-I-2014)
(A) One (B) Two
(C) Three (D) Infinitely many
6. By which property are gases and liquids different from solids? (NTSE Stage-I-2014)
(A) Volume (B) Mass
(C) Conductivity (D) Fluidity
7. Ice is floating on water in a beaker when ice completely melts then level of water in beaker:
(NTSE Stage-I-2015)
(A) increases
(B) decreases
(C) remains the same
(D) first increases decreases
8. The boiling point of a gas is -80°C . This temperature is equivalent to:
(NTSE Stage-I-2015)
(A) -193 K (B) 193 K
(C) 353 K (D) -353 K
9. When the solid melts, its temperature:
(NTSE Stage-I-2015)
(A) increases
(B) decreases
(C) remain constant
(D) first increases then decrease
10. In which state of a substance, it has the fixed shape?
(NTSE Stage-I-2017)
(A) Liquid (B) Liquid and Gas
(C) Gas (D) Solid
11. The physical state of water at 298 K temperature is:
(NTSE Stage-I-2017)
(A) Gaseous (B) Solid
(C) Liquid (D) Plasma
12. The substance showing sublimation property among the following is
(NTSE Stage-I-2018)
(A) Calcium oxide
(B) Copper sulphate
(C) Potassium nitrate
(D) Camphor





13. The rate of evaporation increases with
(NTSE Stage-I-2018)
- (A) Increase of surface area, increase of temperature, decrease in humidity and increase in wind speed
- (B) Increase of surface area, decrease of temperature, decrease in humidity and decrease in wind speed
- (C) decrease of surface area, increase of temperature, increase in humidity and increase in wind speed
- (D) decrease of surface, increase in temperature, decrease in humidity and decrease in wind speed

14. Arrange the following in the increasing order of forces of attraction (NTSE Stage-I-2018)
- (A) water, air, sugar
- (B) O_2 , H_2O , sugar
- (C) salt, air, fruit juice
- (D) sugar, oil, air
15. On converting $25^\circ C$, $38^\circ C$ and $66^\circ C$ to Kelvin scale, the correct sequence of temperatures will be (NTSE Stage-I-2022)
- (A) 298 K, 311 K and 339 K
- (B) 298 K, 300 K and 338 K
- (C) 273 K, 278 K and 543 K
- (D) 298 K, 310 K and 338 K

ANSWER KEY

EXERCISE-I

Single Correct Type Questions

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	D	D	D	B	D	B	A	B	B	A	C	D	A	B
Que.	16	17	18	19	20	21	22	23	24	25					
Ans.	A	D	A	D	A	C	B	B	C	A					

EXERCISE-II

HOTS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	A	C	C	C	C	D	B	D	C	D	D	D	B	A

Assertion and Reason

Que.	1	2	3	4	5										
Ans.	A	A	A	C	D										

EXERCISE-III

Previous Year Questions

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	A	C	D	D	D	A	B	C	D	C	D	A	B	A





DPP

Daily Practice Problems

SUBJECT: CHEMISTRY**CLASS-9****DPP NO. 1****TOPIC : MATTER IN OUR SURROUNDINGS****Multiple Choice Questions**

1. A few substances are arranged in the increasing order of 'forces of attraction' between their particles. Which one of the following represents a correct arrangement?
(A) Water, air, wind (B) Air, sugar, oil
(C) Oxygen, water, sugar (D) Salt, juice, air
2. Which of the following statement is correct?
(A) Matter has mass. (B) Matter occupies space.
(C) Matter has volume. (D) All of these
3. Spaces between particles of matter are called
(A) voids (B) atoms (C) molecules (D) density
4. Which of the following matter possesses fixed shape?
(A) Solid (B) Liquid (C) Both (A) and (B) (D) Gas
5. Liquids do not have
(A) definite volume (B) indefinite shape (C) rigidity (D) one free surface
6. Identify the pair which does not show diffusion process.
(A) Water - Alcohol (B) Ink - Water (C) Oxygen- Nitrogen (D) Chalk – Water
7. Particles of matter
(A) are big enough in size (B) have no spaces between them
(C) repel each other (D) are continuously moving
8. How many of the following are examples of solid?
Wooden block, Rubber, Copper sulphate crystal, Milk, Oxygen, Cold-drink, Sponge
(A) 3 (B) 4 (C) 2 (D) 7
9. Consider the following statements:
a. Gases have high density.
b. Gases can be compressed more than solids.
c. Gases have very specific shapes.
d. Gases undergo diffusion fastest.
Which of these statement(s) is/are correct?
(A) a and c (B) a and d (C) b and d (D) a and c

10. Based on the statements given here choose the correct answer.
a. Some sugar can be added to a full glass of water without causing overflow.
b. A liquid is continuous even though spaces are present between the molecules.
(A) Both a and b are true. (B) Both a and b are true.
(C) Only a is true (D) Only b is true.
11. Select the correct order of evaporation for water, alcohol, petrol and kerosene oil
(A) Water > alcohol > kerosene oil > petrol
(B) Alcohol > petrol > water > kerosene oil
(C) Petrol > alcohol > water > kerosene oil
(D) Petrol > alcohol > kerosene oil > water
12. The melting point temperature of the solid state of a substance is 40°C . The freezing point temperature of the liquid state of the same substance will be
(A) 35°C (B) 40°C (C) 45°C (D) Can't predict
13. Gases can be liquefied either by lowering the temperature or applying pressure. This shows that
a. Molecules of a gas repel each other.
b. There exists a kind of intermolecular attraction between molecules of a gas.
c. Molecules of a gas are in a state of random motion.
d. Intermolecular forces between gas molecules increases when distance between molecules decreases.
(A) a and b (B) a and d (C) b and d (D) a and c
14. The rate of evaporation decreases with
(A) increase in humidity (B) increase of temperature
(C) increase in wind speed (D) increase of surface area
15. A change of state directly from solid to gas without changing into liquid state (or vice versa) is called
(A) Evaporation (B) Sublimation (C) Diffusion (D) Condensation
16. Evaporation always causes
(A) thermal expansion (B) liquefaction
(C) cooling (D) All of these
17. What happens when a fixed amount of oxygen gas is taken in a cylinder and compressed at constant temperature?
a. Number of collisions of oxygen molecules per unit area of the wall of the cylinder increase.
b. Oxygen (O_2) gets converted into ozone (O_3).
c. Kinetic energy of the molecules of oxygen gas increases.
(A) a and c (B) b and c (C) c only (D) a only

18. Bromine has a melting point of -2°C and a boiling point of 59°C . Identify at what temperature will bromine have a definite volume but no definite shape?
(A) 65°C (B) 36°C (C) -26°C (D) 0 K
19. When we put some crystals of potassium permanganate in a beaker containing water, we observe that after sometime whole water has turned pink. This is due to
(A) Boiling
(B) melting of potassium permanganate crystals
(C) Sublimation of crystals
(D) diffusion
20. At what temperature on the Kelvin scale does liquid nitrogen boil? (Its boiling point is -196°C)
(A) 469 K (B) 237 K (C) 330 K (D) 77 K

Very short answer type Questions:

1. Mention two ways to liquefy atmospheric gases.
2. A sponge is a solid but can be easily compressed. Give reason.
3. Which property of gas is used in supplying oxygen cylinders to hospitals?
4. How does the smell of the cooked food reach our nostrils even without entering the kitchen?
5. How will you show the presence of water vapour in the air?

Short answer type Questions:

1. At normal temperature and pressure, a sample of water was found to boil at 102°C . Is the water drinkable? At 0°C , will this water freeze?
2. State any four characteristics of solids.
3. Predict the physical state of matter in each case from the following characteristics.
(a) It has a definite shape but no definite volume.
(b) It is rigid and highly incompressible.
(c) Kinetic energy of particles is the minimum in this state.
(d) It represents the most highly compressible form of matter.
4. (a) Convert -23°C into Kelvin (b) -273°C into Kelvin
5. Give reason for each of the following statements:
(a) Evaporation causes cooling.
(b) Heat is unbearable after rain in hot season.

Long answer type Questions:

- How does the following affect the rate of evaporation of a liquid?
(a) Nature of the liquid (b) Temperature (c) Humidity
- Distinguish between evaporation and boiling.
- What is meant by vapourisation?
 - Define latent heat of fusion.
 - Why should we spread out our clothes for drying?

Case based Study

- The pressure of gas above a liquid affects the boiling point. In an open system, this is called atmospheric pressure. The greater the pressure, the more is the energy required for liquids to boil, and the higher the boiling point.

Higher Atmospheric Pressure = More energy required to boil = higher boiling point

In an open system, this can be visualized as air molecules colliding with the surface of the liquid are creating pressure. This pressure is transmitted throughout the liquid and makes it more difficult for bubbles to form and for boiling to take place. If the pressure is reduced, the liquid required less energy to change to a gaseous phase, and boiling occurs at a lower temperature.

 - The boiling point of a liquid is very high. What does that indicate?
 - Why does steam cause more severe burns than boiling water at the same temperature?
- The molecules leaving a liquid through evaporation create an upward pressure as they collide with air molecules. This upwards push is called the vapour pressure. Different substances have different vapour pressure and therefore different boiling points. This is due to differing intermolecular forces between molecules.

The vapour pressure of a liquid lowers the amount of pressure exerted on the liquid by the atmosphere. As a result, liquids with high vapour pressures have lower boiling points. vapour pressure can be increased by heating a liquid and causing more molecules to enter the atmosphere. At the point where the vapour pressure is equal to the atmospheric pressure boiling will begin. In effect, without any external pressure the liquid molecules will be able to spread out and change from a liquid to a gaseous phase. The gas, as bubbles in the liquid, will rise to the surface and be released into the atmosphere.

 - Define evaporation.
 - How does increase in surface area affects the rate of evaporation? Explain with an example.

ANSWER KEY										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	C	D	A	A	C	D	D	B	C	C
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	D	B	C	A	B	C	D	B	D	D

FOUNDATION

CLASS-IX

SAMPLE

MATHEMATICS



1

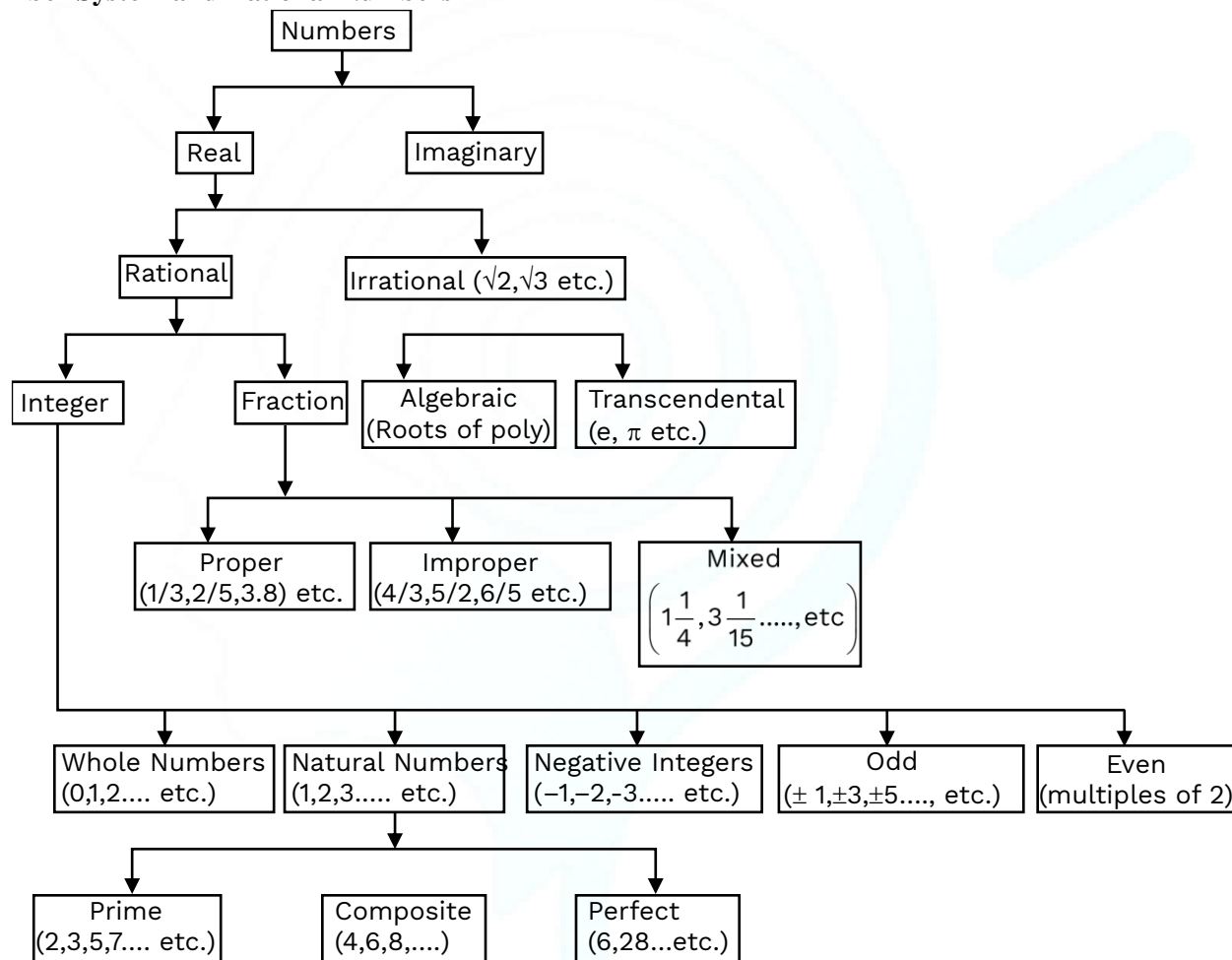
NUMBER SYSTEM

Introduction

A number system defines a set of values used to represent quantity. We talk about the number of people attending class, the number of modules taken per student, and also use numbers to represent grades

achieved by students in tests. The study of number systems is not just limited to computers. We apply numbers every day, and knowing how numbers work will give us an insight into how a computer manipulates and stores numbers.

Number System and Rational Numbers



(a) Classification of Numbers

(i) **Natural numbers** : Counting numbers are known as natural numbers.

$$N = \{1, 2, 3, 4, \dots\}$$

(ii) **Whole numbers** : All natural numbers together with 0 form the collection of all whole numbers.

$$W = \{0, 1, 2, 3, 4, \dots\}$$

(iii) **Integers** : All whole numbers and negative of natural numbers form the collection of all integers.

$$I \text{ or } Z = \{\dots, -3, -2, -1, 0, 1, 2, 3, \dots\}$$

(iv) **Rational numbers** : The numbers which can be expressed in the form of $\frac{p}{q}$, where p and q are

integers and $q \neq 0$. For example : $\frac{2}{3}, -\frac{37}{15}$

All natural numbers, whole numbers and integers are rational.



(v) **Real numbers** : Numbers which can represent actual physical quantities in a meaningful way are known as real numbers. They can be represented on the number line. Real numbers include all rational and irrational numbers.

(vi) **Prime numbers** : Prime numbers are natural numbers greater than 1 and each of which is divisible by 1 and itself only. For example : 2, 3, 5, 7, 11, 13, 17, 19, 23, ... etc.

(vii) **Composite numbers** : All natural numbers greater than 1 which are not prime numbers. 1 is neither prime nor composite number.

(viii) **Co-prime Numbers** : If the H.C.F. of the given numbers (not necessarily prime) is 1 then they are known as co-prime numbers. For example : 4, 9 are co-prime as H.C.F. of (4, 9)=1. Any two consecutive numbers will always be co-prime.

(ix) **Even Numbers** : Integers divisible by 2
 $E = \{ \dots, -2, 0, 2, \dots \}.$

(x) **Odd Numbers** : Integers not divisible by 2
 $E = \{ \dots, -3, -1, 1, 3, \dots \}.$

(b) Rational number in decimal form

(i) Terminating Decimal :

Let x be a rational number whose decimal expansion terminates. Then, x can be expressed in the form $\frac{p}{q}$ where p and q are co-prime, and prime factorization of q is of the form $2^m \times 5^n$, where m, n are non-negative integers. In such finite decimal number of digit occurs after decimal.

For example : $\frac{1}{2} = 0.5, \frac{11}{16} = 0.6875, \frac{3}{20} = 0.15$
 etc.

(ii) Non-Terminating and Repeating (Recurring Decimal) :

Let $x = \frac{p}{q}$ be a rational number, such that the

prime factorization 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. In this a set of digits or a digit is repeated continuously.

For example : $\frac{2}{3} = 0.6666\dots = 0.\overline{6}$ and $\frac{5}{11} = 0.454545\dots = 0.\overline{45}$

(c) Representation of rational number on a real number line

Representing terminating Decimals on Number line :

The process of visualization of number on the number line through a magnifying glass is known as successive magnification.

Sometimes, we are unable to check the numbers like 3.765 and on the number line. We seek the help of magnifying glass by dividing the part into subparts and subparts into again equal subparts to ensure the accuracy of the given number.

Method to Find Such Numbers on the Number Line

- Choose the two consecutive integral numbers in which the given number lies.
- Choose the two consecutive decimal points in which the given decimal part lies by dividing the two given decimal parts into required equal parts.
- Visualize the required number through magnifying glass.

(d) Conversion of recurring decimal into fraction

i. Long Method :

Step 1 : Take the mixed recurring decimal and let it be equal to x .

Step 2 : Count the number of nonrecurring digits after the decimal point. Let it be n .

Step 3 : Multiply both sides of equation by 10^n so that only the repeating decimal is on the right hand side of the decimal point.

Step 4 : Multiply both sides of equation obtained in step 3 by 10^m where m is the number of repeating digits in the decimal part.

Step 5 : Subtract the equation in step 3 from equation obtained in step 4.

Step 6 : Divide both sides of the resulting equation by the coefficient of x .

Step 7 : Write the rational number thus obtained in the simplest form.



ii. Direct Method :

Step 1 : To obtain numerator subtract the number formed by non-repeating digits from the complete number without decimal. (Consider repeated digits only once.)

Step 2 : To obtain denominator take number of nines = Number of repeating digits & after that put number of zeros = number of non-repeating digits.

(e) Finding Rational Numbers Between Two Integral Number :
Method - I

Let a & b are two given rational numbers such that $a < b$.

If n rational numbers are inserted between a & b . Then, multiply numerator and denominator of a

and b by $\frac{n+1}{n+1}$.

$$a = a \times \frac{n+1}{n+1} \text{ and } b = b \times \frac{n+1}{n+1}.$$

Then, as we increase the value of numerator we get rational numbers between a & b .

Method - II

Let a & b are two given rational numbers such that $a < b$ then, $a < b$.

$$\Rightarrow a + a < b + a \text{ [adding } a \text{ both sides]}$$

$$\Rightarrow 2a < a + b \Rightarrow a < \frac{a+b}{2} \text{ Again, } a < b$$

$$\Rightarrow a + b < b + b. \text{ [adding } b \text{ both sides]}$$

$$\Rightarrow a + b < 2b \Rightarrow \frac{a+b}{2} < b. \quad a < \frac{a+b}{2} < b. \text{ i.e.}$$

$$\frac{a+b}{2} b.$$

$\therefore \frac{a+b}{2}$ i.e. lies between a and b .

Hence 1st rational number between a and b is

$$\frac{a+b}{2}$$

For next rational number

$$a + \frac{a+b}{2} = \frac{2a + a + b}{2} = \frac{3a + b}{4}$$

$$\therefore a < \frac{3a+b}{4} < \frac{a+b}{2} < b.$$

$$\text{Next } \frac{\frac{a+b}{2} + b}{2} = \frac{a+b+2b}{2} = \frac{a+3b}{4}$$

$$\therefore a < \frac{3a+b}{4} < \frac{a+b}{2} < \frac{a+3b}{4} < b.$$

and continues like this.

Example 1:

Is (39, 93) a coprime ?

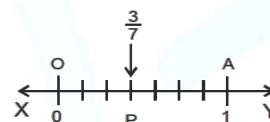
Solution:

HCF of (39, 93) is 3.

\therefore (39, 93) is not coprime.

Example 2:

Represent $\frac{3}{7}$ on a real number line.

Solution:


(i) Draw a line XY which extends endlessly in both the directions.

(ii) Take a point O on it and let it represent O (zero).

(iii) Taking the fixed length, called unit length, mark off $OA = 1$ unit, as shown in figure below

(iv) Divide OA into 7 equal parts. OP represents $\frac{3}{7}$ of a unit.

Example 3:

Represent $\frac{7}{5}$ on a real number line.

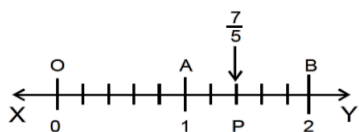
$$\text{Solution: } \frac{7}{5} = 1\frac{2}{5}$$

(i) Draw a line XY which extends endlessly in both the directions.

(ii) Take a point O on it and let it represent O (zero).

(iii) Taking the fixed length, called unit length, mark off $OA = 1$ unit and $OB = 2$ unit.

(iv) Divide OA and AB into 5 equal parts. OP represents the rational number $\frac{7}{5}$



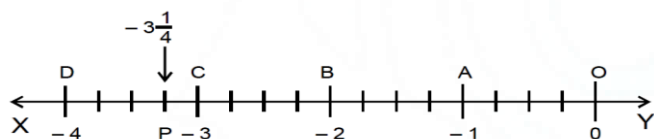
Example 4:

Represent $-\frac{13}{4}$ on a real number line.

Solution: $-\frac{13}{4} = -3\frac{1}{4}$

- (i) Draw a line XY which extends endlessly in both the directions.
- (ii) Take a point O on it and let it represent 0 (zero).
- (iii) Taking the fixed length, called unit length, mark off OA = 1 unit and OB = 2 unit and OC = 3 unit on the left side of O.
- (iv) Divide OA, AB, BC and CD into 4 equal parts. OP represents the rational number

$-\frac{13}{4}$ of a unit.



Example 5:

Represent 2.5 on a real number line.

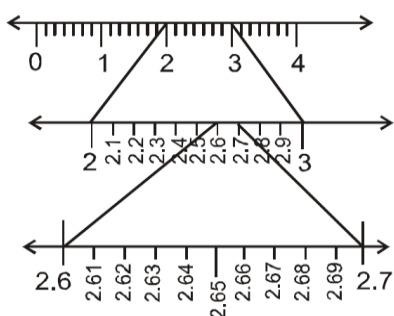
Solution:



Example 6:

Represent 2.65 on a real number line by process of magnification.

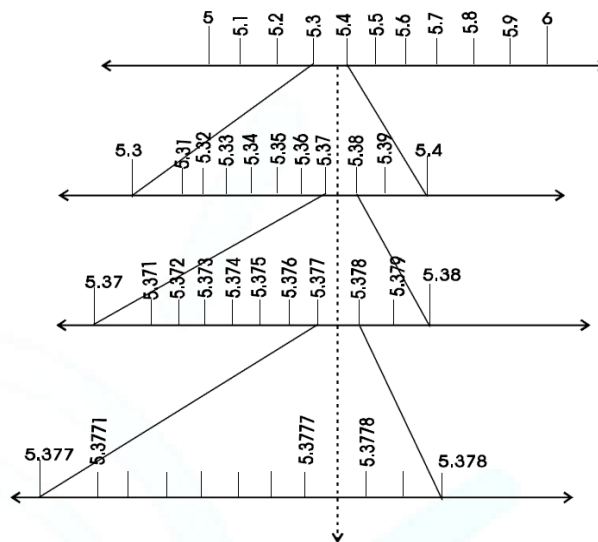
Solution:



Example 7:

Visualize the representation of 5.37 on the number line upto 5 decimal places.

Solution:



Example 8:

Express $0.\overline{6}$ to $\frac{p}{q}$ form.

Solution:

Let $x = 0.\overline{6}$

i.e. $x = 0.6666 \dots$ (i)

Multiply both sides of eq.(i) by 10.

$10x = 6.666 \dots$ (ii)

Subtract eq.(i) from eq.(ii)

$9x = 6$

$x = \frac{6}{9} = \frac{2}{3}$

Example 9:

Express $0.\overline{47}$ to $\frac{p}{q}$ form.

Solution:

Let $x = 0.47$

i.e. $x = 0.474747 \dots$ (i)

Multiply both sides of eq.(i) by 100.

$100x = 47.474747 \dots$ (ii)

Subtract eq.(i) from eq.(ii)

$100x = 47.474747 \dots$

$\frac{-x = -0.474747 \dots}{99x = 47} \Rightarrow x = \frac{47}{99}$

Example 10:

Express $0.12\overline{3}$ to $\frac{p}{q}$ to form.

Solution:

Let $x = 0.12\overline{3}$

i.e. $x = 0.12333.....$... (i)

Multiply both sides of eq.(i) by 100.

$100x = 12.333.....$... (ii)

Multiply both sides of eq.(ii) by 10

$1000x = 123.333.....$... (iii)

Subtract eq.(ii) from eq.(iii)

$1000x = 123.333....$

$- 100x = - 12.333....$

$900x = 111.000$

$\Rightarrow x = \frac{111}{900} \Rightarrow x = \frac{3 \times 37}{900} = \frac{37}{300}$

Example 11:

Express the following to $\frac{p}{q}$ form using direct

method :

(i) $0.4\overline{5}$ (ii) $0.7\overline{37}$ (iii) $0.46\overline{573}$

Solution: (i) $0.4\overline{5} = \frac{45-0}{99} = \frac{45}{99} = \frac{5}{11}$

(ii) $0.7\overline{37} = \frac{737-7}{990} = \frac{730}{990} = \frac{73}{99}$

(iii) $0.46\overline{573} = \frac{46573-46}{99900} = \frac{46527}{99900}$

Example 12:

Find 4 rational numbers between 2 and 3.

Solution: Steps :

(i) Multiplying 2 and 3 in N^r and D^r with $(4+1)$.

(ii) $2 = \frac{2 \times (4+1)}{(4+1)} = \frac{10}{5}$ & $3 = \frac{3 \times (4+1)}{(4+1)} = \frac{15}{5}$

(iii) So, the four required numbers are

$\frac{11}{5}, \frac{12}{5}, \frac{13}{5}, \frac{14}{5}$

Example 13:

Find 3 rational numbers between $\frac{1}{3}$ & $\frac{1}{2}$.

Solution: $\frac{\frac{1}{3} + \frac{1}{2}}{2} = \frac{\frac{2+3}{6}}{2} = \frac{5}{12}$

$\therefore \frac{1}{3}, \frac{5}{12}, \frac{1}{2}$

$\frac{\frac{1}{3} + \frac{5}{12}}{2} = \frac{\frac{4+5}{12}}{2} = \frac{9}{24}$

$\therefore \frac{1}{3}, \frac{9}{24}, \frac{5}{12}, \frac{1}{2}$

$\frac{\frac{5}{12} + \frac{1}{2}}{2} = \frac{\frac{5+6}{12}}{2} = \frac{11}{24}$

$\therefore \frac{1}{3}, \frac{9}{24}, \frac{5}{12}, \frac{11}{24}, \frac{1}{2}$

FUNDAMENTAL UNLOCKED- (FU#1)

Q.1 Represent the number $\frac{3}{5}$ on the number line.

Q.2 Find a fraction between $\frac{3}{8}$ and $\frac{2}{5}$.

Q.3 Insert 5 rational numbers between 3 and 4.

Q.4 Which of the following fractions yield a recurring decimal ?

$\frac{5}{3}, \frac{7}{16}, \frac{9}{14}, \frac{5}{7}, \frac{12}{5}, \frac{6}{11}$

Q.5 Represent 1. 129129129.. as a fraction.

Irrational Numbers

All real number which are not rational are called irrational numbers. These are non-recurring as well as nonterminating type of decimal numbers.

i.e. $\sqrt{2}, \sqrt[3]{4}, 2 + \sqrt{3}, \sqrt{2 + \sqrt{3}}, \sqrt[4]{\sqrt{3}}, \pi$ etc.

(a) Proof of irrationality of numbers

To prove the irrationality of a given number, process is done by contradiction method. In logic, proof by contradiction is a form of proof, and more specifically a form of indirect proof, that establishes the truth or validity of a proposition. It starts by assuming that the opposite proposition is true, and then shows that such an assumption lead to a contradiction.



(b) Insertion of irrational numbers between two real numbers

Let a and b are two given real numbers, then irrational number between a and b is $\sqrt{a \times b}$.

Provide $a \times b$ is not a perfect square.

(c) Irrational Number on a Number Line

Irrational Number in Decimal Form :

$\sqrt{2} = 1.414213\ldots$ i.e. it is non-recurring as well as non-terminating.

$\sqrt{3} = 1.732050807\ldots$ i.e. it is non-recurring as well as non-terminating.

Properties of Irrational Number :

- (i) Negative of an irrational number is an irrational number. e.g. $-\sqrt{3}, -\sqrt[4]{5}$ are irrational.
- (ii) Sum and difference of a rational and an irrational number is always an irrational number.
- (iii) Sum, product and difference of two irrational numbers is either rational or irrational number.
- (iv) Product of a rational number with an irrational number is either rational or irrational.

(d) Geometrical representation of real numbers

To represent any real number \sqrt{x} on number line we follow the following steps :

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 . Such that ABC is a straight line.

STEP V : Find the mid-point of AC by drawing the perpendicular bisector of line segment AC and mark the point as O .

STEP VI : Draw a semi 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} .

STEP VIII : Taking B as centre and BD as radius, draw an arc cutting OC produced at E . Distance BE represents \sqrt{x} .

Explanation :

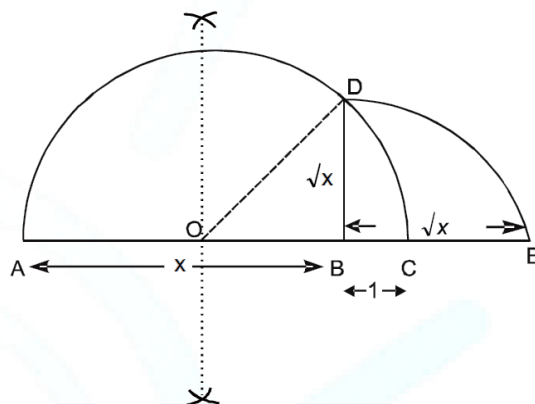
We have,

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

$\therefore AC = (x + 1)$ units

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

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



Now, $OB = AB - OA$

$$= x - \frac{x+1}{2} = \frac{x-1}{2}$$

Using Pythagoras Theorem in $\triangle OBD$, we have

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

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

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

$$\Rightarrow BD = \sqrt{\frac{4x}{4}} \Rightarrow BD = \sqrt{x}$$

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

Example 14:

Prove that $\sqrt{2}$ is an irrational number.

Solution:

Let assume on the contrary that $\sqrt{2}$ is a rational number.

Then, there exists positive integer a and b such

that $\sqrt{2} = \frac{a}{b}$ where, a and b are coprime i.e. their

HCF is 1.





$$\Rightarrow (\sqrt{2})^2 \left(\frac{a}{b}\right)^2 \Rightarrow 2 = \frac{a^2}{b^2}$$

$$\Rightarrow a^2 = 2b^2 \Rightarrow a^2 \text{ is a multiple of } 2$$

$$\Rightarrow a \text{ is a multiple of } 2 \quad \dots (i)$$

$$a = 2c \text{ for some integer } c.$$

$$\Rightarrow a^2 = 4c^2 \Rightarrow 2b^2 = 4c^2$$

$$\Rightarrow b^2 = 2c^2 \Rightarrow b^2 \text{ is a multiple of } 2$$

$$\Rightarrow b \text{ is a multiple of } 2 \quad \dots (ii)$$

From (i) and (ii), a and b have at least 2 as a common factor. But this contradicts the fact that a and b are co-prime. This means that $\sqrt{2}$ is an irrational number.

Example 15:

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

Solution:

Let assume that on the contrary that $3 - \sqrt{5}$ is rational.

Then, there exist co-prime positive integers a and b such that,

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

$$\Rightarrow \frac{3b - a}{b} = \sqrt{5} \Rightarrow \sqrt{5} \text{ is rational}$$

$[\because a, b \text{ are integer } \therefore \frac{3b - a}{b} \text{ is a rational number}]$

This contradicts the fact that $\sqrt{5}$ is an irrational number.

Hence, $3 - \sqrt{5}$ is an irrational number.

Example 16:

Insert an irrational number between 2 and 3.

Solution: $\sqrt{2 \times 3} = \sqrt{6}$

Example 17:

Find two irrational number between 2 and 2.5.

Solution:

1st Method : $\sqrt{2 \times 2.5} = \sqrt{5}$

Since, there is no rational number whose square is 5. So, $\sqrt{5}$ is an irrational number.

Also, $\sqrt{2 \times \sqrt{5}}$ is an irrational number.

2nd Method : 2.101001000100001..... is between 2 and 5 and it is non-recurring as well as nonterminating.

Also, 2.201001000100001 and so on.

Example 18:

Plot $\sqrt{2}, \sqrt{3}, \sqrt{5}$ on a number line.

Solution: Let $X'OX$ be a horizontal line, taken as the x - axis and let O be the origin. Let O represents 0 (zero).

Take $OA = 1$ unit and draw $AB \perp OA$ such that $AB = 1$ unit.

Join OB . Then,

$$OB = \sqrt{OA^2 + AB^2} = \sqrt{1^2 + 1^2} = \sqrt{2} \text{ units.}$$

With O as centre and OB as radius, draw an arc, meeting OY at P .

Then, $OP = OB = \sqrt{2}$ units.

Thus the point P represents $\sqrt{2}$ on the real line.

Now draw $BC \perp OB$ such that $BC = 1$ unit.

Join OC . Then,

$$OC = \sqrt{OB^2 + BC^2} = \sqrt{(\sqrt{2})^2 + 1^2} = \sqrt{3} \text{ units.}$$

$$2 + 1 = 3 \text{ units.}$$

With O as centre and OC as radius, draw an arc, meeting OY at Q .

Then, $OQ = OC = \sqrt{3}$ units.

Thus, the point Q represents $\sqrt{3}$ on the real line.

Now draw $CD \perp OC$ such that $CD = 1$ unit.

Join OD . Then,

$$OD = \sqrt{OC^2 + CD^2} = \sqrt{(\sqrt{3})^2 + 1^2} = \sqrt{4} = 2 \text{ units}$$

Now draw $DE \perp OD$ such that $DE = 1$ unit.

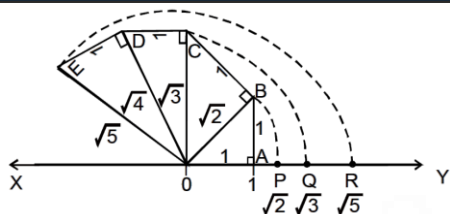
Join OE . Then,

$$OE = \sqrt{OD^2 + DE^2} = \sqrt{(2)^2 + 1^2} = \sqrt{5} \text{ units.}$$

With O as centre and OE as radius, draw an arc, meeting OY at R .

Then, $OR = OE = \sqrt{5}$ units.





Another Method for :

(i) Plot $\sqrt{2}, \sqrt{3}$

Draw a number line and mark a point O, representing zero, on it. Suppose a point A represents 1. Then $OA = 1$. Now draw a right triangle OAB such that $AB = OA = 1$.

By pythagoras theorem,

$$OB = \sqrt{OA^2 + AB^2} = \sqrt{1^2 + 1^2} = \sqrt{2} \text{ units.}$$

Now, draw an arc with centre O and radius OB. It cuts the number line at C.

Then, $OC = OB = \sqrt{2}$ units.

Thus the point C represents $\sqrt{2}$ on the real line.

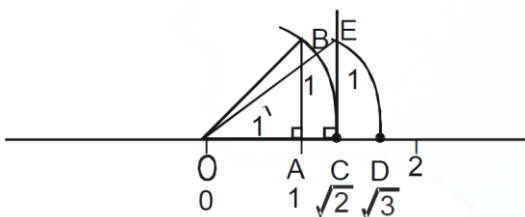
Now, draw a right triangle OEC such that $CE = AB = 1$ unit.

Again by pythagoras theorem,

$$OE = \sqrt{OC^2 + CE^2} = \sqrt{(\sqrt{2})^2 + 1^2} = \sqrt{3} \text{ units.}$$

Now, draw an arc with centre O and radius OE. It cuts the number line at D.

Then, $OD = OE = \sqrt{3}$ units.



FUNDAMENTAL UNLOCKED- (FU#2)

Q.1 Which of the following numbers are not rational?

1.256; 0.45454545.; 0.05005000500005.; 5.51551555151.; 2.012340123401234.;

Q.2 Find two irrational numbers between $\sqrt{5}$ and $\sqrt{6}$

Q.3 Prove that $\sqrt{3}$ is irrational number.

Q.4 Represent $\sqrt{6}$ on the number line.

Q.5 Represent $\sqrt{7.3}$ on the number line.

Surds and their Application

(a) Surds

An irrational number of the form $\sqrt[n]{a}$ is given a special name **Surd**, where 'a' is called **radicand** and it should always be a rational number. Also the symbol $\sqrt[n]{a}$ is called the **radical sign** and the index **n** is called **order** of the surd. $\sqrt[n]{a}$ is read as '**nth root of a**' and can also be written as $a^{\frac{1}{n}}$.

(b) Law of Surds

(i) $(\sqrt[n]{a})^n = \sqrt[n]{a^n} = a$

(ii) $\sqrt[n]{a} \times \sqrt[n]{b} = \sqrt[n]{ab}$

(iii) $\sqrt[n]{a} \div \sqrt[n]{b} = \sqrt[n]{\frac{a}{b}}$

(iv) $\sqrt[n]{a} \times \sqrt[n]{b} = \sqrt[n]{ab}$

(v) $\sqrt[n]{a} = \sqrt[n \times p]{a^p}$ or $\sqrt[n]{a^m} = \sqrt[n \times p]{a^{m \times p}}$

(c) Operation on Surds

(i) Addition and Subtraction of Surds :

Addition and subtraction of surds are possible only when order and radicand are same i.e. only for like surds. The addition of surds follow the following rules. Summation of same degree surds is distributive.

$$a\sqrt[n]{p} + b\sqrt[n]{p} = (+)\sqrt[n]{p}$$

The subtraction of surds follow the following rules. Subtraction of same degree surds is distributive.

$$a\sqrt[n]{p} - b\sqrt[n]{p} = (-)\sqrt[n]{p}$$

(ii) Multiplication and Division of Surds :

For multiplication and division we have to check the order if it is not same then first we make the order of surd same by using las of indices. Then we follow the following rule

$$a\sqrt[n]{p} \times b\sqrt[n]{q} = (a \times b)\sqrt[n]{p \times q}$$

$$\frac{a\sqrt[n]{p}}{b\sqrt[n]{q}} = \left(\frac{a}{b}\right)\sqrt[n]{\left(\frac{p}{q}\right)}$$



(iii) Comparison of Surds :

It is clear that if $x > y > 0$ and $n > 1$ is a positive integer then $\sqrt[n]{x} > \sqrt[n]{y}$.

(d) Rationalization of Surds

Rationalizing factor : Product of two surds is a rational number then each of them is called the **rationalizing factor (R.F.)** of the other. The process of converting a surd to a rational number by using an appropriate multiplier is known as **rationalization**.

When the denominator of an expression contains a term with a square root (or a number with radical sign), the process of converting it to an equivalent expression whose denominator is a rational number is called **rationalizing the denominator**.

Rationalizing factor of $a^{\frac{1}{n}}$ where is $a^{\frac{1}{n}}$ real number.

Example 19:

$$\sqrt{75} - \sqrt{45} + \sqrt{50} - \sqrt{32}$$

Solution:

$$\begin{aligned} & \sqrt{75} - \sqrt{45} + \sqrt{50} - \sqrt{32} \\ &= 5\sqrt{3} - 3\sqrt{5} + 5\sqrt{2} - 4\sqrt{2} \\ &= 5\sqrt{3} - 3\sqrt{5} + \sqrt{2} \end{aligned}$$

Example 20:

$$\text{Simplify : } 5\sqrt[3]{250} + 7\sqrt[3]{16} - 14\sqrt[3]{54}$$

Solution:

$$\begin{aligned} & 5\sqrt[3]{250} + 7\sqrt[3]{16} - 14\sqrt[3]{54} \\ &= 5\sqrt[3]{125 \times 2} + 7\sqrt[3]{8 \times 2} - 14\sqrt[3]{27 \times 2} \\ &= 5 \times 5\sqrt[3]{2} + 7 \times 2\sqrt[3]{2} - 14 \times 3 \times \sqrt[3]{2} \\ &= (25 + 14 - 42)\sqrt[3]{2} = -3\sqrt[3]{2} \end{aligned}$$

Example 21:

$$\text{Simplify : } \sqrt[3]{2} \times \sqrt[4]{3}$$

Solution:

$$\begin{aligned} \sqrt[3]{2} \times \sqrt[4]{3} &= \sqrt[12]{2^4} \times \sqrt[12]{3^3} \quad [\text{order should be made same}] \\ &= \sqrt[12]{2^4 \times 3^3} = \sqrt[12]{16 \times 27} = \sqrt[12]{432} \end{aligned}$$

Example 22:

$$\text{Simplify : } \sqrt{8a^5b} \times \sqrt[3]{4a^2b^2}$$

Solution:

$$\begin{aligned} \sqrt{8a^5b} \times \sqrt[3]{4a^2b^2} &= \sqrt[6]{8^3 a^{15} b^3} \times \sqrt[6]{4^2 a^4 b^4} \\ &= \sqrt[6]{2^{13} a^{19} b^7} = 2^2 a^3 b \sqrt[6]{2ab} = 4a^3 b \sqrt[6]{2ab} \end{aligned}$$

Example 23:

$$\text{Divide : } \sqrt{24} \div \sqrt[3]{200}$$

Solution:

$$\sqrt{24} \div \sqrt[3]{200} = \frac{\sqrt{24}}{\sqrt[3]{200}} = \frac{\sqrt{(24)^3}}{\sqrt[6]{(200)^2}} = \sqrt[6]{\frac{216}{625}}$$

Example 24:

Which is greater :

(i) $\sqrt[3]{6}$ and $\sqrt[5]{8}$

(ii) $\sqrt{\frac{1}{2}}$ and $\sqrt[3]{\frac{1}{3}}$

Solution:

(i) $\sqrt[3]{6}$ and $\sqrt[5]{8}$

L.C.M. of 3 and 5 is 15.

$$\sqrt[3]{6} = \sqrt[3 \times 5]{6^5} = \sqrt[15]{7776}$$

$$\sqrt[5]{8} = \sqrt[3 \times 5]{8^3} = \sqrt[15]{512}$$

$$\therefore \sqrt[15]{7776} > \sqrt[15]{512} \Rightarrow \sqrt[3]{6} > \sqrt[5]{8}$$

(ii) $\sqrt{\frac{1}{2}}$ and $\sqrt[6]{\frac{1}{3}}$

L.C.M. of 2 and 3 is 6.

$$\sqrt{\frac{1}{2}} = \sqrt[6]{\left(\frac{1}{2}\right)^3} \quad \text{and} \quad \sqrt[6]{\left(\frac{1}{3}\right)^2}$$

$$\sqrt[6]{\frac{1}{8}} \quad \text{and} \quad \sqrt[6]{\frac{1}{9}} \quad \left[\text{As } 8 < 9 \therefore \frac{1}{8} > \frac{1}{9} \right]$$

$$\text{So, } \sqrt[6]{\frac{1}{8}} > \sqrt[6]{\frac{1}{9}} \Rightarrow \sqrt{\frac{1}{2}} > \sqrt[6]{\frac{1}{3}}$$

Example 25:

$$\text{Rationalize the denominator } \frac{1}{\sqrt{162}}$$

Solution:

$$\frac{1}{\sqrt{162}} = \frac{1}{\sqrt{81 \times 2}} = \frac{1}{9\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = \frac{\sqrt{2}}{18}$$

Rationalising factor of $a + b\sqrt{c}$ is $a - b\sqrt{c}$ where a, b, c are rational numbers.



Example 26:

Rationalize the denominator $\frac{1}{7+5\sqrt{3}}$.

Solution:

$$\begin{aligned}\frac{1}{7+5\sqrt{3}} &= \frac{1}{7+5\sqrt{3}} \times \frac{7-5\sqrt{3}}{7-5\sqrt{3}} \\ &= \frac{7-5\sqrt{3}}{49-75} = \frac{7-5\sqrt{3}}{-26} = \frac{5\sqrt{3}-7}{26}.\end{aligned}$$

Example 27:

Rationalize the denominator of $\frac{a^2}{\sqrt{a^2+b^2}+b}$

Solution:

$$\begin{aligned}\frac{a^2}{\sqrt{a^2+b^2}+b} &\times \frac{\sqrt{a^2+b^2}-b}{\sqrt{a^2+b^2}-b} = \frac{a^2(\sqrt{a^2+b^2}-b)}{(\sqrt{a^2+b^2})^2-(b)^2} \\ &= \frac{a^2(\sqrt{a^2+b^2}-b)}{a^2+b^2-b^2} = (\sqrt{a^2+b^2}-b).\end{aligned}$$

Example 28:

If $\frac{3+2\sqrt{2}}{3-\sqrt{2}} = a+b\sqrt{2}$, where a and b are rationales in reduced form then, find the values of a and b .

Solution:

$$\begin{aligned}\text{LHS} \quad \frac{3+2\sqrt{2}}{3-\sqrt{2}} &= \frac{(3+2\sqrt{2})(3+\sqrt{2})}{(3-\sqrt{2})(3+\sqrt{2})} \\ &= \frac{9+3\sqrt{2}+6\sqrt{2}+4}{9-2} = \frac{13+9\sqrt{2}}{7} = \frac{13}{7} + \frac{9}{7}\sqrt{2} \\ \therefore &= \frac{13+9\sqrt{2}}{7} = a+b\sqrt{2}\end{aligned}$$

Equating the rational and irrational parts

$$\text{We get } a = \frac{13}{7}, b = \frac{9}{7}$$

Example 29:

If $x = \frac{1}{2+\sqrt{3}}$, find the value of $x^3 - x^2 - 11x + 3$.

Solution: As, $x = \frac{1}{2+\sqrt{3}} = 2-\sqrt{3} \Rightarrow x-2 = -\sqrt{3}$

$$\Rightarrow (x-2)^2 = (-\sqrt{3})^2 \quad [\text{By squaring both sides}]$$

$$\Rightarrow x^2 + 4 - 4x = 3 \Rightarrow x^2 - 4x + 1 = 0$$

$$\text{Now, } x^3 - x^2 - 11x + 3 = x(x^2 - 4x + 1) + 3(x^2 - 4x + 1) = x(0) + 3(0) = 0 + 0 = 0.$$

Example 30:

If $x = 3 - \sqrt{8}$, find the value of $x^3 + \frac{1}{x^3}$.

Solution: $x = 3 - \sqrt{8}$

$$\therefore \frac{1}{x} = \frac{1}{3-\sqrt{8}} \Rightarrow \frac{1}{x} = 3 + \sqrt{8}$$

$$\text{Now, } x + \frac{1}{x} = 3 - \sqrt{8} + 3 + \sqrt{8} = 6$$

$$\Rightarrow x^3 + \frac{1}{x^3} = \left(x + \frac{1}{x}\right)^3 - 3x \cdot \frac{1}{x} \left(x + \frac{1}{x}\right)$$

$$\Rightarrow x^3 + \frac{1}{x^3} = (6)^3 - 3(6)$$

$$\Rightarrow x^3 + \frac{1}{x^3} = 216 - 18 \Rightarrow x^3 + \frac{1}{x^3} = 198.$$

Example 31:

If $\sqrt{5} = 2.236$ and $\sqrt{2} = 1.414$, then evaluate :

$$\frac{3}{\sqrt{5}+\sqrt{2}} + \frac{4}{\sqrt{5}-\sqrt{2}}$$

Solution:

$$\begin{aligned}&\frac{3}{\sqrt{5}+\sqrt{2}} + \frac{4}{\sqrt{5}-\sqrt{2}} \\ &= \frac{3(\sqrt{5}-\sqrt{2})+4(\sqrt{5}+\sqrt{2})}{(\sqrt{5}-\sqrt{2})(\sqrt{5}+\sqrt{2})} \\ &= \frac{3\sqrt{5}-3\sqrt{2}+4\sqrt{5}+4\sqrt{2}}{5-2} = \frac{7\sqrt{5}+\sqrt{2}}{5-2} \\ &= \frac{7\sqrt{5}+\sqrt{2}}{3} = \frac{7 \times 2.236 + 1.414}{3} \\ &= \frac{15.652 + 1.414}{3} = \frac{17.066}{3} = 5.689 \text{ (approximately)}\end{aligned}$$

FUNDAMENTAL UNLOCKED- (FU#3)

Q.1 What is the simplest form of $\sqrt{200} - \sqrt{50}$?

Q.2 Rationalise the denominator of $\frac{5}{\sqrt{10}+\sqrt{5}}$.

Q.3 If $x = \sqrt{2} - 1$, what is the value of $x - \frac{1}{x}$?

Q.4 Simplify $(\sqrt{5}+1)^2 + (\sqrt{5}-1)^2$.

Q.5 If $x = \frac{\sqrt{5}-2}{\sqrt{5}+2}$, find the value of $x + \frac{1}{x}$.



Exponents
(a) Exponents of Real Numbers
(i) Positive Integral Power :

For any real number **a** and a natural number '**n**' we define **aⁿ** as :

$$a^n = a \times a \times a \times \dots \times a \text{ (n times)}$$

aⁿ is called the **nth** power of **a**. The real number '**a**' is called the **base** and '**n**' is called the **exponent** of the **nth** power of **a**.

e.g. $2^3 = 2 \times 2 \times 2 = 8$

Remark : For any non-zero real number '**a**' we define $a^0 = 1$.

e.g.: Thus, $3^0 = 1$, 5^0 , $\left(\frac{3}{4}\right)^0 = 1$ and so on.

(ii) Negative Integral Power :

For any non-zero real number '**a**' and positive integer '**n**' we define $a^{-n} = \frac{1}{a^n}$.

Thus we have defined **aⁿ** for all integral values of **n**, positive, zero or negative. **aⁿ** is called the **nth** power of **a**.

(iii) Rational Exponents of a Real number
Principal of nth Root of a Positive Real Numbers :

If '**a**' is a positive real number and '**n**' is a **positive integer**, then the **principal nth root** of **a** is the unique positive real number **x** such that $x^n = a$.

The principal **nth** root of a positive real number **a** is denoted by $a^{1/n}$ or $\sqrt[n]{a}$.

Remark : If '**a**' is negative real number and '**n**' is an **even positive** integer, then the principal **nth** root of **a** is not defined, because an even power of a real number is always positive. Therefore $(-9)^{1/2}$ is a meaningless quantity, if we confine ourselves to the set of real number, only.

(b) Law of Rational Exponents

The following laws hold the rational exponents

(i) $a^m \times a^n = a^{m+n}$

(ii) $a^m \div a^n = a^{m-n}$

(iii) $(a^m)^n = a^{mn}$

(iv) $a^{-n} = \frac{1}{a^n}$

(v) $a^{m/n} = (a^m)^{1/n} = (a^{1/n})^m$ i.e. $a^{m/n} = \sqrt[n]{a^m} = \sqrt[n]{a}^m = (\sqrt[n]{a})^m$

(vi) $(ab)^m = a^m b^m$

(vii) $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$

(viii) $a^{bn} = a^{b+b+\dots+b \text{ n times}}$

where **a**, **b** are positive real numbers and **m**, **n** are rational numbers.

Example 32:

Evaluate each of the following :

(i) $5^8 \div 5^3$

(ii) $\left(\frac{3}{4}\right)^{-3}$

Solution:

Using the laws of indices, we have :

(i) $5^8 \div 5^3 = \frac{5^8}{5^3} = 5^{8-3} = 5^5 = 3125$ [$\because a^m \div a^n = a^{m-n}$]

(ii) $\left(\frac{3}{4}\right)^{-3} = \frac{1}{\left(\frac{3}{4}\right)^3} = \frac{1}{\frac{3^3}{4^3}} = \frac{1}{\frac{27}{64}} \left[\because a^{-n} = \frac{1}{a^n}\right]$

Example 33:

Evaluate each of the following :

(i) $\left(\frac{1}{2}\right)^5 \times \left(\frac{-2}{3}\right)^4 \times \left(\frac{3}{5}\right)^{-1}$

(ii) $\left(\frac{2}{3}\right)^3 \times \left(\frac{2}{5}\right)^{-3} \times \left(\frac{3}{5}\right)^2$

Solution:

(i) We have,

$$\left(\frac{1}{2}\right)^5 \times \left(\frac{-2}{3}\right)^4 \times \left(\frac{3}{5}\right)^{-1} = \left(\frac{1}{2}\right)^5 \times \left(\frac{-2}{3}\right)^4 \times \left(\frac{1}{\frac{3}{5}}\right)$$

$$= \frac{1^5}{2^5} \times \frac{(-2)^4}{3^4} \times \frac{5}{3} = \frac{1 \times 16 \times 5}{32 \times 81 \times 3} = \frac{5}{2 \times 81 \times 3} = \frac{5}{486}$$



(ii) We have,

$$\left(\frac{2}{3}\right)^3 \times \left(\frac{2}{5}\right)^{-3} \times \left(\frac{3}{5}\right)^2 = \frac{2^3}{3^3} \times \frac{1}{(2/5)^3} \times \frac{3^2}{5^2}$$

$$= \frac{2^3 \times 5^3 \times 3^2}{3^3 \times 2^3 \times 5^2} = \frac{5}{3}.$$

Example 34:

Simplify :

(i) $\frac{(25)^{3/2} \times (243)^{3/5}}{(16)^{5/4} \times (8)^{4/3}}$ (ii) $\frac{16 \times 2^{n+1} - 4 \times 2^n}{16 \times 2^{n+2} - 2 \times 2^{n+2}}$

Solution: We have,

(i) $\frac{(25)^{3/2} \times (243)^{3/5}}{(16)^{5/4} \times (8)^{4/3}} = \frac{(5^2)^{3/2} \times (3^5)^{3/5}}{(2^4)^{5/4} \times (2^3)^{4/3}}$

$$= \frac{5^{2 \times 3/2} \times 3^{5 \times 3/5}}{2^{4 \times 5/4} \times 2^{3 \times 4/3}} = \frac{5^3 \times 3^3}{2^5 \times 2^4} = \frac{125 \times 27}{32 \times 16} = \frac{3375}{512}$$

(ii) $\frac{16 \times 2^{n+1} - 4 \times 2^n}{16 \times 2^{n+2} - 2 \times 2^{n+2}} = \frac{32 \times 2^n - 4 \times 2^n}{64 \times 2^n - 8 \times 2^n}$

$$= \frac{2^n(32 - 4)}{2^n(64 - 8)} = \frac{1}{2}$$

Example 35:

Simplify $\left(\frac{81}{16}\right)^{-3/4} \times \left[\left(\frac{25}{9}\right)^{-3/2} \div \left(\frac{5}{2}\right)^{-3}\right]$

Solution: We have,

$$\left(\frac{81}{16}\right)^{-3/4} \times \left[\left(\frac{25}{9}\right)^{-3/2} \div \left(\frac{5}{2}\right)^{-3}\right]$$

$$= \left(\frac{3^4}{2^4}\right)^{-3/4} \times \left[\left(\frac{5^2}{3^2}\right)^{-3/2} \div \left(\frac{5}{2}\right)^{-3}\right]$$

$$= \left[\left(\frac{3}{4}\right)^4\right]^{-3/4} \times \left[\left(\frac{5}{2}\right)^2\right]^{-3/2} \div \left[\left(\frac{5}{2}\right)^{-3}\right]$$

$$= \left(\frac{3}{2}\right)^{4 \times -3/4} \times \left[\left(\frac{5}{3}\right)^{2 \times -3/2} \div \left(\frac{5}{2}\right)^{-3}\right]$$

$$= \left(\frac{3}{2}\right)^{-3} \times \left[\left(\frac{5}{3}\right)^{-3} \div \left(\frac{5}{2}\right)^{-3}\right]$$

$$= \left(\frac{2}{3}\right)^3 \times \left[\left(\frac{3}{5}\right)^3 \div \left(\frac{2}{5}\right)^3\right]$$

$$= \frac{2^3}{3^3} \times \left[\frac{3^3}{5^3} \div \frac{2^3}{5^3}\right] = \frac{2^3}{3^3} \times \left[\frac{3^3}{5^3} \times \frac{5^3}{2^3}\right] = 1.$$

Example.36

Prove that : $\frac{x^{-1}}{x^{-1} + y^{-1}} + \frac{x^{-1}}{x^{-1} - y^{-1}} = \frac{2y^2}{y^2 - x^2}$

Solution: $\frac{x^{-1}}{x^{-1} + y^{-1}} + \frac{x^{-1}}{x^{-1} - y^{-1}} = \frac{\frac{1}{x}}{\frac{1}{x} + \frac{1}{y}} + \frac{\frac{1}{x}}{\frac{1}{x} - \frac{1}{y}}$

$$= \frac{\frac{1}{x}}{\frac{y+x}{xy}} + \frac{\frac{1}{x}}{\frac{y-x}{xy}} = \frac{xy}{x(y+x)} + \frac{xy}{x(y-x)}$$

$$= \frac{xy(y-x) + xy(y+x)}{x(y^2 - x^2)} = \frac{y(y-x) + y(y+x)}{y^2 - x^2}$$

$$= \frac{y^2 - xy + y^2 + xy}{y^2 - x^2} = \frac{2y^2}{y^2 - x^2}.$$

Example 37:

Find the value of x : $\left(\frac{3}{5}\right)^x \left(\frac{5}{3}\right)^{2x} = \frac{125}{27}.$

Solution: $\left(\frac{3}{5}\right)^x \left(\frac{5}{3}\right)^{2x} = \frac{125}{27}$

$$\left(\frac{5}{3}\right)^{-x} \left(\frac{5}{3}\right)^{2x} = \frac{125}{27}$$

$$\left(\frac{5}{3}\right)^{2x-x} = \frac{125}{27}$$

$$\left(\frac{5}{3}\right)^x = \left(\frac{5}{3}\right)^3$$

Because the base is same, so comparing the powers $x = 3$.

Example 38:

If $25^{x-1} = 5^{2x-1} - 100$, find the value of x.

Solution: We have,

$$\Rightarrow 25^{x-1} = 5^{2x-1} - 100$$

$$\Rightarrow (5^2)^{x-1} = 5^{2x-1} - 100 \Rightarrow 5^{2x-2} - 5^{2x-1} = -100$$

$$\Rightarrow 5^{2x-2} - 5^{2x-2} \cdot 5^1 = -100$$

$$\Rightarrow 5^{2x-2} (1 - 5) = -100 \Rightarrow 5^{2x-2} (-4) = -100$$

$$\Rightarrow 5^{2x-2} = 25$$

$$\Rightarrow 5^{2x-2} = 5^2 \Rightarrow 2x - 2 = 2$$

$$\Rightarrow 2x = 4 \Rightarrow x = 2.$$




Example 39:

Assuming that x is a positive real number and a , b , c are rational numbers, show that :

$$\left(\frac{x^b}{x^c}\right)^a \left(\frac{x^c}{x^a}\right)^b \left(\frac{x^a}{x^b}\right)^c = 1$$

Solution:

$$\begin{aligned} \left(\frac{x^b}{x^c}\right)^a \cdot \left(\frac{x^c}{x^a}\right)^b \cdot \left(\frac{x^a}{x^b}\right)^c &= 1 = (x^{b-c})^a \cdot (x^{c-a})^b \cdot (x^{a-b})^c \\ &= x^{ab-ac} \cdot x^{bc-ba} \cdot x^{ac-bc} \\ &= x^{ab-ac+bc-ba+ac-bc} = x^0 = 1. \end{aligned}$$

FUNDAMENTAL UNLOCKED- (FU#4)

- Q.1** Find the value of the following:
(a) $81^{1/4}$ **(b)** $64^{1/3}$ **(c)** $32^{3/5}$ **(d)** $27^{2/3}$
- Q.2** Simplify the following:
(a) $3^{1/3} \cdot 3^{2/5}$ **(b)** $\left(\frac{4}{9}\right)^{\frac{1}{2}}$
(c) $2^{2/3} \cdot 3^{2/3}$ **(d)** $\left(2^{\frac{1}{3}}\right)^3$
- Q.3** Simplified value of $2^n \times 4^n \times 8^{1-n}$
- Q.4** Find x , if $8^x = 16$
- Q.5** Find x, y, z if $15^3 \times 12^2 \times 16^4 = 2^x \times 3^y \times 5^z$

ANSWER KEY
FUNDAMENTAL UNLOCKED- (FU#1)

- Q.2** $\frac{31}{80}$ **Q.3** $\frac{19}{6}, \frac{20}{6}, \frac{21}{6}, \frac{22}{6}, \frac{23}{6}$
- Q.4** $\frac{5}{3}; \frac{9}{14}; \frac{5}{7}; \frac{6}{11}$ **Q.5** $x = \frac{1128}{999}$

FUNDAMENTAL UNLOCKED- (FU#2)

- Q.1** 0.050050005000005.; 5.51551555151.
- Q.2** $\sqrt{5.1}, \sqrt{5.2}$

FUNDAMENTAL UNLOCKED- (FU#3)

- Q.1** $5\sqrt{2}$ **Q.2** $\sqrt{10} - \sqrt{5}$
- Q.3** -2 **Q.4** 12 **Q.5** 18

FUNDAMENTAL UNLOCKED- (FU#4)

- Q.1** **(a)** 3 **(b)** 4 **(c)** 8 **(d)** 9
- Q.2** **(a)** $3^{11/15}$ **(b)** $2/3$ **(c)** $6^{2/3}$ **(d)** 2
- Q.3** 8
- Q.4** $4/3$
- Q.5** $x = 20, y = 5, z = 3$





EXERCISE - I

Single Correct Type Questions

- The decimal representation of $\frac{27}{400}$ is :
(A) Terminating
(B) Non terminating recurring
(C) Non terminating non recurring
(D) None of these
- $2.23\overline{4}$ is :
(A) Non-terminating only
(B) Non-repeating only
(C) Non-terminating and repeating
(D) Non-terminating and non-repeating
- How many rational numbers exist between any two distinct rational numbers?
(A) 2 (B) 3 (C) 11 (D) Infinite
- The rational form of $2.74\overline{35}$ is :
(A) $\frac{27161}{9999}$ (B) $\frac{27}{99}$
(C) $\frac{27161}{9900}$ (D) $\frac{27161}{9000}$
- Every point on a number line represents :
(A) A natural number
(B) A real number
(C) A rational number
(D) A irrational number
- A rational number lying between $\sqrt{2}$ and $\sqrt{3}$ is :
(A) $\frac{\sqrt{2} + \sqrt{3}}{2}$ (B) $\sqrt{6}$
(C) 1.6 (D) 1.9
- Which one is greatest in the following :
(A) $\sqrt{2}$ (B) $\sqrt[3]{3}$
(C) $\sqrt[3]{4}$ (D) $\sqrt{2}$

- The value of $\sqrt[5]{(32)^{-3}}$ is :
(A) $\frac{1}{8}$ (B) $\frac{1}{16}$
(C) $\frac{1}{32}$ (D) None of these
- If $x = \frac{\sqrt{3} - \sqrt{2}}{\sqrt{3} + \sqrt{2}}$ and $y = \frac{\sqrt{3} + \sqrt{2}}{\sqrt{3} - \sqrt{2}}$ the value of $x^2 + xy + y^2$ is :
(A) 99 (B) 100 (C) 1 (D) 0
- Simplify : $\frac{2}{\sqrt{3} + \sqrt{5}} + \frac{1}{\sqrt{3} + \sqrt{2}} - \frac{3}{\sqrt{5} + \sqrt{2}}$.
(A) 1 (B) 0 (C) 10 (D) 100
- Which of the following is smallest :
(A) $\sqrt[4]{5}$ (B) $\sqrt[3]{4}$ (C) $\sqrt{4}$ (D) $\sqrt{3}$
- The product of $\sqrt{3}$ and $\sqrt[3]{5}$ is :
(A) $\sqrt[3]{375}$ (B) $\sqrt[3]{675}$ (C) $\sqrt[3]{575}$ (D) $\sqrt[3]{475}$
- The value of $\sqrt{20} \times \sqrt{5}$ is :
(A) 10 (B) $2\sqrt{5}$ (C) $20\sqrt{5}$ (D) $4\sqrt{5}$
- $\sqrt[3]{\frac{54}{250}}$ equals :
(A) $\frac{9}{25}$ (B) $\frac{3}{5}$ (C) $\frac{27}{125}$ (D) $\frac{\sqrt[3]{2}}{5}$
- The value of x, if $5^{x-3} \times 3^{2x-8} = 225$, is :
(A) 1 (B) 2 (C) 3 (D) 5
- $\frac{6561 \times 81^2 \times 3^{5x}}{3^{2x}} = 3^7$, then.
(A) $x = -2$ (B) $x = -3$
(C) $x = -1$ (D) $x = 0$
- $3^n \times 9^n \times 27^{1-n} =$
(A) 9 (B) 27 (C) 3 (D) $\frac{1}{3}$





18. $\frac{1}{(3^{-1} + 5^{-1} + 2^{-1})} =$
 (A) $\frac{29}{30}$ (B) $\frac{31}{29}$ (C) $\frac{31}{30}$ (D) None

19. If $2^x = 4^y = 8^z$, then find $x : y : z$.
 (A) $1 : 2 : 3$ (B) $3 : 2 : 1$
 (C) $2 : 3 : 1$ (D) $6 : 3 : 2$

20. The product of a non-zero rational number with an irrational number is :
 (A) Irrational number (B) Rational number
 (C) Whole number (D) Natural number

Very Short Answer Type Questions

- Find the product of any two irrational numbers.
- Find a rational number between $\sqrt{2}$ & $\sqrt{3}$.
- Find the value of $1.999\dots$ in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$.
- Find the number obtained on rationalising the denominator of $\frac{1}{\sqrt{7}-2}$.
- After rationalising the denominator of $\frac{7}{3\sqrt{3}-2\sqrt{2}}$, what will be the denominator
- Find the value of $\frac{\sqrt{32} + \sqrt{48}}{\sqrt{8} + \sqrt{12}}$.
- Simplify $\sqrt[4]{3\sqrt{2^2}}$.
- Simplify $\sqrt[4]{(81)^{-2}}$.
- Express $\frac{2}{11}$ in decimal form.
- Give three rational numbers between -2 and -1 .

Short Answer Type Questions

- If $\sqrt{2} = 1.4142$, then find the value of $\sqrt{\frac{\sqrt{2}-1}{\sqrt{2}+1}}$.
- Find the value of $(256)^{0.16} \times (256)^{0.09}$.
- State whether the following statements are true or false? Justify your answer.
 - $\frac{\sqrt{2}}{3}$ is a rational number.
 - There are infinitely many integers between any two integers.
 - Number of rational numbers between 15 and 18 is finite.
 - There are numbers which cannot be written in the form $\frac{p}{q}$, $q \neq 0$, p, q both are integers.
 - The square of an irrational number is always rational.
 - $\frac{\sqrt{12}}{\sqrt{3}}$ is not a rational number as $\sqrt{12}$ and $\sqrt{3}$ are not integers.
 - $\frac{\sqrt{15}}{\sqrt{3}}$ is written in the form $\frac{p}{q}$, $q \neq 0$ and so it is a rational number.
- Locate $\sqrt{13}$ on the number line.
- Express $0.12\bar{3}$ in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$.
- Find the value of a in the following :
 $\frac{6}{3\sqrt{2}-2\sqrt{3}} = 3\sqrt{2} - a\sqrt{3}$.
- Simplify : $\left[5 \left(8^{\frac{1}{3}} + 27^{\frac{1}{3}} \right)^3 \right]^{\frac{1}{4}}$
- Represent the following numbers on the number line : $7, 7.2, -\frac{3}{2}, -\frac{12}{5}$





9. Multiply
 $\sqrt{27a^3b^2c^4} \times \sqrt[3]{128a^7b^9c^2} \times \sqrt[6]{729ab^{12}c^2}$.
10. Express the following in the form of p/q.
 (i) $0.\overline{37}$ (ii) $43.\overline{54}$
 (iii) $5.3\overline{245}$ (iv) $4.6\overline{21}$

Long Answer Type Questions

1. Locate $\sqrt{5}$, $\sqrt{10}$ and $\sqrt{17}$ on the number line.
2. Represent geometrically the following numbers on the number line :
 (i) $\sqrt{4.5}$ (ii) $\sqrt{2.3}$
3. Simplify the following :
 (i) $\sqrt{45} - 3\sqrt{20} + 4\sqrt{5}$ (ii) $\frac{\sqrt{24}}{8} + \frac{\sqrt{54}}{9}$
 (iii) $\sqrt[4]{12} \times \sqrt[7]{6}$ (iv) $4\sqrt{28} \div 3\sqrt{7} \div \sqrt[3]{7}$
 (v) $3\sqrt{3} + 2\sqrt{27} + \frac{7}{\sqrt{3}}$ (vi) $(\sqrt{3} - \sqrt{2})^2$
 (vii) $\sqrt[4]{81} - 8\sqrt[3]{216} + 15\sqrt[5]{32} + \sqrt{225}$
 (viii) $\frac{3}{\sqrt{8}} + \frac{1}{\sqrt{2}}$ (ix) $\frac{2\sqrt{3}}{3} - \frac{\sqrt{3}}{6}$
4. Rationalise the denominator of the following :
 (i) $\frac{2}{3\sqrt{3}}$ (ii) $\frac{\sqrt{40}}{\sqrt{3}}$ (iii) $\frac{3+\sqrt{2}}{4\sqrt{2}}$
 (iv) $\frac{16}{\sqrt{41}-5}$ (v) $\frac{2+\sqrt{3}}{2-\sqrt{3}}$
 (vi) $\frac{\sqrt{6}}{2+\sqrt{3}}$ (vii) $\frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}-\sqrt{2}}$
 (viii) $\frac{3\sqrt{5}+\sqrt{3}}{\sqrt{5}-\sqrt{3}}$ (ix) $\frac{4\sqrt{3}+5\sqrt{2}}{\sqrt{48}+\sqrt{18}}$
5. Find the values of a and b in each of the following :
 (i) $\frac{5+2\sqrt{3}}{7+4\sqrt{3}} = a - 6\sqrt{3}$
 (ii) $\frac{3-\sqrt{5}}{3+2\sqrt{5}} = a\sqrt{5} - \frac{19}{11}$

$$(iii) \frac{\sqrt{2}+\sqrt{3}}{3\sqrt{2}-2\sqrt{3}} = 2 - b\sqrt{6}$$

$$(iv) \frac{7+\sqrt{5}}{7-\sqrt{5}} - \frac{7-\sqrt{5}}{7+\sqrt{5}} = a + \frac{7}{11}\sqrt{5}b$$

6. If $a = 2 + \sqrt{3}$, then find the value of $a - \frac{1}{a}$.

7. Prove that :

$$\frac{1}{3-\sqrt{8}} - \frac{1}{\sqrt{8}-\sqrt{7}} + \frac{1}{\sqrt{7}-\sqrt{6}} - \frac{1}{\sqrt{6}-\sqrt{5}} + \frac{1}{\sqrt{5}-2} = 5$$

8. Prove that $7 + \sqrt{3}$ is an irrational number.

Case Based Questions

1. Srikanth has made a project on real numbers, where he finely explained the applicability of exponential laws and divisibility conditions on real numbers. He also included some assessment questions at the end of his project as listed below.

Answer them.

- (I) For what value of n, 4^n ends in 0?
 (A) 10 (B) when n is even
 (C) when n is odd (D) no value of n
- (II) If a is a positive rational number and n is a positive integer greater than 1, then for what value of n, a^n is a rational number?
 (A) when n is any even integer
 (B) when n is any odd integer
 (C) for all $n > 1$
 (D) only when $n = 0$
- (III) If x and y are two odd positive integers, then which of the following is true?
 (A) x^2+y^2 is even
 (B) x^2+y^2 is not divisible by 4
 (C) x^2+y^2 is odd
 (D) both (a) and (b)





- (IV) The statement 'One of every three consecutive positive integers is divisible by 3' is
 (A) always true (B) always false
 (C) sometimes true (D) None of these

- (V) If n is any odd integer, then $n^2 - 1$ is divisible by
 (A) 22 (B) 55
 (C) 88 (D) 8

2. Real numbers are numbers which include both rational and irrational numbers. Rational numbers are the numbers which can be expressed in the form of p/q where p and q are integers and q not equal to zero. Irrational numbers are numbers which cannot be expressed as a ratio of two integers.

- (I) Every rational number is.

- (A) Whole number
 (B) Natural number
 (C) Integer
 (D) Real number

- (II) The product of two irrational numbers is.

- (A) Always rational
 (B) Always irrational
 (C) Always integer
 (D) Sometimes rational sometimes irrational





EXERCISE - II

HOTS

- The digit at the 100th place in the decimal representation of $\frac{6}{7}$, is :
(A) 1 (B) 2 (C) 4 (D) 5
- xy is a number that is divided by ab where $xy < ab$ and gives a result 0.xyxyxy... then ab equals:
(A) 11 (B) 33 (C) 99 (D) 66
- When the repeating decimal 0.45454545..... is written in simplest fractional form, the sum of the numerator and denominator is :
(A) 5 (B) 11 (C) 55 (D) 16
- If $\sqrt{9-(n-2)^2}$ is a real number, then the number of integral values of n is :
(A) 3 (B) 5
(C) 7 (D) Infinitely many
- If x is a positive integer less than 100, then the number of x which make $\sqrt{1+2+3+4+x}$ an integer is:
(A) 6 (B) 7 (C) 8 (D) 9
- If
$$\frac{\sqrt{954+\sqrt{\sqrt{484+\sqrt{704+\sqrt{625}}}}}}{0.00155} = \frac{\sqrt{0.0004}}{x(0.009)^2}$$
 . Then approximate value of x is
(A) 123.456 (B) 0.01234
(C) 12.34 (D) 12345.67
- If n is a perfect square, then the next perfect square greater than n is :
(A) $n^2 + 1$ (B) $n^2 + n$
(C) $n + 2\sqrt{n} + 1$ (D) $2n + 1$

- The value of $\left(1-\frac{1}{3}\right)^2 \cdot \left(1-\frac{1}{4}\right)^2 \cdot \left(1-\frac{1}{5}\right)^2 \dots \dots \left(1-\frac{1}{n}\right)^2$ is equal to :
(A) $\left(\frac{1}{n}\right)^2$ (B) $\left(\frac{2}{n}\right)^2$
(C) $\left(\frac{3}{n}\right)^2$ (D) $\left(\frac{4}{n}\right)^2$
- If $x = (7 + 4\sqrt{3})$, then the value of $\sqrt{x} + \frac{1}{\sqrt{x}}$ is :
(A) 8 (B) 6 (C) 5 (D) 4
- If $x = \frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$ and $x = \frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}-\sqrt{2}}$ the value of $x^2 + xy + y^2$ is :
(A) 99 (B) 100 (C) 1 (D) 0
- If $x = 7 - 4\sqrt{3}$ then the value of $x + \frac{1}{x}$ is
(A) 28 (B) 14 (C) $8\sqrt{3}$ (D) $1/14$
- Which of the following statements is true?
(A) The division of a rational and an irrational number is always an rational number.
(B) The sum or difference of two irrational number is always an irrational number.
(C) The product of two irrational number can be rational or irrational
(D) The product of two irrational number is always a rational number.
- The simplified form of $[\sqrt{7+4\sqrt{3}} - \sqrt{3}]$ is -
(A) 2 (B) 1 (C) 5 (D) 10
- Simplify: $\left(\frac{\sqrt{5}+2}{\sqrt{5}-2}\right) - \left(\frac{\sqrt{5}-2}{\sqrt{5}+2}\right)$
(A) 8 (B) 1 (C) $\frac{40}{\sqrt{5}}$ (D) None





15. $\left(\frac{a^x}{a^y}\right)^{x+y} \cdot \left(\frac{a^y}{a^z}\right)^{y+z} \cdot \left(\frac{a^z}{a^x}\right)^{z+x}$
 (A) 0 (B) $\frac{31}{11}$
 (C) integer (D) whole number
16. $(\sqrt{x})^x = x^{\sqrt{x}}$ solve
 (A) -2 (B) -4 (C) 4 (D) 2
17. Simplify: $1 + \frac{6}{5 + \frac{4}{3 - \frac{1}{2}}}$
 (A) $\frac{14}{45}$ (B) $\frac{63}{33}$ (C) $\frac{13}{19}$ (D) $\frac{31}{11}$
18. If $a = \sqrt{6} + \sqrt{5}$; $b = \sqrt{6} - \sqrt{5}$, the find the value of $2a^2 - 5ab + 2b^2$
 (A) 20 (B) 39 (C) 35 (D) 25
19. The value of $\sqrt{6+2\sqrt{3}+2\sqrt{2}+2\sqrt{6}} - \frac{1}{\sqrt{5-2\sqrt{6}}}$ is
 (A) 2 (B) -1
 (C) $\sqrt{3} + \sqrt{2}$ (D) 1
20. If $x = 3 - \sqrt{5}$, then $\frac{\sqrt{x}}{\sqrt{2} + \sqrt{3x-2}} =$
 (A) $\frac{1}{\sqrt{5}}$ (B) $\sqrt{5}$ (C) $\sqrt{3}$ (D) $\frac{1}{\sqrt{3}}$

Assertion and Reason

Directions: Each of the following questions contains an assertion followed by a reason. Read them carefully and answer the questions on the basis of the following options.

- (A) Both assertion and reason are true and the reason is the correct explanation of assertion.
 (B) Both assertion and reason are true but the reason is not the correct explanation of the assertion.
 (C) Assertion is true and the reason is false.
 (D) Both assertion and reason are false.

1. **Assertion:** Every integer is a rational number
Reason: Every integer is expressed in the form of $m/1$ so it is rational number
2. **Assertion:** $\sqrt{2}$ is an irrational number.
Reason: A number is called irrational, if it cannot be written in the form p/q , where p and q are integers and $q \neq 0$.
3. **Assertion:** 0.468 is a terminating decimal.
Reason: A decimal in which a digit or a set of digits is repeated periodically, is called a repeating, or a recurring decimal.
4. **Assertion:** -25 is not a rational number.
Reason: -25 can not be written in in the form of p/q .
5. **Assertion :** 5 is a rational number.
Reason : The square roots of all positive integers are irrationals.

Numerical Type Questions

1. The value of the expression $\sqrt{\frac{1}{\sqrt{2}+1} + \frac{1}{\sqrt{3}+\sqrt{2}} + \frac{1}{\sqrt{4}+\sqrt{3}} \dots \text{upto } 99 \text{ terms}}$ is equal to :
2. If the number 2345p60q is exactly divisible by 3 and 5, then the maximum value of $p+q$ is.
3. If $2^{2008} - 2^{2007} - 2^{2006} + 2^{2005} = k \cdot 2^{2005}$ then the value of k is equal to :
4. If $2^x = 3^y = 6^{-z}$, then $\left(\frac{1}{x} + \frac{1}{y} + \frac{1}{z}\right)$ is equal to :
5. If $\frac{1}{x+1} + \frac{2}{y+2} + \frac{2006}{z+2006} = 1$, find the value of $\frac{x^2}{x^2+x} + \frac{y^2}{y^2+2y} + \frac{z^2}{z^2+2006z}$
6. If $a = \frac{1}{3-2\sqrt{2}}$, $b = \frac{1}{3+2\sqrt{2}}$ then the value of $a^2 + b^2$ is





7. Find the missing value: $\frac{(13)^3 + 7^3}{(13)^2 + 7^2 - ?} = 20$.

8. The value of $\sqrt{\frac{x^\ell}{x^{m^2}}}^{\ell+m} \cdot \sqrt{\frac{x^{m^2}}{x^{n^2}}}^{m+n} \cdot \sqrt{\frac{x^{n^2}}{x^{\ell^2}}}^{n+\ell} =$.

9. If $\left(\frac{a}{b}\right)^{x-1} = \left(\frac{b}{a}\right)^{x-3}$ then the value of x is -

10. If $a^x = b$, $b^y = c$ and $c^z = a$, then value of xyz is




EXERCISE - III
Previous Year Questions

1. What will be the remainder if the number 7^{2012} is divided by 25? **[IJSO-2012]**
 (A) 24
 (B) 18
 (C) 7
 (D) 1
2. The product of three consecutive natural numbers is 124850054994. What is their average? **[IJSO-2012]**
 (A) 4993
 (B) 4994
 (C) 4997
 (D) 4998
3. If $\sqrt[3]{75} = \sqrt[3]{45} = \sqrt[3]{15} = a$, then which of the statement is true **[IJSO-2012]**
 (A) $x + y = 2z$
 (B) $x + y = 3z$
 (C) $x - y = 2z$
 (D) $x - y = 3z$
4. A number is said to be triangular number if it is the sum of consecutive numbers beginning with 1. Which one of the following is not a triangular number : **[IJSO-2014]**
 (A) 1431
 (B) 190
 (C) 28
 (D) 506
5. The sum of 2 digits x and y is divisible by 7. What can one say about a 3 digit number formed by these two digits. **[IJSO-2014]**
 (A) xxy is divisible by 7
 (B) xyx is divisible by 7
 (C) xyx is divisible by 7^2
 (D) yyx is divisible by 7

6. Number plate of a vehicle consists of 4 digits. The first digit is the square of second. The third digit is thrice the second and the fourth digit is twice the second. The sum of all 4 digits is thrice the first. The number is **[IJSO-2014]**
 (A) 1132
 (B) 4264
 (C) 1642
 (D) 9396
7. If p and q are rational numbers and $\frac{5 + \sqrt{11}}{3 - 2\sqrt{11}} = p + q\sqrt{11}$, then find the values of p and q respectively. **[IMO-2016]**
 (A) $\frac{37}{35}, \frac{-13}{35}$
 (B) $\frac{37}{35}, \frac{13}{35}$
 (C) $\frac{-37}{35}, \frac{-13}{35}$
 (D) $\frac{-37}{35}, \frac{13}{35}$
8. Find the value of **[IMO-2014]**

$$9^{3/2} - 3 \times 5^0 - \left[\frac{1}{81} \right]^{-1/2}$$

$$\frac{\left(\frac{64}{125} \right)^{-2/3} + \frac{1}{\left(\frac{256}{625} \right)^{1/4}} + \left(\frac{\sqrt{25}}{\sqrt[3]{64}} \right)}{\quad}$$
 (A) $\frac{15}{13}$
 (B) 0
 (C) $\frac{16}{5}$
 (D) $\frac{48}{13}$





ANSWER KEY

EXERCISE-I

Single Correct Type Questions

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	C	D	C	B	C	C	A	A	B	B	B	A	B	D
Que.	16	17	18	19	20										
Ans.	B	B	D	D	A										

Very Short Answer Type Questions

- Rational or Irrational
- 1.5
- 2
- $\frac{\sqrt{7}+2}{3}$
- $\frac{7(3\sqrt{3}+2\sqrt{2})}{19}$
- 2
- $\frac{1}{2^6}$
- $\frac{1}{9}$
- 0.1818
- $-\frac{7}{4}, -\frac{3}{2}, -\frac{5}{4}$

Short Answer Type Questions

- 0.4142
- 4
- (i) False (ii) False (iii) False (iv) True
(v) False (vi) False (vii) False
- $\frac{37}{300}$
- $a = -2$
- 5
- $36a^4b^6c^3\sqrt[6]{108}$
- (i) $\frac{37}{99}$ (ii) $\frac{479}{11}$ (iii) $\frac{53192}{9990}$ (iv) $\frac{4159}{900}$

Long Answer Type Questions

- (i) $\sqrt{5}$ (ii) $\frac{7\sqrt{6}}{12}$ (iii) $2^8\sqrt{2^{18} \cdot 3^{11}}$ (iv) $\frac{8}{3\sqrt[3]{7}}$
(v) $\frac{34}{\sqrt{3}}$ (vi) $5-2\sqrt{6}$ (vii) 0 (viii) $\frac{5\sqrt{2}}{4}$ (ix) $\frac{\sqrt{3}}{2}$
- (i) $\frac{2\sqrt{3}}{9}$ (ii) $\frac{2\sqrt{30}}{3}$ (iii) $\frac{3\sqrt{2}+2}{8}$ (iv) $\sqrt{41}+5$ (v) $7+4\sqrt{3}$
(vi) $2\sqrt{6}-3\sqrt{2}$ (vii) $5+2\sqrt{6}$ (viii) $9+2\sqrt{15}$ (ix) $\frac{9+4\sqrt{6}}{15}$
- (i) $a = 11$ (ii) $a = \frac{9}{11}$ (iii) $-\frac{5}{6}$ (iv) $a = 0, b = 1$ 6. $2\sqrt{3}$




Case Study Questions

Case-1					
Que.	1	2	3	4	5
Ans.	D	C	D	A	D
Case-2					
Que.	1	2			
Ans.	D	D			

EXERCISE-II
HOTS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	C	D	C	B	B	C	B	D	A	B	C	A	C	D
Que.	16	17	18	19	20										
Ans.	C	B	B	D	A										

Assertion and Reason

Que.	1	2	3	4	5										
Ans.	A	A	B	D	C										

Numerical Type Questions

1. 3 2. 13 3. 3 4. 0 5. 2 6. 34
 7. 91 8. 1 9. 2 10. 1 11. 39

EXERCISE-III
Previous Year Questions

Que.	1	2	3	4	5	6	7	8							
Ans.	D	D	B	A	B	D	C	D							





DPP

Daily Practice Problems

SUBJECT: Mathematics**COURSE: Class-9**
Topic: Number System**DPP NO. 1****Multiple Choices Questions:**

- The rational form of $2.74\overline{35}$ is
(A) $\frac{27161}{9999}$ (B) $\frac{27}{99}$ (C) $\frac{27161}{9900}$ (D) $\frac{27161}{9000}$
- If $x = 7 + 4\sqrt{3}$, then the value of $\sqrt{x} + \frac{1}{\sqrt{x}}$ is
(A) 8 (B) 6 (C) 5 (D) 4
- An irrational number is
(A) A terminating and non-repeating decimal
(B) A non-terminating and non-repeating decimal
(C) A terminating and repeating decimal
(D) A non-terminating and repeating decimal
- The product of rational and irrational number is always
(A) Rational (B) Irrational (C) Both (1) and (2) (D) Can't say
- Rational number between $\sqrt{2}$ and $\sqrt{3}$ is
(A) $\frac{\sqrt{2} + \sqrt{3}}{2}$ (B) $\frac{\sqrt{2} \times \sqrt{3}}{2}$ (C) 1.5 (D) 1.8
- $0.\overline{23} + 0.\overline{22} =$
(A) $0.\overline{45}$ (B) $0.\overline{43}$ (C) $0.\overline{45}$ (D) 0.45
- $$\frac{(x^{a+b})(x^{b+c})(x^{c+a})^2}{(x^a \cdot x^b \cdot x^c)^4} =$$

(A) -1 (B) 0 (C) 1 (D) None of these
- If $x = 2 - \sqrt{3}$ then the value of $x^2 + \frac{1}{x^2}$ and $x^2 - \frac{1}{x^2}$ is
(A) $14, 8\sqrt{3}$ (B) $-14, -8\sqrt{3}$ (C) $14, -8\sqrt{3}$ (D) $-14, 8\sqrt{3}$
- If $x = \frac{\sqrt{3}+1}{2}$ then the value of $4x^3 + 2x^2 - 8x + 7$ is
(A) 10 (B) 8 (C) 6 (D) 4

10. The irrational numbers between $\sqrt{2}$ and $\sqrt{3}$ are
 (A) $2^{\frac{1}{2}} \times 6^{\frac{1}{4}}$ (B) $3^{\frac{1}{4}} \times 3^{\frac{1}{6}}$ (C) $6^{\frac{1}{8}} \times 3^{\frac{1}{4}}$ (D) None
11. If $9^{x-1} = 3^{2x-1} - 486$, then the value of x is
 (A) 3.5 (B) 2.5 (C) 1.5 (D) 0
12. The value of $\sqrt[3]{24} + \sqrt[3]{81} - \sqrt[3]{192}$, is
 (A) $\sqrt[3]{3}$ (B) $\sqrt{3}$ (C) 3 (D) None of these
13. If $2^{2x-y} = 32$ and $2^{x+y} = 16$, then $x^2 + y^2$
 (A) 9 (B) 10 (C) 11 (D) 13
14. If $a = \frac{1}{3-2\sqrt{2}}$, $b = \frac{1}{3+2\sqrt{2}}$ then the value of $a^2 + b^2$ is
 (A) 34 (B) 35 (C) 36 (D) 37
15. If $\sqrt{3} = 1.732$, $\sqrt{5} = 2.236$, then the value of
 (A) 10.905 (B) 11.904 (C) 11.905 (D) None
16. The value of $\frac{(25)^{5/2} \times (243)^{2/5}}{(16)^{3/4} \times (8)^{5/3}}$ is
 (A) $\frac{5625}{128}$ (B) $\frac{5615}{256}$ (C) $\frac{5625}{256}$ (D) None
17. Two irrational numbers between 2 and 2.5 are
 (A) $\sqrt{5}$ and $\sqrt{2 \times \sqrt{5}}$ (B) and (C) and (D) None of these
18. The exponential form of $\sqrt{\sqrt{2}\sqrt{3}}$ is
 (A) $6^{1/2}$ (B) $6^{1/3}$ (C) $6^{1/4}$ (D) 6
19. If $x = \frac{1}{2-\sqrt{3}}$ find the value of $x^3 - 2x^2 - 7x + 5$ is
 (A) 1 (B) 1 (C) 0 (D) 3
20. If $x = 1 - \sqrt{2}$, find the value of $\left(x - \frac{1}{x}\right)^3$.
 (A) 8 (B) 7 (C) 9 (D) 2

Very short answer type Questions

1. Write three irrational numbers between $\sqrt{3}$ and $\sqrt{5}$.
2. Represent $\sqrt{8.3}$ on the number line.

3. Find the rationalising factor of
(I) $\sqrt[3]{49}$
(II) $\sqrt[4]{5}$
4. Simplify by rationalising the denominator : $\frac{7\sqrt{3} - 5\sqrt{2}}{\sqrt{18} + \sqrt{18}}$
5. Given that $\sqrt{3} = 1.732$, find the value of $\sqrt{75} + \frac{1}{2}\sqrt{48} - \sqrt{192}$

Short answer type Questions:

1. Simplify : $\frac{7\sqrt{3}}{\sqrt{10} + \sqrt{3}} - \frac{2\sqrt{5}}{\sqrt{6} + \sqrt{5}} - \frac{3\sqrt{2}}{\sqrt{15} + 3\sqrt{2}}$
2. If $x = \frac{\sqrt{5} - \sqrt{3}}{\sqrt{5} + \sqrt{3}}$ and $y = \frac{\sqrt{5} + \sqrt{3}}{\sqrt{5} - \sqrt{3}}$, find the value of $x^2 + y^2 - 6xy$
3. Find the rational number and b such that $\frac{2+5\sqrt{7}}{2-5\sqrt{7}} = a + \sqrt{7}b$
4. If x and y are rational numbers and $\frac{5+\sqrt{11}}{3-2\sqrt{11}} = x + y\sqrt{11}$, find the values of x and y.
5. Find the values of a and b is $\frac{7+3\sqrt{5}}{3+\sqrt{5}} - \frac{7-3\sqrt{5}}{3-\sqrt{5}} = a + \sqrt{5}b$

Long answer type Questions:

1. Simplify : $\frac{2\sqrt{6}}{\sqrt{2} + \sqrt{3}} + \frac{6\sqrt{2}}{\sqrt{6} + \sqrt{3}} - \frac{8\sqrt{3}}{\sqrt{6} + \sqrt{2}}$
2. If $\frac{9^n \times 3^2 \times (3^{-n/2})^{-2} - 27^n}{3^{3m} \times 2^3} = \frac{1}{27}$, prove that $m-n = 1$.
3. The value of $\sqrt[l+m]{\frac{x^{l^2}}{x^{m^2}}} \cdot \sqrt[m+n]{\frac{x^{m^2}}{x^{n^2}}} \cdot \sqrt[n+l]{\frac{x^{n^2}}{x^{l^2}}} =$
4. The possible values of p and q for the equation $\frac{\sqrt{3}-1}{\sqrt{3}+1} = p + q\sqrt{3}$.

Case based Study

1. Rohan was given a task by his sport teacher to complete 5 rounds of the school ground. The distance of one round is $2\sqrt{5} + 5\sqrt{3}$ km. He takes 10 minutes to complete one round.



- (I) Is $2\sqrt{5} + 5\sqrt{3}$ a rational number?
 (A) Yes (B) No
- (II) Total distance Rohan has to cover is ____
 (A) $4 \times (2\sqrt{5} + 5\sqrt{3})$ (B) $5 \times (2\sqrt{5} + 5\sqrt{3})$
 (C) $3 \times (2\sqrt{5} + 5\sqrt{3})$ (D) $5 \times (2\sqrt{5} + 5\sqrt{2})$
- (III) Total time taken to complete the rounds
 (A) 2 minutes (B) 40 minutes (C) 50 minutes (D) 60 minutes

ANSWER KEY										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	C	D	B	C	C	A	C	C	B	C
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	A	A	B	A	B	C	D	C	D	A

Case Based Study

- (I) (B)
 (II) (B)
 (III) (C)

FOUNDATION

CLASS-IX

SAMPLE

BIOLOGY



THE FUNDAMENTAL UNIT OF LIFE

Introduction

Innumerable kinds of organisms live on our planet earth. These are broadly classified into bacteria, protists, fungi, plants, and animals. All these organisms look different from each other. However, all of them are made up of microscopic units called **cells**.

The cell is defined as “A unit of biological activity, delimited by a differentially permeable membrane and capable of self-reproduction in a medium free of other living systems”.

OR

“Cell is the structural and functional unit of living organisms”.

Cytology/Cell biology

- Cytology is that sub-branch of biology which deals with the overall study of cell.
- Cell is the smallest, basic, structural and functional unit of life.

Discovery of cell

- The term cell was introduced by an English scientist **Robert Hooke** in his book **Micrographia** published in London in 1665. With this, he launched the study of microscopic anatomy. He examined thin slices of cork under a primitive microscope that he had assembled. He saw tiny empty compartments in the slices. He called them **cellulae** (small compartment) and thought them to act as passages for conducting fluids since cork is the dead bark of a **Spanish oak, Quercus**.
- Anton von Leeuwenhoek** was a Dutch merchant and pursued microscopy as a hobby. He designed remarkable simple microscope and with this, he first discovered free living cells such as human sperm cells, bacteria, protozoans and red blood corpuscles in 1674. He called the swimming creatures “**animalcules**”.

- Robert Brown (1831)** discovered the nucleus in an orchid root cell.

- In **1839**, **Johannes E. Purkinje** noted similar material in the plant cells and named it protoplasm, ‘**The first substance**’.

- A **French zoologist Felix Dujardin (1835)** discovered a semi-fluid living material in certain protozoans. He called this material “**sarcode**”.

- Knoll and Ruska (1932)** from Germany designed the electron microscope which was employed to study the **ultra structure** (fine structure) of cell and various cell organelles in **1940s**.

- Huxley (1868) called protoplasm as the “**physical basis of life**”

Microscope

It is an instrument which is used to study those objects that cannot be seen with the naked eye or with the help of a hand lens. A compound microscope has more than one lens. The 1st compound microscope was built by **F. Janssen** and **Zacharias Janssen (1590)**.

The microscope used in schools is called compound microscope. A compound microscope has following parts:

Base: It is a basal, metallic, horse- shoe shaped structure. It bears the whole weight of a microscope.

Handle: It is the curved part to hold the microscope. It is also called as arm.

Stage: It is a strong metallic, rectangular, horizontal plate fixed to the handle.

Stage Clips: Two clips are attached to the stage used for holding the slide in position.

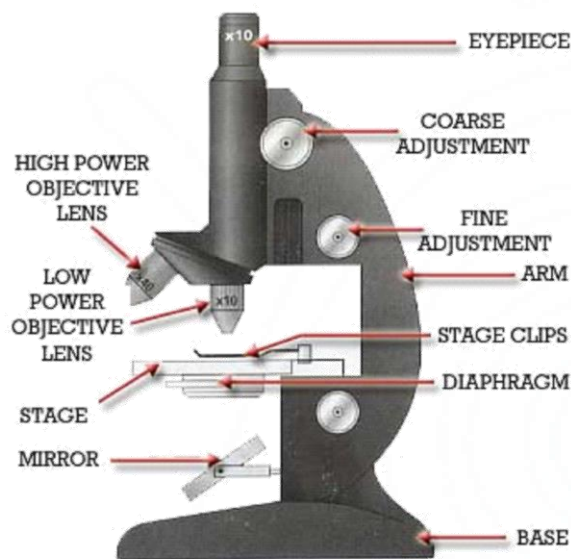
Body Tube: It is a wide and hollow tube attached to the upper part of the arm. To this tube lenses are attached.



Reflecting Mirror: It is meant for reflecting the light rays, so that the light passes through the object which is to be seen.

Adjustment Screw

- **Coarse Adjustment:** It is a bigger sized screw used to move the body tube up and down.
- **Fine Adjustment:** It is a smaller sized screw for fine focusing.



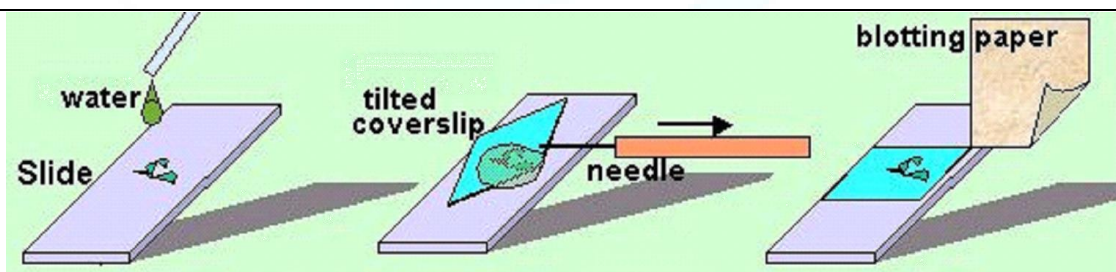
Microscope

NOTE: Resolving power of human eye is 100 nm.

Preparation of Microscopic Slide

The object to be viewed under microscope is called the **specimen**. A thin sheet of glass called **microscopic slide** is used to hold a small sample of the specimen. A second much thinner glass sheet is placed over the sample, called as **coverslip**.

- Take a clean glass slide.
- With a dropper, put a drop of water in the middle of the slide.
- Gently put the object to be observed in the drop of water on the slide with the help of a brush.
- If Object, is colourless, then first stain that with a proper **chemical (Dye or colouring agent)**.
- Hold the coverslip over the object in such a manner that it touches the edge of the drop of water.
- Gently lower the coverslip onto the water with the help of a mounting needle.
- Dry the extra water that may come out from under the coverslip with the help of a blotting paper. Take care that the slide thus prepared is clean and dry.



How to Place Coverslip to Avoid Bubbles

Activity

Aim: To observe the plant cells (**Example:** onion peel cell/Rheo leaf cell) under a microscope.

Apparatus and Materials required: Onion, glass slide, coverslip, stain, microscope, dropper.

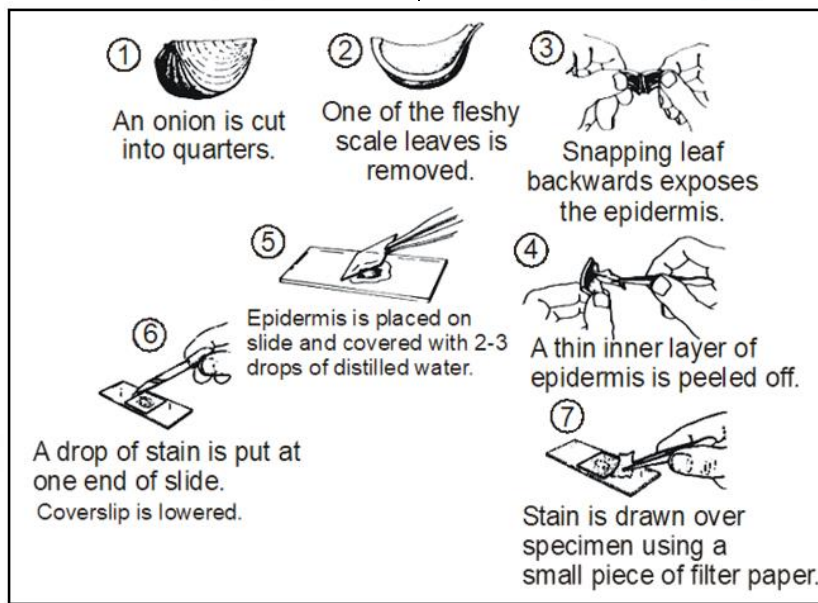
Procedure: Let us take a small piece from an onion bulb.

- With the help of a pair of forceps, we can peel off the skin (called epidermis) from the concave side (inner layer) of the onion.
- This layer can be put immediately in a watch-glass containing water.
- This will prevent the peel from getting folded or getting dry.
- Let us take a glass slide, put a drop of water on it and transfer a small piece of the peel from the watch glass to the slide.



- Make sure that the peel is perfectly flat on the slide.
- A thin camel hair paintbrush might be necessary to help transfer the peel.
- Now we put a drop of water from the watch glass to the slide.
- Now we put a drop of safranin solution on this piece followed by a cover slip.

- Take care to avoid air bubbles while putting the cover slip with the help of a mounting needle.
- We have prepared a temporary mount of the onion peel.
- We can observe this slide under low power lens followed by high power lens of a compound microscope.

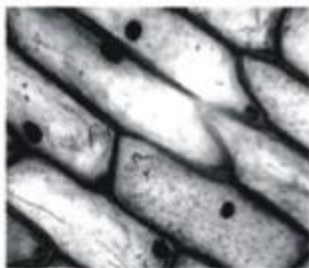


Preparation of A Slide of An Onion Peel

Observations:

It is observed that:

- A number of cells lie side by side.
- Each cell has a distinct wall. This is called cell wall.
- At the centre of each cell, there is a nucleus.
- Some large empty spaces exist within the cell. These are vacuoles.



Onion Peel (Under Microscope)

Cell Theory

Two biologists, “**Schleiden and Schwann**” gave the “**Cell theory**” (1838-1839) which was later on expanded by “**Rudolf Virchow**” 1855.

Cell theory states that –

- All plants and animals are composed of cells.
- Cells are the basic unit of life.
- All cells arise from pre-existing cells. (**Omnis cellula-e-cellula**, by Rudolf Virchow).

Viruses are the exceptions of cell theory.

Reason: Viruses are not true cells. They have a simple coat of protein only. They do not contain any cell organelle like mitochondria, ribosome etc. Viruses are alive only if they are inside their host cell. They are considered as non-living when outside the host cell.

Types of Cell

1. On the basis of number:

- Unicellular organisms:** These are the organisms which are made up of single cell only. This single cell performs all the vital functions of an organism.

Example: Amoeba, Plasmodium etc.



(ii) **Multicellular organisms:** These are the organisms which are made up of numerous cells. These cells then, combine to form tissue, tissues combine to form an organ, and organs combine to form organ system which perform different functions. These organ systems further form an organism.

Example: Plants and Animals

Cell → Tissue → Organ → Organ system
→ Organism

FUNDAMENTAL UNLOCKED- (FU#1)

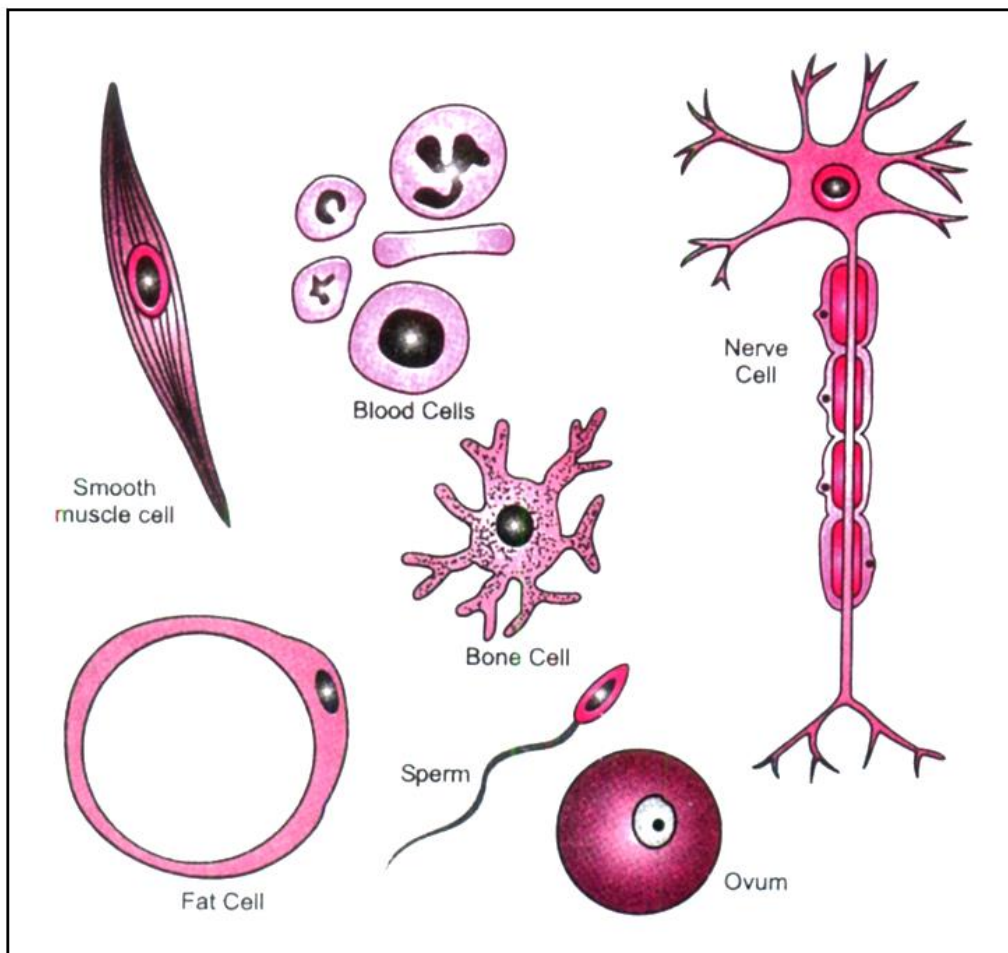
- Q.1** Why is the cell considered as the structural and functional unit of life ?
- Q.2** Who discovered the cell and how?
- Q.3** State and explain the three fundamentals of Cell theory.
- Q.4** Who expanded Cell theory?
- Q.5** Why are viruses excluded from Cell theory?

Cell Shape

- Cells are of variable shapes and sizes.
- Their shape is according to their function and location. Generally, cells are spherical but they may be elongated, branched, discoidal, spindle shaped etc.

Different shapes of the cells are:

- Flattened e.g. Skin cells (upper layer).
- Columnar e.g. Cells lining the intestine.
- Discoidal e.g. R.B.C.
- Spherical e.g. Eggs of many animals.
- Spindle shaped e.g. Smooth muscle fibres.
- Elongated e.g. Nerve cells.



Various Cells of the Human Body



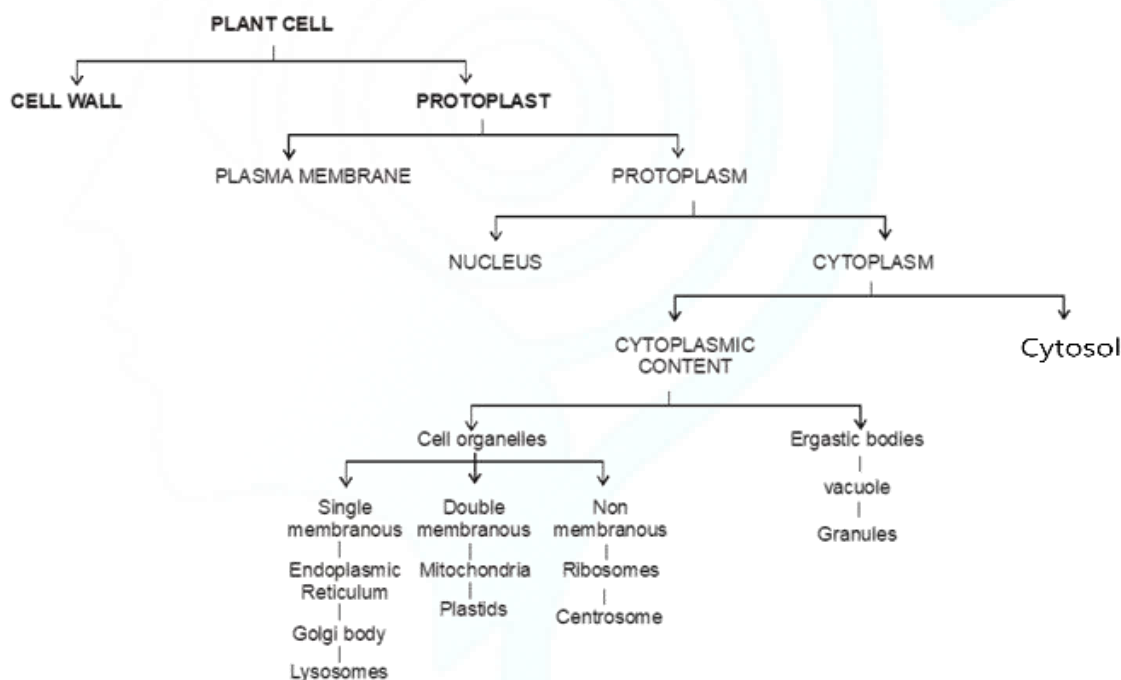
Different size of the cells are:

The largest cell in animals	Ostrich egg (15 cm in diameter with shell and 8 cm in diameter without shell)
The longest cell in animals	Nerve cell. (up to 1 metre or more)
Longest Cell in plants	Hemp fibre
Largest plant cell	<i>Acetabularia</i>
Largest Human cell	Egg cell is 0.1 mm in diameter.
Smallest living cell	PPLO/ <i>Mycoplasma gallisepticum</i> (Pleuro-Pneumonia Like Organisms) 0.2 – 0.3 μ m in size.
Smallest human cell	Sperm Cell

Components of Cell

The three basic components of all the cells are

- (i) Plasma Membrane or Cell Membrane
- (ii) Nucleus
- (iii) Cytoplasm



Plasma membrane and protoplasm together called as protoplast.

Nucleus and cytoplasm together known as protoplasm.

Cell Wall

- It is the outermost covering of the plant (cells).
- Cell wall is rigid, strong, thick, porous and non-living structure. It is made up of cellulose and hemicellulose.

- Cell walls of two adjacent cells are joined by a layer called **middle lamellae**. It is made up of calcium and magnesium pectate.
- Microscopic channels which transverse the cell walls of adjacent plant cells to maintain communication between them are known **plasmodesmata**.
- It is absent in animal cells.



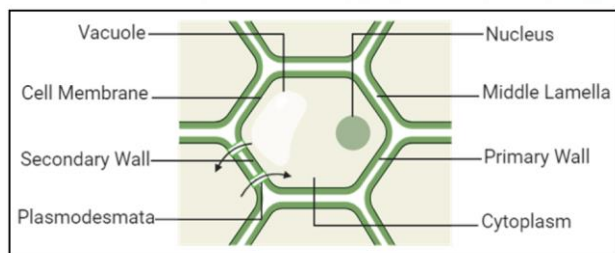
In addition to plant cells, cell wall is also present in bacteria and fungi.

Bacterial cell wall is made up of **peptidoglycan**.

Fungal cell wall is made up of **chitin**.

Functions of cell wall: The plant cell wall has the following functions:

- It maintains the shape of the cell.
- It protects the cells from mechanical injury and prevents their desiccation.
- It provides mechanical support against gravity. It is due to the rigid cell walls that the aerial parts of the plants are able to keep them erect and expose their leaves to sunlight.
- Being freely permeable, it allows the materials to pass in and out of the cells.
- The plasmodesmata form intercellular connections that allow exchange of materials between adjacent living cell contents.



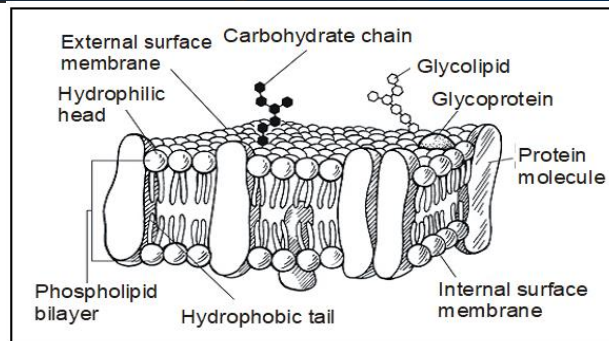
Cell Wall and Plasmodesmata

FUNDAMENTAL UNLOCKED- (FU#2)

- Q.1** Name the largest cell of plants.
- Q.2** Name the smallest cell present in human body?
- Q.3** What is protoplasm?
- Q.4** Define plasmodesmata.
- Q.5** Write any two functions of cell wall.

Cell Membrane / Plasma Membrane

- Cell membrane is also called Plasma Membrane or Plasmalemma.
- It is the limiting boundary of each cell which separates the cytoplasm from its surroundings.



- The term '**Plasma membrane**' was given by **Nageli**.
- It is found in both plant as well as animal cell.
- It is the outer most covering of a cell in case of animals and lies below the cell wall in case of plants.
- It is made up of proteins, lipids and carbohydrates. The ratio of protein and lipid varies considerably in different cell types.
- Plasma membrane is selectively permeable in nature. It allows or permits the entry and exit of some materials in and out of the cell.
- **Fluid Mosaic model of Cell membrane**
- **Singer and Nicolson** gave the **fluid mosaic model** of plasma membrane. According to them it consists of a protein layer sandwiched between two layers of lipids.
- Its thickness is 75 Å. It is found in both plant as well as animal cell.
- Due to its quasi fluid state, it is flexible and can be folded, broken and reunited.

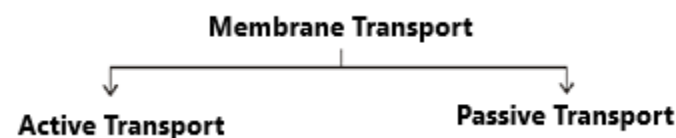
Functions of Plasma Membrane

- It gives framework to the cell.
- It forms organelles within the cytoplasm.
- It keeps the cell contents in place and prevents their mixing with the extracellular materials.
- It protects the cell from injury.
- It is selectively permeable i.e., it regulates the flow of selected materials into and out of the cell.

Membrane Transport

Membranes form physical boundaries between organelle and cytoplasm as well as between the cell and extra cellular fluids. Plasma membrane is selective by permeable membrane. Substances are transferred across the membrane through two major methods as follows:





A. Passive transport: Movement of substances through membrane without the expenditure of energy (ATP). It occurs through diffusion and osmosis.

(I) Diffusion: The spontaneous movement of a substance from a region of high concentration to a region of its low concentration is called

diffusion. It occurs along concentration gradient. Some substances like carbon dioxide or oxygen can move across the cell membrane by diffusion.

(II) Osmosis: Osmosis is the process of movement of water (solvent) molecules through a semi-permeable membrane from a region of lower solute concentration to higher solute concentration. On the contrary, diffusion does not require a semi-permeable membrane to occur and the molecules move from a region of higher concentration to lower concentration.

Comparative Study of Diffusion and Osmosis

	Diffusion	Osmosis
Definition	Movement of ions or molecules from a region of high concentration to a region of their low concentration is called diffusion.	Movement of solvent molecules from their higher concentration to low concentration through semi-permeable membrane is called osmosis.
Occurrence	In both gas and liquid medium.	Only in liquid medium.

Types of Solution

(i) Isotonic Solution

- When concentrations of the solutes on both sides of cell membrane are same, the solution is called Isotonic.
- Water crosses the cell membrane in both directions but the amount going in is the same as the amount going out. So, there is no overall movement of water.

(ii) Hypotonic Solution

- When concentration of the solute in solution is lower than intracellular fluid i.e. cytoplasm and cell sap, the solution is called Hypotonic.
- Water molecules from the solution will enter the cell.
- This results in swelling of the cell and such cell is called as a turgid cell.

(iii) Hypertonic Solution

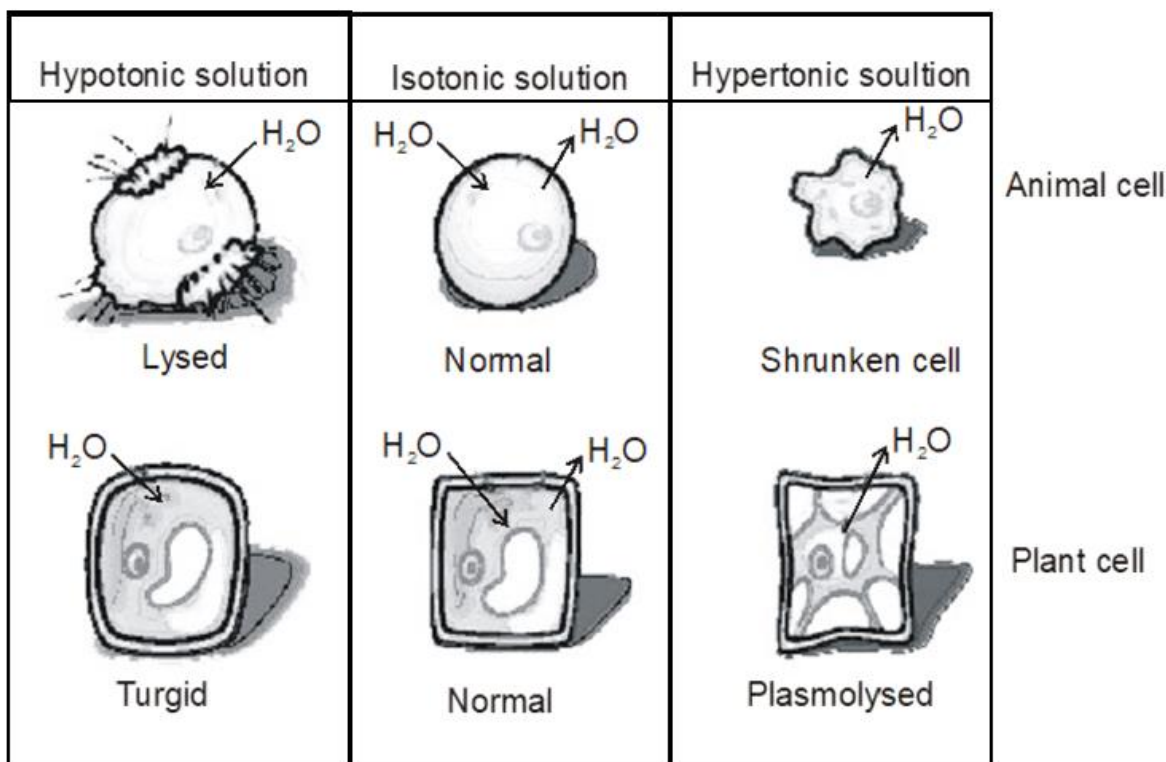
- When concentration of the solute in solution is higher than intracellular fluid i.e., cytoplasm and cell sap, the solution is called Hypertonic.
- In such solution, water leaves the cell and causes shrinkage of cell. The shrinkage of cell is called **Plasmolysis**. Such cells are called **Plasmolysed** cell

Types of Osmosis: On the basis of tonicity of solution, there are two main types of osmosis.

- (i) Endosmosis:** When cells are placed in a hypotonic solution, water flows into the cell. This process of osmotic entry of water is called Endosmosis.
- (ii) Exosmosis:** When cells are placed in a hypertonic solution, water flows out of the cell. This process of osmotic withdrawal of water is called Exosmosis.



Movement of Water in a Cell in Different Types of Solution



Endocytosis: The materials which are engulfed during endocytosis may be either solid or liquid. When the materials engulfed are solid, the process is called **Phagocytosis** (meaning **cell eating**). When the materials taken in are liquid, the process is called **Pinocytosis** (cell drinking).

Exocytosis: Many substances such as enzymes, hormones and antibodies are produced inside Golgi bodies and packed in vesicles. These are transported across the cytoplasm to the surface of the cell and then released into the environment around the cell by reverse pinocytosis or phagocytosis.

B. Active Transport: Active transport is the movement of molecules or ions across a cell membrane from a region of lower concentration to a region of higher concentration i.e. against the concentration gradient. Active transport requires cellular energy to achieve this movement.

FUNDAMENTAL UNLOCKED- (FU#3)

- Q.1** Differentiate between active and passive transport.
- Q.2** Define osmosis.
- Q.3** What is diffusion?
- Q.4** Differentiate between osmosis and diffusion.
- Q.5** What happens to a plant cell when it is placed in hypotonic and hypertonic solutions?

Protoplasm

- The living substance which is essence of life that makes the cell is called protoplasm.
- Protoplasm was termed by **Purkinje (1839)**. It is a viscous colorless fluid and it is the site for all the physiological functions.
- Protoplasm is the physical basis of life.

Cytoplasm

- Cytoplasm was discovered by **Kolliker in 1862**.
- It is the site of both biosynthetic and catabolic pathways.
- It can be divided into two parts:



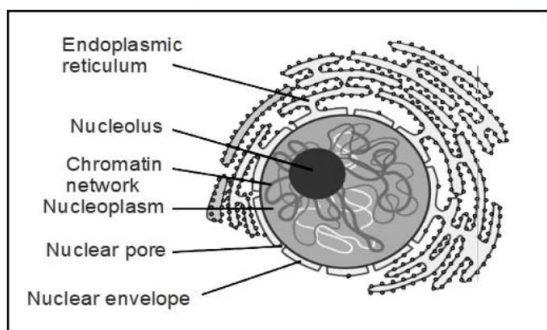
- 1. Cytosol or Hyaloplasm:** Aqueous soluble part contains various fibrous proteins forming cytoskeleton.
- 2. Cytoplasmic inclusions:** In the cell cytoplasm, there are numerous living and non-living structures present, collectively called cytoplasmic inclusions.

Nucleus

- It is called as **headquarter of the cell / brain of the cell / director of the cell** which directs and controls all the cellular activities.
- In Eukaryotes, a well-defined nucleus is present while in Prokaryotes a well-defined nucleus is absent.
- Prokaryotes contain a primitive nucleus called nucleoid.

Structure: It is made up of following four contents.

- (i) Nuclear Envelope:** Nucleus is surrounded by two membranes that separates nucleoplasm from cytoplasm. The nuclear membrane has minute pores. These are called nuclear pores.
- (ii) Nucleoplasm:** The part of protoplasm which is enclosed by nuclear membrane is called nucleoplasm. It contains chromatin threads and nucleolus.



Nucleus

- (iii) Nucleolus:** It is discovered by **Fontana**. Usually, one nucleolus is present in each nucleus but sometimes more than one nucleolus is present. It is the store house of RNA.
- (iv) Chromatin Network:** Darkly stained network of long fine threads are called chromatin threads. Chromatin threads are intermingled with one another forming a network. These are made up of DNA and proteins.

Functions: The nucleus performs following functions:

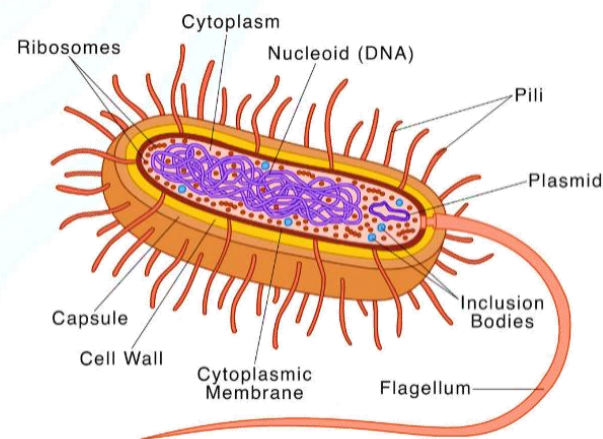
- It controls all the metabolic activities of the cell.
- It brings about growth of the cell by directing the synthesis of structural proteins.
- It takes part in the formation of ribosomes.
- It regulates cell cycle.
- It contains genetic information and is concerned with the transmission of hereditary traits from one generation to another.

Types of cell on the basis of type of nucleus

- (i) Prokaryotic Cells:** (*Pro: primitive or primary, karyon: nucleus*)

Cells which do not have a well defined nucleus are called Prokaryotic Cells. The nuclear region in these cells is not found by a nuclear region in these cells is not found by a **nuclear membrane**. Instead, the genetic material (circular DNA) is localized in a region of cytoplasm, called the nucleoid.

Example: Bacteria, Cynobacteria (blue green algae)



Prokaryotic Cell

- (ii) Eukaryotic cells:** (*Eu: true or well defined, karyon: Nucleus*)

These are well developed cells. They have advanced nucleus surrounded by nuclear membrane (have nucleolus with in it).

They have membrane bound cell organelles.

Example: Plants and animals.



Table: Difference Between Prokaryotic and Eukaryotic Cell

S. No.	Prokaryotic Cells	Eukaryotic Cells
1	Size is generally small (1 - 10µm)	Size is generally small (5 - 100 µm)
2	Most prokaryotes are unicellular.	Most eukaryotes are multicellular.
3	The nucleus is poorly defined due to the absence of a nuclear membrane.	The nucleus is well defined and is surrounded by a nuclear membrane.
4	Membrane bound cell organelles are absent	Membrane bound cell organelles are present
5	70s ribosomes are present	70s, 80s types of ribosomes are present
eg.	Bacteria and blue-green algae are prokaryotic cells.	Fungi, plant, protists and animal cells are eukaryotic cells.

Cell Organelles

The metabolically active, living cytoplasmic inclusions are called cell organelles. On the basis of membrane, cell organelles are following type:-

(A) Double Membranous Cell Organelle

(B) Single Membranous Cell Organelle

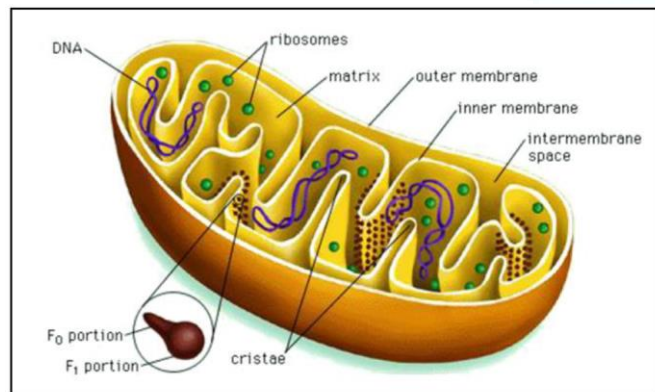
(C) Membrane-less Cell Organelle

(A) Double Membranous Cell Organelle

(a) Mitochondria

- It was first seen by **Kolliker** in insect cells and named by **Benda**.
- It is found in cytoplasm of all eukaryotic cells except mammalian RBC's.
- Maximum mitochondria are found in metabolically active cells.
- It is also called "**Power House of the Cell**" or the "**Storage Battery**".

Structure



Mitochondria

- It is a rod-shaped structure.
- It is a double membranous structure where the outer membrane is smooth while inner membrane is folded inside to form "**Cristae**".
- Cristae are the infoldings of inner mitochondrial membrane that possess ATP synthesizing units called **Oxysomes or F₀- F₁ Particles**. The F₁ particles are also called **Fernandez particles**.
- The fluid present in mitochondria is called matrix. **Mitochondria**
- Matrix contains a circular DNA molecule and ribosomes (70 s). Therefore, mitochondria are called semi-autonomous organelle.

Functions

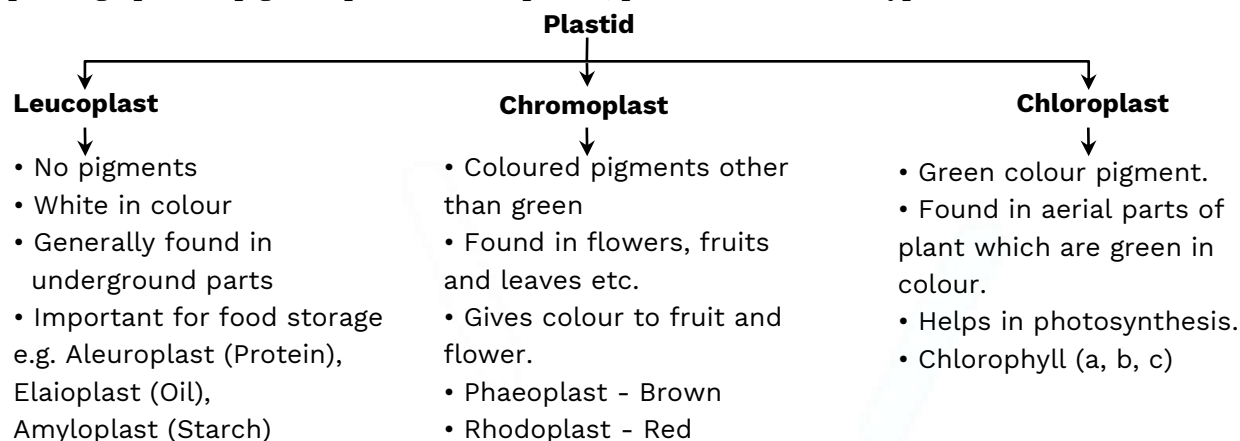
- The main function of mitochondria is to produce and store the energy in the form of ATP.
- It is the site of the cellular respiration.
- Oxysome contains enzymes for ATP production.

(b) Plastids

- Plants also double membrane bound organelles called plastids, which harvest solar energy, manufacture food (glucose) molecules and store food materials.
- Plastid term was coined by **E. Haeckel**.
- Plastids generally contain pigments and may synthesize and accumulate various substances.



Depending upon the pigment present in the plastid, plastids are of three types:

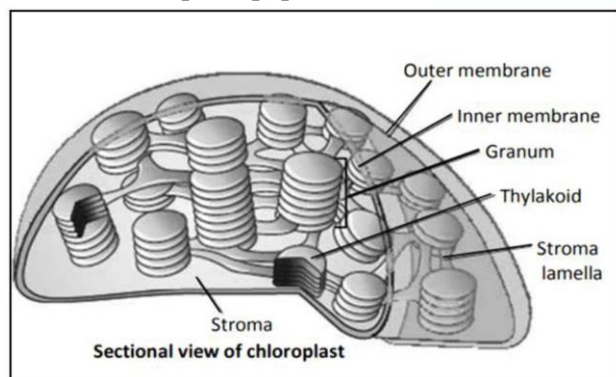


Chloroplast

- Plastids are most common with the greatest biological importance. They take part in photosynthesis to produce gas (oxygen) and energy (glucose) that is further used by several living beings.
- Blue green algae lack chloroplasts and have loosely arranged membrane in the cytoplasm in the form of sacs of typical unit membrane structure called lamellae.
- First observed by **A.V. Leeuwenhoek**.

Structure:

- (i) **Membrane:** The outer covering of chloroplast has an envelope composed of two-unit membranes (outer and inner membrane) which are made up of lipoproteins.



- (ii) **Grana:** It constitutes the lamellar system. These are found the stacks of thylakoids like a stalk of coins (grana is plural, singular is granum).

- Each granum of the chloroplast is formed by 10–100 rounded, flat, sac like structures stacked one above the other like a pile of coins. Such rounded flat and closed compartments are called thylakoid.
- Different grana are connected with the help of tubular connections called stroma lamellae or frets channel or inter granal thylakoids.

(iii) **Stroma:** It is a granular transparent substance also called matrix. Grana are embedded in matrix. Besides grana, stroma also contains lipid droplets, starch granules, ribosomes, strand of circular DNA and RNA, dissolved salts and enzymes. Due to presence of DNA and ribosomes, chloroplast is also called semi-autonomous organelle.

Functions:

- **Grana** are the sites of **light reaction** of photosynthesis as they contain photosynthetic pigment chlorophyll.
- **Stroma** is the site of **dark reaction** of photosynthesis. It also helps in protein synthesis due to presence of ribosomes (70S).

Why are mitochondria and chloroplasts called semi-autonomous?

Mitochondria and chloroplasts are called semi-autonomous organelles because of the following reasons:

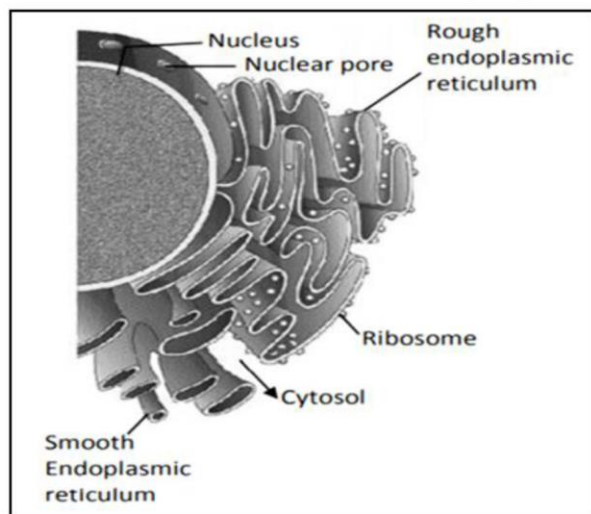
- They have their own DNA which can replicate independently.
- Its matrix possesses its own ribosomes.
- It synthesizes some of its own proteins.
- For the synthesis of some proteins, it depends on nuclear DNA.



B. Single Membranous Cell Organelles

(a) Endoplasmic Reticulum

- It is the network of membranes present in the cytoplasm.
- It was discovered by **Porter, Claude** and **Fullam**.
- These are present in all cells except prokaryotes and mature mammalian erythrocytes.



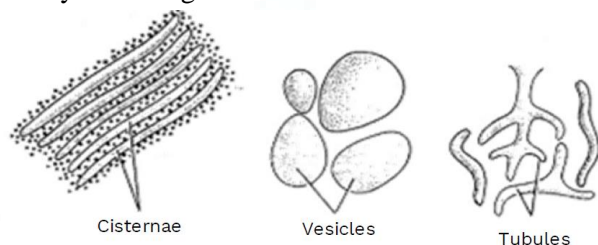
Endoplasmic Reticulum

They are made up of three components.

- (i) **Cisternae:** These are long, flattened, parallelly arranged and unbranched elements. These form successive layers of nucleus. These are found in cells which are active in protein synthesis and are 40 – 50 μm in diameter. These are studded with ribosomes.

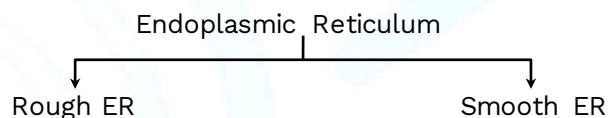
- (ii) **Vesicles:** These are rounded or spherical. They are found in synthetically active cells. These are studded with ribosomes. **Endoplasmic Reticulum**

- (iii) **Tubules:** These are small and smooth walled tubular spaces. These are found in lipid synthesizing cells.



Types of ER:

Endoplasmic reticulum is of two types:



- (i) **Rough Endoplasmic Reticulum (RER):** It has ribosomes attached on its cytoplasmic surface. This makes the surface look rough or granular. It is well developed in the cells that synthesize and secrete proteins.

- (ii) **Smooth Endoplasmic Reticulum (SER):** It mainly consists of tubules. SER are without ribosomes that makes their surface smooth. They synthesize lipids, steroid etc.

Difference between Rough Endoplasmic Reticulum (RER) and Smooth Endoplasmic Reticulum (SER):

Characteristics	RER	SER
Ribosomes	Attached to cisternae	Absent
Components	Mainly made of cisternae and very few tubules	Mainly made of tubules and vesicles.
Protein synthesis	Present	Absent
Steroid and lipid synthesis	Absent	Present
Occurrence	Abundance in protein secreting cells like pancreatic cells fibroblasts, liver cells, etc.	Abundance in lipid and steroid secreting cells like intestine cells, leucocytes etc.



Functions

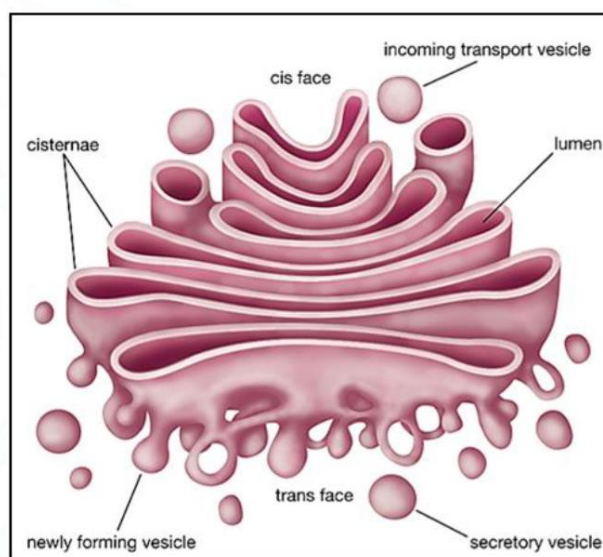
- **Support:** The ER acts as supporting skeletal framework of the cell and also maintains its form.
- **Transport of materials:** The ER facilitates transport of materials from the one part of the cell to another.
- **Exchange of materials:** The ER helps in the exchange of materials between the cytoplasm and nucleus.
- **Localization of organelles:** It keeps the cell organelles properly stationed and distributed in relation to one another.
- **Surface for protein synthesis:** The RER offers extensive surface on which ribosomes carry out protein synthesis.
- **Surface for synthesis of other substances:** The SER surface for the synthesis of lipids including phospholipids, cholesterol and steroid hormones.
- **Detoxification:** The SER brings about detoxification in the liver i.e. it converts harmful materials (drugs, insecticides, pollutants and poisons) into harmless substances for excretion by the cell.
- **Membrane formation:** Plasma membrane and other cellular membranes are formed by ER.

(b) Golgi Apparatus

- Golgi apparatus consists of a system of membrane bounded vesicles arranged parallel to each other in stacks called cisternae along with some large and spherical vacuoles.
- It was discovered by **Camilo Golgi**.
- It is absent in prokaryotes, mature mammalian RBC's & sieve cells.
- In plants, Golgi Body is known as **dictyosome**.

Camilo Golgi was born at Corteno near Brescia in 1843. He studied medicine at the **University of Pavia**. After graduating in 1865, he continued to work in Pavia at the Hospital of **St. Matteo**. At that time, most of his investigations were concerned with the nervous system. In 1872, he accepted the post of Chief Medical Officer at the Hospital for the Chronically Sicks at Abbiategrasso. He first started his investigations into the nervous system in a little kitchen of this hospital which he had converted into a laboratory. However, the work of greatest importance

which Golgi carried out was a revolutionary method of staining individual nerve and cell structures. This method is referred to as the '**black reaction**'. This method uses a weak solution of silver nitrate and is particularly valuable in tracing the processes and most delicate ramifications of cells. All through his life, he continued to work on these cell lines, modifying and improving this technique. Golgi received the highest honours and awards in recognition of his work. He shared the **Nobel prize in 1906** with **Santiago Ramony Cajal** for their work on the structure of the nervous system.

Structure

Golgi Apparatus

- It is single membrane bound cell organelle.
- Golgi apparatus consists of flat sacs or saccules or parallel membranes called cisternae.
- Each cisternae are arranged in stack one above the other. These stacks are surrounded at the circumference (periphery) by vesicles and vacuoles.

Functions

- It is secretory in nature.
- It helps in formation of middle lamellae.
- It helps in formation of lipids.
- Lipids and proteins synthesized in endoplasmic reticulum are packed at Golgi complex.
- They provide the site for assembly of new membrane materials.

(c) **Lysosomes:** (*Lyso* = digestive, *some* = body)

- They are bounded by a single membrane. They do not have a definite shape or size.
- Lysosomes were discovered by **Christian de Duve**.
- These are tiny sac like granules containing hydrolysing enzymes called **acid hydrolases** for intracellular digestion.
- They occur in animal cells and few plant cells.
- If the cell gets damaged, then Lysosomes burst and release digestive enzymes and digest its own cell. Hence lysosomes are called “**suicidal bags of the cell**”.

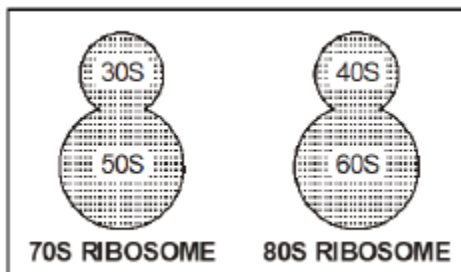
Functions

- Lysosomes act as waste disposal system of the cell.
- These help to keep the cell clean by digesting foreign material and worn-out cell organelles.
- Lysosomes contain powerful digestive enzymes that can break down all organic materials. During disturbances in cellular metabolism i.e. in case of cell damage, lysosomes burst and their enzymes are released into the cytoplasm resulting in digesting their own cell. So, they are also called “**Suicidal Bags**”.

IMPORTANT FACT: These play a vital role during fertilization and **metamorphogenesis** (disappearance of tail) in frogs.

FUNDAMENTAL UNLOCKED- (FU#4)

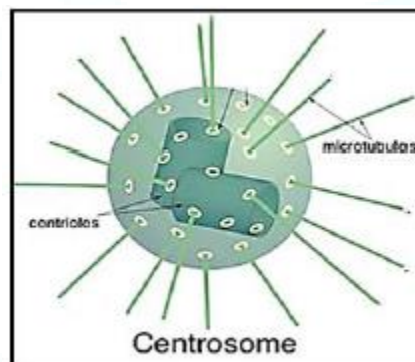
- Q.1** Explain the structure of nucleus?
Q.2 Differentiate between RER and SER.
Q.3 Why are lysosomes known as suicidal bags?
Q.4 Where are proteins synthesized inside the cell?
Q.5 Write any two functions of Golgi Apparatus.

C. Non-membranous Cell Organelles**(a) Ribosomes:****Ribosomes: Protein factory of cell.**

- A ribosome is not just one piece. It has two subunits, one large and one small.
- Prokaryotic cell has 70S ribosomes (50S and 30S subunits).
- Eukaryotic cell has both 70S and 80S (60S and 40S subunits)
- In the cell, ribosomes are found in many places around the cell. Sometimes floating freely in the cytoplasm and sometimes present on the rough endoplasmic reticulum (RER).

Function

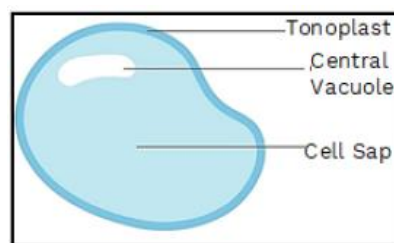
- Its main function is protein synthesis.

(b) Centrosome:

- It is found in animal cell.
- It consists of two centrioles, both centrioles in a centrosome perpendicular to each other.
- It is non membranous.

Function

- It helps in cell division and spindle formation.

Ergastic bodies**(a) Vacuoles**

- These are membrane bound regions in the cytoplasm containing water and other substances.
- They are bound by a single membrane called **Tonoplast**.



- In animal cells vacuoles are smaller in size and numerous, while in plant cells, a single large vacuole is found which occupies about 90% of the volume of cell.

Functions:

- It helps in maintaining osmotic pressure in the cell.
- It stores toxic metabolic products of plant cell.

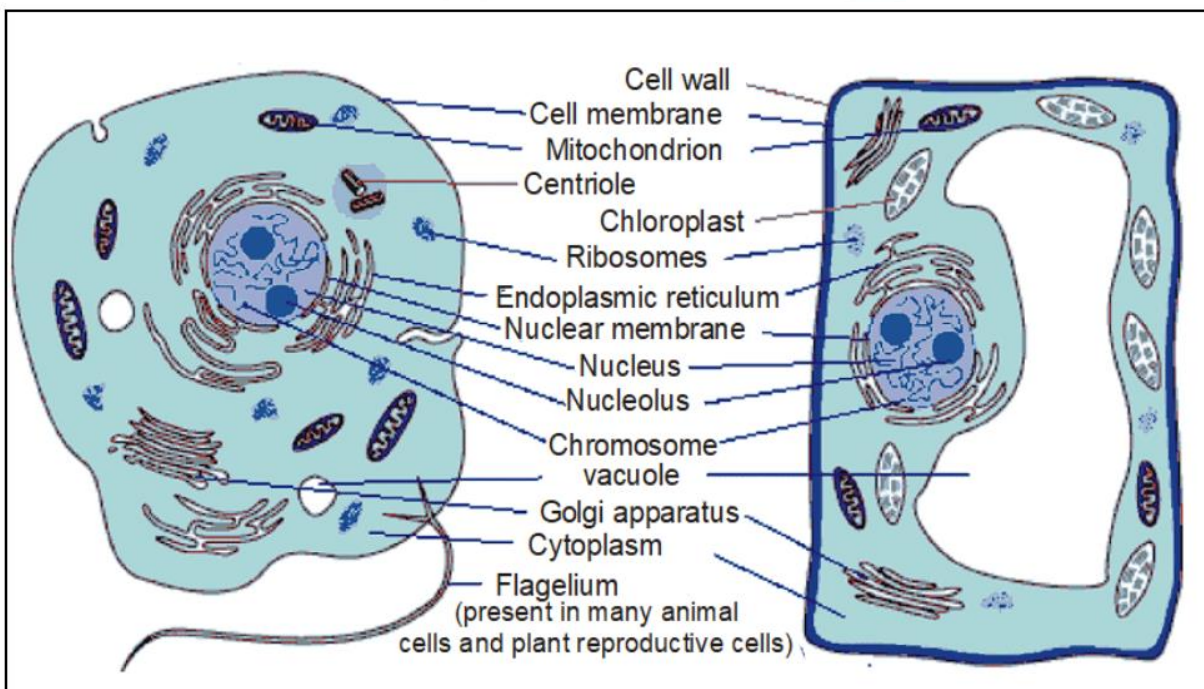
(b) Granules

- These are also non-living cytoplasmic inclusions. These are small particles, crystals or droplets.

Function:

- Starch grains and fat droplets help in the storage of food inside the cells.

Animal Cell and Plant Cell



Differences Between Animal and Plant cell

S. No.	Animal Cell
1	It is enclosed by a thin, flexible, living plasma membrane only
2	Nucleus is generally near the centre.
3	It has many small temporary vacuoles.
4	Mitochondria are generally numerous.
5	Centrosome is present in all animal cells.
6	Plastids are absent.
7	Golgi apparatus occurs as a single or a few scattered units.

S. No.	Plant Cell
1	It is enclosed by a thick, rigid, dead cell wall in addition to plasma membrane.
2	Nucleus is often pushed towards one side in the peripheral cytoplasm by the large central vacuole.
3	It has a large permanent central vacuole.
4	Mitochondria are usually fewer.
5	Centrosome are absent in higher plant cells.
6	Plastids are present.
7	Golgi apparatus occurs as numerous scattered units called dictyosomes.

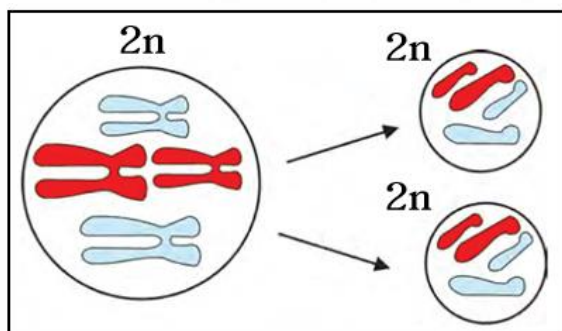


Cell division

New cells are formed in organisms in order to grow, to replace old, dead and injured cells, and to form gametes required for reproduction. The process by which new cells are made is called cell division.

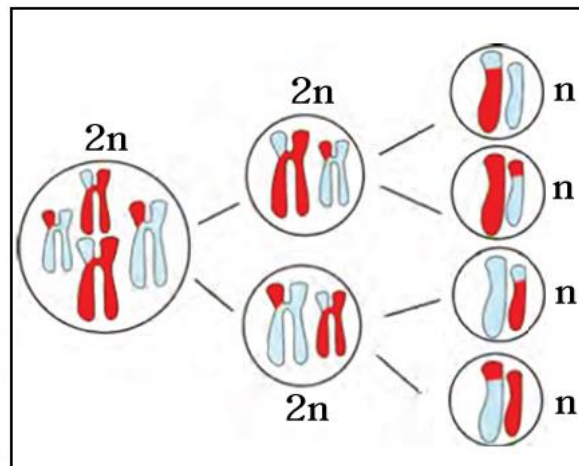
There are two main types of cell division: Mitosis and Meiosis.

Mitosis: Mitosis is a type of cell division in which a cell divides and forms two daughter cells each having a nucleus containing the same number and kind of chromosomes as the mother cells. Mitotic divisions ensure that all the cells of an individual are genetically identical to each other and to the original fertilized egg.



Mitosis

Meiosis: Meiosis (reduction division) is a type of cell division that gives rise to four reproductive cells or daughter cells (gametes) each with half the chromosome number of the parent cell.



Meiosis

FUNDAMENTAL UNLOCKED- (FU#5)

- Q.1 Which organelle helps in cell division?
- Q.2 Which organelle is responsible for color in plants? Explain its types.
- Q.3 Differentiate between plant and animal cell.
- Q.4 Write the functions of vacuole.
- Q.5 Can you name two organelles we have studied that contain their own genetic material?




EXERCISE - I
Single Correct Type Questions

1. The first person to observe a living cell under microscope was –
(A) M. Schleiden (B) T. Schwann
(C) Robert Hooke (D) A.V. Leeuwenhoek
2. The word cell was coined by –
(A) Robert Hooke (B) Weismann
(C) Cuvier (D) Darwin
3. What is protoplasm:
(A) Nucleoplasm-cytoplasm
(B) Cytosol only
(C) Nucleus + cytoplasm
(D) Trophoplasm of cell
4. What is cytology?
(A) Study of cytoplasm
(B) Study of structure and composition of cell
(C) Study of animal cell only
(D) Study of plant cell only
5. Who coined the term protoplasm?
(A) Robert hooke (B) Felix dujardin
(C) Robert brown (D) J.E. Purkinje
6. Cell theory was proposed by –
(A) Morgan
(B) Haldane
(C) Schleiden and Schwann
(D) Robert Hooke
7. Which of the following features is common to prokaryotes and many eukaryotes?
(A) Cell wall present
(B) Nucleolus present
(C) Nuclear membrane present
(D) Membrane bound organelles present
8. Smallest cells so far known are –
(A) Sperm (B) Blue green algae
(C) PPLOs (D) Human egg
9. Which of the following is the longest cell of animal kingdom?
(A) Bacteria (B) Nerve cell
(C) Virus (D) Muscle cell
10. "Omnis cellula e cellula" i.e. new cells arise from pre-existing cells; this statement was given by:
(A) Schleiden and Schwann
(B) Robert Hooke
(C) Robert Brown
(D) Rudolf Virchow
11. Aleuroplast stores -
(A) Protein (B) Carbohydrate
(C) Fat (D) All of the above
12. Which organelle known as 'storage battery' -
(A) ER (B) Mitochondria
(C) Plastid (D) Golgi body
13. Which organelle plays a Crucial role in detoxification of drug and Poisonous substances -
(A) SER (B) RER
(C) Golgi body (D) None of the above
14. Which organelle provide endoskeleton to cell -
(A) Lysosome (B) Mitochondria
(C) ER (D) Plastid
15. What is the main function of the centrosome?
(A) Protein synthesis
(B) Cell division
(C) Photosynthesis
(D) Storage of genetic material
16. Which one is present in bacteria?
(A) Nucleus
(B) Golgi apparatus
(C) Mitochondria
(D) Ribosomes





17. Grapes were put in a concentrated sugar solution. On examination after 12 hours, the grapes were shrunken. This is because,
(A) Grapes become sweeter
(B) Water evaporates from the solution
(C) Sugar induces disintegration of grapes
(D) Loss of water from grapes by osmosis
18. Osmosis takes place between two solutions separated by a semipermeable membrane because.
(A) Water molecules move from the more dilute solution to the less dilute solution
(B) Solute molecules move from the less dilute solution to the more dilute solution
(C) Water molecules move from the less dilute solution to the more dilute solution
(D) Solute molecules move from the more dilute solution to the less dilute solution
19. Plasmolysis is not observed in boiled plant tissue because:
(A) The cell wall becomes impermeable to water
(B) The cell membrane disintegrates
(C) The cell wall disintegrates
(D) The cell membrane becomes impermeable to water
20. A major site for synthesis of lipids is:
(A) Nucleoplasm
(B) RER
(C) SER
(D) Lysosome
21. Mammalian liver cells will swell when kept in
(A) Hypertonic solution
(B) Hypotonic solutions
(C) Isotonic solution
(D) Isothermal solutions
22. Mitochondrial matrix contains:
(A) Enzymes (B) DNA
(C) Ribosomes (D) All of the above
23. Mitochondria are semi-autonomous due to:
(A) Presence of functional naked DNA
(B) Presence of ribosomes
(C) Synthesize its own Protein
(D) All of the above
24. Match the Column-I with Column-II and select the correct option from the codes given below.
Column-I
A. Chloroplasts
B. Chromoplasts
C. Leucoplasts
Column-II
(i) Colourless plastids
(ii) Yellow, orange or red coloured plastids
(iii) Green plastids
(A) A-(iii), B-(i), C-(ii)
(B) A-(i), B-(ii), C-(iii)
(C) A-(i), B-(iii), C-(ii)
(D) A-(iii), B-(ii), C-(i)
25. Endoplasmic Reticulum is absent in:
(A) Animal cells (B) Prokaryotes
(C) Plant cells (D) Protista and fungi

Very Short Answer Type Questions

- Do you agree that "A cell is a building unit of an organism". If yes, explain why?
- Why is endocytosis found in animals only?
- Define protoplast.
- What is the composition of cytoplasm?
- What is the composition of plant cell wall?
- Why nucleus is called the headquarter of the cell?
- What cell organelle mainly helps in detoxification?
- State any one functions of Golgi body.
- Write down the name of the largest animal cell.
- Why are lysosomes known as 'suicidal-bags' of a cell?



Short Answer Type Questions

1. A person takes concentrated solution of salt, after some time, he starts vomiting. What is the phenomenon responsible for such a situation? Explain.
2. Write the name of different plant parts in which chromoplast, chloroplast and leucoplast are present.
3. How is a bacterial cell different from an onion peel cell?
4. Differentiate between osmosis and diffusion.
5. How does amoeba obtain its food?
6. Name the two cell organelles in a plant cell that contain their own genetic material and ribosomes.
7. Why is endoplasmic reticulum responsible for membrane synthesis?
8. What feature of the nucleus earns it the title 'Brain of the cell'?
9. Why are mitochondria linked to power generating station within the cell?
10. Why do plant cells possess large sized vacuole?

Long Answer Type Questions

1. Draw a neat and labeled diagram of an animal cell.
2. Draw a well labeled diagram of a eukaryotic nucleus. How is it different from nucleoid?
3. Differentiate between Rough and Smooth endoplasmic reticulum. How is endoplasmic reticulum important for membrane biogenesis?
4. Explain any two cell organelles that have double membrane?
5. Explain the process of plasmolysis.
6. How are plant cells different from animal cells?

7. How is prokaryotic cell different from animal cell?
8. Write short note on
a. Golgi apparatus b. Vacuole
c. Centrosome d. Ribosome

Case Based Question

1. The body of all organisms are made up of tiny, microscopic units called cell. All basic functions of the body like respiration, excretion is carried out by cell. The first cell was observed in cork slice. The shape and size of cells are related to the specific function they perform; Some cells like Amoeba have changing shapes.

In some cases, the cell shape could be more or less fixed and peculiar for particular type of cell; for example, nerve, cells have a typical shape.

Each living cell has the capacity to perform certain basic functions that are characteristic of all living forms. There is a division of labour in multicellular organisms such as human beings. "This means that different parts of the human body perform different functions.

The human body has a heart to pump blood, a stomach to digest food and so on. Similarly, division of labour is also seen within a single cell.

In fact, each such cell has got certain specific components within it known as cell organelles. Each kind of cell organelle performs a special function, such as making new material in the cell, clearing up the waste material from the cell and so on.

A cell is able to live and perform all its functions because of these organelles. These organelles together constitute the basic unit called the cell.

Thus, the cell is the fundamental structural unit of living organisms. It is also the basic functional unit of life.



- (I) The first cell was observed in
 (A) Bread slice (B) Onion peel
 (C) Cork (D) Cheek cells
- (II) What is the basic functional unit of life.
 (A) Tissue (B) Mitochondria
 (C) Cell (D) Organ
- (III) What is the main function of cell organelle?
- (IV) What is the importance of division of labor?
2. Nucleus is the prominent organelle present in cell which is the controlling centre of all activities of the cell. It is covered by a nuclear membrane.
 The nuclear membrane allows the transfer of material from inside the nucleus to its outside, that is, to the cytoplasm. There are chromosomes, rod shaped structures present in the nucleus which contain genetic information. The nucleus plays a central role in cellular reproduction, the process by which a single cell divides and forms two new cells. It also plays a crucial part, along with the environment, in determining the way the cell will develop and what form it will exhibit at maturity, by directing the chemical activities of the cell.

It helps in the transmission of characters from one generation to the next. If the nucleus is removed from the cell, the protoplasm ultimately dries up and dries.

- (I) Chromosomes are composed of
 (A) Acids and bases
 (B) Mineral and bases
 (C) DNA and proteins
 (D) DNA and RNA
- (II) The nucleus is separated from surrounding cytoplasm by a nuclear membrane, which is
 (A) Single-layered with pores
 (B) Double-layered with pores
 (C) Double-layered without pores
 (D) Single-layered without pores
- (III) When the cell is about to divide, the chromatin material gets organized into
 (A) DNA (B) Nucleoid
 (C) Genes (D) Chromosomes
- (IV) Nucleus controls-
 (A) Cell reproduction
 (B) Metabolic activity
 (C) Both A and B
 (D) Waste disposal




EXERCISE - II
HOTS

1. Organelle which are semi autonomous are
(A) Plastids (B) Golgi bodies
(C) Mitochondria (D) Both (A) & (C)
2. Organelles with double membranes are:
(A) Lysosomes (B) Golgi bodies
(C) Mitochondria (D) Centrosome
3. Which organelle/s is/are absent in bacteria
(A) Cell wall (B) Ribosomes
(C) Plasma Membrane (D) ER
4. Endoplasmic reticulum is responsible for the synthesis of
(A) ATP (B) Carbohydrates
(C) Glucose (D) Steroids
5. Which are coloured plastids
(A) Aleuroplast (B) Leucoplast
(C) Chlorenchyma (D) Chromoplast
6. Which of the following are present in both plant cell and prokaryotic cell?
(A) Cytoplasm (B) Mitochondria
(C) Chloroplast (D) Ribosomes
7. Lysosomes arise from
(A) Endoplasmic reticulum
(B) Golgi apparatus
(C) Nucleus
(D) Mitochondria
8. Number of daughter cells formed after mitosis is
(A) 1 (B) 2 (C) 4 (D) 8
9. Cell wall of which one of these is not made up of cellulose?
(A) Bacteria (B) Hydrilla
(C) Mango tree (D) Cactus
10. Living organisms are grouped into eukaryotes and prokaryotes on the basis of -
(A) Ribosomes
(B) Nucleus
(C) Plasma membrane
(D) Chloroplast
11. **Statement I:** The secreted proteins are packed inside the secretory vesicles which are pinched off from the Golgi apparatus.
Statement I: ER is absent in the red blood cells of mammals.
Which of the two statement(s) is/are true?
(A) Statement I only
(B) Statement II only
(C) Both the statements – I and II
(D) Neither statement I not statement II
12. Which of the following imparts colours to flower to attract insects for pollination?
(A) Plastid (B) Leucoplast
(C) Chloroplast (D) Chromoplast
13. The fine roots of plants absorb water from the soil through the process of
(A) Osmosis
(B) Phagocytosis
(C) Endocytosis
(D) Pinocytosis
14. Which of the following sets of cell organelles contain DNA?
(A) Mitochondria, cell membrane
(B) Plasma membrane, ribosome
(C) Mitochondria, chloroplast
(D) Chloroplast, dictyosome
15. Golgi body is absent in:
(A) Prokaryotes
(B) Mature mammalian R.B.C.
(C) Viruses
(D) All the above





16. Besides producing secretory vesicles, the function of Golgi body is:
(A) Lysosome formation
(B) Formation of spindle fibers
(C) Formation of E.R.
(D) ATP synthesis
17. Which of the organelle contains hydrolytic enzymes?
(A) Lysosomes
(B) Peroxisomes
(C) Centrioles
(D) Chloroplasts
18. Which cellular process involves the fusion of lysosomes with phagocytic vesicle?
(A) Phagocytosis (B) Pinocytosis
(C) Endocytosis (D) Exocytosis
19. Which cell organelle is responsible for the synthesis steroids and cholesterol?
(A) SER (B) RER
(C) Lysosomes (D) Centrosomes
20. What is the primary function of the nuclear pore complex?
(A) To regulate cell growth
(B) To facilitate gene expression
(C) To transport molecule between nucleoplasm & cytoplasm
(D) To facilitate cell division

Assertion and Reason

1. **Assertion:** All plants and animals are composed of cells.
Reason: Cell is the basic unit of life.
(A) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) If Assertion is true but Reason is false.
(D) If both Assertion and Reason are false.
2. **Assertion:** Organisms are made up of cells.
Reason: Cells are structural and functional unit of living organisms.
(A) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) If Assertion is true but Reason is false.
(D) If both Assertion and Reason are false.
3. **Assertion:** Mitochondria are known as the powerhouse of the cell.
Reason: Chloroplasts are responsible for photosynthesis.
(A) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) If Assertion is true but Reason is false.
(D) If both Assertion and Reason are false.
4. **Assertion:** Prokaryotic cells lack a nucleus.
Reason: In prokaryotic membrane bound cell, organelles are absent
(A) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) If Assertion is true but Reason is false.
(D) If both Assertion and Reason are false.
5. **Assertion:** Mitosis results in identical daughter.
Reason: Meiosis results four identical cells having deployed chromosomes
(A) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) If Assertion is true but Reason is false.
(D) If both Assertion and Reason are false.




EXERCISE - III
Previous Years Questions

1. Example of cell organelle which do not have a unit membrane is **(NTSE Stage-I-2007)**
 (A) Mitochondria (B) Lysosome
 (C) Ribosome (D) Plastid
2. Mitosis **(NTSE Stage-I-2013)**
 (A) leads to recombinant daughter cells
 (B) is a reduction division
 (C) leads to formation of parental type of daughter cells
 (D) occurs in gametes
3. Mitochondria and chloroplasts are similar because **(NTSE Stage-I-2013)**
 (A) Both have nuclei
 (B) Both have 80s ribosomes
 (C) Both have DNA
 (D) Both have single membrane envelope
4. DNA (Deoxyribonucleic acid) is not present in one of the following **(NTSE Stage-I-2017)**
 (A) Chloroplast
 (B) Nucleus
 (C) Mitochondria
 (D) TMV (Tobacco Mosaic Virus)
5. Blood cell without nucleus are- **(NTSE Stage-I-2017)**
 (A) Red blood corpuscles
 (B) White blood corpuscles
 (C) Both (A) and (B)
 (D) Osteocyte
6. Which is the longest cell in human body? **(NTSE Stage-I-2017)**
 (A) Ovum (B) Nerve cell
 (C) Muscle cell (D) Kidney cell
7. Who has given the word 'cell'? **(NTSE Stage-I-2017)**
 (A) Robert Hook (B) Robert Brown
 (C) Watson and crick (D) Flamming

8. Which part of the cell is also termed as 'suicide bags of the cell'? **(NTSE Stage-I-2017)**
 (A) Ribosomes (B) Golgi bodies
 (C) Lysosomes (D) Mitochondria
9. Nucleus of the cell was discovered by **(NTSE Stage-I-2018)**
 (A) Robert Hooke (B) Leeuwenhoek
 (C) Robert Brown (D) Virchow
10. Turgidity of cell is maintained by **(NTSE Stage-I-2018)**
 (A) Vacuole (B) Lysosome
 (C) Plastid (D) Golgi body
11. DNA is not present in: **(NTSE Stage-I-2018)**
 (A) Chloroplast (B) Mitochondria
 (C) Nucleus (D) Ribosome
12. Chemical composition of chromosome is **(NTSE Stage-I-2018)**
 (A) DNA and lipid
 (B) DNA and carbohydrates
 (C) Proteins and lipids
 (D) DNA and proteins
13. Cristae is associated with **(NTSE Stage-I-2018)**
 (A) Nucleus
 (B) Chloroplast
 (C) Cell Wall
 (D) Mitochondria
14. Lipoprotein is found in **(NTSE Stage-I-2018)**
 (A) Cell membrane (B) Nucleus
 (C) Cytoplasm (D) Cell wall
15. Which is a Prokaryotic cell amongst the following.... **(NTSE Stage-I-2018)**
 (A) Amoeba (B) Yeast
 (C) Euglena (D) Bacteria





- | | |
|---|--|
| <p>16. Movement of molecules during diffusion can be described all of the following except –
(NTSE Stage-I-2018)</p> <p>(A) Each molecule moves randomly.
(B) Solute molecules always moves down the concentration gradient
(C) Each molecule moves independently of other molecule
(D) Net movement of solute molecules is from region of higher to region of lower concentration</p> | <p>(A) Water will move across the membrane by active transport
(B) Water will move across by the process of Osmosis
(C) Water will move across through plasmolysis
(D) Water will move across by diffusion</p> |
| <p>17. Plasma membrane consists mainly of:
(NTSE Stage-I-2018)</p> <p>(A) Protein embedded in carbohydrate
(B) Phospholipids embedded in protein bilayer
(C) Protein embedded in phospholipid bilayer
(D) Protein embedded with polymer of glucose</p> | <p>19. In Simple organism, exchange of gases and excretion occur through
(NTSE Stage-I-2018)</p> <p>(A) Osmosis
(B) Diffusion
(C) Imbibition
(D) All of the above</p> |
| <p>18. When the concentration of solutes differs on the two sides of a membrane permeable only to water, then –
(NTSE Stage-I-2018)</p> | <p>20. Which of the following is known as 'Currency of Energy'-
(NTSE Stage-I-2018)</p> <p>(A) DNA
(B) RNA
(C) ATP
(D) NAD</p> |





ANSWER KEY

EXERCISE-I

Single Correct Type Question

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	A	C	B	D	C	A	C	B	D	A	B	A	C	B
Que.	16	17	18	19	20	21	22	23	24	25					
Ans.	D	D	A	C	C	B	D	D	D	B					

Case Study Questions

Case-1				
Que.	(I)	(II)		
Ans.	C	C		
Case-2				
Que.	(I)	(II)	(III)	(IV)
Ans.	C	B	D	C

EXERCISE-II

HOTS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	C	D	D	D	B	B	B	A	B	C	D	A	C	D
Que.	16	17	18	19	20										
Ans.	A	A	A	A	C										

Assertion and Reason

Que.	1	2	3	4	5										
Ans.	A	A	B	B	C										

EXERCISE-III

Previous Year Questions

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	C	D	A	B	A	C	C	A	D	D	D	A	D
Que.	16	17	18	19	20										
Ans.	A	C	B	B	C										





DPP

Daily Practice Problems

SUBJECT: BIOLOGY**CLASS-9****DPP NO. 1****TOPIC: THE FUNDAMENTAL UNIT OF LIFE****Multiple Choices Questions:**

1. Which of the following is related to the study of cell, its types, structure, functions and its organelles
(A) Cell biology (B) Microbiology (C) Biotechnology (D) Physiology
2. The process which occurs when raisins are soaked in water is called as
(A) Endosmosis (B) Exosmosis (C) Endocytosis (D) Phagocytosis
3. A cover slip is placed over the specimen to:
(A) prevent the tissue from drying (B) prevent glycerine from leaking out
(C) remove extra stain only (D) crush the cells in order to see the organelles clearly
4. Under a microscope while viewing cheek cells, which of the following will not be visible
(A) Chloroplast (B) Mitochondria (C) Nucleus (D) All of the above
5. Non-membranous cell organelle is
(A) Chloroplast (B) Mitochondria (C) Ribosome (D) Nucleus
6. Identify the common feature of mitochondria and plastids?
(A) Presence of single membrane only (B) Presence of DNA and ribosomes
(C) Presence of green pigment (D) Deeply folded inner membrane
7. Given below are four operations for preparing a temporary mount of human cheek cells:
(i) Taking a scraping from the inner side of the cheek and spreading it on a clean slide
(ii) Putting a drop of glycerin on the material
(iii) Adding two or three drops of methylene blue
(iv) Rinsing the mouth with fresh water and disinfectant solution
Identify the correct sequence of these operations.
(A) (i)—(ii)—(iii)—(iv) (B) (ii)—(i)—(iii)—(iv)
(C) (iv)—(i)—(iii)—(ii) (D) (i)—(iii)—(ii)—(iv)
8. In which of the following the cell wall is present
(A) Fungi (B) Bacteria (C) Plant (D) All of the above
9. Which of the following is not a function of golgi body
(A) Formation of lysosomes (B) Storing and packaging of materials
(C) Detoxification of drugs (D) Production of complex sugars
10. All the functions of cell are controlled by
(A) Mitochondria (B) Cytoplasm (C) Nucleus (D) chloroplast

11. Types of ribosomes present in cytoplasm of eukaryotic cell is
(A) 50 S (B) 60 S (C) 80 S (D) 70 S
12. The components of ER are
(A) Cisternae (B) tubules (C) vesicles (D) All of these
13. The new cell generates from
(A) Pre-existing cell (B) Ribosome (C) Nucleus (D) Lysosome
14. Mitochondria is concerned with
(A) Krebs cycle (B) C_4 cycle (C) glycolysis (D) none of the above
15. Cell organelle taking part in photorespiration is
(A) Glyoxysomes (B) Peroxisome (C) Dictyosome (D) E.R.
16. Cell organelle found only in plant cells are
(A) Mitochondria (B) Nucleus (C) Lysosome (D) Plastids
17. The plasma – membrane is made up of
(A) $CaCO_3$ (B) Phospholipids
(C) Starch (D) Phospholipids and proteins
18. Match the following

(i)	Mitochondria	(a)	Suicidal bag
(ii)	chromosomes	(b)	Head quarter of cell
(iii)	Nucleus	(c)	Genetic information
(iv)	leucoplast	(d)	Power house of cell
(v)	Lysosome	(e)	storage

- (A) (i)-(d), (ii)-(c), (iii)-(b), (iv)-(e), (v)-(a) (B) (i)-(d), (ii)-(b), (iii)-(c), (iv)-(a), (v)-(e)
(C) (i)-(d), (ii)-(a), (iii)-(b), (iv)-(c), (v)-(e) (D) (i)-(d), (ii)-(c), (iii)-(e), (iv)-(b), (v)-(a)

19. Match the following

(i)	Golgi complex	(a)	Blue green algae
(ii)	Nucleoid	(b)	Membrane Biogenesis
(iii)	Mitochondria	(c)	Packaging
(iv)	Endoplasmic reticulum	(d)	Kitchen of plant cell
(v)	Chloroplast	(e)	Energy production

- (A) (i)-(c), (ii)-(a), (iii)-(b), (iv)-(c), (v)-(d) (B) (i)-(c), (ii)-(a), (iii)-(e), (iv)-(b), (v)-(d)
(C) (i)-(a), (ii)-(b), (iii)-(c), (iv)-(d), (v)-(e) (D) (i)-(c), (ii)-(a), (iii)-(d), (iv)-(b), (v)-(e)

20. Match the following

(i)	Cell membrane	(a)	cellulose
(ii)	Cell wall	(b)	endosmosis
(iii)	Hypotonic solution	(c)	Selectively permeable
(iv)	Hypertonic solution	(d)	exosmosis
(v)	Middle lamella	(e)	Pectate

(A) (i)-(c), (ii)-(a), (iii)-(b), (iv)-(d), (v)-(e)

(B) (i)-(a), (ii)-(c), (iii)-(b), (iv)-(d), (v)-(e)

(C) (i)-(c), (ii)-(a), (iii)-(d), (iv)-(b), (v)-(e)

(D) (i)-(c), (ii)-(a), (iii)-(b), (iv)-(e), (v)-(d)

Very short answer type Questions:

- What is plant cell wall is made up of?
- Why is lysosome called as suicidal bag of the cell?
- Why is mitochondria called the powerhouse of the cell?
- Define Prokaryotes.
- Name the different kinds of plastids and also name the plastid important for the process of photosynthesis.

Short answer type Questions:

- Why plastids and mitochondria are different from other cell organelles?
- Enumerate various functions of the nucleus.
- How is the cell wall different from the cell membrane?
- Enumerate various functions of RER and SER.
- Define nucleoid.
 - Name the only cell organelle present in Prokaryotes.
 - How is virus different from prokaryotes.

Long answer type Questions:

- In detail differentiate between plant cell and animal cell.
- Who discovered Golgi body?
 - Golgi body is called as 'middle man of cell'. Justify
 - Why are the Golgi bodies found in large numbers in the cells which secrete digestive enzymes.
- Can you think why during cooking of vegetables a little salt is added?
 - Why are some pulses and beans like kidney beans soaked overnight before cooking?
 - What will happen to RBC's when soaked in:
 - sea water
 - tap water.

Case based study

1. Plasma membrane is the outermost covering of the cell that separates the contents of the cell from its external environment. The plasma membrane is flexible and is made up of lipids and proteins, and some amount of carbohydrates too. The flexibility of the cell membrane also enables the cell to engulf in food and other material from its external environment. Such process is known as endocytosis. The plasma membrane allows or permits the entry and exit of some materials in and out of the cell. It also prevents movement of some other materials. The cell membrane is, therefore, selectively permeable in nature. There is spontaneous movement of a substance from a region of high concentration to a region where its concentration is low, across the plasma membrane. Water also follows the principle of diffusion. The movement of water molecules from the area of higher concentration of water to the area of lower concentration of water is called Osmosis.

- (I) The movement of a substance from the region of higher concentration to the region where its concentration is lower is called as _____
 (A) Osmosis (B) Diffusion
 (C) Excretion of CO₂ (carbon dioxide) (D) All above
- (II) Why is cell membrane known as selectively permeable membrane?
- (III) What would happen if the plasma membrane becomes impermeable?

2. Ria, a student of class IX was studying two different specimens (**Specimen A** and **specimen B**) in a microscope.

She noted the following characters in **Specimen A**:

- The specimen lacked cell wall
- It had all cell organelles like Golgi, ER, lysosomes, etc.
- It lacked plastid, but had a large central nucleus

She noted the following characters in **Specimen B**

- The cell wall was present in the specimen.
- It lacked cell organelles, the only cell organelle that was present in the cell was Ribosome.
- The specimen also lacked the presence of well defined nucleus.

On the basis of the above observations answer the following questions.

- (I) The specimen A could be:
 (A) Plant cell (B) Animal cell (C) Bacterial cell (D) Fungal cell
- (II) The specimen B could be:
 (A) Plant cell (B) Animal cell (C) Bacterial cell (D) Fungal cell

ANSWER KEY										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	A	A	A	A	C	B	C	D	C	C
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	C	D	A	A	B	D	D	A	B	A

Case based study

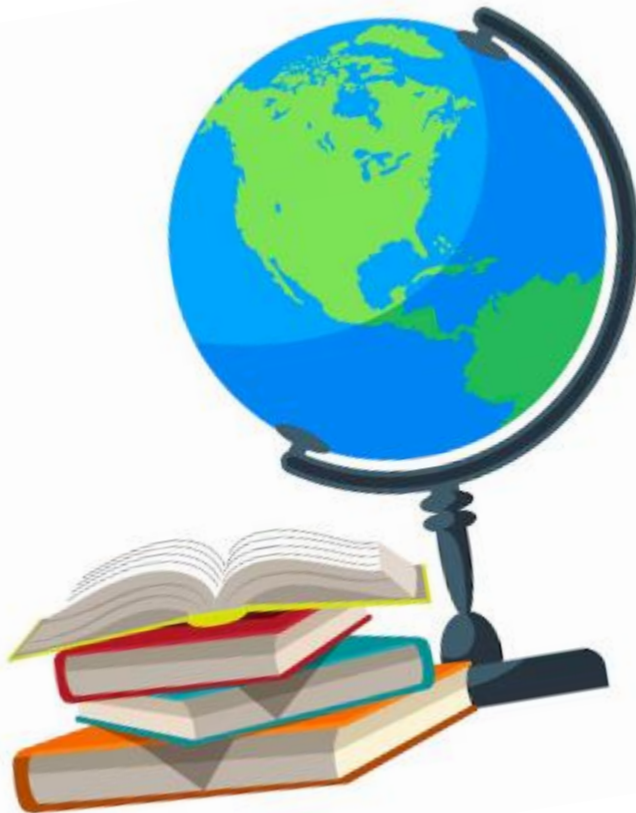
1. (I) (B)
 2. (I) (B) (II) (C)

FOUNDATION

CLASS-IX

SAMPLE

SOCIAL SCIENCE



1

THE FRENCH REVOLUTION

Introduction

- Today the Ideas of Equality, Liberty and fraternity are common and in this chapter we are going to read about the French revolution which brought these ideas into implementation for the first time in world history.
- French revolution is considered as the most important landmark in human history.
- The revolution occurred in 1789 and swept away the existing political institutions, overthrew the French Monarchy and aimed at establishing an Egalitarian society and responsible government.

- The revolution began with the siege of Bastille on July 14, 1789 and continued until the rise of Napoleon Bonaparte to power.

French Society During The Late Eighteenth Century

The term Old Regime is usually used to describe the society and institutions of France before 1789. French society before 1789 was divided into three estates; hence, it was called a society of estates. The estates constituted as follows:



'This poor fellow brings everything, grain, fruits, money, salad. The fat lord sits there, ready to accept it all. He does not even care to grace him with a look.'

(i) The First Estate

The First Estate consisted of the clergy. The clergy were exempted from paying taxes to the king.

(ii) The Second Estate

The Second Estate consisted of nobility. The nobility was also exempted from taxes. The nobles further enjoyed feudal privileges. These included feudal dues, which they extracted from the peasants.

(iii) The Third Estate

The Third Estate consisted of big businessmen, merchants, court officials, lawyers, peasants and artisan, landless labour, servants, etc. The Third Estate comprised both rich and poor persons.

Causes of the French Revolution

Political Causes

- (i) The political structure of the French state was highly unpopular with the people who were burdened with heavy taxes and insecure conditions of life and property.



- (ii) Divine rights of the Kings, despotism and tyranny of the French monarchs topped by the extravagance and inefficiency of the Bourbon Kings.
- (iii) Louis XV indulged in a life of ease and pleasure, was not interested in administrative reforms or the welfare of the people.
- (iv) Louis XVI though good natured was completely under the influence of incompetent and corrupt ministers and a domineering queen, Marie Antoinette.
- (v) Absence of any representative body to voice the needs of the people. Local bodies called 'Parliament' were courts of justice rather than voices of people.

Social Forces

- (i) The unfair division of French society and its feudal nature were also responsible for the revolution.
- (ii) The first two estates enjoyed all the privileges and benefits in the society. The third estate was fraught with inequalities and discriminations. Most of the burden of taxation was borne by the least privileged and most impoverished third estate.
- (iii) Middle class was most receptive to new ideas and values as they were educated and had a broader outlook, denied the whole ideas, rights and privileged existence where the main qualification is that of birth and instead favoured the criterion of merit.

Economic Unrest

- (i) In the 18th century the condition of common man had become pathetic, problem of subsistence due to failure of crops, increase in the prices of food grains
- (ii) In the second half of the 18th century the French economy had started expanding. But its financial impact was uneven, hardest hit were the Third Estate
- (iii) Between 1689 and 1783 France fought several long and exhausting wars which proved to be disastrous both in terms of French Manpower and finances, not only led to mounting debts but interest on these debts also multiplied.
- (iv) To meet its mounting costs the government increased taxes. Peasantry was the hardest hit who owned the minimum land and paid the maximum taxes.

- (v) Taxes were Taille the direct land tax, salt tax known as Gabelle, feudal dues or payments were taken by nobility and taxes known as Tithe was taken by the Church.

A growing middle class envisages an end to Privileges.

- (i) The French Revolution drew its strength from the ideas of philosophers and thinkers of the time, groups of intellectuals classified by scholars according to their thinking.
- (ii) Physiocrats, Philosophers and some others were grouped as liberals depending on their ideologies.
- (iii) Greatest thinkers were Francois Marie, Arouet de Voltaire, Jean Jacques Rousseau, Charles Louis Montesquieu, John Locke and Denis Diderot to name a few.
- (iv) Through their teachings and writings they stirred the people to action, revolutionized the minds of the people and prepared them for the great changes ahead.

Contributions of the Thinkers

- (i) **Charles Montesquieu** - A noblemen by birth, he became a lawyer and a judge. He preferred constitutional monarchy in France, he popularized the theory of separation of powers within the government between the legislative, the executive and the judiciary in his book "The Spirit of the Laws.
- (ii) **Francis Aronet Voltaire** - He was another outstanding philosopher of the revolution. He wanted the people to think about their material life on earth and forget about heaven. He condemned the Church which supported the privileged class and ignored the poor.
- (iii) **Jean Jacques Rousseau** - He is regarded as the architect of the French Revolution. In the famous book "The Social Contract, he proved that the government was the result of a social contract between the people on one hand and ruler on the other. So if the ruler didn't fulfill the contract, the people had the right to withdraw their loyalty to him and bring down the tyranny of the ruler by revolting against him.
- (iv) **John Locke** - He was a great political thinker. He wrote Two Treatises of Government in which he sought to refute the doctrine of the divine and absolute right of monarch.





The Out Break of The Revolution

- On 5 May 1789, Louis XVI called together an assembly of the Estates General to pass proposals for new taxes.
- The Estates General was a political body. The three estates sent their representatives to this body.
- Each of the three estates had one vote each. The first estate and the second estate had sent 300 representatives each.
- They were seated in rows facing each other on two sides. The third estate had sent 600 representatives.
- They required standing at the back. Peasants, artisans and women were denied entry to the assembly.
- New taxes could be proposed only after the Estates General gave its approval to the king's proposal.
- Since the first estate and the second estate were exempted from paying taxes, it was a foregone conclusion that the king's proposals on new taxes would get the approval of the Estates General.

(a) The Tennis Court Oath



Tennis Court Oath

- Voting in the Estates General in the past had been conducted according to the principle that each estate had one vote.
- Members of the third Estate demanded that voting now be conducted by the assembly as a whole, where each member would have one vote.
- When the King rejected this proposal, members of the third Estate walked out of the assembly in protest.
- The representatives of the third Estate on June 20, 1789 assembled in the hall of an indoor tennis court in the grounds of Versailles.
- They declared themselves a National Assembly and swore not to disperse till they had drafted a constitution for France that would limit the powers of the monarch.
- While the National assembly was busy at Versailles the rest of France seethed with turmoil, on 14 July the agitated crowd stormed and destroyed the Bastille.

(b) Storming of the Bastille

- On the morning of July 14, 1789 the city of Paris was in a state of alarm. A severe winter had meant a bad harvest; the price of bread rose. Bakers exploited the situation and hoarded supplies.
- Crowds of angry women stormed into the shops. The army was ordered by the king to move into the city. It was rumored that the army would be ordered to open fire upon the citizens.
- Thousands of persons gathered and decided to form a people's militia. They broke into a number of government buildings in search of arms. Bastille was a dreaded fortress-prison.



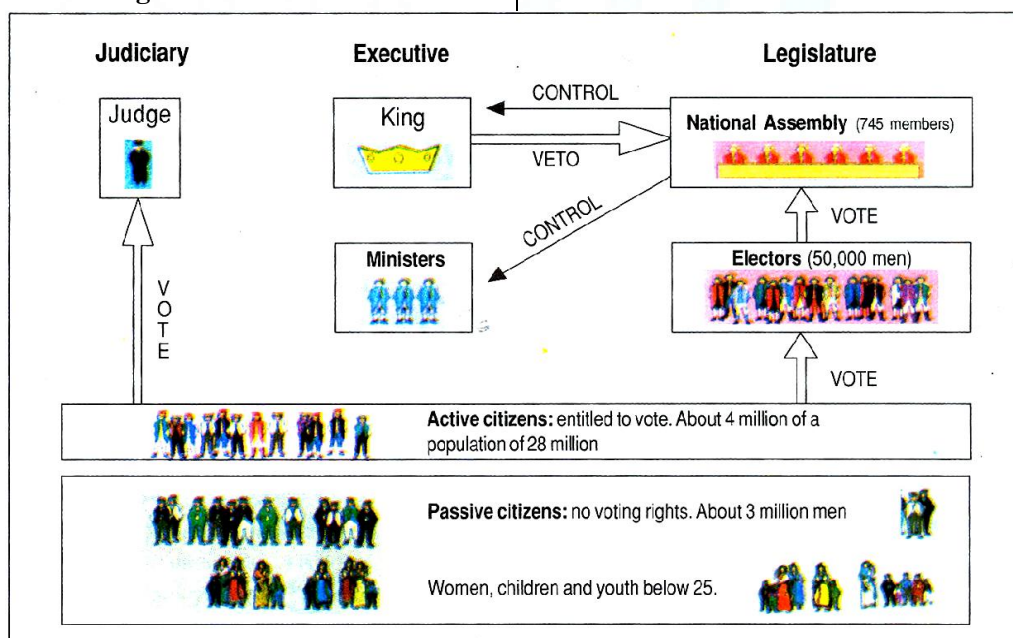
- It was hated by all because it stood for the despotic power of the king. Protestors stormed into the Bastille in search of arms. The commander of Bastille was killed; the prisoners were released.
- The fortress was demolished. Louis XVI finally accorded recognition to the National Assembly and accepted the principle that his powers would from now on be checked by a constitution.
- On the Night of 4 August 1789, the Assembly passed a decree abolishing the feudal system of obligations and taxes.



Storming of Bastille

(c) France becomes a Constitutional Monarchy

- The National Assembly completed the drafting of the constitution in 1791. Power was now separated and assigned to different institutions- the legislature, executive and judiciary making France a constitutionally monarchy.
- The Constitution of 1791 vested the power to make laws in the National Assembly, which was indirectly elected.
- The Constitution began with a Declaration of the Rights of Man and Citizen. Rights such as the Right of life, freedom of speech, freedom of opinion, equality before law were established as natural and inalienable rights.



The Political System under the Constitution of 1791

The Declaration of Rights of Man and Citizen

- Men are born and remain free and equal in rights.
- The aim of every political association is the preservation of the natural and inalienable rights of man; these are liberty, property, security and resistance to oppression.

- The source of all sovereignty resides in the nation; no group or individual may exercise authority that does not come from the people.
- Liberty consists of the power, to do whatever is not injurious to others.
- The law has the right to forbid only those actions that are injurious to society.



- (vi) Law is the expression of the general will. All citizens have the right to participate in its formation, personally or through their representatives. All citizens are equal before it.
- (vii) No man be accused, arrested or detained, except in cases determined by the law.
- (viii) Every citizen may speak, write and print freely; he must take responsibility for the abuse of such liberty in cases determined by the law.
- (ix) For the maintenance of the public force and for the expenses of administration a common tax is indispensable; it must be assessed equally on all citizens in proportion to their means.
- (x) Since property is a sacred and inviolable right, no one may be deprived of it, unless a legally established public necessity requires it. In that case a just compensation must be given in advance

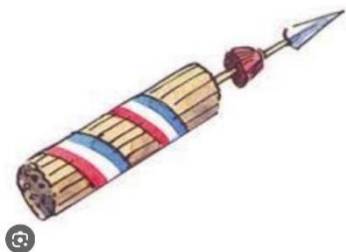
Le Barbier painted the declaration of the rights of man and citizens in 1790. Majority of people at that time could not read and write, so he used many symbols to convey the content of the declaration of rights.

Political Symbols

- (i) **The broken chain** – Stands for the act of becoming free.



- (ii) **The bundle of rods** – It implies that strength lies in unity as one rod can be easily broken but not an entire bundle.



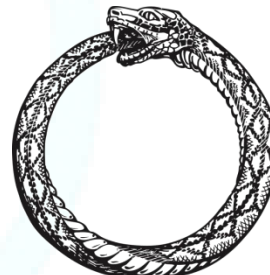
- (iii) **The eye within a triangle radiating light** – Eye stand for knowledge, the rays of sun will drive away the clouds of ignorance.



- (iv) **Sceptre** – It is a symbol of royal power.



- (v) **Snake biting its tail to form a ring** - a symbol of eternity.



- (vi) **Red Phrygian cap** – Cap worn by a slave upon becoming free.



- (vii) **Blue, White, Red** – These are National colours of France.





- (viii) **The Winged woman** – Personification of the law.



- (ix) **The law tablet** – The law is same for all.



France Abolishes Monarchy and Becomes A Republic

- (i) Although Louis XVI had signed the Constitution, he entered into secret negotiations with the king of Prussia.
- (ii) The National Assembly voted in April 1792 to declare war against Prussia and Austria. People saw this as a war of the people against kings and aristocracies all over Europe.
- (iii) The revolutionary wars brought losses and economic difficulties to the people. Political clubs became an important rallying point for people who wished to discuss government policies and plan their own forms of action. The most successful of these clubs was that of the Jacobins, which got its name from the former convent of St. Jacob in Paris.

- (iv) In the summer of 1792 the Jacobins planned an insurrection of a large number of Parisians who were angered by the short supplies and high prices of food. On the morning of August 10 they stormed the Palace of the Tuileries and held the king himself as hostage for several hours.
- (v) Elections were held. The newly elected assembly was called the Convention. On 21 September 1792 it abolished the monarchy and declared France a Republic.
- (vi) Louis XVI was sentenced to death by a court on the charges of treason. On 21 January 1793 he was executed publicly at the Place de la Concorde.

(a) The Reign of Terror

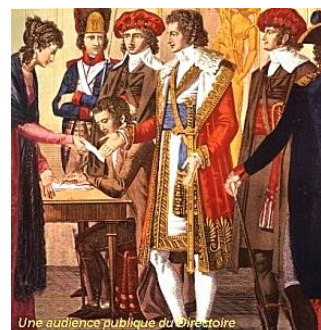


Maximillian Robespierre

The period in between 1793-94 is referred as the “Reign of Terror”.

- (i) During this period Robespierre, who was the head of the government of France followed a policy of severe control and punishment.
- (ii) Ex-nobles and clergy, even members of his own party who did not agree with his methods were arrested, imprisoned and then guillotined.
- (iii) France witnessed the guillotine of thousands of nobles and innocent men who supported monarchy.
- (iv) Robespierre issued laws placing a maximum ceiling on prices. Churches were shut down.
- (v) Finally Robespierre was guillotined in July 1794.

(b) A Directory Rules France



A Directory



The reign of terror ended in 1794. The Jacobin government fell, and a new constitution was prepared by an elected convention providing for a republican form of government with a legislature and an executive body called the Directory. The Directory was an executive made up of five members. Directors often clashed with the legislative councils, who then sought to dismiss them. The political instability of the Directory paved the way for the rise of a military dictator, Napoleon Bonaparte.

Did Women Have A Revolution



- (i) Most women of the third estate had to work for a living, and did not have access to education or job training. Working women also had to care for their families, their wages were lower than those of men.
- (ii) In order to discuss and voice their interests women started their own political clubs and newspapers. About sixty women's clubs came up in different French cities. One of their main demands was that women enjoy the same political rights as men.
- (iii) In the early years the revolutionary government did introduce laws that helped to improve the lives of women, creation of state schools, schooling made compulsory for all girls, could no longer be forced to get into marriage against their will, Divorce could be applied for by both women and men. Women could now train for jobs, could become artists or run small businesses.
- (iv) During the Reign of Terror, the new government issued laws ordering closure of women's clubs and banning their political activities.

- (v) The fight for the vote was carried out through an international suffrage movement during the late nineteenth and early twentieth centuries. It was finally in 1946 that women in France won the right to vote.

(a) The Abolition of Slavery



Working Women's

- (i) Slavery was rampant in the European colonies of the Caribbean and the Americas. The slaves were mostly used on sugar, coffee, indigo and tobacco plantations. Their demand was because of their availability and low costs
- (ii) In a debate in the Constituent Assembly in October 1790, to safeguard commercial interests of planters' two parties holding opposite views emerged. The group that safeguarded planters' interests but pledged to maintain order in the colonies came up around the Massiac Club founded in August 1789 and their adversaries were the Society of the Friends of the Blacks founded in 1783. The outcome of the debate was that it served the purpose of drawing attention to the condition of slaves and sowed seeds of future political divisions.
- (iii) On February 4, 1794 the Convention (National Assembly) ended slavery in the French Colonies. Napoleon Bonaparte revoked the decree in 1802; slavery was finally abolished from the French colonies in 1848.

The Legacy of The French Revolution

The French Revolution produced great effects not only in France but also on the whole of Europe.

(a) Effects on France

- (i) The French Revolution put an end to the arbitrary rule in France and paved the way for the establishment of a republic there. The special privileges of the high order were abolished and led to the regeneration of France on the basis of social equality.



- (ii) The declaration of the rights of man granted freedom and individual liberty to all without any distinction of class or creed. Many reforms were introduced in the administration.
 - (iii) The higher and important posts in the state were opened to talented people. All were granted religious freedom. The Napoleonic code introduced a uniform system of law for France and made it quite clear and simple.
- (b) Effects on Europe**
- (i) **Equality:** The French Revolution had a great influence on Europe. Equality was one of the main principles of French Revolution. It implied the equality of all before law and abolition of privileges enjoyed by the upper order in the society. It established social, economic and political equality in the European countries.
 - (ii) **Liberty:** Revolutionary idea of liberty was hailed all over Europe. It implied social, political and religious freedom. The declaration of rights of man made people understand the importance of personal liberty and rights.
 - (iii) **Sovereignty :** The French revolution emphasized the fact that sovereignty resides in the general public and law should be based on the will of the people. It infused the spirit of nationalism and patriotism in the people.
- (c) Global Impact**
- (i) The French Revolution had a global impact which was felt equally in India.
 - (ii) The UN charter of Human Rights also embodies the principles of the Revolution as laid down in the Declaration of Rights of Man and Citizens.

The Rise and Fall Of Napoleon



Napoleon

- In 1804, Napoleon Bonaparte crowned himself Emperor of France. He set out to conquer neighboring
- European countries, dispossessing dynasties and creating kingdoms where he placed members of his family.
- Napoleon saw his role as a moderniser of Europe.

He introduced many laws such as the protection of private property and a uniform system of weights and measures provided by the decimal system.

- Initially, many saw Napoleon as a liberator who would bring freedom for the people. But soon the Napoleonic armies came to be viewed everywhere as an invading force.
- He was finally defeated at Waterloo in 1815.

Some Important Dates

1774: Louis XVI becomes king of France, faces empty treasury and growing discontent within society of the Old Regime.

1789: Convocation of Estates General, Third Estate forms National Assembly, the Bastille is stormed, and peasant revolts in the countryside.

1791: A constitution is framed to limit the powers of the king and to guarantee basic rights to all human beings.

1792-93: France becomes a republic, the king is beheaded. Overthrow of the Jacobin republic, a Directory rules France.

1804: Napoleon becomes emperor of France, annexes large parts of Europe. 1815- Napoleon defeated at Waterloo




EXERCISE - I
SINGLE CORRECT TYPE QUESTIONS

1. Castle or a stately residence belonging to a nobleman was called:
 (A) Chateau (B) Manor
 (C) Jadidists (D) Kulaks

2. Who is the author of following comment?
 "Yet laws will last only as long as the people agree to obey them. And when they have managed to cast off the yoke of the aristocrats, they will do the same to the other owners of wealth."
 (A) Marat (B) Mira Beau
 (C) Abbe Sieyes (D) Bailly

3. "Under the Old Regime in France, the king was not the only one who could impose taxes at his discretion. Instead, he needed to convene the Estates General, who would then need to approve his plans for additional levies. On the other hand, the king was the only one who could determine when to convene this body. That was last completed in 1614. From the aforementioned statement, it may be inferred that:
 (A) Taxes were not raised between 1614 and 1789
 (B) French monarch was very powerful
 (C) Monarch was in need of more money due to financial crisis
 (D) All of the above

4. Which of the following was not a cause of the French Revolution?
 (A) Attack on France by Germanic tribes of north
 (B) A major economic crisis that bankrupted the monarchy and deprived it of its authority
 (C) Substantial amount of satirical literature directed at the royal family and the court thus lowering the prestige of the government and weakening its authority
 (D) the publication of thousands of pamphlets advocating reform, fostering a critical attitude towards the French government the sudden invasion of France by hostile Germanic tribes.

5. The 1789 oath taken by the representatives of the Third Estate to not disband until a French constitution was created occurred where?
 (A) In the ancient coliseum of Paris
 (B) On a tennis court
 (C) At the Vatican
 (D) In the Bastille

6. Which of the following was not a feature of the French Constitution of 1795?
 (A) It created a franchise limited to male property holders.
 (B) It created the Council of Public Safety
 (C) It created the Council of the Ancients.
 (D) It created a five-man Directorate to hold executive power.

7. The period of the Directory in France came after:
 (A) The Storming of the Bastille
 (B) The Reign of Terror
 (C) The Tennis Court Oath
 (D) The execution of Louis XVI

8. "The law should be the expression of the general will; all female and male citizens should have a say either personally or by their representatives in its formulation; it should be the same for all. All female and male citizens are equally entitled to all honours and public employment according to their abilities and without any other distinction than that of their talents."
 The above statement was declared by:
 (A) Robespierre (B) Marat
 (C) Napoleon (D) Olympe de Gouges





9. Who said these words and when:
“To establish and consolidate democracy, to achieve the peaceful rule of constitutional laws, we must first finish the war of liberty against tyranny. We must annihilate the enemies of the republic at home and abroad, or else we shall perish. In time of Revolution a democratic government may rely on terror. Terror is nothing but justice, swift, severe and inflexible;”
(A) Abbe Sieyes during Tennis Court Oath.
(B) Marat during Directory period
(C) Robespierre on 7 February 1794, at the Convention.
(D) Napoleon during Battle of Waterloo.
10. 1791 constitution had denied political rights to poor men; Jacobins gave equal rights to all men irrespective of their economic or social status; Directory again established rule of wealthier middle class. Despite of all the differences there was one thing common in all these constitutions of Revolutionary France. What was that?
(A) Denial of political rights to Black Slaves.
(B) Denial of Political Rights to Women.
(C) All elected only former feudal lords to highest positions.
(D) They did not have anything in common.
11. Which of the following was a factor in the rise of Napoleon?
(A) Fall of the Jacobin government
(B) Robespierre Reign of Terror
(C) Political instability of the Directory
(D) Nationalist forces
12. In their writings, Voltaire and Rousseau emphasized the:
(A) Superiority of the French nation
(B) Opportunities for world domination by France
(C) Deeds of French heroes
(D) Injustices of the all times in France
13. The coup d'état of 18 Brumaire brought which leader to power in France?
(A) Louis XVI
(B) Robespierre
(C) Napoleon Bonaparte
(D) Marat
14. Finally, a group of several hundred people marched towards the part of the city and stormed the fortress-prison, the Bastille, where they hoped to find hoarded ammunition?
(A) Eastern (B) Northern
(C) Western (D) Southern
15. A triangular slave trade took place between Europe, the Americas and.....?
(A) Asia (B) Australia
(C) Africa (D) None
16. Which of the following decisions was taken by the convention?
(A) It declared France a constitutional Monarchy
(B) Abolished the Monarchy
(C) All men and women above 21 got the right to vote
(D) Declared France a Republic
17. Which of the following statements is false about the Third Estate?
(A) It comprised of poor only
(B) Some were rich some were poor
(C) Rich members owned land
(D) Peasant were obliged to serve in the army
18. Which of the following is true is about Bastille Storming?
(A) It was a fortress prison in France
(B) It represented despotic powers
(C) French common man hated Bastille
(D) All





19. An Englishman who travelled through France during the years 1787-1789 and wrote the descriptions of his journeys was _____.
 (A) George Danton
 (B) Arthur Young
 (C) Montesquieu
 (D) Jean-Jacques Rousseau
20. The National Anthem of France which was sung for the first time by volunteers as they marched into Paris was _____.
 (A) Marseillaise
 (B) Versailles
 (C) Bastille
 (D) Chateaux
21. When was Napoleon Bonaparte crowned as the Emperor of France?
 (A) 1801 (B) 1802
 (C) 1803 (D) 1804
22. In the year _____ Napoleon Bonaparte was defeated at the Battle of Waterloo.
 (A) 1814 (B) 1813
 (C) 1815 (D) 1816
23. Which incident sparked the French Revolution?
 (A) Louis XVI of the Bourbon Family of Kings ascended the throne of France
 (B) A constitution was framed to limit the powers of the king
 (C) The attack by the third estate on the Bastille State prison and setting free the prisoners
 (D) The extravagant lifestyle of the monarch
24. Which estates enjoyed privileges by birth?
 (A) Clergy
 (B) Nobility
 (C) The third estate
 (D) Both (a) and (b)
25. The French Revolution was
 (A) against the dictatorial policies of the monarch
 (B) against the clergy
 (C) against the society
 (D) none of the above
26. What is a feudalism?
 (A) To be a crowned king
 (B) Peasants owned the land
 (C) A social system in medieval Europe
 (D) A classless system
27. Which event gave the idea of liberty, freedom and equality?
 (A) Glorious Revolution of 1688
 (B) The French Revolution
 (C) The Russian revolution
 (D) The American War of Independence
28. _____ is an executive made up of five members.
 (A) Convention
 (B) National Assembly
 (C) Directory
 (D) None of the above
29. Who were not considered 'passive citizens'?
 (A) Women
 (B) Children
 (C) Non-propertied men
 (D) wealthy people
30. When did Louis XVI call the assembly of Estates General to pass Proposals for new taxes?
 (A) 21st July, 1789
 (B) 14th July, 1789
 (C) 5 th May, 1789
 (D) 25th Aug, 1789

VERY SHORT ANSWER TYPE QUESTIONS

1. How was French society organized during the Old Regime?
2. What do you mean by 'subsistence crisis' ? Why did it occur frequently during the old Regime in France?
3. What was the composition of the Estates General of May 5, 1789?
4. What was the main aim of the National Assembly?
5. Mention two activities of French Assembly which hastened the Revolution





6. Why did Louis XVI want to raise taxes? Why was he opposed?
7. What was the National Anthem of France? Who composed it?
8. What is a Guillotine? Who invented it?
9. State any two laws passed by Napoleon.
10. Identify Napoleon, telling the part played by him in the French Revolution.
11. On ascending the throne of France, Louis XVI found the treasury empty. Why was the treasury empty?
12. Describe the middle class in three points.
13. What was the tennis court oath?
14. What was tithes?
15. What was the theme of the book 'The spirit of the Laws' written by Montesquieu
16. Why was Bastille hated by the French people?
17. Which law was introduced by revolutionary government in France as help to improve the lives of women?
18. Name the political body to which the three estates of the French society sent their representatives?
19. The National Assembly completed the draft of the Constitution in 1791'. Mention any two features of the Constitution.
20. Name any four French philosophers who inspired the French people to revolt.

SHORT ANSWER TYPE QUESTIONS

1. What was 'Bastille'? What do you understand by 'Storming of the Bastille'?
2. What was the Tennis Court Oath?
3. Explain how the new political system worked?
4. Who were Jacobins? What role did they play in emergence of republic in France?
5. What was Directory? What were its consequences?
6. What role did the philosophers play in bringing about the French Revolution?
7. Why is the Declaration of the Rights of man citizen regarded as a revolutionary document?
8. Give an estimate of Napoleon Bonaparte as the First Consul.

9. What was the impact of the French Revolution on the world?
10. Which groups of French society benefited from the Revolution? Which groups were forced to relinquish power? Which sections of society would have been disappointed with the outcome of the Revolution?
11. Explain the term 'Third Estate'?
12. "Ideas of liberty and democratic rights were the most important legacy of the French Revolution". Explain the statement in the light of French Revolution.
13. Explain the impact of the French Revolution on the life of people of French.
14. "The inequality that existed in the French Society in the Old Regime became the cause of French Revolution". Justify the statement by giving three suitable examples.
15. What was the role of philosophers and thinkers in the French Revolution? Explain by giving three examples
16. State the events that led to the formation of the National Assembly.
17. What was the Convention? Describe its role in France.
18. Trace rights which we are enjoying today had origin in the French Revolution
19. Describe the effects of abolition of law of censorship on France.
20. How did the peasants contribute to the outbreak of the French Revolution? Explain.

LONG ANSWER TYPE QUESTIONS

1. Explain the role of Mirabeau and Abbe' Sieye's in the French Revolution
2. What was the impact of French Revolution on France?
3. Write short notes on
 - (i) French slave trade
 - (ii) Reign of Terror
 - (iii) Fall of Napoleon.
4. What was the importance of slavery to France?
5. Discuss the impact of abolition of censorship in France.





6. How did the teachings of Rousseau lay the foundations of democracy?
7. List the accomplishments of the National Assembly of France from 1789 to 1791.
8. How did France become a constitutional monarchy?
9. Discuss the role of women in the revolutionary movement in France. When did women gain political equality in France?
10. Give an estimate of the work of the National Assembly?

CASE BASED QUESTION

Read the source given below and answer the following questions:

1. On the morning of 14 July 1789, the city of Paris was in a state of alarm. The king had commanded troops to move into the city. Rumours spread that he would soon order the army to open fire upon the citizens. Some 7,000 men and women gathered in front of the town hall and decided to form a people's militia. They broke into a number of government buildings in search of arms. Finally, a group of several hundred people marched towards the eastern part of the city and stormed the fortress prison, the Bastille, where they hoped to find hoarded ammunition. In the armed fight that followed, the commander of the Bastille was killed and the prisoners released – though there were only seven of them. Yet the Bastille was hated by all because it stood for the despotic power of the king. The fortress was demolished and its stone fragments were sold in the markets to all those who wished to keep a souvenir of its destruction.
 - (I) When and why was Paris in a state of alarm?
 - (II) Who was killed in an armed fight in the fortress of Bastille?
 - (III) Why did people hate Bastille?
2. The revolutionary wars brought losses and economic difficulties to the people. While the men were away fighting at the front, women were left to cope with the tasks of earning a living and looking after their families. Large sections of the population were convinced that the revolution had to be carried further, as the Constitution of 1791 gave political rights only to the richer sections of society. Political clubs became an important rallying point for people who wished to discuss government policies and plan their own forms of action. The most successful of these clubs was that of the Jacobins, which got its name from the former convent of St Jacob in Paris. Women too, who had been active throughout this period, formed their own clubs. The members of the Jacobin club belonged mainly to the less prosperous sections of society. They included small shopkeepers, artisans such as shoemakers, pastry cooks, watchmakers, printers, as well as servants and daily wage workers. Their leader was Maximilian Robespierre. A large group among the Jacobins decided to start wearing long striped trousers similar to those worn by dock workers. This was to set themselves apart from the fashionable sections of society, especially nobles, who wore knee breeches.
 - (I) When the men were away fighting at the front, who became the bread earner?
 - (II) Why were large sections of the population dissatisfied with the Constitution of 1791?
 - (III) What role did political clubs play during the revolutionary period?
 - (IV) Who were the Jacobins, and why were they considered successful?
3. Most women of the third estate had to work for a living, and did not have access to education or job training. Working women also had to care for their families, their wages were lower than those of men. In order to discuss and voice their interests women started their own political clubs and newspapers. About sixty





women's clubs came up in different French cities. One of their main demands was that women enjoy the same political rights as men. In the early years the revolutionary government did introduce laws that helped to improve the lives of women, creation of state schools, schooling made compulsory for all girls, could no longer be forced to get into marriage against their will, Divorce could be applied for by both women and men. Women could now train for jobs, could become artists or run small businesses. During the Reign of Terror, the new government issued laws ordering closure of women's clubs and banning their political activities. The fight for the vote was carried out through an international suffrage movement during the late nineteenth and early twentieth centuries. It was finally in 1946 that women in France won the right to vote.

- (I) What challenges did most women of the third estate face, especially in terms of work and education?
 - (II) How did women respond to their lack of political rights during the revolutionary period?
 - (III) What were some of the demands made by women's clubs in different French cities during the revolution?
 - (IV) What positive changes did the revolutionary government bring for women in the early years, according to the passage?
4. Jacobin's regime's most revolutionary social reform was the abolition of slavery in the French colonies. In the seventeenth century, the slavery trade began. Slaves were brought from local chieftains, branded and shackled and packed tightly into ships for the three-month-long voyage across the Atlantic to the Caribbean. Slave labour met the growing demand in European markets for sugar, coffee, and indigo.
- Throughout the eighteenth century, there was little criticism of slavery in France. In 1794, the Convention legislated to free all slaves in the French overseas possessions. Napoleon introduced slavery after ten years. In 1848, slavery was abolished in French colonies.

- (I) What was one of the most revolutionary social reforms introduced by the Jacobin regime?
- (II) When did the slave trade begin, and what were the conditions for slaves during the Atlantic voyage?
- (III) What were the main products produced by slave labor in the French colonies to meet European market demands?
- (IV) During which century did little criticism of slavery exist in France?




EXERCISE - II
HOT

1. The constitution begins with a declaration of the -
 (A) Rights of Church
 (B) Rights of the king
 (C) Rights of feudal lords
 (D) Rights of Man and Citizens
2. Which of the following was a patriotic song of France during revolution?
 (A) Long live King
 (B) Long live Robespierre
 (C) Versailles
 (D) Marseillaise
3. Who of the following are the examples of individuals who represented the ideas coming from revolutionary France?
 (A) Gandhi and Nehru
 (B) Tilak and Gokhale
 (C) Tipu Sultan and Raja Ram Mohan Roy
 (D) Tagore and V Vivekananda
4. Napoleon's purpose in instituting the Continental System was to
 (A) defeat England through an economic war.
 (B) consolidate separate states of Germany
 (C) unify Italy
 (D) create a united Europe under the leadership of France.
5. Napoleon helped make the French Revolution an international movement in the areas he conquered
 (A) by imposing a universal currency based on the French franc
 (B) by the brutal suppression of guerrilla resistance.
 (C) by abolishing feudalism and manorialism
 (D) by encouraging French as the universal language.
6. The Congress of Vienna hoped to restore the European balance of power after the Wars of the French Revolution and the Napoleonic Wars by
 (A) surrounding France with strong states
 (B) unifying all of Germany
 (C) reestablishing the Holy Roman Empire.
 (D) unifying Italy
7. Who was the man whose ideas and aims dominated the Congress of Vienna and after whose age of reaction, from the fall of Napoleon to the Revolutions of 1848, is named?
 (A) Castlereagh
 (B) Talleyrand
 (C) Metternich
 (D) Hardenburg
8. During the Reign of Terror, the dominant person in the Committee of Public Safety was
 (A) Abbe Sieyes
 (B) Georges Danton
 (C) Napoleon Bonaparte
 (D) Maximilian Robespierre
9. Storming of the Bastille took place on
 (A) 14th July, 1789
 (B) 14th July, 1798
 (C) 14th June, 1789
 (D) 14th June, 1798
10. The Bastille symbolised
 (A) benevolence of the king
 (B) despotic power of the king
 (C) armed might of France
 (D) prestige and power
11. The most important of the privileges enjoyed by the clergy and nobility
 (A) right to collect dues
 (B) ownership of land
 (C) participate in wars
 (D) exemption from taxes to the state





12. Society based on freedom, equal laws and opportunities was advocated by
(A) middle class and people of the Third Estate
(B) clergy and nobility
(C) philosophers such as John Locke and Rousseau
(D) Englishmen Georges Danton and Arthur Young
13. Which of the following refuted the doctrine of divine right and absolute right?
(A) John Locke (B) Rousseau
(C) Montesquieu (D) Voltaire
14. Who advocated government based on Social Contract?
(A) Darwin (B) Spencer
(C) Rousseau (D) Montesquieu
15. Division of power within the government was put forth in
(A) Two Treaties of Government
(B) The Spirit of the Laws
(C) Le Moniteur Universel
(D) The Social Contract
16. Voting in the Estates General was conducted on the principle of
(A) each member one vote
(B) male adult franchise
(C) universal adult franchise
(D) each Estate one vote
17. Where did the Third Estate form and announce the National Assembly?
(A) Indoor Tennis Court
(B) Hall of Mirrors
(C) Firoz Shah Ground
(D) Winter Palace
18. Members of the Third Estate were led by
(A) Louis XVI and Marie Antionette
(B) Lenin and Kerensky
(C) Mirabeau and Abbe Sieyes
(D) Rousseau and Voltaire

19. Which of the following was the main objective of the Constitution of 1791?
(A) to limit the powers of the king alone
(B) do away with feudal privileges
(C) give equal rights to women
(D) establish a constitutional monarchy
20. A broken chain symbolised
(A) Chains used to fetter slaves
(B) Strength lies in unity
(C) Royal power
(D) Act of becoming free

ASSERTION AND REASON

DIRECTION: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

- (A) If Both assertion and reason are true and reason is the correct explanation of assertion.
- (B) If Both assertion and reason are true but reason is not the correct explanation of assertion.
- (C) If Assertion is true but reason is false.
- (D) If Both assertion and reason are false.

1. **Assertion (A):** Robespierre's government issued laws placing a maximum ceiling on wages and prices. Meat and bread were rationed.
Reason (R): Peasants were forced to transport their grain to the cities and sell it at prices fixed by the Government.
2. **Assertion (A):** It was finally in 1946 that women in France won the Right to Vote.
Reason (R): The example of the political activities of French women during the revolutionary years was kept alive as an inspiring memory.
3. **Assertion (A):** So the price of bread which was the staple diet of the majority rose rapidly.
Reason (R): Production of grains could not keep pace with the demand.





4. **Assertion (A):** In many ways, the French Revolution was a very significant event in the history of the world.

Reason (R): The French Revolution not only inspired French citizens to take action, but it inspired many philosophers and leaders across the globe.

5. **Assertion (A):** Soldiers of the French Army were known as Jacobians.

Reason (R): Jacobians were the trained soldiers of King Louis.

6. **Assertion (A):** Tithe was a tax levied by the Church.

Reason (R): It comprised one-tenth of the agricultural produce.

7. **Assertion (A):** Philosophers like John Locke and Jean Jacques Rousseau proposed ideas that influenced the French Revolution.

Reason (R): Locke refuted the divine right of kings, and Rousseau proposed a government based on a social contract.

8. **Assertion (A):** Women in France gained the right to vote in 1946.

Reason (R): The fight for women's suffrage continued internationally during the late nineteenth and early twentieth centuries.

9. **Assertion (A):** In the French Society of Estates, peasants made up to about 40% of the population.

Reason (R): Only a small number of them owned the land they cultivated.

10. **Assertion (A):** Women in France were active participants in the events leading to important changes in society during the French Revolution.

Reason (R): Women formed their own political clubs and newspapers to voice their interests and demands.

ANSWER KEY

EXERCISE-I

SINGLE CORRECT TYPE QUESTIONS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	C	C	A	B	B	B	D	C	B	C	D	C	C	D
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	D	A	D	B	A	D	C	C	D	C	C	B	C	D	C

EXERCISE-II

HOT

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	D	C	A	C	A	C	D	A	B	D	C	A	C	B
Que.	16	17	18	19	20										
Ans.	D	A	C	D	D										

ASSERTION AND REASON

Que.	1	2	3	4	5	6	7	8	9	10					
Ans.	A	B	A	A	D	B	A	B	D	A					





DPP

Daily Practice Problems

SUBJECT: HISTORY**CLASS- 9****DPP NO. 1****TOPIC : THE FRENCH REVOLUTION****Multiple Choice Questions**

1. The Third Estate comprised
 - (A) Poor servants and small peasants, landless labourers
 - (B) Peasants and artisans
 - (C) Big businessmen, merchants, lawyers etc.
 - (D) All the above
2. Which of the following decisions was taken by the convention?
 - (A) Declared France a constitutional monarchy
 - (B) Abolished the monarchy
 - (C) All men and women above 21 years got the right to vote
 - (D) Declared France a Republic
3. Who wrote the pamphlet called 'What is the Third Estate'?
 - (A) Mirabeau, a nobleman
 - (B) Abbe Sieyes
 - (C) Rousseau, a philosopher
 - (D) Montesquieu
4. A guillotine was _____
 - (A) a device consisting of two poles and a blade with which a person was beheaded
 - (B) a fine sword with which heads were cut off
 - (C) a special noose to hang people
 - (D) none of the above
5. The word livre stands for:
 - (A) unit of currency in France
 - (B) tax levied by the Church
 - (C) tax to be paid directly to the state
 - (D) none of these

-
6. The term 'Old Regime' is usually used to describe
(A) France before 100 B.C.
(B) Society of France after 1789 A.D.
(C) Society and institutions of France before 1789 A.D.
(D) None of the above
7. Which of these books was written by John Locke?
(A) The Spirit of the Laws (B) Two Treatises of Government
(C) The Social Contract (D) All the above
8. A kind of tax called Taille was a/an:
(A) Direct tax (B) Indirect tax (C) Indiscriminate tax (D) Custom duty
9. The population of France rose from _____ in 1715 to _____ in 1789:
(A) 20 million to 30 million
(B) 23 million to 28 million
(C) 18 million to 24 million
(D) 13 million to 18 million
10. The National Assembly completed the drafting of constitution in-
(A) 1791 (B) 1779 (C) 1782 (D) 1792
11. To qualify as an elector and then as member of the assembly a man had to belong to the-
(A) Lowest bracket of taxpayers
(B) Middle bracket of taxpayers
(C) Highest bracket of taxpayers
(D) Not to be a taxpayer
12. The constitution begins with a declaration of the-
(A) Rights of Church (B) Rights of the king
(C) Rights of feudal lords (D) Rights of Man and Citizen
13. After signing the constitution, the king of France entered into secret negotiations with the-
(A) King of Russia (B) King of England (C) King of Prussia (D) King of Italy
14. Which of following was a patriotic song of France during revolution?
(A) Long live king (B) Long live Robespierre
(C) Versailles (D) Marseillaise
-

15. Which of the following are the examples of individual who represented the ideas from revolutionary France?
- (A) Gandhi and Nehru (B) Tilak and Gokhale
(C) Tipu Sultan and Raja Ram Mohan Roy (D) Tagore and Vivekananda

Very short answer type Questions:

1. What is a Guillotine? Who invented it?
2. State any two laws passed by Napoleon.
3. What was the most important privilege enjoyed by the first two estates ?
4. What made France a constitutional monarchy ?
5. Why did Louis XVI want to raise taxes ?

Short answer type Questions:

1. What was the subsistence crisis? Why did it occur in France during the Old Regime?
2. What were 'natural and inalienable rights'?
3. Who were Jacobins? What role did they play in emergence of republic in France?
4. What was Directory? What were its consequences?
5. Explain the role of philosophers in the French Revolution?

Long answer type Questions:

1. Write short notes on
 - (i) French slave trade
 - (ii) Reign of Terror
 - (iii) Fall of Napoleon.
2. Discuss the impact of abolition of censorship in France.
3. Discuss the role of women in the revolutionary movement in France. When did women gain political equality in France?

Case based Study

1. Read the given passage and answer the questions that follow:

In the countryside rumours spread from village to village that the lords of the manor had hired band of brigands who were on their way to destroy the ripe crops. Caught in a frenzy of fear, peasants in several districts seized hoes and pitchforks and attacked chateaux. They looted hoarded grain and burnt down documents containing records of manorial dues. A large number of nobles fled from their homes, many of them migrating to neighbouring countries.

- (I) Manor is an estate consisting of _____.
 (A) Countryside and nearby areas (B) Monarch's palaces
 (C) Lord's land and his mansion (D) Assembly hall
- (II) _____ was the castle or stately residence belonging to the king or a nobleman.
 (A) Palace (B) Mahal (C) Versailles grounds (D) Chateaux
- (III) What factor forced the king Louis XVI to recognize the National Assembly?
 (A) Military was forcing him (B) In the fear of his nobles
 (C) His subjects were revolting powerfully (D) His ministers were building pressure on him.
- (IV) King's powers was checked by _____ after the National Assembly was recognized.
 (A) People (B) Constitution (C) Estate General (D) Ministers

2. Read the given passage and answer the questions that follow :

The representatives of the third estate viewed themselves as spokesmen for the whole French nation. On 20 June they assembled in the hall of an indoor tennis court in the grounds of Versailles. They declared themselves a National Assembly and swore not to disperse till they had drafted a constitution for France that would limit the powers of the monarch. They were led by Mirabeau and Abbe Sieyes.

- (I) Who was Mirabeau ?
- (II) Why did the members of the third estate assemble in the hall of an indoor court in the ground of Versailles ?
- (III) Who was Abbe Sieyes?

ANSWER KEY										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	D	B	A	A	C	B	A	B	A
Que.	11	12	13	14	15					
Ans.	C	D	C	D	C					