MOTION SAMPLE BOOKLET CLASS IX

- **MOTION**
- **MATTER IN OUR SURROUNDINGS**
- **FUNDAMENTAL UNIT**
- **NUMBER SYSTEM**
- **THE FRENCH REVOLUTION**

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MOTION
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CLASS - IX

THEORY AND EXERCISE BOOKLET

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MOTION

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MOTION

INTRODUCTION

Motion is a very preliminary state of action associated with living and non-living beings. The study of the displacement, velocity and acceleration associated with moving bodies can make us understand the motion of bodies. To have an in-depth study of motion, equational representation and graphical analysis of various related quantities in motion with time is also done.

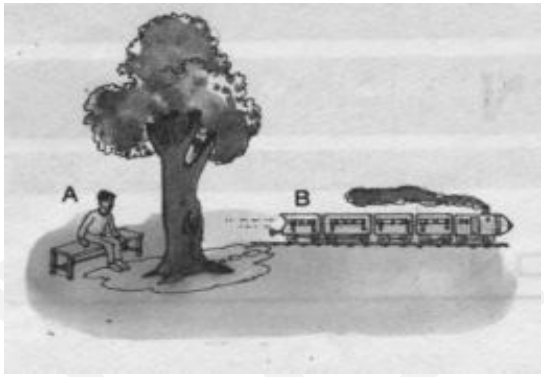
When a body does not change its position with time, we can say that the body is at **rest**. While if a body changes its position with time, it is said to be in **motion**.

(i) An object is said to be a **point object** if it changes its position by distances which are much greater than its size.

(ii) A point or some stationary object with respect to which a body continuously changes its position in the state of motion is known as **origin** or **reference point**.

Describing Motion :

When a tree, is observed by an observer A sitting on a bench, the tree is at rest. This is because position of the tree is not changing with respect to the observer A.



Now, When the same tree T is observed by an observer sitting in a superfast train moving with a velocity v, then the tree is moving with respect to the observer because the position of tree is changing with respect to the observer B.

Vectors : Physical quantities defined with both magnitude and direction are called vector quantities. They should also satisfy the law of vector addition.

Examples: Velocity, acceleration, force, displacement, momentum, weight, torque, electric field, magnetic filed, etc.

Scalars : Physical quantities having only magnitude are called scalar quantities.

Examples: Mass, time, distance, speed, work, power, energy, electric charge, area, volume, density, pressure, electric potential, temperature, etc.

DIFFERENCE BETWEEN SCALAR & VECTOR QUANTITIES :

	Scalar Quantities	Vector quantities
1	These are completely specified by their magnitude only.	These are completely specified by their magnitude as well as direction.
2	These change by change of their magnitude only	These change by change of either their magnitude or direction or both
3	These are added or subtracted by laws of ordinary algebra like 4m+5m=9m.	These are added or subtracted by laws of vector addition.

Newton's Thought
Discuss whether the walls of your classroom are at rest or in motion. **Explanation** The walls of our classroom are at rest with respect to the ground or earth. But, they are in motion with respect to an object or an observer outside the earth. This is because the earth is moving about its own axis as well as it is revolving around the sun. Thus, the state of rest and motion are not absolute, they are relative terms.

TYPES OF MOTION

(A) According to Directions

(i) One dimensional motion is the motion of a particle moving along a straight line.

(ii) Two dimensional motion A particle moving along a curved path in a plane has 2-dimensional motion.

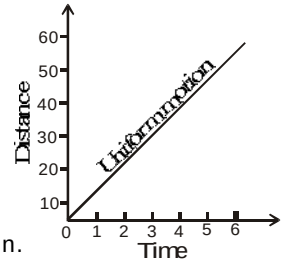
(iii) Three dimensional motion Particle moving in space has 3-dimensional motion.

(B) According to state of motion

A moving body may cover equal distances in equal intervals of time or different distances in equal intervals of time. On the basis of above assumption, the motion of a body can be classified as uniform motion and non-uniform motion.

(i) Uniform motion:

Time (in second)	0	1	2	3	4	5	6
Distance covered (in metre)	0	10	20	30	40	50	60



When a body covers equal distances in equal intervals of time however small may be time intervals, the body is said to describe a uniform motion.

Example of uniform motion –

(a) An aeroplane flying at a speed of 600 km/h

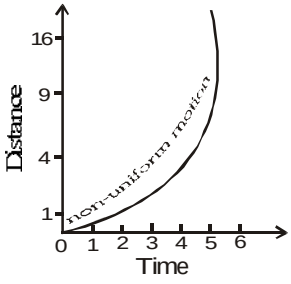
(b) A train running at a speed of 120 km/h

(c) Light energy travelling at a speed of 3×10^8 m/s

(d) A spaceship moving at a speed of 100 km/s

(ii) Non-uniform motion:

Time (in second)	0	1	2	3	4
Distance (in metre)	0	1	4	9	16



When a body covers unequal distances in equal intervals of time, the body is said to be moving with a non-uniform motion.

Example of non-uniform motion –

(i) An aeroplane running on a runway before taking off.

(ii) A freely falling stone under the action of gravity.

(iii) An object thrown vertically upward.

(iv) When the brakes are applied to a moving car.

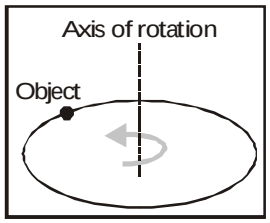
(C) According to path

(i) Linear motion : A body has linear motion if it moves in a straight line or path.

Ex. (a) Motion of a moving car on a straight road.

(b) Motion of a ball dropped from the roof of a building.

(ii) Circular (or rotational) Motion : A body has circular motion if it moves around a fixed point. A vertical passing through the fixed point around which the body moves is known as axis of rotation.



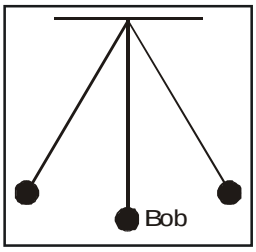
Ex. (a) Motion of an electric fan.

(b) Motion of merry-go-round

(c) Motion of a spinning top.

(iii) Vibratory motion :

A body has vibratory motion if it moves to and fro about a fixed point.



Ex. (a) Motion of a pendulum of a wall clock.

(b) Motion of a simple pendulum.

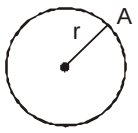
DISTANCE & DISPLACEMENT

(i) The actual path length between the initial and final positions of the particle gives the **distance** covered by the particle.

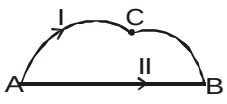
(ii) The minimum distance between the initial and final positions of a body during that time interval is called **displacement**.

Analysis

(i) Distance travelled is a scalar quantity while displacement is a vector quantity. Eg. if a body moves along the circumference of a circle of radius r, then the distance travelled is given by $2\pi r$, while the displacement is given by zero.



(ii) When a body continuously moves in the same straight line and in the same direction then displacement will be equal to the distance travelled. But if the body changes its direction while moving, then the displacement is smaller than the distance travelled.

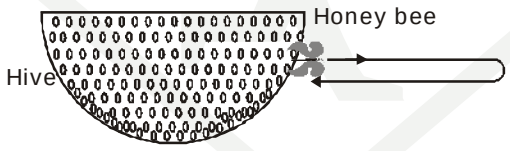


Displacement $\leq$ Distance

DIFFERENCES BETWEEN DISTANCE AND DISPLACEMENT		
	Distance	**Displacement**
1	It is defined as the actual path traversed by a body.	It is the shortest distance between two points which the body moves.
2	It is a scalar quantity	It is a vector quantity
3	It can never be negative or zero	It can be negative, zero or positive.
4	Distance can be equal to or greater than displacement	Displacement can be equal to or less than distance.
5	Distance travelled is not a unique path between two points.	Displacement is a unique path between two points.
6	The distance between two points gives full information of the type of path followed by the body.	Displacement between two points does not give full information of the type of path followed by the body.
7	Distance never decreases with time. for a moving body it is never zero.	Displacement can decrease with time for a moving body it canbe zero.
8	Distance in SI is measured in metre	Displacement in SI is measured in metre.

Newton's Thought

A honeybee leaves the hive and travels 2m before returning. Is the displacement for the trip the same as the distance travelled? If not, why not.



Explanation

No, the displacement and the distance are not same. This is because the displacement is the change of position of object in motion while distance is length of path travelled by it.

Here, the distance travelled = 2m

While, the displacement = 0, because the position of honey bee is not changed.

SPEED AND VELOCITY

Speed : The distance travelled in one second is called speed It is a scalar quantity. Its SI unit is m/s. Speed always remains positive.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} (\text{m/s})$$

$$\text{Speed} = \frac{s_2 - s_1}{t_2 - t_2} = \frac{\Delta s}{\Delta t}$$

Where Δs = distance in time interval Δt.

Velocity : The displacement in one second is called velocity. It is a vector quantity expressed in m/s. Velocity can be positive, negative or zero.

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time taken}} (ms^{-1})$$

$$\text{Velocity} = \frac{\Delta s}{\Delta t}$$

Where Δs = displacement travelled in time interval Δt.

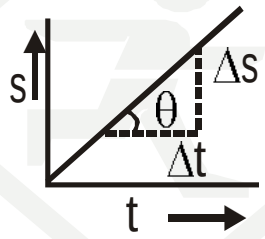
Speed	Velocity
1. Scalar quantity	1. Vector quantity.
2. Rate of distance covered.	2. Rate of displacement.
3. Cannot be zero for a moving body.	3. Can be zero, +ve or –ve.
4. Speed is velocity without direction.	4. Velocity is directed speed.
5. Speed in SI unit is measured in ms^{-1}.	5. Velocity in SI unit is measured in ms^{-1}.

(i) Unit : In M.K.S. system = ms^{-1}

In C.G.S. system = Cms^{-1}

(ii) If distance time graph is a straight line, then speed can be given by the slope of the line,

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



$$\text{slope} = \frac{s_2 - s_1}{t_2 - t_1}$$

(iii) The area of velocity time graph gives distance travelled.

(iv) Conversion from km/hr to m/sec.

$$\frac{1\text{km}}{\text{hr}} = \frac{1000}{60 \times 60} \text{m/s} = \frac{5}{18} \text{m/s}.$$

TYPES OF SPEED

(a) Average and Instantaneous speed

◈ **Average speed :** The ratio of distance travelled by a body to the total time taken, when the motion can be with varying speeds for various intervals of time.

$$\text{Average Speed} = \frac{\text{Total Distance}}{\text{Total Time taken}}$$

OR

It is obtained by dividing the total distance travelled by the total time interval. i.e.

$$\text{Average speed} = \frac{s_2 - s_1}{t_2 - t_1} = \frac{\Delta s}{\Delta t}$$

(i) Average speed is a scalar, while average velocity is a vector.

(ii) For a given time interval average velocity is single valued, while average speed can have many values depending on path following.

(iii) If after motion body comes back to its initial position $\vec{v}_{av} = 0$ [as $\Delta\vec{r} = 0$], but $v_{av} > 0$ and finite (as $\Delta s > 0$)

(iv) For a moving body average speed can never be –ve or zero (unless t = 0), while average velocity can be i.e. $v_{av} > 0$ while $\vec{v}_{av}$ > = or < 0

(v) In general average speed is not equal to magnitude of average velocity (as $\Delta s \neq |\Delta\vec{r}|$). However it can be so if the motion is along a straight line without change in direction (as $\Delta s = |\Delta\vec{r}|$)

(vi) If a particle travels distances L_1, L_2 L_3 at speeds v_1, v_2, v_3 etc respectively, then

$$v_{av} = \frac{\Delta s}{\Delta t} = \frac{L_1 + L_2 + ... + L_n}{\frac{L_1}{v_1} + \frac{L_2}{v_2} + ... + \frac{L_n}{v_n}} = \frac{\sum L_i}{\sum \frac{L_i}{v_i}}$$

(vii) If a particle travels at speeds v_1, v_2 etc for intervals t_1, t_2 etc respectively, then

$$v_{av} = \frac{v_1 t_1 + v_2 t_2 + ...}{t_1 + t_2 + ...} = \frac{\sum v_i t_i}{\sum t_i}$$

(viii) If a particle moves a distance at speed v_1 and comes back with speed v_2, then

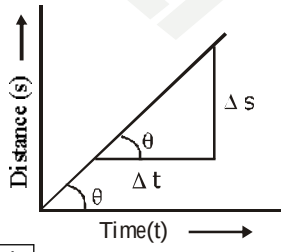
average speed $v_{av} = \frac{2v_1 v_2}{v_1 + v_2}$ $\quad (\vec{v}_{av} = 0)$

(ix) If a particle moves for two equal time intervals

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

◈ **Instantaneous speed** :

The speed of a body at a particular instant of time is called its instantaneous speed.



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

(b) Uniform and Non uniform speed

◈ **Uniform speed** :

If the time speed graph of an object is a straight line parallel to time axis then the body is moving with a uniform speed.

◈ **Non-uniform speed** :

If the speed of a body is changing with respect to time it is moving with a non-uniform speed. Its graph is not a straight line.

TYPES OF VELOCITY

(a) Average Velocity:

Total displacement divided by total time is called an average velocity.

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

$$V_{av} = \frac{x_2 - x_1}{t_2 - t_1}$$

OR

The arithmetic mean of initial velocity and final velocity for a given time period, is called average velocity.

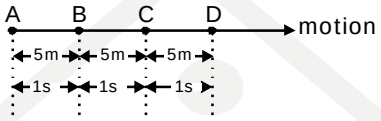
$$\text{Average velocity} = \frac{\text{Initial velocity + Final velocity}}{2}$$

$$V_{av} = \frac{u+v}{2}$$

where u = initial velocity, v = final velocity

(b) Uniform & Non uniform Velocity

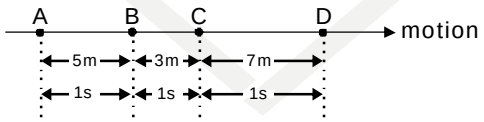
◈ **Uniform velocity**



Body moving with uniform velocity

When a body covers equal displacement in equal interval of time, the body is said to be moving with a uniform velocity.

◈ **Non-uniform velocity / variable velocity :**

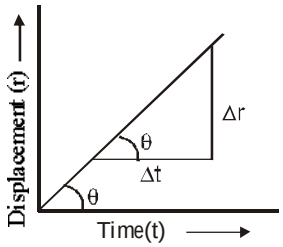


Body moving with non-uniform velocity

When a body covers unequal displacement in equal intervals of time, the body is said to be moving with variable velocity.

Instantaneous velocity :

The velocity of a body at a particular instant of time is called its instantaneous velocity.



$$\text{Instantaneous velocity} = \lim_{\Delta t \to 0} \frac{\Delta r}{\Delta t} = \frac{dr}{dt}$$

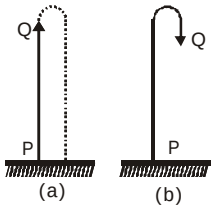
Newton's Thought

A particle is thrown vertically upwards under gravity. What are the signs of displacement and velocity in the given situations (a) & (b) (P to Q):

Explanation

(a) Here, displacement and velocity (average & instantaneous) both are positive.

(b) Here, displacement is positive. Instantaneous velocity is negative & average velocity is positive.



ACCELERATION

The rate at which the velocity changes is called acceleration. It is a vector quantity. Its SI unit is m/s^2 or ms^{-2}.

(i) Rate of change of velocity is called acceleration

(ii) The change in velocity may be in magnitude or in direction or both.

i.e. $\boxed{a = \frac{v-u}{t}}$

(iii) Unit of acceleration = m/s^2 or ms^{-2}

◈ **Deceleration or Retardation :** If the change in velocity is –ve ie. if velocity of a body decreases, the acceleration is called deceleration or retardation.

◈ **Uniformly accelerated motion :** When the change in velocity is same in equal time intervals, the motion called uniformly accelerated motion, otherwise, it is non-uniformly accelerated motion.

TYPES OF ACCELERATION

(i) Uniform & Non uniform acceleration

◈ **Uniform acceleration**

If a body travels in a straight line and its velocity increases by equal amounts in equal intervals of time then it is said to be in state of uniform acceleration e.g. motion of a freely falling body.

◈ **Non uniform acceleration**

A body has a non-uniform acceleration if its velocity increases by unequal amounts in equal intervals of time.

(ii) Average & Instantaneous acceleration

◈ **Average acceleration** :

$$\boxed{a_{av} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}}$$

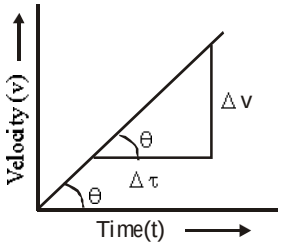
[here it is assumed that acceleration remains the same during the time interval Dt.]

If a body travels with a uniform acceleration a_1 for a time interval t_1 and with uniform acceleration a_2 for a time interval t_2 then

$$\boxed{a_{av} = \frac{(a_1 t_1 + a_2 t_2)}{(t_1 + t_2)}}$$

◈ **Instantaneous acceleration** :

The acceleration of a body at any instant is called its instantaneous acceleration.



e.g. $a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$

(iii) If the velocity of a body decreases, then it will experience a negative acceleration which is called deceleration or retardation.

Acceleration is determined by the slope of time-velocity graph.

$$\boxed{\tan\theta = \frac{dv}{dt}}$$

(i) If the time velocity graph is a straight line, acceleration remains constants.

(ii) If the slope of the straight line is positive, positive acceleration occurs.

(iii) If the slope of the straight line is negative, negative acceleration or retardation occurs.

(iv) Larger the slope (tan θ) longer will be the straight line.

(v) If the time velocity graph is a curve, then the acceleration changes continuously.

EQUATIONS OF MOTION

A. Uniform Motion : If x_i and x_f are the initial and final positions respectively of a-moving particle, the motion is defined by, velocity $v = \frac{x_f - x_i}{t}$ and v will be constant.

B. Non-uniform Motion : $(x_f - x_i)$ varies in equal time intervals. So velocity varies.

C. Average velocity = $\frac{\text{Total displacement}}{\text{Total time taken}}$

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

E. Uniform acceleration : If u and v are the initial and final velocities in time 't', then acceleration $a = \frac{v-u}{t}$. It is a constant.

F. In uniform acceleration (only), the average velocity is given by, $v_{av} = \frac{v+u}{2}$.

G. For uniformly accelerated motion,

(i) $v = u + at$ (ii) $s = ut + \frac{1}{2}at^2$ and (iii) $v^2 = u^2 + 2as$

◈ **Motion under uniform acceleration**

Suppose a body starts with initial velocity u, moving with an acceleration attains a velocity v after time t travels a distance s, then motion can be described by following equations.

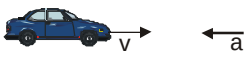
(a) $v = u + at$ **(b)** $s = ut + \frac{1}{2}at^2$ **(c)** $v^2 = u^2 + 2as$

Newton's Thought

A car is travelling along a straight road and is decelerating. Does the car's acceleration necessarily have a negative value?

Explanation

We begin with the meaning of the term "decelerating," which has nothing to do with whether the acceleration 'a' is positive or negative. The term means only that the acceleration is opposite to the velocity and indicates that the moving object is slowing down.



v = +ve; a = –ve

v = –ve; a = +ve

(i) One possibility is that the velocity of the car points to the right (the positive direction) and acceleration points opposite i.e. to the left (the negative direction).

(ii) Another possibility is that the velocity of the car points to the left (the negative direction) and acceleration points opposite i.e. to the right (the positive direction).

DERIVATION OF EQUATIONS OF MOTION

(i) v = u + at

Let a body have an initial velocity 'u' and an uniform acceleration 'a'. At any time 't', if 'v' is the velocity,

Acceleration = $\frac{\text{Change in velocity}}{\text{Time taken}} = \frac{v-u}{t}$

$\therefore \quad v = u + at$

(ii) $s = ut + \frac{1}{2}at^2$

Let the displacement in time 't' be 's' with uniform acceleration 'a'. The average velocity is given by

$v_{av} = \frac{\text{initial velocity} + \text{final velocity}}{2}$

$\therefore \quad v_{av} = \frac{u+v}{2}$

Displacement $s = \left(\frac{u+v}{2}\right)t$

Applying first eq. $s = \left(\frac{u+u+at}{2}\right)t$;

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

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

(iii) $v^2 = u^2 + 2as$

Velocity at any time, v = u + at

$s = \left(\frac{u+v}{2}\right)t \qquad \because \frac{v-u}{t} = a \quad \therefore \frac{v-u}{a} = t$

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

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

(A) It may be remembered always that these equations are applicable only for **constant acceleration** or **Uniform Acceleration**.

(B) The equations of motion under gravity can be obtained by replacing acceleration by acceleration due to gravity (g) and can be written as follows :

(C) When the body is coming towards the centre of earth

(a) $v = u + gt$; **(b)** $h = ut + \frac{1}{2}gt^2$; **(c)** $v^2 = u^2 + 2gh$

(D) When a body is thrown upwards with some initial velocity, then a retardation produced due to attraction of the earth. In equations of motion, a is replaced by (–g) and thus equations become.

(a) $v = u - gt$; **(b)** $h = ut - \frac{1}{2}gt^2$; **(c)** $v^2 = u^2 - 2gh$

(E) Distance covered by a body in n^{th} sec. i.e.

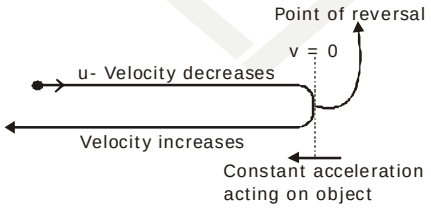
$$s_n = u + \frac{1}{2}a(2n - 1)$$

Newton's Thought

An object moving with a constant acceleration can certainly slow down. But can an object ever come to a permanent halt (stop) if its acceleration truly remains constant? Explain.

Explanation

An object moving with a constant acceleration will slow down if the acceleration is opposite to the velocity. However, if the acceleration remains constant the object will never come to a permanent halt. As time increase, the magnitude of the velocity will get smaller and smaller. At some time, the velocity will be instantaneously zero. An instant after the velocity is zero, the magnitude of the velocity will begin increasing in the same direction as the acceleration. As time increases, the velocity of the object will then increase in the same direction as the acceleration. In other words, if the acceleration truly remains constant, the object will slow down, stop for an instant, reverse direction and then speed up.



BODY FALLING FREELY UNDER GRAVITY

A body released near the surface of the earth is accelerated downward under the influence of force of gravity.

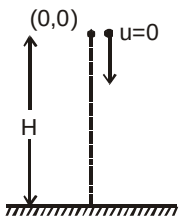
(a) Time of Flight :

from equation $S = ut + \frac{1}{2}at^2$

$S = -H$, $u = 0$, $a = -g$

$t = T$ (Let assume)

$$\Rightarrow \quad -H = (0)T - \frac{1}{2}gt^2 \Rightarrow T = \sqrt{\frac{2H}{g}}$$



(b) Final Velocity when body reaches the ground

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

$s = -H$ $\quad v = v_f$ $\quad u = 0$ $\quad a = -g$

$\Rightarrow \quad v_f^2 - 0 = 2(-g)(-H) \Rightarrow v_f = \sqrt{2gH}$

Assuming u = 0 for a freely falling body :

(i) As $h = \left(\frac{1}{2}\right)gt^2$ i.e. $h \propto t^2$

Distance fallen in time t, 2t, 3t etc will be in the ratio of $1^2 : 2^2 : 3^2$ ..... i.e. square of integers.

(ii) The distance fallen in n^{th} sec $= \frac{1}{2}g(2n-1)$

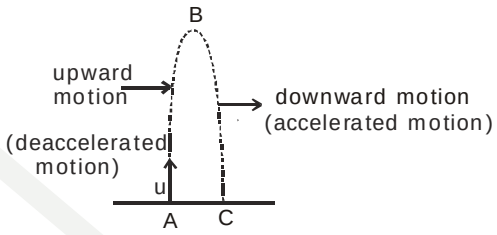
so distance fallen in I^{st}, 2^{nd}, 3^{rd} sec will be in the ratio 1 : 3 : 5 i.e. odd integers only.

BODY IS PROJECTED VERTICALLY UP

It includes two types of motion

(i) Decelerated motion from A to B because the direction of velocity and acceleration is opposite. So speed decreases

(ii) Accelerated motion from B to C because the direction of velocity and acceleration is same (downward). So speed increases



(a) Time of flight :

It is the time taken by the particle to reach the ground. If the particle is thrown vertically upward with initial velocity u then

$u_i = u$

$a = -g$ (take downward direction negative)

from equation

$S = ut + \frac{1}{2}at^2 \Rightarrow S_{net} = 0$ (when particle again reaches the ground)

$t = T$ (time of flight)

$0 = uT - \frac{1}{2}gT^2 \Rightarrow T = \frac{2u}{g}$

(b) Maximum Height :

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

at maximum height $v = 0$, $s = H_{max}$

$\Rightarrow 0 = u^2 - 2gH_{max} \Rightarrow \quad H_{max} = \frac{u^2}{2g}$

(c) Final velocity

from $v = u + at$

$v = v_f$ $\quad a = -g$ $\quad t = T = \frac{2u}{g} \Rightarrow v_f = u - g\left(\frac{2u}{g}\right)$

$v_f = -u$

i.e. the body reaches the ground with the same speed with which it was thrown vertically upwards as it thrown vertically upward.

Taking initial position as origin and direction of motion (i.e. vertically up) as positive.

(a) At the highest point v = 0 $\quad$ (b) a = – g

◈ It is clear that in case of motion under gravity

(a) Time taken to go up is equal to the time taken to fall down through the same distance.

(b) The speed with which a body is projected up is equal to the speed with which it comes back to the point of projection.

(c) The body returns to the starting point with the same speed with which it was thrown.

DISPLACEMENT- TIME GRAPH

⇒ The slope of displacement time (x – t) graph gives the velocity of motion. One can find the velocity of motion, finding the slope of x - t graph. To find the slope,

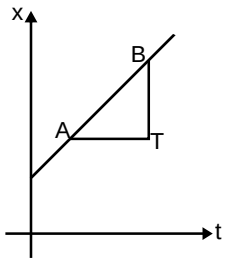
(i) Select any two points on the graph A and B.

(ii) Draw a right triangle below the graph (ABT)

(iii) Find the length of BT and AT from the axis

(iv) Take the ratio of BT to AT

The ratio has the units of velocity.



$$\text{Slope} = \frac{BT}{AT} = \frac{\text{Displacement}}{\text{Time taken}} = \text{Velocity}$$

⇒ If x-t graph is a straight line, then there may be

(i) State of rest – parallel to time axis

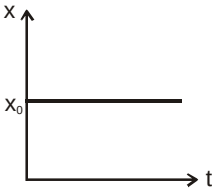
(ii) uniform motion – inclined to time axis.

The slope of the straight line is a measure of velocity of motion.

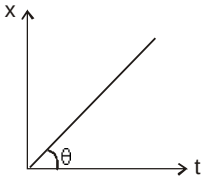
⇒ If the x – t graph is not a straight line, the motion will be a non-uniform motion – accelerated motion.

For example, a body dropped from a height undergoes free fall satisfying the relation $y = \frac{1}{2}gt^2$.

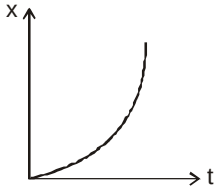
Displacement- time graph (examples)

(1) 

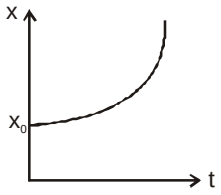
Body is at rest at x_0.

(2) 

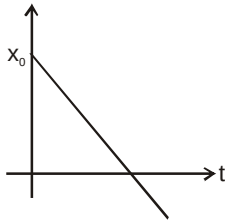
Body starts from origin and is moving with speed tan θ away from origin.

(3) 

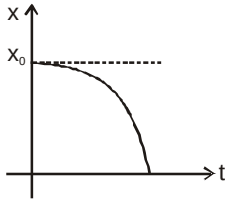
Body starts from rest from origin and moves away from origin with increasing speed velocity and positive acceleration.

(4) 

Body starts from rest from $x = x_0$ and moves away from origin with increasing velocity or +ve acceleration.

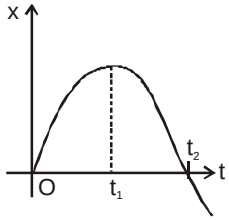
(5) 

Body starts from $x = x_0$ and is moving toward the origin with constant velocity passes throw origin after same time and continues to move away from origin.

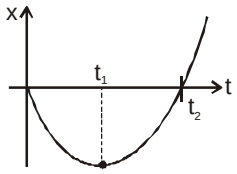
(6) 

Body starts from rest at $x = x_0$ and then moves with increasing speed towards origin

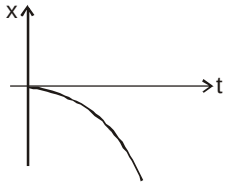
$\therefore$ acceleration is –ve

(7) 

Body starts moving away from origin with some initial speed. Speed of body is decreasing till t_1 and it becomes 0 momentarily of $t = t_1$ and At this instant. Its reverses its direction and move towards the origin with increasing speed.

(8) 

Body starts from origin moves away from origin in the –ve x-axis at $t = t_1$ with decreasing speed and at $t = t_1$ it comes at rest momentarily, Reverses its direction moves towards the origin the increasing speed. Crosses the origin at $t = t_2$.

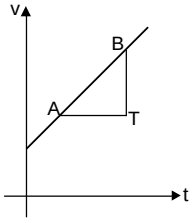
(9) 

Body starts from origin from rest and moves away from origin with increasing speed.

VELOCITY -TIME GRAPH

⇒ The slope of velocity-time (v – t) graph gives the acceleration of motion.

Slope of v – t graph is, $\frac{BT}{AT} = \frac{\text{Change in velocity}}{\text{Time taken}}$

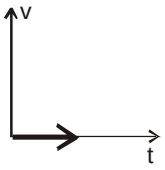


⇒ If v – t graph is a straight line, then there may be

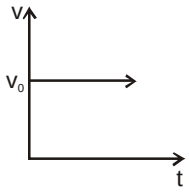
(i) uniform motion –parallel to time axis

(ii) non-uniform motion – inclined to time axis.

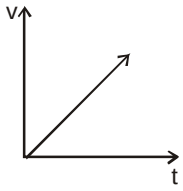
Velocity -time graph (examples)

(1) 

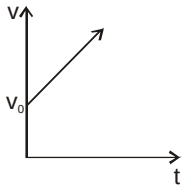
Body is always at rest.

(2) 

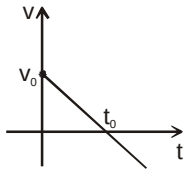
Body is moving with constant velocity v_0

(3) 

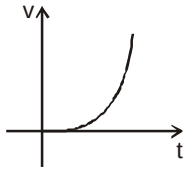
Body is at rest initially then it starts moving with its velocity increasing at a constant rate i.e. body is moving with constant acceleration.

(4) 

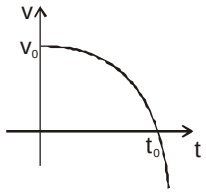
Body starts its motion with initial velocity v_0 and continues to move with its velocity increasing at a constant rate i.e. acceleration of the body is constant.

(5) 

Body starts its motion with initial velocity v_0. Then it continues to move with its velocity decreasing at a constant rate i.e. acceleration of the body is negative and constant. At $t = t_0$ the body comes to rest instantaneously and reverses its direction of motion and then continues to move with decreasing velocity or increasing speed.
For $0 < t < t_0$ motion of the body is decelerated ($\therefore$ speed is decreasing)
$t > t_0$ motion of the body is accelerated ($\therefore$ speed is increasing)

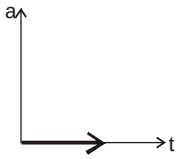
(6) 

Body is at rest initially. Then it starts moving with increasing velocity. As time increases its velocity is increasing more rapidly. i.e. the moving with increasing acceleration.

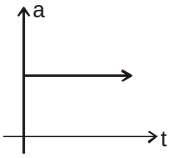
(7) 

Body starts its motion with initial velocity v_0. Its velocity is decreasing with time and at $t = t_0$. It becomes zero after body reverse its direction of motion and continues to move with decreasing velocity or increasing speed. Since velocity of the body is decreasing for whole motion. Therefore, its acceleration is negative.For $0 < t < t_0$ motion of the body is decelerated (speed is decreasing) $t > t_0$ motion of the body is accelerated ($\because$ speed is increasing)

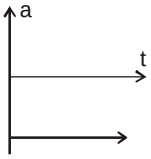
ACCELERATION TIME GRAPH

(1) 

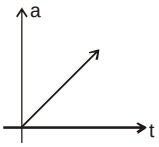
acceleration of the body is zero that means the body is moving constant velocity.

(2) 

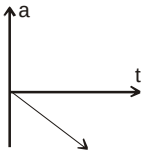
Acceleration of the body is constant and positive.

(3) 

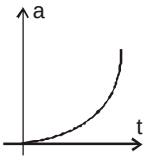
Acceleration of the body is constant and negative

(4) 

Initially the acceleration of the body is zero. Then its acceleration is increasing at a constant rate.

(5) 

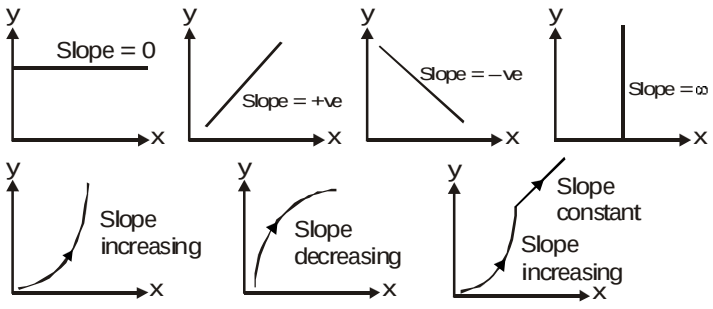
The body starts accelerating(initial acceleration zero) at t = 0. Its acceleration is negative for whole of its motion and is decreasing at a constant rate.

(6) 

Initially acceleration of the body is zero. Its acceleration is positive for whole of its motion. Its acceleration is increasing for whole of its motion.

COMPETITIVE WINDOW

Nature of Slope:-



Newton's Thought

Two cars moving on straight sections of a highway. The acceleration of the first car A is greater than the acceleration of the second car B and both accelerations have the same direction. Which one of the following is true? (a) The velocity of the first car is always greater than the velocity of the second car. (b) The velocity of the second car is always greater than the velocity of the first car. (c) In the same time interval, the velocity of the first car changes by a greater amount than the velocity of the second car does. (d) In the same time interval, the velocity of the second car changes by a greater amount than the velocity of the first car does.

Explanation

Option (c) is true because the acceleration of the first car is greater than the acceleration of the second car, thus in the same time interval, the velocity of the first car changes by a greater amount that the velocity of the second car does.

Option (d) is reverse of option (c), thus it cannot be true simultaneously. It is therefore, a false statement.

Option (a) is false because initial velocity of car A may be less than the velocity of car B. After a certain time interval, velocity of A will become more than the velocity of B.

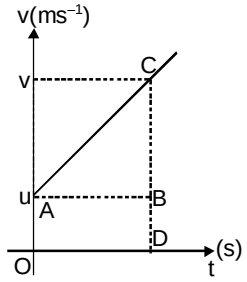
Option (b) is also false because initial velocity of car A may be less or more than the velocity of car B. Even if the initial velocity of car B is more than velocity of car A, after a certain time interval it will become less than that of car A.

EQUATIONS OF MOTION – GRAPHICAL METHOD

I. Velocity-time equation

Consider the v – t graph shown for a body having velocity u at t = 0 and v at t seconds.

The acceleration 'a' associated with the motion is given by,



$$a = \text{slope} = \frac{BC}{AB} = \frac{v-u}{t-0} = \frac{v-u}{t}$$

$\therefore v - u = at$ or $v = u + at$

II. Position-time equation :

Area below the v – t graph is a measure of the displacement in straight line.

$\therefore$ Displacement s = Area (OACBD)

$$s = \frac{1}{2}(BC \times OD) + OA \times OD = \frac{1}{2}at \times t + ut \quad (\because v - u = at)$$

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

III. Position-velocity equations :

Displacement in 't' seconds is given by

$$s = \text{Area of trapezium OACBD} = \frac{1}{2}(OA + CD) \times OD = \frac{1}{2}(u + v) \times t$$

$$s = \frac{1}{2}(u + v) \times \left(\frac{v-u}{a}\right) = \frac{v^2 - u^2}{2a}$$

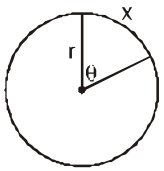
$\therefore v^2 - u^2 = 2as \quad \Rightarrow \quad v^2 = u^2 + 2as$

CIRCULAR MOTION

Motion in a circular path is called circular motion. It is of two kinds – uniform or non- uniform. If the speed of motion is same in the circular path, the motion is called uniform circular motion. If the speed varies – may increase or decrease, then it is non-uniform circular motion.

In a circular motion of radius r,

(i) Angular displacement $\theta = \frac{\text{arc length}}{\text{radius}} = \frac{x}{r}$



(ii) Angular velocity $\omega = \frac{\theta_f - \theta_i}{t}$

(iii) Linear velocity v = radius × angular velocity

$v = r\omega$

(iv) Angular acceleration $\alpha = \frac{\omega_f - \omega_i}{t}$

(v) Linear acceleration a = radius × angular acceleration

(v) Linear acceleration $a = r\alpha$

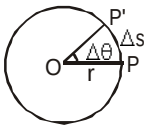
UNIFORM CIRCULAR MOTION :

(i) If the radius vector sweeps out equal angles in equal times, then its motion is said to be uniform circular motion.

(ii) In uniform circular motion speed remains const.

(iii) Linear velocity, being a vector quantity, its direction changes continuously.

(iv)The direction of velocity is along the tangent at every point.



◈ **Angular displacement :**

In a circular motion, the angle subtended at the centre by any arc of the circular path of motion is called the angular displacement (θ). It is measured in radians. One radian is that angular displacement whose are length is equal to the radius of the circle.

◈ **Angular velocity :**

The angular displacement of any moving object per second is called its angular velocity (ω).

Angular velocity (ω) = $\frac{\text{Angular displacement}}{\text{Time taken}}\left(\frac{\Delta\theta}{\Delta t}\right)$.

It is expressed in radian per second.

(i) A vector quantity

(ii) Direction is perpendicular to plane of rotation

Note : If the particle is revolving in the clockwise direction then the direction of angular velocity is perpendicular to the plane downwards. Whereas in case of anticlockwise direction the direction will be upwards.

(iii) Unit is Radian/sec.

(iv) In uniform circular motion the direction of angular velocity is along the axis of rotation which is constant throughout.

(v) Angular velocity remains constant in magnitude as well as in direction.

(vi) $v = r\omega$ where r = radius of the circle.

◈ **Angular acceleration :**

The change in angular velocity in unit time is called the angular acceleration (α).

$$\text{Angular acceleration} = \frac{\text{Change in angular velocity}}{\text{Time taken}}$$

(i) Acceleration in a uniform circular motion is directed towards the centre and the direction of velocity at any instant is given by the tangent at that point.

(ii) Since the acceleration is always directed towards the centre in a uniform circular motion, it is an example of variable acceleration even through the magnitude of acceleration is the same.

◈ **Centripetal acceleration :**

(i) In uniform circular motion the particle experiences an acceleration called the centripetal acceleration.

(ii) $\boxed{a_c = \frac{v^2}{r}}$

(iii) The direction of centripetal acceleration is along the radius towards the centre.

◈ **Centripetal force :**

(i) Always acts towards centre.

(ii) Centripetal force is required to move a particle in a circle.

(iii) Because F_c is always perpendicular to velocity or displacement, hence the work done by this force will always be zero.

Note :

(i) Circular motion in horizontal plane is usually uniform circular motion.

(ii) Remember that equations of motion are not applicable for circular motion.

◈ **Time period :**

(i) It is the time taken to complete one complete revolution.

(ii) In one revolution, angle subtended is 2π and if T is time period, then the angular velocity is given by

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

◈ **Frequency :**

(i) Frequency is defined as the no. of revolutions per second.

i.e. $\boxed{n = \frac{1}{T} = \frac{\omega}{2\pi}}$

DO YOU KNOW?

If on X-axis	& on Y-axis	then Slope	Formula	
Time	Displacement	Velocity	$\vec{v} = \frac{d\vec{s}}{dt}$	$\vec{v}_{av} = \frac{\vec{s}_f - \vec{s}_i}{\text{time}}$
Time	Velocity	Acceleration	$\vec{a} = \frac{d\vec{v}}{dt}$	$\vec{a}_{av} = \frac{\vec{v}_f - \vec{v}_i}{\text{time}}$
Time	Momentum	Force	$\vec{F} = \frac{d\vec{p}}{dt}$	$P_{av} = \frac{W}{\text{time}}$
Time	Energy	Power	$P = \frac{dW}{dt}$	$\vec{\tau}_{av} = \frac{\vec{J}_f - \vec{J}_i}{\text{time}}$

SOLVED PROBLEMS

Ex.1 An object has moved through a distance. Can it have zero displacement ? If yes, support you answer with an example.

Sol. Yes, an object which has moved through a distance can have zero displacement.

Example : When a person, walking along a circular path, returns back to the starting point, after completing a circle, his displacement is zero. But he covers a distance $2\pi r$ where 'r' is the radius of circular path.

The displacement is zero, as the shortest distance between the initial and final position of the person is zero.

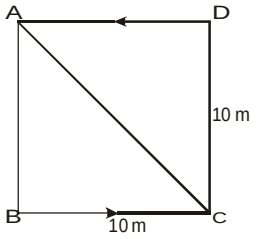
Ex.2 A farmer moves along the boundary of a square field of side 10 m in 40 s. What will be the magnitude of displacement of the farmer at the end of 2 minutes 20 seconds ?

Sol. The perimeter square field ABCD = 4 × 10m = 40 m.

Time for moving around the 10 m square field once = 40 s.

Time for journey of farmer = 2 min and 20 s = 140 s.

Number of times the farmer moves around the square field = $\frac{140}{40} = 3.5$ times.



For going once around the square field, the displacement = 0

For going thrice around the square field, the displacement = 0

For going $\frac{1}{2}$ times the square field, the distance covered = 40 m × $\frac{1}{2}$ = 20 m.

It is obvious from the figure, that if the farmer starts from pt A, then he will cover 10 m along AB and then10 m along BC.

Therefore displacement of farmer from the point A to point C is

$$AC = \sqrt{(AB)^2 + (BC)^2} = \sqrt{(10)^2 + (10)^2} = 14.14 \text{ m}$$

Ex.3 Which of the following is true for displacement ?

(a) It cannot be zero.

(b) Its magnitude is greater than the distance travelled by the object.

Sol. None of the statement (a) or (b) is true for displacement.

Ex.4 Distinguish between speed and velocity.

Sol. (i) Speed is the rate of change of motion but velocity is the rate of change of motion in a specified direction.

(ii) Speed is a scalar quantity, but velocity is a vector quantity.

Ex.5 Under what condition is the magnitude of average velocity of an object equal to its average speed?

Sol. The magnitude of average velocity of an object is equal to its average speed when the velocity of an object changes at uniform rate, i.e., the body is in uniformly accelerated motion. If a body is moving with uniform acceleration.

Initial velocity = u, Final velocity = v, Average speed = Average velocity = $\frac{u+v}{2}$.

SPEED

Speed of a body is the distance travelled by the body per unit time. or The rate of change of motion is called speed.

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

If a body covers a distance S in time t then speed,

$$\boxed{v = \frac{S}{t}}$$

Ex.6 What does speedometer of an automobile measure ?

Sol. The speedometer measures the instantaneous speed of the automobile at some particular time.

Ex.7 What does the path of an object look like when it is in uniform motion ?

Sol. The path of an object will be a straight line.

Ex.8 During an experiment, a signal from a spaceship reached the ground station in five minutes. What was the distance of the spaceship from the ground station ? The signal travels at the speed of light, that is 3×10^8 ms^{-1}.

Sol. Speed of signal = 3×10^8 ms^{-1}

Time in which signal reaches ground = 5 min = $5 \times 60 = 300$ s

Distance of spaceship from the ground level = speed × time = $3 \times 10^8 \times 300 = 9 \times 10^{10}$ m

Ex.9 When will you say a body is in

(i) Uniform acceleration.

(ii) Non uniform acceleration ?

Sol. (i) A body is in uniform acceleration when equal changes in velocity take place in equal intervals of time,however small these intervals may be.

(ii) A body is said to be possessing non-uniform acceleration when unequal changes in velocity take place in equal intervals of time, however small these intervals may be.

Ex.10 A bus decreases its speed from 80 km h^{-1} to 60 km h^{-1} in 5 s. Find the acceleration of the bus.

Sol. Given t = 5 s

Initial speed of bus

$$u = 80 \text{ km h}^{-1} = 80 \times \frac{5}{18} = 22.2 \text{ ms}^{-1}$$

Final speed of the bus

$$v = 60 \text{ km h}^{-1} = 60 \times \frac{5}{18} = 16.7 \text{ ms}^{-1}$$

Now acceleration is given by the relation

$$a = \frac{v - u}{t} = \frac{16.7 - 22.2}{5} = -1.1 \text{ ms}^{-1}$$

Ex.11 A train starting from a railway station and moving with uniform acceleration attains a speed 40 kmh^{-1} in 10 minutes. Find its acceleration.

Sol. Given t = 10 min = $10 \times 60 = 600$ s

Initial speed of train, u = 0 ms^{-1}

Final speed of train

$$v = 40 \text{ km h}^{-1} = 40 \times \frac{5}{18} = 11.1 \text{ ms}^{-1}$$

Now acceleration is given by the relation

$$a = \frac{v - u}{t} = \frac{11.1 - 0}{600} = 0.0185 \text{ ms}^{-1}$$

Ex.12 What is the nature of the distance time graphs for uniform and non-uniform motion of an object ?

Sol. The distance time-graph for uniform motion is a straight line not parallel to the time axis. The distance time-graph for non-uniform motion is not a straight line. It can be a curve or a zigzag line not parallel to time axis.

Ex.13 What can you say about the motion of an object whose distance time-graph is a straight line parallel to the time axis ?

Sol. The object is stationary.

Ex.14 What can you say about the motion of an object if its speed-time graph is a straight line parallel to the time axis ?

Sol. The object has uniform speed.

Ex.15 What is the quantity which is measured by the area occupied below the velocity-time graph ?

Sol. Displacement is the quantity which is measured by the area under velocity time graph.

Ex.16 A bus starting from rest moves with a uniform acceleration of 0.1 ms^{-2} for 2 minutes. Find
(a) the speed acquired. (b) the distance travelled.

Sol. Given

Initial speed of bus, u = 0 ms^{-1}

Final speed of bus, v = ?

a = 0.1 ms^{-2}, t = 2 min = 120 s

S = ?

(i) We know, v = u + at

or v = 0 + 0.1 × 120 = 12 ms^{-1}

(ii) $S = ut + \frac{1}{2}at^2$

$S = 0 \times 120 + \frac{1}{2} \times 0.1 \times (120)^2 = 720$ m

Therefore

Final speed acquired = 12 ms^{-1}

Distance travelled = 720 m

Ex.17 A train is travelling at a speed of 90 kmh^{-1}. Brakes are applied so as to produce a uniform acceleration of – 0.5 ms^{-2}. Find how far the train will go before it is brought to rest.

Sol. Given

Initial speed of train,

$u = 90 \text{ km h}^{-1} = 90 \times \frac{5}{18} = 25 \text{ ms}^{-1}$

Final speed, v = 0 ms^{-1}

Acceleration a = – 0.5 ms^{-2}

Distance covered, S = ?

Using the relation $v^2 - u^2 = 2aS$, we have

$$S + \frac{v^2 - u^2}{2a} = \frac{0 - (25)^2}{2 \times (-0.5)} = 625 \text{ m}$$

Ex.18 A trolley, while going down an inclined plane, has an acceleration of 2 cms^{-2}. What will be its velocity 3 s after the start ?

Sol. Given

Initial velocity, u = 0

Final velocity, v = ?

Time, t = 3 s

Acceleration, a = 2 cms^{-2}

We know that v = u + at

Or v = 0 + 2 × 3 = 6 cms^{-1}

Therefore, final velocity = 6 cms^{-1}.

Ex.19 A racing car has uniform acceleration of 4 ms^{-2}. What distance will it cover in 10 s after start.

Sol. Given

Initial velocity, u = 0

Acceleration, a = 4 ms^{-2}

Time, t = 10 s

Distance covered, S = ?

We know ; $S = ut + \frac{1}{2}at^2$

$S = 0 \times 10 + \frac{1}{2} \times 4 \times (10)^2$

= 0 + 200 = 200 m

Therefore, distance covered = 200 m.

Ex.20 A stone is thrown in a vertically upward direction with a velocity of 5 ms^{-1}. If the acceleration of the stone during its motion is 10 ms^{-2} in the downward direction, what will be the height attained by the stone and how much time will it take to reach there ?

Sol. Given

Initial velocity, u = 5 ms^{-1}

Final velocity, v= 0

Acceleration in the downward direction = 10 ms^{-2}

Therefore acceleration in the upward direction

a = – 10 ms^{-2}

Height attained by stone, S = ?

Time taken to attain height, t = ?

(i) Using the relation ; v = u + at

0 = 5 + (– 10) t or

t = 5/10 = 0.5 s

(ii) Using the relation ; $v^2 - u^2 = 2aS$, we have

$$S = \frac{v^2 - u^2}{2a} = \frac{(0)^2 - (5)^2}{2 \times (-10)} = 1.25 \text{ m}$$

Ex.21 An artificial satellite is moving in a circular oribit of radius 42250 km. Calculate its speed if it takes 24 hours to revolve around the earth.

Sol. R = 42250 km.

t = 24 hrs.

v = ?

$$V = \frac{2\pi r}{t} = \frac{2\pi \times 42250}{24}$$

v = 3.07 km/sec.

NCERT QUESTIONS WITH SOLUTIONS

Q.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?

Ans. Given

Diameter of circular track, 2r =200 m

Circumference of circular track = $2\pi r$

$s = \pi(2r) = \frac{22}{7} \times 200 = \frac{4400}{7}$ m

Time for completing one round = 40 s.

Time for which the athlete ran =2 min and 20 s = 140s

$s = \frac{4400}{7}$ m $\therefore$ Distance covered in 1s = $\frac{4400}{7 \times 40}$ m

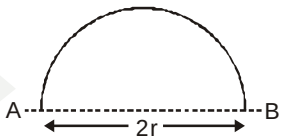
(i) Therefore, distance covered by athlete in 140s = $\frac{4400}{7} \times \frac{140}{40} = 2200$m

(ii) As the athlete returns to the initial point in 40s, his displacement = 0

Now,

Number of rounds in 40 seconds = 1

Hence number of rounds in 140s is = $\frac{140}{40} = 3\frac{1}{2}$.



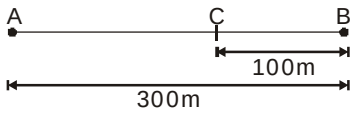
For each complete round the displacement is zero. Therefore for 3 complete rounds, the displacement will be zero.

The final displacement will be due to half the round (i.e. semicircle).

Thus, his displacement = diameter of circular track = 200 m.

Q.2 Joseph jogs from one end A to the other end B of a straight 300 m road in 2 minutes 50 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?

Ans. The required figure is as shown



(a) Distance covered = 300m

Time taken = 2 min and 50s = 170 s

Now average speed from A to B is given by

$V_{av} = \frac{\text{distance covered}}{\text{time}} = \frac{300}{170} = 1.76 ms^{-1}$

Now average velocity from A to B is given by

$V_{av} = \frac{\text{displacement}}{\text{time}} = \frac{300}{170} = 1.76 ms^{-1}$

(b) When Joseph turns around from B to C towards west, then

Distance covered = 300 + 100 = 400 m

Time taken = 170 + 60 = 230s

Therefore, average speed from A to C is

$$V_{av} = \frac{\text{distance covered}}{\text{time}} = \frac{400}{230} = 1.74\ ms^{-1}$$

Now displacement from A to C = 200m

Therefore, average velocity from A to C is

$$V_{av} = \frac{\text{displacement}}{\text{time}} = \frac{200}{230} = 0.869\ ms^{-1}$$

Q.3 Abdul 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 40 km h^{-1}. What is the average speed for Abdul's trip?

Ans. Let one way distance for his trip be s.

Let t_1 be the time for his trip from home to school and t_2 be the time for his return trip.

Then $t_1 = \frac{S}{v_1} = \frac{S}{20}h$, and $t_2 = \frac{S}{v_2} = \frac{S}{40}h$

Therefore, total time of trip is

$$T = t_1 + t_2 = \frac{S}{20} + \frac{S}{40} = \frac{3S}{40}h$$

Total distance covered = 2S

Therefore, average speed of Abdul

$$V_{av} = \frac{\text{total distance}}{\text{total time}} = \frac{2S \times 40}{3S} = 26.6\ kmh^{-1}$$

Q.4 A motorboat starting from rest on a lake accelerates in a straight line at a constant rate or 3.0 ms^{-2} for 8.0 s. Hew far does the boat travel during this time?

Ans. Given, initial velocity of boat, u = 0

Acceleration, a = 3.0 m s^{-2}

Time, t = 8s

Distance covered, s = ?

Using the relation $s = ut + \frac{1}{2}at^2$ we have,

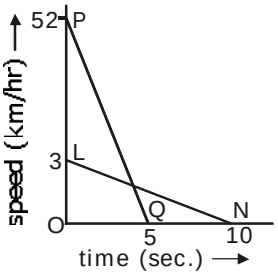
$s = 0 \times 8 + \frac{1}{2} \times 3 \times 8^2 = 96m.$

Q.5 The driver of a car travelling at 52 km h^{-1} applies the brakes and accelerates uniformly in the opposite direction. The car stops in 5s. Another driver going at 3 kmh^{-1} in another car applies his brakes slowly and stops in 10s. On the same graph paper, plot the speed versus time graphs for the two cars. Which of the two cars travelled father after the brakes were applied?

Ans. The speed time graph of both the cars are shown below.

(i) Distance covered by car moving at 52 kmh^{-1} (or $52 \times \frac{5}{18} = 14.4\ ms^{-1}$)

= area of $\triangle PQR = \frac{1}{2} \times PO \times OQ = \frac{1}{2} \times 14.4 \times 5 = 36$ m



(ii) Distance covered by car moving at 3 kmh^{-1} (or $3 \times \frac{5}{18} = 0.83\ ms^{-1}$)

= area of $\triangle PLN = \frac{1}{2} \times LO \times ON = \frac{1}{2} \times 0.83 \times 10 = 4.15$ m

$\therefore$ The car moving at 52 km h^{-1} travels more distance on the application of brakes.

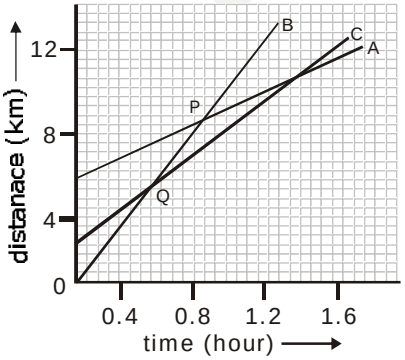
Q.6 Figure below shows the distance-time graph of three objects A, Band C. Study the graph and answer the following questions:

(a) Which of the three is travelling the. fastest?

(b) Are all three ever at the same point on the road?

(c) How far has C travelled when B passes A ?

(d) How far has B travelled by the time it passes C ?



Ans. (a) Car B is travelling the fastest, because its slope is largest among the three.

(b) No, they are never at the same point because aU the graphs of A, Band C do not intersect at one point.

(c) When car B passes car A at point P, the distance covered by car C = 8 – 2 = 6 km. (approx.)

(d) Car B and C pass each other at point Q. The distance travelled by B at that point is nearly 5.7 km.

Q.7 A ball is gently dropped from a height of 20 m. If its velocity Increases uniformly at the rate of 10 ms^{-2}, with what velocity will it strike the ground? After what time will it strike the ground? .

Ans. Given, initial velocity of ball, u = 0

Final velocity of ball, v = ?

Distance through which the ball falls, s = 20 m

Acceleration a = 10 ms^{-2}

Time of fall, t = ?

We know

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

or $v^2 - 0 = 2 \times 10 \times 20 = 400$ or $v = 20\ ms^{-1}$

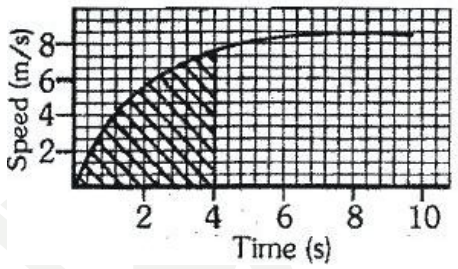
Now using v = u + at we have

$20 = 0 + 10 \times t$ or t = 2s

Q.8 The speed-time graph for a car is shown in figure below.

(a) Shade the area on the graph that represents the distance travelled by the car during the first 4 seconds.

(b) Which part of the graph represents uniform motion of the car?



Ans. (a) During first 4 seconds, car is moving with nonuniform acceleration. Area of shaded portion represents distance travelled.

(b) The straight line portion of the graph represents uniform motion of the car.

Q.9 State which of the following situations are possible and give an example for each of these;

(a) An object with a constant acceleration but with zero velocity.

(b) An object moving in a certain direction with acceleration in the perpendicular direction.

Ans. (a) A body with a constant acceleration but with zero velocity is possible. For example, when a body is just released, its initial velocity u = 0, but acceleration g = 10 ms^{-2}.

(b) It is possible. When a stone, tied to a string, is whirled in a circular path, the acceleration acting on it is always at right angle to the direction of motion of stone.

Q.10 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.

Ans. Distance covered by the satellite in 24 hours

$S = 2\pi r$

$$= 2 \times \frac{22}{7} \times 42250 = 265571.43 km$$

Therefore speed of satellite

$$v = \frac{\text{distance travelled}}{\text{time taken}} = \frac{265571.43}{24 \times 60 \times 60} = 3.07 kms^{-1}$$

EXERCISE – I BOARD PROBLEMS

Q.1 Distinguish between speed and velocity.

Q.2 What does the path of an object look like when it is in uniform motion?

Q.3 Under what condition will the displacement and distance have the same magnitude?

Q.4 A boy hits a football high up into the air. He runs and catches the foot ball before it hits the ground. Which of the two, the boy or the football has had greater displacement?

Q.5 Can the speed of a body be negative?

Q.6 What is the average velocity of particle when it returns to the starting point ? Can its average speed by zero?

Q.7 A car manufacturer advertises that the brakes are so perfect that the car stops instantaneous. Comment.

Q.8 Give an example of a body which covers a certain distance, but its displacement is zero?

Q.9 Can the displacement of a particle be zero when the distance travelled is not zero?

Q.10 What is the relation between distance and time

(i) when body is moving with uniform speed?

(ii) when body is moving with variable speed?

Q.11 Draw velocity-time graphs for the following situations :

(i) When body is moving with uniform velocity.

(ii) When body is moving with variable velocity, but uniform acceleration

(iii) When body is moving with variable velocity, but uniform retardation

(iv) When body is moving with variable velocity and variable acceleration

Q.12 Distinguish between terms distance and displacement.

Q.13 Mention some uses of velocity time graphs.

Q.14 A train starting from a railway station and moving with uniform acceleration attains a speed 40 km h^{-1} in 10 minutes. Find its acceleration.

Q.15 A bus starting from rest moves with a uniform acceleration of 0.1 ms–2 for 2 minutes. Find (a) the speed acquired,

(b) the distance travelled.

Q.16 A driver of a car travelling at 52 kmh^{-1} applies the brakes and accelerates uniformly in the opposite direction. The car stops in 5s. Another driving going at 3 kmh^{-1} in another car applies his brakes slowly and stops in 10s. On the same graph paper, plot the speed versus time graphs for the two cars. Which the two cars travelled farther after the brakes were applied.

Q.17 A train is travelling at a speed of 90 kmh^{-1}. Brakes are applied so as to produce a uniform acceleration of – 0.5 ms^{-2}. Find how far the train will go before it is brought to rest.

Q.18 An athlete completes one round of a circular track of diameter 200m in 40s. What will be the distance covered and the displacement at the end of 2 minutes 20 s?

Q.19 An aeroplane lands at 216 kmh^{-1} and stops after covering a runway of 2km. Calculate the acceleration and the time, in which it comes to rest.

Q.20 A truck running at 90 kmh^{-1} is brought to rest over a distance of 25m. Calculate the retardation and time for which brakes are applied.

Q.21 A motor bike running to 90 kmh^{-1}, is slowed down to 54 kmh^{-1} by the application of brakes, over a distance of 40m. If the brakes are applied with the same force, calculate (i) total time in which bike comes to rest (ii) total distance travelled by bike.

Q.22 A person travels a distance of 5 m towards east, then 4 m towards north and then 2 m towards west.

(i) Calculate the total distance travelled.

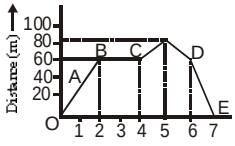
(ii) Calculate the resultant displacement.

Q.23 A body is moving in a straight line. Its distances from origin are shown with time in Fig. A, B, C, D and E represent different parts of its motion. Find the following :

(i)Displacement of the body in first 2 seconds.

(ii) Total distance travelled in 7 seconds.

(iii) Displacement in 7 seconds



Distance-time graph

Q.24 The distance between two points A and B is 100 m. A person moves from A to B with a speed of 20 m/s and from B to A with a speed of 25 m/s. Calculate average speed and average velocity.

Q.25 A car moves with a speed of 40 km/hr for first hour, then with a speed of 60 km/hr for next half hour and finally with a speed of 30 km/hr for next $1\frac{1}{2}$ hours. Calculate the average speed of the car.

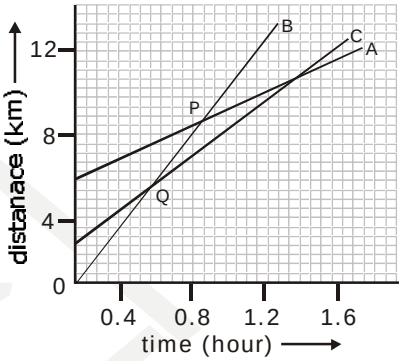
Q.26 Figure below shows the distance-time graph of three objects A, Band C. Study the graph and answer the following questions:

(a) Which of the three is travelling the. fast-est?

(b) Are all three ever at the same point on the road?

(c) How far has C travelled when B passes A ?

(d) How far has B travelled by the time it passes C ?



Q.27 A bus starting from rest moves with a uniform acceleration of 0.1 ms^{-2} for 2 minutes. Find

(a) the speed acquired.

(b) the distance travelled.

Q.28 A train starting from a railway station and moving with uniform acceleration attains a speed 40 kmh^{-1} in 10 minutes. Find its acceleration.

Q.29 From the top of a tower of height 490 m, a shell is fired horizontally with a velocity 100 m/s. At what distance from the bottom of the tower, the shell will hit the ground ?

Q.30 The brakes applied to a car produce a negative acceleration of 6 m/s^2. If the car takes 2 seconds to stop after applying the brakes, calculate the distance it travels during this time.

Q.31 Starting from rest, Deepak paddles his bicycle to attain a velocity of 6 m/s in 30 seconds then he applies brakes so that the velocity of the bicycle comes down to

4 m/s in the next 5 seconds. Calculate the acceleration of the bicycle in both the cases.

Q.32 A body starts moving with an initial velocity 50 m/s and acceleration 20 m/s^2. How much distance it will cover in 4s ? Also, calculate its average speed during this time interval.

Q.33 A body is moving with a speed of 20 m/s. When certain force is applied, an acceleration of 4 m/s^2 is produced. After how much time its velocity will be 80 m/s ?

Q.34 A body starts from rest and moves with a constant acceleration. It travels a distance s_1 in first 10 s, and a distance s_2 in next 10 s. Find the relation between s_2 and s_1.

Q.35 A train is moving with a velocity 400 m/s. With the application of brakes a retardation of 10 m/s^2 is produced. Calculate the following :

(i) After how much time it will stop ?

(ii) How much distance will it travel before it stops?

Q.36 A body is thrown vertically upwards with an initial velocity of 19.6 m/s. If g = –9.8 m/s^2. Calculate the following :

(i) The maximum height attained by the body.

(ii) After how much time will it come back to the ground ?

EXERCISE – II OLYMPIAD QUESTIONS

Q.1 A body goes from A to B with a velocity of 20 m/s and comes back B to A with a velocity of 30 m/s. The average velocity of the body during the whole journey is
(A) zero (C) 25 m/s
(B) 24 m/s (D) none of these

Q.2 If an object covering distances in direct proportion to the square of the time lapsed, then the acceleration is
(A) increasing (B) decreasing
(C) constant (D) none of these

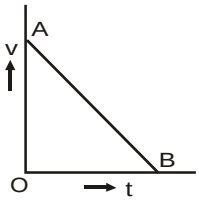
Q.3 Distance travelled by a freely falling body is proportional to :-
(A) mass of the body
(B) square of the acceleration due to gravity
(C) square of the time of fall
(D) time of fall

Q.4 The rate of change of displacement with time is :-
(A) speed (B) acceleration
(C) retardation (D) velocity

Q.5 Which of the following is not vector quantity?
(A) Retardation
(B) Acceleration due to gravity
(C) Average speed
(D) Displacement

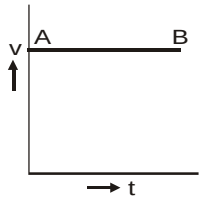
Q.6 If the time-displacement graph of a particle is parallel to the time-axis, then velocity of the particle is :-
(A) infinity
(B) unity
(C) equal to acceleration of the body
(D) zero

Q.7 In the velocity-time graph, AB shows that the body has :-



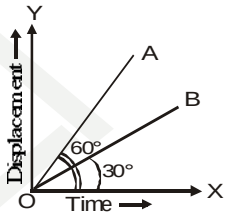
(A) uniform acceleration
(B) non-uniform retardation
(C) uniform speed
(D) initial velocity OA and is moving with uniform retardation

Q.8 In the given velocity-time graph, AB shows that the body has



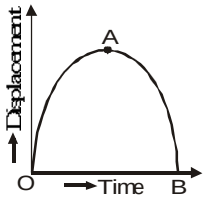
(A) uniform acceleration
(B) uniform retardation
(C) uniform velocity throughout its motion and has zero initial velocity
(D) none of these

Q.9 If the displacement-time graph for the two particles A and B are straight lines inclined at angles of 30° and 60° with the time axis, then ratio of the velocities v_A: v_B will be



(A) 1 : 2 (B) 1 : 3
(C) $\sqrt{3}$: 1 (D) 3: 1

Q.10 In the given figure, velocity of the body at A is



(A) zero (B) unity
(C) maximum (D) infinite

Q.11 The velocity-time graph for a body with nonuniform motion is a
(A) curved line
(B) straight line parallel to x-axis
(C) straight line parallel to y-axis
(D) none of these

Q.12 Area under a velocity-time graph gives
(A) time taken by a moving object
(B) distance travelled by a moving object
(C) acceleration of moving object
(D) retardation of a moving object

Q.13 If a body is thrown up with an initial velocity u and covers a maximum height of h, then h is equal to :-
(A) $\frac{u^2}{2g}$ (B) $\frac{u}{2g}$
(C) $2u^2g$ (D) None of these

Q.14 A body is thrown vertically upwards and rises to a height of 10m. The velocity with which the body was thrown upwards is ($g = 9.8\ m/s^2$)
(A) 16 m/s (B) 15 m/s
(C) 14 m/s (D) 12 m/s

Q.15 A truck running along a straight line increases its speed uniformly from 30 m/s to 60 m/s over a time interval 1 min. The distance travelled during this time interval is
(A) 900 m (B) 1800 m
(C) 2700 m (D) 3600m

Q.16 A car travels $\frac{1}{3}$rd distance on a straight road with a velocity of 10 km/hr, next $\frac{1}{3}$rd with velocity 20 km/hr and the last $\frac{1}{3}$rd with velocity 60 km/hr. What is the average velocity of the car in the whole journey?
(A) 4 km/hr (B) 6 km/hr
(C) 12 km/hr (D) 18 km/hr

Q.17 A motor ship covers the distance of 300 km between two localities on a river in 10 hrs downstream and in 12 hrs upstream. Find the flow velocity of the river assuming that these velocities are constant.
(A) 2.0 km/hr (B) 2.5 km/hr
(C) 3 km/hr (D) 3.5 km/hr

Q.18 Driver of a train travelling at 115 km/hr sees on a same track, 100m infront of him, a slow train travelling in the same direction at 25 km/hr. The least retardation that must be applied to faster train to avoid a collision is
(A) 3.125 m/s^2 (B) 3.5 m/s^2
(C) 2.75 m/s^2 (D) 3.0 m/s^2

Q.19 Distance of the moon from the earth is 4×10^8 m. The time taken by a radar signal transmitted from the earth to reach the moon is
(A) 5.2 s (B) 1.3 s
(C) 2.6 s (D) 0.70 s

Q.20 A stone is dropped into a well in which the level of water is h, below the top of the well. If v is velocity of sound, then time T after which the splash is heard is equal to
(A) $\frac{2h}{v}$ (B) $\sqrt{\frac{2h}{v}} + \frac{h}{g}$
(C) $\sqrt{\frac{2h}{g}} + \frac{h}{v}$ (D) $\sqrt{\frac{h}{2g}} + \frac{2h}{v}$

Q.21 A stone weighing 3 kg falls from the top of a tower 100 m high and buries itself 2 m deep in the sand. The time of penetration is :-
(A) 0.09 sec (B) 0.9 sec
(C) 2.1 sec (D) 1.3 sec

Q.22 The velocity of a body at any instant is 10 m/s. After 5 sec, velocity of the particle is 20 m/s. The velocity at 3 seconds before is
(A) 8 m/sec (B) 4 m/sec
(C) 6 m/sec (D) 7 m/sec

Q.23 A body covers 200 cm in the first 2 sec.and 220 cm in next 4 sec. What is the velocity of the body at the' end of 7th second?
(A) 40 cm/sec (B) 20 cm/sec
(C) 10 cm/sec (D) 5 cm/sec

Q.24 If two bodies of different masses m_1 and m_2 are dropped from different heights h_1 and h_2, then ratio of the times taken by the two to drop through these distances is :-
(A) $h_1 : h_2$ (B) h_2/h_1
(C) $\sqrt{h_1} : \sqrt{h_2}$ (D) $h_1^2 : h_2^2$

Q.25 Name the instrument used to measure instantaneous speed of a vehicle:
(A) Accelerator (B) Speedometer
(C) Ammeter (D) Multicenter

Q.26 A ball is dropped on the floor from a height of 10 m. It rebounds to a height of 2.5 m. If the ball is in contact with the floor for 0.01 sec, then average acceleration during contact is :-
(A) 2100 m/s^2 (B) 1400 m/s^2
(C) 700 m/s^2 (D) 400 m/s^2

Q.27 A stone is thrown vertically upward with an initial velocity u from the top of a tower, reaches the ground with a velocity 3u. The height of the tower is :-

(A) $\frac{3u^2}{g}$ (B) $\frac{4u^2}{g}$

(C) $\frac{6u^2}{g}$ (D) $\frac{9u^2}{g}$

Q.28 If a ball is thrown up with a certain velocity. It attains a height of 40 m and comes back to the thrower, then :-

(A) total distance covered by it is 40 m
(B) total displacement covered by it is 80 m
(C) total displacement is zero
(D) total distance covered by it is zero

Q.29 Acceleration of a body projected upwards with a certain velocity is

(A) 9.8 m/s^2 (B) – 9.8 m/s^2
(C) zero (D) insufficient data

Q.30 If a body of mass 0.10 kg is moving on circular path of diameter 1.0 m at the rate of 10 revolutions per 31.4 sec, then centripetal force acting on the body (n = 3.14) is

(A) 0.2 Newton (B) 2.0 Newton
(C) 0.02 Newton (D) 20.0 Newton

Q.31 The earth's radius is 6400 km. It makes one revolution about its own axis in 24 hrs. The centripetal acceleration of a point on its equator is nearly

(A) 340 cm/s^2 (B) 34 cm/s^2
(C) 3.4 cm/s^2 (D) 0.34 cm/s^2

Q.32 The acceleration of a point on the rim of flywheel 1 m in diameter, if it makes 1200 revolutions per minute is

(A) $8\pi^2$ m/s^2 (B) 80 π^2 m/s^2
(C) 800 π^2 m/s^2 (D) none of these

Q.33 A phonograph record on turn table rotates at 30 rpm. The linear speed of a point on the record at the needle at the beginning of the recording when it is at a distance of 14 cm from the centre is

(A) 22 cm/sec (B) 44 cm/sec
(C) 48 cm/sec (D) 52 cm/sec

Q.34 The relationship between average speed, time and distance is

(A) Average speed = distance × time
(B) Average speed = $\frac{\text{total distance}}{\text{total time}}$
(C) Time = average speed/distance
(D) Distance = average speed × time

Q.35 A body moving along a circular path has
(A) constant speed
(B) constant velocity
(C) no radial acceleration
(D) no tangential velocity

Q.36 A rubber ball dropped from a certain height is an example of
(A) uniform acceleration
(B) uniform retardation
(C) uniform speed
(D) non-uniform speed

Q.37 If the velocity of a body does not change, its acceleration is
(A) zero (B) infinite
(C) unity (D) none of these

Q.38 When the distance an object travels is directly proportional to the length of time, it is said to travel with
(A) zero velocity
(B) constant speed
(C) constant acceleration
(D) uniform velocity

Q.39 A body moves on three quarters of a circle of radius r. The displacement and distance travelled by it are:-
(A) displacement = r, distance = 3r
(B) displacement $\sqrt{2}r$, distance = $\frac{3\pi r}{2}$
(C) distance 2r, displacement = $\frac{3\pi r}{2}$
(D) displacement 0, distance = $\frac{3\pi r}{2}$

Q.40 For the motion on a straight line path with constant acceleration the ratio of the magnitude of the displacement to the distance covered is :-
(A) = 1 (B) ≥ 1
(C) ≤ 1 (D) < 1

Answers

1.	A	**2.**	C	**3.**	C	**4.**	D
5.	C	**6.**	D	**7.**	D	**8.**	D
9.	D	**10.**	A	**11.**	A	**12.**	B
13.	A	**14.**	C	**15.**	C	**16.**	D
17.	B	**18.**	A	**19.**	B	**20.**	C
21.	A	**22.**	B	**23.**	C	**24.**	C
25.	B	**26.**	A	**27.**	B	**28.**	C
29.	B	**30.**	A	**31.**	C	**32.**	C
33.	B	**34.**	B	**35.**	A	**36.**	D
37.	A	**38.**	B	**39.**	B	**40.**	A

MATTER IN OUR SURROUNDING

INTRODUCTION

All the substances around us have different shape, size and texture. Everything in universe is made up of matter. The air we breathe, the food we eat, the water we drink, the pen with which we write, the book we read, are made up of matter. In this chapter, we shall discuss the matter in our surroundings.

IMPORTANT TERMS AND CONCEPTS

1. **Material :–** The term used to describe a particular kind of matter, is called material e.g. – wood, water and marble.

Type of material :–

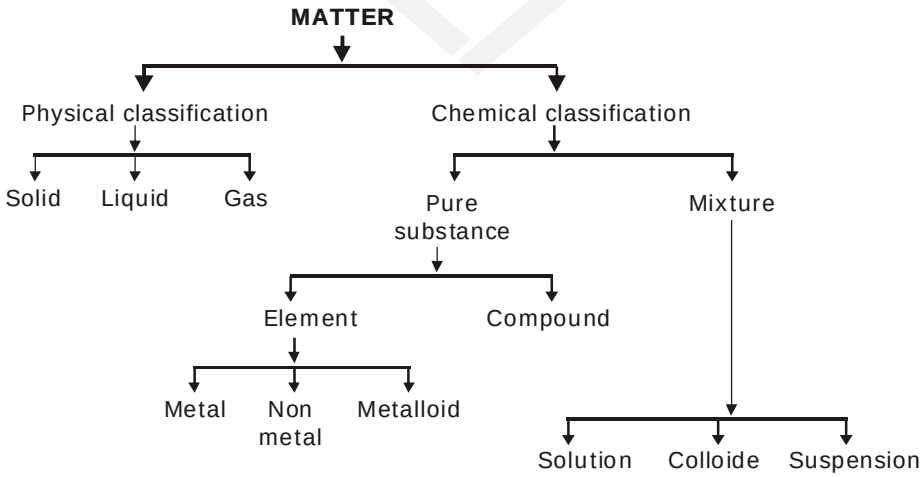
Homogeneous Material	Heterogeneous Material
Which has same composition and same properties is called. Homogeneous material.	Which has different composition and different properties in material different parts is, called heterogeneous material. For e.g.: In marble, presence of grey and red grains of other materials.

2. **Matter :** It is substance which occupies space and has mass. Air, Earth, Fire, Sky and water five basic element, "The Panch Tatva" according to the earlier Indian Philosophers. According to them everything i.e., living or non-living is made up of these five elements.

3. **Classification of Matter :** Nowadays scientists have classified matter in the following two ways :

(i) The physical classification based on physical properties of matter and

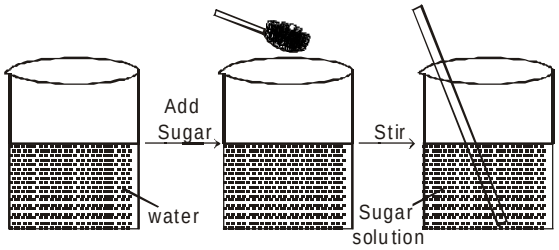
(ii) The chemical classification based on chemical composition of matter.



Classification of Matter

4. **Physical Nature of Matter :** Matter is made up small particles and there is space between particles of matter. It can be proved with the help of following experiment.

Experiment: To show that there is space between particles of matter.



Dissolution of sugar in water. In solution particles of sugar are present in the spaces between particles of water

Materials Required : 100 ml beaker, water, salt, glass rod.

Procedure :

Take a 100 ml beaker and fill it with water and mark the level of water.

Dissolve the given salt with the help of glass rod.

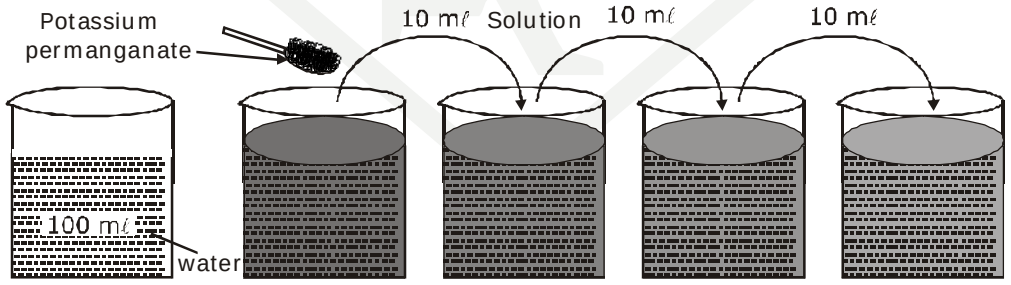
Observe the change in the water level and record your observations.

Observations : The salt gets dissolve in water. The particle of salt have entered the space between water molecules, therefore, the level of water does not change.

Conclusion : The salt consists of large number of small particle which occupy the space between molecules of water.

5. **Size of Particles of Matter :** The particles of matter are extremely small in size which cannot be seen even with powerful microscope. Their size can be observed with the help of following experiment.

Experiment : To show that matter is made up of very small particles.



Decrease in colour of potassium permanganate solution

Materials Required : Crystals of $KMnO_4$ (potassium permagnate), water, 3 separate beakers.

Procedure :

Take 2-3 crystals of $KMnO_4$ and dissolve them in 50ml of water in beaker 1.

Take 5 ml of solution from beaker 1 and put it into 50 ml of water in beaker 2 and observe the colour of solution.

Take 5ml of solution from beaker 2 and put it into 50 ml of water in beaker 3 and observe the colour of solution.

Observations : The colour of solution remains purple in all the beakers.

Conclusion : It shows that even 2-3 crystals of $KMnO_4$ consists of millions of small particle which dissolve in water giving purple colour to the solution.

6. Space between Particles of Matter : When we dissolve sugar, salt or KMnO4 in water, particles get evenly distributed in water. Similarly, when we prepare tea or coffee, the particles of one type of matter diffuse into space between particles of the other. This shows that there is enough space between particles of matter.

Swimming is possible because of space between water molecule.

7. Continuous movement of Particles :

Particles of matter are continuously moving, i.e., they possess kinetic energy which increases with increases in temperature.

Experiment : To show the particles of matter are continuously moving.

Materials Required : Incense stick or agarbati, match box.

Procedure :

Put an unlit incense stick in a corner of your class.

Go close to the incense stick to smell it.

Now light the incense stick. And try to get the smell from a distance.

Observations : The smell of unlit incense stick can be observed only by going close to it whereas the smell of lighted incense stick can be observed from a distance.

Conclusion : The particles of matter of continuously moving but the speed of particles is very slow. The speed of particles increase with the increase in temperature.

8. Diffusion : The process of intermixing of particles of two or more substance on their own is called diffusion. The rate of diffusion increases on heating that is why an incense stick gives smell only when we come close to it, but on lighting the stick we get smell even far away from it.

9. Attraction between Particles of Matter :

There is force of attraction between particles of matter. It can be explained with the help of following game in the field.

Make four groups and form human chains as follows.

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

The second group should hold hands to form human chain.

The third group should from a chain by touching each other with only their finger tips.

The fourth group should run around and try to break three human chains one by one into groups as small as possible.

Observations and Conclusions

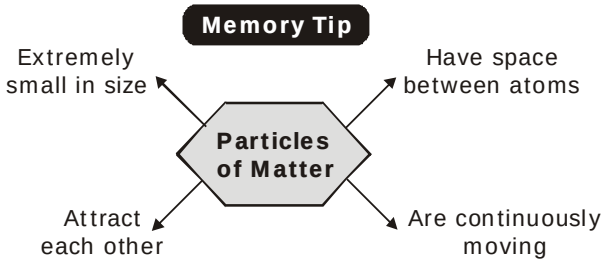
The third group is easily to break because of least force of attraction. It is similar to particles in gaseous state.

The first group is most difficult to break due to maximum force of attraction. It represents particles present in solid state.

The second group requires little force to break which shows it has force of attraction less than first group but more than third group. It represents particles in the liquid state.

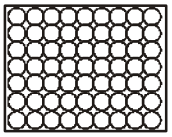
Even in solids, the force of attraction differs from one substance to another. There is maximum force of attraction between particles of iron nail, less in a piece of chalk and least in rubber band.

It is difficult to cut a stream of water with the help of fingers due to force of attraction between particle of liquids. Thus, there is force of attraction between particles of matter which keeps the particles together. The strength of forces varies in different kinds of matter.



10. Classification of Matter on the basis of Physical State : Matter can be classified into Solid, Liquid and Gas.

11. Properties of the Solid State :



Arrangement of particles in a solid

They have fixed shape.

They have fixed volume.

They are rigid an have fixed boundaries.

They are incompressible because intermolecular space is less.

They have high density as compared to other states of matter.

They have strong force of attraction between the particles.

The particles are closely packed in solid, therefore, there is less intermolecular space between the particles.

The kinetic energy of particles in solid is very less. They vibrate only at their mean position that is why solids have rigid shape.

Solid diffuse into solids to very less extent, e.g., it is difficult to rub a blackboard on which something is written in chalk without cleaning for 10-15 days.

12. Volume : The space occupied by a substance is called volume. Its SI unit is cubic metre (m^3). Its common unit is litre. (1L = $1dm^3$, 1L = 1000 ml, 1ml = $1cm^3$).

13. Density : The mass per unit volume of a substance is called density.

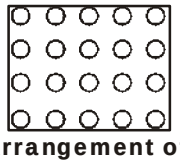
Density = mass/volume. The SI unit of density is km/m^3 where common unit is g/cm^3. (CGS unit)

Density is maximum in the solid state of a substance

14. Kinetic Energy : The energy possessed by particles by virtue of its motion is called kinetic energy.

Internal structure of rubber in like that of spring i.e. why it is stretchaber

15. Properties of the Liquid State :



Arrangement of molecule in a liquid

Liquids do not have fixed shape or boundaries.

They have fixed volume.

They can flow, i.e., they have fluidity.

They have low compressibility but more than solids.

They have lower density as compared to solids.

The intermolecular forces of attraction are weaker as compared to solids.

The intermolecular space is more than that of solids.

The particles in liquid state can move freely and hence have higher kinetic energy than solids but less than that of gases.

They shows the property of intermixing and thus they can diffuse. It can be shown by the following experiment.

Experiment : To compare the rate of diffusion of liquids having different densities.

Materials Required : Two beakers filled with water, blue ink, honey.

Procedure :

Take two beakers filled with water.

Add a drop of blue ink into first beaker slowly and honey in the second beaker.

Leave them undistributed at you home or in a corner in the class.

Record you observations.

Observations :

The blue ink diffuses into water and water become light blue in colour.

Honey diffuses very slowly into water, therefore, takes lots of time to diffuse evenly.

Conclusion : Liquids with higher density, diffuse slower than liquids having lower density.

Factor Affecting Rate of Diffusion :

(i) Density : The rate of diffusion depends upon density of liquids. Higher the density, lesser will be the rate of diffusion.

(ii) Temperature : The rate of diffusion depends upon temperature, i.e, the rate of diffusion increase with an increase in temperature which can be shown experimentally.

(iii) Physical State : Solids can diffuse into liquids slowly whereas liquids can diffuse into liquids faster and gases can also diffuse into liquids.

Experiment : To study the variation of rate of diffusion with temperature of solid in liquids.

Materials Required : Copper sulphate, two beakers, cold water and hot water.

Procedure :

Take 50ml of cold water in a beaker.

Take 50ml of hot water in another beaker.

Add a crystal of copper sulphate into the beaker containing 50ml of cold water.

Add a crystal of copper sulphate into the beaker containing 50ml of hot water.

Leave them undisturbed.

Record the observations.

Observations : The colour of solutio in first beaker becomes blue slowly whereas the colour becomes blue faster in second beaker.

Conclusion : The rate of diffusion increases with increase in temperature because kinetic energy of molecules increases.

16. Diffusion of Gases in Liquids : Gases can also diffuse in liquids. Oxygen and carbon dioxide get dissolved in water which is essential for growth of aquatic plants and animals.

17. Properties of Gaseous State :

Gases do not have fixed shape, i.e., they take the shape of container.

They do not have fixed volume, therefore no definite boundaries.

They can flow in all directions, hence gases also show fluidity.

They are highly compressible.

They have lower densities as compared to liquids and solids.

They have higher kinetic energy as compared to liquids and solids.

The rate of diffusion is fastest in gases.

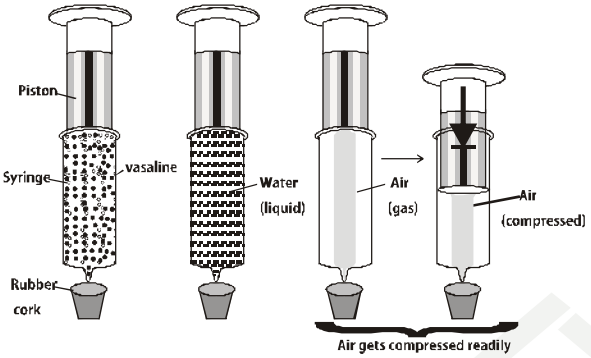
There is weak intermolecular force of attraction.

There is large intermolecular space, therefore, gases can be easily compressed.

Gases can be compressed more easily than liquids which can be shown by following experiment.

Experiment : To show that gases can be compressed more easily than liquids.

Material Required : Two 10ml syringes, rubber cork, vaseline.



Study the compressibility of solid, liquid and gas.

L.P.G is obtained by compresing petroleum gas into cylinder Its major constitual is butane C_4H_{10}.

Procedure :

Take two 10ml syringes and close their nozzle by inserting them in a rubber cork as shown in figure.

Remove the piston from both the syringes.

Allow the air to fill the space inside one syringe and fill water in the other.

Insert type pistons back into syringes.

Apply some vaseline on the piston fro smooth movement.

Now try to compress by pushing piston in the syringe.

Record your observations.

Observations : In case or air, piston is easily pushed in as compared to syringe filled with water.

Conclusion : The bases can be compressed more easily than liquids. It is because there are weak intermolecular forces of attraction between particles, so the distance between the particles in gaseous state is very large as compared to solids and liquids, e.g., CNG is compressed natural gas which is being used in vehicles. LPG is liquified petroleum gas which is used for cooking.

18. **Pressure** : It is defined as force exerted per unit area, e.g., gases exert pressure on the walls of the containing. The kinetic energy of the particles in gaseous state i maximum. The particles are in state of constant random motion therefore, they collide with themselves as well as with the walls of the container and exert pressure.

19. **Change of state :** The state of substance depends upon temperature and pressure, e.g., water exists as solid at 0ºC, as liquid at room temperature whereas in gaseous state at 100ºC. The state of matter will change with change in temperature which is shown by following experiment.

Change in State of Water

$$\underset{\text{Solid}}{\text{Ice}} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \underset{\text{(liquid)}}{\text{Water}} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \underset{\text{(gas)}}{\text{Steam}}$$

Experiment : To study the effect of temperature on solids and liquids.

Materials Required : Ice, thermometer, beaker.

Procedure :

Take about 50g of ice in a beaker and hang a laboratory thermometer in it so that bulb is in contact with ice.

Start heating the beaker at low flame.

Now down the temperature when ice starting melting.

Note the temperature when all the ice has converted into water.

Record your observations for conversion of solid into liquid state.

Now put a glass rod in the beaker and heat while constant stirring till the water starts boiling.

Keep a close look at the thermometer reading till most of the water has vapourised.

Record your observations for the conversion of ice into liquid water and then into vapour state.

Observations and Conclusion : When temperature of solid is increased, the kinetic energy of particles increases. Due to increase in kinetic energy, the particle starts vibrating at a greater speed and overcome intermolecular forces of attraction. A stage is reached when intermolecular forces become so less that it changes into liquid. When temperature is further increased, a state comes when liquid changes into vapour.

20. **Melting Point :** The temperature at which solid changes into liquid completely is called melting point. Melting point of solids gives indication of the strength of intermolecular forces of attraction. Higher the melting point, more will be intermolecular forces of attraction.

21. **Melting :** The process in which solid changes into liquid is called melting. It is also called fusion.

22. **Kelvin :** It is SI unit of temperature. $0^oC = 273.16$ K.
If we want to change K into ^oC, subtract 273.16 from the temperature given in Kelvin. For converting ^oC to Kelvin (K), add 273.16 (For convenience we take $0^oC = 273K$)

23. **Latent heat of fusion :** The amount of energy that is required to change 1kg of a solid into liquid at atmospheric pressure without any change of temperature at its melting point is called latent heat of fusion.

24. **Boiling Point :** The temperature at which a liquid changes into gas or vapour is known as boiling point. It also indicates strength of intermolecular force of attractions. Greater then intermolecular forces of attractions, higher will be the boiling point. The boiling point of water is 100^oC (373K).

25. **Boiling :** The process of converting liquid into vapour is called boiling. It is bulk phenomenon, i.e, particles from inside the liquid gain enough energy to change into vapour state. It takes place only at boiling point.

26. **Latent Heat of Vapourisation :** The amount of energy that is required to change 1kg of liquid into vapours at atmospheric pressure without any change in temperature at its boiling point is called latent heat of vapourisation.

27. **Gas :** It is stable state as compared to vapours, e.g., O_2, N_2, H_2, CO_2, etc.

28. **Vapour :** It is unstable state. On cooling, vapours change into liquid state. The work 'vapour' is used to describe those gases which usually exist as liquid at room temperature.

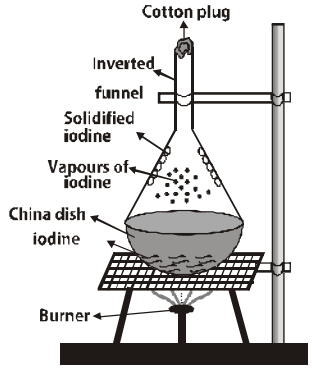
29. **Vapourisation :** It is process in which liquid changes into vapour. It is a surface phenomenon. It takes place at all temperatures. It is a slow process and its rate increase with increase in temperature.

30. **Volatile Liquids :** Those liquids which can change into vapours easily are called volatile liquids, e.g., petrol, alcohol, acetone, ether, etc. evaporate easily because they have low boiling points due to weak intermolecular forces of attraction. Water has high boiling point due to strong intermolecular forces of attraction.

31. **Sublimation :** It is a process in which solid directly changes into vapours without changing into liquid state, e.g., camphor, I_2, NH_4Cl, naphthalene can sublime. It can be shown experimentally.

Experiment : To show the process of sublimation experimentally.

Materials Required : Solid iodine, funnel, tripod stands, china dish, wire gauze, burner or spirit lamp, cotton.



Sublimation process

Procedure :

Take 2g of iodine in china dish.

Put an inverted funnel over it whose stem is closed by cotton plug and set the apparatus as shown in diagram.

Heat and china dish so that vapours are formed and record the observations.

The vapours of iodine get condensed on the walls of the funnel.

Observations : The violet coloured vapours of iodine get condensed and change into solid iodine.

Conclusion : Iodine can sublime and can be purified by sublimation.

32. **Effect of Pressure on Change in State :** When we apply pressure and compress the gas, intermolecular force of attraction increases and molecules come close to each other. It may be change into liquid depending upon temperature and nature of the gas.

33. **Liquidification of Gases :** Gases can be liquified at low temperature and high pressure, e.g., H_2, N_2 and O_2 can be liquified at low temperature at high pressure. NH_3 can be liquified at room temperature. CO_2 can be solidified at low temperature and high pressure. Solid CO_2 is also called dry ice.

Evaporation		Boiling (Vaporisation)	
1	It takes place spontaneously at all temperature.	1	It takes place at definite temperature i.e. at B.P.
2	It is a surface phenomenone.	2	It is a bulk phenomenone.
3	It always cause cooling.	3	No colling.

34. **Atmosphere (atm) :** It is unit of measuring pressure exerted by a gas. The pressure of air in atmosphere is called atmospheric pressure.

35. **Pascal (Pa) :** It is unit of measuring pressure exerted by a gas. The pressure of air in atmosphere is called atmospheric pressure.

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

The atmospheric pressure at seal level is 1 atmosphere and is taken as normal atmospheric pressure. As we go higher, atmospheric pressure decreases.

36. Evaporation : It is a process in which liquid changes into vapours e.g., water changes into vapours if left uncovered. Wet clothes dry up because water gets evaporated. The particles of water collide with each as well as with particles of gases in atmosphere. After some time, the particles on the surface gain sufficient energy so as to change into vapours. It is a surface phenomenon.

37. Factor Affecting evaporation :

(a) Surface area : Greater the surface area, more will be the rate of evaporation because it is a surface phenomenon. There will be more number of molecules on the surface which will change into vapour easily.

(b) Humidity : It is amount of water vapours present in air. The air around us cannot hold more than a definite amount of water vapours at a given temperature. If the amount of water in air is already of water is air is already high, the rate of evaporation decreases. Decrease in humidity leads to increase in rate of evaporation.

(c) Temperature : The rate of evaporation increases with increase in temperature because more number of particles gain enough kinetic energy to go to vapour state.

(d) Wind speed : The rate of evaporation increase with increase in wind speed because particles of water vapours are taken away decreasing the amount of water vapours in atmosphere.

38. Effect of Evaporation : Evoparation leads to cooling because high energy molecules leave the surface and average energy of remaining molecules decreases, which results in drop in temperature of the part of liquid that is left. Therefore, evaporation cause cooling.

Evaporation causes cooling:–

During evaporation, cooling is always caused. This is because evaporation is a phenomenon in which only the high energy particles leave the liquid surface. As a result, the particles having low energy are left behind. Therefore, the average molecular energy of the remaining particles left in the liquid state is lowered. As a result, there is decrease in temperature on the part of the liquid that is left. Thus evaporation causes cooling.

Example:– (i) When we pour some acetone on our palm, we feel cold. This is because the particles gain energy from our palm or surroundings and leave the palm feeling cool.

(ii) We sprinkle water on the root or open ground after a sunny hot day. This cools the roof or open ground. This is because the large latent heat of vaporization of water helps to cool the hot surface.

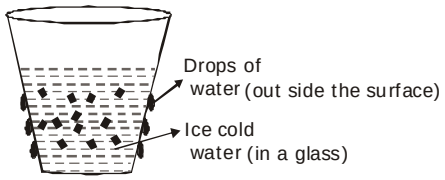
Some other examples of evaporation:–

(i) We should wear cotton clothes in hot summer days to keep cool and comfortable.

This can be explained as follows. We get a lot of sweat on our body in hot summer days. Cotton is a good absorber of water, so it absorbs the sweat from our body and exposes it to the air for evaporation. The evaporation of this sweat cools our body. The synthetic clothes (made of polyester etc) do not absorb much of sweat, so they fail to keep our body cool in summer.

(ii) We see water droplets on the outer surface of a glass containing ice-cold water.

Take some ice-cold water in a glass. Soon we will see water droplets on the outer surface of the glass. The water vapour 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 water droplets.



Droplets formed on the surface of the glass containing ice cold water

(iii) Water keeps cool in the earthen pot (matki) during summer:–

When the water oozes out of the pores of an earthen pot, during hot summer, it evaporates rapidly. As the cooling is caused by evaporation, therefore, the temperature of water within the pot falls and hence it becomes cool.

(iv) Rapid cooling of hot tea:–

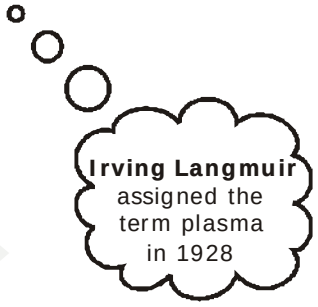
If tea is too hot to sip, we pour it in the saucer. In doing so, we increase the surface area and the rate of evaporation. This, in turn, causes cooling and the tea attains a desired temperature for sipping

(v) A wet handkerchief is placed on the fore head of a person suffering from high fever. The logic behind placing wet cloth is that as the water from the wet cloth evaporates, it takes heat from the skull and the brain within it. This, in turn, lowers the temperature of brain and protects it from any damage due to high temperature.

(vi) We often sprinkle water on the road in summer. The water evaporates rapidly from the hot surface of the road, there by taking heat away from it. Thus, the road becomes cool.

39. **Effect of Temperature on Clothes :** Cotton is good absorber of water, helps in absorption of sweat and exposing it to atmosphere for easy evaporation during summers. It causes cooling of our body.

40. **Plasma :** It is fourth state of matter. It consists of super energetic and super excited particles which are in the form of ionised gases. The fluorescent tube, neon sign bulbs consist of plasma. Inside the neon bulb, there is neon gas whereas inside the fluorescent tube, there is helium gas or some other gas. The gas gets ionised, i.e., gets charged when electrical energy flows through it. This charging up creates glowing plasma inside the tube or bulb. The plasma glows with a special colour depending upon the nature of the gas. The sun and stars glow because of presence of plasma in them. The plasma is created in stars due to very high temperature.



41. Bose-Einstein Condensate (B.E.C.) is fifth state of matter which is formed from matter that has been cooled to near absolute zero (–273ºC). When a group of atoms is cooled to a very low temperature, the velocity decreases because they have very low energies. This causes the individual atoms to overlap each other forming a single super atom with all of its constituting atoms sharing a single energy state.


Bose and A.Einstein

A rotating B.E.C. could be used as model black hole, allowing light to enter but not to escape. Condensate can also be used to 'free' pulses of light, to be released again when condensate break down. Research in this field is going on.

1. **Matter**

(i) Anything which occupies space and has mass is called matter.

(ii) Food, water, air, clothes, table, chair, plants and trees.

(iii) Indian philosophers said that all the matter living or non-living, was made up of five basic elements air, earth, fire, sky and water

(iv) On the basis of its physical properties and on the basis of its chemical properties.

(v) On the basis of chemical properties the matter is classified as **elements, compounds** and **mixtures**.

(vi) Everything around us is made of tiny pieces or particles. The particles make up matter are atoms or molecules.

❑ **Characteristics of particles of matter :**

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

(ii) The particles of matter have spaces between them

(iii) The particles of matter are constantly moving

(iv) The particles of matter attract each other

❑ **Classification of matter**

On the basis of physical states, all the matter can be classified into three groups.

1. Solids 2. liquids 3. Gases

❑ **Properties of solids**

(i) Solids have a fixed shape and a fixed volume

(ii) Solids cannot be compressed much.

(iii) Solids have high densities. They are heavy

(iv) Solids do not fill their container completely.

(iv Solids do not flow.

Ex. Ice, wood, coal, stone, iron, brick

❑ **Properties of liquid**

(i) Liquids have a fixed volume but they have no fixed shape. Liquids take the shape of the vessel in which they are placed.

(ii) Like solids, liquids cannot be compressed much.

(iii) Liquids have moderate to high densities. They are usually less dense than solids.

(iv) Liquids do not fill their container completely.

(v) Liquids generally flow easily.

Ex. Water, milk, fruit juice, ink, groundnut oil, kerosene etc.

❑ **Properties of gases**

(1) Gases have neither a fixed shape nor a fixed volume. Gases acquire the shape and volume of the vessel in which they are kept.

(2) Gases can be compressed easily.

(3) Gases have very low densities. They are very light.

(4) Gases fill their container completely.

(5) Gases flow easily.

Ex. Air, oxygen, hydrogen, nitrogen

❑ **Comparison of characteristic properties of solids, liquids and gases**

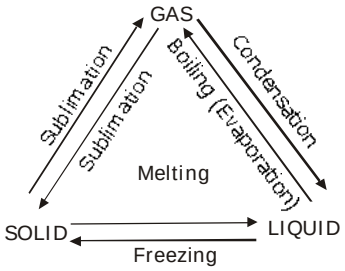
	Property	Solids	Liquids	Gases
1	**Shape**	Definite	Take the shape of the container, but do not necessarily occupy all of it.	Take the shape of the container by occupying whole of the space available to them.
2	**Volume**	Definite	Definite	Take the volume of the container.
3	**Compressibility**	Almost nil	Almost nil	Very large
4	**Fluidity or Rigidity**	Rigid	Fluid	Fluid
5	**Density**	Large	Large	Very small
6	**Diffusion**	Generally do not diffuse	Diffuse slowly	Diffuse rapidly
7	**Free surfaces**	Any number of free surfaces	Only one free surface	No free surface.

2. Change of state of matter : –

(i) A substance may exist in any of the three states of matter (i.e. solid, liquid or gas) depending upon the conditions of temperature and pressure.

(ii) By changing the conditions of temperature and pressure, a substance can be made to exist as solid, liquid or a gas.

(iii) A solid on heating usually changes into a liquid which on further heating changes into gas. Similarly, a gas on cooling condenses into a liquid which on further cooling changes into a solid.



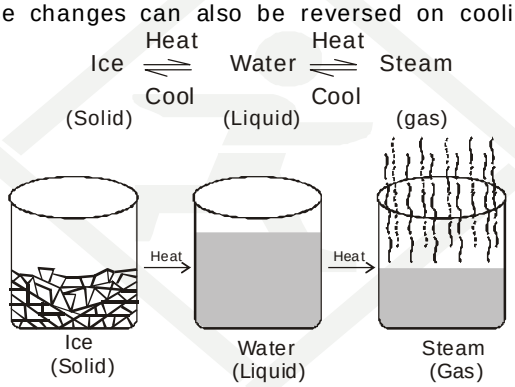
The most familiar and common example is water. It exists in all the three states**:**

(a) Solid **:** ice

(b) Liquid **:** water and

(c) Gas **:** water vapour.

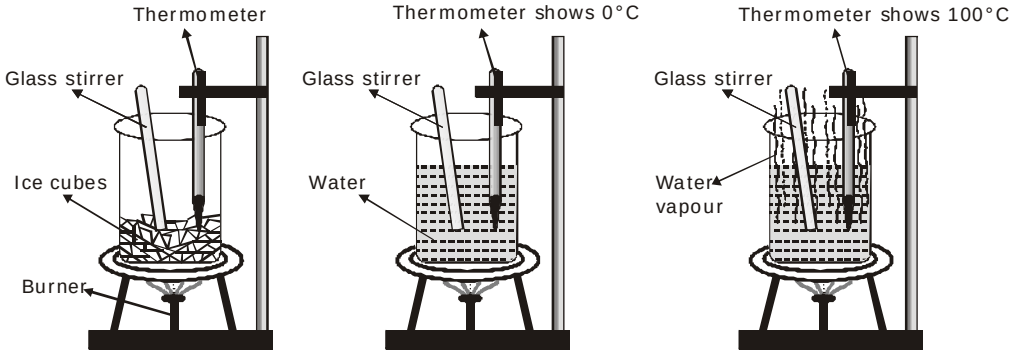
Ice is a solid state and may be melted to form water (Liquid) which on further heating changes into steam (gas). These changes can also be reversed on cooling.



Change in three states of matter

3. Effect of temperature change

By increasing the temperature (by heating), a solid can be converted into liquid state; and the liquid can be converted into gaseous state (or vapour state). And by decreasing the temperature (by cooling), a gas can be converted into liquid state; and a liquid can be converted into solid state.



Conversion of ice to water and water to water vapour

❑ **Solid to liquid change : Melting**

(i) **Definition** : The process in which a solid substance changes into a liquid on heating, is called melting (or fusion).

(ii) **Melting point :** The temperature at which a solid substance melts and changes into a liquid at atmospheric pressure, is called melting point of the substance.

(iii) Ice is a solid. In solids, the particles are tightly packed together. When we heat a solid, its particles become more energetic and kinetic energy of the particles increases. Due to the increase in kinetic energy, the particles start vibrating more strongly with greater speed. The energy supplied by heat overcomes the intermolecular forces of attraction between the particles. As a result, the particles leave their mean position and break away from each other. When this happens, the solid melts and a liquid is formed.

Ex. Melting point of ice = 0ºC

Melting point of wax = 63ºC

Melting point of iron = 1535ºC

The melting point of a solid is a measure of the force of attraction between its particles. Higher the melting point of a solid substance, greater will be the force of attraction between its particles.

Liquid to gas change : Boiling (or vaporisation)

(i) **Definition** : The process in which a liquid substance changes into a gas rapidly on heating, is called boiling.

(ii) **Boiling point :** The temperature at which a liquid boils and changes rapidly into a gas at atmospheric pressure, is called boiling point of the liquid.

(iii) In a liquid most of the particles are close together. When we supply heat energy to the liquid, the particles of water start vibrating even faster. Some of the particles become so energetic that they can overcome the attractive forces of the particles around them. Therefore, they become free to move and escape from the liquid. When this happens, the liquid evaporates i.e., starts changing into gas.

Ex. Boiling point of water = 100ºC

Boiling point of alcohol = 78ºC

Boiling point of mercury = 357ºC

Remember
Impurities decreases the F.P. and increase B.P. of liquids.

The boiling point of a liquid is a measure of the force of attraction between its particles. Higher the boiling point of a liquid, greater will be the force of attraction between its particles.

When a liquid is heated, the heat energy makes its particles move even faster. At the boiling point the particles of a liquid have sufficient kinetic energy to overcome the forces of attraction holding them together and separate into individual particles. And the liquid boils to form a gas.

Gas to liquid change : Condensation

The process of changing a gas to a liquid by cooling, is called condensation. Condensation is the reverse of boiling.

Remember
Condensation is opposite to evaporation

Liquid to solid change : Freezing

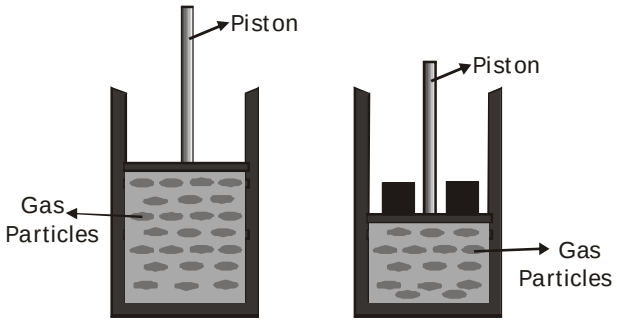
The process of changing a liquid into a solid by cooling, is called freezing. Freezing means solidification. Freezing is the reverse of melting. So, the freezing point of a liquid is the same as the melting point of its solid form.

Remember
Freezing is opposite to melting

Ex. Melting point of ice = 0ºC

Freezing poing of water = 0ºC

4. Effect of change of pressure



By applying pressure particles of matter can be brought close together

(i) The three states of matter differ in the intermolecular forces and intermolecular distances between the constituent particles.

(ii) Gases are compressible because on applying pressure, the space between the gaseous particles decreases. Therefore, gases can be compressed readily.

(iii) When we apply pressure and reduce temperature the gases can be converted into liquids i.e., gases will be liquefied.

(iv) The process of conversion of a gas into a liquid by increasing pressure or decreasing temperature is called **liquidification.**

A substance may exist in any of the three different states of matter depending upon the conditions of temperature and pressure.

(1) If the melting point of a substance is above the room temperature at the atmospheric pressure, it is said to be a solid.

(2) If the boiling point of a substance is above room temperature under atmospheric pressure, it is classified as liquid.

(3) If the boiling point of the substance is below the room temperature at the atmospheric pressure, it is called a gas.

5. Latent heat

(i) **Definition :** The heat energy which has to be supplied to change the state of a substance is called its latent heat.

(ii) Latent heat does not raise the temperature but latent heat has always to be supplied to change the state of a substance. The word 'latent' means 'hidden'

(iii) Every substance has some forces of attraction between its particles which hold them together. Now, if a substance has to change its state, then it is necessary to break these forces of attraction between its particles. The latent heat does not increase the kinetic energy of the particles of the substance, the temperature of a substance does not rise during the change of state.

Latent heat is of two types

(i) **Latent heat of fusion :** The heat required to convert a solid into the liquid state is called latent heat of fusion. In other words 'The latent heat of fusion of a solid is the quantity of heat in joules required to convert 1 kilogram of the solid to liquid, with out any change in temperature.

Ex.16 The latent heat of fusion of ice = 3.34×10^5 J/kg

(i) **Latent heat of vaporisation :** The heat required to convert a liquid into the vapour state is called latent heat of vaporisation.

(ii) The other words 'The latent heat of vaporisation of a liquid is the quantity of heat in joules required to convert 1 kilogram of the liquid to vapour or gas, without any change in temperature.

Ex. Latent heat of vaporisation of water

$= 22.5 \times 10^5$ J/kg

6. Sublimation

(i) **Definition :** The changing of a solid directly into vapours on heating, and of vapours into solid on cooling, is known as sublimation.

(ii) Sublimation can be represented as:

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

(iii) The solid substance which undergoes sublimation is said to 'sublime'. the solid obtained by cooling the vapours of the solid is called a 'sublimate'.

Ex. When solid ammonium chloride is heated, it directly changes into ammonium chloride vapour. And when hot Ammonium chloride vapour is cooled, it directly changes into solid ammonium chloride. Ammonium chloride, Iodine, Camphor, Naphthalene and Anthracene.

7. Evaporation

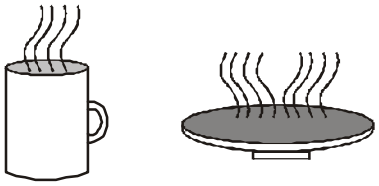
(i) **Definition :** The process of change of a liquid into vapour at any temperature below its boiling point is called evaporation.

Factors affecting evaporation : –

(i) **Temperature :** Rate of evaporation increase with increase in temperature. This is because with the increase in temperature more number of particles get enough kinetic energy to go into the vapour state.

Ex. Drying of clothes take place rapidly in summer than in winter

(ii) **Surface Area :** The rate of evaporation increases on increasing the surface area of the liquid



Increase in surface area increases rate of evaporation.

Ex. If the same liquid is kept in a test tube and in a china dish, then the liquid kept in the china dish will evaporate more rapidly : Because more of its surface area is exposed to air.

(iii) **Humidity :** Humidity is the amount of water vapour present in air. Air around us cannot hold more than a definite quantity of water vapour at a given temperature. If the amount of water in air is already large i.e., humidity is more, the rate of evaporation decreases. Thus, the rate of evaporation increases with decrease in humidity in the atmosphere.

Ex. Clothes do not dry easily during rainy season because rate of evaporation less due to humidity.

(iv) Wind speed : The rate of evaporation also increases with increase in speed of the wind. This is because with increase in speed of wind, the particles of water vapour move away with wind resulting decrease in the amount of vapour in the atmosphere.

Ex. Clothes dry faster on a windy day.

8. Diffusion

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

(ii) Diffusion is a property of matter which is based on the motion of its particles.

(iii) Diffusion is fastest in gases because the particles in gases move very rapidly. The diffusion is slowest in solids because the particles in solids do not move much.

(iv) The rate of diffusion increases on increasing the temperature of the diffusing substance. This is because when the temperature of a substance is increased by heating, its particles gain kinetic energy and move more rapidly and this increase in the speed of the particles of a substance increases the rate of diffusion.

Diffusion in gases

Diffusion in gases is very fast. This is because the particles in gases move very quickly in all directions.

Ex. When we light an incense stick (agarbatti) in a corner of our room, its fragrance spreads in the whole room very quickly. The fragrance of burning incense stick spreads all around due to the diffusion of its smoke into the air.

Ex. When someone opens a bottle of perfume in one corner of a room, its smell spreads in the whole room quickly. The smell of perfume spreads due to the diffusion of perfume vapours into air.

Diffusion in liquids

Diffusion in liquids is slower than that in gases. This is because the particles in liquids move slower as compared to the particles in gases.

Ex. The spreading of purple colour of potassium permanganate into water, on its own, is due to the diffusion of potassium permanaganate particles into water

Ex. The spreading of blue colour of copper sulphate into water, on its own, is due to the diffusion of copper sulphate particles into water.

The rate of diffustion in liquids is much faster than that in solids because the patricles in a liquid move much more freely, and have greater spaces between them as compared to particles in the solids.

Diffusion in solids

Diffusion in solids in a very, very slow process.

Ex. If we write something on a blackboard and leave it uncleaned for a considerable period of time we will find that it becomes quite difficult to clean the blackboard afterwards. This is due to the fact that some of the a particles of chalk have diffused into the surface of blackboard.

Ex. If two metal blocks are bound together tightly and kept undisturbed for a few years, then the particles of one metal are found to have diffused into the other metal.

IMPORTANT DEFINITIONS

1. **Melting or Fusion :** The process due to which a solid changes into liquid state at constant temperature, by absorbing heat energy, is known as **melting** or **fusion.**

2. **Freezing or Solidification :** The process due to which a liquid changes into solid state at constant temperature, by giving out heat energy, is known as **freezing** or **solidification.**

3. **Melting point :** The constant temperature at which a solid changes into liquid state by absorbing heat energy, is called **melting point.**

4. **Freezing point :** The constant temperature at which a liquid changes into solid state by giving out heat energy, is called **freezing point.**

Note : The numerical value of melting point and freezing point is the same. For example, if melting point of ice is 0°C (273 K), then the freezing point of water is 0°C (273 K).

(a) Liquid to gas change (Boiling or vaporizations) :–

In a liquid most of the particles are close together. When we supply heat energy to the liquid, the particles of water start vibrating even faster. Some of the particles become so energetic that they can overcome the attractive forces of the particles around them. Therefore, they become free to move and escape from the liquid. Thus the liquid evaporates i.e., starts changing into gas.

"The temperature at which a liquid changes into a gas or vapour at the atmospheric pressure is called its boiling point".

"Boiling" is a bulk phenomenon.

Example – *For water, the boiling point is 100°C or 373 K. The particles in steam i.e., water vapour at 373 K have more energy than water at the same temperature.*

Reason :– *This is because the particle in steam have absorbed extra energy in the form of latent heat of vaporization.*

(b) Latent heat of vaporization :– The latent heat of vaporization of a liquid is the quantity of heat in joules required to convert 1 kilogram of the liquid (at its boiling point) to vapour or gas, without any change in temperature. The latent heat of vaporization of water is **22.5×10^5 joules per kilogram (or 22.5×10^5 J/kg).**

IMPORTANT POINTS

Density :– The mass of a substance per unit of volume.

Formula – $\boxed{\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{\text{kg}}{\text{m}^3}}$ or kgm^{-3}

In SI unit it is measured in kgm^{-3}

Volume :– All solids occupy a fixed volume the shape occupied by a substance is called volume. The unit of volume is m^3 (cubic meter). The common unit of volume is litre. (L)

$1m^3 = 1000\ dm^3 = 1000\ L$

$1\ L = 1\ dm^3$

$1\ L = 1000\ ml = 1000\ cm^3$

Note: –

Pressure :– In the gaseous state the particle move about randomly at high speed. Due to their random movement, the particles hit each other and also the walls of the container. The pressure exerted by the gas is because of this force exerted by gas particles per unit area on the walls of the container. The atmospheric pressure at sea level is 1 atm, and is taken as the normal atmospheric pressure.

$\boxed{P = \frac{F}{A}}$ P = Pressure, F = Force, A = Area

It is measured in "pascals" (Pa) in SI units and other unit is atm. these two units are related as–

$1\ atm = 1.01 \times 10^5\ Pa$

$1\ bar = 1 \times 10^5\ Pa$

$1\ bar = 1.01\ atm.$

Quantity	Unit	Symbol
Mass	Kilogram	Kg
Length	Meter	m
Temperature	Kelvin	K
Weight/force	Newton	N
Volume	Cubic meter	m^3
Density	Kilogram/Cubic meter	Kg/m^3
Pressure	Pascal	Pa

Some Important Relations
1Kg = 1000g
1m = 100 cm
$1m^3 = 10^6\ cm^3$ or 10^3 L (litre)
$10^3 cm^3 = 1L$

SOLVED PROBLEMS

Ex.1 What do you observe when force is applied and then removed on the plunger of the syringe containing air ? Give a reason for your answer.

Sol. The plunger moves downward on the application of force to a considerable length. When the force is removed, the plunger moves backward and takes its original position.

Ex.2 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.

(c) A wooden table should be called a solid.

(d) We can easily move our hand in air, but to do the same through a solid block of wood, we need a karate expert.

Sol. (a) The molecules of a gas have large intermolecular spaces and kinetic energy, but extermely small intermolecular forces. Thus, the molecules of the gas spread in the entire space of the containing vessel on account of high kinetic energy and practically to intermolecular forces, hence fill entire space of the vessel.

(b) The molecules of a gas have very large kinetic energy. When these molecules strike against the walls of containing vessel, they exert certain average force per unit area. As the force per unit area is known as pressure, therefore, the gases exert pressure on the sides of the containing vessel.

(c) Solids are rigid, incompressible and have definite shape and volume. Since the table has all the above mentioned properties, therefore, it it solid.

(d) The intermolecular forces between the molecules of a gas are almost negligible and intermolecular spaces are very large. Thus, we can easily move our hand in air, without any appreciable force.

The intermolecular forces between the molecules of a solid are very large and intermolecular spaces are very small. Thus, a lot of force is required to separate the molecules of a solid. It is for the same reasons that we need karate expert to break a block of wood.

Ex.3 The mass per unit volume of a substance is called density. (Density = Mass / Volume). Arrange the following in the order of increasing density :

air, exhaust from chimneys, honey, water, chalk, cotton and iron.

Sol. Exhaust from chimneys, air, cotton, water, honey and iron.

e.g..

(i) CNG (compressed Natural gas) is used as fuel in internal combustion engines.

(ii) Oxygen in compressed form is supplied to hospitals for serious patients in cylinders.

(iii) LPG (Liquefied petroleum gas) which is used in home for cooking.

(iv) The gases exhibit the property of diffusing very fast into other gases.

Ex.4 We can easily move our hand in the air but to do the same through a solid block of wood we need a karate expert.

Sol. In air the interparticle attractive forces are negligible and hence, it is easy to separate the particles in air and we can easily move our hand through it. In a solid block of wood, the interparticle forces are very strong and hence, it is not easy to separate the particles. Therefore it is not easy to move our hand through a solid block of wood (only a karate expert can do it). Dut to this property large volume of a gas

can be compressed into a small cylinder and transported easily.

Ex.5 Arrange the following substances in increasing order of forces of attraction between the particles -water, sugar, oxygen.

Sol. Oxygen < water < Sugar

Ex.6 The diver is able to cut through water in a swimming pool.

Sol. **Explanation** :– The diver is able to cut through water in the swimming pool because matter is not continuous, but it is made up of particles which have vacant spaces between them moreover, the attractive forces between molecules of water are not very strong. The diver can easily cut through water by applying force to displace water and occupy its place.

Ex.7 Why ice floats on water?

Sol. Solids generally have higher density than the 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.

Temperature and pressure are the two factors which decide whether a given substance would be in a solid, liquid or gaseous state.

Ex.8 Convert the following temperatures to the celsius scale.

(a) 300 K (b) 573 K

Sol. (a) (300 – 273) = 27°C. Temperature in °C = Temperature in K – 273

(b) (573 – 273) = 300°C. Temperature in °C = Temperature in K – 273

Ex.9 Convert the following temperature to the Kelvin scale.

(a) 25°C (b) 373°C

Sol. (a) 25 + 273 = 298 K (b) 373 + 273 = 646 K

Ex.10 What is the physical state of water at –

(a) 25°C (b) 0°C (c) 100°C

Sol. (a) 25°C – Water is in liquid state.

(b) 0°C – Water is in solid state.

(c) 100°C – Water is in gaseous state.

NCERT QUESTIONS WITH SOLUTIONS

Q.1 Convert the following temperature to the Celsius scale-
(i) 293 K (ii) 410 K

Ans. (i) 293 – 273 = 20°C
(ii) 470 – 273 = 197°C

Q.2 Convert the following temperature to the kelvin scale.
(i) 25°C (ii) 373°C

Ans. (i) 25 + 273 = 298K
(ii) 373 + 273 = 646K

Q.3 Arrange the following substances in the increasing order of forces of attraction between the particles water, sugar and oxygen.

Ans. Oxygen, water and sugar.

Q.5 What is the physical state of water at
(a) 25°C (b) 0°C (c) 100°C?

Ans. (a) At 25°C, water is in liquid state.
(b) At 0°C, water is in solid state, provided heat is removed from it.
(c) At 100°C, water is in gaseous state, provided heat is supplied to it.

Q.6 Give two reasons to justify –
(a) Water at room temperature is a liquid.
(b) An iron almirah is solid at room temperature.

Sol. (a)
(i) Intermolecular forces are less.
(ii) Intermolecular spaces and kinetic energy is more.
Thus, the molecule of water can interchange their spaces and hence water is in liquid state at room temperature.
(b)
(i) Intermolecular forces are very large.
(ii) Intermolecular spaces, as well as, kinetic energy are very small.

Q.7 Ice is at 273 K more effective in cooling, than water at the same temperature, why?

Sol. One kilogram of ice at 273 K, needs 3, 36000 J of heat energy in order to form water at 273 K. As the 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.

Q.8 What produces more severe burns, boiling water or steam?

Sol. Steam will produce more severe burns than boiling water. It is because, 1 g of steam at 373 K (100°C) contains 2260 J of heat energy more in the form of latent heat of vaporization as compared to water at 373 K(100°). Thus steam produces more severe burns.

Q.9 Naphthalene balls disappear with time without leaving any solid why?

Sol. Naphthalene is volatile solid and has a tendency to sublime, therefore, it changes into vapours completely which disappear into the air and no solid is left.

Q.10 We cna get the smell of perfume sitting several metere away.

Ans. This is because perfumes contain volatile solvent which carries pleasent smelling vapour. They diffuse quite fast and can reach to people sitting several metere away.

EXERCISE – I BOARD PROBLEMS

Q.1 Give reasons for the following observation: The smell of hot sizzling food reaches you several metres away, but to get the smell from cold food you have to go close.

Q.2 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.
(c) A wooden table should be called a solid.
(d) We can easily move our hand in air but to do the same through a solid block of wood we need a karate expert.

Q.3 Why does a desert cooler cool better on a hot dry day?

Q.4 Convert the following temperatures to the Celsius scale.

Q.5 What produce more sever burns boiling water or steam?

Q.6 Define matter.

Q.7 What is plasma?

Q.8 What is Bose-Einstein condensate [BEC]?

Q.9 Why do we see water droplets on the outer surface of a glass container of ice cold water?

Q.10 Define specific heat of substance.

Q.11 Define latent heat of a substance.

Q.12 Why gases are compressible but not liquids?

Q.13 Give two factors which determine the rate of diffusion of a liquid in another liquid.

Q.14 Arrange the solids, liquids and gases in order of :
(A) increasing intermolecular space
(b) Increasing intermolecular force

Q.15 Which phenomenon occurs during the following changes :
(a) Formation of clouds
(b) Drying of wet clothes
(c) Was melts in the sun
(d) Size of naphthalene balled decreases

Q.16 Why does a wet khus-khus screen hung at the door keep the room cool?

Q.17 What is mean by evaporation? How is this process different from boiling?

Q.18 Why can you smell the perfume of incense stick

Q.19 Why cannot you smell its perfume at a short distance when incense stick is not lighted ?

Q.20 Why is the smell of the perfume of incense stick filled the whole room in few minutes, when lighted ?

Q.21 A rubber band is a solid, but it can change its shape. Why ?

Q.22 When salt or sugar are poured into different kinds of vessels, why do they take the shape of vessel ?

Q.23 Sponge is a solid, yet we are able to compress it. Why ?

Q.24 Arrange the following substances in the increasing order of forces of attraction between the particles – water, sugar and oxygen.

Q.25 What is the physical state of water at :
(a) 25°C (b) 0°C (c) 100°C

Q.26 Give two reason to justify.
(a) Water at room temperature is a liquid.
(b) An iron almirah is solid at room temperature.

Q.27 State your observation immediately after adding the blue ink drop.

Q.28 State your observation immediately after adding the honey drop.

Q.29 How much time does it take for the colour of ink to spread evenly ?

Q.30 How does the diffusion of honey varies with the diffusion of ink and why ?

Q.31 What happens around each crystal of solid on introducing in water ?

Q.32 What happens as the time passes, and why ?

Q.33 Does the rate of diffusion change with temperature ? If so, why ?

EXERCISE – II OLYMPIAD QUESTIONS

Q.1 When salt is dissolved in water :-

(A) Boiling point increases
(B) Boiling point does not change
(C)Boiling point decreases
(D) None of the above

Q.2 Mixture of butane, ethane and propane is called:-

(A) Coal gas (B) Oil gas
(C) Petroleum gas (D) Producer gas

Q.3 In the kinetic theory of gases, it is assumed that molecular collisions are :-

(A) Inelastic
(B) Short in duration
(C) One-dimensional
(D) Not able to exert mutual forces

Q.4 Triple point of water is :-

(A) 373.16 K (B) 273.16° F
(C) 273.16 K (D) 273.16 F

Q.5 Based on the statements given here choose the correct answer.

(1) Same sugar can be added to a full glass of water without causing overflow.

(2) A liquid is continuous even-though space is present between the molecules.

(A) (1) and (2) are true and (2) explains (1)
(B) (1) and (2) are true but (2) does not explain (1)
(C) Only (1) is true
(D) Only (2) is true

Q.6 Vanderwaal's forces are also known as :-

(A) Intermolecular forces
(B) Intramolecular forces
(C) Atomic forces
(D) Molecular forces

Q.7 Based on the statements given here choose the correct answer.

(1) If we increase the temperature of a gas inside a container, its pressure also increases.

(2) Upon heating, the rate of collisions of the gas molecules increase and increases the impact of force onthe walls of the container.

(A) (1) and (2) are true and (2) explains (1)
(B) (1) and (2) are true but (2) does not explain(1)
(C) Only (1) is true
(D) Only (2) is true

Q.8 Match the following and choose the correct answer :-

(i) Solid
(a) Super energetic particles

(ii) Liquid
(b) No shape nor fixed volume at a given pressure

(iii) Gas
(c) Has definite shape

(iv) Plasma
(d) Define shape with less molecular forces than that in solids

(A) (i) – a, (ii) – b, (iii) – c, (iv) – d
(B) (i) – c, (ii) – d, (iii) – b, (iv) – a
(C) (i) – c, (ii) – d, (iii) – a, (iv) – b
(D) (i) – a, (ii) – d, (iii) – b, (iv) – c

Q.9 The process for the change of a solid directly into its vapour is called –

(A) Evaporation (B) Ebullition
(C) Condensation (D) Sublimation

Q.10 When water particles condenses on air on dust, it forms :-

(A) mist (B) fog
(C) frost (D) Vapour

Q.11 Which is more effective in cooling ?

(A) Water at 0°C (B) Water at 100°C
(C) Ice at 0°C (D) All of these

Q.12 The temperature at which Celsius and Fahrenheit scales show the same reading is:-

(A) 40° K (B) 100° F
(C) – 40° C (D) – 100°C

Q.13 Latent heat of fusion for ice is :-

(A) 80 gm cal^{-1} (B) 80 cal / gm
(C) 19 J cal^{-1} (D) None of these

Q.14 Based on the statements given here choose the correct answer.

(1) In polar regions aquatic life is safe in water under frozen ice.

(2) Water has a high latent heat of fusion and the upper portion of ice does not allow the heat of the waterto escape to the surroundings.

(A) (1) and (2) are true and (2) explains (1)

(B) (1) and (2) are true but (2) does not explain (1)

(C) Only (1) is true

(D) Only (2) is true

Q.15 Based on the statements given here choose the correct answer.

(1) Boiling point of a liquid increases with increase in temperature.

(2) The volume of liquids increases on boiling and the vaporisation curve shows the variation of the boilingpoint of a liquid with pressure and expands the equilibrium state between liquid and vapour phase.

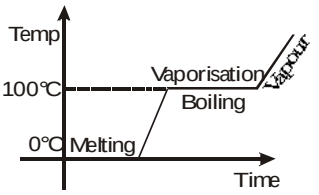
(A) (1) and (2) are true and (2) explains (1)

(B) (1) and (2) are true but (2) does not explain(1)

(C) Only (1) is true

(D) Only (2) is true

Q.16 In an experiment of conversion of ice into water and water into vapour, observations were recorded and a graph plotted for temperature against time as shown below. From the graph it can be concluded that :-



(A) Ice takes time to heat up to 0°C

(B) During melting and boiling temperature does not rise

(C) Process of boiling takes longer time than the process of melting

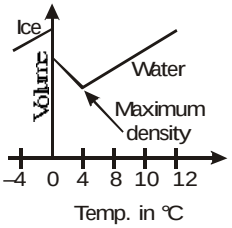
(D) All the above

Q.17 The SI unit of temperature is :-

(A) °C (B) °F

(C) K (D) All of the above

Q.18 Study the graph given below and select the correct statement :-



(A) When water is cooled to 4°C it contracts

(B) At 0°C water freezes

(C) The volume of ice is more than that of water

(D) All of these

Q.19 The solid state of CO_2 is called :-

(A) Tear gas (B) Cooking gas

(C) Dry ice (D) Laughing gas

Q.20 Corresponding temperature in the Kelvin scale for 104°C F is :-

(A) 313 K (B) 203

(C) 308 K (D) 377 K

Q.21 When the vapour pressure of a liquid is equal to its atmospheric pressure, then it :-

(A) Freezes

(B) Evaporates

(C) Boils

(D) Does not undergo any change

Q.22 When ice is converted into water :-

(A) Heat is absorbed

(B) Heat is released

(C) Temperature increases

(D) Temperature decreases

Q.23 Which of the following has the strongest interparticle force at the room temperature?

(A) Nitrogen (B) Mercury

(C) Iron (D) Chalk

Q.24 What is volume of gases?

(A) Definite

(B) Almost Nil

(C) Large

(D) Take the volume of container

Q.25 The change of state from solid to liquid known as –

(A) Fusion (B) Boiling

(C) Melting (D) None of these

Q.26 Dry ice is –

(A) Water in solid state

(B) Water in gaseous state

(C) CO_2 in liquid state

(D) CO_2 in solid state

Q.27 The boiling point of water on kelvin scale is–

(A) 573 K (B) 273 K

(C) 373 K (D) 100 K

Q.28 The process of change of a liquid into vapour at any temperature is called –

(A) Diffusion (B) Evaporation

(C) Cooling (D) Heating

Q.29 Which factor affecting Evaporation –

(A) Temperature (B) Surface area

(C) Both (A) & (B) (D) None of these

Q.30 On increasing the temperature of the liquid the rate of evaporation is –

(A) Increase (B) Decreases

(C) No change (D) None of these

Q.31 Fluids are –

(A) Liquids and gases

(B) Solids and gases

(C) Liquids and solids

(D) Only solids

Q.32 Which substance undergo sublimation process–

(A) Naphthalene (B) CO_2

(C) Ice (D) N_2

Q.33 Condensation process is –

(A) Change of state from gas to liquid

(B) Change of state from liquid to gas

(C) Change of state from gas to solid

(D) Change of state from solid to liquid

Q.34 The temperature at which liquid starts boiling at atmospheric pressure known as –

(A) Melting point (B) Boiling point

(C) Latent heat (D) Condensation

Q.35 The melting point of ice is –

(A) 0°C (B) 4°C

(C) 5°C (D) None of these

Q.36 The physical state of matter which can be easily compressed –

(A) Liquid (B) Gas

(C) Solid (D) None of these

Q.37 Name the process by which a drop of ink spreads in a beaker of water –

(A) Diffusion (B) Vaporization

(C) Condensation (D) Sublimation

Q.38 The temperature at which a solid changes into liquid at atmospheric pressure is called –

(A) Melting point (B) Boiling point

(C) Diffusion (D) Evaporation

Q.39 Convert the temperature of 373°C to the kelvin scale ?

(A) 646 K (B) 546 K

(C) 300 K (D) 500 K

Q.40 Convert the temperature of 270 K to the celsius scale –

(A) – 3°C (B) – 4°C

(C) 2°C (D) 5°C

Q.41 Plasma is the..... state of matter –

(A) First (B) Second

(C) Third (D) Fourth

Answers

1.	C	**2.**	C	**3.**	B	**4.**	C
5.	A	**6.**	A	**7.**	A	**8.**	B
9.	D	**10.**	A	**11.**	C	**12.**	C
13.	B	**14.**	A	**15.**	A	**16.**	D
17.	C	**18.**	D	**19.**	C	**20.**	A
21.	C	**22.**	A	**23.**	C	**24.**	D
25.	C	**26.**	D	**27.**	C	**28.**	B
29.	C	**30.**	A	**31.**	A	**32.**	A
33.	A	**34.**	B	**35.**	A	**36.**	B
37.	A	**38.**	A	**39.**	A	**40.**	A
41.	D						

THE FUNDAMENTAL UNIT : CELL

Cell

Cell is the basic structural and functional unit of all living organisms. All living organisms are structurally composed of cells.

Unicellular Organisms

A single cell constitute the whole organism, e.g., Amoeba, Chlanydononas, bacteria.

Multicellular Organisms

Many cells grouped together and assume different functions in the body to form various body parts e.g., plants, animals. Every multicellular organism has come from a single cell which divides to form cells of their own kind.

Prokaryotic Cell

It have no nuclear envelope and membrane bound organelle, e.g., bacteria, cyanobacteria.

Eukaryotic Cell

Nucleus is well defined and have DNA in it, e.g. plant, animal

Plant Cell

Cell well is present, so the cell shape well defined. Comparatively larger, the peripheral, central space is occupied by a large vacuole. Plant cells lack centrosome and centrioler, nucleus lies on one side.

Animal Cell

Generally smaller in size. Do not have cell wall. Prominent and highly complex golgi bodies are present. Animal cells posses centrioles, nucleus lies in the centre.

Structural Organisation of Cell

Plasma Membrane

It is outermost covering of cell that is composed of proteins and lipid. It allows permit the entry and exist of some materials. It maintains the shape of the cell, acts as mechanical barrier and protects the internal contents of the cell. Transport of substances across the membrance takes place by **diffusion** and **osmosis.**

Cell wall

It is found only in plant cell. It is tough, flexible, but fairly rigid outer convering living outside plasma membrane. It permits the cells of plants, fungi and bacteria to withstand much greater changes in surrounding medium than animal cells.

Nucleus

It is popularly called as brain of cells. It controls all functions of a cell. It determines the cell development and maturity by directing the chemical activities of cell. It plays an important role in cellular reproduction in which a cell divide to form

Cytoplasm

It is the fluid content inside the plasma membrane. It also contains many specialised cell organelle. It helps in exchange of material between cell organelles. It is a site of certain metabolic pathways such as glycolysis.

ER

It is large network of membrane bound tubules and sheet. ER membrane is made up of lipid and proteins.

Mitochondria

It is know as power house or cell. It release energy required by cell in form of ATP.

Golgi Apparatus

It consist of a system of membrane bound vesicles called cisternae. It helps in formation of lysosomes and acrosomes.

Lysosomes

They are suicidal bags of a cell. It forms the waste disposal system of a cell.

Plastids

These are found only in plant cell. They are chromoplast, chloroplast and leucoplast.

Vacuoles

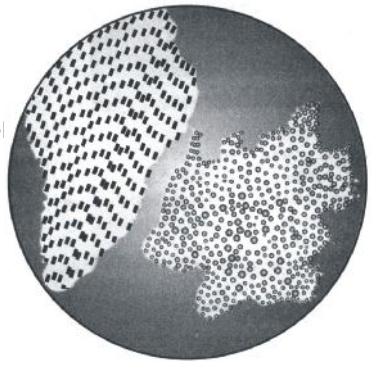
These are storage sacs for solid and liquid contents. Tehy are small sized in animal cell and large sized an plant cell.

CYTOLOGY

The cell and its structures are studied under a branch of biology called cytology.

Definition :- The structural & functional unit of living beings is called cell.

DISCOVERY OF CELL



Cork section shown in Robert Hooke's Microscope

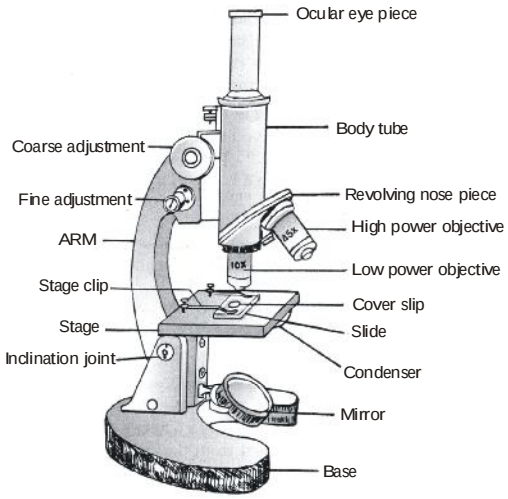
1. **Robert Hooke (1665) :–** An English man and first curator of **Royal society of London.**
   Observed a thin transverse section of bark of a tree under se
   He noticed **honey - comb like compartments.**
   He coined the term cell .
   He wrote a book - **Micrographia.**
   He actually observed dead cells.
2. **Antony Van Leeuwenhoek (1674)** was first to observe living cells like bacteria [from tartar of teeth] erythrocytes [fish], sperms and protozoans [eg. *Vorticella*]
3. **N. Grew (1682) :–** Proposed cell concept which states that **cell is unit of structure of organisms.**
4. **Cell is called structural & functional unit of life because –**
   (i) All the living organisms are composed of one or more cells.
   (ii) All the cells have similar basic structure.
   (iii) Similar cell organelles of different cells perform similar functions.
5. **Knoll and Ruska (1932)** of Germany designed the electron microscope which was employed to study the ultrastructrue (fine structure) of cell and various cell organelles in 1940s.

MICROSCOPE

It is 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 microscope has more than one lens. The 1st compound microscope was built by F. Janssen and Zacharias Janssen (1590).

◈ **Structure of Microscope:** The microscope used in schools is called compound microscope, a compound microscope has following parts:

1. **Base:** It is the basal, metallic, horse-shoe shaped structure. It bears the whole weight of microscope.
2. **Handle:** It is the curved part to hold the microscope. It is also called as arm.
3. **Stage:** It is a strong metallic, rectangular, horizontal plate fixed to the handle.
4. **Stage Clips:** Two clips are attached to stage used for holding the slide in position.
5. **Condenser:** Below the stage is present a condenser for concentrating the light rays.
6. **Body tube:** It is wide, hollow tube attached to the upper part of the arm. To this tube lenses are attached.
7. **Adjustment Screw:**
   (a) Coarse adjustment: It is bigger sized screw used to move the body tube up and down.
   (b) Fine adjustment: It is a smaller sized screw for fine focussing.
8. **Reflecting Mirror:** It is meant for reflecting the light rays, so that light passes through the object which is to be seen.



Parts of an ordinary compound microscope

CELL THEORY

Two biologists, "Schleiden and Schwann' gave the "Cell theory" which was later on expanded by "Rudolf Virchow". Cell theory states that-

(i) All plants and animals are composed of cells.

(ii) Cells is the basic unit of life.

(iii) All cells arise from pre-existing cells.

Ciruses are the exceptions of cell theory.

CELL SIZE & SHAPE

(A) Size of cell – Normal size in human 20 µm to 30 µm in diametre.

(i) Largest cell – In animals – Ostrich egg [15 cm is diametre]

In plants – *Acetabularia* [6-10 cm]

(ii) Longest cell – In animals – Nerve cell [upto 1mt]

In plants – Hemp fibre.

(iii) Smallest cell – PPLO – Pleuro Pneumonia Like Organism [***Mycoplasma*** – 0.1 to 0.5 µm.]

(B) Shape of cell – Shape of cell mainly depends upon the specific function it performs.

(i) Elongated – Nerve cell (ii) Discoidal/saucer – RBC

(iii) Spindal – Muscle cell (iv) Spherical – Eggs.

(v) Branched – Pigment cell of the skin. (vi) Slipper shaped – *Paramecium*

(vii) Cuboidal – Germ cells of gonads. (viii) Polygonal – Liver cells.

TYPES OF CELL

(A) On the basis of type of organization, cells are of two types:

(i) Prokaryotic cells: these are primitive and incomplete cells. they have less developed nucleus without nuclear membrane and nucleolus e.g. Bacteria.

(ii) Eukaryotic cells: these are well developed cells. They have advanced nucleus with nuclear membrane.

(B) On the basis differentiation:

(i) Undifferentiated: These are unspecialized cells which by mitotic divisions give rise to new cells for the formation and maintenance of tissues.

(ii) Differentiated: These are specialized cells formed from the unspecialized cells by change in structure and function during develoment and growth of an organism.

(iii) Dedifferentiated: These are specialized cells reverted to a more generalized (embryonic), actively dividing state. Dedifferentiation often occurs for regeneration.

DIFFERENCES BETWEEN PROKARYOTIC & EUKARYOTIC CELLS

Feature	Prokaryotic cell	Eukaryotic cell
Cell size	Average diameter 0.5-5μm	Diameter varies between. 1μm-40 μm
Protoplasm	Relatively rigid, resistant to desiccation (drying) and can withstand wide changes in pressure and temperature	More fluid and sensitive to drying and to changes in temperature and pressure.
Nucleus	Lacks true nucleus; circular DNA lies naked in the cytoplasm; no chromosomes, nucleolus or nuclear membrane; **nucleoplasm** undifferentiated from cytoplasm	True nucleus bound by nuclear membrane contains linear DNA associated with proteins and RNA (forming chromosomes); nucleolus and nuclear membrane present; nucleoplasm distinct
Organelles	Membrane-bound organelles like Golgi bodies, plastids, mitochondria and endoplasmic reticulum (ER) are absent.	Membrane-bound organelles present.
Ribosomes	Smaller and randomly scattered in the cytoplasm	Bigger, can be free or attached to the ER
Cell division	Divides by simple fission; spindle is not formed; no mitosis and meiosis	Divides by mitosis or by meiosis
Respiration	Respiratory enzymes are located on the plasma membrane	Mitochondria are the seat of aerobic respiration
Photosynthesis	No organized chloroplast; photosynthesis takes place on photosynthetic membranes which lie freely in the cytoplasm.	Organized chloroplasts (containing stacked membranes called grana) take part in photosynthesis
Examples	Bacteria and cyanobacteria (blue-green algae)	All other organisms.

DIFFERENCES BETWEEN PLANT CELL & ANIMAL CELL

	PLANT CELL	ANIMAL CELL
1.	Plant cells are usually larger than animal cells	Animal cells are generally small in size.
2.	The plasma membrane of a plant cell is surrounded by a rigid cell wall made up of cellulose.	Cell wall is absent.
3.	Plastids (leucoplasts, chloroplasts, chromoplasts) are present in plant cells.	Plastids are absent.
4.	Vacuoles are present in abundance. They are larger in size.	Vacuoles are less in number and smaller in size.
5.	Plant cells have many simpler units of Golgi complex, called **dictyosomes**.	Animal cells have a single highly elaborate Golgi complex.
6.	Centrioles have not been found in plant cells (except in a few lower plants.	Animal cells possess centrioles.
7.	Cytokinesis takes place by cell-plate formation.	Cytokinesis takes place by constriction during cell division.
8.	Plant cells usually have a regular shape.	Animal cells are usually irregular in shape.

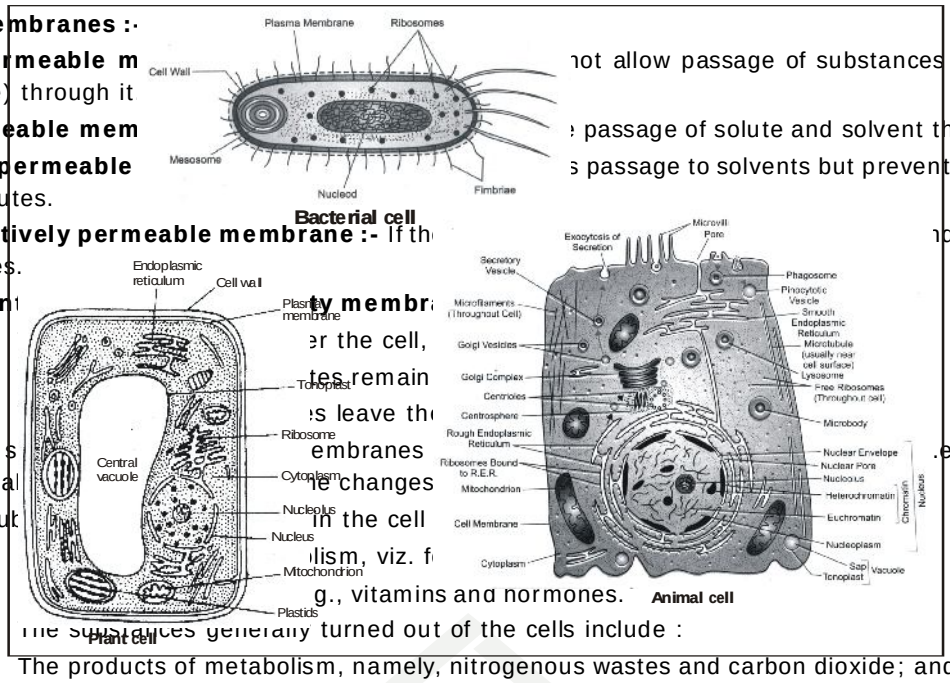
Types of membranes :-

(i) **Impermeable m** ...not allow passage of substances (solvent and solute) through it

(ii) **Permeable mem** ...e passage of solute and solvent through it.

(iii) **Semipermeable** ...s passage to solvents but prevents the passing of solutes.

(iv) **Selectively permeable membrane :-** If th... ...d few selected solutes.



Advan... **...y membr...**

1. ...er the cell,
2. ...tes remain
3. ...s leave th...

Thus, s... ...embranes ...e., a constant internal ...e changes

The sut... ...in the cell

(i) ...lism, viz. f...

(ii) ...g., vitamins and normones.

The substances generally turned out of the cells include :

(i) The products of metabolism, namely, nitrogenous wastes and carbon dioxide; and

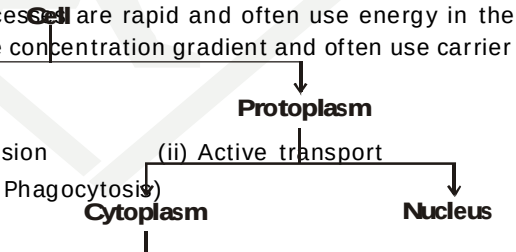
(ii) Secretions.

COMPONENTS OF A CELL

There is an occurrence of division of labour within a cell as they all got certain specific components called "Cell organelles" each of them performs a specific function.

The three basic components of all the cells are

(i) PM (Plasma Membrane) (ii) Nucleus (iii) Cytoplasm



Following mechanisms are involved in the entry or exit of various materials across p.m.

(A). Physical processes. (B) Biological processes.

A. Physical Processes :- These processes are slow and do not expend energy. These occur down the concentration gradient and do not use carrier proteins. Physical processes include. (i) Diffusion, (ii) Osmosis.

B. Biological processes :- These processes are rapid and often use energy in the form of ATP. These can occur down as well as against the concentration gradient and often use carrier proteins. Biological processes include :-

1. Mediated transport
   (i) Facilitated transport / diffusion
2. Endocytosis (Pinocytosis and Phagocytosis)
3. Exocytosis.

1. Diffusion :- The process by which a substance uniformly spreads into another substance by random movement of its particles from a region of higher concentration to a region of its lower concentration due to their kinetic energy is called diffusion.

It is faster in gaseous phase than in liquid phase or solid phase.

Significance of diffusion :-

(i) Diffusion helps in the distribution of various substances throughout the cytoplasm of the cell without much delay.

(ii) It helps in the exchange of respiratory gases (oxygen and carbon dioxide) between the body cells and their environment.

(iii) Various materials such as gases, liquids and solids dissolve in the vacuolism, i.e., air or liquid by diffusion.

(iv) Loss of water in vapours form from the aerial parts of the plants (transpiration) occurs through diffusion.

(v) Flowers of plants spread aroma through diffusion. It attracts insects and other animals for pollination.

CELL MEMBRANE OR PLASMA MEMBRANE

Each cell (prokaryotic as well as eukaryotic) is surrounded by a covering called **plasma membrane** or ***plasmalemma or cell membrane.*** Most cell organelles in eukaryotic cells (e.g., Mitochondria, Plastids, Golgi apparatus, Lysosomes, Endoplasmic reticulum, Peroxisomes, Vacuoles etc). are enclosed by subcellular unit membranes. These membranes, thus, compartmentalise the cell.

Molecular Structure of Plasma membrane.

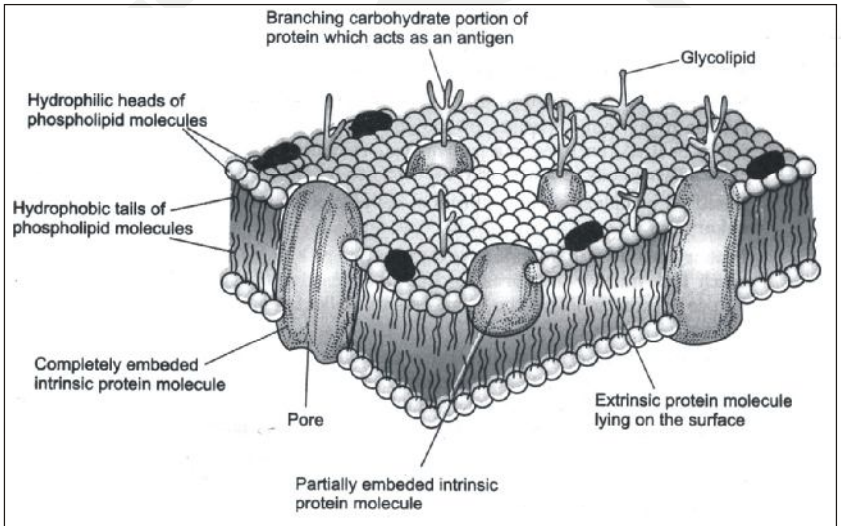
Plasma membrane is a living, ultra-thin, elastic, selectively permeable membrane. Chemically, it is composed of phospholipids, proteins, oligosaccharides and cholesterol.

Trilamilar or 3-layered structure :- J.D. Robertoson noted trilamilar or 3-layered structure for all membranes he studied. Based on his findings, he proposed the **'unit membrane hypothesis' in 1959**.

Fluid Mosaic Model :- In 1972, **S.J. Singer and G. Nicolson** proposed fluid mosaic model **to explain the structure and functions of plasma membrane.** According to this model, the plasma membrane is made up of a **phospholipid bilayer** and two types of **protein molecules** 'floating about' in the fluid phospholipid bilayer. The two types of proteins are (i) **Intrinsic proteins** which are embeded in the phospholipid matrix incompletely or completely, and (ii) **Extrinsic proteins** which occur superficially either on the outer surface or on the inner surface of the phospholipid layer. In other words, the membrane is a viscous fluid with phospholipids and protein molecules arranged as a mosaic.

Oligosaccharide molecules are present on the exposed surface of the plasma membrane. They are associated with proteins as well as lipid molecules forming glycoproteins and glycolipids respectively. **Cholesterol** molecules are inserted between the phospholipid molecules of plasma membrane of animal cells to stabilize the membrane.

Presence of lipids and proteins provides flexibility to the plasma membrane. Proteins present in the membrane serve as :-



Fluid mosaic structure of the plasma membrane

(i) **Enzymes** catalysing chemical reactions within the membrane.

(ii) **Transport proteins** (permeases) for movement of water soluble ions.

(iii) **Pumps** for active transport of materials and

(iv) **Receptor proteins** (e.g., glycoproteins on the cell surface) to recognize and bind specific molecules such as hormones.

Fluid mosaic model is also described as "a number of protein icebergs floating in the sea of lipids'.

Osmosis :-

The diffusion of water or solvent through a semipermeable membrane from a solution of lower concentration of solutes to a solution of higher concentration of solutes to which the membrane is relatively impermeable, is called osmosis.

Osmosis is of two types :

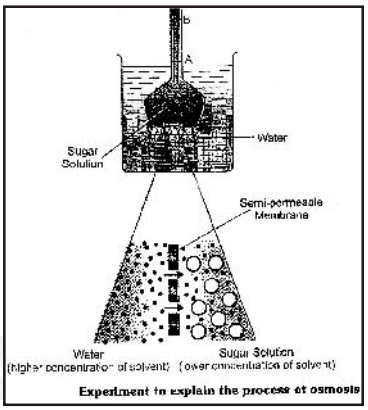
1. **Endomosis**
2. **Exomosis**

Endosmosis : It is the entry of water molecules into the cells through semipermeable plasma membrane when surrounded by hypotonic solution.

Exosmosis : It is the exit of water molecules from the cells through semipermeable plasma membrane when surrounded by hypertonic solution.

Experiment : Demonstration of osmosis in the laboratory.

Requirements : Funnel fitted with a semipermeable membrane, beaker, sugar solution, water.



Experiment to explain the process of osmosis

Procedure : Take sugar solution in a funnel fitted with a semipermeable membrane (fish bladder or egg membrane) upto mark 'A' and place it in an inverted position in a beaker filled with clean water as shown in figure. After some time, observe the level of sugar solution in the funnel.

Result :- You would find that the sugar solution has risen from level 'A' to a new level 'B'.

Explanation and conclusion : Sugar solution in the funnel and water in the beaker are separated by a semipermeable membrane. The fitted membrane is permeable to small water molecules but is relatively impermeable to large sugar molecules dissolved in water.

Due to difference in the concentration of solute on the two sides of semipermeable membrane, water molecules have moved from the solution having lower concentration of solutes (e.g., water in this experiment) to the solution having higher concentration of solutes [e.g. sugar solution] due to osmosis has risen to new level 'B'.

Types of solutions :

1. **Isotonic solution**
2. **Hypotonic solution, and**
3. **Hypertonic solution.**

1. Isotonic solution :-

Isotonic solution is one in which the concentration of water and solutes is the same as in the cytoplasm of the red blood cells. 0.9% salt solution and 5% glucose solution are isotonic for red blood cells.

2. Hypotonic solution :-

Hypotonic solution is one in which the concentration of solutes is less and concentration of water is more as compared to inside the red blood cells. 0.66% salt solution and 0.2% glucose solution are hypotonic for red blood cells.

3. Hypertonic solution :-

Hypertonic solution is one in which the concentration of solutes is more and the concentration of water is less as compared to in the cytoplasm of the red blood cell. 1.25% salt solution and 10% glucose solution are hypertonic for red blood cells.

Other examples of osmosis :-

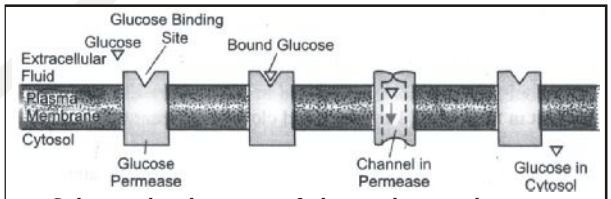
1. Fresh water unicellular organisms (e.g., ***Amoeba, Paramecium***) continuously gain water in their bodies due to osmosis. These organisms have mechanisms (e.g., contractile vacuoles) to throw out excess of water from their bodies.
2. Most plant cells have the tendency to gain water due to osmosis.
3. Absorption of water by the plant roots from the soil through root hairs is also an example of osmosis.
4. Certain plant movements (e.g., seismonastic movements in 'touch-me-not' plant) occur due to loss or gain of water.
5. Stomata are present in the leaves. They open and close at different times of the day due to osmotic movements of water.
6. In plants, cells, tissues and soft organs (leaves, young shoots, flowers) maintain turgidity or stretched form due to osmotic absorption of water.

DIFFERENCES BETWEEN DIFFUSION AND OSMOSIS

S.No.	Diffusion	S.No.	Osmosis
1	Diffusion can occur both in air and liquid (water) medium	1	Osmosis occurs only in liquid medium
2	It involves movement of molecules (Solids, liquids or gases) from the region of their higher concentration to the region of their lower concentration.	2	It involves movement of solvent molecules only from the region of their higher concentration to the region of their lower concentration.
3	It can occur without or through a semipermeable membrane.	3	It always takes place through a semipermeable membrane.
4	It equalizes the concentration of diffusable molecules throughout the medium.	4	It does not equalize the concentration of solvent molecules in the medium involved.
5	It is dependent upon the kinetic energy of the molecules of diffusing substance only.	5	Though it is the diffusion of solvent molecules only, yet it is influenced by the presence of solutes in the system.

Mediated transport :

Type of transport of materials across the plasma membrane with the help of carrier proteins is called mediated transport.



Scheme showing entry of glucose into erythrocytes

Types of mediated transport

Mediated transport is of following two types :

(i) Facilitated transport

(ii) Active transport

(i) Facilitated transport :- In this case, transport proteins (e.g. permeases) assist molecules to diffuse through the membrane down the concentration gradient, i.e., from the region of higher concentration to the region of lower concentration across the membrane. It is, therefore, also termed as **facilitated diffusion.** No cellular energy is used in such transport. A carrier protein combines with a specific substance (e.g., glucose) to be transported and moves it down the concentration gradient from one side of membrane to another through a channel formed by it.

In liver and red blood cells, facilitated transport moves glucose across the cell membrane by specific carrier protein molecule in both directions, depending upon whether glucose concentration is higher inside or outside the membrane.

(ii) Active transport :- In this case, carrier proteins move substances against the concentration gradient, i.e., from lower concentration to higher concentration. This "uphill" transport involves work and always requires energy provided by ATP (adenosine triphosphate).

Mechanism of active transport of materials is described below :

(i) The carrier protein has a binding site for ATP in addition to the binding site for the substrate. As the ATP molecule binds to the carrier protein, it is hydrolyzed to ADP.

(ii) The energy so set free brings the substrate binding site of the carrier protein to the surface of the membrane. The substrate present in the medium joins the carrier protein at substrate binding site to form carrier-substrate complex.

(iii) The substrate bond carrier protein undergoes conformational change and carries the substrate through a channel in it to the cytoplasmic side of the membrane.

(iv) Now, the form of binding site changes and the substrate is released. The carrier protein regains its original form and is ready to transport another molecule of substrate.

There are many active transport systems in the cell. Among these, **sodium-potassium exchange pump** is prominent. It maintains sodium and potassium gradients between cells and the surrounding extracellular fluid.

Importance of active transport :- The $Na^+ - K^+$ exchange pump plays following roles :

(i) It helps in maintaining a positive charge on the outside of the membrane and negative charge on the inside (resting potential),

(ii) It helps in nerve impulse conduction,

(iii) It helps in muscle contraction,

(iv) It helps in urine formation in kidney tubules,

(v) It helps in salt excretion in marine birds, and

(vi) It helps in controlling water contents of the cell.

DIFFERENCES BETWEEN ACTIVE TRANSPORT AND DIFFUSION

S. No.	Active Transport	S. No	Diffusion
1	It is a rapid process.	1	It is a slow process.
2	It can move materials through a biomembrane against the concentration gradient.	2	It can move materials across a biomembrane down the concentration gradient.
3	It takes place in one direction only.	3	It takes place in both directions.
4	It needs carrier proteins to occur.	4	It occurs without carrier proteins.
5	It uses energy of ATP.	5	It does not use energy.
6	It brings about selective uptake of materials.	6	It allows all transmissible molecules to pass through membranes
7	It leads to accumulation of materials in the cells.	7	It does not accumulate materials in the cells.

Bulk Transport :-

Animal cells can also actively take in and turn out materials in masses much larger than in the hither to described processes by utilizing energy. Such materials include macromolecules, lipid droplets and solid particles. Items of this size cannot cross the phospholipid bilayer by diffusion or with the help of transport proteins. Special processes are involved in the transport of such large quantities of materials.

These include endocytosis (phagocytosis) and exocytosis.

Endocytosis :-

The term endocytosis refers to invagination of a small region of plasma membrane, and ultimately forming an intracellular membrane-bound vesicle. Endocytosis is not shown by plant cells because of their rigid cell wall and internal turgor pressure. Depending upon the intake of fluid droplet or solid particles, endocytosis is of two types :

(i) Pinocytosis **(ii) Phagocytosis**

(i) Pinocytosis :- The non-specific intake of a tiny droplet of extracellular fluid by a cell through the cell membrane which cannot otherwise pass through it. It is also, therefore, termed as **cell drinking**. It was first observed in *Amoeba*. In this process, a small region of plasma membrane invaginates and the fluid droplet passes into the pocket so formed. This pocket is called **caveola**. The pocket deepens and finally nips off as a fluid-filled vacuole called **pinosome or pinocytotic vesicle.**

(ii) Phagocytosis :- Phagocytosis is the intake of solid particles by a cell through cell membrane. It is also called cell eating. Phagocytosis is the major feeding method in many unicellular organisms (e.g., *Amoeba*) and simple metazoa (e.g., sponges).

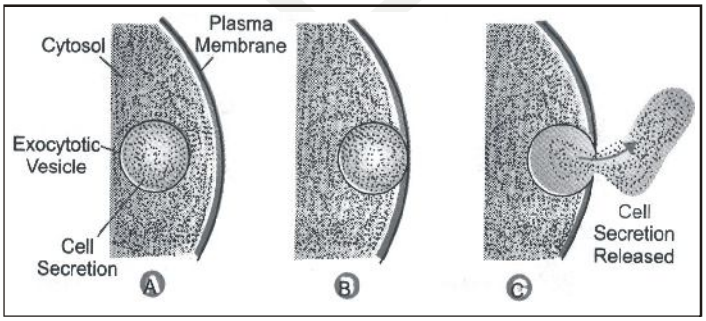
An area of the plasma membrane, coated initially with actin-myosin, comes in contact with the food particle(s). The contact induces the cell membrane to put out tiny protoplasmic processes, the **pseudopodia,** around the food particle(s). The pseudopodia meet on the other side of the food particle(s) and fuse. In this way, an internal vacuole, called **phagosome,** containing food particle(s) in a droplet of water is acquired.

INTERNAL STRUCTURE OF A MITROCHONDRION

DIFFERENCES BETWEEN PINOCYTOSIS AND PHAGOCYTOSIS			
S. No.	**Pinocytosis**	**S. No**	**Phagocytosis**
1	It is the intake of extracellular fluid droplets.	1	It is the intake of extracellular particles
2	Cell membrane invaginates to take up the material.	2	Cell membrane grows around the particle as pseudopodia.
3	Microfilaments play no role in endocytosis.	3	Microfilaments play an important role in phagocytosis.
4	It is a nutritive process.	4	It is a nutritive and defensive process.
5	Pinocytotic vesicles are only 0.1 µm wide.	5	Phagocytotic vesicles are 1 to 2 µm or more wide.

Exocytosis :-

Exocytosis is the process that involves fusion of membrane of the exocytotic vesicle with the plasma membrane to extrude its contents to the surrounding medium.



This process is also called **cellular vomiting** or **ephagy** and the vesicles that turn out the materials are termed **exocytotic vesicles.**

Exocytosis process is responsile for :

(i) removal of undigested food left in the food vacuoles in the cells.

(ii) secretion of substances such as hormones, enzymes, and

(iii) replacement of internalized membrane by the fusion of exocytotic vesicles with the cell membrane.

Functions of plasma membrane

1. It gives a definite shape to the cell.
2. It provides protection to the internal contents of the cell.
3. It regulates entry and exit of substances in and out of the cell.
4. It can internalize solid and liquid materials by infolding or extending around them. This is a process of active intake of materials.
5. In animal cells, it is involved in adhesion, recognition and in the formation of vesicles, cilia, flagella, microvilli, etc.

- Plasma membrane acts as a mechanical barrier to protoplasm so after rupturing or breakdown of plasma membrane, the protoplasmic contents will be dispersed in the surrounding medium.

CELL WALL

Discovered by **Robert Hooke**

(i) The outermost covering of the plant cell is called *cell wall*.

(ii) It is absent in animal cell.

(iii) It is rigid, thick, porous and non-living structure. It become impermeable due to deposition of cell wall materials.

Middle lamella : Common layer between two plant cells is called middle lamella. It consists Ca & Mg pectates (Plant cement). Fruits becomes soft and juicy due to dissolve of middle lamella.

(i) **Cell wall**
- **Primary wall** : Outermost layer
- **Secondary wall** : Rigid, thick (absent in meristem cells)
- **Tertiary wall** : Present only in tracheids of gymnosperm.

(ii) Cellulose is a main constituent of cell wall but addition to cellulose – Hemicellulose, cutin, pectin, Lignin, Suberin are also presents in cell wall

(iii) Cellulose microfibrils and macrofibrils arranged in layers to form skeleton of cell wall. In between these layers other substances like pectin, hemicellulose may be present. These form matrix of cell wall.

(iv) Network of cellulose fibre forms skeleton of cell wall.

35-100 cellulose chain = 1 micelle.

20 micelle = 1 Microfibril

250 micro fibril = 1 macrofibril in cell wall.

(v) **Composition:–**
- (i) Cellulose + Hemicellulose-**in plants**
- (ii) Chitin – **in fungi**
- (iii) Peptidoglycan – **in bacteria and mycoplasma.**

Functions of cell wall :–

1. It determines the shape of the plant cell.
2. It prevents desiccation of cell. [desiccation means drying up of cells]
3. It protects the plasma membrane and internal structures of the cell.
4. It helps in the transport of various substances in and out of the cell.
5. It does not allow too much of water to come in. In this way it prevents the cytoplasm from becoming too dilute.

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:

  (i) Cytosol: Aqueous soluble part contains various fibrous proteins forming cytoskeleton.

  (ii) Cytoplasmic Inclusion: In the cell cytoplasm, there are present numerous living and non-living structures, collectively called cytoplasmic inclusions.

  (iii) Cytoplasmic Inclusion: In the cell cytoplasm, there are present numerous living and non-living structures, collectively called cytoplsmic inclusions.

  (a) The living cytoplasmic inclusions are called cell organelles or protoplasmic inclusions or organolds and

  (b) the non-living structures are called Deutoplasmic or ergastic bodies.
- **Role of Cytoplasm:**

  (i) Participates in intracellular distribution of nutrients, metabolites and enzymes.

  (ii) Helps in exchange of materials between cell organelle.

  (iii) acts as a site of chemical reactions like glycolysis (step of respiration), synthesis of fatty acids.

CELL ORGANELLES

- These are living sub-cellular structures of the cytoplasm and are also called protoplasmic bodies or organoids. These include-
- **Single membranous:** Endoplasmic reticulum, Golgi apparatus, Lysosomes, peroxisomes, Glyoxysomes etc.
- **Double membranous:** Plastid and Mitochondria.
- **Non-membranous:** Ribosomes etc.

NUCLEUS

Introduction :

(i) The nucleus is the most important component of the cell and controls all functional activities of the cell.

Historical Account :

(i) **Robert Brown** (1831) discovered a dense, spherical body in the cells of an 'orchid' and named it as 'Nucleus'.

Ultrastructure :

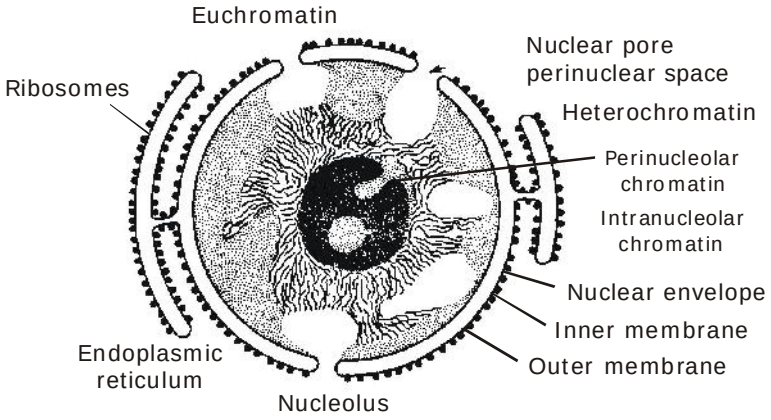
- Nuclear membrane/Nuclear envelope/Karyotheca
- Nuclear sap/ Nucleoplasm/karyolymph.
- Nucleolus.
- Chromatin threads.

(a) Nuclear envelope : Nucleus is surrounded by two membranes, that separates nucleoplasm from cytoplasm. The nuclear membrane has minute pores. These are called nucleo-pores.

(b) Nucleoplasm : The part of protoplasm which is enclosed by nuclear membrane is called nucleoplasm. It contains chromatin threads and nucleolus.

(c) Nucleolus : Discovered by Fontaina. Usually one nucleolus is present in each nucleus but sometimes more than one nucleoli are present. It is a store house of RNA.

(d) Chromation threads : A darkly stained network of long and fine threads called chromatin threads. Chromatin threads are intermingled with one another forming a network called chromation reticulum. Whenever the cell is about to divide the chromatin material gets organized into chromosomes.



ELECTRON MICROSCOPICS
STRUCTURE OF NUCLEUS

❑ **Functions of Nucleus :**

(i) The nucleus control all metabolic activities of the cell.

(ii) It regulates the cell cycle.

(iii) It brings about growth of the cell by directing the synthesis of structural proteins.

(iv) It takes part in the formation of ribosomes.

(v) It contains genetic information and is concerned with the transmission of hereditary traits from one generation to another.

Do you know?

- Chromatin threads are made up of –
  (i) DNA **(ii)** Protein [Histone protein]
- **Gene:–** The segment of DNA and act as unit of heredity
- **ATP:–** Adenosine triphosphate. It is also known as energy currency. It provides energy to perform bio-synthesis & mechanical work.
- **Homologous chromosomes:–** All chromosomes are found in pair and the chromosomes of a pair are called homologous chromosomes.
- **Non-homologous chromosomes:–** Chromosomes of different pair.
- The nucleus of prokaryotes is also known **nucleoid.**
- Nucleus is also called **director of cell** as it controls most of the cellular activities.
- Nucleus is absent in **sieve tubes of vascular plants & mature RBC's of mammals.** Mammalian RBC also lacks Golgibodies, mitochondria, ER, lysosomes.

ENDOPLASMIC RETICULUM

Introduction :

(i) In the cytoplasm some closed or open, branched cavities are present which are bounded by membranes to form a network of membranous system called **Endoplasmic Reticulum.**

Historical Account :

(i) **K.R.Porter** (1948) reported this net-like system under electron microscope.

Ultrastructrure :

(i) A system of membranes attached to the nucleus and present in the cytoplasm is called E.R.

(ii) The Endoplasmic Reticulum (ER) is divided into two parts

✧ It is the netowork of membranes present in the cytoplasm.

- It was discovered by Porter, Claude and Fullan.
- These are present in all cells except prokaryotes and mammalian erythrocytes.
- They are made up of three components:

(A) Cisternate:

- These are long, flattened, parallely arranged, unbranched tubules.
- These form successive layers of nucleus.
- These are found in cells which are active in protein synthesis and are 40 - 50 μm in diameter.

(B) Vesicles: These are rounded or spherical, They are found in synthetically active cells.

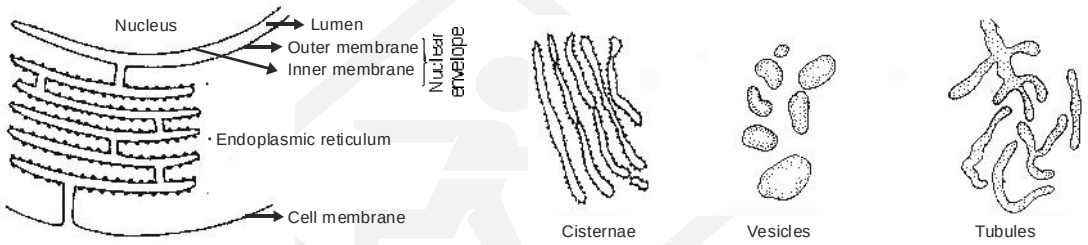
(C) Tubules: These are small, smooth walled and have tubular spaces. These are found in non secretory as well as steroid synthesizing cells.

(a) Rough Endoplasmic Reticulum (RER)

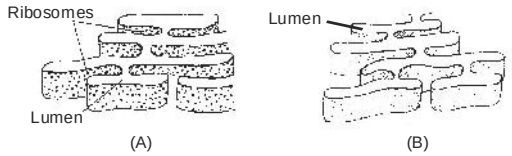
(b) Smooth Endoplasmic Reticulum (SER)

(i) RER possesses rough wall because ribosomes remain attached on the surface. **RER** is present in cells which are involved in protein synthesis.

(ii) **SER** mainly present in cells which are involved in lipoproteins and glycogen synthesis. It perfoms **detoxification**.



Endoplasmic reticulum as seen in section **Parts of Endoplasmic reticulum**



(A) : Rough endoplasmic reticulum
(B) : Smooth endoplasmic reticulum

❑ **Functions of Endoplasmic Reticulum :**

(i) It forms supporting skeleton framework of the cell.

(ii) Certains enzymes present in smooth E.R. synthesis fats (lipids), steroids and cholesterol.

(iii) Rough E.R. is concerned with protein synthesis.

(iv) Smooth E.R. is involved in the process of detoxification.

PLASTID

- Plants and some protists have several types of double membrane bound organelles called plastids, which harvest solar energy, manufacture nutrient molecules and store materials.
- Plastid term was coined by E. Haeckel.

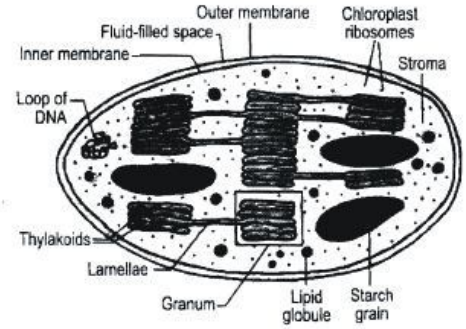
- Plastids generally contian pigments and may synthesize & accumulate various substances.
- Depending upon the type of pigment present in them they are of following three types.

S.NO.	LEUCOPLAST	CHROMOPLAST	CHLOROPLAST
1	Non Pigmented White in colour	Coloured pigments All colours except green Phaeoplast - Brown Rhodoplast - Red	Green pigment chlorophyll is found in them.
2	Generally found in underground parts Important for food storage. E.g. Aleuroplast (Protein), Elaioplast (Oil), Amyloplast (Starch)	Found in flowers, Fruits, Leaves etc.	Found in aerial parts of plant which are green in colour

- **Chloroplast:**
  - It is a double membranous discoidal structure, found only in plant cells.
  - Chloroplast was discovered by A.V. Leeuwenhoek and named by Schimper.
  - Besides being discoidal or rhombic in plant cells they occur in variable shapes like in algae they can be 'U' shaped, spiral, coiled, ribbon shaped etc.
  - In each thylakoid Quantasomes are present which are called as Photosynthetic units.
  - Each quantasome possesses 230 chlorophyll molecules.
  - Each chloroplast consists of two parts.

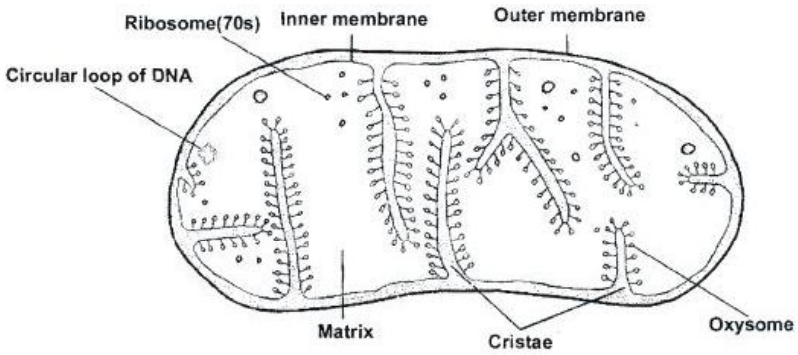
  (i) Grana: It constitutes the lamellar system. These are found layered on top of each other, these stacks are called as Grana.
  - Each granum of the chloroplast is formed by superimposed closed compartments called Thylakoids.
  - **Functions:** Grana are the sites of light reaction of photosynthesis as they contain phtosynthetic pigment chlorophyll.

  (ii) Stroma: It is a granular transparent substance also called as matrix.
- Grana are embedded in it. Besides grana they also contain lipid droplets, starch grains, ribosomes etc.
- **Function:** This is the site of drak reaction of photosynthesis.



INTERNAL STRUCTURE OF CHLOROPLAST

MITOCHONDRIA



MITOCHONDRIA

- It was first seen by Kolliker in insect cells and named by Benda.
- It is a rod shaped structure found in cytoplasm of all eukaryotic cell except mammalian RBC's.
- These are also absent in prokaryotes.
- Maximum mitochondria are found in metabolically active cells.
- It is also called as "Power House of the Cell" or the "Storage Battery".
- It is double membranous structure where outer membrane has specific proteins while inner me:nbrane is folded inside to form chambers called Cnstae."Cristae" are the infoldings of inner mitochondrial membrane that possess enzymes for respiratory cycles like Kreb Cycle. ATP synthesizing units are called Oxysomes or $F_0 - F_1$ Particles.
- Space between inner and outer mitochondrial membranes is called as perimitochondrial space. The fluid present in mitochondria is called as matrix.

(a) Functions:

(i) Its main function is to produce and store the energy in the form of ATP.

(ii) It is the site of Kreb's cycle of respiration, as it contains enzymes for Kreb cycle.

(iii) Oxysome contains enzymes for ATP production.

GOLGI COMPLEX

Discovered by **Camillo Golgi (1898)** in nerve cells of owl.

Other names:–

(i) Lipochondrion, (ii) Idiosome,

(iii) Baker's body, - In fungus (iv) Dalton complex

(v) Dictyosomes – In plants

Position:– It is located near the nucleus.

- The cytoplasm surrounding Golgi body have fewer or no other organelles. It is called **Golgi ground substance or zone of exclusion.**
- Golgi bodies are **pleomorphic structures**, becaue component of golgi body are differ in structure & shape in different cells.

Structure:– It is formed of four types of contents.

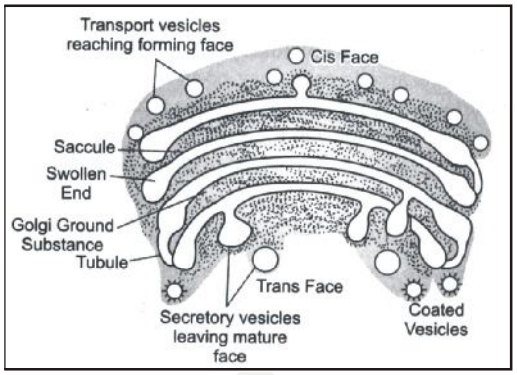
(i) Cisternae – These are long flattened and unbranched saccules. 4 to 8 saccules are arranged in a stack.

(ii) Tubules – These are branched and irregular tube like structures associated with cisternae.

(iii) Vacuoles – Large spherical structures associated to tubules.

(iv) Vesicles – Spherial structures arise by budding from tubules. Vesicles are filled with secretory materials.

Golgibody is single membrane bound cell organelle.



Function:–

(i) It involved in cell-secretion and acts as storage, modification and condensation or **packaging membrane**.

(ii) It forms the **Acrosome** of sperm [**Acrosome :-** A bag like structure filled with lytic enzymes which dissolve egg membrane at the time of fertilization]

(iii) It forms the lysosomes and secretory vesicles.

(iv) It is the site for formation of glycolipids and glycoproteins.

(v) Synthesis of cell wall material (Polysaccharide synthesis)

(vi) Cell plate formation (phragmoplast) during cell formation.

(vii) **Vitelline membrane of egg** is secreted by Golgi body.

LYSOSOME

First observed and the term coined by **Christian De Duve (1955)**

- Lysosomes are spherical bag like structures [0.1 – 0.8 µm] which is covered by single unit membrane.**With the exception of mammalian RBC** they are reported from all cells. Lysosomes are filled about 50 different types of digestive enzymes termed as **acid hydrolases.**
- **Lysosomes are highly polymorphic cell organelle**. Because, during functioning, lysosomes have different morphological and physiological states.

Types of Lysosomes

- **Primary lysosomes or storage granules –** These lysosomes store enzyme Acid Hydrolases in their inactive form. These are newly formed lysosome.
- **Digestive vacuoles or Heterophagosomes –** These lysosome forms by the fusion of primary lysosomes and phagosomes. These are also called **secondary lysosomes.**
- **Residual bodies –** Lysosomes containing undigested material are called **residual bodies.** These may be eliminated by exocytosis. These are also called as Telolysosomes. **(Tertiary lysosomes)**
- **Autophagic lysosomes or cytolysosomes or autophagosomes –** Lysosomes which digest cell organelles are known as **Autophagosomes.**

Functions :–

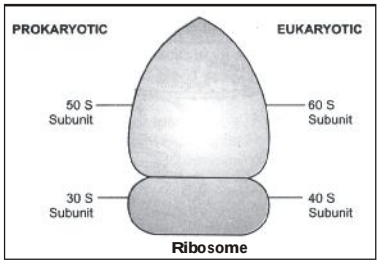
(i) Heterophagy :– It involve in digestion of foreign materials received in cell.

(ii) Autophagy :– Digestion of old or dead cell organelles.

(iii) Cellular digestion (Autolysis) :– Sometimes all lysosomes of a cell burst to dissolve the cell completely.

That's why lysosomes also known as **suicidal bags.**

RIBOSOME-ENGINE OF CELL

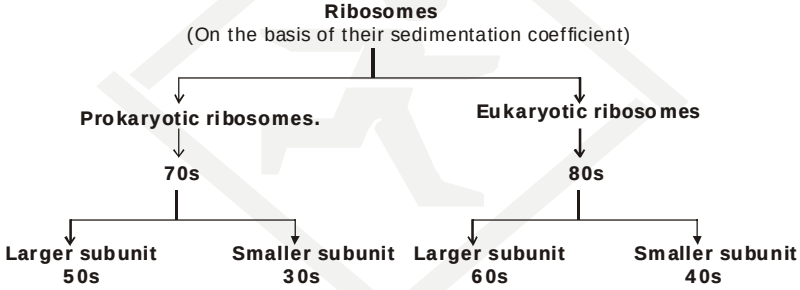


Chemically a ribosome is made of proteins and RNA.

- First reported by Claude and named by G.P alade.
- They are small granular structures visible only under electro microscope.
- They are the only organelles which are present in all types of cells.
- They help in protein synthesis and are known as 'protein factories'.
- Each ribosomes consists of two unequal subunits, larger dome shaped and small ovoid.

The size of ribosome is determined by sedimentation coefficient in the centrifuge.

The cytoplasmic ribosomes of eukaryotes are 80S and in prokaryotes and cell organelles like mitochondria and chloroplast it is 70S type. The two sub units of 80S ribosomes are 60S and 40S while 70S type ribosomes have 50S and 30S subunits.



- Magnesium ion [Mg^{++}] is essential for binding of both the sub units of ribosome.

Functions :–

Site of protein synthesis, so these are also called **protein factories**.

Peroxisomes / Uricosomes.

- Discovered by **Rhodin & Tolbert.**
- Peroxisome term was first used by **De Duve.**

It contains per-oxide forming enzymes.

Functions :–

(i) In animals peroxisomes are concerned with β-oxidation of fatty acids & peroxide metabolism.

(ii) In plants peroxisomes are concerned with **β-oxidation of fatty acids, peroxide metabolism and photorespiration.**

COMPETITION WINDOW

- Scattered Golgibodies in the cytoplasm of plant cells are also called **Dictyosomes.**
- Lysosome found in four forms that's why it is also called **polymorphic cell organelle.**
- Chloroplasts are centres of photosynthesis to prepare the organic food so are called **kitchens of the cells.**

VACUOLES

- Vacuoles of animal cells arise from Golgi-complex.
- **Tonoplast:–** Plasma membrane that covers the vacuole is called tonoplast.

Vacuoles are of three types :-

1. **Food vacuole** – The vacuole which contain food material.
2. **Sap vacuole** – The vacuole which is filled by liquid material [sap]
3. **Contratile vacuole** – The vacuole that concern with osmoregulation e.g. *Amoeba*

Functions :–

(i) Storage of food, water and other substences.

(ii) They help in the elimination of excess water from the cell **(osmoregulation)**, and maintains internal pressure of the cell

Centrosome :– Discovered by **Benden. Boveri** named it as centrosome.

- Centrosome is generally found in animal cells. Only few type of a plant cells show its presence.
- It is situated near the nucleus of the cell and shaped like star.
- Each centrosome has two centrioles. The two centrioles are placed perpendicular to each other.
- Cytoplasm which surrounds centrioles called as **"Centrosphere"**. Centrioles and centrosphere collectively called **centrosome or microcentrum or diplosome.**

Function :–

(i) In animal cells centrioles play important role in initiation of cell division by arranging spindle fibres between two poles of cell.

(ii) The location of centrioles during cell division decides the **plane of division.**

(iii) It form the **basal granule of cilia and flagella** in micro-organisms, zoo-spores & motile gametes.

(iv) Form tail of sperm.

◈ **Cytoskeleton (Cilia and flagella) :**

(i) In many eukaryotic as well as prokaryotic cells of both plants and animals a cytoskeleton has been reported in recent years.

(ii) The elements of this cytoskeleton are proteins.

(iii) The cytoskeleton consists of following two elements within a cell.

(a) Microtubules

(b) Microfilaments

(iv) Cilia and flagella of eukaryotic cells are microscopic, contractile & filamentous process of cytoplasm.

(v) Cilia is shorter than flagella and are numerous.

◈ **Microtubules & Microfilaments :**

(A) Microtubules :

***Introduction* :**

(i) These are cylindrical structures formed by the polymerization of two-part subunits of globular protein tubulin into helical stacks.

Historical Account :

The term **'microtubule'** was coined by **Slautterback** in 1963.

Ultrastructure :

(i) Microtubles radiate from each end of the cell. Which helps in the movement of chromosomes.

(ii) These are found in many plant and animal cells.

- **Function :**

(i) Microtubules help in the structure and movement of cillia and flagella.

(ii) It also play a role in cell division.

(B) Microfilaments :

Ultrastructure *:*

(i) These are long and helically intertwined polymers. Microfilaments are made up of protein **actin.**

- **Function :**

(i) These filaments help in cell movement and in formation of cell furrow and cell plate.

CELL DIVISION

(i) Cell multiplication is needed for the growth, development and repair of the body. Cell multiplies by dividing itself again and again this process called **cell division**.

(ii) Cell divisions are two types

(a) Mitosis (b) Meiosis

MITOSIS

Stages of Mitosis :

Interphase, prophase, metaphase, anaphase and telophase are roughly the five stages or phases of mitosis.

(a) Interphase :

(i) The period between one cell division and the next is called **interphase** in which the cell is said to be in the resting stage.

(ii) Interphase, however, includes three phases, i.e. G1-phase, S-phase and G2-phase. G1-phase is a resting phase or pre-DNA synthesis phase.

(iii) During S-phase, DNA synthesis takes place. G2-phase is again a resting phase and it may be described as a post-DNA synthesis phase.

(iv)The main mitosis division takes place during M-phase which involves prophase, metaphase, anaphase and telophase.

(b) Prophase :

(i) Prophase is actually the first and the longest phase in the mitosis cell division.

(ii) Chromosomes become visible in the nucleus as short, thick and helically-coiled threads.

(iii) Each chromosome splits into two chromatids joined at the centromere.

(iv)Nuclear membrane dissolves away.

(v) Nucleolus also dissolves away and finally disappears.

(c) Metaphase :

(i) It is the second stage in the mitotic cell division.

(ii) Nuclear membrane and nucleolus disintegrate and they are lost completely.

(iii) Spindle tubules start appearing, and these tubules get attached to chromosomes at the centromeres.

(iv) Chromosomes move actively, become shorter and thicker and arrange themselves in the centre or on the equator of the spindle.

(v) Separation of the two chromatids from each chromosomes also begins at the end of metaphase.

(d) Anaphase :

(i) It is the third stage of mitosis.

(ii) Chromatids separate from each other at centromeres.

(iii) Separated sister chromatids, each with a centromere, are called daughter chromosomes. They move to the ends of opposite poles of the spindle.

(iv) Daughter chromosomeres appear in V, U or J-shaped during their movement towards the poles.

(v) During the late anaphase stage, the cell starts constricting in the middle region.

(e) Telophase :

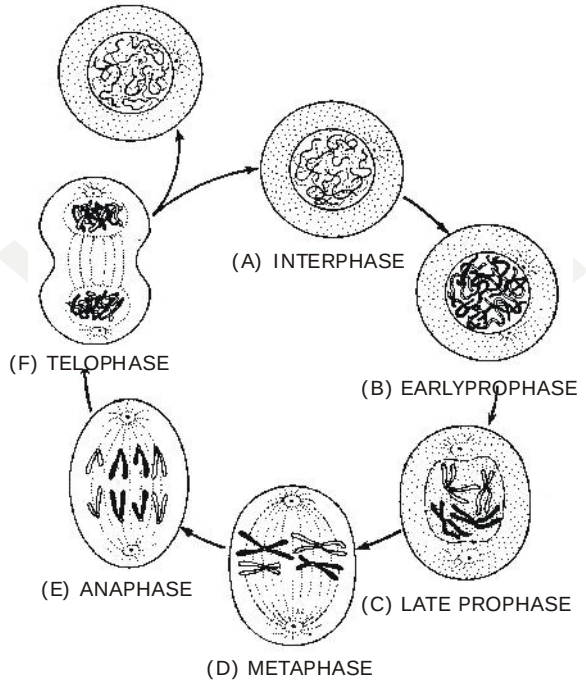
(i) Telophase is the last stage of mitotic cell division.

(ii) Chromatids or daughter chromosomes are now at the end of the spindle.

(iii) Nuclear membranes and nucleoli reform around each group of chromosomes and thus two new nuclei are reorganized at each pole.

(iv) Chromosomes begin to lose their compact structure.

(v) Spindle Xapparatus disappears gradually.



VARIOUS STAGES OF MITROSIS

◈ **Karyokinesis :**

Division of nucleus is called **karyokinesis** and, the process of the division of cytoplasm is called cytokinesis.

(i) In animal cells, a circular constriction appears at the equator, the constriction deepens and eventually divides the cell into two.

(ii) In plant, there is no constriction. A cell plate or new cell wall forms across the cell resulting in the separation of two daughter cells.

Significance of Mitosis :

(i) Mitosis occurs during the growth and development of multicellular plants and animals.

(ii) Mitosis ensures that the two daughter cells inherit the same number of chromosomes.

(iii) It helps the cell in maintaining proper size.

(iv) In unicellular organisms mitosis helps in asexual reproduction during which two or more individuals arise from the mother cell.

(v) If mitosis becomes uncontrolled it may cause tumour or cancerous growth.

MEIOSIS

(i) **Meiosis is also called reduction division** because the chromosomes in this division are reduced from the diploid to the haploid number.

(ii) Meiosis occurs in all organisms which reproduce sexually.

(iii) Meiosis produces haploid sex cells from diploid cells.

(iv) Meiosis involves two cell division, viz., meiosis I and meiosis II.

(v) In meiosis I, the replicated homologous chromosomes pair with each other on the spindle, cross over and then separate to either end of the spindle.

(vi) On the other hand, in meiosis II, the chromatids of each chromosome move towards the centromere, and these chromatids separate at each end of the second spindle.

(vii) As a result of this process, a diploid cell divides to form four haploid cells.

First Meiosis Division :

First meiosis division is actually the reduction division. It consists of prophase I, metaphase I, anaphase I and telophase I.

(a) Prophase I :

(i) Prophase I is the longest phase of meiosis and includes five sub-phases.

(i) Leptotene :

(i) This is the first stage in the first meiosis prophase.

(ii) In this stage, the chromosomes appear as separate thin and fine thread-like structures.

(ii) Zygotene :

(i) Homologous chromosomes come together, or arrange themselves side by side in pairs to form bivalents.

(ii) This **pairing of homologous chromosomes** during zygotene in the first meiosis prophase is called **synapsis**.

(iii) Pachytene :

(i) The bivalents or chromosomes become shorter and thicker.

(ii) They replicate or split into chromatids but remain linked at the centromeres.

(iii) Each bivalent thus now consists of four chromatids.

(iv) **Crossing over** between non-sister chromatids of homologous pair takes place.

(iv) Diplotene :

(i) The centromeres of paired chromosomes or bivalents move away from each other and crossing over can also be seen.

(ii) The points in a bivalent where the two chromosomes appear to be joined and crossed over are called **chiasmata**.

(iii) Chiasmata formation and crossing over are the distinguishing features of diplotene.

(v) Diakinesis :

(i) This is the last stage of first meiosis prophase.

(ii) The chromosomes become shortest and thickest.

(iii) **Terminalisation of chiasmata**.

(iv) Nuclear membrane starts disintegrating. Nucleolus also disintegrates. Diakinesis followed by metaphase I.

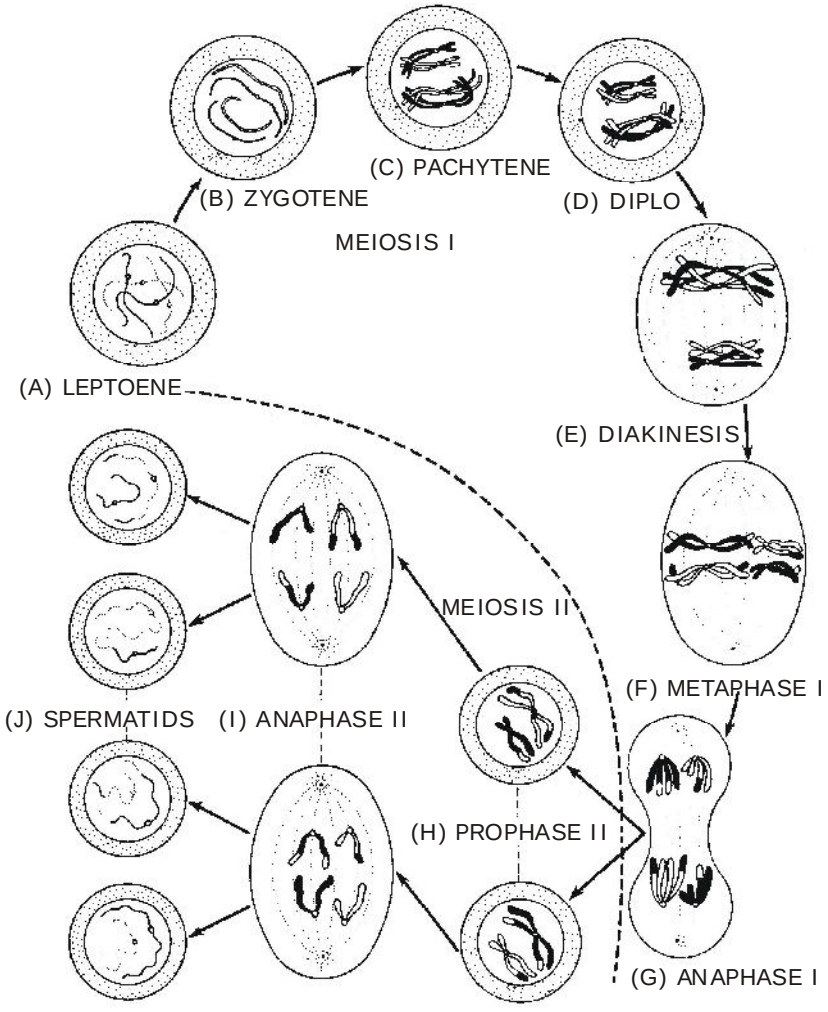
(b) Metaphase I :

(i) Nuclear membrane disappears completely at the beginning of metaphase I.

(ii) Pairs of homologous chromosomes are lined up at the centre.

(iii) Spindle apparatus starts appearing. Few spindle fibres get attached with the centromeres of chromosomes.

(iv) Metaphase I change into anaphase I.



DIFFERENTSTAGES OF MEIOSIS

(c) Anaphase I :

(i) Partners of homologous chromosomes separate completely and move to opposites poles of spindle during anaphase I, which in turn changes into telophase I.

(d) Telophase I :

(i) The separated partners of homologous chromosomes collect at the poles of the spindle and nuclear membranes form around them. Two daughter haploid nuclei are thus formed. The chromosomes lengthen as they uncoil. Nucleoli start reappearing.

Second Meiosis Division :

Like mitosis, the second meiosis divisions also consists of four phases, i.e. prophase II, metaphase II, anaphase II and telophase II.

- **Prophase II :**

(i) In both the haploid nuclei, each chromosome splits up into two chromatids with a single functional centromere. The nuclear membrane and nucleolus disintegrate partially or completely.

- **Metaphase II :**

(i) The chromatids arrange themselves at metaphase plate or spindle.

- **Anaphase II :**

(i) During anaphase II, the centromere splits. The two chromatids belonging to each chromosomes may now be called chromosomes and pass to the two opposite poles of spindle.

- **Telophase II :**

(i) The haploid set of chromosomes at two different poles of spindle uncoil and form chromatin material. Nuclear membrane forms around each haploid set of chromosomes. Nucleolus also reappears.

Significance of Meiosis :

(i) Meiosis results in the formation of haploid gametes (sperm and ovum)

(ii) The phenomenon of crossing over provides new combinations of chromosomes and, hence new combinations of genes and also of characters in offspring.

(iii)The four chromatids of a homologous pair of chromosomes are passed on to four different daughter cells. This is called the segregation of chromosomes. This causes genetic variations in daughter cells.

(iv)Failure of meiosis leads to the formation of diploid gametes which on fusion form polyploids.

DIFFERENCE BETWEEN MITOSIS AND MEIOSIS CELL DIVISION ::

Special Note :

Besides mitosis and meiosis, there is also a third type of division. It is called **amitosis**. It is a direct division of the nucleus by constriction.

S.No.	Mitosis	Meiosis
1	It occurs in all somatic cells.	It occurs in reproductive cells (germ cells or sex cells)
2	In the resultant daughter cells, the number of chromosomes remains the same (i.e. diploid) hence called equational division.	In resultant daughter cells the number of chromosomes reduces to half (i.e. haploid) hence, called reductional division.
3	By mitosis two daughter cells are produced.	By meiosis, four daughter cells are produced.
4	During mitosis no crossing over takes place.	During meiosis crossing over take place.
5	Daughter cells have identical chromosomes which are also identical to that of parent cell (i.e., remains constant)	Chromosomes of the daughter cells are with combined components (genes) of both parents (i.e. genetic variability occurs)

SOLVED PROBLEMS

Q.1 Plasma membrane is made up of which two components?

Sol. The two components are lipids and proteins.

Q.2 Cell wall is made up of which components?

Sol. Cell wall is made up of cellulose.

Q.3 Give an example of unicellular organism.

Sol. Amoeba, Bacteria, Paramedium.

Q.4 What is the intracellular source of digestive enzyme?

Sol. Lysosome.

Q.5 What is the function of mitochondria?

Sol. Mitochondria are sites of cellular respiration in which energy, i.e., packets of ATP are formed.

Q.6 Name two structures found in animal cells but not in plant cells.

Sol. Lysosomes and Centrioles.

Q.7 Give the name of colourless plastids.

Sol. Leucoplast.

Q.8 What is plasmolysis?

Sol. The shrinkage of protoplasm away from cell wall due to loss of water by osmosis when the cell is kept in hypoertonic medium.

Q.9 What is the function of the cell wall?

Sol. The cell wall lies outside the plasma membrane and is responsible for providing structural strength to the plants.

Q.10 There would be no plant life in chloroplasts did not exist. Justify.

Sol. Chloroplast contains the pigment chlorophyll which is responsible for food preparation by photosynthesis in plants. Hence, if there were no chloroplasts then there would not have been any plant life.

Q.11 Why the Golgi apparatus is called the secretary organelle of the cell?

Sol. This is because it packages material synthesised in the ER and dispatches it to intracellular (plasma membrane and lysosomes) and extracellular (cell surface) targets.

Q.12 Differentiate between smooth and rough endoplasmic reticulum.

Sol. Differences between Smooth and Rough Endoplasmic Reticulum are

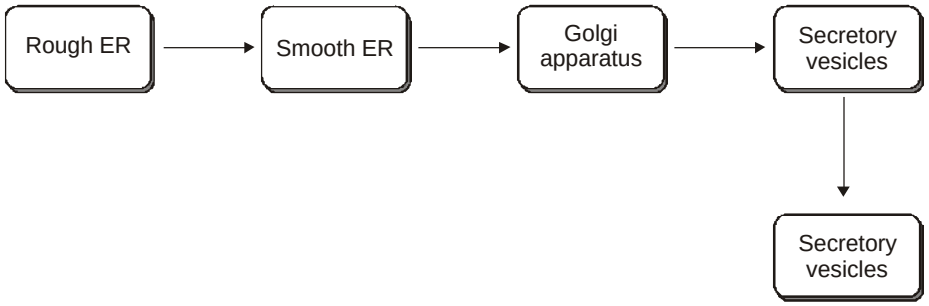
Rough endoplasmic reticulum	Smooth endoplasmic reticulum
1. They have ribosomes attached on their surface.	1. They don't have ribosomes attached on their surfaces.
2. RER manufactures proteins and transport them to various places.	2. SER helps in manufacturing lipids and transport them to various places.

Q.13 What is Cytosol and Cytoskeletone?

Sol. Cytosol is the semi-fluid part of the cell cytoplasm which is embedded with organelles. Cytoskeletone is a network of fibres present in the cell which provides a supporting framework for the organelles.

Q.14 What is membrane biogenesis? How plasma membrane is formed during this process?

Sol. The process of plasma membrane formation is called membrane biogenesis.



Q.15 Why are peroxisomes mostly found in kidney and liver cells?

Sol. Peroxisomes contain various oxidative enzymes which detoxify the toxic material.

Since the blood carries various toxic substances to kidney and liver, a large number of peroxisomes are present in them to oxidise the toxid material.

Q.16 What is the difference between plant cell and animal cell?

Sol.

Plant cell	Animal Cell
1. Plant cell has rigid cell wall.	1. Cell wall is absent
2. It can't change its shape.	2. An animal cell can often change its shape.
3. Plastics are present.	3. Plastics are usually absent.
4. A mature plant cell contains a large central vacuole.	4. Generally absent but may possess many small vacuoles.
5. Nucleus lies on one side in the peripheral cytoplasm.	5. Nucleus usually lies in the centre.
6. Nucleus is usually elliptical.	6. Nucleus is usually round.
7. Plant cells do not burst if placed in hypotonic solution due to the presence of cell wall.	7. Animal cell usually burst, if placed in hypotonic solution.
8. Centrioles are usually absent except in lower plants.	8. Centrioles are found in animal cell.
9. The cell can't take part in phagocytosis	9. It can ingest material through phagocytosis.

Q.17 What is the active transport? Differentiate between active and passive transport.

Sol. The process in which the molecules are moved uphill against the concentration gradient. Active transport always involves the expenditure of energy because the materials are pumped against the concentration gradient.

Active transport	Passive transport
1. It involves movement of molecules against the concentration gradient.	1. It involves movement of molecules along the concentration gradient.
2. It requires energy in the form of ATP molecule.	2. No energy is required
3. It is a rapid movement.	3. It is a slow movement.
4. Movement of large molecules occurs by active transport.	4. Small molecules or water molecules only are transported passively.

EXERCISE – I BOARD PROBLEMS

Q.1 Who discovered cells and how ?

Q.2 Why the cell is called the structural and functional unit of life ?

Q.3 How substances like carbon dioxide and water move in and out of the cell ?

Q.4 Why is the plasma membrane called a selectively permeable membranes ?

Q.5 Fill in the gaps in the following difference between prokaryotic and eukaryotic cells.

Q.6 Can you mane the two organelles we have studied that contain their own genetic material?

Q.7 If the organisation of a cell is destroyed due to some physical or chemical influence, what will happen ?

Q.8 Why are lysosomes known as suicidal bags ?

Q.9 Where are protein systhesised inside the cell ?

Q.10 Plasmas membrane is made up of which two components ?

Q.11 What is hypotonic solution ?

Q.12 What is hypertonic solution ?

Q.13 What is isotonic solution ?

Q.14 Cell wall is made up of which component ?

Q.15 Give an example of unicellular organism.

Q.16 Give an example of multicelluar organism.

Q.17 What is active transport ?

Q.18 What is the intracellular source of digestive enzyme ?

Q.19 What is endocytosis ?

Q.20 What is the function of mitochondria ?

Q.21 What does ATP stand for ?

Q.22 Which cell organelle is responsible for the release of energy as ATP ?

Q.23 Where are genes located ?

Q.24 Name two structures found in plant cells but not in animal cells.

Q.25 Name two structures found in animal cells but not in plant cells.

Q.26 Give the name of colourless plastids.

Q.27 What is membrane biogenesis ?

Q.28 Which organelle is involved in the formation of lysosomes ?

Q.29 Which organelle is responsible for the storage, modification and packaging of produce in vesiscles ?

Q.30 What is the outermost layer found in animal cells ?

Q.31 What is the outermost layer found in the plant cell ?

Q.32 Which organelle helps in photosynthesis ?

Q.33 Which organelle is the storage sac of solid and liquid materials ?

Q.34 Which organelle serves as a channel for transport of materials between cytoplasm and nucleus ?

Q.35 What is microscope ?

Q.36 Why light microscope is called a compound microscope ?

Q.37 What are cell organelles ?

Q.38 Which organelle digests unwanted organic substances ?

Q.39 Which organelle helps in protein synthesis ?

Q.40 Which organelle is associated with ribosome formations ?

EXERCISE – II OLYMPIAD QUESTIONS

Q.1 Double membrane is absent in –

(A) Mitochondrion (B) Chloroplast
(C) Nucleus (D) Lysosome

Q.2 Animal cell is limited by–

(A) Plasma membrane

(B) Shell membrane

(C) Cell wall

(D) Basement membrane

Q.3 The radiant energy of sunlight is converted to chemical energy and stored as –

(A) AMP (B) ADP

(C) ATP (D) APP

Q.4 Root hair absorbs water from soil through –

(A) Osmosis (B) Active transport
(C) Diffusion (D) Endocytosis

Q.5 The barrier between the protoplasm and outer environment in a plant cell is –

(A) Cell membrane (B) Nuclear membrane
(C) Cell wall (D) Tonoplast

Q.6 An animal cell differs from a plant cell in respect of –

(A) ER (B) Cell wall

(C) Ribosomes (D) Cell membrane.

Q.7 If the nucleus is a cell's "control centre" and chloroplasts its "solar collectors". Which of the following might be called the cell's combination "food processor" and "garbage disposer"?

(A) Lysosome (B) Ribosome

(C) Golgi apparatus (D) Nucleolus

Q.8 The longest cell in human body is –

(A) Neuron (B) Muscle fibre
(C) Epithelial cell (D) Bone cell

Q.9 Identify human cells which lack nucleus–

(A) WBC (B) RBC

(C) Platelets (D) Nerve cells

Q.10 The energy currency of a cell is –

(A) ADP (B) AMP

(C) ATP (D) CTP

Q.11 Which organelle releases oxygen?

(A) Ribosome (B) Golgi apparatus
(C) Mitochondria (D) Chloroplast.

Q.12 The term "protoplasm" to the living substance present inside the cell, was given by

(A) Robert Hooke (B) Robert Brown
(C) J.E. Purkinje (D) W.Flemming

Q.13 Ribosomes are the centre for –

(A) Respiration (B) Photosynthesis
(C) Protein synthesis (D) Fat synthesis.

Q.14 Lysosomes are the reservoirs of

(A) Fat

(B) RNA

(C) Secretory glycoproteins

(D) Hydrolytic enzymes.

Q.15 The membrane surrounding the vacuole of a plant cell is called

(A) Tonoplast (B) Plasma membrane
(C) Nuclear membrane (D) Cell wall

Q.16 Centriole is associated with –

(A) DNA synthesis (B) Reproduction
(C) Spindle formation (D) Respiration

Q.17 The cell organelle associated with cell secretion is

(A) Plastids (B) Mitochondria
(C) Golgi apparatus (D) Nucleolus

Q.18 Which of the following is an inclusion?

(A) Mitochondrion (B) Lysosome

(C) Golgi complex (D) Starch grain

Q.19 Which of the following would not be considered part of a cell's cytoplsm?

(A) Ribosome (B) Nucleus

(C) Mitochondrion (D) Microtubule

Q.20 Which of the following is called the brain of the cell?

(A) Nucleus (B) Mitochondria
(C) Ribosomes (D) Plasma membrane

Q.21 Which one is not a part of nucleus?

(A) Chromatin (B) Nucleolus
(C) Centrosome (D) Nucleoplasm

Q.22 The common feature amongst nucleus, chloroplast and mitochondrion is –

(A) DNA (B) Lamellae
(C) Cristae (D) All of these

Q.23 Nucleus is separated from surrounding cytoplasm by a nuclear envelope which is –

(A) Single and porous
(B) Double and porous
(C) Single and nonporous
(D) Double and nonporous

Q.24 Nucleoplasm is continuous with cytoplasm through –

(A) Centriole
(B) Golgi apparatus
(C) Nuclear pores
(D) Endoplasmic reticulum

Q.25 Nucleolus was discovered by

(A) Fontana (B) Schleiden
(C) Altmann (D) Robert Brown

Q.26 The function of the nucleolus in the cell is

(A) Secretory
(B) Synthesis of DNA
(C) Synthesis of RNA and ribosomes
(D) None of these

Q.27 Which of the following phenomena is commonly referred as 'cell drinking'?

(A) Exocytosis (B) Pinocytosis
(C) Endocytosis (D) Phagocytosis

Q.28 The cell organelle taking part in photorespiration is

(A) Glyoxysome
(B) Dictyosome
(C) Peroxisome
(D) Endoplasmic reticulum

Q.29 Endoplasmic reticulum sometime contains –

(A) Ribosomes (B) Lysosomes
(C) Golgi bodies (D) None of these

Q.30 Ribosomes are composed of –

(A) 1 subunit (B) 5 subunits
(C) 2 subunits (D) 4 subunits

Q.31 In chloroplasts, chlorophyll is present in the–

(A) Stroma (B) thylakoids
(C) Outer membrane (D) Inner membrane

Q.32 The sedimentation coefficient of complete ribosome in bacterial cell is

(A) 70S (B) 80S
(C) 78S (D) 60S

Q.33 Which one of the following is common in plant and animal?

(A) Mitochondria (B) chloroplast
(C) Centriole (D) Cell wall

Q.34 Which of the following is a nonliving cell inclusion?

(A) Vacuoles (B) Ribosomes
(C) Centrosomes (D) Golgi complex

Q.35 Cell vacuole contains

(A) Water
(B) Metabolic gases
(C) Cytoplasm
(D) Water and dissolved substances

Q.36 A mature plant cell has –

(A) Protoplasm and vacuole
(B) Vacuole and cell wall
(C) Cell wall and protoplasm
(D) Protoplasm, cell wall and vacuole

Q.37 Centriole takes part in –

(A) Cell plate formation

(B) Spindle formation

(C) Nucleolus formation

(D) Start of cell division

Q.38 Which of the following is called 'an organelle within an organelle'? –

(A) Plastid (B) Ribosome

(C) Lysosome (D) Microsome

Q.39 Cell organelle common in Protista and Monera is –

(A) Vacuole (B) Ribosome

(C) Lysosome (D) Chloroplast

Q.40 Which of the following organelles lack membranes?

(A) Ribosome (B) Mitochondria

(C) Golgi complex (D) Nucleus

Q.41 Besides cellulose microfibrils, the other two cell wall networks are :-

(A) Protein and hemicellulose

(B) Hemicellulose and protein

(C) Pectin and glycoprotein

(D) Pectin and hemicellulose

Q.42 Middle lamella occurs :-

(A) Inner to primary wall

(B) Inner to secondary wall

(C) Outer to secondary wall

(D) Outer to primary wall

Q.43 Hydrophilic chemical of cell wall is :-

(A) Pectin (B) Suberin

(C) Fat (D) Lignin

Q.44 Structural element of cell wall is :-

(A) Matrix

(B) Microfibrils

(C) Microtubules

(D) Arabinogalactans

Q.45 Different layers of cell wall are :-

(A) Middle lamella and primary wall

(B) Primary wall and secondary wall

(C) Middle lamella, primary wall and secondary wall

(D) Wall layers exclude middle lamella

Q.46 The first wall layer of cell is :-

(A) Tertiary wall, if present

(B) Secondary wall

(C) Primary wall

(D) Middle lamella, if present

Q.47 Plant cells are distinguishable from animal cell in containing :-

(A) Mitochondria (B) Ribosomes

(C) E.R. (D) Cell wall

Q.48 Ripe fruits soften due to :-

(A) Degeneration of cell walls

(B) Partial solubilisation of pectic compounds

(C) Metabolism of tannins

(D) Exosmosis

Q.49 Ribosomes contain large quantities of :-

(A) haemoglobin (B) fatty acid

(C) ribonucleic acid (D) deoxyribonucleic acid

Q.50 Glycocalyx is :-

(A) Glycoproteins and glycolipids

(B) Oligosaccharide part of glycolipids and glycoproteins

(C) Lipid and protein parts of glycolipids

(D) Mucopolysaccharides attached to cell wall

Q.51 Which of the following organelles lack membranes?

(A) Ribosome (B) Lysosome

(C) Golgi body (D) Nucleus

Q.52 Protein synthesis occurs on :-

(A) ribosome (B) nucleus

(C) lysosome (D) centrosome

Q.53 The term protoplasm was coined by :-

(A) Huxley (B) Purkinje

(C) Dujardin (D) Schultze

Q.54 A unit of protoplasm having a nucleus and covered by plasmalemma is called :-

(A) Ectoplast (B) Cell

(C) Cytoplast (D) All the above

Q.55 The term cytoplasm was coined by :-

(A) Sachs (B) Strasburger

(C) Hanstein (D) Flemming

Q.56 Which of the following is correct for prokaryotic ribosome :-

(A) it dissociates into 50S and 30S

(B) it dissociates into 40S and 40S

(C) it dissociates into 60S and 20S

(D) it dissociates into 70S and 30S

Q.57 Golgi apparatus takes part in synthesis of :-

(A) Glycolipids (B) Glycoproteins

(C) Hormones (D) All the above

Q.58 In a cell DNA is found in :-

(A) nucleus, mitochondria and plastid

(B) nucleus, mitochondria and Golgi body

(C) mitochondria, Golgi body and plastid

(D) nucleus, Golgi body and plastid

Q.59 Cartilage matrix is digested during its osteogenesis through :-

(A) Intracellular autophagic activity

(B) Extracellular lysosomal activity

(C) Intracellular heterophagic activity

(D) Both B and C

Q.60 Which one is lysosomal activity :-

(A) Reabsorption of tadpole tail

(B) Mobilisation of stored substances

(C) Removal of obstructions

(D) All the above

Q.61 When are lysosomes extra-active :-

(A) Seed maturation (B) Seed germination

(C) Flowering (D) Fruiting

Q.62 In animal cell, a mitochondrion is :-

(A) Largest organelle

(B) Second largest organelle

(C) Third largest organalle

(D) None of the above.

Q.63 Outer mitochondrial membrane resembles bacterial membrane and outer chloroplast membrane in having :-

(A) Selective permeability

(B) Single ion channels

(C) Porin

(D) All the above

Q.64 Chromoplasts are formed from chloroplasts during :-

(A) Ripening of Tomato

(B) Ripening of Chilli

(C) Development carrot

(D) Both A and B

Q.65 Experiments on *Acetabularia* by Hammerling proved the role of :-

(A) nucleus in heredity

(B) nucleoplasmic ratio

(C) chromosomes in heredity

(D) cytoplasm in controlling differentiation

Q.66 The plastids with irregular shape are :-

(A) Leucoplasts

(B) Chloroplasts

(C) Chromoplasts

(D) Amyloplasts

Q.67 Peroxisomes and glyoxisomes are :-

(A) Energy transforming organelles

(B) Membrane-less organelles

(C) Macrobodies

(D) Microbodies

Q.68 Structure of nuclear envelope facilitates :-

(A) spindle organization

(B) separation of daughter chromosomes

(C) synapsis of homologous chromosomes

(D) nucleocytoplasmic exchange of materials

Q.69 Microfilaments were discovered by :-

(A) Slautterback (B) Paleviz *et al*

(C) Altman (D) Ledbetter and Porter

Q.70 Microfilaments are required for :-

(A) Movement of flagella and cilia

(B) Cell polarity

(C) Sol-gel changes

(D) All the above

Q.71 Cell polarity is determined by :-

(A) Intermediate filaments

(B) Microtubules

(C) Protofilaments

(D) Centrioles

Q.72 Who coined the term 'Nucleolus' ?

(A) Brown (B) Hooke

(C) Fontana (D) Bowman

Q.73 Which of the following phenomena is commonly referred as 'cell drinking' ?

(A) Exocytosis (B) Pinocytosis

(C) Endocytosis (D) Phagocytosis

Q.74 The two centrioles of a pair occur :-

(A) Parallel to each other

(B) At right angles to each other

(C) At an angle other than 90°

(D) End to end

Q.75 Cell organelle having a cartwheel constitution is :-

(A) Centriole and basal body

(B) Microtubule

(C) Microfilament

(D) Basal plate

Q.76 A flagellum beats :-

(A) Independently, undulatory and asymmetrically

(B) Independently, undulatory and symmetrically

(C) Coordinated, pendular and symmetric

(D) Coordinated, pendular and asymmetric

Q.77 Food vacuole is formed from :-

(A) Absorbed and digested food

(B) Phagosome + Lysosome

(C) Feeding canals + Lysosome

(D) Feeding canals + Phagosome

Q.78 Chromatin material which remains condensed during interphase is called :-

(A) Heterochromatin (B) Euchromatin

(C) Chromonemata (D) Megachromatin

Q.79 Nucleolus was discovered by :-

(A) Robert Brown (B) Leeuwenhoek

(C) Robert Hooke (D) Fontana

Q.80 Nucleolus is formed from :-

(A) Nucleus

(B) nuclear sap

(C) Sat chromosome

(D) Giant chromosome

Q.81 Components of nucleus are :-

(A) Karyotheca, nucleolus, chromatin, nucleoplasm and nuclear matrix

(B) Nuclear envelope, nucleolus and chromatin

(C) Nuclear envelope, nucleoplasm and chromatin

(D) All the above

Q.82 Which one of the following pairs is not correctly matched ?

(A) Nucleus - Genetic information

(B) Cell membrane - Permeability

(C) Golgi complex - Secretion

(D) Microtubular organelles - Glycolysis

Q.83 Calcium is deposited in plant cells as :-

(A) Calcium carbonate

(B) Calcium oxalate

(C) Calcium sulphate

(D) All the above

Q.84 What is the latest and most acceptable model of cell membranes :-

(A) Lamellar model

(B) Fluid mosaic model

(C) Micellar model

(D) Unit membrane concept

Q.85 Cell membrane is composed of :-

(A) Phospholipid (B) Nucleoprotein
(C) Polysaccharides (D) Lipoprotein

Q.86 In a membrane phospholipid, there are :-

(A) One polar head and two nonpolar tails

(B) Two polar heads and one nonpolar tail

(C) One nonpolar head and two polar tails

(D) Two nonpolar heads and one polar tail

Q.87 Extrinsic proteins of cell membrane are :-

(A) Present superficially and are easily separable

(B) Present superficially but are not separable

(C) Attached to intrinsic proteins but are easily separable

(D) Attached to intrinsic proteins and are not easily separable

Q.88 Main function of plasma membrane is to :-

(A) Control cell movements

(B) Control cell activities

(C) Maintain cell shape and size

(D) Regulate exchange of materials

Q.89 The process of taking in liquid material by infolding of membrane is known as :-

(A) Phagocytosis (B) Osmosis

(C) Active transport (D) Pinocytosis

Q.90 Active transport across biomembrane involves:-

(i) Production of ATP

(ii) Requirement of energy

(iii) Production of toxin

(iv) Release of energy

(A) light microscope (B) electron microscope
(C) both of these (D) none of these

Answers

1.	D	**2.**	A	**3.**	C	**4.**	A
5.	C	**6.**	B	**7.**	A	**8.**	A
9.	B	**10.**	C	**11.**	D	**12.**	C
13.	C	**14.**	D	**15.**	A	**16.**	C
17.	C	**18.**	D	**19.**	B	**20.**	A
21.	C	**22.**	A	**23.**	B	**24.**	C
25.	A	**26.**	C	**27.**	B	**28.**	C
29.	A	**30.**	C	**31.**	B	**32.**	A
33.	A	**34.**	A	**35.**	D	**36.**	D
37.	D	**38.**	B	**39.**	B	**40.**	A
41.	C	**42.**	D	**43.**	A	**44.**	B
45.	B	**46.**	C	**47.**	D	**48.**	B
49.	C	**50.**	B	**51.**	A	**52.**	A
53.	B	**54.**	C	**55.**	B	**56.**	A
57.	D	**58.**	A	**59.**	B	**60.**	D
61.	B	**62.**	A	**63.**	A	**64.**	D
65.	A	**66.**	C	**67.**	D	**68.**	D
69.	B	**70.**	D	**71.**	B	**72.**	D
73.	B	**74.**	B	**75.**	A	**76.**	B
77.	B	**78.**	A	**79.**	D	**80.**	C
81.	A	**82.**	D	**83.**	D	**84.**	B
85.	D	**86.**	A	**87.**	A	**88.**	D
89.	D	**90.**	B				

NUMBER SYSTEMS

BASIC CONCEPTS AND IMPORTANT RESULTS

1. Natural Numbers (N) :

Counting numbers are known as natural numbers. Thus 1, 2, 3, 4, ...etc. are natural numbers.

- The first and the least natural number is 1 (one)
- Consecutive natural nos. differ by 1 (one).

2. Whole numbers (w) :

All natural numbers together with '0' form whole numbers. Thus 0, 1, 2, 3, 4, ... etc. one are whole nos.

- The first and the least whole number is zero.
- Consecutive whole number differe by one.

3. Integers (I or Z) :

All natural nos. 0 and negative of natural nos. form integers for example. .....–4, –3, –2, –1, 0, 1, 2, 3, 4, ... etc.

- O is neither a negative nor a positive number. It is a neutral no.

4. Prime numbers (P) :

A natural number, which is greater than 1 and divisible by one and by itself only, is called a prime number. For eg : 2, 3, 5, 7, 11, ...

- The smallest prime number is 2
- Except 2 ; all other prime nos. are odd.

5. Composite number (C) :

A natural number, which is greater than 1 and is not prime, is called a composite number. Thus 4, 6, 8, 9, 10, 12, 14, ...

- The smallest composite number is 4.
- A composite number can be even or odd.
- It has atleast three distinct factor.

6. Co-prime numbers :

If two numbers do not have any factor (other than 1) common; the numbers are said to be co-prime Thus (i) 6 and 25 are coprime, no any common factor other than 1. (ii) 3 and 5 are co-prime, no any common factor other than 1.

- It is not necessary that any of the two co-prime numbers has to be prime also.
- All consecutive nos. are coprime.

7. Terminating decimals :

The decimal expansion ends after a finite number of steps of division. Such decimal expansions are called terminating decimals

For example : $\frac{2}{5} = 0.4$, $\frac{33}{8} = 4.125$ and so on.

8. Non-terminating decimals :

The decimal expansions never come to an end. Such decimal expansions are called non-terminating

For example = $\frac{2}{11} = 0.1818...$, $\frac{16}{45} = 0.3555.....$

9. Rational Numbers (Q) :

The numbers of the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$, are known as rational numbers.

or

A number is rational if and only if its decimal representation is terminating or non-terminating but recurring

Ex. $\frac{2}{5}$, 3, $\frac{5}{1}$, 1.75, 1.666....., 4.23535, ..., $\frac{7}{9}$

10. Irrational numbers :

A number which cannot be put in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$, is called an irrational number

or

A number whose decimal expression is non-terminating and non recurring is called an irrational number.

Eg : $\sqrt{5}$, $\sqrt{3}$, $5\sqrt{7}$, $\sqrt{3}+2$, $\frac{1}{3+\sqrt{7}}$, π, $\sqrt[4]{3}$, ...

11. Non-terminating : Repeating (or Recurring) decimals :

A decimal in which a digit or a group of digits repeats continually or periodically is called a repeating or a recurring or a periodic decimal.

Ex : $\frac{5}{6} = 0.8333... = 0.8\overline{3}$; $\frac{2}{11} = 0.181818..... = 0.\overline{18}$

✯ Put a bar ($\overline{\ }$) above those digit/digits which are repeated.

12. Real Numbers (R) :

Rational numbers and irrational numbers taken together form real numbers.

13. Pure recrring decimal :

It is a decimal representation in which all the digits after the decimal point are repeated Eg: $2.\overline{53}$, $0.\overline{35}$, $0.\overline{315}$, ...

14. Mixed recurring decimal :

It is a decimal representation in which there are one or more digits present before the repeating digits.

Eg : $0.3\overline{2}$, $1.2\overline{3}$, $35.1\overline{23}$, ...

15. Negative of an irrational number is an irrational number.

16. The sum or difference of a rational number and an irrational number is an irrational number.

17. The product of a non-zero rational number and an irrational number is an irrational number.

18. The sum, difference, product and quotient of two irrational numbers need not be an irrational number.

19. There are an infinite number of rational (irrational) numbers between two rational (or irrational) numbers.

20. If a is a rational number and n is a positive integer such that the n^{th} root of a is an irrational number, then $a^{1/n}$ is called a surd eg. $\sqrt{7}$, $\sqrt{3}$, $\sqrt{11}$ etc

21. If $\sqrt[n]{a}$ is a surd, or radical then 'n' is known as ordern or index of surd and 'a' is known as radicand.

22. A surd which has unity only as rational factor is called a pure surd.

Eg. $\sqrt{5}$, $\sqrt{11}$, $\sqrt{7}$, $\sqrt{335}$, ...

23. A surd which has a rational factor other than unity is called a mixed surd.

Eg . $2\sqrt{5}$, $3\sqrt{11}$, ...

24. Surds having same irrational factors are called similar or like surds.

25. Only similar surds can be added or subtracted by adding or subtracting their rational parts.

26. Surds of same order can be multiplied or divided.

27. If the surds to be multiplied or to be divided are not of the same order, we first reduce them to the same order and then multiply or divide.

28. The two irrational numbers whose product is a rational number, are called rationalising factor of each other. For eg : $x - \sqrt{y}$ is called rationalising factor $x + \sqrt{y}$.

Similarly $\sqrt{3}$ is a R.F. of $6\sqrt{3}$ Similarly $5^{\frac{1}{3}}$ is a R.F. of $5^{\frac{2}{3}}$

29. The surds which differ only in sign (+ or –) between the terms connecting them, are called conjugate surds eg. $\sqrt{5}+\sqrt{3}$ and $\sqrt{5}-\sqrt{3}$ or $2+\sqrt{5}$ and $2-\sqrt{5}$ are conjugate surds (binomial).

★ Sum and product of two cojugate binomial factors are always rational numbers.

30. Laws of exponents for Real numbers :

(i) $a^m \times a^n = a^{m+n}$ (ii) $(a^m)^n = a^{mn}$ (iii) $\frac{a^m}{a^n} = a^{m-n}$; $m > n$

(iv) $a^m \times b^m = (a \times b)^m$ (v) $a^{-m} = \frac{1}{a^m}$ or $\frac{1}{a^{-m}} = a^m$, if $a \neq 0$

(vi) $(a \times b)^m = a^m \times b^m$ (vii) $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$ (viii) $a^o = 1$ where a is any rational no.

(ix) $(1)^p = 1$ where p is any rational no.

(x) If $a \neq 1$ and $a^p = a^q$ then $p = q$ where p & q are rational nos

(xi) $\sqrt{a} = a^{\frac{1}{2}}$, $\sqrt[3]{a} = a^{\frac{1}{3}}$ and $\sqrt[n]{a} = a^{\frac{1}{n}}$

(xii) $(-a)^m = a^m$, if m is even and $(-a)^m = -a^m$, if m is odd.

31. Laws of radicals :

(i) $\left(\sqrt[n]{a}\right)^n = a$ (ii) $\sqrt[n]{a} \times \sqrt[n]{b} = \sqrt[n]{ab}$ (iii) $\frac{\sqrt[n]{a}}{\sqrt[n]{a}} = \sqrt[n]{\frac{a}{b}}$

(iv) $\sqrt[m]{\sqrt[n]{a}} = \sqrt[mn]{a} = \sqrt[n]{\sqrt[m]{a}}$ (v) $\frac{\sqrt[p]{a^n}}{\sqrt[p]{a^m}} = \sqrt[p]{a^{n-m}}$ (vi) $\sqrt[p]{a^n \times a^m} = \sqrt[p]{a^{n+m}}$

(vii) $\sqrt[p]{(a^n)^m} = \sqrt[p]{a^{nm}}$

32. Indentities related to square roots :

(i) $\sqrt{a} \times \sqrt{b} = \sqrt{ab}$ and $\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$ (ii) $\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$ and $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$

(iii) $\left(\sqrt{a}+\sqrt{b}\right)\left(\sqrt{a}-\sqrt{b}\right) = \left(\sqrt{a}\right)^2 - \left(\sqrt{b}\right)^2 = a-b$ (iv) $\left(a+\sqrt{b}\right)\left(a-\sqrt{b}\right) = a^2 - \left(\sqrt{b}\right)^2 = a^2 - b$

(v) $\left(\sqrt{a}+b\right)\left(\sqrt{a}-b\right) = a - b^2$ (vi) $\left(\sqrt{a}+\sqrt{b}\right)^2 = a + 2\sqrt{ab} + b$

(vii) $\left(\sqrt{a}-\sqrt{b}\right)^2 = a - 2\sqrt{ab} + b$ (viii) $\left(\sqrt{a}+\sqrt{b}\right)\left(\sqrt{c}+\sqrt{d}\right) = \sqrt{ac} + \sqrt{ad} + \sqrt{bc} + \sqrt{bd}$

SOLVED PROBLEMS

Ex.1 Is zero a rational number ? Can you write it in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$?

Sol. Yes, zero is a rational number. We can write zero in the form $\frac{p}{q}$ whose p and q are integers and $q \neq 0$.

so, 0 can be written as

$\frac{0}{1} = \frac{0}{2} = \frac{0}{3}$ etc

Ex.2 Find six rational numbers between 3 and 4.

Sol. **Hint :** first rational number between 3 and 4

$= \frac{3+4}{2} = \frac{7}{2}$

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

Sol. **Hint :** Let $a = \frac{3}{5}$, $b = \frac{4}{5}$, $n = 5$

$$d = \frac{b-a}{n+1} = \frac{\frac{4}{5} - \frac{3}{5}}{5+1} = \frac{1}{30}$$

so, Rational number are

$a + d, a + 2d, a + 3d$.....

Ex.4 State whether the following statements are true or false ? Give reasons for you answers.

(i) Every natural number is a whole number.

(ii) Every integer is a whole number.

(iii) Every rational number is a whole number.

Sol. (i) True, the collection of whole number contain all natural number.

(ii) False, –2 is not whole number

(iii) False, $\frac{1}{2}$ is a rational number but not whole number.

Ex.5 State whether the following statements are true or false ? Justify your answers.

(i) Every irrational number is a real number.

(ii) Every point on the number line is of the form $\sqrt{m}$, where m is a natural number.

(iii) Every real number is an irrational number.

Sol. (i) True, since collection of real number consist of rational and irrational.

(ii) False, because no negative number can be the square root of any natural number.

(iii) False, 2 is real but not irrational.

Ex.6 Are the square roots of all positive integers irrational ? If not, give an example of the square root of a number that is a rational number.

Sol. No, $\sqrt{4} = 2$ is a rational number.

Ex.7 Write the following in decimal form and say what kind of decimal expansion each has :

(i) $\frac{36}{100}$ (ii) $\frac{1}{11}$ (iii) $4\frac{1}{8}$ (iv) $\frac{3}{13}$ (v) $\frac{2}{11}$ (vi) $\frac{329}{400}$

Sol. (i) $\frac{36}{100} = 0.36$ (Terminating)

(ii) $\frac{1}{11} = 0.090909.....$ (Non terminating Repeating)

$$11\overline{)1.00000}\,(0.090909....$$
$$-99$$
$$100$$
$$99$$
$$100$$
$$99$$
$$1$$

(iii) $4\frac{1}{8} = \frac{33}{8} = 4.125$ (terminating decimal)

(iv) $\frac{3}{13} = 0.230769230769.....$

$= 0.\overline{230769}$ (Non Terminating repeating)

(v) $\frac{2}{11} = 0.1818..... = 0.\overline{18}$

(Non Terminating repeating)

(vi) $\frac{329}{400} = 0.8225$ terminating

Ex.8 Classify the following numbers as rational or irrational :

(i) $2-\sqrt{5}$ (ii) $(3+\sqrt{23})-\sqrt{23}$ (iii) $\frac{2\sqrt{7}}{7\sqrt{7}}$ (iv) $\frac{1}{\sqrt{2}}$ (v) 2π

Sol. (i) $\because$ 2 is a rational number and $\sqrt{5}$ is an irrational number

$\therefore$ $2-\sqrt{5}$ is an irrational number.

(ii) $(3+\sqrt{23})-\sqrt{23}$

$\Rightarrow$ $(3+\sqrt{23})-\sqrt{23} = 3$ is a rational number.

(Rest Try Yourself)

Ex.9 Simplify each of the following expressions

(i) $(3+\sqrt{3})(2+\sqrt{2})$ (ii) $(3+\sqrt{3})(3-\sqrt{3})$ (iii) $(\sqrt{5}+\sqrt{2})^2$ (iv) $(\sqrt{5}-\sqrt{2})(\sqrt{5}+\sqrt{2})$

Sol. (i) $(3+\sqrt{3})(2+\sqrt{2}) = 3(2+\sqrt{2})+\sqrt{3}(2+\sqrt{2})$

$= 6+3\sqrt{2}+2\sqrt{3}+\sqrt{6}$

(ii) $(3+\sqrt{3})(3-\sqrt{3}) = (3)^2-(\sqrt{3})^2 = 9-3 = 6$

(Rest Try Yourself)

Ex.10 Recall, p is defined as the ratio of the circumference (say c) of a circle to its diameter (say d). That is, $\pi = \frac{c}{d}$. This seems to contradict the fact that π is irrational. How will you resolve this contradiction ?

Sol.. $\frac{c}{d} = \frac{22}{7}$ which is approximate value of π

Ex.11 Rationalise the denominators of the following

(i) $\frac{1}{\sqrt{7}}$ (ii) $\frac{1}{\sqrt{7}-\sqrt{6}}$ (iii) $\frac{1}{\sqrt{5}+\sqrt{2}}$ (iv) $\frac{1}{\sqrt{7}-2}$

Sol. (i) $\frac{1}{\sqrt{7}} = \frac{1}{\sqrt{7}} \times \frac{\sqrt{7}}{\sqrt{7}} = \frac{\sqrt{7}}{7}$ (ii) $\frac{1}{\sqrt{7}-\sqrt{6}} = \frac{1}{\sqrt{7}-\sqrt{6}} \times \frac{\sqrt{7}+\sqrt{6}}{\sqrt{7}+\sqrt{6}} = \frac{\sqrt{7}+\sqrt{6}}{7-6}$

$= \frac{\sqrt{7}+\sqrt{6}}{1} = \sqrt{7}+\sqrt{6}$

(Rest Try Yourself)

Ex.12 Find :

(i) $(64)^{1/2}$ (ii) $32^{1/5}$ (iii) $125^{1/3}$

Sol.. (i) $(64)^{1/2} = (8^2)^{1/2} = (8^{2\times\frac{1}{2}}) = 8^1 = 8$

(ii) $32^{1/5} = (2^5)^{1/5} = (2^{5\times\frac{1}{5}}) = 2^1 = 2$

(Rest Try Yourself)

Ex.13 Find :

(i) $9^{3/2}$ (ii) $32^{2/5}$ (iii) $16^{3/4}$ (iv) $125^{-1/3}$

Sol.. (i) $9^{\frac{3}{2}} = \left(9^{\frac{1}{2}}\right)^3 = (3)^3 = 27$

(ii) $32^{\frac{2}{5}} = (2^5)^{\frac{2}{5}} = 2^{5\times\frac{2}{5}} = 2^2 = 4$

(Rest Try Yourself)

Ex.14 Simplify :

(i) $2^{2/3}.2^{1/5}$ (ii) $\left(\frac{1}{3^3}\right)^7$ (iii) $\frac{11^{1/2}}{11^{1/4}}$ (iv) $7^{1/2} \cdot 8^{1/2}$

Sol. (i) $2^{\frac{2}{3}} . 2^{\frac{1}{5}} = 2^{\frac{2}{3}+\frac{1}{5}} = 2^{\frac{10+3}{15}} = 2^{\frac{13}{15}}$

(ii) $\left(\frac{1}{3^3}\right)^7 = \frac{1^7}{(3^3)^7} = \frac{1}{3^{21}} = 3^{-21}$

(Rest Try Yourself)

Ex.15 Insert 4 rational numbers between $\frac{2}{3}$ and $\frac{5}{3}$.

Sol. As numbers to be inserted are more than 3, we would follow method II., (Method I, $a < \frac{a+b}{2} < b$)

Here the numbers given are $\frac{2}{3}$ and $\frac{5}{3}$ both of which have the same denominator.

$\therefore$ We multiply numerator and denominator of each number by (4 + 1) = 5

to get $\frac{2\times5}{3\times5}$ and $\frac{5\times5}{3\times5}$ or $\frac{10}{15}$ and $\frac{25}{15}$. Any 5 integers between 10 and 25 are 11, 12, 13, 14, 15.

$\therefore$ Required rational numbers between the two given numbers are $\frac{11}{15}, \frac{12}{15}, \frac{13}{15}, \frac{14}{15}, \frac{15}{15}$.

Ex.16 Convert $\frac{237}{16}$ in the decimal form.

Sol.

$$16\overline{)237}\,(14.8125$$

16
77
64
130
128
20
16
40
32
80
80
×

$\therefore \quad \frac{237}{16} = 14.8125$

Ex.17 Convert $0.7\overline{283}$ into the form $\frac{p}{q}$.

Sol. The given number is $0.7\overline{283}$ = 0.7283283 ….

Let, x = 0.7283283 … …(1)

Here after decimal there is only one digit namely 7, which is not recurring.

∴ We multiply both sides of equation (1) by 10 to get 10 x = 7.283283… …(2)

Now after decimal 3 digits are recurring (283).

∴ We multiply both sides of equation (2) by 1000 to get, 10000 x = 7283.283… …(3)

Subtracting equation (2) from equation (3), we get 90 x = 7276

$\Rightarrow x = \frac{7276}{9990} = \frac{3638}{4995}$ which is the required form of the number.

Ex.18 Write 3 irrational number between 4.75 and 4.76.

Sol. Keeping in mind that decimal representation of an irrational number is neither terminating nor recurring, we can write any three numbers between 4.75 and 4.76 whose decimal representation is neither terminating nor recurring e.g., 4.7513428965832…, 4.7523471098623…, 4.7534829153785… .

Ex.19 Locate $\sqrt{5}$, $\sqrt{6}$, $\sqrt{7}$ on number line.

Sol. We know that $5 = 2^2 + 1^2$. So on real number line X'OX, take a point A so that OA = 2 units. At A, draw a ray AY_1 perpendicular to real number line. Now with A as centre and 1 unit as radius draw an arc intersecting ray AY_1 at B_1. Join OB_1. With O as centre and OB_1 as radius draw an arc intersecting number line at P_1. P_1 is the point on number line representing $\sqrt{5}$ i.e., $OP_1 = \sqrt{5}$.

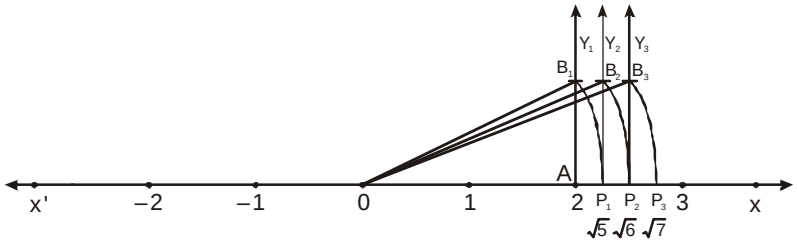


Fig. 11 Representing $\sqrt{5}$, $\sqrt{6}$, $\sqrt{7}$ on number line.

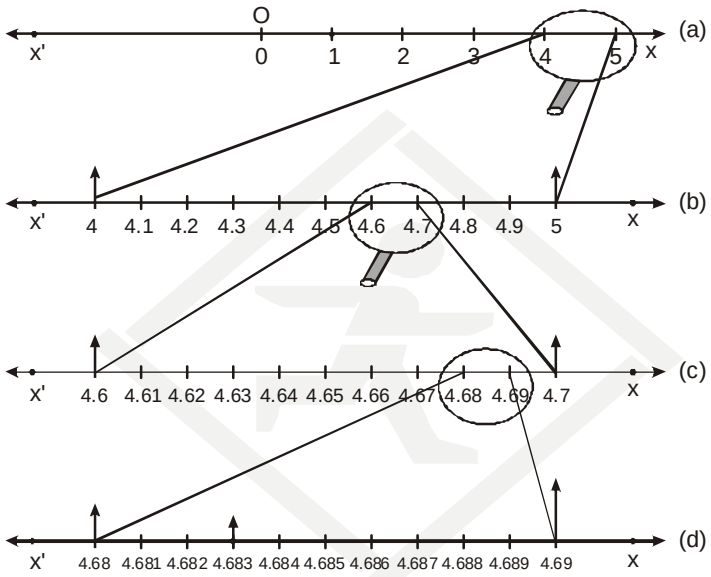
Now at P_1 draw ray P_1Y_2 perpendicular to number line and with P_1 as centre and 1 unit as radius draw an arc intersecting P_1Y_2 at B_2. Join OB_2. With O as centre and OB_2 as radius draw an arc intersecting the number line at P_2. P_2 is the point representing the location of $\sqrt{6}$. Again at P_2 draw a ray P_2Y_3 perpendicular to number line and cut an arc at B_3 on it with arc radius 1 unit and centre as P_2. Join OB_3. With O as centre and OB_3 as radius draw another arc intersecting the number line at P_3. P_3 is the point corresponding to $\sqrt{7}$.

Ex.20 With the help of examples show that the quotient of two irrational numbers can be rational or irrational.

Sol. Consider two irrational numbers a = $3\sqrt{2}$ and b = $5\sqrt{2}$ then their quotient $\frac{a}{b}=\frac{3\sqrt{2}}{5\sqrt{2}}=\frac{3}{5}$ which is rational, while if we take two numbers as c = $3\sqrt{6}$ and d = $\sqrt{8}$ both of which are irrational then their quotient $\frac{c}{d}=\frac{3\sqrt{6}}{\sqrt{8}}=\frac{3\sqrt{6}}{2\sqrt{2}}=\frac{3}{2}\times\sqrt{\frac{6}{2}}=\frac{3\sqrt{3}}{2}$ which is an irrational number.

Ex.21 Locate 4.683 on number line by the method of successive magnification.

Sol. Lie between 4–5, 4.6–4.7, 4.68–4.69.



Visualization of 4.683 on number line.

Ex.22 If $\frac{-32\times2^{x+5}+(2^x)^2}{2\times2^{x+1}-2^{12}} = 2^{3x-10}$. Find the value of x, given that $x \neq 10$.

Sol. $\frac{(2^x)^2-32\times2^{x+5}}{2\times2^{x+1}-2^{12}}=2^{3x-10} \Rightarrow \frac{2^{x\times2}-2^5\times2^{x+5}}{2^{1+x+1}-2^{12}} = 2^{3x-10} \Rightarrow \frac{2^{2x}-2^{5+x+5}}{2^{2+x}-2^{12}} = 2^{3x-10} \Rightarrow \frac{2^{x+x}-2^{x+10}}{2^{x+2}-2^{10+2}} = 2^{3x-10}$

$\Rightarrow \frac{2^x\cdot2^x-2^x\cdot2^{10}}{2^x\cdot2^2-2^{10}\cdot2^2} = 2^{3x-10} \Rightarrow \frac{2^x(2^x-2^{10})}{2^2(2^x-2^{10})} = 2^{3x-10} \Rightarrow \frac{2^x}{2^2} = 2^{3x-10}$

$\Rightarrow 2^{x-2} = 2^{3x-10} \Rightarrow x-2 = 3x-10 \Rightarrow 2x = 8$

$\Rightarrow x = 4.$

Ex.23 If $2^x = 5^y = 10^z$, then prove that $\frac{1}{x}+\frac{1}{y}=\frac{1}{z}$.

Sol. Let $2^x = 5^y = 10^z = K$. $\Rightarrow$ $2 = K^{1/x}$, $5 = K^{1/y}$, $10 = K^{1/z}$

Now we know that $2 \times 5 = 10$ $\Rightarrow$ $K^{\frac{1}{x}} \times K^{\frac{1}{y}} = K^{\frac{1}{z}}$ $\Rightarrow$ $K^{\frac{1}{x}+\frac{1}{y}} = K^{\frac{1}{z}}$

$\Rightarrow$ $\frac{1}{x}+\frac{1}{y}=\frac{1}{z}$.

Ex.24 If $x = \sqrt{3} + 1$, find the value of $\left(x+\frac{2}{x}\right)^2$.

Sol. $x = \sqrt{3} + 1$ $\Rightarrow \frac{2}{x}=\frac{2}{\sqrt{3}+1}\times\frac{\sqrt{3}-1}{\sqrt{3}-1}=\frac{2(\sqrt{3}-1)}{(\sqrt{3})^2-1^2}$

$=\frac{2(\sqrt{3}-1)}{3-1}=\frac{2(\sqrt{3}-1)}{2}=\sqrt{3}-1$ $\therefore \left(x+\frac{2}{x}\right)^2=\left(\sqrt{3}+1+\sqrt{3}-1\right)^2=\left(2\sqrt{3}\right)^2=4\times\left(\sqrt{3}\right)^2 = 4 \times 3 = 12.$

Ex.25 If $x = 2 + \sqrt{3}$, find the value of $x^2 + \frac{1}{x^2}$.

Sol. $x = 2 + \sqrt{3}$ $\Rightarrow \frac{1}{x}=\frac{1}{2+\sqrt{3}}\times\frac{(2-\sqrt{3})}{(2-\sqrt{3})}=\frac{2-\sqrt{3}}{2^2-(\sqrt{3})^2}$ $\therefore \frac{1}{x}=\frac{2-\sqrt{3}}{4-3}=2-\sqrt{3}$

Also $\left(x+\frac{1}{x}\right)^2=x^2+\frac{1}{x^2}+2$ $\therefore$ $x^2+\frac{1}{x^2}=\left(x+\frac{1}{x}\right)^2-2=\left(2+\sqrt{3}+2-\sqrt{3}\right)^2-2$ $= 4^2 - 2 = 16 - 2 = 14.$

Ex.26 If $x = \frac{\sqrt{5}+\sqrt{2}}{\sqrt{5}-\sqrt{2}}$ and $y = \frac{\sqrt{5}-\sqrt{2}}{\sqrt{5}+\sqrt{2}}$, find the value of $3x^2 + 4xy + 3y^2$.

Sol. $x=\frac{\sqrt{5}+\sqrt{2}}{\sqrt{5}-\sqrt{2}}\times\frac{\sqrt{5}+\sqrt{2}}{\sqrt{5}+\sqrt{2}}=\frac{(\sqrt{5}+\sqrt{2})^2}{(\sqrt{5})^2-(\sqrt{2})^2}=\frac{(\sqrt{5})^2+(\sqrt{2})^2+2\sqrt{5}\times\sqrt{2}}{5-2}=\frac{5+2+2\sqrt{10}}{3}=\frac{7+2\sqrt{10}}{3}$

$y=\frac{\sqrt{5}-\sqrt{2}}{\sqrt{5}+\sqrt{2}}\times\frac{\sqrt{5}-\sqrt{2}}{\sqrt{5}-\sqrt{2}}=\frac{(\sqrt{5}-\sqrt{2})^2}{(\sqrt{5})^2-(\sqrt{2})^2}=\frac{(\sqrt{5})^2+(\sqrt{2})^2-2\sqrt{5}\sqrt{2}}{5-2}=\frac{5+2-2\sqrt{10}}{3}=\frac{7-2\sqrt{10}}{3}$

$\therefore$ $x + y = \frac{7+2\sqrt{10}}{3}+\frac{7-2\sqrt{10}}{3}=\frac{7+2\sqrt{10}+7-2\sqrt{10}}{3}=\frac{14}{3}$ Also, $xy = \frac{\sqrt{5}+\sqrt{2}}{\sqrt{5}-\sqrt{2}}\times\frac{\sqrt{5}-\sqrt{2}}{\sqrt{5}+\sqrt{2}} = 1$

Hence $3x^2 + 4xy + 3y^2 = 3(x^2 + y^2) + 4xy = 3\left[(x+y)^2-2xy\right]+xy$

$=3\left[\left(\frac{14}{3}\right)^2-2.1\right]+4.1$ $=3\left[\frac{196}{9}-2\right]+4$ $=3\left[\frac{196-18}{9}\right]+4$ $=\frac{178}{3}+4$ $=\frac{178+12}{3}=\frac{190}{3}$

Ex.27 If $x = \frac{1}{\sqrt{5}+2}$, find the value of $x^2 + 4x - 1$ and $x^3 - 2x^2 - 25x + 7$.

Sol. $x = \frac{1}{\sqrt{5}+2}\times\frac{\sqrt{5}-2}{\sqrt{5}-2}=\frac{\sqrt{5}-2}{(\sqrt{5})^2-(2)^2}=\frac{\sqrt{5}-2}{5-4}=\sqrt{5}-2 \Rightarrow x + 2 = \sqrt{5} \Rightarrow (x + 2)^2 = (\sqrt{5})^2 \Rightarrow x^2 + 4x + 4 = 5$

$\Rightarrow$ $x^2 + 4x - 1 = 0$ Also $x^3 - 2x^2 - 25x + 7 = (x^2 + 4x - 1)(x - 6) + 1$

(Here we observe that if $(x^3 - 2x^2 - 25x + 7)$ is divided by $x^2 + 4x - 1$, quotient is $x - 6$ and remainder = 1. So we can use dividend = divisor × quotient + remainder, to get the above relationship.)

$\therefore$ $x^3 - 2x^2 - 25x + 7 = 0 \times (x - 6) + 1 = 1.$

EXERCISE – I UNSOLVED PROBLEMS

Q.1 Find 3 rational number between 2 and 5.

Q.2 Find 4 rational numbers between 4 and 5.

Q.3 Find three rational number between $\frac{6}{5}, \frac{7}{5}$

Q.4 Express $\frac{7}{8}$ in the decimal form by long division method.

Q.5 Convert $\frac{35}{16}$ into decimal form by long division method.

Q.6 Find the decimal representation of $\frac{8}{3}$.

Q.7 Express $\frac{2}{11}$ as a decimal fraction.

Q.8 Represent $\frac{1}{2}$ and $-\frac{1}{2}$ on the number line.

Q.9 Represent $\frac{4}{7}$ on number line.

Q.10 Represent $\frac{-9}{5}$ on number line.

Q.11 Express each of the following numbers in the form $\frac{p}{q}$.

(i) 0.15 (ii) 0.675 (iii) –25.6875

Q.12 Express each of the following decimals in the form $\frac{p}{q}$.

(i) $0.\overline{6}$ (ii) $0.\overline{35}$ (iii) $0.\overline{585}$

Q.13 Convert the following decimal numbers in form $\frac{p}{q}$

(i) $5.\overline{2}$ (ii) $23.\overline{43}$

Q.14 If $\frac{1}{7} = 0.\overline{142857,}$ write the decimal expression of $\frac{2}{7}, \frac{3}{7}, \frac{4}{7}$, and $\frac{5}{7}$ without actually doing the long division.

Q.15 Express the following decimals in the form $\frac{p}{q}$

(i) $0.3\overline{2}$ (ii) $0.12\overline{3}$

Q.16 Insert a rational and an irrational number between 2 and 3.

Q.17 Find two irrational numbers between 2 and 2.5.

Q.18 Find two irrational numbers lying between $\sqrt{2}$ and $\sqrt{3}$.

Q.19 Find two irrational numbers between 0.12 and 0.13.

Q.20 Find two rational numbers between 0.232332333233332... and 0.252552555255552.....

Q.21 Find a rational number and also an irrational number between the numbers a and b given below :
a = 0.101001000100001..... ,
b = 0.1001000100001.....

Q.22 Find one irrationl number between the number a and b given below :
a = 0.1111..... = $0.\overline{1}$ and b = 0.1101

Q.23 Examine, whether the following numbers are rational or irrational :

(i) $(\sqrt{2}+2)^2$ (ii) $(5+\sqrt{5})(5-\sqrt{5})$

Q.24 State giving reasons, whether each one of the following number is rational or irrational

(i) $-\sqrt{5}$ (ii) $2+\sqrt{6}$ (iii) $5\sqrt{3}$

(iv) $(\sqrt{7}-2)$ (v) $\frac{7}{3\sqrt{5}}$ (vi) $(3+\sqrt{3})^2$

Q.25 Represent $\sqrt{3.28}$ geometrically on the number line.

Q.26 Evaluate each of the following :-

(i) $2^5 \times 5^2$ (ii) $(2^3)^2$ (iii) $\left(\frac{7}{9}\right)^3$

(iv) $\left(\frac{2}{5}\right)^{-3}$ (v) $\left(\frac{4}{5}\right)^7 \div \left(\frac{5}{4}\right)^{-5}$

Q.27 Evaluate the following :-

(i) $(216)^{\frac{-2}{3}}$ (ii) $\left(\frac{121}{169}\right)^{\frac{-3}{2}}$ (iii) $\left(\sqrt{81}\right)^{\frac{-3}{4}}$

(iv) $\left(\sqrt[3]{64}\right)^{\frac{-1}{2}}$ (v) $\left(\sqrt{25}\right)^{-7} \times \left(\sqrt{5}\right)^{-5}$

(vi) $\left(\frac{5^{-1} \times 7^2}{5^2 \times 7^{-4}}\right)^{\frac{7}{2}} \times \left(\frac{5^{-2} \times 7^3}{5^3 \times 7^{-5}}\right)^{\frac{-5}{2}}$

Q.28 Simplify the following :-

(i) $\sqrt[3]{ab^2} \div \sqrt{a^2b}$ (ii) $\sqrt[4]{\sqrt[3]{a^2}}$

(iii) $\sqrt{a^{-1}b}.\sqrt{b^{-1}c}\sqrt{c^{-1}a}$

Q.29 If $a^x = b$, $b^y = c$ and $c^z = a$, prove that $xyz = 1$.

Q.30 If $a^x = b^y = c^z$ and $b^2 = ac$, prove that

$y = \frac{2xz}{x+z}$.

Q.31 Assuming that x is a positive real number and a, b, c are rational numbers, show that :

(i) $\left(\frac{x^b}{x^c}\right)^a \left(\frac{x^c}{x^a}\right)^b \left(\frac{x^a}{x^b}\right)^c = 1$

(ii) $\left(\frac{x^a}{x^b}\right)^{1/ab} \left(\frac{x^b}{x^c}\right)^{1/bc} \left(\frac{x^c}{x^a}\right)^{1/ac} = 1$

(iii) $\left(\frac{x^a}{x^b}\right)^{a^2+ab+b^2} \left(\frac{x^b}{x^c}\right)^{b^2+bc+c^2} \left(\frac{x^c}{x^a}\right)^{c^2+ca+a^2} = 1$

(iv) $\left(\frac{x^a}{x^b}\right)^{a+b} \left(\frac{x^b}{x^c}\right)^{b+c} \left(\frac{x^c}{x^a}\right)^{c+a} = 1$

Q.32 If $\frac{9^n \times 3^2 \times (3^{-n/2})^{-2} - (27)^n}{3^{3m} \times 2^3} = \frac{1}{27}$,

prove that $m - n = 1$.

Q.33 Assuming that x is a positive real number and a, b, c are rational numbers, show that:

(i) $\left(\frac{x^a}{x^b}\right)^{a+b-c} \left(\frac{x^b}{x^c}\right)^{b+c-a} \left(\frac{x^c}{x^a}\right)^{c+a-b} = 1$

(ii) $\left(\frac{x^a}{x^{-b}}\right)^{a^2+b^2-ab} . \left(\frac{x^b}{x^{-c}}\right)^{b^2+c^2-bc} . \left(\frac{x^c}{x^{-a}}\right)^{c^2+a^2-ca} = x^{2(a^3+b^3+c^3)}$

Q.34 If $25^{x-1} = 5^{2x-1} - 100$, find the value of x.

Q.35 Simplify :-

(i) $5\sqrt{2} + 20\sqrt{2}$ (ii) $6\sqrt{3} - 4\sqrt{3} + 9\sqrt{3}$

(iii) $2\sqrt{3} + \sqrt{27}$ (iv) $4\sqrt{3} - 3\sqrt{12} + 2\sqrt{75}$

Q.36 Simplify : $15\sqrt{6} - \sqrt{216} + \sqrt{96}$

Q.37 Simplify :- (i) $5\sqrt{147} - \frac{4}{3}\sqrt{\frac{1}{3}} + 7\sqrt{\frac{1}{3}}$

(ii) $\sqrt{294} - \sqrt{150} + 2\sqrt{6} - 3\sqrt{\frac{1}{6}}$

Q.38 Simplify by combining similar terms :-

(i) $2.\sqrt[3]{40} + 3.\sqrt[3]{625} - 4.\sqrt[3]{320}$

(ii) $\sqrt[4]{81} - 8.\sqrt[3]{216} + 15.\sqrt[5]{32} + \sqrt{225}$

Q.39 Given that $\sqrt{3} = 1.7321$, find correct to 3 places of decimals, the value of $\sqrt{192} - \frac{1}{2}\sqrt{48} - \sqrt{75}$

Q.40 Multiply :

(i) $3\sqrt{5}$ by $5\sqrt{5}$

(ii) $5\sqrt{2}, 3\sqrt{10}$ and $2\sqrt{15}$

Q.41 Multiply : $\sqrt[3]{4}$ by $\sqrt[3]{22}$

Q.42 Multiply : $\sqrt{14}$ by $\sqrt{21}$

Q.43 Simplify each of the following expressions :-

(i) $(3+\sqrt{3})(2+\sqrt{2})$ (ii) $(3+\sqrt{3})(3-\sqrt{3})$

(iii) $(\sqrt{5}+\sqrt{2})^2$ (iv) $(\sqrt{5}-\sqrt{2})(\sqrt{5}+\sqrt{2})$

Q.44 Multiply : $\sqrt[3]{7}$ by $\sqrt{2}$

Q.45 Divide :- $\sqrt[3]{24}$ by $\sqrt[3]{100}$

Q.46 Simplify :- $\frac{\sqrt{a^2-b^2}+a}{\sqrt{a^2+b^2}+b} \div \frac{\sqrt{a^2+b^2}-b}{a-\sqrt{a^2-b^2}}$

Q.47 Simplify and express the result in its simple form :-

(i) $5 . \sqrt[3]{4} \div (3\sqrt{2} . \sqrt[3]{3})$

(ii) $9 . \sqrt[3]{4} \div (3 . \sqrt[3]{2} . \sqrt{3})$

Q.48 Find the rationalizing factors of following :

(i) $\sqrt{10}$ (ii) $\sqrt{162}$ (iii) $\sqrt[3]{4}$

(iv) $\sqrt[3]{16}$ (v) $\sqrt[4]{162}$ (vi) $\sqrt[3]{40}$

Q.49 Find the rationalising factor of : $(\sqrt{3}+\sqrt{10}-\sqrt{5})$

Q.50 Find the simplest rationalising factor of : $2+\sqrt{3}+\sqrt{5}$

Q.51 Rationalise the denominator in each of the following :

(i) $\frac{2\sqrt{7}}{\sqrt{11}}$ (ii) $\frac{3\sqrt[3]{5}}{\sqrt[3]{9}}$

Q.52 Find the value to three places of decimals; of each of the following. It is given that $\sqrt{2}=1.414$, $\sqrt{3}=1.732$ and $\sqrt{5}=2.236$ and $\sqrt{10}=3.162$ (approx).

(i) $\frac{\sqrt{2}+1}{\sqrt{5}}$ (ii) $\frac{2-\sqrt{3}}{\sqrt{3}}$ (iii) $\frac{\sqrt{10}-\sqrt{5}}{\sqrt{2}}$

Q.53 Rationalise :

(i) $\frac{1}{\sqrt{7}-\sqrt{6}}$ (ii) $\frac{1}{\sqrt{5}+\sqrt{2}}$

Q.54 Simplify each of the following by rationalising the denominator :

(i) $\frac{5+\sqrt{6}}{5-\sqrt{6}}$ (ii) $\frac{\sqrt{7}-\sqrt{5}}{\sqrt{7}+\sqrt{5}}$

Q.55 Simplify the following :

$$\frac{6}{2\sqrt{3}-\sqrt{6}}+\frac{\sqrt{6}}{\sqrt{3}+\sqrt{2}}-\frac{4\sqrt{3}}{\sqrt{6}-\sqrt{2}}$$

Q.56 If $\frac{3+2\sqrt{2}}{3-\sqrt{2}}=a+b\sqrt{2}$, where a and b are rationals. Find the values of a and b

Q.57 If $x=\frac{1}{2+\sqrt{3}}$, find the value of $x^3-x^2-11x+3$

Q.58 If $x=3-2\sqrt{2}$, find $x^2+\frac{1}{x^2}$

Q.59 If $x=1-\sqrt{2}$, find the value of $\left(x-\frac{1}{x}\right)^3$

Q.60 If $x=\frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}-\sqrt{2}}$ and $y=\frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$, find x^2+y^2.

Q.61 If $x=1+\sqrt{2}+\sqrt{3}$, prove that $x^4-4x^3-4x^2+16x-8=0$

Q.62 Express the following surd with a rational denominator : $\frac{8}{\sqrt{15}+1-\sqrt{5}-\sqrt{3}}$

ANSWER KEY

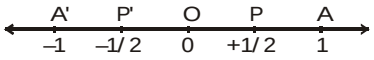
1. $2,\left[\frac{7}{2},\frac{11}{4},\frac{17}{4}\right]5$ **2.** $4,\left[\frac{21}{5},\frac{22}{5},\frac{23}{5},\frac{24}{5}\right],5$

3. $\frac{6}{5},\left[\frac{5}{4},\frac{13}{10},\frac{27}{20}\right];\frac{7}{5}$ **4.** $\frac{7}{8}=0.875$

5. $\frac{35}{16}=2.1875$ **6.** $\frac{8}{3}=2.6666...=2.\overline{6}$

7. $\frac{2}{11}=0.181818.....=0.\overline{18}$

8.



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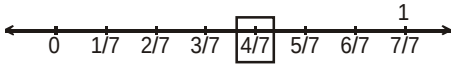

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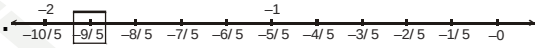


11. (i) $\frac{3}{20}$ (ii) $\frac{27}{40}$ (iii) $\frac{-411}{16}$

12. (i) $\frac{2}{3}$ (ii) $\frac{35}{99}$ (iii) $\frac{65}{111}$

13. (i) $\frac{47}{9}$ (ii) $\frac{2320}{99}$

14 $\frac{2}{7}=2\times\frac{1}{7}=0.\overline{285714}$; $\frac{3}{7}=3\times\frac{1}{7}=0.\overline{428571}$; $\frac{4}{7}=4\times\frac{1}{7}=0.\overline{571428}$; $\frac{5}{7}=5\times\frac{1}{7}=0.\overline{714285}$

15. (i) $\frac{29}{90}$ (ii) $\frac{37}{300}$

16. Rational number = 2.5, Irr. no. = $\sqrt{ab}=\sqrt{2\times3}=\sqrt{6}$

17. $\sqrt{5}$ and $\sqrt{2\times\sqrt{5}}$

18. 1.414213562..... & 1.732050808.....

19. 0.1201001000100001...,0.12101001000100001...

20. 0.25 and 0.2525

21. 0.101, 0.1002000100001.....

22. 0.111101001000100001.....

23. (i) irrational. (ii) rational.

24. (i) $\sqrt{5}$ is the square root of a nonperfect square natural number.

$\therefore$ $\sqrt{5}$ is irrational and negative of an irrational number is irrational.

$\therefore$ $-\sqrt{5}$ is irrational.

(ii) We know that the sum of a rational number and an irrational number is always an irrational number

$\therefore$ $(2+\sqrt{6})$ is irrational

[$\because$ 2 is rational and $\sqrt{6}$ is irrational]

(iii) We know that the product of a nonzero rational number and an irrational number is always irrational.

$\therefore$ $5\sqrt{3}$ is irrational.

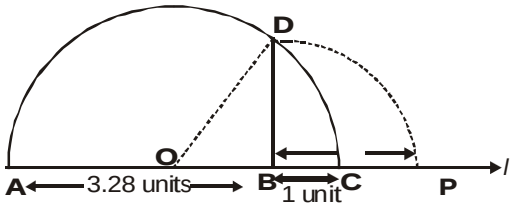
[$\because$ 5 is rational and $\sqrt{3}$ is irrational]

(iv) $(\sqrt{7}-2)$ = [(–2) + $\sqrt{7}$] being the sum of a rational number and an irrational number, is irrational.

(v) $\frac{7}{3\sqrt{5}}=\frac{7}{3\sqrt{5}}\times\frac{\sqrt{5}}{\sqrt{5}}=\frac{7}{15}\sqrt{5}$ which is irrational, being the product of a non-zero rational number and an irrational number.

(vi) $(3+\sqrt{3})^2$ = (9 + 3 + $6\sqrt{3}$) = (12 + $6\sqrt{3}$) which is irrational, being the sum of a rational number and an irrational number.

25.



26. (i) 800 (ii) 64 (iii) $\frac{343}{729}$ (iv) $\frac{125}{8}$ (v) $\frac{16}{25}$

27. (i) $\frac{1}{36}$ (ii) $\frac{2197}{1331}$ (iii) $\frac{1}{(27)^{\frac{1}{2}}}$ (iv) $\frac{1}{2}$ (v) $\frac{1}{(5)^{\frac{19}{2}}}$

(vi) 175

28. (i) $\left(\frac{b}{a^4}\right)^{\frac{1}{6}}$ (ii) $a^{\frac{1}{6}}$ (iii) 1

34. 2

35. (i) $25\sqrt{2}$ (ii) $11\sqrt{3}$ (iii) $5\sqrt{3}$ (iv) $8\sqrt{3}$

36. $13\sqrt{6}$

37. (i) $\frac{332}{9}\sqrt{3}$ (ii) $\frac{7}{2}\sqrt{6}$

38. (i) $3.\sqrt[3]{5}$ (ii) 0

39. 1.732

40. (i) 75 (ii) $300\sqrt{3}$

41. $2\sqrt[3]{11}$

42. $7\sqrt{6}$

43. (i) $6+3\sqrt{2}+2\sqrt{3}+\sqrt{6}$ (ii) 6 (iii) $7+2\sqrt{10}$ (iv) 3

44. $\sqrt[6]{392}$

45. $\sqrt[3]{\frac{6}{25}}$

46. $\frac{b^2}{a^2}$

47. (i) $\frac{5}{3}\times\sqrt[6]{\frac{2}{9}}$ (ii) $3.\sqrt[6]{\frac{4}{27}}$

48. (i) $\sqrt{10}$ (ii) $\sqrt{2}$ (iii) $\sqrt[3]{4^2}$ (iv) $\sqrt[3]{2^2}$ (v) $\sqrt[4]{8}$ (vi) $5^{\frac{2}{3}}$

49. $(3+\sqrt{10}+\sqrt{5})(8-2\sqrt{30})$

50. $(2+\sqrt{3}-\sqrt{5})(1-2\sqrt{3})$

51. (i) $\frac{2}{11}\sqrt{77}$ (ii) $\sqrt[3]{15}$

52. (i) 1.079 (ii) 0.154 (iii) 0.654

53. (i) $\sqrt{7}+\sqrt{6}$ (ii) $\frac{1}{3}(\sqrt{5}-\sqrt{2})$

54. (i) $\frac{31+10\sqrt{6}}{19}$ (ii) $6-\sqrt{35}$

55. 0

56. $a=\frac{13}{7}$, $b=\frac{9}{7}$

57. 0

58. 34

59. 8

60. 98

62. $\left(\sqrt{15}+1+\sqrt{5}+\sqrt{3}\right)$

EXERCISE – II SCHOOL EXAM/BOARD

Q.1 Express the following in the form of p/q.
(i) $.\overline{3}$ (ii) $.\overline{37}$

Q.2 Write two irrational numbers between 0.2 and 0.21.

Q.3 Write three irrational numbers between 0.2020020002000002... and 0.203003000300003...

Q.4 Write three irrational numbers between $\sqrt{3}$ and $\sqrt{5}$

Q.5 Find two irrational numbers between 0.5 and 0.55.

Q.6 Find two irrational numbers lying between 0.1 and 0.12.

Q.7 Given a rational approximation of $\sqrt{3}$ correct to two places of decimals.

Q.8 Express 2 as a surd of fifth order.

Q.9 Express $\sqrt[3]{2}$ as a surd of order 12.

Q.10 Express $\sqrt[24]{49}$ as a surd of order 12.

Q.11 In the following express the result in the simplest form : $\sqrt[3]{-108a^4b^3}$

Q.12 Express as a pure surd : $\frac{1}{3}\sqrt[3]{54}$

Q.13 Simplify : $2.\sqrt[3]{40} + 3.\sqrt[3]{625} + 4.\sqrt[3]{320}$

Q.14 Simplify : $(3\sqrt{5}-2\sqrt{3})(3\sqrt{5}+2\sqrt{3})$

Q.15 Simplify : $\sqrt{m^2n^2}\times\sqrt[6]{m^2n^2}\times\sqrt[3]{m^2n^2}$

Q.16 Simplify : $\sqrt[5]{\sqrt[4]{(2^4)^3}} - 5\sqrt[5]{8} + 2\sqrt[4]{\sqrt[5]{(2^3)^4}}$

Q.17 If $\sqrt{3}$ = 1.732, find the value of $\frac{2}{\sqrt{3}}$.

Q.18 Which of the following is
(i) rational (ii) irrational number
(A) $(2+\sqrt{3})^2$ (B) $(3+\sqrt{4})^2$

Q.19 Which of the following numbers are
(i) rational (ii) irrational
(A) $(5+\sqrt{3})^2$ (B) $(2+\sqrt{3})(2-\sqrt{3})$

Q.20 Given that $\sqrt{3}$ = 1.732, find the value of $\sqrt{75}+\frac{1}{2}\sqrt{48}-\sqrt{192}$

Q.21 Determine a and b if $\frac{5+\sqrt{3}}{7-4\sqrt{3}} = 94\ a + 3\sqrt{3}\ b$

Q.22 If $\sqrt{5}$ = 2.236 and $\sqrt{6}$ = 2.449, find the value of $\frac{1+\sqrt{2}}{\sqrt{5}+\sqrt{3}} + \frac{1-\sqrt{2}}{\sqrt{5}-\sqrt{3}}$

Q.23 If $x = 7+4\sqrt{3}$, find the value of $\sqrt{x}+\frac{1}{\sqrt{x}}$

Q.24 If $p = 3-2\sqrt{2}$, determine $p^2+\frac{1}{p^2}$

Q.25 Find the simplest rationalising factor of $\sqrt{5}+\sqrt{3}+2$

Q.26 Express $\sqrt[4]{3}$, $\sqrt[6]{4}$, $\sqrt[3]{2}$ and $\sqrt[24]{81}$ as surds of order 12.

Q.27 Simplify : $3\sqrt{2} + \sqrt[4]{64} + \sqrt[4]{2500} + \sqrt[6]{8}$

Q.28 Simplify and express the results in simplest form : $\frac{\sqrt{x^2-y^2}+x}{\sqrt{x^2+y^2}+y}\div\frac{\sqrt{x^2+y^2}-y}{x-\sqrt{x^2-y^2}}$

Q.29 Simplify by rationalising the denominator : $\frac{7\sqrt{3}-5\sqrt{2}}{\sqrt{48}+\sqrt{18}}$.

Q.30 Find x if $x = \frac{\sqrt{\sqrt{5}+2}+\sqrt{\sqrt{5}-2}}{\sqrt{\sqrt{5}+1}}$

Q.31 Express with a rational denominator :
$$\frac{15}{\sqrt{10}+\sqrt{20}+\sqrt{40}-\sqrt{5}-\sqrt{80}}$$

Q.32 Express with a rational denominator :
$$\frac{1}{\sqrt{10}+\sqrt{14}+\sqrt{15}+\sqrt{21}}$$

Q.33 Find x if $x = \frac{2\left(\sqrt{2}+\sqrt{6}\right)}{3\sqrt{2+\sqrt{3}}}$

Q.34 Evaluate : $\sqrt{5+2\sqrt{6}}$

Q.35 If $a = 1-\sqrt{2}$, find the value of $\left(a-\frac{1}{a}\right)^3$.

Q.36 If $x = \frac{\sqrt{3}+1}{2}$, find the value of $4x^3 + 2x^2 - 8x + 7$.

Q.37 If $x = 6 - \sqrt{35}$, find $x^2 + \frac{1}{x^2}$

Q.38 If $x = \frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$ and $y = \frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}-\sqrt{2}}$, find the value of $x^2 + y^2 + xy$.

Q.39 If $x = \frac{2-\sqrt{5}}{2+\sqrt{5}}$ and $y = \frac{2+\sqrt{5}}{2-\sqrt{5}}$, find the value of $x^2 - y^2$.

Q.40 Given $\sqrt{2} = 1.4142$, $\sqrt{3} = 1.7321$ and $\sqrt{5} = 2.236$, find correct to three places of decimals the value of

$$\frac{4}{3\sqrt{3}-2\sqrt{2}} + \frac{3}{3\sqrt{3}+2\sqrt{2}}$$

Q.41 Determine rational numbers p and q if

$$\frac{7+\sqrt{5}}{7-\sqrt{5}} - \frac{7-\sqrt{5}}{7+\sqrt{5}} = p - 7\sqrt{5}q$$

Q.42 Taking $\sqrt{2} = 1.414$, $\sqrt{3} = 1.732$, $\sqrt{5} = 2.236$ and $\sqrt{6} = 2.449$, find the value of the following : $\frac{2+\sqrt{3}}{2-\sqrt{3}} + \frac{2-\sqrt{3}}{2+\sqrt{3}} + \frac{\sqrt{3}-1}{\sqrt{3}+1}$

Q.43 Simplify : $\frac{6}{2\sqrt{3}-\sqrt{6}} + \frac{\sqrt{6}}{\sqrt{3}+\sqrt{2}} - \frac{4\sqrt{3}}{\sqrt{6}-\sqrt{2}}$

Q.44 Simplify : $\frac{3\sqrt{2}}{\sqrt{6}-\sqrt{3}} + \frac{2\sqrt{3}}{\sqrt{6}+2} - \frac{4\sqrt{3}}{\sqrt{6}-\sqrt{2}}$

Q.45 Show that $\frac{1}{3-\sqrt{8}} - \frac{1}{\sqrt{8}-\sqrt{7}} + \frac{1}{\sqrt{7}-\sqrt{6}}$

$$- \frac{1}{\sqrt{6}-\sqrt{5}} + \frac{1}{\sqrt{5}-2} = 5$$

Q.46 Determine rational numbers a and b if

$$\frac{\sqrt{3}-1}{\sqrt{3}+1} + \frac{\sqrt{3}+1}{\sqrt{3}-1} = a + 3\sqrt{3}b$$

Q.47 $x = 3 + 2\sqrt{2}$, find the value of $x^4 + \frac{1}{x^4}$

Q.48 Simplify $\frac{7\sqrt{3}}{\sqrt{10}+\sqrt{3}} - \frac{2\sqrt{5}}{\sqrt{6}+\sqrt{5}} - \frac{3\sqrt{2}}{\sqrt{15}+3\sqrt{2}}$

Q.49 If $x = \frac{\sqrt{5}+\sqrt{2}}{\sqrt{5}-\sqrt{2}}$ and $y = \frac{\sqrt{5}-\sqrt{2}}{\sqrt{5}+\sqrt{2}}$, find the value of $3x^2 + 4xy - 3y^2$

ANSWER KEY

1. (i) $\frac{1}{3}$ (ii) $\frac{37}{99}$

2. 0.2010010001....., 0.2020020002.....

3. 0.20201001000100001....., 0.202020020002..., 0.202030030003.....

4. 1.8010010001....., 1.9010010001....., 2.010010001.....

5. 0.501001001..... and 0.5020020002.....

6. 0.10100100010000..... and 0.1020020002.....

7. 1.73 **8.** $\sqrt[5]{32}$ **9.** $\sqrt[12]{16}$

10. $\sqrt[12]{7}$ **11.** $-3ab\sqrt[3]{4a}$ **12.** $\sqrt[3]{2}$

13. $35\sqrt[3]{5}$ **14.** 33 **15.** m^2n^2

16. $-2.\sqrt[5]{8}$ **17.** 1.154

18. (a) irrational (b) rational

19. (a) irrational (b) rational

20. – 1.732 **21.** $a = \frac{1}{2}$, b = 9

22. – 0.213 **23.** 4 **24.** 34

25. $(2+\sqrt{3}-\sqrt{5})(1-2\sqrt{3})$

26. $\sqrt[12]{27}, \sqrt[12]{16}, \sqrt[12]{16}, \sqrt[12]{9}$ **27.** $11\sqrt{2}$ **28.** $\frac{y^2}{x^2}$

29. $\frac{114-41\sqrt{6}}{30}$ **30.** $\sqrt{2}$ **31.** $\sqrt{10}+\sqrt{5}$

32. $\frac{\sqrt{21}+\sqrt{10}-\sqrt{14}-\sqrt{15}}{2}$ **33.** $\frac{4}{3}$ **34.** $\sqrt{3}+\sqrt{2}$

35. 8 **36.** 7 **37.** 142 **38.** 99

39. $-144\sqrt{5}$ **40.** 2.063 **41.** p = 0, $q = \frac{-1}{11}$

42. 14.268 **43.** 0 **44.** 0

46. a = 4, b = 0 **47.** 1154

48. 1 **49.** $\frac{12+56\sqrt{10}}{3}$

EXERCISE – III MULTIPLE CHOICE QUESTIONS

Q.1 If x, y, z be rational numbers such that $x > y$ and $z < y$ then
(A) $z > x$ (B) $z < x$
(C) $y < z$ (D) $y < x$

Q.2 For any two rational numbers x and y, which of the following properties are correct ?
(i) $x < y$ (ii) $x = y$ (iii) $x > y$
(A) Only (i) and (ii) are correct
(B) Only (ii) and (iii) are correct
(C) Only (ii) is correct
(D) All (i), (ii) and (iii) are correct

Q.3 The number $\frac{3-\sqrt{3}}{3+\sqrt{3}}$ is
(A) rational (B) irrational
(C) both (D) can't say

Q.4 The rational number between $\frac{1}{2}$ and $\frac{1}{3}$ is
(A) $\frac{2}{5}$ (B) $\frac{1}{5}$
(C) $\frac{3}{5}$ (D) $\frac{4}{5}$

Q.5 If A : The quotient of two integers is always a rational number and R : $\frac{1}{0}$ is not rational, then which of the following statements is true ?
(A) A is true and R is the correct explanation of A
(B) A is false and R is the correct explanation of A
(C) A is true and R is false
(D) Both A and R are false

Q.6 The two irrational numbers between $\sqrt{2}$ and $\sqrt{3}$ are
(A) $2^{\frac{1}{2}}, 6^{\frac{1}{4}}$ (B) $3^{\frac{1}{4}}, 3^{\frac{1}{6}}$
(C) $6^{\frac{1}{8}}, 3^{\frac{1}{4}}$ (D) none

Q.7 The number $(\sqrt{x}+\sqrt{y})(\sqrt{x}-\sqrt{y})$ where $x, y > 0$ is
(A) rational (B) irrational
(C) both (D) none

Q.8 The sum of rational and irrational number is always
(A) rational (B) irrational
(C) both (D) can't say

Q.9 The product of rational and irrational number is always
(A) rational (B) irrational
(C) both (D) can't say

Q.10 The number $(6+\sqrt{2})(6-\sqrt{2})$ is
(A) rational (B) irrational
(C) can't say (D) none

Q.11 Which of the following numbers has the terminal decimal representation?
(A) $\frac{1}{7}$ (B) $\frac{1}{3}$
(C) $\frac{3}{5}$ (D) $\frac{17}{3}$

Q.12 The ascending order of the following surds $\sqrt[9]{2}, \sqrt[6]{3}, \sqrt[9]{4}$ is
(A) $\sqrt[9]{4}, \sqrt[6]{3}, \sqrt[3]{2}$ (B) $\sqrt[9]{4}, \sqrt[3]{2}, \sqrt[6]{3}$
(C) $\sqrt[3]{2}, \sqrt[6]{3}, \sqrt[9]{4}$ (D) $\sqrt[6]{3}, \sqrt[9]{4}, \sqrt[3]{2}$

Q.13 Which of the following is a pure surd ?
(A) $4\sqrt{3}$ (B) $3\sqrt[3]{5}$
(C) $\sqrt{12}$ (D) $\frac{3}{4}\sqrt{8}$

Q.14 The greatest among $\sqrt[3]{4}, \sqrt[4]{5}, \sqrt[4]{3}$ is
(A) $\sqrt[3]{4}$ (B) $\sqrt[4]{5}$
(C) $\sqrt[4]{3}$ (D) none of these

Q.15 The greater among $\sqrt{17}-\sqrt{12}$ and $\sqrt{11}-\sqrt{6}$ is
(A) $\sqrt{17}-\sqrt{12}$ (B) $\sqrt{11}-\sqrt{6}$
(C) both are equal (D) can't say

Q.16 Which of the following is a rational number
(A) $\sqrt{5}$ (B) $\sqrt{6}$
(C) $\sqrt{8}$ (D) $\sqrt{9}$

Q.17 Representation of $3.\overline{6}$ in rational
(A) $\frac{11}{3}$ (B) $\frac{3}{11}$
(C) $\frac{36}{10}$ (D) $\frac{33}{10}$

Q.18 The value of b if $f(x) = x^2 + 4\sqrt{x} + b$ and $f(16) = 275$ is
(A) 3 (B) 2
(C) 1 (D) 0

Q.19 The value of a and b if $f(x) = ax + b$ and $f(2) = 8$, $f(3) = 11$ is
(A) a = 3, b = –2 (B) a = –3, b = 2
(C) a = –3, b = –2 (D) a = 3, b = 2

Q.20 The distance between –3 and |–3| is
(A) 6 (B) 0
(C) can't say (D) none

Q.21 The given rational numbers are $\frac{1}{2}, \frac{4}{-5}, \frac{-7}{8}$. If these numbers are arranged in the ascending order or descending order, then the middle number is
(A) $\frac{1}{2}$ (B) $\frac{-7}{8}$
(C) $\frac{4}{-5}$ (D) None

Q.22 The value of x in $|x - 2| = 12$ is
(A) 14, 10 (B) 14, –10
(C)–14, –10 (D) –14, 10

Q.23 Solution of $|2x - 1| \geq 5$ is
(A) $x \geq -2, x \geq 3$ (B) $x \leq -2, x \leq 3$
(C) $x \leq -2, x \geq 3$ (D) $x \leq -2, x \leq 3$

Q.24 The number $(\sqrt{2}+\sqrt{3})^2$ is
(A) rational number (B) irrational number
(C) can't say (D) none

Q.25 The average of the middle two rational numbers if $\frac{4}{7}, \frac{1}{3}, \frac{2}{5}, \frac{5}{9}$ are arranged in ascending order is
(A) $\frac{86}{90}$ (B) $\frac{86}{45}$
(C) $\frac{43}{45}$ (D) $\frac{43}{90}$

Q.26 What is the percentage of least number in the greatest number if $\frac{3}{5}, \frac{9}{5}, \frac{1}{5}, \frac{7}{5}$ are arranged in ascending or desending order ?
(A) $11\frac{1}{9}\%$ (B) 10%
(C) 20% (D) 25%

Q.27 The irrational number between 2 and 3 is
(A) $\sqrt{2}$ (B) $\sqrt{3}$
(C) $\sqrt{5}$ (D) $\sqrt{11}$

Q.28 The value of a if $f(x) = \frac{1}{x} + ax$ and $f\left(\frac{1}{5}\right) = \frac{28}{5}$
(A) 3 (B) 2
(C) 1 (D) 0

Q.29 $\frac{217}{143}$ can be expressed decimal from as
(A) $1.51\overline{7}$ (B) $1.\overline{517}$
(C) $1.5\overline{17}$ (D) 1.517...

Q.30 The equivalent rational form of $17.\overline{6}$ is
(A) $\frac{53}{3}$ (B) $\frac{88}{5}$
(C) $\frac{44}{25}$ (D) none

Q.31 The value of x if $|3x + 2| = 8$
(A) 2 (B) –2
(C) $\frac{10}{3}, -2$ (D) $-\frac{10}{3}, 2$

Q.32 $\frac{961}{625}$ is
(A) terminating decimal
(B) nonterminating decimal
(C) cannot be determined
(D) none of these

Q.33 2.003 can be expressed in the rational form as
(A) $\frac{2003}{100}$ (B) $\frac{2003}{1000}$
(C) $\frac{2003}{10000}$ (D) $\frac{2003}{10}$

Q.34 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

Q.35 Which of the following is not a rational number?
(A) $\sqrt{2}$ (B) $\sqrt{4}$
(C) $\sqrt{9}$ (D) $\sqrt{16}$

Q.36 Set of natural numbers is a subset of
(A) set of even number
(B) set of odd numbers
(C) set of composite numbers
(D) set of real numbers

Q.37 Which of the following statement is false ?

(A) Every fraction is a rational number

(B) Every rational number is a fraction

(C) Every integer is a rational number

(D) All the above

Q.38 A rational number can be expressed as a terminating decimal if the denominator has factors

(A) 2 or 5 (B) 2, 3 or 5

(C) 3 or 5 (D) none of these

Q.39 Express 0.75 as rational number.

(A) $\frac{75}{99}$ (B) $\frac{75}{90}$

(C) $\frac{3}{4}$ (D) None

Q.40 $\sqrt{a} > \sqrt{b} > \sqrt{c} > \sqrt{d}$ where d, c, b a are consecutive natural numbers. Then which of the following is true ?

(A) $\sqrt{a} - \sqrt{b} > \sqrt{c} - \sqrt{d}$ (B) $\sqrt{c} - \sqrt{d} > \sqrt{a} - \sqrt{b}$

(C) $\sqrt{a} - \sqrt{c} > \sqrt{b} - \sqrt{d}$ (D) None of these

Q.41 The smaller among the following surds is

$\sqrt{\frac{1}{2}}, \sqrt[3]{\frac{2}{3}}, \sqrt{\frac{1}{3}}, \sqrt{\frac{1}{4}}$

(A) $\sqrt{\frac{1}{2}}$ (B) $\sqrt[3]{\frac{2}{3}}$

(C) $\sqrt{\frac{1}{3}}$ (D) $\sqrt{\frac{1}{4}}$

Q.42 The product of $\sqrt[3]{2}, \sqrt[4]{3}$ is

(A) $(234)^{\frac{1}{12}}$ (B) $(324)^{\frac{1}{12}}$

(C) $(432)^{\frac{1}{12}}$ (D) $(433)^{\frac{1}{12}}$

Q.43 Divide $\sqrt[6]{12}$ by $\sqrt{3}\ \sqrt[3]{2}$.

(A) $\frac{1}{\sqrt[2]{3}}$ (B) $\frac{1}{\sqrt[3]{3}}$

(C) $\frac{1}{\sqrt[4]{3}}$ (D) $\frac{1}{\sqrt[5]{3}}$

Q.44 The rationalising factor of $2\sqrt[3]{5}$ is

(A) $\sqrt[3]{5}$ (B) $\sqrt[3]{5^2}$

(C) 5^2 (D) 5^3

Q.45 The rationalising factor of $\sqrt[5]{a^2b^3c^4}$ is

(A) $\sqrt[5]{a^3b^2c}$ (B) $\sqrt[4]{a^3b^2c}$

(C) $\sqrt[3]{a^3b^2c}$ (D) $\sqrt{a^3b^2c}$

Q.46 The rationalising factor of $\sqrt{108}$ is

(A) $\sqrt{3}$ (B) $\sqrt[3]{3}$

(C) $\sqrt[3]{27}$ (D) $\sqrt[3]{15}$

Q.47 The rational denominator of the surd $\frac{3\sqrt[3]{5}}{\sqrt[3]{9}}$ is

(A) 1 (B) 2

(C) 3 (D) 4

Q.48 Given that $\sqrt{2}$ = 1.414, $\sqrt{3}$ = 1.732, $\sqrt{5}$ = 2.236.

Then the value of $\frac{1}{\sqrt{10}}$ up to three decimal places is

(A)2.414 (B) 0.316

(C)1.079 (D) 3.162

Q.49 $\frac{-3}{0}$ is ..... .

(A) positive rational number

(B) negative rational number

(C) either positive or negative rational number

(D) neither positive nor negative rational number

Q.50 A rational number equivalent to $\frac{-5}{-3}$ is

(A) $\frac{-25}{15}$ (B) $\frac{25}{-15}$

(C) $\frac{25}{15}$ (D) none of these

Q.51 $\frac{-2}{-19}$ is a

(A) positive rational number

(B) negative rational number

(C) either positive or negative rational number

(D) neither positive nor negative rational number

Q.52 The rational number $\frac{0}{7}$

(A) has a positive numerator

(B) has negative numerator

(C) has either a positive numerator or a negative numerator

(D) has neither a positive numerator nor a negative numerator

Q.53 Which of the following rational numbers is in the standard form ?

(A) $\frac{8}{-36}$ (B) $\frac{-7}{56}$

(C) $\frac{3}{-4}$ (D) None

Q.54 Which of the following statement is true ?

(A) $\frac{3}{-8} > \frac{-12}{32}$ (B) $\frac{3}{-8} = \frac{-12}{32}$

(C) $\frac{3}{-8} < \frac{-12}{32}$ (D) $\frac{3}{5} > \frac{4}{3}$

Q.55 If $\frac{-3}{5} = \frac{-24}{x}$, then x is

(A) 40 (B) – 40
(C) ± 40 (D) none

Q.56 If $\frac{-3}{x} = \frac{x}{27}$ then x is

(A) a rational number
(B) not a rational number
(C) an integer
(D) a natural number

Q.57 A rational number $\frac{-2}{3}$

(A) lies to the left side of 0 on the number line
(B) lies to the right side of 0 on the number line
(C) it is not possible to represent on the number line
(D) cannot be determined on which side the number lies

Q.58 Which of the following statement is true?

(A) $\frac{-5}{8}$ lies to the left of 0 on the number line

(B) $\frac{3}{7}$ lies to the right at 0 on the number line

(C) The rational numbers $\frac{1}{3}$ and $\frac{-7}{3}$ are on opposite sides of 0 on the number line

(D) All the above

Q.59 Out of the rational numbers $\frac{-5}{11}, \frac{5}{-12}, \frac{-5}{17}$, which is greater ?

(A) $\frac{-5}{11}$ (B) $\frac{5}{-12}$

(C) $\frac{-5}{17}$ (D) None

Q.60 Out of the rational numbers $\frac{7}{-13}, \frac{-5}{13}, \frac{-11}{13}$ which is smaller ?

(A) $\frac{7}{-13}$ (B) $\frac{-5}{13}$

(C) $\frac{-11}{13}$ (D) None

Q.61 If both 'a' and 'b' are rational numbers then 'a' and 'b' from the following $\frac{3-\sqrt{5}}{3+2\sqrt{5}} = a\sqrt{5} - b$ are

(A) $a = \frac{9}{11}, b = \frac{19}{11}$ (B) $a = \frac{19}{11}, b = \frac{9}{11}$

(C) $a = \frac{2}{11}, b = \frac{-8}{11}$ (D) $a = \frac{10}{11}, b = \frac{21}{11}$

Q.62 The value of $\frac{\sqrt{5}-2}{\sqrt{5}+2} - \frac{\sqrt{5}+2}{\sqrt{5}-2}$ is

(A) $-\sqrt{5}$ (B) $-2\sqrt{5}$

(C) $-4\sqrt{5}$ (D) $-8\sqrt{5}$

Q.63 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) $-14, 8\sqrt{3}$

Q.64 The value of $\frac{1}{1+\sqrt{2}} + \frac{1}{\sqrt{2}+\sqrt{3}} + \frac{1}{\sqrt{3}+\sqrt{4}} + \frac{1}{\sqrt{4}+\sqrt{5}}$

$+ \frac{1}{\sqrt{5}+\sqrt{6}} + \frac{1}{\sqrt{6}+\sqrt{7}} + \frac{1}{\sqrt{7}+\sqrt{8}} + \frac{1}{\sqrt{8}+\sqrt{9}}$

(A) 0 (B) 1
(C) 2 (D) 4

Q.65 If $x = 3 + \sqrt{8}$ then $x^3 + \frac{1}{x^3} =$

(A) 216 (B) 198
(C) 192 (D) 261

Q.66 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

Q.67 If $x = \frac{\sqrt{a}+\sqrt{b}}{\sqrt{a}-\sqrt{b}}$, $y = \frac{\sqrt{a}-\sqrt{b}}{\sqrt{a}+\sqrt{b}}$ then the value of $x^2 + xy + y^2$ is

(A) $\frac{4(a-b)}{(a+b)}$ (B) $\frac{4(a+b)}{(a-b)}$

(C) $\frac{2(a+b)}{(a-b)}$ (D) $\frac{2(a-b)}{(a+b)}$

Q.68 The smallest positive number from the numbers below is

(A) $10 - 3\sqrt{11}$ (B) $3\sqrt{11} - 10$

(C) $18 - 5\sqrt{13}$ (D) $51 - 10\sqrt{26}$

Q.69 $\frac{2\sqrt{6}}{\sqrt{2}+\sqrt{3}+\sqrt{5}}$ equals

(A) $\sqrt{2}+\sqrt{3}-\sqrt{5}$ (B) $4-\sqrt{2}-\sqrt{3}$

(C) $\sqrt{2}+\sqrt{3}+\sqrt{6}-5$ (D) $\frac{1}{2}(\sqrt{2}+\sqrt{5}-\sqrt{3})$

Q.70 The value of $\left(\sqrt[6]{27}-\sqrt{6\frac{3}{4}}\right)^2$

(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{3}{2}$

(C) $\frac{\sqrt{3}}{4}$ (D) $\frac{3}{4}$

Q.71 Which of the following is closest to $\sqrt{65}-\sqrt{63}$?

(A) 0.12 (B) 0.25

(C) 0.14 (D) 0.15

Q.72 The value of $\sqrt{8}+\sqrt{18}$ is

(A) $\sqrt{26}$ (B) $2(\sqrt{2}+\sqrt{3})$

(C) 7 (D) $5\sqrt{2}$

Q.73 The fraction $\frac{2\left(\sqrt{2}+\sqrt{6}\right)}{2\left(\sqrt{2}+\sqrt{3}\right)}$ is equal to

(A) $\frac{2\sqrt{2}}{3}$ (B) 1

(C) $\frac{2\sqrt{3}}{3}$ (D) $\frac{4}{3}$

Q.74 If $N=\frac{\sqrt{\sqrt{5}+2}+\sqrt{\sqrt{5}-2}}{\sqrt{\sqrt{5}+1}}-\sqrt{3-2\sqrt{2}}$ then N equals to

(A) 1 (B) $2\sqrt{2} - 1$

(C) $\frac{\sqrt{5}}{2}$ (D) None of these

Q.75 If $t = \frac{1}{1-\sqrt[4]{2}}$ then t equal to

(A) $(1-\sqrt[4]{2})(2-\sqrt{2})$ (B) $(1-\sqrt[4]{2})(1+\sqrt{2})$

(C) $-(1+\sqrt[4]{2})(1+\sqrt{2})$ (D) $(1+\sqrt[4]{2})(1+\sqrt{2})$

Q.76 If $x = \sqrt{3}+\sqrt{2}$ then $x^2 + \frac{1}{x^2}$ is

(A) $2\sqrt{3}$ (B) 10

(C) 12 (D) 14

Q.77 The biggest surd among $\sqrt[3]{2}$; $\sqrt{3}$, $\sqrt[3]{5}$ is

(A) $\sqrt[3]{2}$ (B) $\sqrt{3}$

(C) $\sqrt[3]{5}$ (D) None

Q.78 The value of the surd $4\sqrt{3}-3\sqrt{12}+2\sqrt{75}$ is

(A) $2\sqrt{3}$ (B) $4\sqrt{3}$

(C) $6\sqrt{3}$ (D) $8\sqrt{3}$

Q.79 The product of $\sqrt[3]{4}$ and $\sqrt[3]{22}$ is

(A) $2\sqrt[3]{11}$ (B) $3\sqrt[3]{11}$

(C) $4\sqrt[3]{11}$ (D) none

Q.80 The value of $\frac{a+\sqrt{a^2-b^2}}{\sqrt{a^2+b^2}+b}+\frac{\sqrt{a^2+b^2}-b}{a-\sqrt{a^2-b^2}}$

(A) $\frac{a^2}{b^2}$ (B) $\frac{b^2}{a^2}$

(C) $\frac{a}{b}$ (D) None

Q.81 If p : Every fraction is a rational number and q : Every rational number is a fraction, then which of the following is correct ?

(A) p is true and q is false

(B) p is false and q is true

(C) Both p and q are true

(D) Both p and q are false

Q.82 Which of the following is a rational number(s)?

(A) $\frac{-2}{9}$ (B) $\frac{4}{-7}$

(C) $\frac{-3}{-17}$ (D) All the three

Q.83 If p : All integers are rational numbers and q : Every rational number is an integer, then which of the following statement is correct?

(A) p is true and q is false

(B) p is false and q is true

(C) Both p and q are true

(D) Both p and q are false

Q.84 If A : if the denominator of a rational number has 2 as a prime factor, then that rational number can be expressed as a terminating decimal and R : $\frac{83}{64}$ is a terminating decimal, then which of the following statements is correct ?

(A) A is false and R is true

(B) A is true and R is false

(C) A is true and R is an example of A

(D) A is false and R is an example supporting A

Q.85 If x and y are two rational numbers, then which of the following statements is wrong ?

(A) $|x + y| \le |x| + |y|$

(B) $|x \times y| = |x| \times |y|$

(C) $|x - y| \le |x| - |y|$

(D) None of these

Q.86 Which of the following statements is true ?

(A) $\frac{-2}{3} < \frac{4}{-9} < \frac{-5}{12} < \frac{7}{-18}$ (B) $\frac{7}{-18} < \frac{-5}{12} < \frac{4}{-9} < \frac{-2}{3}$

(C) $\frac{4}{-9} < \frac{7}{-18} < \frac{-5}{12} < \frac{-2}{3}$ (D) $\frac{-5}{12} < \frac{-2}{3} < \frac{4}{-9} < \frac{7}{-18}$

Q.87 The difference between the greatest and least number of $\frac{5}{9}, \frac{1}{9}, \frac{11}{9}$ is

(A) $\frac{2}{9}$ (B) $\frac{4}{9}$

(C) $\frac{10}{9}$ (D) $\frac{2}{3}$

Q.88 $0.\overline{018}$ can be expressed in the rational form as

(A) $\frac{18}{1000}$ (B) $\frac{18}{990}$

(C) $\frac{18}{9900}$ (D) $\frac{18}{999}$

Q.89 $2.53\overline{6}$ can be expressed in the rational form as

(A) $\frac{716}{300}$ (B) $\frac{761}{3000}$

(C) $\frac{761}{300}$ (D) $\frac{761}{3000}$

Q.90 $0.\overline{23} + 0.\overline{22} =$

(A) $0.\overline{45}$ (B) $0.\overline{43}$

(C) $0.4\overline{5}$ (D) 0.45

Q.91 Which of the following statement(s) is true

(A) $|x \times y| = |x| \cdot |y|$, where x and y are rational numbers

(B) Infinite number of rational numbers lie between any two rational numbers

(C) $|x| = -x$ if $x < 0$ where x is a rational number

(D) All the above

Q.92 Express $0.3\overline{58}$ as rational number

(A) $\frac{358}{1000}$ (B) $\frac{358}{999}$

(C) $\frac{355}{990}$ (D) All

Q.93 Which of the following statement is true ?

(A) $\frac{5}{7} < \frac{7}{9} < \frac{9}{11} < \frac{11}{13}$ (B) $\frac{11}{13} < \frac{9}{11} < \frac{7}{9} < \frac{5}{7}$

(C) $\frac{5}{7} < \frac{11}{13} < \frac{7}{9} < \frac{9}{11}$ (D) $\frac{5}{7} < \frac{9}{11} < \frac{11}{13} < \frac{7}{9}$

Q.94 A rational number between $\frac{1}{4}$ and $\frac{1}{3}$ is

(A) $\frac{7}{24}$ (B) 0.29

(C) $\frac{13}{48}$ (D) all the above

Q.95 If A : Every whole number is a natural number and R : 0 is not a natural number, then which of the following statement is true?

(A) A is false and R is the correct explanation of A

(B) A is true and R is the correct explanation of A

(C) A is true and R is false

(D) Both A and R are true

Q.96 $2-\frac{11}{39}+\frac{5}{26}=$ .....

(A) $\frac{149}{39}$ (B) $1+\frac{71}{78}$

(C) $\frac{149}{76}$ (D) $\frac{149}{98}$

Q.97 $\frac{-143}{21}=$ .....

(A) $-6+\frac{17}{21}$ (B) $6+\left(\frac{-17}{21}\right)$

(C) $(-6)+\left(\frac{-17}{21}\right)$ (D) none

Q.98 Addition of rational numbers does not satisfy which of the following property?

(A) Commutative (B) Associative

(C) Closure (D) None

Q.99 $\frac{-7}{5}+\left(\frac{2}{-11}+\frac{-13}{25}\right)=\left(\frac{-7}{5}+\frac{2}{-11}\right)+\frac{-13}{25}$

This property is

(A) closure (B) commutative

(C) associative (D) identity

Q.100 Which of the following statement is correct ?

(A) 0 is called the additive identity for rational numbers.

(B) 1 is called the multiplicative identity for rational numbers.

(C) The additive inverse of 0 is zero itself.

(D) All the above

Q.101 The sum of two rational numbers is –3. If one of the numbers is $\frac{-7}{5}$, then the other number is

(A) $\frac{-8}{5}$ (B) $\frac{8}{5}$

(C) $\frac{-6}{5}$ (D) $\frac{6}{5}$

Q.102 What number should be added to $\frac{-5}{6}$ so as to get $\frac{3}{2}$?

(A) $\frac{-7}{3}$ (B) $2\frac{1}{3}$

(C) $\frac{8}{3}$ (D) $\frac{-8}{3}$

Q.103 Which of the following alternatives is wrong ? Given that

(i) difference of two rational numbers is a rational number

(ii) subtraction is commutative on rational numbers

(ii) addition is not commutative on rational numbers

(A) (ii) and (iii) (B) (i) only

(C) (i) and (iii) (D) All the above

Q.104 Which of the following statements is true

(A) The reciprocals 1 and –1 are themselves

(B) 0 has no reciprocal

(C) The product of two rational numbers is a rational number

(D) All the above

Q.105 Which is the property of multiplication

$$-\frac{4}{3}\left(\frac{-6}{5}+\frac{8}{7}\right)=\left(\frac{-4}{3}\times\frac{-6}{5}\right)+\left(\frac{-4}{3}\times\frac{8}{7}\right)$$

(A) Associative property

(B) commutative property

(C) distributive property

(D) none of these

Q.106 The product of a rational number and its reciprocal is

(A) 0 (B) 1

(C) –1 (D) none

Q.107 The product of two rational numbers is $-\frac{9}{16}$. If one of the numbers is $\frac{-4}{3}$, the other number is

(A) $\frac{36}{48}$ (B) $\frac{25}{64}$

(C) $\frac{27}{49}$ (D) $\frac{27}{64}$

Q.108 By what rational number should $\frac{-8}{39}$ be multiplied to obtain 26 ?

(A) $\frac{507}{4}$ (B) $\frac{-507}{4}$

(C) $\frac{407}{4}$ (D) None

Q.109 How many pieces of equal size can but cut from a rope of 30 meters long, each measuring $3\frac{3}{4}$ meters ?

(A) 8 (B) 10

(C) 6 (D) 12

Q.110 If A : Rational number are always closed under division and R : Division by zero is not defined, then which of the following statement is correct ?

(A) A is true and R is the correct explanation of A

(B) A is false and R is the correct explanation of A

(C) A is true and R is false

(D) None of these

Q.111 π is

(A) rational (B) irrational

(C) imaginary (D) an integer

Q.112 The set of all irrational numbers is closed for

(A) addition (B) multiplication

(C) division (D) none of these

Q.113 The additive inverse of $\frac{-a}{b}$ is

(A) $\frac{a}{b}$ (B) $\frac{b}{a}$

(C) $\frac{-b}{a}$ (D) $\frac{-a}{b}$

Q.114 Multiplicative inverse of '0' is

(A) $\frac{1}{0}$ (B) 0

(C) does not exist (D) none of these

Q.115 Express $0.\overline{75}$ as rational number.

(A) $\frac{75}{90}$ (B) $\frac{25}{33}$

(C) $\frac{3}{4}$ (D) None

Q.116 An irrational number is

(A)a terminating and nonepreating decimal

(B) a nonterminating and non repeating decimal

(C) a terinating and repeating decimal

(D) a nonterminating and repeating decimal

Q.117 Which of the following statement is true ?

(A) Every point on the number line represents a rational number

(B) Irrational number cannot be represent on the number line

(C) $\frac{22}{7}$ is a rational number

(D) None of these

Q.118 The set of real numbers does not have the property of

(A) multiplicative inverse

(B) additive inverse

(C) multiplicative identity

(D) none of these

Q.119 Which step in the following problem is wrong ?

$a = b = 1$ $a = b$

Step-1 = $a^2 = ab$

Step-2 = $a^2 - b^2 = ab - b^2$

Step-3 = $(a + b)(a - b) = b(a - b)$

Step-4 : $a + b = \frac{b(a-b)}{a-b}$

$a + b = b$ $1 + 1 = 1$ $2 = 1$

(A) Step-4 (B) Step-3

(C) Step-2 (D) Step-1

Q.120 If 'm' is an irrational number then '2m' is _____ .

(A) a rational number (B) an irrational number

(C) a whole number (D) a natural number

Q.121 The value of $\sqrt{3}$ is

(A) 1.414 (B) 2.256

(C) 1.732 (D) none

Q.122 The greatest among the following is

I. $\sqrt[3]{1.728}$ II. $\frac{\sqrt{3}-1}{\sqrt{3}+1}$

III. $\left(\frac{1}{2}\right)^{-2}$ IV. $\frac{17}{8}$

(A) I (B) IV

(C) II (D) III

Q.123 A fraction $\frac{a}{b}$ can be expressed as a terminating decimal, if b has no prime factors other than

(A) 2, 3 (B) 3, 5

(C) 2, 5 (D) 2, 3, 5

Q.124 The sum of a rational and an irrational number is

(A) an irrational number

(B) a rational number

(C) an integer

(D) a whole number

Q.125 The product of two irrationals is

(A) a rational number (B) an irrational number

(C) either A or B (D) neither A nor B

Q.126 The value of $1.\overline{34} + 4.\overline{12}$ is

(A) $\frac{133}{99}$ (B) $\frac{371}{90}$

(C) $\frac{5169}{990}$ (D) $\frac{5411}{990}$

Q.127 The value of $4-\cfrac{5}{1+\cfrac{1}{3+\cfrac{1}{2+\frac{1}{4}}}}$ is

(A) $\frac{40}{31}$ (B) $\frac{4}{9}$

(C) $\frac{1}{8}$ (D) $\frac{31}{40}$

Q.128 The sum of the additive inverse and multiplicative inverse of 2 is

(A) $\frac{3}{2}$ (B) $\frac{-3}{2}$

(C) $\frac{1}{2}$ (D) $\frac{-1}{2}$

Q.129 If $\sqrt{6}$ = 2.449 then the value of $\frac{3\sqrt{2}}{2\sqrt{3}}$ is close to

(A) 1.225 (B) 0.816

(C) 0.613 (D) 2.449

Q.130 The value of $\sqrt{5\sqrt{5\sqrt{5\sqrt{5}.....}}}$ is

(A) 0

(B) 5

(C) can't be determined

(D) none

Q.131 Arrange the following numbers in descending order. $-2, \frac{4}{-5}, \frac{-11}{20}, \frac{3}{4}$

(A) $\frac{3}{4} > -2 > \frac{-11}{20} > \frac{4}{-5}$

(B) $\frac{3}{4} > \frac{-11}{20} > \frac{-4}{5} > -2$

(C) $\frac{3}{4} > \frac{4}{-5} > -2 > \frac{-11}{20}$

(D) $\frac{3}{4} > \frac{4}{-5} > \frac{-11}{20} > -2$

ANSWER KEY

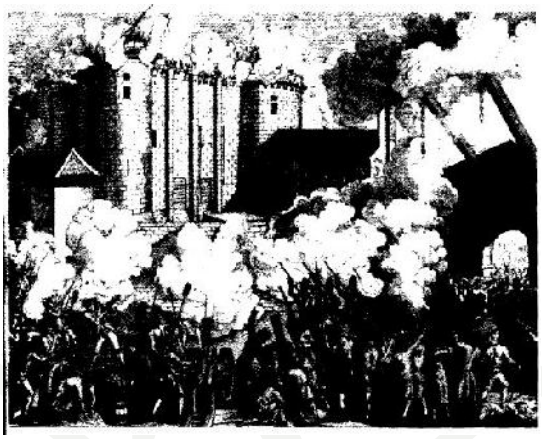
1.	B	**2.**	D	**3.**	B	**4.**	C
5.	B	**6.**	C	**7.**	A	**8.**	B
9.	B	**10.**	A	**11.**	C	**12.**	A
13.	C	**14.**	A	**15.**	B	**16.**	D
17.	A	**18.**	A	**19.**	D	**20.**	A
21.	C	**22.**	B	**23.**	C	**24.**	B
25.	D	**26.**	A	**27.**	C	**28.**	A
29.	D	**30.**	A	**31.**	D	**32.**	A
33.	B	**34.**	C	**35.**	A	**36.**	D
37.	B	**38.**	A	**39.**	C	**40.**	B
41.	B	**42.**	C	**43.**	D	**44.**	B
45.	A	**46.**	A	**47.**	C	**48.**	B
49.	D	**50.**	C	**51.**	A	**52.**	D
53.	D	**54.**	B	**55.**	A	**56.**	B
57.	A	**58.**	D	**59.**	C	**60.**	C
61.	A	**62.**	D	**63.**	C	**64.**	C
65.	B	**66.**	A	**67.**	B	**68.**	D
69.	A	**70.**	D	**71.**	B	**72.**	D
73.	D	**74.**	A	**75.**	C	**76.**	B
77.	B	**78.**	D	**79.**	A	**80.**	D
81.	A	**82.**	D	**83.**	B	**84.**	C
85.	C	**86.**	A	**87.**	C	**88.**	D
89.	C	**90.**	A	**91.**	D	**92.**	C
93.	A	**94.**	D	**95.**	A	**96.**	B
97.	C	**98.**	D	**99.**	C	**100.**	D
101	A	**102.**	B	**103.**	A	**104.**	D
105.	C	**106.**	B	**107.**	D	**108.**	B
109.	A	**110.**	B	**111.**	B	**112.**	D
113.	A	**114.**	C	**115.**	B	**116.**	B
117.	C	**118.**	D	**119.**	A	**120.**	B
121.	C	**122.**	D	**123.**	C	**124.**	A
125.	C	**126.**	D	**127.**	C	**128.**	B
129.	A	**130.**	B	**131.**	B		

THE FRENCH REVOLUTION

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 peoples' militia.

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 days that followed saw more rioting both in Paris and the countryside. Most people were protesting against the high price of bread. Much later, when historians looked back upon this time, they saw it as the beginning of a chain of events that ultimately led to the execution of the king in France, though most people at the time did not anticipate his outcome. How and why did this happen?

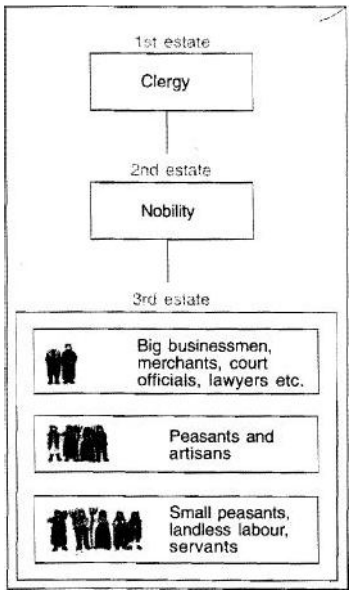


Storming of the Bastille

FRENCH SOCIETY DURING THE LATE EIGHTEENTH CENTURY

In 1774, Louis XVI of the Bourbon family of kings ascended the throne of France. He was 20 years old and married to the Austrian princess Marie Antoinette. Upon his accession the new king found an empty treasury. Long years of war had drained the financial reousrces of France. Added to this was the cost of maintaining an extravagant court at the immense palace of Versailles. Under Louis XVI, France helped the thirteen American colonies to gain their independence from the common enemy, Britain. The war added more than a billion livres to a debt that had already risen to more than 2 billion livres. To meet its regular expenses, such as the cost of maintaining an army, the court, running government offices or universities, the state was forced to increase taxes. Yet even this measure would not have sufficed. French society in the eighteenth century was divided into three estates, and only members of the third estate paid taxes.

The society of estates was part of the feudal system that dated back to the middle ages. The term Old Regime is usually used to describe the society and institutions of France before 1789.



A Society of Estates

Figure shows how the system of estates in French society was organised. Peasants made up about 90 per cent of the population. However, only a small number of them owned the land they cultivated. About 60 per cent of the land was owned by nobles, the Church and other richer members of the third estate. The members of the first two estates that is, the clergy and the nobility, enjoyed certain privileges by birth. Peasants were obliged to render services to the lord-to work in his house and fields-to serve in the army or to participate in building roads.

The Church too extracted its share of taxes called tithes from the peasants, and finally, all members of the third estate had to pay taxes to the state. These included a direct tax, called taille, and a number of indirect taxes which were levied on articles of everyday consumption like salt or tobacco. The burden of financing activities of the state through taxes was borne by the third estate alone.

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.

The nobleman is the spider, the peasant the fly.

The more the devil has, the more he wants.

The Spider and the Fly

1. **The Struggle to Survive:** The population of France rose from about 23 million in 1715 to 28 million in 1789. This led to a rapid increase in the demand for foodgrains. Production of grains could not keep pace with the demand. So the price of bread which was the staple diet of the majority rose rapidly. So the gap between the poor and the rich widened. Things became worse whenever drought or hail reduced the harvest. This led to a subsistence crisis, something that occurred frequently in France during the Old Regime.

2. **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) Physiocrates, 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 then for them 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, that 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.

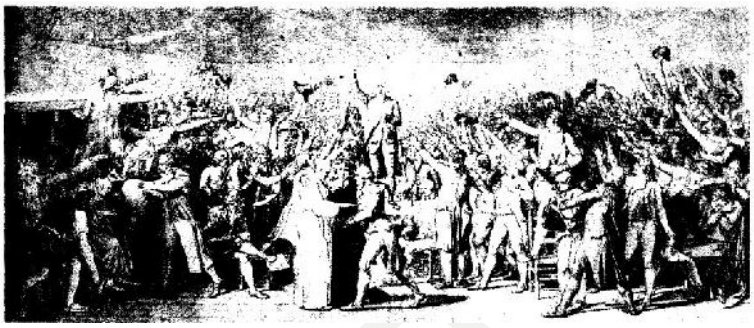
THE OUTBREAK OF THE REVOLUTION

The Estates General was a political body to which the three estates sent their representatives. However, the monarch alone could decide when to call a meeting of this body. The last time it was done was in 1614.

On 5 May 1789, Louis XVI called together an assembly of the Estates General to pass proposals for new taxes. A resplendent hall in Versailles was prepared to host the delegated. The first and second estates sent 300 representatives each, who were seated in rows facing each other on two sides, while the 600 members of the third estate had to stand at the back. The third estate was represented by its more prosperous and educated members. Peasants, artisans and women were denied entry to the assembly. However, their grievances and demands were listed in some 40,000 letters which the representatives had brought with them.

This was one of the democratic principles put forward by philosophers like Rousseau in his book The Social Contract. When the king rejected this proposal, members of the third estate walked out of the assembly in protest.

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. Mirabeau was born in a noble family but was convinced of the need to do away with a society of feudal privilege. He brought out a journal and delivered powerful speeches to the crowds assembled at Versailles.



The Tennis Court Oath

Abbe Sieyes, originally a priest, wrote an influential pamphlet called What is the Third Estate?

While the National Assembly was busy at Versailles drafting a constitution, the rest of France seethed with turmoil. A severe winter had meant a bad harvest; the price of bread rose, often bakers exploited the situation and hoarded supplies. After spending hours in long queues at the bakery, crowds of angry women stormed into the shops. At the same time, the king ordered troops to move into Paris. On 14 July, the agitated crowd stormed and destroyed the Bastille.

In the countryside rumours spread from village to village that the lords of the manor had hired bands of brigads 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.

Faced with the power of his revolting subjects, 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. Members of the clergy too were forced to give up their privileges. Tithes were abolished and lands owned by the Church were confiscated. As a result, the government acquired assets worth at least 2 billion liveres.

◈ **France Becomes a Constitutional Monarchy:**

(i) 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.

(ii) The Constitution of 1791 vested the power to make laws in the National Assembly, which was indirectly elected.

(iii) 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.

FRANCE ABOLISHES MONARCHY AND BECOMES A REPUBLIC

Among the partriotic songs they sang was the Marseillaise, composed by the poet Roget de L'Isle. It was sung for the first time by volunteers from Marseilles as they marched into Paris.

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, watch-makers, printers, as well as servants and daily wage workers. Their leader was maximilian Robespierre.

These Jacobins came to be known as the sans-culottes, literally meaning those without knee breeches'. Sans-culottes men wore in addition the red cap that symbolised liberty. Women however were not allowed to do so.

On the morning of August 10 they stormed the Place of the Tuileries, massacred the king's guards and held the king himself as hostage for several hours. Later the Assembly voted to imprison the royal family. Elections were held. From now on all men of 21 years and above, regardless of wealth, got the right to vote.

The newly elected assembly was called the Convention. On 21 September 1792 is abolished the monarchy and declared France a republic.

On 21 January 1793 he was executed publicly at the Place de la Concorde. The queen Marie Antoinette met with the same fate shortly after.

1. **The Reign of Terror:** The period from 1793 to 1794 is referred to as the Reign of Terror. Robespierr followed a policy of severe control and punishment. All those whom he saw as being 'enemies' of the republic - ex-nobles and clergy, members of other political parties, even members of his own party who did not agree with his methods - were arrested, imprisoned and then tried by a revolutionary tribunal. If the court found them 'guilty' they were guillotined.

   Robespierre's government issued laws placing a maximum ceiling on wages and prices. Meat and bread were rationed. Peasants were forced to transport their grain to the cities and sell it at prices fixed by the government.

   He was convicted by a court in July 1794, arrested and on the next day sent to the guillotine.

2. **A Directory Rules France:** The fall of the Jacobin government allowed the wealthier middle classes to seize power. A new constitution was introduced which denied the vote to non-propertied sections of society. It provided for two elected legislative councils. These then appointed a Directory, an executive made up of five members. This was meant as a safeguard against the concentration of power in a one-man executive as under the Jacobins. However, the 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?

From the very beginning women were active participants in the events which brought about so many important changes in French society. They hoped that their involvement would pressurise the revolutionary government to introduce measures to improve their lives. Most women of the third estate had to work for a living. They worked as seamstresses or laundresses, sold flowers, fruits and vegetables at the market, or were employed as domestic servants in the houses of prosperous people. Most women did not have access to education or job trainning. Only daughters of nobles or wealthier members of the third estate could study at a convent, after which their families arranged a marriage for them. Working women had also to care for their families, that is, cook, fetch water, queue up for bread and look after the children. 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. The Society of Revolutionary and republican Women was the most famous of them. One of their main demands was that women enjoy the same political rights as men. Women were disappointed that the Constitution of 1791 reduced them to passive citizens. They demanded the right to vote, to be elected to the Assembly and to hold political office. Only then, they felt, would their interests be represented in the new government.

In the early years, the revolutionary government did introduce laws that helped improve the lives of women. Together with the creation of state schools, schooling was made compulsory for all girls. Their father could no longer force them into marriage against their will. Marriage was made into a contract entered into freely and registered under civil law. Divorce was made legal, and could be applied for by both women and men. Women could now train for jobs, could become artists or run small business.

THE ABOLITION OF SLAVERY

One of the most revolutionary social reforms of the Jacobin regime was the abolition of slavery in the French colonies. The colonies in the Caribbean-Martinique, Guadeloupe and San Domingo-were important suppliers of commodities such as tobacco, indigo, sugar and coffee. But the reluctance of Europeans to go and work in distant and unfamiliar lands meant a shortage of labour on the plantations. So this was met by a triangular slave trade between Europe, Africa and the Americas. The slave trade began in the seventeenth century. French merchants sailed from the ports of Bordeaux or Nantes to the African coast, where they bought slaves from local chieftians. Branded and shackled, the slaves were packed tightly into ships for the three-month long voyage across the Atlantic to the Caribbean. There they were sold to plantation owners. The exploitation of slave abour made it possible to meet the growing demand in European markets for sugar, coffee, and indigo. Port cities like Bordeaux and Nantes owned their economic prosperity to the flourishing slave trade.

Thoughout the eighteenth century there was little criticism of slavery in France. The National Assembly held long debates about whether the rights of man should be extended to all French subjects including those in the colonies. But it did not pass any laws, fearing opposition from businessmen whose incomes depended on the slave trade. It was finally the Convention which in 1794 legislated to free all slaves in the French overseas possessions. This, however, turned out to be a short-term measure: ten years later, Napoleon reintroduced slavery. Plantation owners understood their freedom as including the right to enslave African Negroes in pursuit of their economic interests. Slavery was finally abolished in French colonies in 1848.

THE REVOLUTION AND EVERYDAY LIFE

Can politics change the clothes people wear, the language they speak or the books they read? The years following 1789 in France saw many such changes in the lives of men, women and children. The revolutionary governments took it upon themselves to pass laws that would translate the ideals of liberty and equality into everyday practice. One important law that came into effect soon after the storming of the Bastille in the summer of 1789 was the abolition of censorship. In the Old Regime all written material and cultural activities -books, newspapers, plays -could be published or performed only after they had been approved by the censors of the king. Now the Declaration of the Rights of Man and Citizen proclaimed freedom of speech and expression to be a natural right. Newspapers, pamphlets, books and printed pictures flooded the towns of France from where they travelled rapidly into the countryside. They all described and discussed the events and changes taking place in France. Freedom of the press also meant that opposing views of events could be expressed. Each side sought to convince the others of its position through the medium of print. Plays, songs and festive processions attracted large numbers of people. This was one way they could grasp and identify with ideas such as liberty or justice that political philosophers wrote about at length in texts which only a handful of educated people could read.

Conclusion: In 1804, Napoleon Bonaparte crowned himself Emperor of France. He set out to conquer neighbouring 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. Many of his that carried the revolutionary ideas of liberty and modern laws other parts of Europe had an impact on people long after Napoleon had left.

The ideas of liberty and democratic rights were the most important legacy of the French Revolution. These spread from France to the rest of Europe during the nineteenth century, where feudal systems were abolished. Colonised peoples reworked the idea of freedom from bondage into their movements to create a sovereign nation state. Tipu Sultan and Rammohan Roy are two examples of individuals who responded to the ideas coming from revolutionary France.

Exercise - I UNSOLVED PROBLEMS

VERY SHORT ANSWER QUESTION

Q.1 What was the main aim of the National Assembly?

Q.2 What was the National Anthem of France? Who composed it?

Q.3 What is a Guillotine? Who invented it?

Q.4 State any two laws passed by Napoleon.

Q.5 Mention two activities of French Assembly which hastened the Revolution.

Q.6 How was The French society organized during the Old Regime?

Q.7 What do you mean by 'Subsistence crisis'? Why did it occur frequently during the old Regime in France?

Q.8 Why did Louis XVI want to raise taxes? Why was he opposed?

Q.9 What was the composition of the Estates General of May 5, 1789?

Q.10 Identify Nepoleon, telling the part played by him in the French Revolution.

SHORT ANSWER QUESTION

Q.1 Who was Mirabeau?

Q.2 What was the main objective of the National Assembly?

Q.3 What was the subsistence crisis? Why did it occur in France during the Old Regime?

Q.4 What were 'natural and inalienable rights'?

Q.5 Describe the role of the Bourbon kings in the French Revolution.

Q.6 What was 'Bastille'? What do you understand by 'Storming of the Bastille'?

Q.7 Explain how the new political system worked?

Q.8 Who were Jacobins? What role did they play in emergence of republic in France?

Q.9 What was Directory? What were its consequences?

Q.10 What role did the philosophers play in bringing about the French Revolution?

Q.11 Why is the Declaration of the Rights of man citizen regarded as a revolutionary document?

Q.12 Give an estimate or Napoleon Bonaparte as the First Consul.

Q.13 What was the impact of the French Revolution on the world?

Q.14 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?

Q.15 Explain the term 'Third Estate'?

LONG ANSWER QUESTION

Q.1 Who were the Jacobins? What was their contribution to the French Revolution?

Q.2 Discuss the participation of women in political clubs, their activities and demands.

Q.3 What was the impact of French Revolution on France?

Q.4 Write short notes on

(i) French slave trade

(ii) Reign of Terror

(iii) Fall of Napoleon.

Q.5 What was the importance of slavery to France?

Q.6 Discuss the impact of abolition of censorship in France.

Q.7 How did the teachings of Rousseau lay the foundations of democracy?

Q.8 List the accomplishments of the National Assembly of France from 1789 to 1791.

Q.9 How did France become a constitutional monarchy?

Q.10 Discuss the role of women in the revolutionary movement in France. When did women gain political equality in France?

Q.11 Give an estimate of the work of the National Assembly?

Exercise - II OLYMPIAD PROBLEMS

Q.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

Q.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

Q.3 Which of the following is not the idea of the revolutionary journalist Desmoulins about Liberty?

(A) Liberty is finishing off your enemies
(B) Liberty is Happiness, Reason, Equality and Justice

(C) Liberty is the Declaration of Right
(D) Liberty is not a child who has to be disciplined before maturity

Q.4 How does a 'Subsistence Crisis' happen?

(A) Bad harvest leads to scarcity of grains
(B) Food prices rise and the poorest cannot buy bread

(C) Leads to weaker bodies, diseases, deaths and even food riots

(D) All the above

Q.5 Which of the following statements is untrue about the Third Estate?

(A) The Third Estate was made of the poor only

(B) Within the Third Estate some were rich and some were poor

(C) Richer members of the Third Estate owned lands

(D) Peasants were obliged to serve in the army, or build roads

Q.6 Who wrote the pamphlet called 'What is the Third Estate'?

(A) Mirabeau, a nobleman

(B) Abbe sieyes

(C) Rousseau, a philosopher

(D) Montesquieu

Q.7 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

Q.8 When did the French Revolution begin?

(A) July 14, 1789

(B) January 10, 1780

(C) August 12, 1782

(D) None of the above

Q.9 The word livres 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

Q.10 What was the effect of the rise of population of France from about 23 million in 1715 to 28 million in 1789?

(A) Education became difficult

(B) Rapid increase in the demand for foodgrains

(C) Housing problem occurred

(D) All the above

Q.11 What was the name of tax which was directly paid to the state by the Third Estate?

(A) tithes (B) livres

(C) taille (D) all of these

Q.12 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

Q.13 Who wrote the book The Spirit of the laws?

(A) Lenin (B) Karl Marx

(C) E H Carr (D) Montesquieu

Q.14 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

Q.15 Who wrote the book The Social Contract?

(A) Lenin (B) Karl Max

(C) Rousseau (D) E H Carr

Q.16 The various groups in French society were known as:

(A) Caster (B) Classes

(C) Estates (D) Tribes

Q.17 The term old regime was used to describe the society and institution of France:

(A) Before 1879 (B) Before 1689

(C) Before 1789 (D) Before 1859

Q.18 Peasants made about ..... percent of the French population at the time of revolution.

(A) 70% (B) 80%

(C) 50% (D) 90%

Q.19 A kind of tax called Taille was a/an:

(A) Direct tax

(B) Indirect tax

(C) Indiscriminate tax

(D) Custom duty

Q.20 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

Q.21 Montesquieu wrote:

(A) The social contract

(B) Two treatises of government

(C) The spirit of laws

(D) From monarchy to diarchy

Q.22 The agitated crowd stormed and destroyed the Bastille on:

(A) 4 July 1789 (B) 5 May 1789

(C) 14 July 1789 (D) 24 July 1789

Q.23 The National Assembly completed the drafting of constitution in-

(A) 1791 (B) 1779

(C) 1782 (D) 1792

Q.24 The members of National Assembly were-

(A) Nominated

(B) Indirectly elected

(C) Directly elected

(D) Appointed by the king

Q.25 To qualify as an elector and then as member of the assembly a man had to belong to the-

(A) Lowest braclet of taxpayers

(B) Middle braclet of taxpayers

(C) Highest braclet of taxpayers

(D) Not to be a taxpayer

Q.26 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

Q.27 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

Q.28 Which of following was a patriotic song of France during revolution?

(A) Long live king (B) Long live Robespierre

(C) Versailles (D) Marseillaise

Q.29 France become a republic after abolishing the monarchy on-

(A) 11 Sept. 1792

(B) 1st Sept. 1792

(C) 21 Sept. 1792

(D) 31 Aug. 1792

Q.30 Which of the following are the examples of individual who represented the ideas from revlutionay France

(A) Gandhi and Nehru

(B) Tilak and Gokhale

(C) Tipu Sultan and Raja Ram Mohan Roy

(D) Tagore and Vivekananda

Q.31 From about 13th century to the time of the French Revolution sumptuary laws were expected to be followed strictly to **[NTSE 2013]**

(A) Regulate the behaviour of the royalty

(B) Regulate the income of people by social rank

(C) Control the behaviour of those consideral social inferiors

(D) Provide religions sanctity to social behaviour

Q.32 In Medieval times, fews lived in separately marked areas known as **[NTSE 2013]**

(A) Ghettos

(B) Lebensraum

(C) Symagogues

(D) Gas chambere

ANSWER KEY

1.	D	**2.**	D	**3.**	B	**4.**	D
5.	A	**6.**	B	**7.**	A	**8.**	A
9.	A	**10.**	B	**11.**	C	**12.**	C
13.	D	**14.**	B	**15.**	C	**16.**	C
17.	C	**18.**	D	**19.**	A	**20.**	B
21.	C	**22.**	C	**23.**	A	**24.**	B
25.	C	**26.**	D	**27.**	C	**28.**	D
29.	C	**30.**	C	**31.**	C	**32.**	A