CAREER POINT

Study Material for Pre foundation Class 9

Prepared by Career Point Kota Experts

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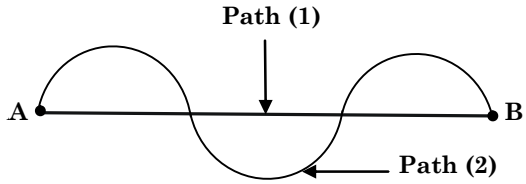
Chapter

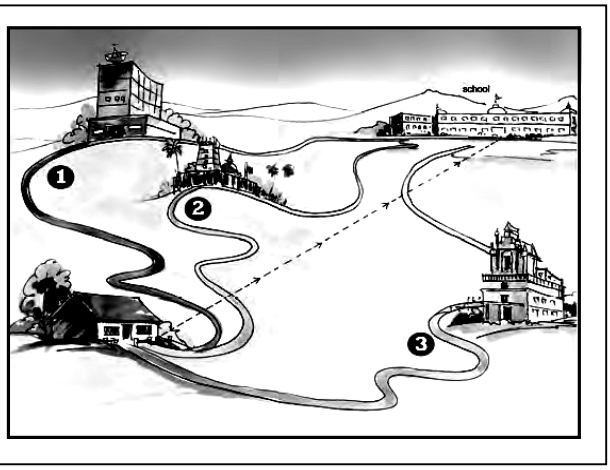
1

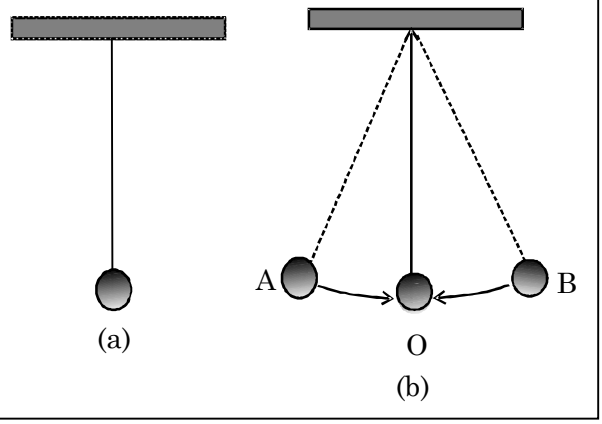
MOTION

Chapter Outline

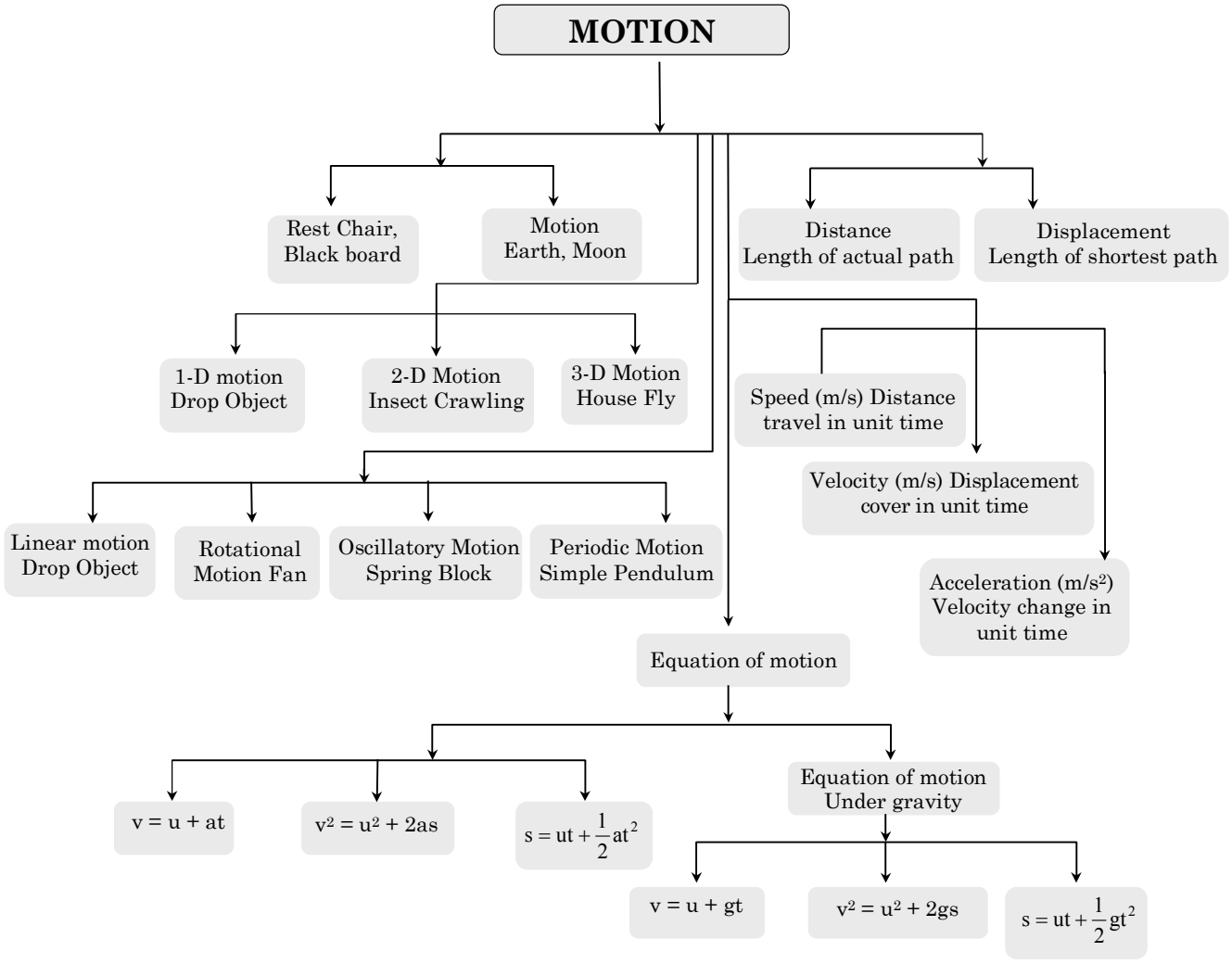
- Physics
- Rest and Motion
- Types of motion
- Scalar and Vector Quantity
- Distance and displacement
- Speed & Velocity
- Uniform and non uniform motion
- Acceleration
- Graphical representation of motion
- Equation of uniformly accelerated motion
- Circular motion







MIND MAP


MOTION
Rest Chair, Black board
Motion Earth, Moon
Distance Length of actual path
Displacement Length of shortest path
1-D motion Drop Object
2-D Motion Insect Crawling
3-D Motion House Fly
Speed (m/s) Distance travel in unit time
Velocity (m/s) Displacement cover in unit time
Acceleration (m/s²) Velocity change in unit time
Linear motion Drop Object
Rotational Motion Fan
Oscillatory Motion Spring Block
Periodic Motion Simple Pendulum
Equation of motion
v = u + at
v² = u² + 2as
s = ut + 1/2 at²
Equation of motion Under gravity
v = u + gt
v² = u² + 2gs
s = ut + 1/2 gt²

MOTION

Physics

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

◈ Mechanics

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

(i) Statics (ii) Kinematics and Dynamics

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

(ii) Kinematics and Dynamics:

Kinematics: It deals with the study of motion of objects without considering the cause of motion.

e.g.: equations of motion

Dynamics: It deals with the study of motion of objects with considering the cause of motion.

e.g.: Newton's laws of motion

Rest & Motion

◈ Rest

An object is said to be at rest if it does not change its position w.r.t. its surroundings with the passage of time.

e.g.: The chair, black board, table in the class room are at rest w.r.t. the students.

◈ Motion

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

e.g.: A car moving on the road will be in motion w.r.t. to the person standing on the road

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

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

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

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

◈ Concept of a Point Object

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

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

◈ Frame of Reference

A fixed point or a fixed object with respect to which the given body changes its position is known as reference point or origin

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

Note: *We need Frame of reference to define dimensions of motion.*

Types of Motion

◈ Motion in 1-D

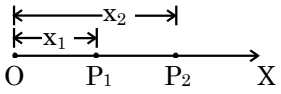
If only one of the three co-ordinates specifying the position of object changes w.r.t. time then its motion is known as 1D motion. In such a case the object moves along a straight line. This motion is also known as rectilinear or linear motion.

e.g.:

(i) Motion of train along straight railway track.

(ii) An object falling freely under gravity.

(iii) When a particle moves from P_1 to P_2 along a straight line path only the x-co-ordinate changes.



◈ Motion in 2-D

If two of the three co-ordinates specifying the position of object changes w.r.t. time, then the motion of object is called two dimensional. In such a motion the object moves in a plane.

e.g:

(i) Motion of queen on carom board.

(ii) An insect crawling on the floor of the room.

(iii) Motion of object in horizontal and vertical circles etc.

(iv) Motion of planets around the sun.

(v) A car moving along a zig-zag path on a level road.

◈ Motion in 3-D

If all the three co-ordinates specifying the position of object changes w.r.t. time, then the motion of object is called 3-D. In such a motion the object moves in a space.

e.g.:

(i) A bird or kite flying in the sky (Also kite).

(ii) Random motion of gas molecules.

(iii) Motion of an aeroplane in space.

◈ Linear Motion (or Translatory Motion)

The straight line motion is called linear motion.

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

◈ Rotational Motion

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

e.g.: The motion of an electric fan, motion of earth about its own axis.

◈ Oscillatory Motion

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

e.g.: The motion of a simple pendulum, a body suspended from a spring.

Scalar and Vector Quantity

Physical quantities (i.e. quantities of physics) can be divided into two types:

◈ Scalar quantity

Any physical quantity, which can be completely specified by its magnitude, is known as scalar quantity or a scalar.

e.g.: Charge, distance, area, speed, time, temperature, density, volume, work, power, energy, pressure, potential etc.

◈ Vector quantity

The quantity which can be determined by its magnitude and direction and also can be added or subtracted by vector algebra, is called a vector quantity.

e.g.: Displacement, velocity, acceleration, force, momentum, weight, electric field etc.

◈ Difference between scalar and vector

Scalar	Vector
1. They have magnitude only.	1. They have magnitude as well as direction.
2. They are added or subtracted arithmetically like 3 kg + 5 kg = 8 kg	2. They are added or subtracted by the process of vector addition.

COMPETITIVE LEVEL

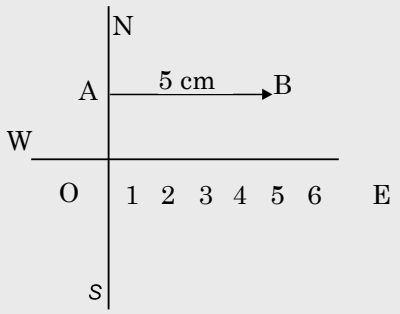
- **Representation of a vector:** A vector is represented by a directed line segment drawn in the given direction on a certain scale.The length of line shows its magnitude and arrow shows direction.

Tail ⟶ head

(symbolic representation)

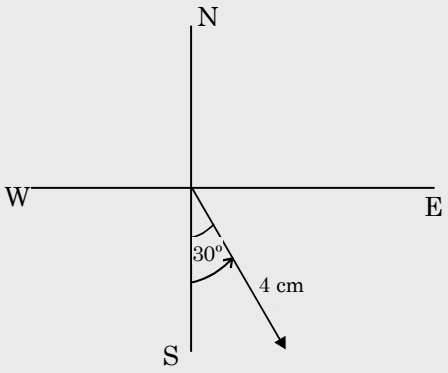
Ex.1 Represent a displacement of 50 m towards east.

Sol. Take the scale 10 m = 1 cm



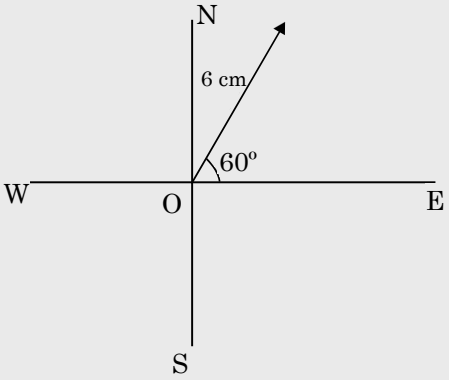
Ex.2 Represent a velocity of 20 km/h towards 30º east of south.

Sol. Take scale 5 km/h = 1 cm.



Ex.3 Represent on graph 6 m displacement, 60º north–east (north of east)

Sol. Take scale 1 m = 1 cm



◈ Addition of Vectors

Two or more vectors are added by following laws:

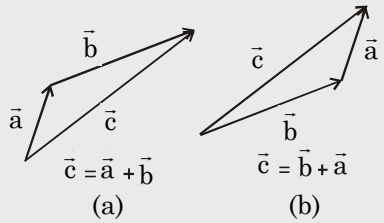
(i) triangle law

(ii) parallelogram law

(iii) polygon law

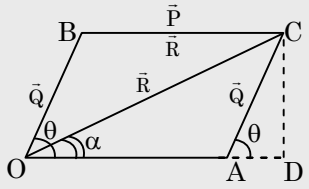
- **Triangle law of vector addition:** If two vectors are represented both in magnitude and direction by the two sides of a triangle taken in the same order, then the resultant of these two vectors is represented in magnitude and direction by the third side of the triangle taken in the opposite order.

  Given two vectors $\vec{a}$ and $\vec{b}$, put the tail of $\vec{b}$ at the head of $\vec{a}$, then the sum of $\vec{a}$ and $\vec{b}$ is defined as the vector $\vec{c}$ drawn from the tail of $\vec{a}$ to the head of $\vec{b}$.



- **Parallelogram Law of Vector Addition Statement:** If two vectors acting simultaneously at a point are represented in magnitude and direction by the two adjacent sides of a parallelogram, then the diagonal of the parallelogram passing through that point represents the resultant in magnitude and direction.

- **Analytical approach to parallelogram law of vector addition:** Let the two vectors $\vec{P}$ and $\vec{Q}$ be represented in magnitude and direction by the adjacent sides $\overrightarrow{OA}$ and $\overrightarrow{OB}$ of the parallelogram OACB. Suppose the angle between the vectors is θ, i.e. $\angle AOB = \theta$. According to parallelogram law of vector addition, the diagonal represents the resultant $\vec{R}(\overrightarrow{OC})$ in magnitude and direction. Suppose $\vec{R}$ makes an angle α with $\vec{P}$ i.e. $\angle AOC = \alpha$



Magnitude of Resultant:

$\therefore \quad R = \sqrt{P^2 + q^2 + 2PQ\cos\theta}$

Direction of resultant:

$\therefore \quad \tan\alpha = \dfrac{Q\sin\theta}{P + Q\cos\theta}$

Ex.4 Find the resultant of two forces each having magnitude F_0, and angle between them is θ.

Sol. $F^2_{Resultant} = F_0^2 + F_0^2 + 2F_0^2\cos\theta$

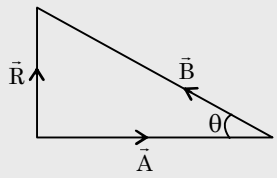
$= 2F_0^2(1 + \cos\theta) = 2F_0^2 \times 2\cos^2\dfrac{\theta}{2}$

$2 \times 2\cos^2\dfrac{\theta}{2}$

$F_{resultant} = 2F_0\cos\dfrac{\theta}{2}$

Ex.5 The resultant of two velocity vectors $\vec{A}$ and $\vec{B}$ is perpendicular to $\vec{A}$. Magnitude of Resultant $\vec{R}$ is equal to half magnitude of $\vec{B}$. Find the angle between $\vec{A}$ and $\vec{B}$?

Sol. Since $\vec{R}$ is perpendicular to $\vec{A}$. Figure shows the three vectors $\vec{A}$, $\vec{B}$ and $\vec{R}$.



angle between $\vec{A}$ and $\vec{B}$ is $\pi - \theta$

$\sin\theta = \frac{R}{B} = \frac{R}{2B} = \frac{1}{2}$

$\Rightarrow \quad \theta = 30^o$

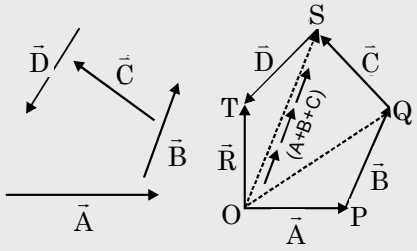
$\Rightarrow$ angle between A and B is 150^o.

◈ Polygon Law of Vector Addition

If a number of vectors are represented both in magnitude and direction by the sides of a polygon taken in the same order, then the resultant vector is represented both in magnitude and direction by the closing side of the polygon taken in the opposite order.

Let the number of vectors $\vec{A}$, $\vec{B}$, $\vec{C}$ and $\vec{D}$ etc. be acting in different directions as shown in figure.

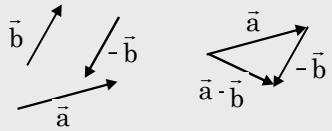
To find their resultant vector, coincide the tail of $\vec{B}$ with the head of $\vec{A}$, tail of $\vec{C}$ with the head of $\vec{B}$ and tail $\vec{D}$ with the head of $\vec{C}$. Then the single vector drawn form the tail of $\vec{A}$ to head of $\vec{D}$.



will thus, it is clear it the vectors $\vec{A}$ $\vec{B}$ $\vec{C}$ and $\vec{D}$ are represented in magnitude and direction by the sides $\overrightarrow{OP}$, $\overrightarrow{PQ}$, $\overrightarrow{QS}$ and $\overrightarrow{ST}$ of an open polygon taken in the same order, then their resultant vector $\vec{R}$ will be represented in magnitude and direction by the closing side $\overrightarrow{OT}$ of the polygon taken in opposite order. This method of finding the resultant is called polygon law of vectors.

- **Subtraction of Vectors:** The negative of a vector is defined as a vector of same magnitude but opposite direction.

The Subtraction of a vector $\vec{b}$ from another vector $\vec{a}$ is defined as the addition of $-\vec{b}$ to $\vec{a}$, as shown in figure

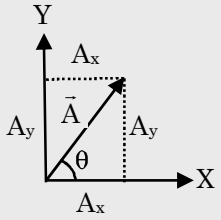


- **Resolution of A Vector:** It is the process of splitting a single vector into two or more vectors in different directions which together produce the same effect as is produced by the single vector alone. The vectors into which the given single vector is splited are called component vectors. Infect, the resolution of a vector is just opposite to composition of vectors.

  A vector can have infinite component vectors but for simplicity a vector is resolved into two or three mutually perpendicular components

- **Resolution into mutually Perpendicular Vectors in a plane (2D Resolution):** The figure shows resolution of a vector $\vec{A}$ into two oblique vectors $\vec{A}_x$ and $\vec{A}_y$.

  Using the elementary knowledge of trigonometry the vectors $\vec{A}_x$ and $\vec{A}_y$ are given by $\vec{A}_x = \vec{A}\cos\theta$, $\vec{A}_y = \vec{A}\sin\theta$



Resolution of a vector into mutually perpendicular components

◈ Scalar Product

The scalar product or dot product of any two vectors $\vec{A}$ and $\vec{B}$, denoted as $\vec{A}.\vec{B}$ (read $\vec{A}$ dot $\vec{B}$) is defined as the product of their magnitude with cosine of angle

between them. Thus, $\vec{A}.\vec{B} = AB\cos\theta$ {here θ is the angle between the vectors}

If the scalar product of two nonzero vectors vanishes then the vectors are perpendicular.

The scalar product of a vector by itself is termed as self dot product and is given by

$(\vec{A})^2 = \vec{A}.\vec{A} = AA\cos\theta = AA\cos0^o = A^2$

$\Rightarrow \quad A = \sqrt{\vec{A}.\vec{A}}$

In case of unit vector $\hat{n}$,

$\hat{n}.\hat{n} = 1 \times 1 \times \cos 0^o = 1$

$\Rightarrow \hat{n}.\hat{n} = \hat{i}.\hat{i} = \hat{j}.\hat{j} = \hat{k}.\hat{k} = 1$

In case of orthogonal unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$;

$\hat{i}.\hat{j} = \hat{j}.\hat{k} = \hat{k}.\hat{i} = 0$

$\vec{A}.\vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k}).(B_x\hat{i} + B_y\hat{j} + B_z\hat{k}) = [A_xB_x + A_yB_y + A_zB_z]$

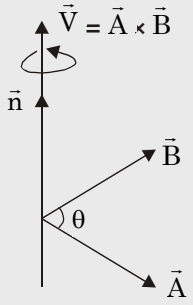
◈ Vector Product

The vector product or cross product of any two vectors $\vec{A}$ and $\vec{B}$, denoted as $\vec{A}\times\vec{B}$ (read $\vec{A}$ cross $\vec{B}$) is defined as:

$$\vec{A}\times\vec{B} = AB\sin\theta\ \hat{n}$$

Here θ is the angle between the vectors and the direction $\hat{n}$ is given by the right-hand-thumb rule.

- **Right-Hand-Thumb Rule:** To find the direction of $\hat{n}$, draw the two vectors $\vec{A}$ and $\vec{B}$ with both the tails coinciding. Now place your stretched right palm perpendicular to the plane of $\vec{A}$ and $\vec{B}$ in such a way that the fingers are along the vector $\vec{A}$ and when the fingers are closed they go towards $\vec{B}$. The direction of the thumb gives the direction of.



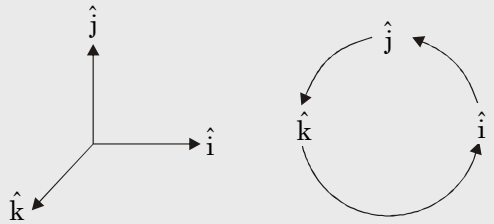
$\vec{A} \times \vec{A} = AA \sin 0^{o}\, \hat{n} = \vec{0}$.

In case of unit vector $\hat{n}$, $\hat{n} \times \hat{n} = \vec{0}$

$\Rightarrow \hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = \vec{0}$

In case of orthogonal unit vectors $\hat{i}, \hat{j}, \hat{k}$

in accordance with right-hand-thumb-rule, $\hat{i} \times \hat{j} = \hat{k}$ $\hat{j} \times \hat{k} = \hat{i}$ $\hat{k} \times \hat{i} = \hat{j}$



In terms of components, $\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$

$= i\begin{vmatrix} A_y & A_z \\ B_y & B_z \end{vmatrix} - \hat{j}\begin{vmatrix} A_x & A_z \\ Bx & B_z \end{vmatrix} + \hat{k}\begin{vmatrix} A_x & A_y \\ B_x & B_y \end{vmatrix}$

$\vec{A} \times \vec{B} = \hat{i}(A_y B_z - A_z B_y) - \hat{j}(A_x B_z - A_z B_x) + \hat{k}(A_x B_y - A_y B_x)$

The magnitude of area of the parallelogram formed by the adjacent sides of vector and equal to $|\vec{A} \times \vec{B}|$.

Ex.6 If the Vectors $\vec{P} = a\hat{i} + a\hat{j} + 3\hat{k}$ and $\vec{Q} = a\hat{i} - 2\hat{j} - \hat{k}$ are perpendicular to each other. Find the value of a?

Sol. If vectors $\vec{P}$ and $\vec{Q}$ are perpendicular

$\Rightarrow \vec{P} \cdot \vec{Q} = 0$

$\Rightarrow (a\hat{i} + a\hat{j} + 3\hat{k}) \,.\, (a\hat{i} - 2\hat{j} - \hat{k}) = 0$

$\Rightarrow a^2 - 2a - 3 = 0$

$\Rightarrow a^2 - 3a + a - 3 = 0$

$\Rightarrow a(a - 3) + 1(a - 3) = 0$

$\Rightarrow a = -1, 3$

Ex.7 Two vectors $\vec{A}$ and $\vec{B}$ are inclined to each other at an angle θ. Find a unit vector which is perpendicular to both $\vec{A}$ and $\vec{B}$.

Sol. $\vec{A} \times \vec{B} = AB \sin\theta \quad \Rightarrow \quad \hat{n} = \dfrac{\vec{A} \times \vec{B}}{AB\sin\theta}$

here $\hat{n}$ is perpendicular to both $\vec{A}$ and $\vec{B}$.

Ex.8 Find $\vec{A} \times \vec{B}$, if $\vec{A} = \hat{i} - 2\hat{j} + 4\hat{k}$ and $\vec{B} = 2\hat{i} - \hat{j} + 2\hat{k}$

Sol. $$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 4 \\ 3 & -1 & 2 \end{vmatrix}$$

$= \hat{i}\,(-4 - (-4)) - \hat{j}\,(2 - 12) + \hat{k}\,(-1 - (-6)) = 10\hat{j} + 5\hat{k}$

Distance and Displacement

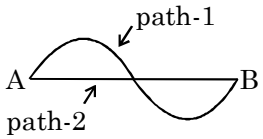
◈ **Distance:**

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

◈ **Displacement:**

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

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



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

◈ **Some important points:**

(i) When an object moves towards right from origin, its displacement consider as positive.

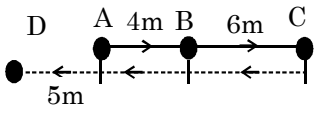
(ii) When an object moves towards left from origin its displacement consider as negative.

(iii) When an object remains stationary or it moves first towards right and then an equal distance towards left, its displacement is zero.

(iv) Shifting origin causes no change in displacement.

(v) If body moves along the circumference of the circle of radius r then distance travelled by it is given by $2\pi r$ and displacement is given by zero, for one complete revolution.

Ex.9 A body starts from A and moves according to given figure. (Body retraces the path after C then reaches to D)



The distance and displacement are as follows for different path

Sol.

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

◈ **Difference between distance and displacement**

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

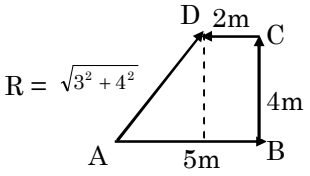
Ex.10 A person travels a distance of 5 m towards east, then 4 m towards north and then 2 m towards west.

(i) Calculate the total distance travelled.

(ii) Calculate the resultant displacement.

Sol. (i) Total distance travelled by the person = 5 m + 4 m + 2 m = 11 m

(ii) The resultant displacement is calculated by joining the initial position A to the final position D. Hence, the displacement of the person = 5m towards AD.

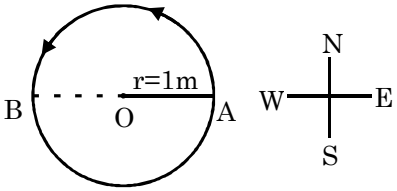


Ex.11 A person moves in a circular path centered at O. He starts from A and reaches diametrically opposite point B. Then find:

(i) distance between A and B

(ii) displacement between A and B

Sol.



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

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

r = 1m

$\therefore$ Distance = π m

(ii) Displacement = 2r along west = 2m along west

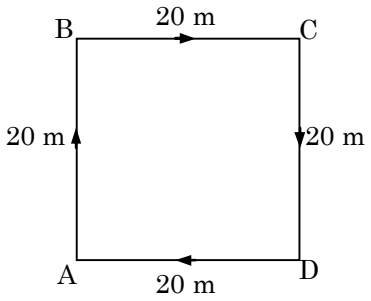
Ex.12 What does the odometer of an automobile measure?

Sol. The odometer of an automobile measures the distance covered by an automobile.

Ex.13 An object has moved through a distance. Can it have zero displacement? If yes, support your answer with an example.

Sol. Yes, an object that has moved through a distance can have zero displacement. Displacement is the shortest measurable distance between the initial and the final position of an object. An object which has covered a distance can have zero displacement, if it comes back to its starting point, i.e., the initial position.

Consider the following situation: A man is walking in a square park of length 20 m (as shown in the following figure). He starts walking from point A and after moving along all the corners of the park (point B, C, D), he again comes back to the same point, i.e., A.



In this case, the total distance covered by the man is 20 m + 20 m + 20 m + 20 m = 80 m. However, his displacement is zero because the shortest distance between his initial and final position is zero.

Ex.14 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 farmer takes 40 s to cover $4 \times 10 = 40$ m.

In 2 min and 20 s (140 s), he will cover a distance $\frac{40}{40} \times 140 = 140$ m

Therefore, the farmer completes $\frac{140}{40} = 3.5$ rounds (3 complete rounds and a half round) of the field in 2 min and 20 s.

That means, after 2 min 20 s, the farmer will be at the opposite end of the starting point.

Now, there can be two extreme cases.

Case I: Starting point is a corner point of the field.

In this case, the farmer will be at the diagonally opposite corner of the field after 2 min 20 s.

Therefore, the displacement will be equal to the diagonal of the field.

Hence, the displacement will be $\sqrt{10^2 + 10^2} = 14.1$ m

Case II: Starting point is the middle point of any side of the field.

In this case the farmer will be at the middle point of the opposite side of the field after 2 min 20 s.

Therefore, the displacement will be equal to the side of the field, i.e., 10 m.

For any other starting point, the displacement will be between 14.1 m and 10 m.

Speed & Velocity

◈ Speed

The distance travelled by a body in unit time is called its speed. Therefore, speed = $\frac{\text{Distance}}{\text{Time}}$ or $s = \frac{d}{t}$

S.I. unit of speed or average speed is m/sec. It is a scalar quantity.

◈ Types of Speed

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

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

(i) Let initial speed of an object is v_1, final speed is v_2 and acceleration is constant, then

average speed = $\frac{v_1 + v_2}{2}$

(ii) A body covers a distance s_1 in time t_1, s_2 in time t_2 and s_3 in time t_3.

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

(iii) A body travels with speed v_1 for a time t_1 v_2 for time t_2 and v_3 for the time t_3.

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

$s_1 = v_1 t_1$, $s_2 = v_2 t_2$ and $s_3 = v_3 t_3$

if $t_1 = t_2 = t_3 = t$

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

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

(iv) A body covers a distance s_1 with speed v_1 , s_2 with speed v_2 and s_3 with speed v_3.

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

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

(v) A boy goes from home to school with speed v_1 and come back to home with speed v_2.

Here distance covered by the boy is same

Time taken by the boy, while traveling from home to school,

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

and time taken by the boy, while traveling from school to home,

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

Then, average speed, $v_{av} = \frac{s + s}{t_1 + t_2} = \frac{2s}{\frac{s}{v_1} + \frac{s}{v_2}}$

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

(vi) If an object covers 1/3rd distance with speed u, next 1/3rd with speed v and last 1/3rd distance with speed w, then $v_{avg} = \frac{3uvw}{uv + vw + wu}$

- **Uniform Speed (or Constant Speed):** When an object covers equal distance in equal intervals of time, it is said to move with uniform speed. e.g.: A car moves 10 m in every one second so its motion is uniform.
- **Variable Speed (Non-Uniform Speed):** If a body covers unequal distance in equal intervals of time, its motion is said to be non-uniform. e.g.: Falling of an apple from a tree, a cyclist moving on a rough road, an athlete running a race, vehicle starting from rest, the motion of a freely falling body etc.
- **Instantaneous speed:** The speed of object at a particular instant is called instantaneous speed.

COMPETITIVE LEVEL

The limiting value of average speed when the time interval approaches zero, Thus,

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

◈ Velocity

It is defined as the rate of change of displacement.

Therefore, velocity = $\frac{\text{displacement}}{\text{time}}$

or it is the distance travelled in unit time in a given direction.

Velocity = $\frac{\text{Distance travelled in a given direction}}{\text{time taken}}$

S.I. unit of velocity is m/s. It is a vector quantity.

(Magnitude of the velocity is known as speed)

Note:
- *To convert m/s into km/h we multiply by 18/5*
- *To convert km/h into m/s we multiply by 5/18*

◈ Types of Velocity

- **Uniform Velocity (Constant Velocity):** If a body covers equal distance in equal intervals of time in a given direction then it is said to be moving with constant velocity.
- **Non-Uniform Velocity:** When a body does not cover equal distances in equal intervals of time, in a given direction (in this case speed is not constant), then it is known as non uniform velocity.

  In uniform circular motion speed is constant but velocity is not constant.
- **Average Velocity:** It is defined as the ratio of total displacement to the total time taken for this displacement. It is denoted by $\bar{v}_{av}$ **or** $\bar{v}$. It is a vector quantity.

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

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

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

Note:
- *If for a straight line motion displacement is positive then $\bar{v}$ is positive.*
- *If displacement is negative then $\bar{v}$ is also negative.*

- **Instantaneous Velocity:** The velocity of an object at a particular instant of time is called instantaneous velocity. It is a vector quantity.

COMPETITIVE LEVEL

It is equal to the limiting value of average velocity of the object when the time interval approaches zero, thus Instantaneous velocity $\vec{v} = \lim_{\Delta t \to 0} \frac{\Delta \vec{s}}{\Delta t} = \frac{d\vec{s}}{dt}$

◈ **More about Speed and Velocity:**

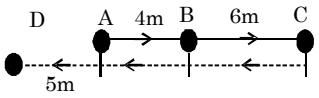
(i) The instantaneous velocity in magnitude is equal to instantaneous speed.

(ii) A particle may have constant speed but variable velocity. In uniform circular motion speed remains constant while velocity changes because of change in direction in motion.

(iii) If particle is moving along a straight line without changing the direction, its average velocity will be equal to its average speed. Otherwise average velocity will be less than average speed.

$$\left|\frac{\text{Average velocity}}{\text{average speed}}\right| \leq 1$$

Ex.15 A body starts from A and moves according to given figure. Time for each interval is:
t_{AB} = 2s, t_{BC}= 3s, t_{CB}=2s, t_{BA} = 3s, t_{AD}= 4s



Find the distance, displacement, speed and velocity for path AB, ABC, ABCB, ABCA, ABCAD.

Sol. The distance, displacement, speed and velocity are as follows for different paths.

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

Ex.16 Distinguish between speed and velocity.

Sol. Difference between speed and velocity:

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

Ex.17 What does the path of an object look like when it is in uniform motion?

Sol. An object having uniform motion has a straight line path.

Ex.18 During an experiment, a signal from a spaceship reached the ground station in five minutes. What is the distance of the spaceship from the ground station? The signal travels at the speed of light, that is, 3×10^8 m s^{-1}.

Sol. Time taken by the signal to reach the ground station from the spaceship = 5 min = $5 \times 60 = 300$ s
Speed of the signal = 3×10^8 m/s

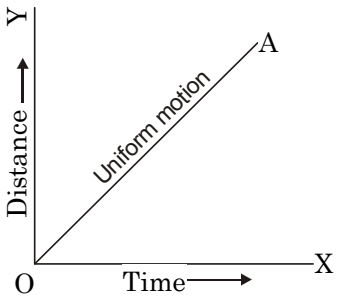
$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

$\therefore$ Distance travelled = Speed × Time taken = $3 \times 10^8 \times 300 = 9 \times 10^{10}$
Hence, the distance of the spaceship from the ground station is 9×10^{10} m.

Uniform and Non-Uniform Motion

◈ Uniform Motion

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



◈ Non-Uniform Motion

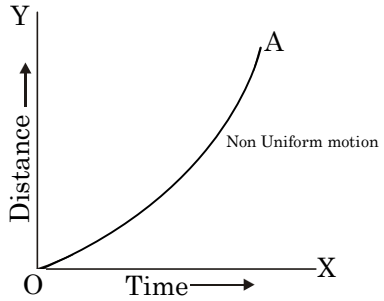
A body has a non-uniform motion if it travels unequal distances in equal intervals of time. For example, if we drop a ball from the roof of a building, we will find that it covers unequal distances in equal intervals of time. It covers:

4.9 metre in the 1st second,

14.7 metre in the 2nd second,

24.5 metre in the 3rd second, and so on.

Thus, a freely falling ball covers smaller distance in the initial '1 second' interval and larger distance in the later '1 second' interval. From this discussion we conclude that the motion of a freely falling body is an example of non-uniform motion. The motion of a train starting from the railway station is also an example of non-uniform motion. This is because when the train starts from a station, it moves a very small distance in the 'first' second. The train moves a little more distance in the '2nd' second and so on. And when the train approaches the next station, the distance travelled by it per second decreases.



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

◈ Features of Uniform Motion

(i) The velocity in uniform motion does not depend on the choice of origin.

(ii) The velocity in uniform motion does not depend on the choice of the time interval.

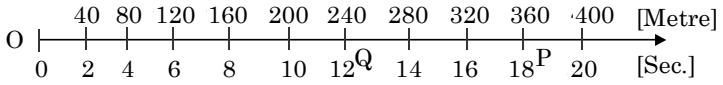
(iii) For uniform motion along a straight line in the same direction, the magnitude of the displacement is equal to the actual distance covered by the object.

(iv) The velocity is positive if the object is moving towards the right of the origin and negative if the object is moving towards the left of the origin.

(v) For an object in uniform motion no force is required to maintain its motion.

(vi) In uniform motion, the instantaneous velocity is equal to the average velocity at all times because velocity remains constant at each instant, at each point of the path.

Ex.19 A car is moving along x-axis. As shown in figure it moves from O to P in 18 s and returns from P to Q in 6 second. What is the average velocity and average speed of the car in going from (i) O to P and (ii) from O to P and back to Q.



Sol. (i) Average velocity $= \frac{\text{Displacement}}{\text{time interval}} = \frac{360}{18} = 20 \text{ms}^{-1}$

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

(ii) From O to P and back to Q

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

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

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

Ex.20 A car covers the 1st half of the distance between two places at a speed of 40 km h^{-1} and the 2nd half with 60 km h^{-1}. What is the average speed of the car?

Sol. Suppose the total distance covered is 2S.

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

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

Time taken to cover the next distance 'S' with speed 60 km/h,

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

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

$$V_{av} = \frac{2S}{\left(\frac{3S+2S}{120}\right)} = \frac{2S}{5S}\times 120$$

$$\Rightarrow\ V_{av} = 48\ km/h$$

Ex.21 A non-stop bus goes from one station to another station with a speed of 54 km/h, the same bus returns from the second station to the first station with a speed of 36 km/h. Find the average speed of the bus for the entire journey.

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

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

Time taken in returning back,

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

Total time $t = t_1 + t_2$

$$t = \frac{S}{54}+\frac{S}{36} = \frac{2S+3S}{108} = \frac{5S}{108}\,h$$

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

$$V_{av} = \frac{2S}{5S}\times 108$$

$$V_{av} = \frac{216}{5} = 43.2\ km/h$$

Acceleration

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

Its S.I unit is m/s^2 and c.g.s unit is cm/s^2.

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

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

◈ Types of Acceleration

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

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

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

  e.g.: Car moving in a crowded street & motion of a train leaving or entering the platform.

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

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

  e.g.: A train slows down, then its acceleration will be negative.

Ex.22 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. Initial speed of the bus, u = 80 km/h = $80 \times \frac{5}{18}$ = 22.22 m/s

Final speed of the bus, v = 60 km/h = $60 \times \frac{5}{18}$ = 16.66 m/s

Time take to decrease the speed, t = 5 s

Acceleration a = $\frac{v-u}{t} = \frac{16.66-22.22}{5}$ = –1.112 m/s^2

Here, the negative sign of acceleration indicates that the velocity of the car is decreasing.

Ex.23 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.

Sol. Initial velocity of the train, u = 0 (since the train is initially at rest)

Final velocity of the train, v = 40 km/h = $40 \times \frac{5}{18}$ = 11.11 m/s

Time taken, t = 10 min = 10 × 60 = 600 s

Acceleration a = $\frac{v-u}{t} = \frac{11.11-0}{600}$ = 0.0185 m/s^2

Hence, the acceleration of the train is 0.0185 m/s^2.

Graphical Representation of Motion

◈ Distance–Time Graph

A moving body changes its position continuously with time. The simplest way to describe the motion of a moving body is to draw its distance–time graph.

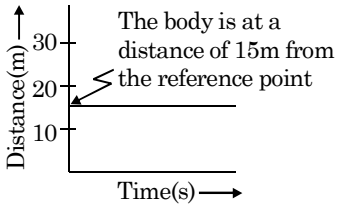
The distance–time graphs of a body under the following three conditions are described below:

(i) When the body is at rest.

(ii) When the body is moving with a uniform speed

(iii) When the body is moving with a non–uniform speed

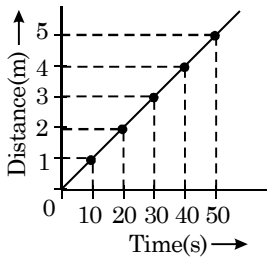
- Distance–time graph for a body at rest



The distance–time graph for a body at rest is a straight line parallel to the time axis

- Distance–time graph for a body moving with a uniform speed:

When a body covers equal distances in equal intervals of time, it is said to have uniform speed.



Distance–time graph of a body moving with uniform (Constant) speed

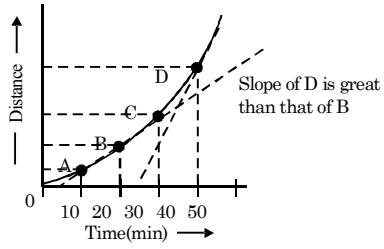
The about graph shows that the distance travelled by a body moving with uniform speed is directly proportional to time.

- Distance–time graph for a body moving with a non–uniform speed:

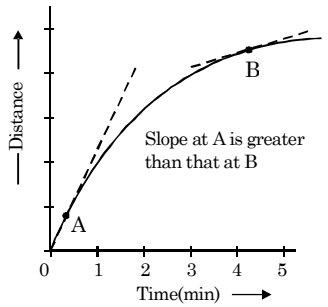
A body moving with a non–uniform speed covers unequal distances in equal intervals of time. Therefore, the distance–time graph of a body moving with a non–uniform speed is a curve.

The shape of the distance–time graph for a body moving with non–uniform speed depends upon the way speed of the body changes with time. Two typical cases are described below:

(i) When the speed increases with time: When the speed of a body increases with time, the distance covered by it in one unit of time also increases with time. Therefore, the distance–time graph for a body moving with an increasing non–uniform speed is a curve whose slope increases with time (Figure).

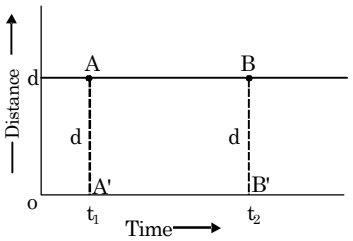


(ii) When the speed decreases with time: When the speed of a body decreases with time, the distance covered by it in one unit of time also decreases with time. Therefore, the distance–time graph for a body moving with a decreasing non–uniform speed is a curve whose slope decreases with time (Figure).



◈ Displacement-Time Graph

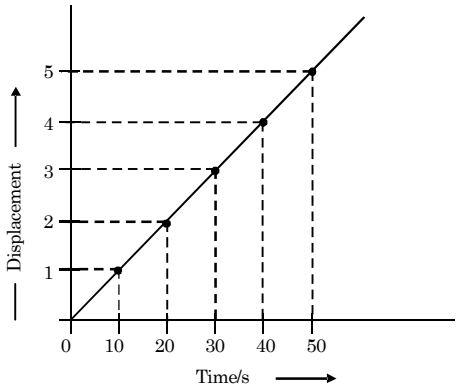
- **Displacement – time graph of a body at rest:** The position of a body at rest remains unchanged with time. Let us consider a body at a distance d from a reference point in a particular direction. Then from figure 4.1.



The above graph shows that position of the body does not change w.r.t. time, so that body is said to be at rest.

Thus, the velocity of a body at rest is zero.

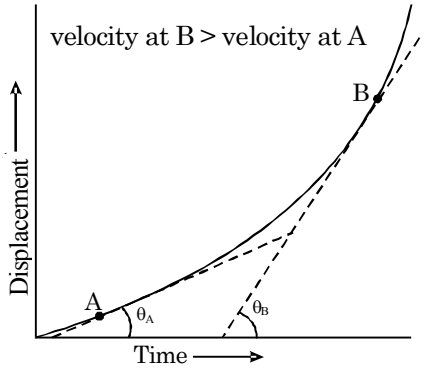
- **Displacement – time graph of a body moving with uniform velocity:** The displacement–time graph of a body moving with uniform (constant) velocity is a straight line inclined to the time–axis at certain angle.



The slope of the displacement–time graph for a body moving with uniform velocity is equal to the velocity of the body.

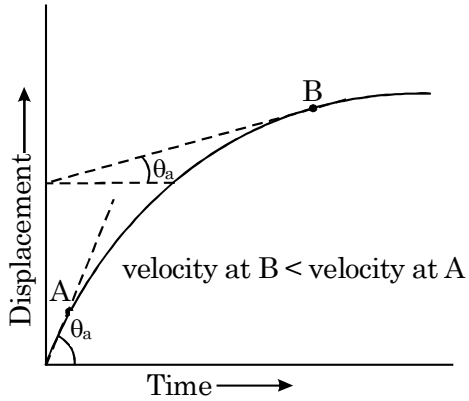
- **Displacement–time graph of a body moving with an increasing non–uniform velocity :** The displacement–time graph of a body moving with an increasing non–uniform velocity is a curve (Figure). Here, the slope of the curve increases with time. So, the velocity of the body increases with time.

  i.e., velocity at B > velocity at A



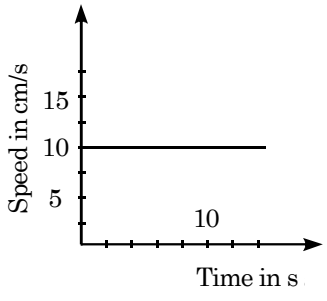
- **Displacement–time graph of a body moving with decreasing non–uniform velocity :** The displacement–time graph of a body moving with a decreasing non–uniform velocity is a curve (Figure). Here, the slope of the curve decreases with time. So, the velocity of the body decreases with time.

  i.e., velocity at B < velocity at A



◈ Speed-Time Graph

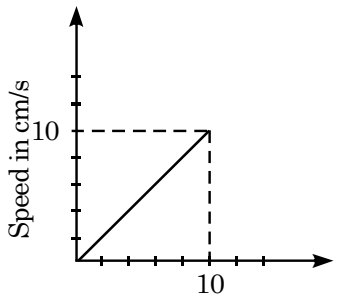
Some information about the motion of an object can also be obtained from its speed–time graph. Following figures give the speed–time graphs of four different objects in motion. Let us see what information can be obtained from these graphs.



(a)

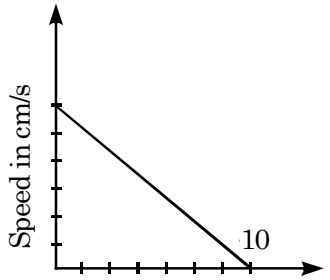
Figure (a) shows that for any time, the speed has the same value (10 cm/s). Thus it represents an object moving with a constant speed.

Whenever an object moves with a constant speed, its speed–time graph is a straight line, parallel to the time–axis.



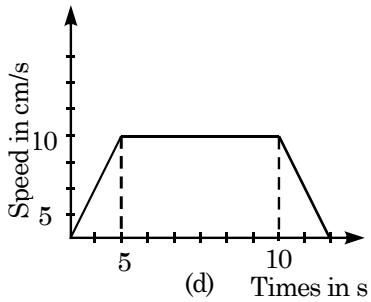
(b)

Figure (b) shows that the speed continuously increases with time. At time t = 0, the speed is 0. At t = 10 s, it becomes 10 cm/s. The straight–line nature of the graph indicates that the speed increases at a constant rate.



(c)

Figure (c) shows that the speed is 10 cm/s at t = 0 and gradually decreases as time passes. Thus it represents a decelerating object. Here also the speed changes at constant rate. At t = 10s, the speed becomes zero.



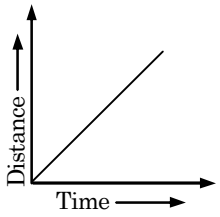
(d)

Figure (d) represents the motion of an object which speeds up from t = 0 to t = 5s, then moves at a constant speed from t = 5s to 10s and then decelerates to stop at t = 15 s.

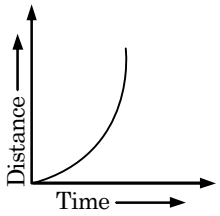
Note: *Distance covered by the body is shown by the area under speed–time graph.*

Ex.24 What is the nature of the distance - time graphs for uniform and non-uniform motion of an object?

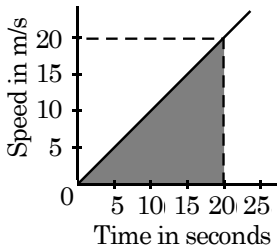
Sol. The distance–time graph for uniform motion of an object is a straight line (As shown in the following figure).



The distance - time graph for non-uniform motion of an object is a curved line (As shown in the given figure).



Ex.25 Find the distance covered by a particle during the time interval t = 0 to t = 20s for which the speed–time graph is shown in figure.

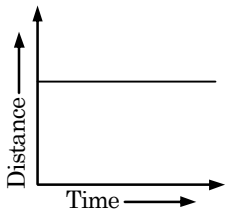


Sol. The distance covered in the time interval 0 to 20s is equal to the area of the shaded triangle. It is

$\frac{1}{2}$ × base × height = $\frac{1}{2}$ × (20s) × (20 m/s) = 200 m.

Ex.26 What can you say about the motion of an object whose distance-time graph is a straight line parallel to the time axis?

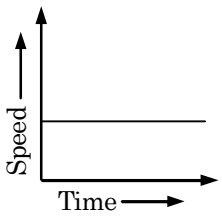
Sol. When an object is at rest, its distance-time graph is a straight line parallel to the time axis.



A straight line parallel to the x-axis in a distance - time graph indicates that with a change in time, there is no change in the position of the object. Thus, the object is at rest.

Ex.27 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. Object is moving uniformly.



A straight line parallel to the time axis in a speed-time graph indicates that with a change in time, there is no change in the speed of the object. This indicates the uniform motion of the object.

◈ Velocity-Time Graph

If a graph is plotted taking the velocity of an object moving along a straight line on the vertical axis and time on the horizontal axis, we get a velocity–time graph.

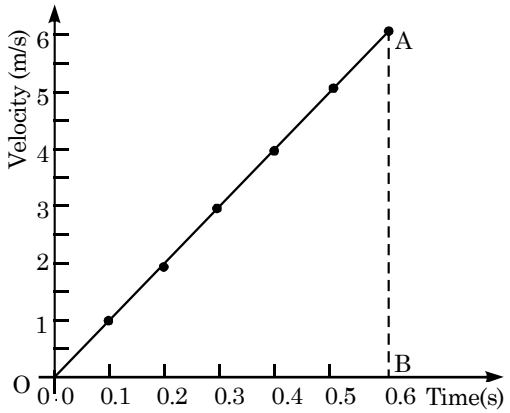
Suppose an object moves along a straight line in a fixed direction. That means the object does not turn around during its motion. Taking the direction of motion as the positive direction, the velocity of the object is given by the same value as its speed. Thus the speed–time graph for such an object is also its velocity–time graph.

The area under the speed–time graph gives the distance covered. But for a particle moving in a fixed direction, the distance covered in a time interval has the same value as its displacement in that time interval. So, the area under the velocity–time graph of an object gives its displacement.

Let us take an example. A ball is dropped from a height. We take the downward direction as positive. As the ball falls, its velocity increases. The velocity of the ball at different instants are given in Table-1. The velocity versus time graph is shown in figure.

Table-1: Velocity of the falling ball at different instants:

Time in s	Velocity in m/s
0	0
0.1	1
0.2	2
0.3	3
0.4	4
0.5	5
0.6	6



What is the displacement of the ball in the time interval 0 to 0.6s? It is equal to the area under the velocity–times graph from t = 0 to t = 0.6 s. This area is in the shape of a triangle. The area is

$\frac{1}{2}$ × base × height

= $\frac{1}{2}$ (OB) × (AB)

= $\frac{1}{2}$ × (0.6s) × (6 m/s) = 1.8 m.

The ball has fallen through 1.8 m in 0.6 s.

- **Velocity–time graph of an object thrown upwards:** Suppose a ball is thrown upwards. We take the upward direction as the positive direction. The velocity decreases as the ball goes up. Table-2 gives the velocity of the ball at different instants.

Table-2: Velocity of the rising ball at different instants:

Time(s)	Velocity (m/s)
0	10
1	12
2	14
3	16
4	18
5	20

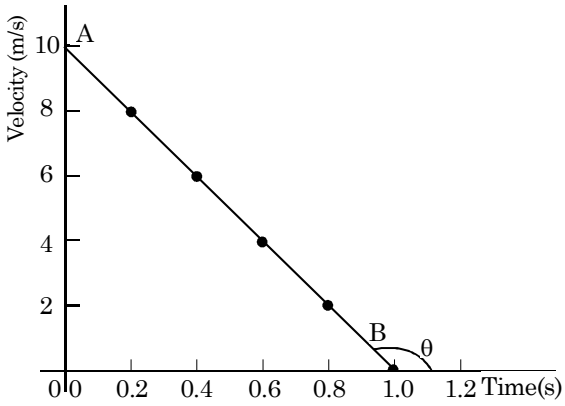
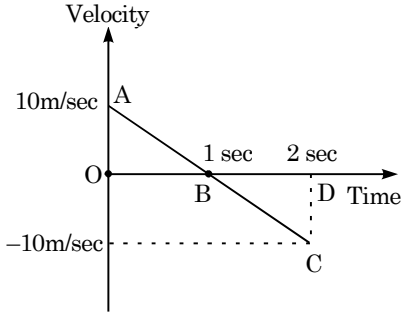


Figure shows the velocity–time graph. The plotted points fall on a straight line, AB. At t = 1.0 s, the velocity becomes zero. This means that the ball reaches the highest point at t = 1.0 s.

Ex.28 A ball is thrown vertically upwards with a velocity of 10m/sec. It strikes the ground after 2 sec. Its velocity–time graph is as shown in figure below. Find the displacement travelled by the ball in 2 second.



Sol. Displacement = area under velocity-time curve along time axis

= area of triangle AOB + area of triangle BDC

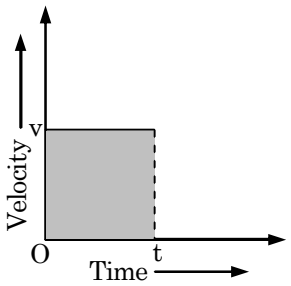
$$= \left(\frac{1}{2}\times OB\times AO\right) + \left(\frac{1}{2}\times BD\times CD\right)$$

$$= \left(\frac{1}{2}\times 1\,\text{sec}\times 10\,\text{m/sec}\right) + \left(\frac{1}{2}\times 1\text{sec}\times(-10\,\text{m/sec})\right)$$

= 5m –5m = 0m

Ex.29 What is the quantity which is measured by the area occupied below the velocity - time graph?

Sol. Displacement



The graph shows the velocity-time graph of a uniformly moving body.
Let the velocity of the body at time (t) be v.
Area of the shaded region = length × breath
Where, Length = t; Breath = v
Area = vt = velocity × time …(i)
We know, velocity = displacement / time
∴ Displacement = Velocity × Time …(ii)
From equations (i) and (ii), Area = Displacement

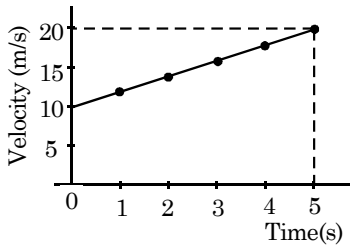
Hence, the area occupied below the velocity-time graph measures the displacement covered by the body.

- **Acceleration from velocity–time graph:** Suppose a particle moves with a uniform acceleration of 2 m/s^2 along a straight line. This means that the velocity increases by 2 m/s in one second. Also suppose its speed at t = 0 is 10 m/s.

  Let us plot the velocity–time graph for this situation. We first find the values of the velocity at certain instants. At t = 0, the velocity is 10 m/s, at t = 1s it will become 10 m/s + 2m/s = 12 m/s, at t = 2s, it will become 14 m/s and so on. These values are given in Table-3 and the velocity–time graph is shown in Figure.

Table-3: Velocity at different instants

Time(s)	Velocity (m/s)
0	10
1	12
2	14
3	16
4	18
5	20



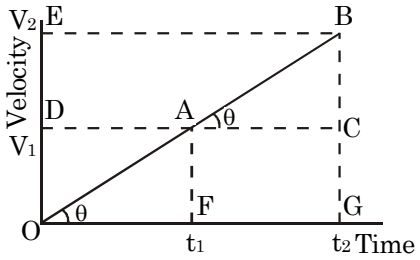
We see that the graph is a straight line. Whenever the acceleration is uniform the velocity–time graph is a straight line. We will now show that the slope of the velocity–time graph gives the acceleration.

Suppose the velocity–time graph of a particle moving along a straight line is as shown in figure. The graph is a straight line. At time t_1, the velocity is v_1, and at time t_2, it is v_2. These values are represented by the points A and B on the graph.

The acceleration of the object is

$$a = \frac{v_2 - v_1}{t_2 - t_1} = \frac{OE - OD}{OG - OF} = \frac{DE}{FG} = \frac{BC}{AC} = \tan\theta$$

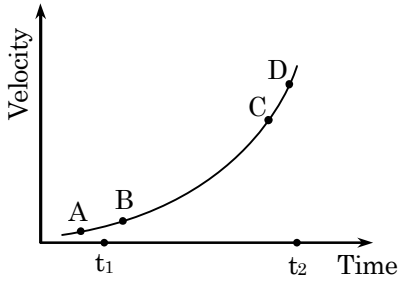
where, θ is the angle made by the graph with the time-axis.



As defined earlier, the ratio $\frac{BC}{AC} = \tan\theta$ is called the slope of the line. Thus, we have the following:

The slope of the velocity–time graphs gives the acceleration for an object moving along a straight line.

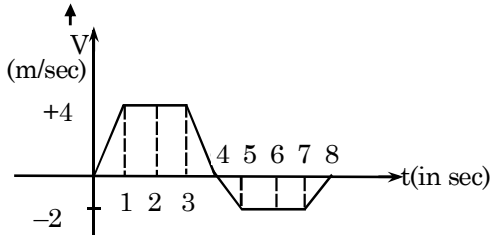
- **Non–uniform acceleration:** If the acceleration of an object moving along a straight line is not constant, the velocity-time graph is not a straight line. Consider the velocity–time graph shown in figure. To find the acceleration at time t_1 we should treat the small part AB as a straight line and find its slope. Similarly, the slope of the small part CD gives the acceleration at time t_2. It is clear from the figure that the slope of CD is greater than that of AB. Thus, the acceleration at t_2 is greater than that at t_1. The graph in figure represents a motion in which acceleration increases with time.



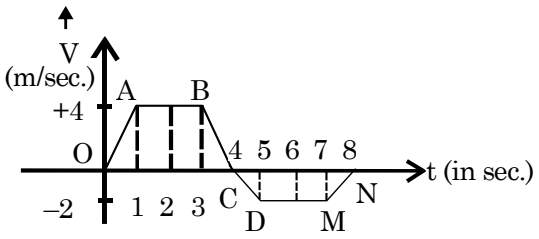
Displacement of particle from velocity time graph.

The area under the velocity–time curve along time axis gives the displacement of the particle.

Ex.30 The velocity versus time graph of a linear motion is shown in figure. Find the distance from the origin in 8 second.



Sol.



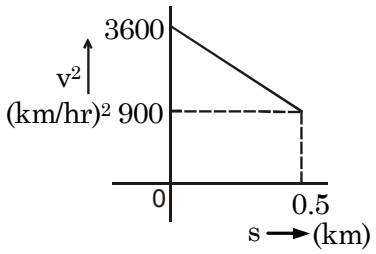
Distance in 8 second

S = Area of OABC + Area of CDMN

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

S = 18 m

Ex.31 A graph between the square of the velocity of a particle and the distance moved by the particle is as shown in the figure. Find the acceleration of the particle in km/h^2.



Sol. Given : $u^2 = 3600$ (km/h)^2, $v^2 = 900$ (km/h)^2,

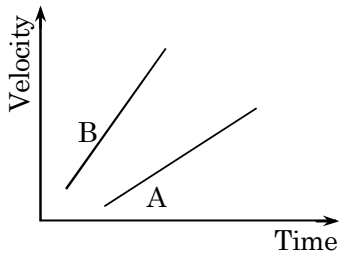
s = 0.5 km

From III equation of motion,

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

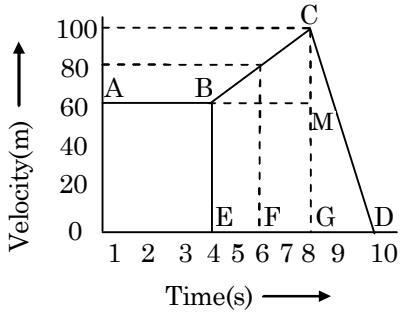
$$\Rightarrow a = \frac{(900)-(3600)}{2\times 0.5} = \frac{-2700}{2\times 0.5} = -2700 \text{ km/h}^2$$

Ex.32 Figure shows the velocity–time graphs for two objects, A and B, moving along the same direction. Which object has greater acceleration?



Sol. The slope of the velocity–time graph for B is greater than that for A. Thus, the acceleration of B is greater than that of A.

Ex.33 Time-velocity graph of a particle is shown in figure. Find its instantaneous acceleration at following intervals:



(i) at t = 3s (ii) at t = 6s (iii) at t = 9s

Sol. (i) Instantaneous acceleration at t = 3s, is given by

a = slope of line AB = zero

(ii) Instantaneous acceleration at t = 6 s, is given by a = slope of line

$$BC = \frac{CM}{BM} = \frac{100-60}{8-4} = 10 \text{ m/s}^2$$

(iii) Instantaneous acceleration at t = 9 s is given by, a = slope of line $CD = \frac{0-100}{10-8} = -50 \text{ m/s}^2$

Ex.34 When will you say a body is in

(i) uniform acceleration? (ii) non-uniform acceleration?

Sol. (i) A body is said to have uniform acceleration if it travels in a straight path in such a way that its velocity changes at a uniform rate, i.e., the velocity of a body increases or decreases by equal amounts in an equal interval of time.

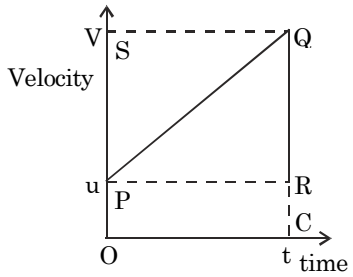
(ii) A body is said to have non-uniform acceleration if it travels in a straight path in such a way that its velocity changes at a non-uniform rate, i.e., the velocity of a body increases or decreases in unequal amounts in an equal interval of time.

Equations of Uniformly Accelerated Motion

◈ Graphical Derivation of Equations of Motion

- **First Equation:** v = u + at

It can be derived from v– t graph, as shown in figure: From line PQ, the slope of the line = acceleration



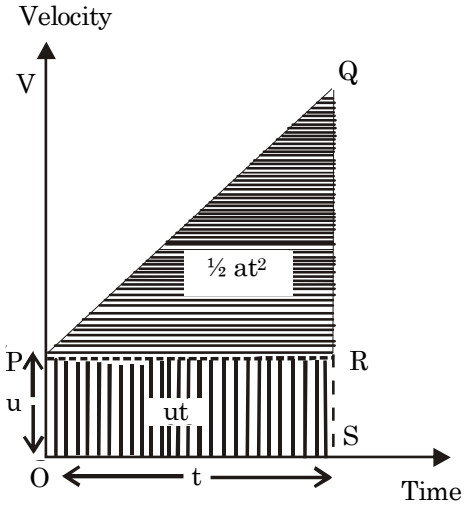
$$a = \frac{QR}{RP} = \frac{SP}{RP}$$

$\because$ SP = v – u and RP = t

So $a = \frac{v-u}{t}$ **or** v = u + at

- **Second Equation:** $s = ut + \frac{1}{2} at^2$

It can also be derived from v - t graph as shown in figure. From relation, Distance covered = Area under v - t graphs = Area of trapezium OPQS = Area of rectangle OPRS + Area of triangle PQR



$= OP \times PR + \frac{RQ \times PR}{2}$

Putting values,

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

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

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

- **Third Equation :**

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

From above graph OP = u, SQ = v, OP + SQ = u + v

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

s = Area of trapezium OPQS = $\frac{OP + SQ}{2} \times PR$

On putting the values,

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

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

COMPETITIVE LEVEL

◈ Analytical Derivation for Equations of Uniformly Acceleration Motion

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

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

  $$\text{acceleration} = \frac{\text{final velocity} - \text{initial velocity}}{\text{time taken}}$$

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

  So $at = v - u$ and $v = u + at$

  1st equation of motion: $v = u + at$

- **2nd Equation of Motion:** We know

  Distance covered = (Average velocity) × (Time)

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

  But $v = u + at$

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

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

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

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

  2nd equation of motion: $s = ut + \frac{1}{2} at^2$

- **3rd Equation of Motion:** We know that

  $$v = u + at$$

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

  Distance travelled = (Average velocity) × (time)

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

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

  3rd equation of motion: $v^2 - u^2 = 2as$

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

  So, $S_{nth} = S_n - S_{(n-1)}$

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

  [Putting t = n and t = (n – 1) respectively in equation (ii)]

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

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

Ex.35 A bus starting from rest moves with a uniform acceleration of 0.1 m s^{-2} for 2 minutes. Find

(i) the speed acquired, (ii) the distance travelled.

Sol. (i) Initial speed of the bus, u = 0 (since the bus is initially at rest)

Acceleration, a = 0.1 m/s^2

Time taken, t = 2 minutes = 120 s

Let v be the final speed acquired by the bus.

$\therefore \quad a = \frac{v - u}{t}$

$$0.1 = \frac{v - 0}{120}$$

$\therefore \quad v = 12$ m/s

(ii) According to the third equation of motion:

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

where, s is the distance covered by the bus $(12)^2 - (0)^2 = 2(0.1)$ s

s = 720 m

Speed acquired by the bus is 12 m/s.

Distance travelled by the bus is 720 m.

Ex.36 A train is travelling at a speed of 90 km h^{-1}. Brakes are applied so as to produce a uniform acceleration of −0.5 m s^{-2}. Find how far the train will go before it is brought to rest.

Sol. Initial speed of the train, u = 90 km/h = 25 m/s

Final speed of the train, v = 0 (finally the train comes to rest)

Acceleration = −0.5 m s^{-2}

According to third equation of motion: $v^2 = u^2 + 2as$

$(0)^2 = (25)^2 + 2(-0.5)$ s

where, s is the distance covered by the train

$$s = \frac{(25)^2}{2(0.5)} = 625 \text{ m}$$

The train will cover a distance of 625 m before it comes to rest.

Ex.37 A trolley, while going down an inclined plane, has an acceleration of 2 cm s^{-2}. What will be its velocity 3 s after the start?

Sol. Initial velocity of the trolley, u = 0 (since the trolley was initially at rest)

Acceleration, a = 2 cm s^{-2} = 0.02 m/s^2

Time, t = 3 s

According to the first equation of motion:

v = u + at

where, v is the velocity of the trolley after 3 s from start

v = 0 + 0.02 × 3 = 0.06 m/s

Hence, the velocity of the trolley after 3 s from start is 0.06 m/s.

Ex.38 A racing car has a uniform acceleration of 4 m s^{-2}. What distance will it cover in 10 s after start?

Sol. Initial velocity of the racing car, u = 0 (since the racing car is initially at rest)

Acceleration, a = 4 m/s^2

Time taken, t = 10 s

According to the second equation of motion:

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

where, s is the distance covered by the racing car

$s = 0 + \frac{1}{2} \times 4 \times (10)^2 = \frac{400}{2} = 200$ m

Hence, the distance covered by the racing car after 10 s from start is 200 m.

◈ Equations of Motion for Freely Falling Object

Since the freely falling bodies fall with uniformly accelerated motion, the three equations of motion derived earlier for bodies under uniform acceleration can be applied to the motion of freely falling bodies. For freely falling bodies, the acceleration due to gravity is 'g', so we replace the acceleration 'a' of the equations by 'g' and since the vertical distance of the freely falling bodies is known as height 'h', we replace the distance 's' in our equations by the height 'h'. This gives us the following modified equations for the motion of freely falling bodies.

General equations of motion		**Equations of motion for freely falling bodies**
(i) $v = u + at$	changes to	$v = u + gt$
(ii) $s = ut + \frac{1}{2} at^2$	changes to	$h = ut + \frac{1}{2} gt^2$
(iii) $v^2 = u^2 + 2as$	changes to	$v^2 = u^2 + 2gh$

We shall use these modified equations to solve numerical problems. Before we do that, we should remember the following important points for the motion of freely falling bodies.

(i) When a body is dropped freely from a height, its initial velocity 'u' becomes zero.

(ii) When a body is thrown vertically upwards, its final velocity 'v' becomes zero.

(iii) The time taken by a body to rise to the highest point is equal to the time it takes to fall from the same height.

(iv) The distance travelled by a freely falling body is directly proportional to the square of time of fall.

- **Sign conventions:**

  (i) g is taken as positive when it is acting in the same direction as that of motion and g is taken as negative when it is opposing the motion.

  (ii) Distance measured upward from the point of projection is taken as positive, while distance measured downward from the point of projection is taken as negative.

  (iii) Velocity measured away from the surface of earth (i.e. in upward direction) is taken as positive, while velocity measured towards the surface of the earth is taken as negative.

- **To solve numerical problems:**

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

  (ii) If a body comes to rest its final velocity v = 0 or, if a body reaches the highest point after being thrown upwards its final velocity v = 0 but has acceleration (acting).

  (iii) If a body moves with uniform velocity, its acceleration is zero i.e. a = 0.

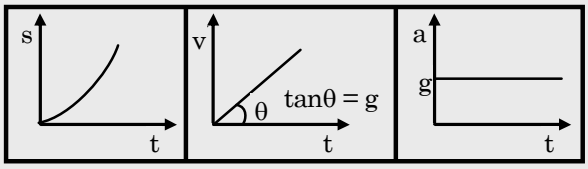
  (iv) Motion of a body is called free fall if only force acting on it is gravity (i.e. earth's attraction).

COMPETITIVE LEVEL

◈ Body Falling Freely Under Gravity

Assuming u = 0 for a freely falling body:

t is given	h is given	v is given
$v = gt$	$t = \sqrt{\frac{2h}{g}}$	$t = \frac{v}{g}$
$h = \frac{1}{2} gt^2$	$v = \sqrt{2gh}$	$h = \frac{v^2}{2g}$

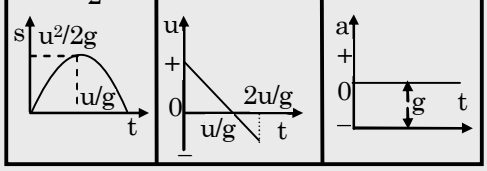


- **Body is projected vertically up:** Taking initial position as origin and direction of motion (i.e. vertically up) as positive.

  (i) At the highest point v = 0

  (ii) a = – g

t is given	h is given	u is given
$u = gt$	$t = \sqrt{2h/g}$	$t = \frac{u}{g}$
$h = \frac{1}{2} gt^2$	$u = \sqrt{2hg}$	$h = \frac{u^2}{2g}$



Ex.39 A stone is thrown in a vertically upward direction with a velocity of 5 m s^{-1}. If the acceleration of the stone during its motion is 10 m s^{-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. Initially, velocity of the stone, u = 5 m/s

Final velocity, v = 0 (since the stone comes to rest when it reaches its maximum height) Acceleration of the stone, a = acceleration due to gravity, g = 10 m/s^2 (in downward direction) There will be a change in the sign of acceleration because the stone is being thrown upwards.

Acceleration, a = −10 m/s^2

Let s be the maximum height attained by the stone in time t. According to the first equation of motion:

v = u + at

0 = 5 + (−10) t

$\therefore t = \frac{-5}{-10} = 0.5$ s

According to the third equation of motion: $v^2 = u^2 + 2as$

$(0)^2 = (5)^2 + 2(-10)\ s$

$s = \frac{5^2}{20} = 1.25$ m

Hence, the stone attains a height of 1.25 m in 0.5 s.

Ex.40 A stone drops from the edge of a roof. It passes a window 2 metre high in 0.1 second. How far is the roof above the top of the window?

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

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

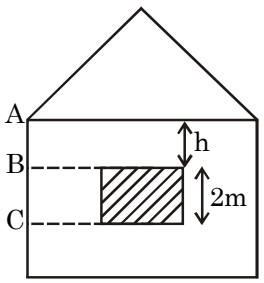
Let, Velocity at B = u m/s

Distance travelled, s = 2 m

Time taken, t = 0.1s

Acceleration, a = g = 9.8 m/s^2

Using the relationship,



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

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

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

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

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

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

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

Initial velocity, u = 0 m/s

Final velocity, v = 19.51 m/s

Acceleration due to gravity, g = 9.8 m/s^2

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

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

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

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

Ex.41 A car is moving at a speed of 50 km/h after two seconds it is moving at 60 km/h. Calculate the acceleration of the car.

Sol. Here u = 50 km/h $= 50 \times \frac{5}{18}$ m/s $= \frac{250}{18}$ m/s

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

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

Ex.42 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.

Sol. Given: u = 50 m/s, a = 20 m/s^2,

t = 4s, s =?

$s = ut + \frac{1}{2}at^2 = 50 \times 4 + \frac{1}{2} \times 20 \times (4)^2$

$= 200 + 160 = 360$ m

Average speed during this interval,

$\overline{V} = \frac{\text{distance travelled}}{\text{time interval}} = \frac{360}{4} = 90$ m/s

Ex.43 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.

Sol. Given: $u = 0$, $t_1 = 10$ s

$\therefore$ Distance travelled in first 10 seconds, is given by

$$s_1 = ut + \frac{1}{2} at^2 = 0 + \frac{1}{2} \times a \times (10)^2$$

$$= 50a \qquad \text{.....(1)}$$

To calculate the distance travelled in next 10s, we first calculate distance travelled in 20 s and then subtract distance travelled in first 10 s.

$$s = ut + \frac{1}{2} at^2 = 0 + \frac{1}{2} \times a \times (20)^2$$

$$= 200a \qquad \text{..... (2)}$$

$\therefore$ Distance travelled in next 10 seconds interval,

$$s_2 = s - s_1 = 200a - 50a \qquad \text{..... (3)}$$

or $s_2 = 150a$

Now, $\frac{s_2}{s_1} = \frac{150a}{50a} = \frac{3}{1}$

or $s_2 = 3s_1$

Ex.44 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?

Sol. We know that the horizontal motion and the vertical motion are independent of each other. Now for vertical motion, we have $u = 0$, $h = 490$ m, $g = 9.8$ m/s^2, $t = ?$

Using equation, $h = ut + \frac{1}{2} gt^2$, we get

$$490 = 0 + \frac{1}{2} \times 9.8 \times t^2 \qquad \textbf{or} \qquad t^2 = \frac{490}{4.9} = 100$$

or $t = 10$ s

$\therefore$ It takes 10 seconds to reach the ground.

Now, horizontal distance

= horizontal velocity × time

= 100 m/s × 10 s = 1000 m

$\therefore$ The shell will strike the ground at a distance of 100 m from the bottom of the tower.

Circular Motion

◈ Definition

The motion of a body moving around a fixed point in a circular path is known as circular motion.

◈ Uniform Circular motion

If the body covers equal distances along the circumference of the circle in equal intervals of time, the motion is said to be a uniform circular motion. A uniform circular motion is a motion in which speed remains constant but direction of velocity changes.

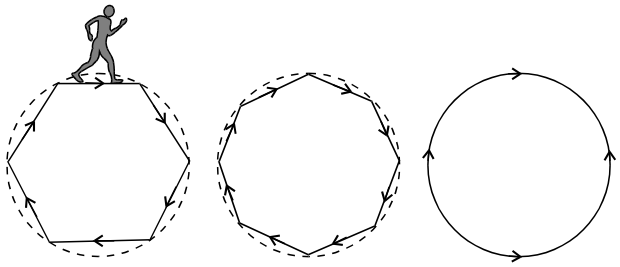
e.g.: Examples of uniform circular motion are:

(i) Motion of moon around the earth.

(ii) Motion of satellite around its planet.

◈ Circular motion is known as accelerated motion

Explanation: Consider a boy running along a regular hexagonal track (path) as shown in figure. As the boy runs along the side of the hexagon at a uniform speed, he has to take a turn at each corner changing direction but keeping the speed same. In one round he has to take six turns at regular intervals. If the same boy runs along the side of a regular octagonal track with same uniform speed, he will have to take eight turns in one round at regular intervals but the interval will become smaller.



By increasing the number of sides of the regular polygon, we find that number of turns per round becomes more and the interval between two turns become still shorter. A circle is a limiting case of a polygon with an infinite number of sides. On the circular track, the turning becomes a continuous process without any gap in between. The boy running along the sides of such a track will be performing a circular motion. Hence, circular motion is the motion of a body along the sides of a polygon of infinite number of sides with uniform speed, the direction changing continuously, it means the body moves with changing velocity in a circular path thus the uniform circular motion is known as accelerated motion.

◈ Difference between a Uniform Linear and Circular Motion

Uniform linear motion	Uniform circular motion
1. The direction of motion does not changes.	**1.** The direction of motion changes continuously.
2. The motion is non accelerated.	**2.** The motion is accelerated.

Note: *Example of a body performing accelerated motion with uniform speed is circular motion.*

COMPETITIVE LEVEL

◈ Radian

It is the unit of plane angle.

- **Definition:** One radian is defined as the angle subtended at the centre of the circle by an arc equal in length to its radius.

  e.g.: In figure, the arc AB of the circle has length ℓ and subtends an angle θ at the centre C.

  If $\angle ACB = \theta$ radians.

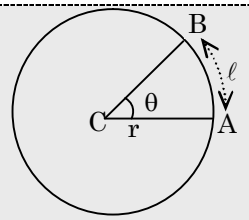
  Then, $\theta = \frac{\ell}{r}$ radians.

  [For $\ell = r$, $\theta = 1$ radian]

  Angle subtended by the circumference at the centre,

  $\theta = \frac{2\pi r}{r} = 2\pi$ radians {or $2\pi^c$ }

  [^{c}] is symbol for radian, just as (^{0}) is symbol for degree.



Relation between radian and degree: For complete circle at centre

$2\pi^c = 360^o$ **or** $1^c = \left|\frac{360}{2\pi}\right| = 57.3^o$

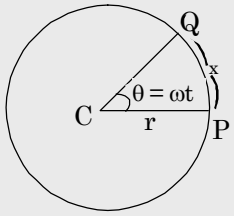
◈ Angular Displacement and Angular Velocity

- **Angular displacement:** In a circular motion, the angular displacement of a body is the angle subtended by the body at the centre in a given interval of time. It is represented by the symbol θ (theta). The unit of angular displacement is radian.
- **Angular velocity:** The angular displacement per unit time is called the angular velocity. It is represented by the symbol ω (omega).
- **Expression for angular displacement and angular velocity:**

(i) Let a body move along a circle of radius r and perform a uniform circular motion. Let the body be at point P to start with and reach point Q after time t. Then, angular displacement = ∠PCQ = θ

angular velocity = $\omega = \frac{\theta}{t}$ (i.e. $\theta = \omega t$)

(ii) In terms of time period and frequency: If the time period of the body is T(time taken in one complete round), the angular displacement = $2\pi^C$



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

But $\frac{1}{T} = n$ (frequency)

There $\omega = 2\pi n$

The unit of angular velocity is rad/s

◈ Angular acceleration

The rate of the change of angular velocity is called angular acceleration. Let angular velocity at time t_1 is ω_1 and at time t_2 is ω_2 change in angular velocity in the time interval $t_2 – t_1$ is $\omega_2 – \omega_1$

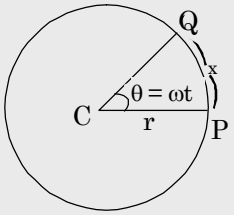
thus, rate of change of angular velocity = $\frac{\omega_2 - \omega_1}{t_2 - t_1}$

$\alpha = \frac{\Delta\omega}{\Delta t}$ (here α is average angular acceleration)

- The unit of angular acceleration is rad/s^2.

◈ Relation between Linear and Angular Quantities

(i) Relation between linear displacement and angular displacement.



$$\text{angle} = \frac{\text{arc}}{\text{radius}}$$

$$\theta = \frac{x}{r} \Rightarrow x = r\theta \qquad \text{..... (i)}$$

(ii) Relation between linear velocity and angular velocity.

From (i) $x = r\theta$

$$\frac{x}{t} = r\frac{\theta}{t} \Rightarrow v = r\omega \qquad \text{..... (ii)}$$

(iii) Relation between linear acceleration and angular acceleration.

From (ii) $v = r\omega$

$$\frac{v}{t} = r\frac{\omega}{t} \Rightarrow a = r\alpha \qquad \text{..... (iii)}$$

◈ Centripetal Force

- Always acts towards centre.
- Centripetal force is required to move a particle in a circle.
- Because F_c is always perpendicular to velocity or displacement, hence the work done by this force will always be zero.

Note: • *Circular motion in horizontal plane is usually uniform circular motion.*

• *Remember that equations of motion are not applicable for circular motion.*

◈ Centripetal Acceleration

- In uniform circular motion the particle experiences an acceleration called the centripetal acceleration.
- $a_c = \frac{v^2}{r}$
- The direction of centripetal acceleration is along the radius towards the centre.

Ex.45 A fly wheel making 120 revolutions/minute. Find the angular speed of the wheel:

Sol. ∵ 120 revolution/ minute = 2 rev/s

Angular speed = angle in one revolution × number of revolution/s

$= 2\pi \times 2 = 4\pi$ rad/s

Ex.46 A stone tied to the end of a string 80 cm is whirled in a horizontal circle with a constant speed. If the stone makes 14 revolutions in 25 sec., what is the magnitude of the angular speed. $\left(\text{use}\,\pi = \frac{22}{7}\right)$

Sol. angular speed = angle × number of rev./s

$\omega = 2\pi \times \frac{14}{25} = 3.52$ rad/s

Ex.47 Earth revolves around the Sun in 365 days. Calculate its angular speed.

Sol. T = 365 days = 365 × 24 × 60 × 60 s

So, $\omega = \frac{2\pi}{T} = \frac{2\pi}{365 \times 24 \times 60 \times 60} = 1.99 \times 10^{-7}$ rad/s

Ex.48 A particle moves in a circle of radius 2 m and completes 5 revolutions in 10 seconds. Calculate the following:

(i) Angular velocity (ii) Linear velocity

Sol. Since, it completes 5 revolutions in 10 seconds.

$\therefore$ Time period = $\frac{10}{5} = 2$s

(i) Now angular velocity, $\omega = \frac{2\pi}{T} = \frac{2\pi}{2} = \pi$ rad/s

(ii) Linear velocity is given by

$v = r\omega = 2\pi$

$\therefore$ $v = 2\pi$ m/s

Ex.49 The length of second's needle in a watch is 1.2 cm. Calculate the following:

(i) Angular velocity and (ii) Linear velocity of the tip of the needle.

Sol. (i) We know that the second's needle in a watch completes one revolution in 60 seconds.

$\therefore$ Time period, T = 60 s

Angular velocity, $\omega = \frac{2\pi}{T} = \frac{2\pi}{60} = \frac{\pi}{30}$ rad/s

(ii) Length of the needle = 1.2 cm = Radius of the circle

Linear velocity of the tip of the needle is given by

$v = r\omega = 1.2 \times \frac{\pi}{30} = \frac{\pi}{25}$ **or** $v = \frac{\pi}{2s} = 1.266 \times 10^{-1}$ cm/sec.

Ex.50 Earth revolves around the sun in 365 days. Calculate its angular velocity.

Sol. Time period, T = 365 days = 365 × 24 × 60 × 60 seconds

Angular velocity, $\omega = \frac{2\pi}{T} = \frac{2\pi}{365 \times 24 \times 60 \times 60}$ rad/s = 1.99×10^{-7} rad/s.

EXERCISE-1

➢ Very Short Answer Type Questions

Q.1 A ball is thrown up with a certain velocity. It attains a height of 40 m and comes back to the thrower. Find the distance and magnitude of displacement.

Q.2 What is the S.I. unit of displacement?

Q.3 A horse runs a distance of 1200 m in 3 min and 20 s. What is the speed of the horse?

Q.4 What is the S.I. unit of velocity?

Q.5 What is the S.I. unit of acceleration?

➢ Short Answer Type Questions – Type I

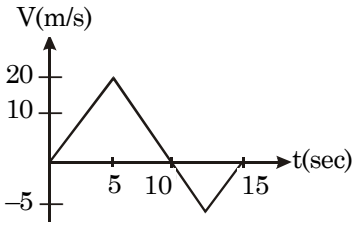
Q.6 Distance and displacement are equal in some cases. Give reasons.

Q.7 A stone is thrown upwards, reaches a height h and comes back. What are the distance moved and displacement?

Q.8 Under what condition(s) is the magnitude of average velocity of an object equal to its average speed?

Q.9 Define uniform circular motion.

Q.10 From the following (V-t) graph find:



(i) Distance and displacement in 10 second.

(ii) Distance and displacement in 15 second.

➢ Short Answer Type Questions – Type II

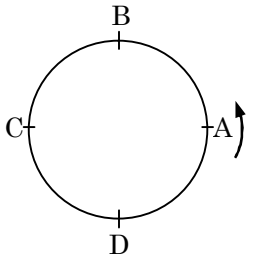
Q.11 Give three examples to explain that motion is relative.

Q.12 Which of the following is true for displacement?

(i) It cannot be zero.

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

Q.13 A particle moves along a circle of radius R as shown in figure. It starts from A and moves in anti-clockwise direction.



Calculate the distance travelled and displacement:

(i) From A to B

(ii) From A to C

(iii) From A to D

Q.14 A train covers 80 km in 2 hours. Find its average speed in kmh^{-1}, m min^{-1} and ms^{-1}.

Q.15 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.

Q.16 Which one of the following have maximum and the least average speed?

(i) Sanjeev moving with 12 kmh^{-1}

(ii) Rajeev running with 5 ms^{-1}

(iii) Kabir moving with 150 m min^{-1}

Q.17 What do you mean by negative and positive acceleration? Explain.

Q.18 Why circular motion is accelerated motion?

Q.19 Draw the graph for uniform motion.
(i) Displacement - Time
(ii) Velocity - Time

Q.20 An engine is moving with a velocity 44 m/s. After applying the brakes, it stops after covering a distance of 121 m. Calculate retardation and time taken by the engine to stop.

➢ Long Answer Type Questions

Q.21 Define rest and motion and give two examples of each.

Q.22 Write five difference between distance and displacement.

Q.23 Write the short notes on:
(i) Uniform motion
(ii) Non uniform motion
(iii) Average speed
(iv) Velocity

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 body starting with initial velocity u moves with a constant acceleration a. Find the expression for distance travelled in nth seconds.

EXERCISE-2

Q.1 ABC is the shortest path length between the two points and ADC is the actual path length. Then which of the two corresponds to displacement?
(A) ADC (B) ABC
(C) Can't say (D) None of these

Q.2 Rest and motion both are
(A) Relative terms
(B) Absolute terms
(C) Can't say
(D) None of these

Q.3 An object has travelled 10 km in 15 minutes, its displacement will be
(A) 10 km
(B) zero
(C) More than 10 km
(D) Cannot be predicted

Q.4 Which of the following does not need direction to be defined completely
(A) Speed (B) Velocity
(C) Force (D) Displacement

Q.5 Speedometer is a device, which is used to measure
(A) Distance (B) Displacement
(C) Speed (D) None of these

Q.6 A boy travels 50km with 5km/hr and then for next 4hr travels with a uniform speed of 20km/hr. What is theaverage speed for the whole journey?
(A) 62/7km/hr (B) 65/7km/hr
(C) 60/7km/hr (D) 9km/hr

Q.7 Magnitude of average speed of an object is equal to its average velocity if
(A) it is moving in a definite direction.
(B) its initial and final positions are same.
(C) and only if it is in a uniform motion.
(D) they travel equal distances.

Q.8 From the top of a tower, a particle is projected upwards and it reaches the ground after 5 s. The initial velocity of the particle is 12 m/s, the height of the tower is
(A) 55 m (B) 65 m
(C) 75 m (D) 85 m

Q.9 A train passes over a 400 m long bridge. If the speed of the train is 30 m/s and the train takes 20 s to cross the bridge, then the length of the train is
(A) 400 m (B) 600 m
(C) 800 m (D) 200 m

Q.10 If a body covers a distance d with velocity v_1 and another distance d with same velocity v_2, then average velocity for the whole journey would be equal to
(A) $\frac{2v_1v_2}{v_1+v_2}$ (B) $\frac{v_1v_2}{v_1+v_2}$
(C) $\frac{v_1v_2}{2v_1+v_2}$ (D) $\frac{2(v_1v_2)}{v_1v_2}$

Q.11 If a body covers some distance with speed v_1 for time t_1 and some another distance with speed v_2 for some time t_2. Then what would be the average velocity for the whole duration?
(A) $\frac{v_1v_2}{2}$ (B) $\frac{v_1t_1+v_2t_2}{t_1+t_2}$
(C) $\frac{v_1v_2}{v_1+v_2}$ (D) $\frac{2v_1v_2}{v_1+v_2}$

Q.12 A body strikes the floor vertically with a speed 'u' and rebounds at the same speed. The change in velocity would be
(A) u (B) 3u (C) 2u (D) zero

Q.13 One car moving on a straight road covers one third of the distance with 20 km/hr and the rest with 60 km/hr. The average speed is
(A) 40 km/hr (B) 80 km/hr
(C) $46\frac{2}{3}$ km/hr (D) 36 km/hr

Q.14 A 150 m long train is moving with a uniform velocity of 45 km/h. The time taken by the train to cross a bridge of length 850 meters is

(A) 56 sec (B) 68 sec
(C) 80 sec (D) 92 sec

Q.15 The ratio of the numerical values of the average velocity and average speed of a body is always

(A) Unity (B) Unity or less
(C) Unity or more (D) Less than unity

Q.16 The formula for average velocity $\frac{u+v}{2}$ is valid for the case when acceleration is

(A) Variable (B) Zero
(C) Uniform (D) None of these

Q.17 If a body travels 20m in 10s starting from rest then the acceleration of the particle is:

(A) $0.4 m/s^2$ (B) $0.6 m/s^2$
(C) $1 m/s^2$ (D) $0.8 m/s^2$

Q.18 For the equation $s = ut - \frac{1}{2}at^2$ acceleration is in the:

(A) Opposite direction of initial velocity
(B) Opposite direction of displacement
(C) Same direction of initial velocity
(D) Both (A) and (B)

Q.19 An aeroplane lands at 432 km/h and stops after covering a runway of 4 km. The time in which it comes to rest is

(A) 1.8s (B) 60s
(C) 66.6s (D) 150s

Q.20. The correct statement from the following is

(A) A body having zero velocity will not necessarily have zero acceleration
(B) A body having zero velocity will necessarily have zero acceleration
(C) A body having uniform speed can have only uniform acceleration
(D) A body having non-uniform velocity will have zero acceleration

Q.21 The average velocity of a body moving with uniform acceleration travelling a distance of 3.06 m is 0.34 ms^{-1}. If the change in velocity of the body is $0.18 ms^{-1}$ during this time, its uniform acceleration is

(A) $0.01 ms^{-2}$ (B) $0.02 ms^{-2}$
(C) $0.03 ms^{-2}$ (D) 0.04 ms

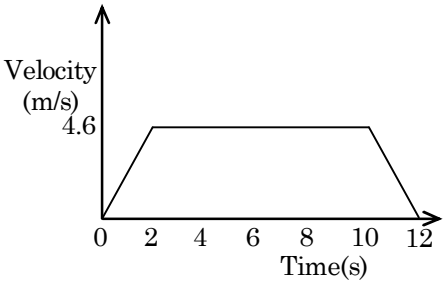
Q.22 A body under the action of several forces will have zero acceleration

(A) when the body is very light
(B) when the body is very heavy
(C) when the body is a point body
(D) when the vector sum of all the forces acting on it is zero

Q.23 The x and y coordinates of a particle at any time t are given by $x = 7t + 4t^2$ and $y = 5t$, where x and y are in metre and t in seconds. The acceleration of particle at t = 5s is

(A) Zero (B) $8 m/s^2$
(C) $20 m/s^2$ (D) $40 m/s^2$

Q.24 In the following velocity-time graph of a moving object

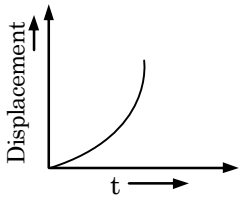


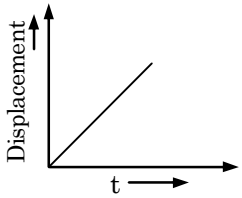
(A) Acceleration in the first 2 seconds is 2.3 ms^{-2}
(B) Acceleration in the last 2 seconds is $2.3 ms^{-2}$
(C) Motion is non-uniform between second and tenth second
(D) The body comes to rest at t = 2 and t =10 sec

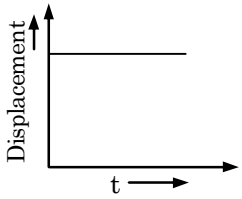
Q.25 The distance – time graph for an object moving with uniform speed is

(A) a straight line (B) is curvilinear
(C) rectilinear (D) parabolic

Q.26 Which of the following is correct for uniformly accelerated motion?

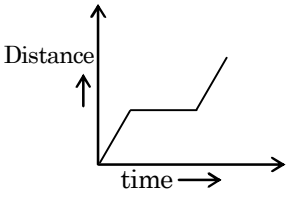
(A) 

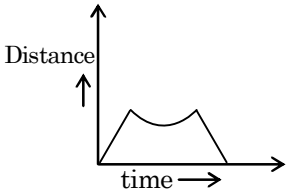
(B) 

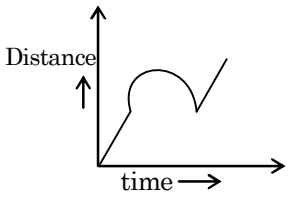
(C) 

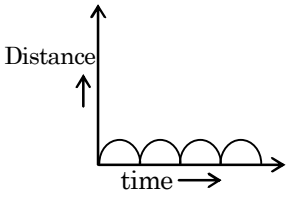
(D) All are correct

Q.27 Which of the following graph is possible?

(A) 

(B) 

(C) 

(D) 

Q.28 A bullet fired into a fixed target loses half of its velocity after penetrating 3 cm. How much further it will penetrate before coming to rest assuming that it faces constant resistance to motion?

(A) 1.5 cm (B) 1.0 cm
(C) 3.0 cm (D) 2.0 cm

Q.29 A particle experiences a constant acceleration for 20 sec after starting from rest. If it travels a distance S_1 in the first 10 sec and a distance S_2 in the next 10 sec, then

(A) $S_1 = S_2$ (B) $S_1 = S_2/3$
(C) $S_1 = S_2/2$ (D) $S_1 = S_2/4$

Q.30 A particle starting from rest travels a distance x in first 2 seconds and a distance y in next two seconds with constant acceleration, then

(A) y = x (B) y = 2x
(C) y = 3x (D) y = 4x

EXERCISE-3

(Previous Year Questions - NTSE & NSO)

Q.1 Value of one Fermi is

(A) 10^{-13}metre

(B) 10^{-14} metre

(C) 10^{-15} metre

(D) 10^{-16} metre

Q.2 A student starts with a velocity 40 km/hr for school at 4 km away from his house. Due to closing of school he returns soon to his house with a velocity of 60km/hr.His average velocity will be

(A) zero

(B) 10 km/hr

(C) 48 km/hr

(D) 50 km/hr

Q.3 A person takes time t to go once around a circular path of diameter 2R. The speed (v) of this person would be

(A) $\frac{t}{2\pi R}$ (B) $\frac{2\pi R}{t}$

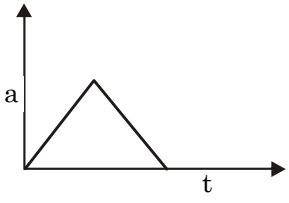
(C) $\frac{\pi R^2}{t}$ (D) $2\pi R.t$

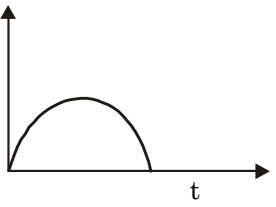
Q.4 A car travels 40 kms at an average speed of 80 km/h and then travels 40 kms at an average speed of 40 km/h. The average speed of the car for this 80 km trip is

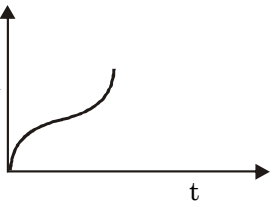
(A) 40 km/h (B) 45 km/h

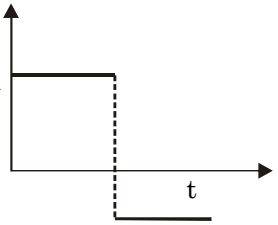
(C) 48 km/h (D) 53 km/h

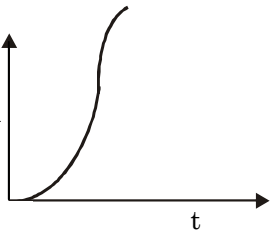
Q.5 The acceleration versus time graph of an object is as shown in figure. The corresponding velocity-time graph of the objects is



(A) 

(B) 

(C) 

(D) 

Q.6 A bullet of mass 10 g travelling horizontally with a velocity of 160 ms^{-1} strikes a stationary wooden block and comes to rest in 0.02 s. The distance of penetration of the bullet into the block will be

(A) 1.20 m (B) 1.60 m

(C) 2.00 m (D) 2.40 m

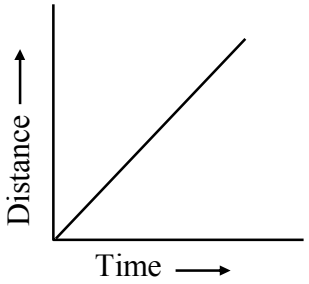
Q.7 The brakes applied to a car produce an acceleration of 8 m/s^2 in the opposite direction to the motion. If the car takes 3 seconds to stop after the application of brakes, the distance it travels during the time will be

(A) 30 m (B) 36 m

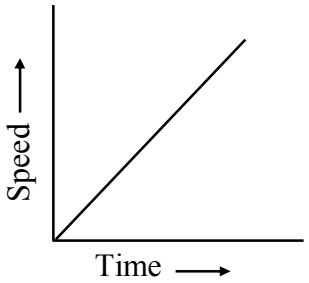
(C) 25 m (D) 40 m

Q.8 Consider the following five graphs (note the axes carefully). Which of the following represents motion at constant speed?

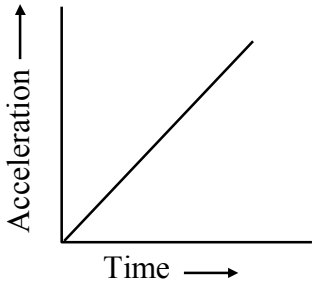
(1)



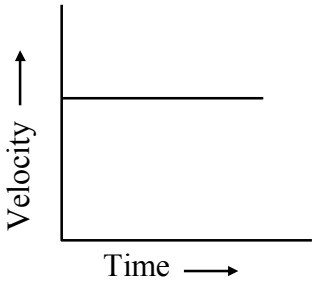
(2)



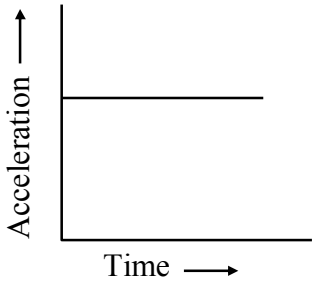
(3)



(4)

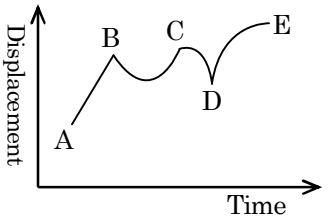


(5)



(A) 4 only (B) 4 and 5
(C) 1, 2 and 3 (D) 1 and 4

Q.9 The figure given below shows the displacement plotted time for a particle. In which regions is the force acting on the particle zero?



(A) AB (B) BC
(C) CD (D) DE

Q.10 Correct relation is.....
(A) $v^2 = u^2 + 2a^2s^2$
(B) $v^2 = u^2 - 2a^2s^2$
(C) $v^2 = u^2 + 2as$
(D) $v^2 = u^2 + 2a^2s$

Q.11 Two cars of unequal masses use similar tyres. If they are moving with same initial speed, the minimum stopping distance (air friction = 0)
(A) is smaller for the heavier car.
(B) is same for both the cars
(C) is smaller for the lighter car.
(D) depends on the volume of the car

Q.12 A ball hits a wall horizontally with a velocity of 6.0 ms^{-1}. After hitting wall it rebounds horizontally with a velocity of 4.4 ms^{-1}. If the balls remains in the contact of all for 0.040 sec. the acceleration of ball would be
(A) $-260\ m/s^2$ (B) $+260\ m/s^2$
(C) $-26\ m/s^2$ (D) $+26\ m/s^2$

Q.13 A man running with a uniform speed 'u' on a straight road observes a stationary bus at a distance 'd' ahead of him. At that instant, the bus starts with an acceleration 'a'. The condition that he would be able to catch the bus is
(A) $d \le \frac{u^2}{a}$ (B) $d \le \frac{u^2}{2a}$
(C) $d \le \frac{u^2}{3a}$ (D) $d \le \frac{u^2}{4a}$

Q.14 A car is moving with a constant speed of 70 km/h. Which of the following statements is correct?

(A) The acceleration of the car is definitely zero.

(B) The car has an acceleration only if it is moving along a curved path

(C) The car may have an acceleration even if it is moving along a straight path

(D) The car may not have an acceleration even if it is moving along a curved path

Q.15 A body cover half of the distance with a speed of 20m/s and the other half with 30m/s. The average speed of the body during the whole journey is

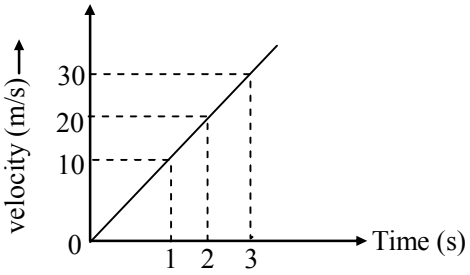
(A) Zero

(B) 24m/s

(C) 25 m/s

(D) None of the above

Q.16. Velocity-time graph of a body moving with uniform acceleration is shown in the diagram. The distance travelled by the body in 3 second is



(A) 90 m (B) 45 m

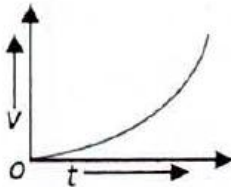
(C) zero (D) 10 m

Q.17 A body starts from rest is accelerated uniformly for 30s. If S1, S2, S3 are the distances travelled in first 10s; next 10s and last 10s respectively, then S1 : S2 :S3 is

(A) 1 : 2 : 3 (B) 1 : 1 : 1

(C) 1 : 3 : 5 (D) 1 : 3 : 9

Q.18 The velocity – time graph of a moving body is shown in the figure. Which of the following statements is true?



(A) The acceleration is constant and positive.

(B) The acceleration is constant and negative.

(C) The acceleration is increased and positive.

(D) The acceleration is decreasing and negative.

Q.19 If the distance travelled by an object is zero, then the displacement of the object is :

(A) zero

(B) not zero

(C) negative

(D) May or may not be zero

Q.20 How much time the satellite will take to complete one revolution around the earth, if velocity of satellite is 3.14 km/s and its height above earth's surface is 3600 km. (Radius of earth is 6400 km)

(A) 2000 S (B) 20000 S

(C) 1000 S (D) 10000 S

ANSWER KEY

EXERCISE - 1

1. 80 m and zero

3. 6m/s

7. 2h, 0

10. (i) 100 m, 100 m (ii) 112.5 m, 87.5 m

13. (i) $\frac{\pi R}{2}, \sqrt{2}R$ (ii) πR, $2R$ (iii) $\frac{3\pi R}{2}, \sqrt{2}R$

14. 40km/hr, 666.67m/min, 11.11m/sec

15. 3.069 km/s

20. 8 m/sec^2, 5.5s

24. 22.2 m/s

EXERCISE - 2

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	B	A	D	A	C	B	A	B	D	A	B	C	D	C	B
Ques.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	C	A	D	C	A	B	D	B	A	A	A	A	B	B	C

EXERCISE - 3

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

EXERCISE-1

➢ Very Short Answer Type Questions

Sol.1 40 m.

Displacement = 0
Distance = 40m + 40m = 80m

Sol.2 Metre

Sol.3 $\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{1200}{200} = 6 \text{ m/sec.}$

Sol.4 m/sec

Sol.5 m/sec^2

➢ Short Answer Type Questions – Type I

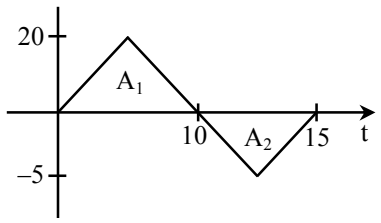
Sol.6 When body moving in straight line in certain direction.

Sol.7 Displacement = 0
Distance = 2h
Travelled

Sol.8 When body moving in straight line in certain direction.

Sol.9 If a body covers equal distance in equal interval along the circumference of the circle in equal interval of time.

Sol.10



Area $A_1 = \frac{1}{2} \times 20 \times 10 = 100$

Area $A_2 = -\frac{1}{2} \times 5 \times 5 = -12.5$

(i) Distance = Displacement = Area A_1
= 100 m.

(ii) Displacement = Area A_1 + Area A_2
= 100 – 12.5 = 87.5 m

Distance = (Area A_1) + (Area A_2)
= 100 + 12.5 = 112.5 m.

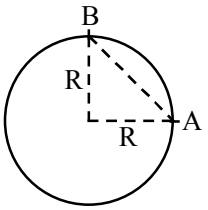
➢ Short Answer Type Questions – Type II

Sol.11 A train is moving on the track, the passenger are seated, will be stationary w.r.t. to each other but in moving condition w.r.t. to station.

Sol.12 Both are incorrect.

Sol.13 (i) $A \rightarrow B$

Distance $= \frac{1}{4}(2\pi R) = \frac{\pi}{2} R$



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

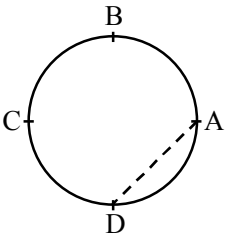
(ii) $A \rightarrow C$

Distance $= \frac{1}{2}(2\pi R) = \pi R$

Displacement = 2R

(iii) $A \rightarrow D$

Distance = $\frac{3}{4}(2\pi R) = \frac{3\pi R}{2}$



$\therefore$ Displacement = $\sqrt{2}\,R$

Sol.14 Avg. Speed $= \frac{\text{total distance}}{\text{total time}}$

$= \frac{80\,\text{km}}{2\,\text{hr}} = 40$ Km/hr.

or $= \frac{80\times10^3\,\text{m}}{2\times60\,\text{min}} = 666.67\ \text{m/min}.$

or $= \frac{80\times10^3\,\text{m}}{2\times60\times60\,\text{sec}} = 11.12\ \text{m/min}.$

Sol.15 Speed $= \frac{\text{Distance}}{\text{Time}} = \frac{2\pi R}{t} = \frac{2\pi R(42250)}{24}$

= 11,055.42 Km/hr

Sol.16 Convert all the units in SI (m/sec)

(i) 12 km/hr = 3.33 m/sec

(ii) 5 m/sec

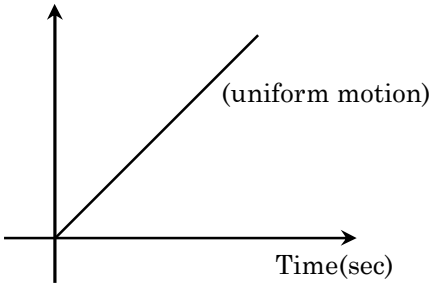
(iii) 150 m/min = 2.5 m/sec

So Rajeev has maximum speed & kabir has minimum speed.

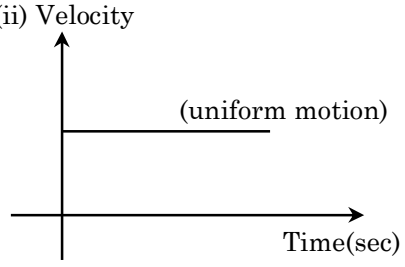
Sol.17 If direction of acceleration is in the direction of motion of body then it be positive acceleration and if the acceleration is in opposite direction of motion of body the it be negative acceleration.

Sol.18 In circular motion velocity is changing at every instant that's why circular motion is called as accelerated motion.

Sol.19 (i) Displacement(m)



(ii) Velocity



Sol.20 u = 44 m/sec

s = 121 M

v = 0

By using. Equation of motion.

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

$0 = (44)^2 + 2(a)\ (121)$

$a = -8\text{m/sec}^2$

$v = u + at$

$0 = 44 + (-8)\ (t)$

t = 5.5 sec

Long Answer Type Questions

Sol.21 An object is said to be at rest if it does not change its position w.r.t. its surrounding with the passage of time.

A body is said to be in motion if its position change continuously with the surroundings with the passage of time.

Although rest it motion are relative terms.

Sol.22

Distance	Displacement
1. Distance is the length of the path actually traveled by a body in an direction.	1. Displacement is the short distance between the initial and the final position.
2. Distance b/w two given points depends upon the path chosen	2. Displacement b/w two points is measured by the straight path b/w the points.
3. Distance is always positive.	3. Displacement may be positive negative or zero.
4. Distance is a scalar quantity.	4. Displacement is vector quantity.
5. Distance will never decreases	5. Displacement my decreases.

Sol.23 (i) Uniform motion :

If an object moves equal distance in equal interval of time in a certain direction.

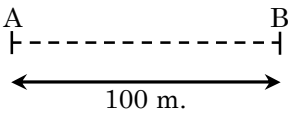
(ii) Non uniform motion :

If an object moves unequal distance in equal interval of time.

(iii) Average speed :

Total distance traveled by body divided by total time taken.

Sol.24



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

$$= \frac{100+100}{\frac{100}{20}+\frac{100}{25}} = \frac{200}{9} \text{ m/sec}$$

$$\text{Average velocity} = \frac{\text{displacement}}{\text{total time}} = 0$$

Sol.25 $S_{n^{th}} = S_n - S_{n-1}$

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

$$= un + \frac{1}{2}an^2 - un + u - \frac{1}{2}an^2 - \frac{a}{2} + an$$

$$S_{n^{th}} = u - \frac{a}{2} + \frac{an}{2}$$

EXERCISE-2

Sol.1 Shortest path between two points is shown as displacement.

Sol.2 Rest and motion both are relative terms.

Sol.3 Displacement ≤ distance traveled.
So cannot be predicted by this information only.

Sol.4 Speed is a scalar quantity.

Sol.5 odometer is used to measure speed.

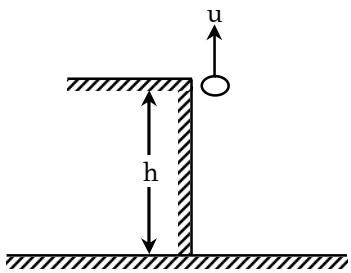
Sol.6 $$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

$$= \frac{S_1 + S_2}{t_1 + t_2}$$

$$= \frac{50 + (20 \times 4)}{\left(\frac{50}{5}\right) + 4} = \frac{65}{7} \text{ km/hr.}$$

Sol.7 |avg speed| = |avg velocity|
⇒ distance = displacement
It is only possible when body moving in definite direction.

Sol.8 U = + 12 m/sec
t = 5 sec
s = –h
a = –g = – 10 m/sec²



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

$$-h = 12 \times 5 + \frac{1}{2}(-10)(25)$$

h = 65 m

Sol.9 Let the length of the train is x.
Distance = Speed × Time
(400 + x) = 30 × 20
x = 200 m

Sol.10 $$\text{Average velocity} = \frac{\text{total displacement}}{\text{time taken}}$$

$$= \frac{2d}{t_1 + t_2}$$

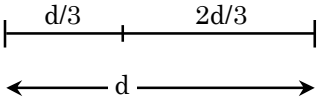
$$= \frac{2d}{\frac{d}{v_1} + \frac{d}{v_2}} = \frac{2v_1v_2}{v_1 + v_2}$$

Sol.11 $$\text{Average velocity} = \frac{\text{total displacement}}{\text{total time taken}}$$

$$= \frac{v_1t_1 + v_2t_2}{t_1 + t_2}$$

Sol.12 Change in velocity
= final velocity – initial velocity
$= u\hat{j} - (-u\hat{j}) = 2u\hat{j}$
(as velocity is a vector quantity)

Sol.13



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

$$= \frac{d}{t_1 + t_2}$$

$$= \frac{d}{\frac{d/3}{20} + \frac{2d/3}{60}}$$

$$= \frac{d}{\frac{d}{60} + \frac{d}{90}} = 36 \text{ km/hr}$$

Sol.14 Total distance travelled by train
= 850 m + 190 m
Speed = 45 km/hr

$$\text{time} = \frac{\text{distance}}{\text{speed}} = \frac{1}{43}\text{hr} = 80 \text{ sec.}$$

Sol.15 $|\text{avg velocity}| \le |\text{avg speed}|$

Sol.16 If uniform acceleration.

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

$$v^2 - u^2 = 2\left(\frac{v-u}{t}\right)s$$

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

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

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

Sol.17 $S = ut + \frac{1}{2}at^2$

$$20 = 0 + \frac{1}{2} \times a \times 100 \Rightarrow a = 0.4 \text{ m/sec}^2$$

Sol.18 acceleration is negative
initial velocity is positive.
displacement is positive.
So acceleration is in opposite direction & both displacement in velocity.

Sol.19 u = 432 Km/hr = 120 m/sec
s = 4km = 400m
$v^2 = u^2 + 2as$
$o = (120)^2 + 2(a)\ (4000)$
$a = -1.8 \text{ m/sec}^2$
$v = u + at$
$o = 120 - 1.8\ \pi t$

$$t = \frac{120}{1.8} = 66.66 \text{ sec}$$

Sol.20 A body having zero velocity will not necessarily have zero acceleration

Sol.21 $\text{avg velocity} = \frac{\text{total displacement}}{\text{total time taken}}$

$$0.34 = \frac{3.06}{t}$$

$$t = \frac{3.06}{0.34} = 9$$

$$\text{acceleration} = \frac{v-4}{t} = \frac{0.18}{9} = 0.02 \text{ m/sec}^2$$

Sol.22 $\overrightarrow{F_{net}} = m\vec{a} = \overrightarrow{F_1} + \overrightarrow{F_2} + \overrightarrow{F_3} \ldots..$
If vector sum of all forces is zero.
acceleration of body will be zero.

Sol.23 $x = 7t + 4t^2 \Rightarrow v_x = \frac{dx}{dt} = 7 + 8t \Rightarrow a_x = 8$

$$y = 5t \Rightarrow v_y = \frac{dy}{dt} = 5 \Rightarrow a_y = 0$$

$$\overrightarrow{a_{net}} = a_x\hat{i} + a_y\hat{i} = 8\hat{i}$$

Sol.24 Slope of velocity time graph provide the value of acceleration.

time	$0 \to 2$	$a = 2.3 \text{ m/sec}^2$
time	$2 \to 10$	$a = 0$ (uniform motion)
time	$10 \to 12$	$a = -2.3 \text{ m/sec}^2$

Sol.25 Slope of distance time graph provides the value of speed.
If uniform speed slope is constant.
$\Rightarrow$ Straight line.

Sol.26 Uniformly accelerated motion means velocity is increasing.
Slope of displacement v/s time graph provide velocity

Sol.27 Distance always increase with time it never decrease with time.

Sol.28 Let is assume initial speed of bullet be U after a displacement of 3cm its velocity becomes u/2.

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

$$\left(\frac{u}{2}\right)^2 = u^2 + 2(a)(3) \Rightarrow a = -\frac{u}{8}$$

as the resistance is constant, finally velocity becomes zero.

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

$0 = \left(\frac{u}{2}\right) + 2\left(-\frac{u}{8}\right)s$

$s = 1cm$

Sol.29 $S = ut + \frac{1}{2}at^2$

$S_{20} = 0 + \frac{1}{2} \times a \times (20)^2$

$S_{10} = 0 + \frac{1}{2} \times a(10)^2$

$S_1 = S_{10} - 0 = 50a$

$S_2 = S_{20} - S_{10} = 200a - 50a = 150a$

$\frac{S_2}{3} = S_1$

Sol.30 $S = 4t + \frac{1}{2}at^2$

$S_4 = 0 + \frac{1}{\alpha}a \times (4)^2 = 8a$

$S_2 = 0 + \frac{1}{\alpha}a \times (2)^2 = 2a$

$x = S_2 - 0 = 2a$

$y = S_4 - S_2 = 6a$

$y = 3x$

EXERCISE-3

Sol.1 1 fermi = 10^{-15} m.

Sol.2 avg velocity $= \frac{\text{displacement}}{\text{total time}}$

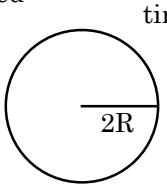
in this cost displacement = 0

$\Rightarrow$ avg velocity = 0

Sol.3 circumference = $2\pi(R)$

time = t

speed $= \frac{\text{distance travelled}}{\text{time}} = \frac{2\pi R}{t}$



Sol.4 average speed $= \frac{\text{total distance travelled}}{\text{total time taken}}$

$= \frac{40+40}{t_1+t_2} = \frac{80}{\frac{40}{80}+\frac{40}{40}} = \frac{160}{3} \approx 53.33$ km/hr

Sol.5 Acceleration is increasing and then decreasing but acceleration is positive.

Velocity time graph first increases paraboliclly and then decreases in same manner.

Sol.6 u = 160 m/sec

t = 0.02 sec

v = u + at

o = 160 + a(0.02)

$a = -8000$ m/sec^2

$v^2 = 4^2 + 2as$

$o = (160)^2 + 2(-8000)(5)$

s = 1.6m

Sol.7 $a = -8$ m/sec^2

t = 3sec

v = 0

v = 4 + at

o = u + (–8)(3)

u = 24 m/sec

$S = 4 + \frac{1}{2}a + 2$

$= 24 \times 3 + \frac{1}{2} \times (-8)(3)^2 = 36$m.

Sol.8 Slope of distance v/s time graph provide speed.

Sol.9 A $\rightarrow$ B velocity is constant

$\Rightarrow$ Acceleration is zero.

$\Rightarrow$ Force is zero

Sol.10 $v^2 = u^2 + 2as$

Sol.11 $a = \frac{F}{m}$

Heavy car win have low retardation.

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

$0 = u^2 - 2as$

$s = \frac{u^2}{2a}$

As retardation is law for heavy car distance cover will be more for it.

Sol.12 $\vec{a} = \frac{\overrightarrow{vf} - \overrightarrow{v_1}}{t} = \frac{-4.4\hat{i} - (6\hat{i})}{(0.04)} = -260$ m/sec^2

Sol.13 Let after time t man catches bus

For bus distance travel in Time t

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

Man has to cover distance (d + s) in time t,

So

d + s = speed × time

$$d + \frac{1}{2}at^2 = u.t$$

or $\frac{2d}{a} + t^2 = \frac{2u}{a} \cdot t$

or $t^2 - \frac{2u}{a}t + \frac{2d}{a} = 0$

for positive roots.

$b^2 - 4ac \geq 0$

$$\frac{4u^2}{a^2} - 4(1)\left(\frac{2d}{a}\right) \geq 0$$

$$d \leq \frac{u^2}{2a}$$

Sol.14 In uniform circular motion speed is constant and it is an accelerated motion.

Sol.15 Let the total distance bed.

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

$$= \frac{d}{t_1 + t_2} = \frac{d}{\frac{d/2}{20} + \frac{d/2}{30}} = 24 \text{ m/sec.}$$

Sol.16 Slope of the line = (30-0)/3 = $10M/S^2$

a = 10m/s2

s = $\frac{1}{2}$ 10^3

s = 45m

Sol.17 $S_1 = \frac{1}{2}a(10)^2 = 100\left(\frac{a}{2}\right)$

$$S_2 - S_1 = \frac{1}{2}a(20)^2$$

$$S_3 - S_2 - S_1 = \frac{1}{2}a(30)^2$$

$$S_3 = 500\left(\frac{a}{2}\right)$$

$S_1 : S_2 : S_3 = 100 : 300 : 500 = 1 : 3 : 5$

Sol.18 Velocity of object is continue increasing parabolically hence acceleration is also increasing in positive manner.

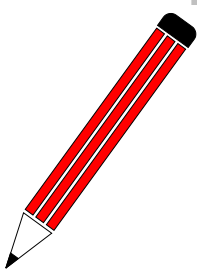
Sol.19 If distance travel by object is zero its mean it is in the rest.

Sol.20 Radius of circle = 6400 + 3600 = 10,000 km

$$time = \frac{Distance}{Speed} = \frac{2 \times 3.14 \times 10,000}{3.14}$$

= 20,000 sec.

NOTES



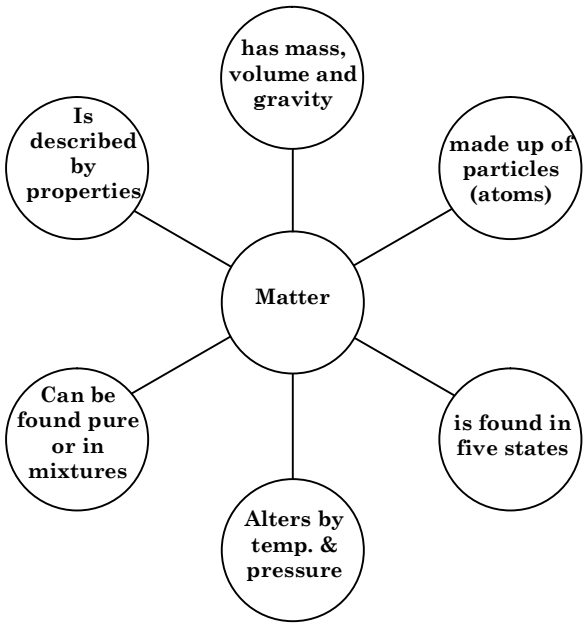
Chapter

1

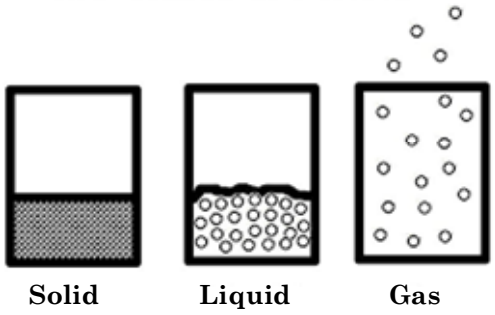
MATTER IN OUR SURROUNDINGS

Chapter Outline

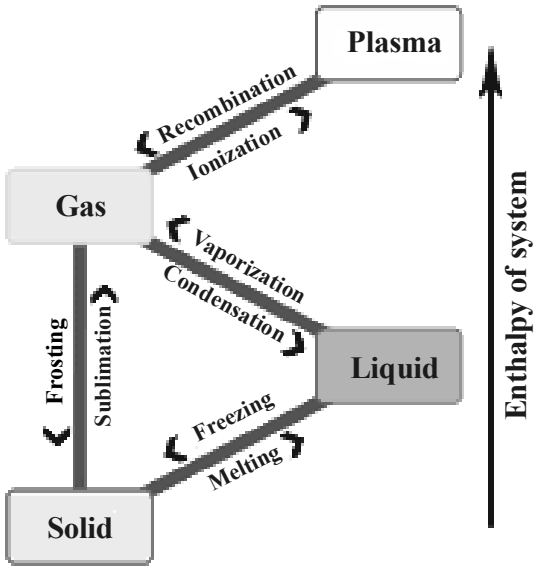
- Physical Nature of Matter
- Classification of Matter
- Properties of Solid, Liquid & Gas
- Fourth and Fifth State of Matter
- Interconversion of States of Matter
- Scales of Measuring Temperature
- Evaporation



Properties of matter

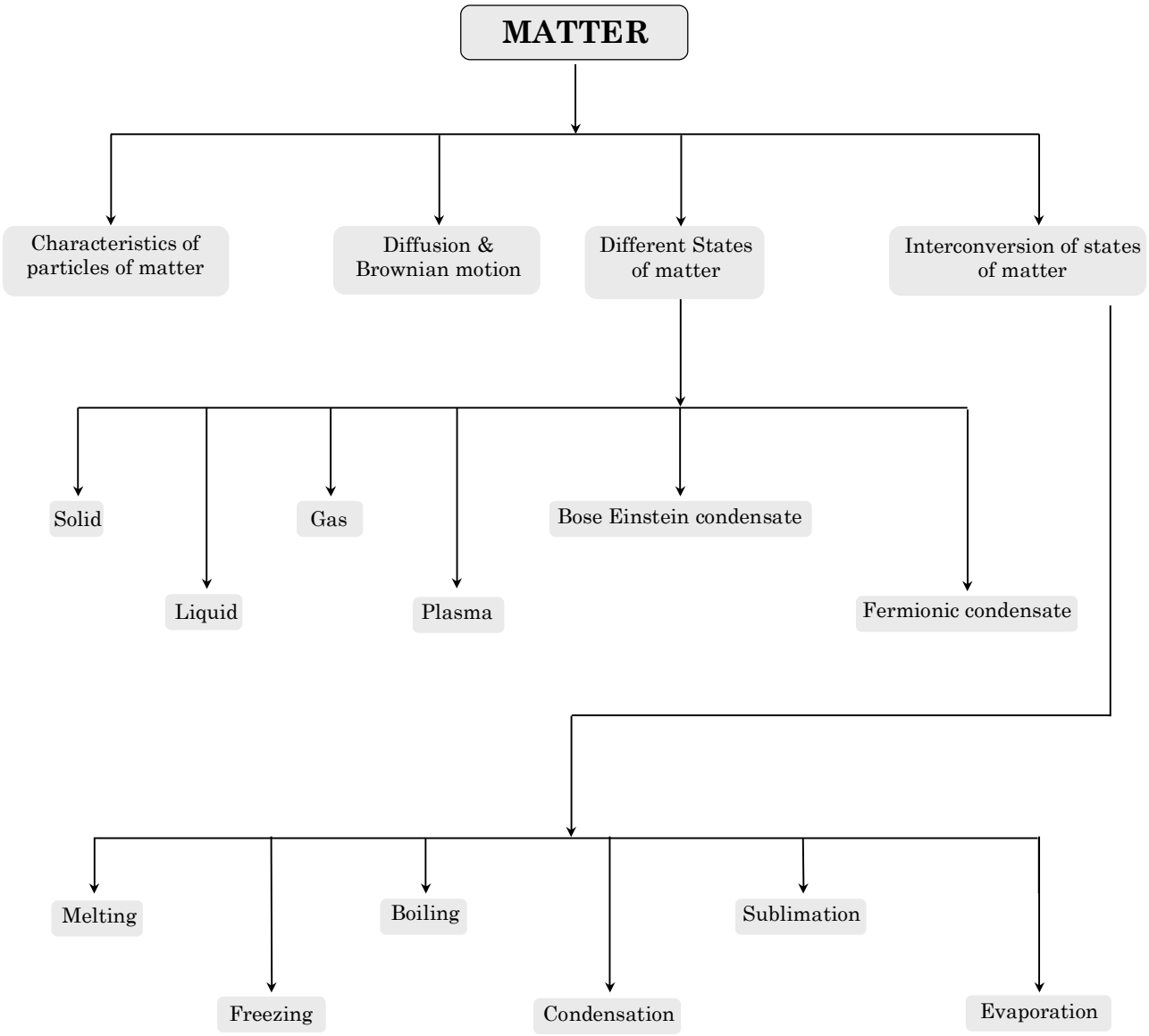


The States of Matter



Conversion of states of matter

MIND MAP


MATTER
Characteristics of particles of matter
Diffusion & Brownian motion
Different States of matter
Interconversion of states of matter
Solid
Liquid
Gas
Plasma
Bose Einstein condensate
Fermionic condensate
Melting
Freezing
Boiling
Condensation
Sublimation
Evaporation

MATTER IN OUR SURROUNDINGS

Introduction

There are large numbers of things around us which we see and feel. For example, you can see this book in front of you. This book occupies some space. The Space occupies by the book is called its volume. If you pick up the book, you can also feel its weight. So, you conclude that the book has some mass.

Further, that matter offers resistance is borne out by the fact that you can not displace an object from one place to another without applying some force.

Thus, matter can be defined as

Anything that occupies space has mass and offers resistance.

Physical nature of matter

Matter is made of enormous tiny particles with some important characteristics are as follows:

(1) The particles of matter are very, very small.

(2) The particles of matter have spaces between them.

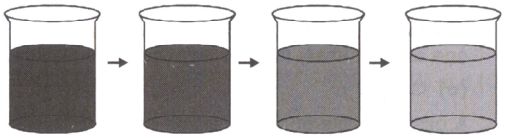
(3) The particles of matter are constantly moving.

(4) The particles of matter attract each other.

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

- **Evidence:**

(i) Experiment: Potassium permanganate is a purple coloured solid substance and water is a liquid. We will take 2.5 gm crystals of potassium permanganate and dissolve them in 100 ml of water. Now we will take out 10 ml of this solution and put into another 90 ml of clear water. We will keep diluting the solution like this 5 to 8 times.



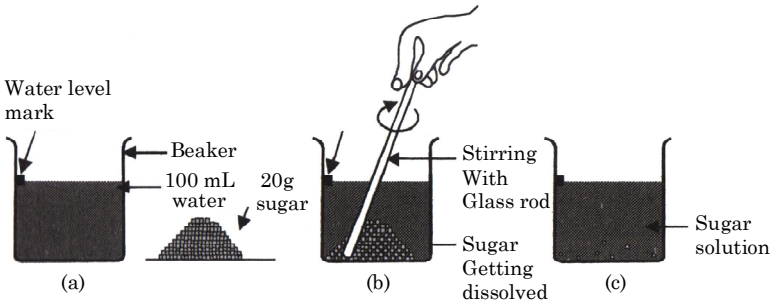
Just a few crystals of potassium permanganate can colour a huge volume of water

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

(2) The particles of matter have spaces between them.

- **Evidence:**

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



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

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

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

It shows that particles of sugar go into the spaces between various molecules of water due to which there is no change in the volume Thus, from this experiment it can be concluded that, the molecules in water are not tightly packed, they have spaces between them.

(3) The particles of matter are constantly moving: This property can be explained by diffusion and Brownian motion.

◈ Diffusion

"Intermixing of particles of two different types of matter on their own is called diffusion." It is the phenomenon in which the movement of molecules or particles occurs from their higher concentration towards their lower concentration.

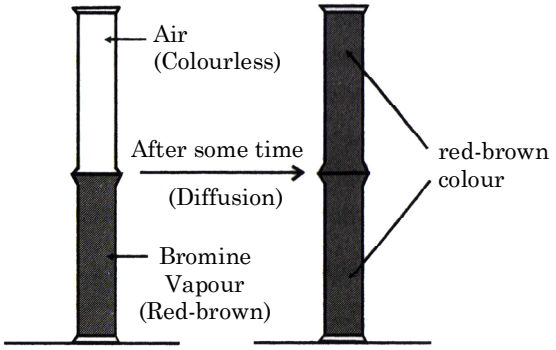
Diffusion is very commonly observed in our day-to-day life.

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

- **Diffusion in gases:** Diffusion is fastest in gases.

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

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



Diffusion of bromine vapour (or bromine gas) into air

Note: *The particles of matter possess kinetic energy and so are constantly moving. As the temperature rises particles move faster.*

- **Diffusion in liquids:** Diffusion in liquids is slower than that in gases.

  For example:

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

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

Note: *The rate of diffusion in liquids is much faster than that in solids because the particles 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 is a very, very slow process.

  For example:

  (i) 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 particles of chalk have diffused into the surface of blackboard.

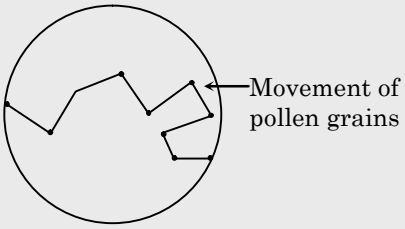
  (ii) If two metal blocks are bound together tightly and kept undisturbed for a few years, then the particles of one metal are found to have diffused into the other metal.

COMPETITIVE LEVEL

◈ Movement of pollen grains in water

The best evidence for the existence and movement of particles in liquids was given by Robert Brown in 1827.

Robert Brown suspended extremely small pollen grains in water. On looking through the microscope, it was found that the pollen grain were moving rapidly throughout water in very irregular way (or zig-zag way).



- **Brownian motion:** Zig-zag motion (in a very irregular way) of particles is known as Brownian motion. It is also known as **Pedesis**. Sometimes, when a beam of light enters a room, we can see tiny dust particles suspended in air which are moving rapidly in a very random way. This is an example of Brownian motion in gases. The tiny dust particles move here and there because they are constantly hit by the fast moving particles of air.
- **Conclusion:** Water is made up of tiny particles which are moving very fast (The water molecules themselves are invisible under the microscope because they are very, very small). The Pollen grains move on the surface of water because they are constantly being hit by the fast moving particles of water. So, though the water particles (or water molecules) are too small to be seen, but their effect on the pollen grains can be seen clearly. The random motion of visible particles (pollen grains) caused by the much smaller invisible particles of water is an example of Brownian motion (after the name of the scientist Robert Brown who first observed this phenomenon).

  The existence of Brownian motion gives two conclusions.

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

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

COMPETITIVE LEVEL

(i) Cohesive Force: The force of attraction between the particles of same substances is called cohesive force.

(ii) Adhesive force: The force of attraction between the particles of different substances is called adhesive force.

e.g.: If we take a piece of chalk, a cube of ice and an iron nail and beat them with a hammer, chalk will easily break into smaller pieces, but more force will be required to break a cube of ice and iron nail will not break.

Reason: The reason for this is, that the force of attraction is quite weak in between the chalk particles, force of attraction in between the particles of ice cube is a bit stronger, while force of attraction in between the particles of iron is very-very strong.

Ex.1 Give reasons-

(i) A gas fills completely the vessel in which it is kept.

(ii) A gas exerts pressure on the walls of the container.

(iii) We can get the smell of perfume sitting several metres away.

Sol. (i) In gases, the intermolecular forces are negligible. So, the particles of gases are free to move in any direction. As a result, gases fill the container in which they are kept.

(ii) The particles in all the gases move with high speeds in all directions. When these particles strike the walls of the container, they exert force on the walls of the container. Force per unit area is called pressure. So, gases exert pressure on the walls of the container due to the impact of the striking particles.

(iii) The particles of perfume, in vapour form, diffuse into the air. As the gas molecules are continuously moving randomly they reach to a person sitting several metres away.

Ex.2 A diver is able to cut through water in a swimming pool. Which property of matter does this observation prove?

Sol. This observation supports the following properties of water (or liquids)-

(i) The intermolecular forces in water (or liquids) are not very strong.

(ii) The particles in liquids can be easily displaced from their original position.

(iii) Liquids show reasonable fluidity.

Ex.3 "The smell of hot sizzling food reaches you several meters away, but to get the smell from cold food you have to go close." Give reason.

Sol. This is because the particles of fragrance move faster at higher temperature due to more Kinetic Energy and diffuse into the air to reach various rooms.

Ex.4 Arrange the following in order of increasing density. exhaust from chimneys, Air, cotton, Iron, water, honey, chalk.

Sol. Air < exhaust from chimneys < water < honey < cotton < chalk < iron.

Ex.5 What are the characteristics of the particles of matter?

Sol. Particles of matter-

(i) have space between them.

(ii) are continuously moving.

(iii) attract each other.

Classification of Matter

On the basis of physical properties and arrangement of particles matter is mainly classified into three states: Solids, Liquid and Gas.

◈ 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 flow.

e.g. Ice, wood, coal, stone, iron, brick e.t.c.

◈ 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 generally flow easily.

e.g., Water, milk, fruit juice, ink, groundnut oil, kerosene etc.

◈ Properties of gases

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

(ii) Gases can be compressed easily.

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

(iv) Gases fill the container completely.

(v) Gases flow easily.

e.g., Air, oxygen, hydrogen, nitrogen etc.

Note: ***Rigid:*** *In solids, the constituent particles are very closely packed and there are hardly any spaces between them, hence they have a tendency to maintain shape when some outside force is applied i.e., solids are rigid.*

Fluids*: Liquids and gases are often grouped as fluids because they can flow. Liquids can flow only from higher to lower levels. Hence, liquids can be kept only in containers having rigid sides. Gases spread or flow in all directions, hence, they can be stored only in tightly closed containers.*

COMPETITIVE LEVEL

Applications of compressibility of gases:

- Liquefied petroleum Gas (LPG) which we use in homes.
- The oxygen gas supplied to hospitals in cylinders is compressed gas.
- Similarly, compressed natural gas (CNG) is filled in cylinders and is used as a fuel in vehicles like cars and buses.

Fourth & Fifth State of Matter

◈ Plasma

The fourth state of matter.

Scientists are reported to have discovered a new state of matter which is called plasma state. This state does not fit into any of the hitherto known three states of matter. Hence, it is often called the *fourth state of matter*. Plasma state consists of highly ionized gas in which the particles exist in super energetic and super excited states.

The discovery of plasma has found some practical applications. We very well know about fluorescent tubes and neon sign bulbs. The fluorescent tubes contain helium or some other gas. When electric current is passed through the gas, it produces glowing plasma, having a characteristic colour depending upon the nature of the gas.

Plasma is produced in the sun and in the stars due to high temperature. It is the presence of plasma that makes them glow.

◈ Bose-Einstein condensate

The fifth state of matter.

In 1920, the noted Indian scientist Satyendra Nath Bose on the basis of his statistical calculations gave the concept of the fifth state of matter. Einstein too predicted the possibility of such a state. Later three American scientists succeeded in obtaining this state by supercooling a gas of extremely low density, The process is called Bose-Einstein condensation, and this state of matter is called Bose-Einstein Condensate (BEC).

COMPETITIVE LEVEL

◈ Fermionic condensate

- Fermionic condensates are a type of superfluid. As the name suggests, a superfluid possesses fluid properties similar to those possessed by ordinary liquids and gases, such as the lack of a definite shape and the ability to flow in response to applied forces.
- *Fermionic condensates are attained at temperatures lower than Bose–Einstein condensates.*

Ex.6 Differentiate between solid, liquid and gases.

Sol. Comparison of characteristic properties of solids, liquids and gases

S.No.	Solids	Liquids	Gases
1.	Definite shape	No Definite shape, acquire shape of container	Not definite ,acquire whole space of container
2.	Definite volume	Definite volume	Take the volume of the container
3.	Rigid	Fluid	Fluid
4.	Diffusion occurs very slowly	Diffuse slowly	Diffuse rapidly
5.	Large number of free surfaces	Only one free surface	No free surface
6.	Closely packed	Loosely packed	Very loosely packed
7.	Voids are extremely small so incompressible	Relatively larger voids so slightly compressible	Voids are very very large so easily compressible
8.	Motion is restricted to vibratory only	Motion is transitional, rotational and vibrational motion.	Motion is rapid & random
9.	Inter particle force is very strong so highly dense	Intermediate of solid and gases so low density	Inter particle forces are negligible so density is very very low.
10.	K.E. is very very low	K.E. is comparatively high	K.E. is very high

Ex.7 What is the physical state of water at

(a) 25°C? (b) 100°C?

Sol. (a) At 25 °C it is liquid.

(b) At 100 °C evaporation will take place and water will convert into vapours (gas)

Interconversion of States of Matter

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

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

(1) Temperature

(2) Pressure.

◈ Altering the Temperature of Matter

- **Interconversion of solid and liquid states:** Solids can be converted into liquids by heating them. Similarly liquid can be cooled to form solids.

  e.g.: Ice at 0°C changes into water at 0°C, when heat energy is supplied to it. The water at 0°C changes into ice at 0°C on cooling. Ice on heating above 273 K or 0°C changes into water. Water on heating upto 373 K or 100°C changes to steam, which is the gaseous state of water. On the other hand, steam can be converted into water on cooling below 373 K, whereas water can be converted to ice by cooling it down to 273 K.

COMPETITIVE LEVEL

Triple Point

- In thermodynamics, the triple point of a substance is the temperature and pressure at which the three phases (gas, liquid and solid) of that substance coexist in thermodynamics equilibrium.
- For example: the pressure and temperature at which liquid water, solid ice and water vapour can coexist in a stable equilibrium occurs at exactly 273.16 K (0.01°C; 32.02 °F) and partial vapour pressure of 611.657 pascal (.00603659 atm).

(i) **Melting or Fusion:** The process due to which a solid changes into liquid state by absorbing heat energy is called melting or fusion.

(ii) **Freezing or solidification:** The process due to which a liquid changes into solid state by giving out heat energy is called freezing or solidification.

(iii) **Melting Point:** The constant temperature at which a solid changes into liquid state by absorbing heat energy at 1 atm pressure is called its melting point.

(iv) **Freezing Point:** The constant temperature at which a liquid changes into solid state by giving out heat energy at 1 atm pressure is called freezing point.

Note: *The numerical value of freezing point and melting point is same.*

Melting point of ice = Freezing point of water = 0°C (273.16 K).

- **Explanation:** On increasing the temperature of solids, the kinetic energy (K.E.) of particles increases. Due to increase in K.E., the particle start vibrating with greater speed. The energy supplied by heat overcomes the force of attraction between the particles. Then, the particles leave their fixed positions and start moving freely and thus solid melts.

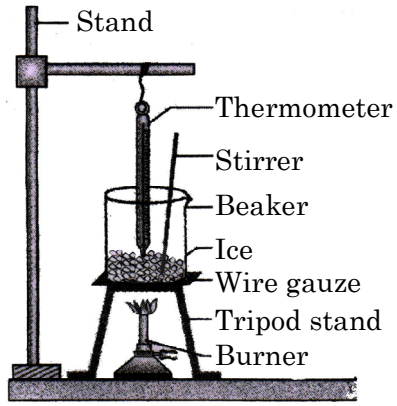
◆ **Activity:** To study the change of state from ice to water.

- **Materials required:**

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

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

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



Change of state from ice to water

◈ Latent Heat of Fusion

The amount of heat energy that is required to change 1 kg of solid into liquid at atmospheric pressure and its melting point without any change in temperature is known as the latent heat of fusion. (In Greek Latent means Hidden). For *e.g*. Latent heat of fusion of ice = 3.34×10^5 J/kg.

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

- **Interconversion of liquid and gaseous state:** Liquids can be converted into gases by heating them. Similarly gases can be converted into liquids by cooling them.

  e.g.: Water at 1 atm pressure changes into steam at 100°C by absorbing heat. Steam at 100°C changes into water by giving out energy.

  (i) **Boiling or Vaporisation:** The process due to which a liquid changes into gaseous state by absorbing heat energy is called boiling.

  (ii) **Condensation or Liquefaction:** The process due to which a gas changes into liquid state by giving out heat energy is called condensation.

  (iii) **Boiling Point:** The constant temperature at which a liquid rapidly changes into gaseous state by absorbing heat energy at atmospheric pressure is called boiling point.

  (iv) **Condensation Point:** The constant temperature at which a gas changes into liquid state by giving out heat energy at atmospheric pressure is called condensation point.

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

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

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

Scales of Measuring Temperature

Celsius scale (°C), Fahrenheit scale (°F) and Kelvin scale (K).

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

$^\circ F = \frac{9}{5} (^\circ C) + 32^\circ$

Ex.8 Convert the following temperatures into the Kelvin scale.
(a) 25^0C
(b) 373^0C

Sol. (a) 25^0C

$T = t+273$

$T = 25+273$

$T = 298$ K

(b) 373^0C

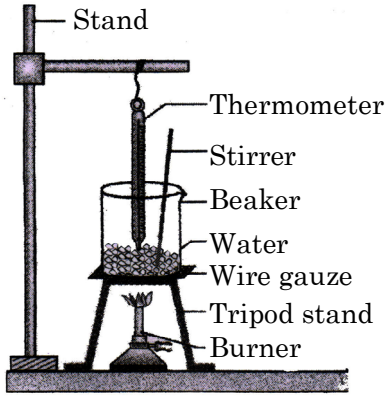
$T = 373 +273$

$T = 646$K.

- **Activity:** To study the change of state from water to steam.
  - **Materials required:** A 100 cc beaker, a thermometer (Celsius), a glass stirrer, a wire gauze, a tripod stand, a Bunsen burner, an iron stand, tap water.
  - **Method:** Half fill the beaker with water and place it over a wire gauze and tripod stand. Suspend a Celsius thermometer from the iron stand, such that it bulb is touching the water level. Place a glass stirrer in the water.

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

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



Change of state from water to steam

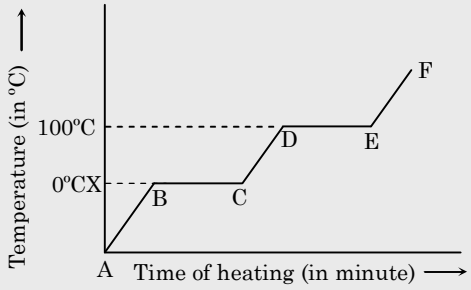
◈ Latent heat of vapourization

The amount of heat which in required to convert 1 kg of the liquid at atmospheric pressure (at its boiling point) to vapour without any change in temperature is called Latent heat of vapourization. For e.g. latent heat of vapourization of water is = 22.5×10^5 J/kg.

COMPETITIVE LEVEL

Curve [Temperature-Time Graph]

We can show the change of temperature during interconversion of states with time in the form of a temperature-time graph. Below is the temperature – time curve of water.



In this graph at point A, we have all ice. As we heat it, its temperature rises. The ice starts melting to form water but the temperature of ice and water mixture does not rise. It remains constant at 0°C during the melting of ice. Between points B and C, water and ice remain in equilibrium Now, on heating beyond point C, the temperature of water (formed from ice) starts rising as shown by the sloping line CD in the graph. At 100°C water starts boiling into water vapours. Both the states remain in dynamic equilibrium. On heating beyond point E, kinetic energy of vapour particles increase.

Ex.9 For any substance, why does the temperature remain constant during its phase change?

Sol. This is because the heat supplied to the substance is used up (absorbed) in overcoming the intermolecular forces, and therefore, it does not show up a rise in the temperature. Thus, the heat supplied during melting and boiling remains hidden from the thermometer and is called latent heat.

Ex.10 What produces more severe burns, boiling water or steam?

Sol. Steam produces more severe burns than boiling water due to its high latent heat .

- **Direct interconversion of solid and gaseous states :** The changing of solid directly into vapours on heating and of vapours directly into solid on cooling is known as sublimation.
  - The solid which undergoes sublimation to form vapour is called 'sublime'.
  - The solid which is obtained by cooling the vapours is called 'sublimate'.

  Examples of sublimable solids are:

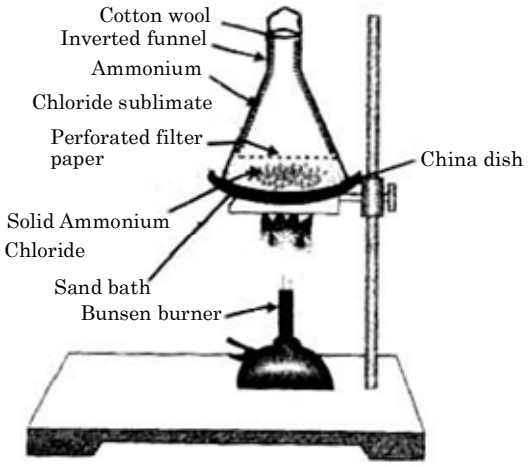
  Ammonium Chloride (NH_4Cl), iodine, camphor, naphthalene (moth balls) and anthracene solid CO_2.

- **Activity:**

  To study the change of state from solid to gas:

  - **Materials required:** A 100 cc beaker, a china dish, a wire gauze, a tripod stand, a Bunsen burner, a glass funnel, ammonium chloride and a cotton plug.
  - **Method:** We will take little amount of ammonium chloride in a china dish and cover the dish with a perforated filter paper. We will place an inverted funnel on the filter paper and will plug the stem of the funnel with cotton wool to prevent the escape of the ammonium chloride vapours. Now, heat the china dish over a sand bath.

    Ammonium chloride sublimes and the vapours thus formed pass through the holes in filter paper and get deposited as solid on the inner walls of funnel. The filter paper used for covering the porcelain china dish prevents the sublimed ammonium chloride to drop back into the dish.

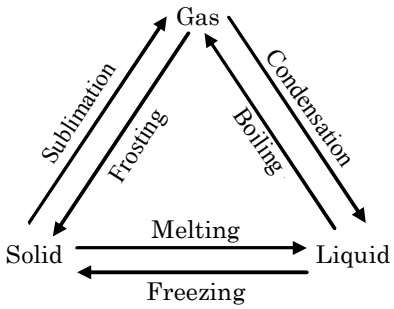


Sublimation of Ammonium Chloride

  - **Conclusion:** The solid ammonium chloride directly gets converted into vapours without passing through the intervening liquid state. The vapours, in turn, condense on the cooler portions of the funnel to give sublimate of pure ammonium chloride.

    It shows that particles of ammonium chloride undergo sublimation.

Note: *The conversion of gaseous state directly into solid state is known as* ***frosting****.*



◈ Effect of change of pressure on the state of matter

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

Pressure and temperature determine the state of a substance. So, high pressure and low temperature can liquefy gases.

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

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

Ex.11 Suggest a method to liquify atmospheric gases.

Sol. Atmospheric gases can be liquified by lowering its temperature and increasing pressure simultaneously.

Evaporation

The phenomenon of change of a liquid into vapours at any temperature below its boiling point is called evaporation.

Water changes into vapours below 100ºC. The particles of matter are always moving and are never at rest. At a given temperature in any gas, liquid or solid, there are particles with different K.E.

In case of liquids a small fraction of particles at the surface, having higher K.E. is able to break the forces of attraction of other particles and gets converted into vapour.

◈ Factors affecting Evaporation

(i) Temperature:.

Rate of evaporation α Temperature

With the increase in temperature the rate of evaporation increases.

Reason: On increasing temperature more number of particles get enough K.E. to go into the vapour state.

(ii) Surface Area:

Rate of evaporation α surface area. Since evaporation is a surface phenomena. If the surface area is increased, the rate of evaporation increases. So, while putting clothes for drying up we spread them out.

(iii) Humidity of Air: Rate of evaporation $\alpha \frac{1}{\text{Humidity}}$.

Humidity is the amount of water vapour present in air. When humidity of air is low, the rate of evaporation is high and water evaporates more readily. When humidity of air is high, the rate of evaporation is low and water evaporates very slowly.

(iv) Wind Speed:

Rate of evaporation α wind speed.

With the increase in wind speed, the particles of water vapour move away with the wind. So the amount of water vapour decreases in the surroundings thereby increasing evaporation.

(v) Nature of substance:

Substances with high boiling points will evaporate slowly, while substances with low boiling points will evaporate quickly.

◈ Cooling caused by Evaporation

The cooling caused by evaporation is based on the fact that when a liquid evaporates, it draws (or takes) the latent heat of vapourisation from 'anything' which it touches. It has many applications in everyday life.

For examples:

- Perspiration (or sweating) in our body is a method of maintaining a constant temperature. During summer, we perspire more because of the mechanism of our body which keeps us cool. During evaporation, the particles at the surface of liquid gain energy from the surroundings of body surface. The heat energy equal to latent heat of vapourization, is absorbed from the body, leaving the body cool. Cotton, being a good absorber of water helps in absorbing the sweat. Thus, we wear cotton clothes in summer.

Ex.12 Give differences between evaporation and boiling.

Sol. Differences between evaporation and boiling are:

Evaporation	Boiling
It is a surface phenomenon	It is a bulk phenomenon
It occurs at all temperatures below B.P.	It occurs at B.P. only.
The rate of evaporation depends upon the surface area of the liquid, humidity temperature & wind speed.	The rate of boiling does not depend upon the surface area, wind speed, and humidity.
It causes cooling.	It does not causes cooling.

Ex.13 Why does our palm feel cold when we put some acetone, petrol or perfume on it?

Sol. When we put some acetone, petrol or perfume on our palm, the particles of these substances absorb energy from the palm or surroundings and vaporize causing cooling. Hence, our palm feels cold.

Ex.14 What type of clothes should we wear in summer?

Sol. During summers, we perspire more due to the body mechanism to keep it cool. The perspiration comes out through the pores in our skin. It evaporates absorbing heat from our body leaving it cool. Cotton is a good absorber of water. It absorbs the sweat and exposes it to the atmosphere. This speeds up evaporation of the sweat and makes us comfortable. Hence, we should wear cotton clothes during summers.

Ex.15 How does the water kept in an earthen pot (matka) become cool during summer?

Sol. An earthen pot (matka) has small pores in its walls. When water is poured into it, some of it seeps through these pores to its outer surface. On reaching there, it evaporates.The heat required for evaporation is taken from the earthen pot and from the water in it. As a result, the water in an earthen pot gets cooled down.

Ex.16 Why are we able to sip hot tea or milk faster from a saucer rather than a cup?

Sol. The surface area of the liquid hot tea on saucer is more than in a cup. Therefore, evaporation and cooling will be faster in a saucer than in a cup. So we are able to sip hot tea faster from a saucer rather than a cup.

Ex.17 Why does a desert cooler cool better on a hot dry day?

Sol. In a desert cooler, hot and dry air passes through wet pads of wood-shaving. Water takes heat from the hot air and evaporates. The evaporation of water-cools the pads, and the circulating water too. As a result the incoming air also gets cooled down.

EXERCISE-1

➢ Very Short Answer Type Questions

Q.1 Which state of matter has neither definite shape nor volume?

Q.2 Which will have more density: ice or steam?

Q.3 What is the general name of fluid form of matter?

Q.4 Which diffuses faster: a liquid or a gas?

Q.5 What is the chemical name of dry ice?

➢ Short Answer Type Questions – Type I

Q.6 Name four substance which can sublime.

Q.7 How will increase in surface area increase or decrease rate of evaporation?

Q.8 A piece of chalk can be broken into small particles by hammering but a piece of iron cannot be broken into small particles by hammering. Which characteristic of the particles of matter is illustrated by these observations?

Q.9 Convert the following temperature to Kelvin
(i) 57˚C (ii) 13˚C

Q.10 Explain why there is no rise in temperature of water when it starts boiling although it is still being heated.

➢ Short Answer Type Questions – Type II

Q.11 If the back of your hand is moistened with alcohol, you will find that it rapidly becomes dry. Why is it that while it is drying, your hand feels cool?

Q.12 What do you understand by the term 'latent heat'? What are the two types of latent heat?

Q.13 (i) Define 'melting point' of a substance. What is the melting point of ice?
(ii) Define 'boiling point' of a substance. What is the boiling point of water?

Q.14 When a crystal of potassium permanganate is placed in a beaker, its purple colour spreads throughout of water. What does this observation tell us about the nature of potassium permanganate and water?

Q.15 Write three methods that can be used to dry up a wet dress quickly.

Q.16 When sugar is dissolved in water, there is no increase in the volume. Which characteristic of matter is illustrated by this observation? Explain in detail

Q.17 What is meant by inter-convertibility of the states of matter?

Q.18 How does perspiration or sweating helps to keep our body cool on a hot day?

Q.19 Define:
(i) Diffusion (ii) BEC
(iii) Plasma

Q.20 Convert the following temperature to degree Celsius
(i) 773K (ii) 333K
(iii) 185K

➢ Long Answer Type Questions

Q.21 (i) We can smell an incense stick lightened at the other end of the room. Name three properties of matter responsible for this.
(ii) When you heat water, you see that the particles of water starts moving and their motion increases on increasing the temperature. Why?
(iii) We observe water drops on the outer surface of a glass tumbler filled with ice- cold water. Why?

Q.22 Explain the following:
(i) Evaporation causes cooling
(ii) Solids can be converted to liquids
(iii) Gases diffuse rapidly

Q.23 Explain the various factors which affect the rate of evaporation.

Q.24 What are the different characteristics of matter? Explain each with an example.

Q.25 (i) When common salt is added to water, it dissolves. Name the property which is exhibited by this activity.
(ii) The melting points of solids (A), (B) (C) and (D) are 50°C, 250°C, 110°C and 160°C respectively. Name the solid which has strongest inter particle forces of attraction.
(iii) Suppose you are going out on a hot summer day. Should you wear a cotton T-shirt or nylon T-shirt? Give reason also.
(iv) Which is more volatile: Liquid A (Boiling point 85°C) or water (Boiling point 100°C)?

➢ Practical & Value Based Type Questions

Q.26 Adding a few drops of water to the bottle contaning carbon disulphide prevents its evaporation at room temperature. Explain why?

Q.27 If in the determination of melting point of ice, the ice is contaminated with some non-volatile impurity like common salt, how the melting point of ice is affected?

Q.28 In an experiment to determine the boiling point of water, state reason for the following precautions:
(i) The bulb of thermometer should not touch the sides of beaker.
(ii) While boiling water, pumice stones should be added.

Q.29 Shelly and her mother went to a shop to buy some cooling equipment for her house to heal the summer heat. The shop-keeper showed them two types of cooling equipments–a desert cooler and an all weather air conditioner. The desert cooler was much cheaper than the air conditioner. Shelly's mother wanted to buy the desert cooler as it was much cheaper.
Now answer the following questions:
(i) As a student of science, why would you suggest to Shelly's mother to buy the expensive air conditioner? Give two reason.
(ii) What are the values associated with the above decision?

Q.30 In cold countries where large amount of snow falls during winter season, the roads are cleared to snow by sprinkling either common salt (sodium chloride) or magnesium chloride or calcium chloride or mixture of these. Since these chemicals have damaging effect on the environment, therefore, potassium acetate is preferred.
Now answer the following questions:
(i) How does common salt or magnesium chloride (or calcium chloride) help in clearing snow from roads?
(ii) Discuss the damaging effect of these chemicals on the environment and how does the use of potassium acetate remove these damaging effects?

EXERCISE-2

Q.1 Which of the following is not a matter?
(A) Water (B) Heat
(C) Steel (D) Kerosene

Q.2 The interparticle distance is minimum in -
(A) nitrogen (B) water
(C) diamond (D) carbon dioxide

Q.3 The interparticle forces are strongest in -
(A) graphite (B) milk
(C) oxygen (D) water

Q.4 The rate of evaporation -
(A) decreases with a rise in temperature
(B) increases with an increase in surface area
(C) increases with increase in humidity
(D) decreases with increase in the wind speed

Q.5 Which of the following substances is unable to undergo sublimation?
(A) Camphor
(B) Napthalene
(C) Common salt
(D) Dry ice

Q.6 The boiling point of water on the Kelvin scale is -
(A) 173 K (B) 100 K
(C) 272 K (D) 373.16 K

Q.7 Gases have -
(A) fixed shape
(B) fixed volume
(C) both fixed shape and fixed volume
(D) neither fixed shape nor fixed volume

Q.8 Which of the following shows the strongest interparticle forces at the room temperature?
(A) Nitrogen (B) Mercury
(C) Iron (D) Bromine

Q.9 As the pressure of air decreases, the boiling point of liquid?
(A) increase (B) decreases
(C) remains fixed (D) none of these

Q.10 The change of state from solid to liquid is known as -
(A) Fusion (B) Boiling
(C) Freezing (D) Frosting

Q.11 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.12 The freezing point of water on Kelvin scale is -
(A) 573 K (B) 273.16 K
(C) 373.16 K (D) 100 K

Q.13 The rate of evaporation does not increase with:
(A) increase in movement of air
(B) increase in temperature of liquid
(C) increase in humidity in air
(D) increase in temperature of surroundings

Q.14 Water changes into ice at 0^oC, by giving out heat energy. The heat energy so given out is called:
(A) specific heat of water
(B) latent heat of fusion of ice
(C) latent heat of solidification of water
(D) latent heat of vaporisation

Q.15 Ice floats on the surface of water because -
(A) it is heavier than water.
(B) the density of both water and ice is the same.
(C) ice is lighter than water
(D) none of the above

Q.16 A solid changes into a liquid at its melting point by absorbing heat energy, but the temperature does not rise. Which of the following statement is incorrect?
(A) Heat energy is utilised in increasing intermolecular spaces of solids.
(B) Kinetic energy of the molecules does not increase.
(C) The intermolecular forces increase.
(D) None of the above.

Q.17 Which of the following statements do not express the properties of a solid?
(i) The particles of a solid have high energy.
(ii) The interparticle forces of attraction in a solid are very strong.
(iii) A solid melts at a fixed temperature.
(iv) Solids are highly compressible.

(A) (i) and (ii) only
(B) (i) and (iv) only
(C) (ii) and (iii) only
(D) (iii) and (iv) only

Q.18 Collisions of the particles with the walls of the container in a gas is responsible for …… .
(A) pressure
(B) density
(C) volume
(D) atmospheric pressure

Q.19 If an agarbatti is lighted in one corner of a room, the smell can be felt after some-time in another corner of the room. This shows that -
(A) particles of matter are constantly moving
(B) the perfume is strong
(C) the room has a fan which circulates the perfume
(D) none of these

Q.20 Vibratory motion is present in …….. .
(A) solids (B) liquid
(C) gases (D) plasma state

Q.21 The type of motion present in plasma state is-
(A) vibratory
(B) linear (in a straight line) only
(C) random
(D) circular

Q.22 In solid state, the kinetic energy of the particles will be …….. when compared to liquid state or gaseous state -
(A) highest
(B) least
(C) can be least or highest
(D) cannot say

Q.23 Plasma state is -
(A) neutral
(B) ionic
(C) fused
(D) all three (a, b and c)

Q.24 Liquid particles sticking to the walls of the container is due to -
(A) cohesive forces
(B) adhesive forces
(C) both cohesive and adhesive forces
(D) none of these

Q.25 The more effective in cooling is -
(A) water at 0°C
(B) water at 100^0C
(C) ice at 0°C
(D) gas at 0^0C

Q.26 Condensation is the change of state of -
(A) from gas to solid state
(B) from gas to liquid state
(C) from liquid to gas
(D) both (A) and (B)

Q.27 Change of state occurs because -
(A) change of pressure
(B) change of temperature
(C) either (A) or (B) or both
(D) neither (A) nor (B)

Q.28 Sublimation is not involved in …… .
(A) incense stick and odonil
(B) camphor and incense stick
(C) perfume and alchol
(D) naphthalene balls and camphor

Q.29 The slowest process is -
(A) evaporation (B) vaporization
(C) boiling (D) melting

Q.30 Rate of evaporation of water -
(A) is more in coastal area than in non coastal area
(B) is more in non coastal area than in coastal area.
(C) is the same in both coastal and non coastal area
(D) cannot be predicted.

EXERCISE-3

(Previous Year Questions - NTSE & NSO)

Q.1 Boiling point of water is –

(A) 273K (B) 0K

(C) 373K (D) 100K

Q.2 By which property are gases and liquids different from solid?

(A) Volume (B) Mass

(C) Conductivity (D) Fluidity

Q.3 Ice is floating on water in a beaker when ice completely melts then level of water in beaker:

(A) Increases

(B) Decreases

(C) remains the same

(D) First increases decreases

Q.4 The boiling point of a gas is –80°C. This temperature is equivalent to

(A) –193 K (B) 193 K

(C) 353 K (D) – 353 K

Q.5 When the solid melts, its temperature:

(A) increases

(B) decreases

(C) remain constant

(D) first increases then decrease

Q.6 The substance showing sublimation property among the following is

(A) common salt

(B) copper sulphate

(C) potassium nitrate

(D) camphor

Q.7 The melting point of ice is --------

(A) 273.15 k (B) 173.15 k

(C) 373.5 k (D) 100 k

Q.8 Physical state of water at 0°C is

(A) Solid

(B) Liquid

(C) Gas

(D) None of the above

ANSWER KEY

EXERCISE - 1

9. (i) 330 K, (ii) 286 K,

20. (i) 500°C, (ii) 100°C, (iii) -88°C

EXERCISE - 2

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	B	C	A	B	C	D	D	C	B	A	D	B	C	C	C
Ques.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	C	B	A	A	A	C	B	B	B	C	B	C	C	A	B

EXERCISE - 3

Ques.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Ans.	C	D	C	B	C	D	A	A

SOLUTIONS

EXERCISE-1

➢ Very Short Answer Type Questions

Sol.1 Gaseous state

Sol.2 ice (∵ solid state)

Sol.3 Liquids & Gases.

Sol.4 A gas diffuses faster than a liquid.

Sol.5 Solid CO_2

➢ Short Answer Type Questions – Type I

Sol.6 Ammonium chloride, Naphthalene, Dry ice and camphor

Sol.7 Rate of evaporation ∝ surface area.
Surface area increases rate of evaporation increases

Sol.8 These observations show the presence of forces of attraction between the particles. It also shows that the forces of attraction have varied strengths in different forms of matter. Iron has stronger force of attraction than chalk.

Sol.9 (i) 57°C = 57+273 = 330K
(ii) 13°C = 13+273 = 286K

Sol.10 Once the change in state of a substance starts, the temperature of the substance does not change because, the heat energy supplied is used to overcome intermolecular forces. It is absorbed as latent heat of vaporization

➢ Short Answer Type Questions – Type II

Sol.11 Alcohol evaporates faster as it is volatile in nature and due to evaporation the hand feels cold as evaporation causes cooling.

Sol.12 The word latent means hidden. This heat used to change the state.
Latent heat of Fusion & Latent heat of Vapourization

Sol.13 (i) **Melting Point :** The constant temperature at which a solid changes into liquid state by absorbing heat energy at 1 atm pressure is called its melting point.
Ice has MP = 0°C = 273K
(ii) **Boiling Point :** The constant temperature at which a liquid rapidly changes into gaseous state by absorbing heat energy at atmospheric pressure is called boiling point.
BP of water =100°C = 373K

Sol.14 The particles of matter is very small and has space between them.
Also the intermixing of particles of two different types of matter on their own is called diffusion. Particles of potassium permanganate and water intermix due to diffusion.

Sol.15 1. Spread the dress completely in sun.
2. Spread the dress completely under fan.
3. Iron the dress.

Sol.16 The particles of matter have spaces between them

Sol.17 The phenomenon of change of matter from one state to another state and back to original state, by altering the conditions of temperature and pressure, is called interconversion of states of matter.
Solid ↔ liquid ↔ gas.

Sol.18 On a hot day, our body temperature tends to rise and our body perspires. When this sweat evaporates, it takes the latent heat of vapourisation that cools our body.

Sol.19 (i) Diffusion: "Intermixing of particles of two different types of matter on their own is called diffusion."

(ii) BEC : Bose – Einstein Condensate
The fifth state of matter.
this state is obtained by supercooling a gas of extremely low density

(iii) Plasma: The fourth state of matter
Plasma state consists of highly ionized gas in which the particles exist in super energetic and super excited states.

Sol.20 (i) 773K = 773 – 273 = 500 °C
(ii) 333 K – 333 – 273 = 60°C
(iii) 285K = 285 – 273 = 12 °C

➢ Long Answer Type Questions

Sol.21 (i) We can smell an incense stick lightened at the other end of the room because the particles of matter:
1. are constantly moving.
2. possess kinetic energy.
3. intermix with each other by getting into the spaces between the particles.

(ii) This is because kinetic energy of particles increases on increasing the temperature.

(iii) The outer surface of the glass tumbler filled with ice-cold water becomes cold due to the presence of ice-cold water inside it. When the water vapours present in the atmosphere come in contact of this colder surface, they condense on it and are seen as water drops.

Sol.22 (A) In gases, the intermolecular forces are negligible. So, the particles of gases are free to move in any direction. As a result, gases fill the container in which they are kept.

(B) The particles in all the gases move with high speeds in all directions. When these particles strike the walls of the container, they exert force on the walls of the container. Force per unit area is called pressure. So, gases exert pressure on the walls of the container due to the impact of the striking particles.

(C) Because-
1. It has a fixed shape and definite volume.
2. It is rigid and cannot be deformed easily as the intermolecular forces in wood are strong.

Sol.23 Factors affecting Evaporation

(i) Temperature:.
Rate of evaporation α Temperature
With the increase in temperature the rate of evaporation increases.
Reason: On increasing temperature more number of particles get enough K.E. to go into the vapour state.

(ii) Surface Area:
Rate of evaporation α surface area. Since evaporation is a surface phenomena. If the surface area is increased, the rate of evaporation increases. So, while putting clothes for drying up we spread them out.

(iii)Humidity of Air: Rate of evaporation $\alpha \frac{1}{\text{Humidity}}$.
Humidity is the amount of water vapour present in air. When humidity of air is low, the rate of evaporation is high and water evaporates more readily. When humidity of air is high, the rate of evaporation is low and water evaporates very slowly.

(iv) Wind Speed:
Rate of evaporation α wind speed.
With the increase in wind speed, the particles of water vapour move away with the wind. So the amount of water vapour decreases in the surroundings thereby increasing evaporation.

(v) Nature of substance:
Substances with high boiling points will evaporate slowly, while substances with low boiling points will evaporate quickly.

Sol.24 The particles of matter
(i) are vary small eg. $KMnO_4$ in H_2O
(ii) have space between them, eg. Salt in H_2O
(iii) are constantly moving eg. perfume
(iv) attract each other eg. iron can't be broken

Sol.25 (i) Spaces are found between particles of matter.
Melting point of a solid is an indication of the strength of intermolecular forces of attraction present in the solid. Therefore, solid (B) will have strongest inter particle forces of attraction.

(ii) Melting point of a solid is an indication of the strength of intermolecular forces of attraction present in the solid. Therefore, solid (B) will have strongest inter particle forces of attraction.

(iii) One should wear a cotton T-shirt while going out on a hot summer day. We sweat a lot in summer and cotton absorbs sweat quickly. When this sweat is exposed to air, it takes away heat from the body and we feel comfortable. But a nylon T-shirt does not absorb much sweat and therefore, does not cool our body as a cotton T-shirt does.

(iv) Liquid (A) is more volatile as compared to water because its boiling point is less than that of water.

EXERCISE-2

Sol.1 [B]
Heat is form of energy.

Sol.2 [C]
diamond – solids closely packed

Sol.3 [A]
graphite – solid

Sol.4 [B]
increases with an increase in surface area

Sol.5 [C]
Common salt is not sublimative substance

Sol.6 [D]
373.16 K = 100°C

Sol.7 [D]
neither fixed shape nor fixed volume

Sol.8 [C]
Iron – solid more force

Sol.9 [B]
Pressure $\propto$ temperature

Sol.10 [A]
Fusion is also known as melting

Sol.11 [D]
solid CO_2 **is dry ice**

Sol.12 [B]
273.16K = 0°C

Sol.13 [C]
More humidity less evaporation

Sol.14 [C]
heat lost when there is change of state

Sol.15 [C]
density of ice is lesser than water

Sol.16 [C]
A solid changes into a liquid intermolecular forces decreases and space increases

Sol.17 [B]
There is no energy for solids & incompressible

Sol.18 [A]
Pressure – collisions of particles.

Sol.19 [A]
This is due to diffusion.

Sol.20 [A]
solids

Sol.21 [C]
random

Sol.22 [B]
least

Sol.23 [B]
ionic

Sol.24 [B]
adhesive forces
Adhesive force. force of attraction between particles of different substance.

Sol.25 [C]
ice at 0°C has more energy.

Sol.26 [B]
Condensation gas → Liquid

Sol.27 [C]
Change of state due to change of temp or pressure or by both

Sol.28 [C]
naphthalene balls and camphor – example for sublimative substance

Sol.29 [A]
slowest process. no heat is applied for evaporation

Sol.30 [B]
is more in non coastal area than in coastal area.

EXERCISE-3

Sol.1 [C]
373K = 100°C boiling point of H_2O

Sol.2 [D]
Fluidity is for gases and liquid

Sol.3 [C]
remains same.

Sol.4 [B]
–80°C = 193K

Sol.5 [C]
solid melts – temperature remains same

Sol.6 [D] camphor

Sol.7 [A] 273.15 k

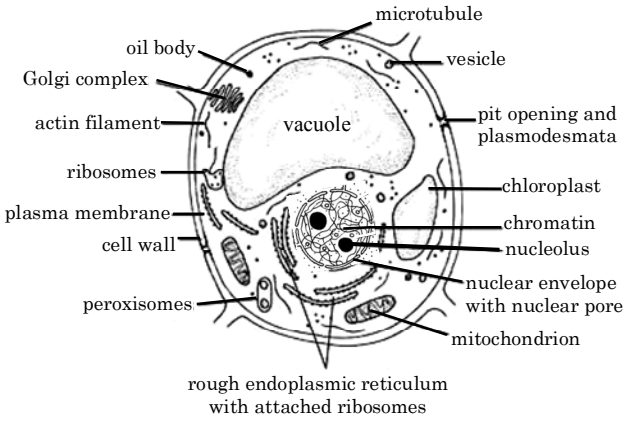
Sol.8 [A] Solid

Chapter 1

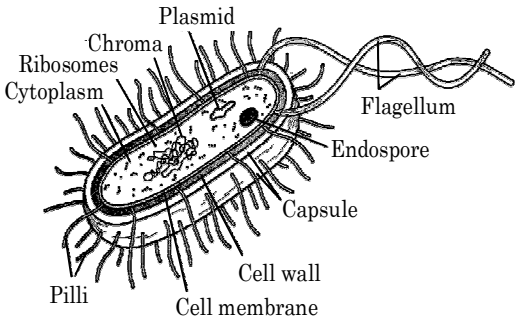
The Fundamental Unit of Life-Cell

Chapter Outline

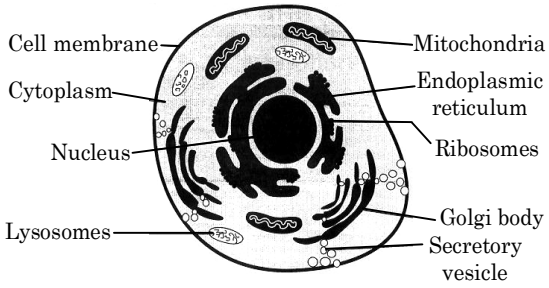
- Cell
- Microscope
- Cell theory
- Ultra structure of cell
- Cell organelles



Plant Cell

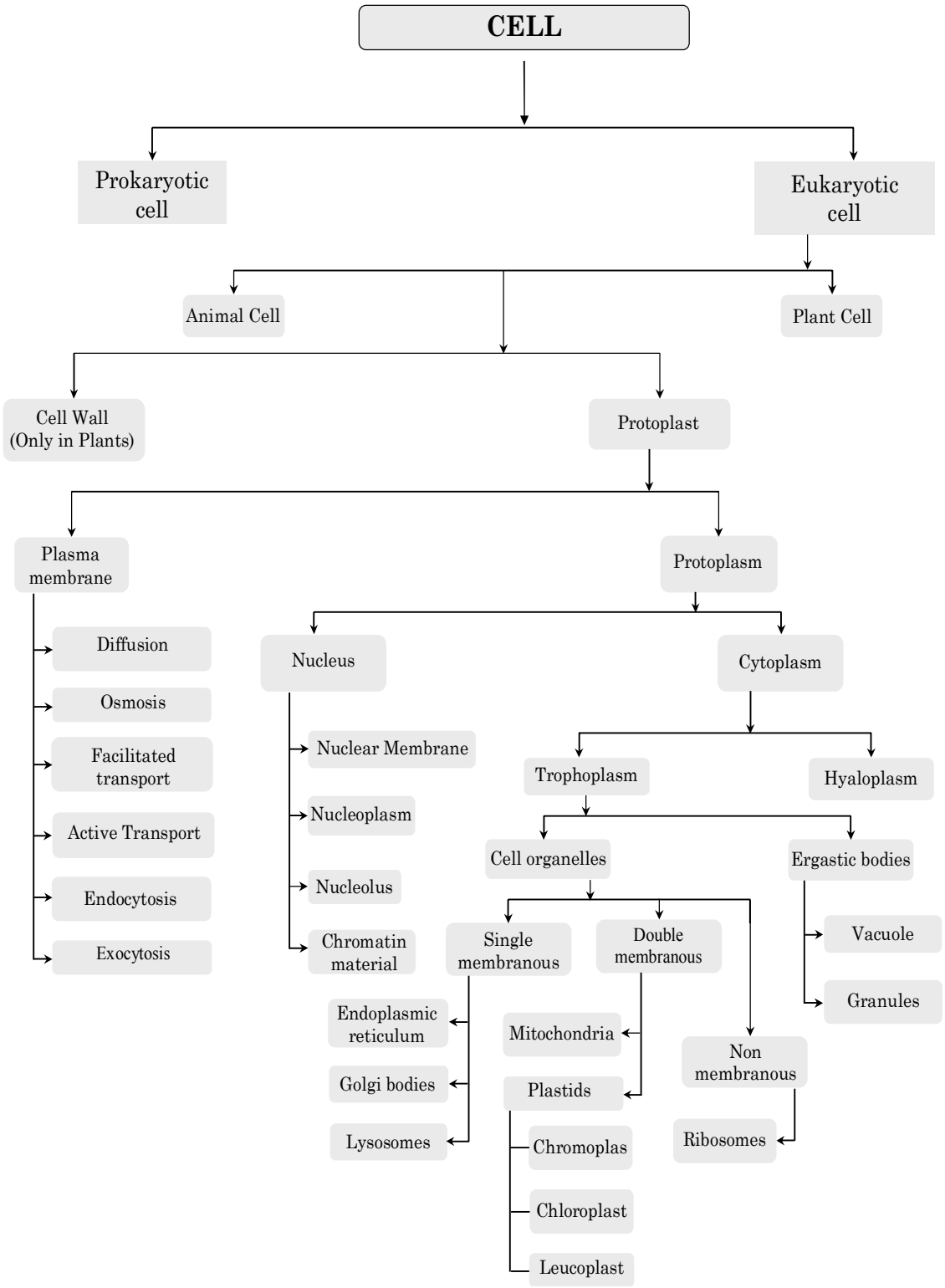


Bacterial Structure



Animal Cell

MIND MAP


CELL
Prokaryotic cell
Eukaryotic cell
Animal Cell
Plant Cell
Cell Wall (Only in Plants)
Protoplast
Plasma membrane
Protoplasm
Diffusion
Osmosis
Facilitated transport
Active Transport
Endocytosis
Exocytosis
Nucleus
Cytoplasm
Nuclear Membrane
Nucleoplasm
Nucleolus
Chromatin material
Trophoplasm
Hyaloplasm
Cell organelles
Ergastic bodies
Single membranous
Double membranous
Vacuole
Granules
Endoplasmic reticulum
Golgi bodies
Lysosomes
Mitochondria
Plastids
Chromoplas
Chloroplast
Leucoplast
Non membranous
Ribosomes

THE FUNDAMENTAL UNIT OF LIFE-CELL

Cell

It is the structural and functional unit of life. It forms the organization of a living creature which can be identify as single cell or more than one cell.

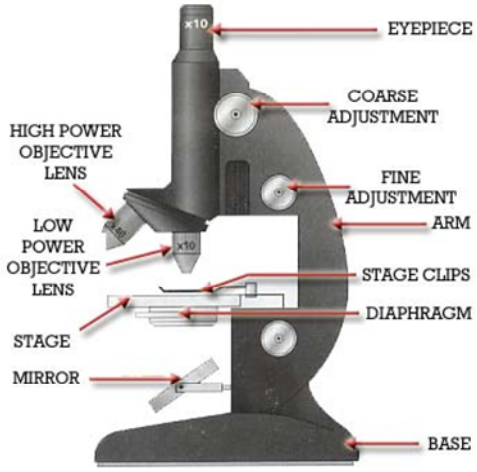
The cell may also defined as a small speck of nucleated protoplasm bounded by cell membrane or plasma membrane and is capable of independent existence and perpetuation.

◈ Discovery of Cell :

- Cell was first observed by "Robert Hooke" in a dead cork slice in the year 1665. He described about this in his book "Micrographia".
- First living cell was discovered by "A.V. Leeuwenhoek" in 1674 in pond water.
- Protoplasm was discovered by "Felix Dujardin" and named as sarcode.
- The term protoplasm was coined by Purkinje in 1839.
- Robert Brown discovered nucleus in the year 1831.

Microscope

- It is an instrument which is used to study those objects that cannot be seen with the naked eye or with the help of a hand lens. A microscope has more than one lens.
- The 1st compound microscope was built by F. Janssen and Zacharias Janseen (1590)



COMPETITIVE LEVEL

- We have approximately 100 trillion cells in our body. A typical cell is 10 micrometers in size and 1 nanogram in mass.
- The biggest cell in the world is the ostrich egg, which can be seen with your naked eye

◈ 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 strong metallic rectangular, horizontal plate fixed to the handle.

(4) Stage Clips : Two clips are attached to stage used to hold 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 line focusing.

(8) Reflecting Mirror : It is meant for reflecting the light rays, so that light passes through the object which is to be seen.

◈ Cell Theory :

It is was given by two eminent scientist named "Schleiden (1838) and Schwann (1839)" which was later on expanded by "Rudolf Virchow (1855)". Cell theory states that.

- All plants and animals are composed of cells.
- Cell is the basic unit of life.
- All cells arise from pre-existing cells.

  (Viruses are the exception of cell theory.)

◈ Cell Shape and Size :

- Variations are there on planet earth so different kind of cells are there which forms different kind of creatures.
- The shape and size of cells are related to the specific function they perform.

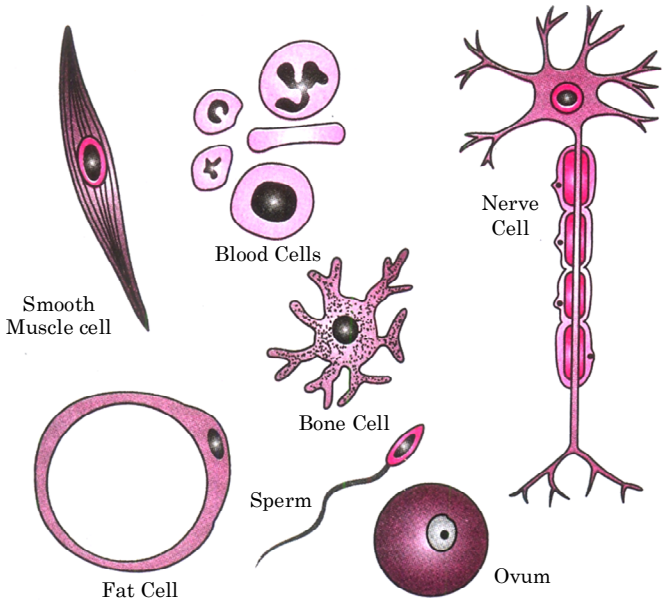


Fig. : Various Cells from the Human Body

- The size of different cells ranges between broad limits.
- Most cells are visible only with microscope.

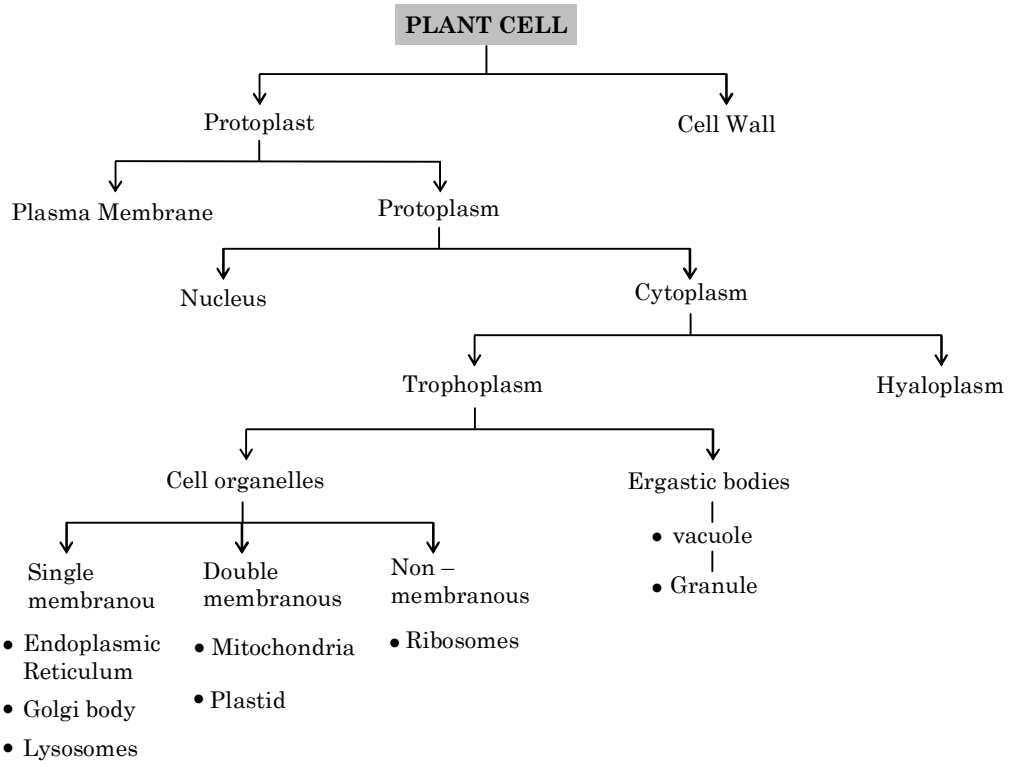
COMPETITIVE LEVEL

- The longest cell of animal is nerve cell which is about 1 – 1.5 mt. long.
- Nerve cells - elongated, pigment cells - branched, muscle cells - are spindle shaped.
- *Amoeba proteus* may reach a diameter of 0.5 mm.
- The smallest cells are those of *Mycoplasma laidlawii (0.1μ in dimeter)* or PPLO (pleuro pneumonia like organism).
- The largest cell is egg of an Ostrich.

Ultra Structure of Cell

It is gives us detail about the over all structure of a cell in which matrix as well as microbodies are included. They are as follows.

(i) Plasma membrane (P.M.) (ii) Nucleus (iii) Cytoplasm



COMPETITIVE LEVEL

- Eukaryotic cells are 10 times larger than prokaryotic cells, simply because they have a nucleus
- Some other important organelles are
  (1) Single Membraned - Glyoxisomes, Peroxisome
  (2) Non Membraned - Centrosome, Microtubules

Note : Many cells make up one tissue, and many tissues make up an organ, and many organs make up an organ system.

Cell Wall

- It is a rigid outer layer made up of cellulose
- When a living plant cell losses water through osmosis there is a shrinkage or contraction of cellular contents away from the cell wall. The phenomenon is called as plasmolysis.

Function : Its function is to maintain shape of cell.

- It protect the cells from mechanical injury & prevents their dessication.
- It provide mechanical support against gravity. It is due to rigid cell wall that the aerial part of plant are able to keep erect & expose their leaves to sunlight.
- Cell wall permits the cells to with stand very dilute external media without bursting.

Ex.1 What is the importance of cell wall in plants, bacteria, fungi in withstanding dilute solutions ?

Ans. Cell walls permit the cells of plants, fungi and bacteria to withstand very dilute (hypotonic) external media without bursting. In such media the cells tend to take up water by osmosis. The cell swells, building up pressure against the cell wall. The wall exerts an equal pressure against the swollen cell. Because of their walls, such cells can withstand much greater changes in the surrounding medium than animal cells.

Cell Membrane

- It is also called plasma membrane or plasmal-emma.
- It is present in both plants and animals.
- It do not allow any material to enter inside the cell. But select the material according to the demand of cell metabolism hence called 'selectively permeable'.
- Singer and Nicholson gave the fluid mosaic model of plasma membrane. According to him it consists of a protein layer sandwitched between two layers of lipids which is in quasi fluid state and 75 Å thick.

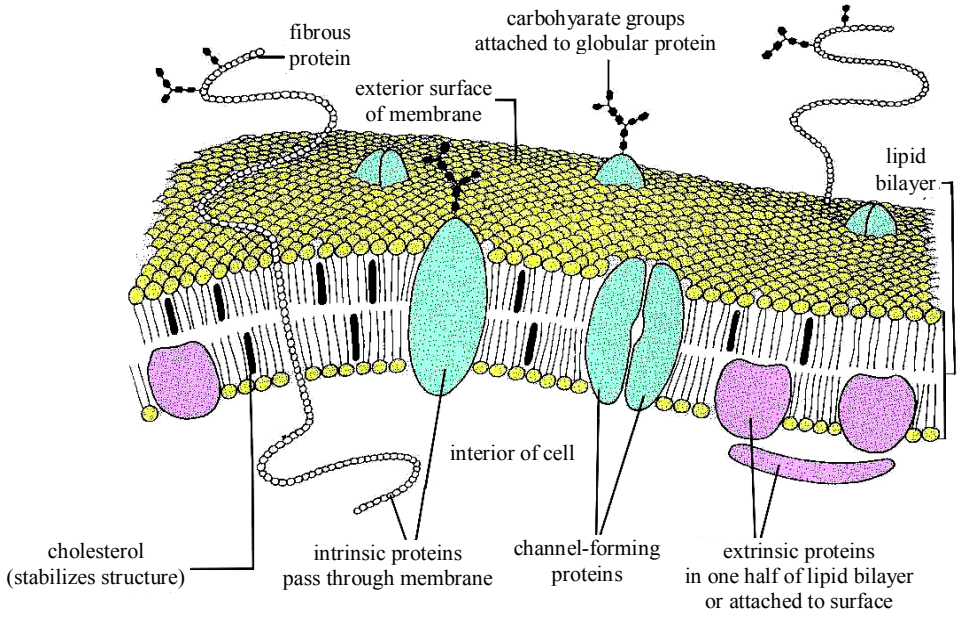


Fig. Fluid Mosaic Model of Plasma Membrane Structure

◈ Functions of Plasma Membrane :

1. It provides and maintains the shape of cell.
2. It provides mechanical support for the protection of internal structures of a cell.
3. It allows only useful substances to enter into the cells.
4. It provides specificity to the cell.
5. It is the limiting boundary of each cell which separates the cytoplasm from its surrounding.

- **Endomosis :** Movement of solvent into the cell is called as Endomosis.
- **Exosmosis :** Movment of solvent outside the cell is called as Exosmosis.

◈ Types of Solutions on the Basis of Concentration :

(A) Isotonic solutions : When the concentration of the solution outside the cell is equal to the concentration of cytoplasm of the cell it is called as isotonic solution.

(B) Hypertonic solution : When the concentration of the solution outside the cell is more than that inside the cell. Due to this cell loose water and becomes plasmolysed.

(C) Hypotonic solution : When the concentration of the solution outside the cell is lesser than that of cytoplasm, the cell swells up and bursts.

◈ Transportation of Molecules Across the Plasma Membrane :

This can be done by following ways :

(A) Diffusion : Movement of molecules or ions from higher concentration to lower concentration is called as diffusion e.g., CO_2 & O_2 move across the membrane.

(B) Osmosis : The movement of solvent or water from lower concentration of solution to higher concentration of solution through a semi permeable membrane is called as osmosis. Osmosis can also be called as "Diffusion of solvents".

Ex. 2 How do substances like CO_2 and water move in and out of the cell ? Discuss.

Ans. CO_2 moves in and out of the cells by the process of diffusion which involves movement of molecules from higher concentration of lower concentration across the cell membrane.

Water moves in and out of the cells by osmosis. Osmosis is the movement 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.

Ex.3 Write difference between diffusion and osmosis.

Ans.

DIFFERENCES BETWEEN DIFFUSION AND OSMOSIS		
S.no.	**Diffusion**	**Osmosis**
1.	Diffusion can occur in any medium	It occurs only in liquid medium
2.	The diffusing molecules may be solids, liquids or gases	It involves movement of solvent molecules only
3.	Semipermeable membrane is not required	Semipermeable membrane is required
4.	It is dependent upon the free energy of the molecules of diffusing substance only; presence of other substance in the system is of no importance	Though it is the diffusion of solvent molecules only, yet influenced by the presence of other substances (solutes) in the system

COMPETITIVE LEVEL

- Semi Permeable membranes : these membranes permit the movement of solvent molecules but prevent the movement solute particles.
- Selectively Permeable membranes : these membranes permit all solvents through them but allows select passage of solutes through them.
- Cell wall of two adjacent cells are joined by a layer called middle lamella, it is made up calcium and magnesium pectate
- Shrinking of protoplasm

  In plant cell → Plasmolysis

  In animal cell → Crenation
- The process of taking in a bulk of materials from external environment into the cell is known as Endocytosis. It is two

  Phagocytosis (cell eating) and **Pinocytosis** (cell drinking).
- Phagocytosis + Pinocytosis → **Endocytosis.**
- **Exocytosis :** is a process in which an intracellular vesicle (membrane bounded sphere) moves to the plasma membrane.

Nucleus

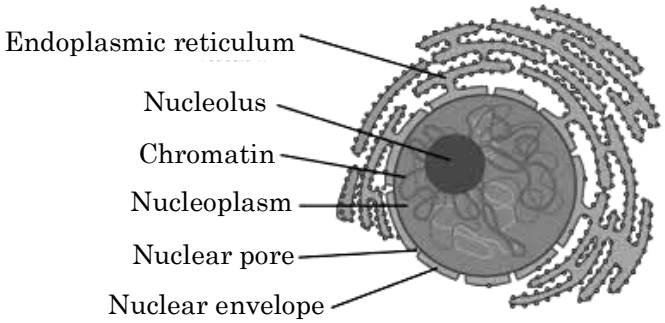


Fig. : Structure of Nucleus

- Nucleus-Headquarter of the cell
- Discovered by – Robert Brown (1831)
- "Nucleus is double membrane bound dense protoplasmic body, which controls all cellular metabolism and encloses the genetic information of cell".
- Nucleus is consider as controller or director of cell.
- Nucleopore takes part in exchange of different substances between nucleoplasm and cytoplasm.
- Chromosomes are chemically made up of DNA and histone proteins. DNA carries all genetic information which is passed on to next generation. The functional segment of DNA is called genes.

◈ Structure :

It is made up of following four contents

(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 Fontana. Usually one nucleolus is present in each nucleus but sometimes more than one nucleoli are present. It is a store house of RNA.

(d) Chromatin threads : A darkly stained network of long fine threads called chromatin threads. Chromatin threads are intermingled with one another forming a network.

◈ **Functions of Nucleus :** The nucleus performs following functions :

1. It controls all the metabolic activities of the cell.
2. It brings about growth of the cell by directing the synthesis of structural proteins.
3. It takes part in the formation of ribosomes.
4. It regulates cell cycle.
5. It contains genetic information and is concerned with the transmission of hereditary traits from one generation to another.

Cytoplasm

- It is the fluid portion of a cell. It was discovered by Kolliker in 1862.
- It can be divided into two parts.

  (i) Cytosol : It is the liquid portion which contain fibrous protein utilize for the formation of cytoskeleton.

  (ii) Trophoplasm : In the cell's cytoplasm both living and non-living component are there.
- Living component are termed as cell organelles. or protoplasmic inclusion.
- Non-living component are the deutoplasmic or ergastic bodies.

◈ **Role of cytoplasm :**

- Helps in exchange of materials between cell organism.
- Acts as a site of chemical reaction like glycolysis, synthesis of fatty acids.

Cell Organelles

- Small membrane bound structures, which perform a lot of chemical activities to support the function & structure of a cell, called cell organelles.
- **Single membranous :** Endoplasmic reticulum, Golgi apparatus, Lysosomes.
- **Double membranous :** Plastid and Mitochondria.
- **Non-membranous :** Ribosomes.

Single Membranous Cell Organelles

◈ **Endoplasmic Reticulum :**

It forms the network within the cell or we can say forms cytoskeleton of a cell.

- It was discovered by Porter, Claude.
- These are present in all cells except prokaryotes and mammalian erythrocytes.
- **Endoplasmic reticulum is of two types :**

  (i) Smooth Endoplasmic Reticulum : It helps in manufacture of fat molecules and membrane biogenesis.

  (ii) Rough Endoplasmic Reticulum : It appears rough due to the present of ribosomes on its surface which are involved in protein synthesis. The Proteins form are transported via RER.

Ex.4 Write difference between SER and RER.

Ans.

DIFFERENCES BETWEEN SMOOTH AND ROUGH ENDOPLASMIC RETICULUM			
S. No.	**CHARACTER**	**SER**	**RER**
1.	Compounds	Made up of tubules mainly	Made up of cisternae & vesicles
2.	Ribosomes	Absent	Present
3.	Position	Mainly present near cell membranes	Mainly present near the nucleus
4.	Functions	Helps in steroid, lipids & polysaccharide synthesis Helps in membrane biogenesis	Helps in protein synthesis
5.	Occurrence	Mainly found in lipid forming cells like adipocytes (Fat cells)	Mainly found in protein forming cells like nerve cells

◈ Function :

(i) It is the only organelle which can move within a cell so it serves as a channel for the transport of materials between various regions of cytoplasm and between cytoplasm and nucleus.

(ii) It also functions as a cytoplasmic framework to provide space for some of the biochemical activities.

(iii) It forms endoskeleton of cell.

(iv) It helps in synthesis of fats, steroids, cholesterol.

(v) It contains secretory proteins and lipids, which act as enzymes and hormones.

(vi) SER plays a crucial role in detoxification of drugs and poisonous by-products and membrane biogenesis.

◈ Golgi Apparatus :

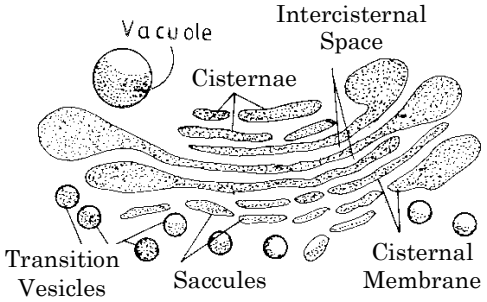


Fig. : Structure of Golgi Apparatus

- Golgi body is a part of complex cellular membrane system along with the ER.
- It is structurally similar to ER, also its membranes have connections with the ER.
- The materials manufactured near the ER are packaged and dispatched to different sites and outside to the golgi body.
- **Camillo Golgi** (1898), a zoologist, observed Golgi bodies in the form of a network in nerve cells of owl.

  Golgi carried out a method of staining individual nerve and cell structures. This method is referred to as the **'black reaction'**. This method uses a weak solution of silver nitrate and is particularly valuable in tracing the proceses and most delicate ramifications of cells. Golgi received the Nobel prize in 1906 with Santiago Ramony Cajal for their work on the structure of the nervous system.

- Golgi bodies are absent in prokaryotic cells. Golgi complex is found in all eukaryotic cells except RBCs.
- It is also called **Golgi complex** or **Golgi apparatus** or **Dictyosome** (in plants cell).

◈ Functions of Golgi Apparatus :

- The main function of Golgi apparatus is secretion, storage modification and packaging ?
- It produces vacuoles or secretory vesicles which contain cellular secretions like enzymes, proteins, cellulose etc.
- Golgi apparatus is also involved in the synthesis of cell wall, plasma membrane and lysosomes.
- It forms the acrosome of sperm.
- It forms lysosomes.

◈ Lysosomes :

- The term **lysosome** was introduced by **De Duve** in 1955.
- Lysosomes are generally found in the cytoplasm of animal cells.
- It is also called **demolition squads, scavengers, cellular house keepers and suicidal bags.**
- Lysosome are simple tiny spherical sac like structures evenly distributed in the cytoplasm.
- Lysosome is small vesicle surrounded by a **single membrane** and contains powerful enzymes.
- It contain 40 type of enzymes which are called as hydrolases.
- Lysosomes serve as interacellular digestive system, hence called **digestive bags**.
- Lysosomes also remove the worn out and poorly working cellular organelles by digesting them.
- During disturbances in cellular metabolism i.e. in case of cell damage lysosomes burst and their enzymes are released into the cytoplasm and they digest their own cell so they are also called as **"Suicidal Bags"**.

COMPETITIVE LEVEL

- ER and Golgi body are made up of three components.

  (A) Cisternae : These are long, flattened, parallely arranged, unbranched tubules. These form successive layers of nucleus.

  (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.

Cisternae Vesicles Tubules

- In plants golgi body is called as Dictyosomes.
- It is absent in prokaryotes, mammalian RBC's and sieve cells
- Acrosome is a bag like structure filled with lytic enzymes which dissolve egg membrane at the time of fertilization
- ER, golgi body and lysomes are together called as GERL complex.

Double Membranous Cell Organelles

◈ Plastid :

- **E. Heckel** (1865) gave the term plastid. Plastids are largest cell organelles.
- Plastids occur in most plant cells and are absent in animal cells.
- Plastids internally have many membrane layers embedded in matrix stroma.
- They also have there own cDNA and can synthesize the required proteins on their own, so are called as "semi-autonomous" organelles.
- The photosynthetic bacteria to not have any plastid.
- **Schimper** divided plastids into three types :

  (a) **Chromoplast** - Coloured plastids (except green colour)

  (b) **Chloroplast** - Green coloured plastids (they also have some yellow and orange pigments)

  (c) **Leucoplast** - Colourless plastid

Ex.5 List the difference between three types of plastids.

Ans.

LEUCOPLAST	CHROMOPLAST	CHLOROPLAST
Non Pigmented White in colour	Coloured pigments includes All colour except green Phaeoplast – Brown Rhodoplast – Red	Green pigment chlorophyll is found in them
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.

◈ Mitochondria

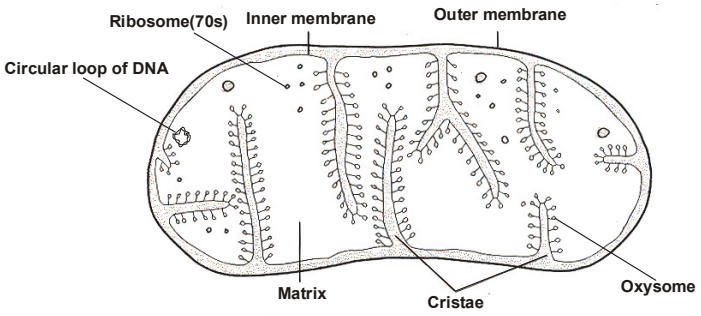


Fig. : Structure of Mitochondria

- Mitochondria are rod shaped organelles, bounded by a double membrane envelope.
- The outer membrane is smooth and porous the inner membrane surrounds a central cavity of **matrix.** Central cavity is filled with jel like substances.
- Inner membranes folds are called cristae in order to increase the surface area for energy production.
- It is the site of aerobic respiration, and all the energy required for varies activities is produced in the mitochondria.
- Synthesis of ATP (**Adenosine Tri-phosphate**) occurs in mitochondria. ATP is the energy currency of the cell.
- Mitochondria are called **power plants** or **power houses** or **cellular furnaces**.

COMPETITIVE LEVEL

◈ Chloroplast :

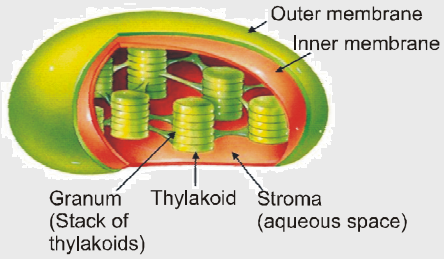


Fig. : Structure of Chloroplast

- Chloroplast was discovered by A.V. Leeuwen hoek and named by Schimper.
- It is a double membranous discoidal structure, found only in plant cells.
- Each chloroplast consists of two parts.

  (i) Grana : It constitutes the lamellar system. Each granum of the chloroplast is formed by superimposed closed compartments called **Thylakoids**.

  (ii) Functions : Grana are the sites of light reaction of photosynthesis as they contain photosynthetic pigment chlorophyll.

  (iii) Stroma : It is a granular transparent substance also called as matrix.

  (iv) Function : This is the site of dark reaction of photosynthesis.

◈ Mictochondia :

- **C.Benda** (1897) gave the name Mitochondria (Mitos, thread + Chondrion, granules).
- Term 'Bioplast' for mitochondria was used by **Altman.**
- A single mitochondrion is present in unicellular green alga, Microsterias. Number of mitochondria varies from **50–50,000** per cell. Mitochondria of a cell are collectively known as **chondriome.**
- Mitochondria contain electron transport systems aggregated into compact structure, **F_0 - F_1 particles or Fernandez particle or oxysome**, tennis racket like bodies on inner membrane involved in oxidation & phosphorylation.

◈ Ribosome :

- They are usually attached on the outer surface of endoplasmic reticulum as well as freely in the cytoplasm.
- They are the only organelles which are present in all types of cells.
- They help in protein synthesis and are known as 'protein factories'.

◈ Vacuole :

- Vacuoles are non-living structures of cytoplasm.
- They are bounded by a single membrane called **Tonoplast**.
- In animal cells vacuoles are smaller in size and numerous while in plant cells a single large vacuole is found which occupies about 90% of the volume of cell.

◈ Function :

- It helps in maintaining osmotic pressure in a cell.
- It stores toxic metabolic products of plant cell.
- It store amino acids, sugars, various organic acids and some proteins
- In unicellular organism like amoeba, it helps in neutrinos.

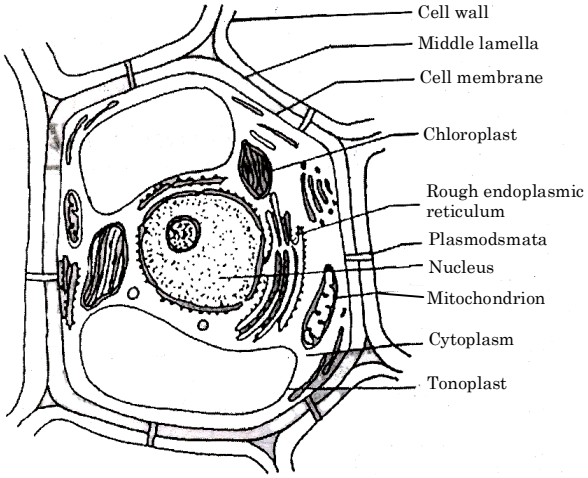
Ex.6 Why are vacuole large sized in plants cells.

Ans. In plant cells vacuoles are full of cell sap and provide turgidity and rigidity to the cell.

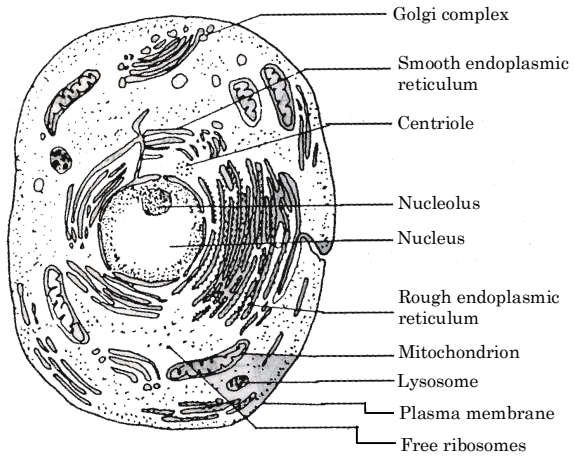
Ex.7 Write difference between a plant and animal cell.

Ans.

COMPARATIVE STUDY OF PLANT AND ANIMALS CELL			
S. No.	**Characters**	**Animal Cell**	**Plant Cell**
1.	Cell wall	Absent	Present
2.	Plasma membrane	Only cell membrane	Present
3.	Microtubules/Microflaments	Present	Present
4.	Lysosomes	Lysosomes occur in cytoplasm	Lysosomes usually not evident
5.	Nucleus	Present	Present
6.	Shape	Round (irregular shape)	Rectangular (fixed shape)
7.	Chloroplast	Animal cell don't have chloroplasts	Plant cell have chloroplasts because they make their own food
8.	Cytoplasm	Present	Present
9.	Endoplasmic Reticulum	Present	Present
10.	Ribosomes	Present	Present
11.	Mitochondria	Present	Present
12.	Vacuole	One or more small Vacuole (much smaller than point cells)	One, large central Vacuole taking up to 90% of cell volume
13.	Centrioles	Present in all animal cells	Only present in lower plant forms



PLANT CELL



ANIMAL CELL

◈ Prokaryotic & Eukaryotic Cell :

- **Prokaryotic cell -** Cell which do not have well defined nuclear region, called prokaryotic cells. (Pro - Primitive)
- **Eukaryotic cells** - Cells which have well defined nuclear region, called eukaryotic cells.
- Along with nuclear membrane, prokaryotic cells lack most of cell organelles.

Ex.8 Write difference between prokaryotic and eukaryotic cell.

Ans.

DIFFERENCE BETWEEN PROKARYOTIC AND EUKARYOTIC CELL			
S.No.	**Characters**	**Prokaryotic Cells**	**Eukaryotic Cells**
1.	Nuclear body	Incipient nucleus, No nuclear membrane nucleolus absent	True nucleus, Nuclear membrane present, Nucleolus present.
2.	Mitosis	No mitosis	Mitosis found
3.	Respiratory system	n plasma membrane, (mitochondria absent), mesosomes present.	In Eukaryotic cells mitochondria is present
4.	Respiratory system	Single closed loop, (histones absent)	Multiple chromosomes, (histones present in chromosome)
5.	Photosynthetic apparatus	In internal membranes, (chloroplasts absent)	In chloroplasts is present.
6.	Ribosomes	70 S type	80 S type
7.	Cell wall	Generally present, complex chemical composition	Presnt in some types, simple chemical composition
8.	Flagella and cilia	Submicroscopic, have 9 + 0 fibrillar structure	Microscopic size have 9 + 2 fibrillar structure
9.	Cytoplasmic movements	Cytoplasmic streaming rare or absent	Cytoplasmic streaming often occurs
10.	Vacuoles	Absent	Present
11.	Capsule	May be present	Always absent
12.	Chromosome	Single	More than one
13.	Size	Generally small (1 – 10 μm)	Generally large (5 – 100 μm)

◈ Preparation of Microscopic Slide :

The object to be viewed under microscope is called the **specimen**. A thin sheet of glass called a **microscopic slide** is used to hold a small sample of the specimen. A second much thinner glass sheet is placed over the sample, called as **coverslip**.

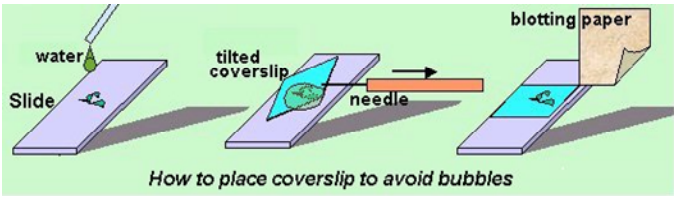
(i) Take a clean glass slide.

(ii) With a dropper, put a drop of water in the middle of the slide.

(iii) Gently put the object to be observed in the drop of water on the slide with the help of a brush.

(iv) Objects, if transparent, are first stained with a proper chemical.

(v) Hold the coverslip over the object in such a manner that it touches the edge of the drop of water. Gently lower the coverslip onto the water.



(vi) Dry the extra water that may come out from under the coverslip with the help of a blotting paper. Take care that the slide thus prepared is clean and dry.

◈ Activity :

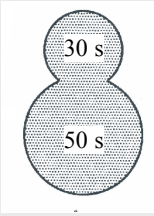
- To observe the plant cells (e.g., onion peel cell/ leaf Cell) under a microscope.
- **Materials required :** Onion, glass slide, coverslip, stain, microscope.
- **Procedure :** Cut a slice of an onion and peel off its skin. Take out the thin membrane present between the two fleshy layers. Place it on a clean glass slide. Put a drop of water on it and place coverslip over it. Observe the slide under a microscope. Prepare another slide of onion peel stained with saffranine. Observe it also under a microscope.

Fig. : Making a Slide of an Onion Peel

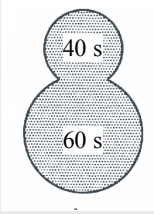
- **Observation :** It is observed that :
- A number of cells lie side-by-side.
- Each cell has a distinct wall. This is called the cell wall.
- At the centre of each cell, there is a nucleus.
- Some large empty spaces exist within the cell. These are vacuoles.

COMPETITIVE LEVEL

- Each ribosomes consists of two unequal subunits, larger dome shaped and small ovoid. 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.



70S Ribosome
(a) Prokaryotic ribosome



80S Ribosome
(b) Eukaryotic ribosome

EXERCISE-1

➢ Very Short Answer Type Questions

Q.1 Name the protein factory of cell ?

Q.2 Which cell organelle is commonly called cellular housekeeper ?

Q.3 Name the organelles having double membrane envelope ?

Q.4 Give 2 examples of unicellular organisms ?

Q.5 Name two types of Endoplasmic reticulum present in the cell ?

➢ Short Answer Type Questions – Type I

Q.6 Who discovered cell & how ?

Q.7 Define diffusion.

Q.8 Define osmosis ?

Q.9 What are leucoplasts ?

Q.10 What is chromatin ?

➢ Short Answer Type Questions – Type II

Q.11 Why is plasma membrane called selectively permeable membrane ?

Q.12 Which organelle is known as the power house of cell & why ?

Q.13 Why are lysosomes known as suicide bags ?

Q.14 Why do raisins swell up when kept in water ?

Q.15 What will happen to the shape of a grape if it is placed in a high concentrated solution of sugar (hypertonic solution) ?

Q.16 What are the three main regions of the cell ? Write their functions.

Q.17 What does the term plasmolysed mean when used to describe a cell ?

Q.18 What are the genes ? Where are they located in the cell ?

Q.19 Do you agree that "A cell is a building unit of an organism". If yes, explain why ?

Q.20 What are ribosomes ? Where are they located in the cell ? What is their function ?

➢ Long Answer Type Questions

Q.21 Draw a well labelled sketch of a ultra structure of plant cell ?

Q.22 Explain the following -
(a) Membrane biogenesis
(b) Diffusion
(c) Endocytosis
(d) Cell organelles

Q.23 (a) Draw a diagram of an animal cell & label its seven parts.
(b) Mention two cell organelles which are bounded by double membrane. Give structural details also.

Q.24 Draw a cell in which no nuclear membrane is present.

Q.25 Write differences between a eukaryotic and prokaryotic cell.

➢ Practical & Value Based Type Questions

Q.26 You are telling your 10 years old sister that cells were discovered by Robert Hook in 1665. Based on his observation, cell theory was developed. You do not have a microscope and hence not able to show the structure of a cell to your sister. Your sister is too small to understand this and asked you to show her a cell.
(i) What will you show to your sister which can give her an idea of a cell ?
(ii) What is the life of a cell ?
(iii) What values are shown by you and your sister ?

Q.27 You are told by your teacher that plants have mostly dead cells in its body. On the other hand most of the animal cells are alive. A student wants to know from your teacher if it gives any advantage to the organisms.

(i) What advantage do plant get by having mostly dead cell ?

(ii) Why should we protect trees ?

(iii) What value is shown by the student ?

Q.28 Medical science took a giant step forward when it, declared its capability to store stem cells. Stem cells can be used later on to treat certain diseases if need arises. Along with many Western countries. India also has the facility for storage of stem cell and for use of the same for the therapy. Scientists' are trying their best to maximize the benefit from storage of stem cells

(i) What is the main source of stem cells ?

(ii) What are the disease that can be treated by storing stem cells ?

(iii) What value is shown by the scientists ?

Q.29 Why is glycerine used before keeping coverslip on the materials ?

Q.30 Why does one use safranin stain to prepare temporary mount of onion peel ?

EXERCISE-2

Q.1 Power house of cell is -
(A) Lysosome (B) Ribosome
(C) Mitochondria (D) Vacuole

Q.2 Who discovered the cell -
(A) Robert hooke (B) Purkinje
(C) Robert brown (D) Davson

Q.3 Mitochondria are site of -
(A) Electron transport
(B) Cellular respiration
(C) ATP formation
(D) All

Q.4 Golgi body take part in -
(A) Lipid synthesis
(B) Carbohydrate synthesis
(C) Protein synthesis
(D) Oxidative phosphorylation

Q.5 Protein synthesis occurs on -
(A) Ribosome (B) Lysosome
(C) Nucleus (D) Chloroplast

Q.6 Which of the following has a single membrane -
(A) Nucleus
B) Mitochondrion
(C) Golgi Bodies
(D) Plastid

Q.7 What is the function of ER -
(A) Nucleus
(B) Chloroplast
(C) ATP formation
(D) Exchange of molecules

Q.8 Grana & Stroma lamella occur in -
(A) Ribosome (B) Chloroplast
(C) Mitochondria (D) Golgi body

Q.9 Kreb's cycle occurs in -
(A) Matrix of mitochondria
(B) Nucleoplasm
(C) Cytoplasm
(D) Protoplasm

Q.10 Organelle, which remove worn-out cell organelle is -
(A) Lysosome (B) Plastid
(C) Mitochondria (D) Golgi complex

Q.11 Which of the following organelle is involved in formation of lysosomes -
(A) SER (B) Golgi complex
(C) RER (D) Mitochondria

Q.12 Numerous membrane layer present in plastid known as -
(A) Cisternae (B) Stroma
(C) Grana (D) Matrix

Q.13 Chromosomes are made up of -
(A) DNA (B) Protein
(C) DNA & protein (D) RNA

Q.14 Cell wall of which one of these is not made up of cellulose -
(A) Bacteria (B) Hydrilla
(C) Mango tree (D) Cactus

Q.15 Kitchen of the cell -
(A) Mitochondria (B) ER
(C) Chloroplast (D) Golgi complex

Q.16 Membrane biogenesis is related with -
(A) Cell membrane
(B) Nuclear membrane
(C) Cell wall
(D) None

Q.17 Organelle other than nucleus, containing DNA is -
(A) Endoplasmic reticulum
(B) Mitochondria
(C) Golgi apparatus
(D) Lysosome

Q.18 Amoeba acquires its food through a process termed as -
(A) Exocytosis
(B) Plasmolysis
(C) Endocytosis
(D) Both A & B

Q.19 The outermost layer of human cheek cell is -
(A) Cell wall
(B) Nuclear membrane
(C) Plasma membrane
(D) Cytoplasm

Q.20 The diffusion of water from external solution into dry raisins is called -
(A) Exosmosis
(B) Endosmosis
(C) Imbibition
(D) Plasmolysis

Q.21 The plasma membrane of all living cell is -
(A) Impermeable
(B) Semi permeable
(C) Permeable
(D) Selectively permeable

Q.22 Which cell organelle is not bounded by a membrane -
(A) Nucleus (B) Lysosome
(C) Ribosome (D) ER

Q.23 In plant cells, the cell wall is -
(A) Dynamic & living
(B) Rigid & non living
(C) Dynamic & non living
(D) Rigid & living

Q.24 The outer most covering of amoeba is -
(A) Tonoplast
(B) Plasma membrane
(C) Cell wall
(D) Neurolemma

Q.25 Oxysomes are present in -
(A) Mitochondria (B) Peroxisomes
(C) Plastid (D) Cytoplasm

Q.26 Inner membrane convolutions of a mitochondrion are known as
(A) lamellae. (B) cristae.
(C) grana. (D) thylakoids.

Q.27 The term 'protoplasm' was coined by
(A) Robert Hooke. (B) Virchow.
(C) Leeuwenhoek. (D) Purkinje.

Q.28 In cell, rigid outer layer cell wall and plasma membrane both give the
(A) length. (B) colour.
(C) shape. (D) size.

Q.29 The shape of the cells is related to its
(A) function. (B) structure.
(C) position. (D) origin.

Q.30 Cork is a part of the
(A) leaf of the tree.
(B) root of the tree.
(C) flower of the tree.
(D) bark of the tree.

EXERCISE-3

(Previous Year Questions - NTSE & NSO)

Q.1 Cell organelle which differentiates plant cell from animal cell is –
(A) Cell Membrane
(B) Plastids
(C) Nucleolus
(D) Vacuoles

Q.2 Example of cell organelle which do not have a unit membrane is
(A) Mitochondria (B) Lysosome
(C) Ribosome (D) Plastid

Q.3 Mitochondria and chloroplasts are similar because
(A) Both have nuclei
(B) Both have 80s ribosomes
(C) Both have DNA
(D) Both have signle membrane envelope

Q.4 Ribosome is present in both eukaryotic and prokaryotic cells, it infers that ribosome is.
(A) Necessary for protein synthesis
(B) A membrane less organelle
(C) Independent of nucleus
(D) Meeting body's energy requirement in all the above conditions.

Q.5 What happens when a cell placed in hypertonic solution ?
(A) Endosmosis (B) Exosmosis
(C) Deplasmolysis (D) Imbibition

Q.6 Organisms lacking nuclear membrane and cell organelles is called as :
(A) Prokaryotes (B) Eukaryotes
(C) Protozoa (D) Fungi

Q.7 Ribosomes are the centre for:
(A) Respiration
(B) Protein sythesis
(C) Photosynthesis
(D) Fat synthesis

Q.8 Lipids and proteins constituting the cell membrane are synthesized at :
(A) endoplasmic reticulum
(B) mitochondria
(C) golgi apparatus
(D) Lysosomes

Q.9 Which one of the following cell organelle does not participate in cellular division.
(A) Ribosomes (B) Chromosomes
(C) Cytoplasm (D) Nucleus

Q.10 Cell organelle 'Bioplast' was given another name by Benda, which is
(A) Chloroplast (B) Mitochondria
(C) Ribosome (D) Lysosome

Q.11 Cell organelle that allows certain substances to enter or come out from the cell is
(A) Ribosome
(B) Plasma membrane
(C) Centrosome
(D) Golgi body

Q.12 Which cell organelle is known as "Suicidal bag"-
(A) Centrosome (B) Mesosome
(C) Lysosome (D) Chromosome

Q.13 Mitochondria and Plastids are able to synthesis some of their proteins because they have:
(A) DNA
(B) RNA
(C) DNA and Ribosomes
(D) RNA and Ribosomes

Q.14 The cell organelle storing substances like starch, oil and proteins is
(A) Vacuole (B) Lysosome
(C) Plastid (D) Nucleus

Q.15 The common component of nuclear membrane of organelles like Mitochondria, Endoplasmic reticulum and Nucleus is:
(A) Glycoliped (B) Glycoprotein
(C) Nucleoprotein (D) Lipoprotein

Q.16 During rainy season, wooden doors are difficult to open or close. It is due to :
(A) Plasmolysis (B) Osmosis
(C) Imbibition (D) Dehydration

Q.17 The capsule present in Bacteria is mainly made of :
(A) Glycolipids and proteins
(B) Phospholipids and protein
(C) Poly saccharide and proteins
(D) All of above

Q.18 Which is a prokaryotic cell, amongst the following ?
(A) Amoeba (B) Bacteria
(C) Yeast (D) Euglena

Q.19 A cell will plasmolyse, if it is placed in:
(A) Hypertonic solution
(B) Hypotonic solution
(C) Isotonic solution
(D) Concentration of water molecules does not matter

Q.20 Which organelle is considered as a suicide bag ?
(A) Centrosome (B) Mososomes
(C) Lysosomes (D) chromosome

Q.21 Number of mitotic divisions required to produce 128 cells from a single cell is –
(A) 7 (B) 8 (C) 6 (D) 4

Q.22 If a cell has twice as much DNA as in the normal functional cell, it shows that?
(A) cell has completed division
(B) cell is preparing to divide
(C) cell is preparing to die
(D) cell is preparing to modify

Q.23 In a cell which cell organelle other than nucleus contains DNA ?
(A) Lysosome
(B) Golgi bodies
(C) Endoplasmic reticulum
(D) Mitochondira

Q.24 Nucleus of the cell was discovered by
(A) Robert Hooke (B) Leeuwenhoek
(C) Robert Brown (D) Virchow

Q.25 Turgidity of cell is maintained by
(A) Vacuole (B) Lysosome
(C) Plastid (D) Golgi body

Q.26 The cell organelle discovered by de Duve is
(A) Plastid (B) Ribosome
(C) Lysosome (D) Centrosome

Q.27 DNA is not present in
(A) Chloroplast (B) Mitochondria
(C) Nucleus (D) Ribosome

Q.28 Cell division in plants is promoted by :
(A) Abscisic acid (B) Gibberllin
(C) Ethylene (D) Cytokinin

Q.29 An exception to cell theory is
(A) Bacteria (B) Virus
(C) Algae (D) All

Q.30 Chemical composition of chromosome is
(A) DNA and lipid
(B) DNA and carbohydrates
(C) Proteins and lipids
(D) DNA and proteins

Q.31 Cristae is associated with
(A) Nucleus (B) Chloroplast
(C) Cell Wall (D) Mitochondria

ANSWER KEY

EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	A	D	B	B	A	D	B	A	A	B	C	C	A	C
Ques.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	A	B	C	C	B	D	C	B	B	A	B	D	C	A	D

EXERCISE - 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	C	C	A	B	A	B	A	A	B	B	C	C	C	D
Ques.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	C	C	C	C	C	C	B	D	C	A	C	D	D	B	D
Ques.	31														
Ans.	D														

SOLUTIONS

EXERCISE-1

➢ Very Short Answer Type Questions

Sol.1 Ribosomes are the protein factory of cell

Sol.2 Lysosome is commonly called cellular housekeeper

Sol.3 Mitochondrian and Chloroplast are the organelles having double membrane envelope

Sol.4 Bacterium and Protozoan like Amoeba are 2 examples of unicellular organisms

Sol.5 (a) Smooth Endoplasmic Reticulum (SER) helps in Lipid synthesis
Rough Endoplasmic Reticulum (RER) helps in Protein synthesis

➢ Short Answer Type Questions – Type I

Sol.6 Cell was discovered by Robert Hooke in a dead slice and the described it in his book "Micrographia".

Sol.7 The movement of the molecules or ions from higher concentration to a region of lower concentration is called "Diffusion"

Sol.8 Movement of the molecules of H_2O from low conc. solution to high conc. Solution through a semipermeable membrane is called osmosis.

Sol.9 Leucoplasts are colourless plastids that stores the food materials like starch (Amyloplasts). Proteins (Aleuroplasts) and oils (Elaioplast).

Sol.10 The material of which the chromosomes of organisms are composed consisting of DNA & protein.

➢ Short Answer Type Questions – Type II

Sol.11 Plasma membrane do not allow any material to enter inside the cell. But selects the material according to the demand of cell metabolism. Hence it is called "Selectively Permeable" membrane.

Sol.12 "Mitochondrian" is commonly known as "Power House" of the cell because the synthesis of metabolic energy in the form of "ATP" occurs during respiration in Mitochondria.

Sol.13 In case of cellular damages "Lysosomes" may burst and their enzymes are released into the cytoplasm and digest their own cell. So, They are called "Suicidal bags" of the cell.

Sol.14 Raisins are dried grapes when they are placed in water they absorbs water from surrounding by endo-osmosis and swell up.

Sol.15 The grapes will shrink and become "flaccid" by loosing water exo-osmotically when they are placed in a high concentrated sugar solution.

Sol.16 (a) Plasmamembrane (b) cytoplasm
(c) Nucleus
(a) Plasmamembrane regulates the movement of substance entering or leaving the cell.
(b) Cytoplasm is a gel like substance where all cell organelles are suspended. Most of the metabolic pathway occur in the cytoplasm
(c) Nucleus is controller of cell and it regulates all cellular activities.

Sol.17 The shrinking of cytoplasm (Protoplast) in plant cell is called "Plasmolysis". It is occured due to loss of water from cell into outer high concentrated solution by a process called Exo osmosis.

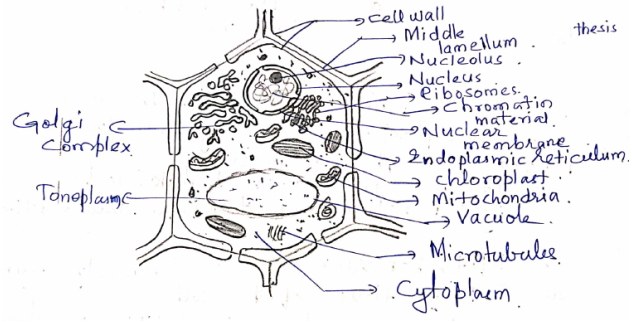
Sol.18 "Genes" are units of inheritance or heredity which transmits characters from one generation to other. Genes are present on chromosomes. Genes are the functional segment of DNA

Sol.19 According to cell theory proposed by M.J. Schleiden and theodor schwann "Cell is described as structural and functional unit of a living body. Without cell there is no tissues and organs formed. Hence cell is described as building unit of living body.

Sol.20 Ribosomes are membraneless cell organelles present in both prokaryotic cell and eukaryotic cell and exist in cytoplasm of the cell and usually attached on the outer surface of ER. They are involved in "Protein synthesis".

➢ Long Answer Type Questions

Sol.21 Structure of plant cell



Sol.22 (a) Membrane biogenesis : It is the process the synthesis of cell membrane with the help of proteins + Lipids.

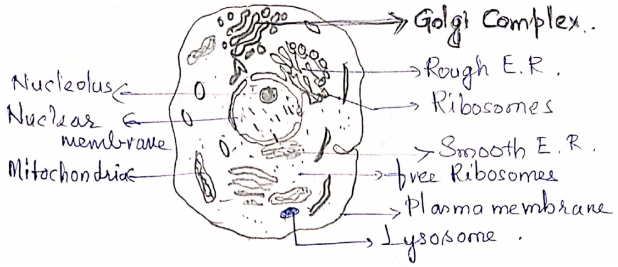
(b) Diffusion : Movement of molecules or ions from a region of high conc. to a region of low conc.

(c) Endocytosis : The taking in all matter by a living cell by invagination of its membrane to form vacuole

(d) cell organelles

Small membrane bound structures, which perform a lot of chemical activities to support the function & structure of a cell are called cell organelles.

Sol.23 (a) Animal cell structure and its labelling



(b) Double membranous cell organelles are

(1) Chloroplast : (i) It is the green colored plastid for photosynthesis.

(ii) It has grana with thylakoids for light reaction and stroma for dark reaction.

(2) Mitochondria- (i) It is commonly known us "Power house" of the cell.

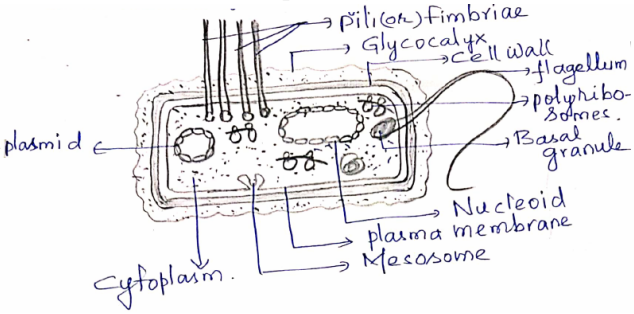
(3) It has two membranes Inner membrane is modified into finger like cristae into the matrix

(4) Cristae may consists of stalked particles called elementory particles (F_0- f1, particles) known as oxysomes.

Sol.24 Cell having nucleus without nuclear membrane is "Prokaryotic cell"

Eg. Bacteria & blue green algae

** structure of prokaryotic cell



Sol.25

Prokaryotic cell		Eukaryotic cell	
1.	Cell wall is made up of peptidoglycans	1.	Cell wall is madeup of cellulose. Hemicellulose and pectins
2.	Nucleus has naked ds DNA without nuclear membrane and nucleolus	2.	Nucleus is covered by nuclear membrane and has nucleolus

3.	Plasma membrane forms mesosome	3.	Mesosome is absent
4.	Only 70S Ribosomes are present	4.	Both 70S & 80S Ribosomes are present
5	Plasmid is present	5	Plasmid is absent
6.	Membrane bounded cell organelles are absent	6.	Membrane bounded cell organelles are present

➢ Practical & Value Based Type Questions

Sol.26. (i) Shilpa can show her a beehive, each chamber of which looks like a cell.
(ii) Different cells have different life span. Some cells live for few days where as few time upto a year.
(iii) The value shown by shilpa is adequate knowledge on the subject and scientific approach to find solution to a problem. The value shown by her sister is the attitude to go for details.

Sol.27 (i) Most of the plant tissues are dead since dead cells can provide mechanical strength and give rigidity. They also do not need energy to maintain the dead cells.
(ii) Trees give us oxygen to breadth. They give us cool breeze. We get fruits vegetables and many other food items from trees. Trees help in conserving the biodiversity. We should therefore protect the trees.
(iii) The value shown by the student is inquisitiveness and desire for knowledge.

Sol.28 (i) The main source of stem cell is the umbilical cord. It is also available in bone marrow.
(ii) Stem cell has the capacity to rapidly form cardiac muscles, nervous tissue and Pancreatic cell. It can therefore be used to treat cardiac disorder neurological disorder and pancreatic diseases. Diseases like thalassemia, leukemia etc can also be treated by stem cell.
(iii) The scientists have shown the value of love for mankind. scientists are dealing with similar different challenges to overcome them and build a curable future for man kind

Sol.29 We use glycerin before placing the cover slip on the slide, as it helps in not drying the safrarin solution on the leaf peel. It helps in keeping the peel moisten. This is for the sample to not get dried.

Sol.30 Safranin is used to stain the peel to observe the very small biological object which is barely visible with naked eyes because these objects are after transparent or translucent.

EXERCISE-2

Sol.1 **[C]**
Mitochondria involves in cellular respiration and forms ATP.

Sol.2 **[A]**
Robert Hooke discovered the cell

Sol.3 **[D]**
Electron transport, Cellular respiration as well at ATP formation occurs in Mitochondria.

Sol.4 **[B]**
Carbohydrate synthesis takes place in Golgi complex

Sol.5 **[A]**
Ribosome are the protein factories

Sol.6 **[C]**
Nucleus, Plastids & Mitochondria are double membranous organelles.

Sol.7 **[D]** ER helps in exchange of molecules

Sol.8 **[B]**
Grana and stroma are two different parts of chloroplasts

Sol.9 **[A]**
Krebs cycle is the important step of Aerobic respiration that occurs in Matrix of Mitochondria.

Sol.10 [A]
Functionless and inactive cell organelles are generelly removed / worn out by lysosomes.

Sol.11 [B]
Lysosomes are considered as one of the three cell organelles of endomembrane system along with E.R. and Golgi complex.

Sol.12 [C]
Grana are formed by Thylakoids

Sol.13 [C]
Chromosomes are the vehicles of inheritance composed of DNA & Proteins.

Sol.14 [A]
Bacterial cell wall is made up of peptidoglycans instead of cellulose.

Sol.15 [C]
Chloroplast is the cell organelle that involves in synthesis of food by photosynthesis.

Sol.16 [A]
Cell membrane or plasma membrane formation

Sol.17 [B]
Mitochondria, Because it is selfduplicative and Semi autonomous cell organelle. It has DNA in its matrix.

Sol.18 [C]
Endocytosis is intake of matter by a living cell by invagination of its membrane to form vacuole

Sol.19 [C]
Plasma membrane (All animal cells including Human cheek cell is covered by plasma membrane.

Sol.20 [B]
Endosmosis (Influx of water)

Sol.21 [D]
Plasma membrane - Because it allows the movement of molecules of selective substances only.

Sol.22 [C] Ribosome is a membraneless organelle

Sol.23 [B]
Cell wall is the Non-Living system of the cell it provides definite shape & structure to the cell.

Sol.24 [B]
Plama membrane (Amoeba is an protozoan)

Sol.25 [A]
Mitochondria : Oxysomes involves in electron transport system (ETS) and present on cristae of mitochondrian.

Sol.26 [B]
The infoldings of inner membrane of mitochandrion is colled cristae

Sol.27 [D]
The term 'protoplasm' was coined by Purkinje.

Sol.28 [C]
plasma membrane and cell wall gives definite shape to the cell

Sol.29 [A]
The shape of the cells is related to its function.

Sol.30 [D]
Cork is formed during secondary growth in the cortical region of the stem and forms non living Bark.

EXERCISE-3

Sol.1 [B]
Plastids are present in plant cell

Sol.2 [C]
Ribosome is membrane less cell organelle concerned with the biosynthesis of proteins

Sol.3 [C]
Both chloroplast and mitrochondrian has DNA. Hence they are semi-genetic autonomous cell organelles.

Sol.4 [A]
Ribosome is necessary for protein synthesis

Sol.5 [B]
Cell undergo exosmosis and become flaccid

Sol.6 [A]
Prokaryotic organisms like bacteria and blue green algae do not posses nuclear membrane and cell organelles except Ribosomes.

Sol.7 [B]
Ribosomes are always involved in Protein synthesis

Sol.8 [A]
Endoplasmic Reticulum
Rough E.R. helps in Protein synthesis
Smooth E.R. helps in Lipids synthesis

Sol.9 [A]
Ribosome mainly involves in Protein synthesis

Sol.10 [B]
Mitochondria was initially named as "Bioplast" by R. Altmann.

Sol.11 [B]
Plasma membrane is selectively permeable to allow the movement of molecules of some selective chemical substances.

Sol.12 [C]
Lysosome - Because of its involvement of self destructive processes.

Sol.13 [C]
DNA and Ribosomes are essential for protein synthesis and both of them are present in chloroplast and mitochondrian.

Sol.14 [C]
Plastids like leucoplast may store the food materials in the starch (Amyloplast), Proteins (aleuroplasts) and fats and oils (elaeoplast)

Sol.15 [D]
According to unit membrane concept proposed by Robertson the cell membrane, Nuclear membrane and membranes of Mitochondria, E.R. is made up of proteins + Lipids

Sol.16 [C]
Imbibition (Superficial adsorption of liquids or water by soil objects like wooden block or dry seeds is called "Imbibition"

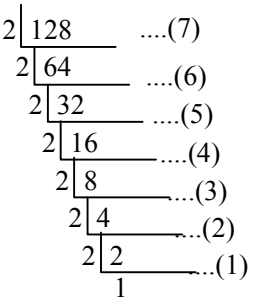
Sol.17 [C]
The capsule present in Bacteria is mainly made of Polysaccharides and Proteins

Sol.18 [B]
Bacteria cell that donot contain true nucleus having naked DNA

Sol.19 [A]
Hypertonic solution when a plant cell is placed in an outer high concentrated solution cell loses the water by exosmosis and become flaccid.

Sol.20 [C]
Lysosomes which may cause cellular destruction of unwanted cell components and functionless cell organelles by secreting hydrolysing enzymes.

Sol.21 [A]



Sol.22 [B]
When a cell become ready to involve in cell division then the amount its DNA is duplicated

Sol.23 [D]
Mitochondria as well as chloroplast of the cell also contain DNA almong with Nucleus.

Sol.24 [C]
Robert Brown

Sol.25 [A]
Vacuole is repository cell organelle

Sol.26 [C]
Lysosome was discovered by de Duve

Sol.27 [D]
Ribosome does not contain DNA

Sol.28 [D]
Cell division in plants is promoted by Cytokinin

Sol.29 [B]
Virus is composed nucleic acid and proteins

Sol.30 [D]
Chromosomes are composed of DNA and proteins

Sol.31 [D]
Cristae are the infolding of inner membrane of mitochondria

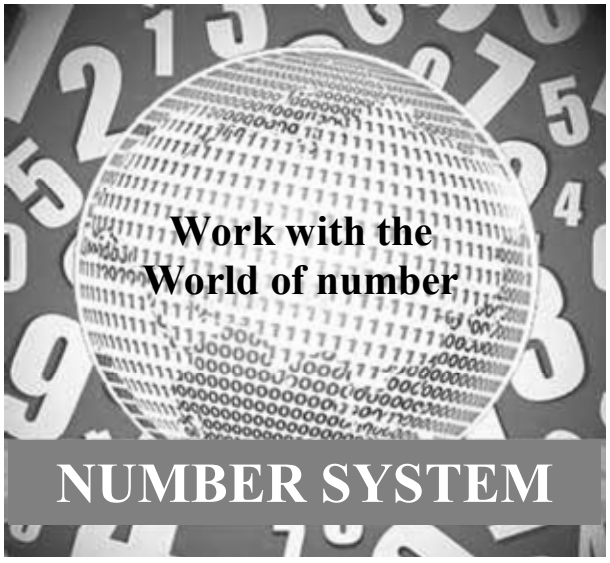
Chapter

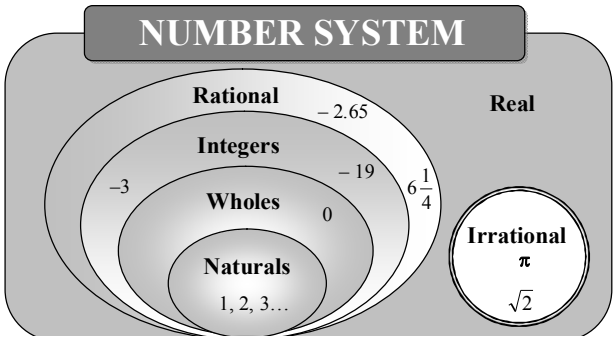
1

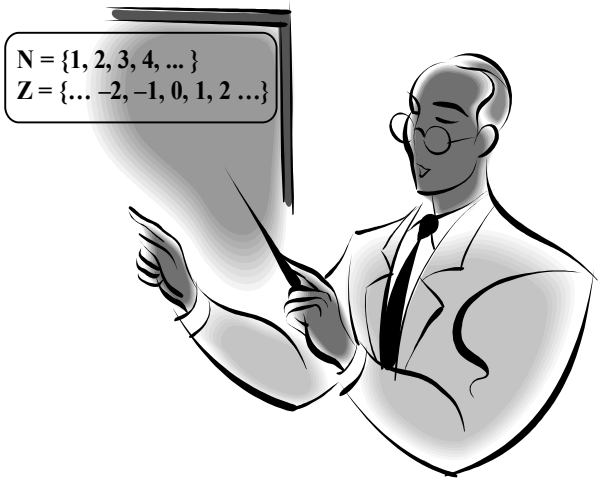
NUMBER SYSTEMS

Chapter Outline

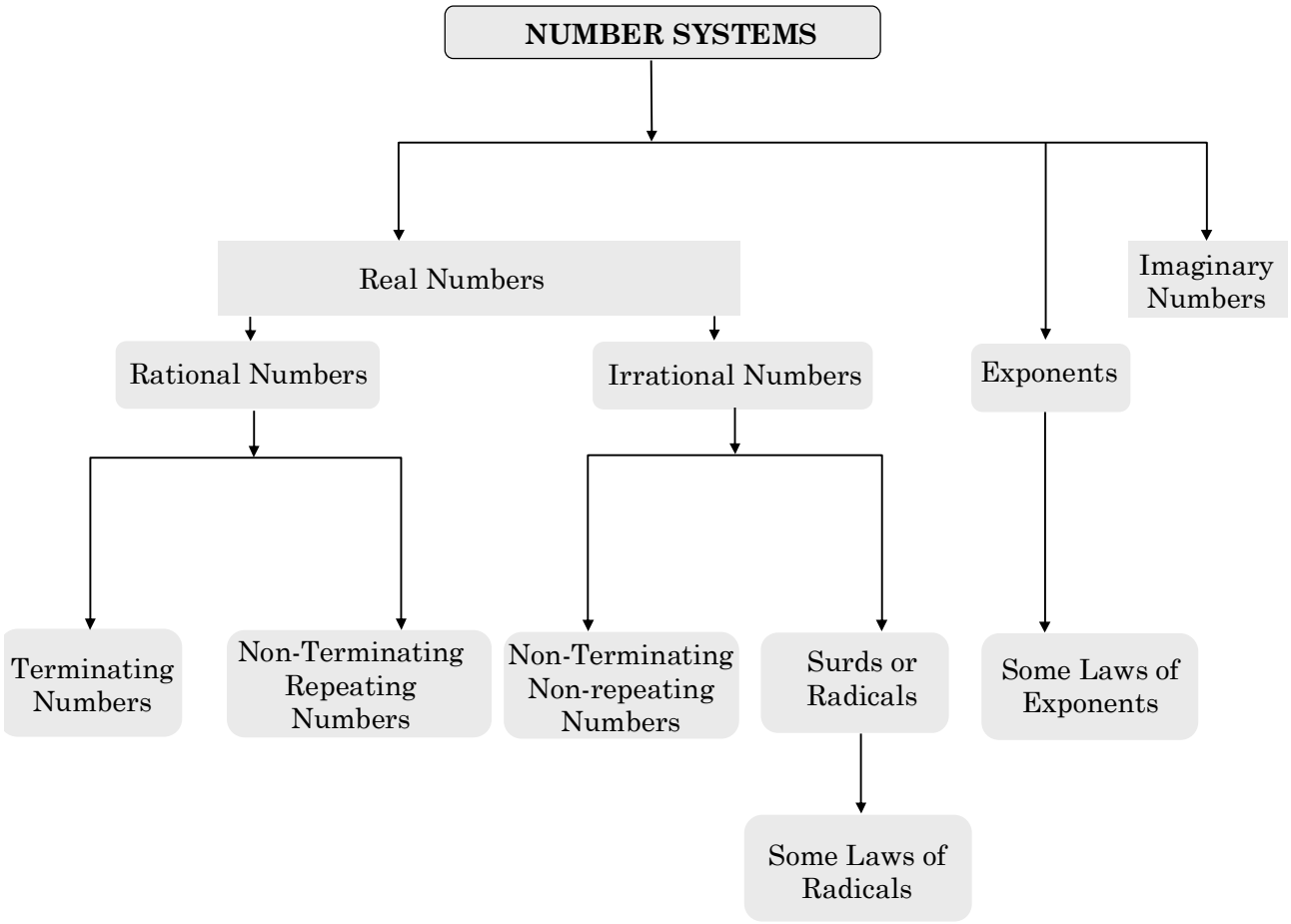
- Number System
- Real Number
- Decimal Representation of Rational & Irrational number
- Representing Rational and Irrational Numbers on the Number Line
- Surds or Radicals & Exponents
- Operations on Surds & Exponents
- Rationalisation of Surds
- Rules for Exponents
- Factors and Multiples
- Remainders
- Cyclicity







MIND MAP


NUMBER SYSTEMS
Real Numbers
Imaginary Numbers
Rational Numbers
Irrational Numbers
Exponents
Terminating Numbers
Non-Terminating Repeating Numbers
Non-Terminating Non-repeating Numbers
Surds or Radicals
Some Laws of Exponents
Some Laws of Radicals

NUMBER SYSTEMS

Number System

◈ Natural Numbers

Counting numbers are known as natural numbers.

N = { 1, 2, 3, 4, ... }.

- **Even Numbers :** All natural numbers which are multiples of 2 are even numbers (i.e.) 2,4,6,8… are even numbers.
- **Odd numbers :** All natural numbers which are not multiples of 2 are odd numbers.
- **Prime and composite Numbers :** A natural number which has exactly two factors, 1 and the number itself is called a **prime number**.

  All natural numbers other then 1 which are not prime are **composite numbers**.

Note : *1 is neither a prime nor a composite number.*
2, 3, 5, 7, 11, 13, 17… are prime numbers. 4, 6, 8, 9, 10, 12 …… are ***composite numbers.***
Co-prime: *Any natural numbers a and b are said to be co-prime if HCF(a, b) = 1. For example 4, 9 are co-prime numbers as H.C.F. (4, 9) = 1*

◈ Whole numbers

The natural numbers along with the zero form the set of whole numbers i.e. numbers 0, 1, 2, 3, 4 are whole numbers. W = {0, 1, 2, 3, 4…}

◈ Integers

The natural numbers, their negatives and zero make up the integers.

Z = {…–4, –3, –2, –1, 0, 1, 2, 3, 4…}

The set of integers contains positive numbers, negative numbers and zero.

◈ Rational Numbers

(i) A rational number is a number which can be put in the form p/q, where p and q are both integers and $q \neq 0$.

(ii) A rational number is either a terminating or non-terminating but recurring (repeating) decimal.

(iii) A rational number may be positive, negative or zero.

◈ Irrational Number

All real numbers are irrational if and only if their decimal representation is non-terminating and non-repeating. e.g. $\sqrt{2}$, $\sqrt{3}$, π… etc.

Real Numbers

Rational number and irrational number taken together form the set of real numbers.

Note: (1) If a and b are two real numbers, then either (i) $a > b$ or (ii) $a = b$ or (iii) $a < b$

(2) Negative of an irrational number is an irrational number.

(3) The sum of a rational number with an irrational number is always irrational number.

(4) The product of a non-zero rational number with an irrational number is always an irrational number.

(5) The sum of two irrational numbers is not always an irrational number.

(6) The product of two irrational numbers is not always an irrational number.

(7) $\pi = 3.14159265358979\ldots$

while $\frac{22}{7} = 3.1428571428\ldots$

$\therefore\ \pi \neq \frac{22}{7}$ but for calculation we can take $\pi \approx \frac{22}{7}$.

◈ The Absolute Value (or modulus) of a Real Number

If a is a real number, modulus a is written as $|a|$; $|a|$ is always positive or zero. It means positive value of 'a' whether a is positive or negative

$|3| = 3$ and $|0| = 0$, Hence $|a| = a$; if $a = 0$ or $a > 0$ (i.e.) $a \geq 0$

$|-3| = 3 = -(-3)$. Hence $|a| = -a$ when $a < 0$

Ex.1 Is zero a rational number? Can you write it in the form of p/q, where p and q are integers and $q \neq 0$?

Sol. Yes, zero is a rational number. It can be written as $\frac{0}{1} = \frac{0}{2} = \frac{0}{3}$ etc. where denominator $q \neq 0$, it can be negative also.

Ex.2 Find five rational numbers between $\frac{3}{5}$ and $\frac{4}{5}$.

Sol. A rational number between two rational numbers r and s is $\frac{r+s}{2}$.

A rational number between

$\frac{3}{5}$ and $\frac{4}{5} = \frac{1}{2}\left(\frac{3}{5}+\frac{4}{5}\right) = \frac{7}{10}$.

And a rational number between

$\frac{3}{5}$ and $\frac{7}{10} = \frac{1}{2}\left(\frac{3}{5}+\frac{7}{10}\right) = \frac{13}{20}$

Similarly; $\frac{5}{8}, \frac{27}{40}, \frac{31}{40}$ are between $\frac{3}{5}$ and $\frac{4}{5}$.

So, five rational numbers between

$\frac{3}{5}$ and $\frac{4}{5}$ are $\frac{5}{8}, \frac{13}{20}, \frac{7}{10}, \frac{31}{40}, \frac{27}{40}$

Ex.3 Find six rational numbers between 3 and 4.

Sol. We can solve this problem in two ways.

Method 1 : A rational number between two rational numbers r and s is $\frac{r+s}{2}$.

Therefore, a rational number between 3 and 4 = $\frac{1}{2}(3+4) = \frac{7}{2}$

A rational number between 3 and $\frac{7}{2} = \frac{1}{2}\left(\frac{6+7}{2}\right) = \frac{13}{4}$. We can accordingly proceed in this manner to find three more rational numbers between 3 and 4.

Hence, six rational numbers between 3 and 4 are $\frac{25}{8}, \frac{13}{4}, \frac{27}{8}, \frac{7}{2}, \frac{29}{8}, \frac{15}{4}$.

Method 2 : Since, we want six numbers, we write 3 and 4 in $\frac{p}{q}$ form with denominator 6 + 1, i.e., $3 = \frac{21}{7}$ and $4 = \frac{28}{7}$. Then we can check that $\frac{22}{7}, \frac{23}{7}, \frac{24}{7}, \frac{25}{7}, \frac{26}{7}$ and $\frac{27}{7}$ are all between 3 and 4.

Hence, the six numbers between 3 and 4 are $\frac{22}{7}, \frac{23}{7}, \frac{24}{7}, \frac{25}{7}, \frac{26}{7}$ and $\frac{27}{7}$.

Ex.4 Are the following statements true or false? Give reasons for your answer.
(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, because N = {1, 2, 3…}
W = {0, 1, 2, 3…}
(ii) False, because negative integers are not whole number.
(iii) False, because rational numbers such as $\frac{1}{4}$, $\frac{1}{2}$ are not whole numbers.

Ex.5 Find 3 irrational numbers between 3 & 5.

Sol. ∵ 3 and 5 both are rational
The irrational are 3.1010010001…;
3.2020020002…; 3.3030030003…

Ex.6 Find two rational & two irrational numbers between 4 and 5.

Sol. Rational numbers $\frac{4+5}{2} = 4.5$ & $\frac{4.5+4}{2} = \frac{8.5}{2} = 4.25$
Irrational numbers 4.1010010001…
4.2020020002…

Ex.7 Find two irrational numbers lying between $\sqrt{2}$ and $\sqrt{3}$.

Sol. We know that, if a and b are two distinct positive irrational numbers, and if $\sqrt{ab}$ is irrational then $\sqrt{ab}$ is an irrational number lying between a and b, if ab is not a perfect square
∴ Irrational number between $\sqrt{2}$ and $\sqrt{3}$ is $\sqrt{\sqrt{2}\times\sqrt{3}} = \sqrt{\sqrt{6}} = 6^{1/4}$
Irrational number between $\sqrt{2}$ and $6^{1/4}$ is $\sqrt{\sqrt{2}\times 6^{1/4}} = 2^{1/4}\times 6^{1/8} = 2^{2/8}\times 6^{1/8} = (4\times 6)^{1/8} = 24^{1/8}$
Hence required irrational numbers are $6^{1/4}$ and $24^{1/8}$

Decimal Representation of Rational Numbers

(A) Terminating

Ex.8 $\frac{6}{5}, \frac{8}{5}, \frac{7}{4}$… are equal to 1.2, 1.6, 1.75 respectively, so these are terminating

Ex.9 Express $\frac{-17}{8}$ in decimal form by long division method.

Sol. In order to convert $\frac{-17}{8}$ in the decimal form, we first express $\frac{17}{8}$ in the decimal form and the decimal form of $\frac{-17}{8}$ will be negative of the decimal form of $\frac{17}{8}$

We have,

$$8\overline{)17.000}(2.125$$
$$\underline{16}$$
$$10$$
$$\underline{8}$$
$$20$$
$$\underline{16}$$
$$40$$
$$\underline{40}$$
$$0$$

$\therefore \quad \frac{-17}{8} = -2.125$

(B) Non Terminating Recurring (Repeating)

Ex.10 $\frac{10}{3} = 3.333\ldots \text{or } 3.\overline{3} \quad \Rightarrow \frac{1}{7} = 0.14285714285\ldots \text{or } 0.\overline{142857} \quad \Rightarrow \frac{2320}{99} = 23.434343\ldots \text{or } 23.\overline{43}$

These expansions are not terminated but digits are continuously repeated so we use a line on those digits, called bar (–).
So we can say that rational numbers are of the form either terminating, or non terminating repeating (recurring).

Ex.11 Find the decimal representation of $\frac{22}{7}$.

Sol. By long division, we have

$$7\overline{)22}\ (3.142857142857$$
$$\underline{21}$$
$$10$$
$$\underline{7}$$
$$30$$
$$\underline{28}$$
$$20$$
$$\underline{14}$$
$$60$$
$$\underline{56}$$
$$40$$
$$\underline{35}$$
$$50$$
$$\underline{49}$$
$$10$$
$$\underline{7}$$
$$30$$
$$\underline{28}$$
$$20$$
$$\underline{14}$$
$$60$$
$$\underline{56}$$
$$40$$
$$\underline{35}$$
$$50$$
$$\underline{49}$$
$$1$$

$\therefore \frac{22}{7} = 3.142857142857\ldots = 3.\overline{142857}$

Conversion of Decimal Numbers into Rational Number of the Form $\frac{p}{q}$

Case I : When the decimal number is of terminating nature.

Step-1 : Obtain the rational number.

Step-2 : Determine the number of digits in its decimal part

Step-3 : Remove decimal point from the numerator. Write 1 in the denominator and put as many zeros on the right side of 1 as the number of digits in the decimal part of the given rational number.

Step-4 : Find a common divisor of the numerator and denominator and express the rational number to lowest terms by dividing its numerator and denominator by the common divisor.

Ex.12 Express each of the following numbers in the form $\frac{p}{q}$.

(i) 0.675 (ii) –25.6875

Sol. (i) $0.675 = \frac{675}{1000} = \frac{675 \div 25}{1000 \div 25} = \frac{27}{40}$

(ii) $-25.6875 = \frac{-256875}{10000} = \frac{-256875 \div 625}{10000 \div 625} = \frac{-411}{16}$

Case II : When decimal representation is of non-terminating repeating nature.

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

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

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

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

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

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

Algorithm :

Step-1 : Obtain the repeating decimal and put it equal to x (say)

Step-2 : Write the number in decimal form by removing bar from the top of repeating digits and listing repeating digits at least twice. For example, write $x = 0.\overline{8}$ as x = 0.888.... and $x = 0.\overline{14}$ as x = 0.141414.....

Step-3 : Determine the number of digits having bar on their heads.

Step-4 : If the repeating decimal has one place repetition, multiply by 10; two place repetition, multiply by 100; three place repetition, multiply by 1000 and so on.

Step-5 : Subtract the number in step 2 from the number obtained in step 4

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

Step-7 : Write the rational number in its simplest form.

Ex.13 Express each of the following decimals in the form $\frac{p}{q}$:

(i) $0.\bar{6}$ (ii) $0.\overline{585}$

Sol. (i) Let $x = 0.\bar{6}$

then, $x = 0.666\ldots$ ....(i)

Here, we have only one repeating digit, So, we multiply both sides of (i) by 10 to get

$10x = 6.66\ldots$ ....(ii)

Subtracting (i) from (ii), we get

$10x - x = (6.66\ldots) - (0.66\ldots)$

$\Rightarrow 9x = 6 \Rightarrow x = \frac{6}{9} \Rightarrow x = \frac{2}{3}$ Hence $0.\bar{6} = \frac{2}{3}$

(ii) Let $x = 0.\overline{585}$

$\Rightarrow x = 0.585585585\ldots$ ....(i)

Here, we have three repeating digits after the decimal point. so, we multiply both sides of (i) by $10^3 = 1000$ to get

$1000x = 585.585585\ldots$ ....(ii)

Subtracting (i) from (ii), we get

$1000x - x = (585.585585...) - (0.585585585...)$

$1000x - x = 585$

$\Rightarrow 999x = 585$

$\Rightarrow x = \frac{585}{999} = \frac{65}{111}$

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

Step-1 : Obtain the mixed recurring decimal and write it equal to x (say)

Step-2 : Determine the number of digits after the decimal point which do not have bar on them. Let there be n digits without bar just after the decimal point

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

Step-4 : Use the method of converting pure recurring decimal to the form $\frac{p}{q}$ and obtain the value of x

Ex.14 Express the following decimals in the form

(i) $0.3\bar{2}$ (ii) $0.12\bar{3}$

Sol. (i) Let $x = 0.3\bar{2}$

Clearly, there is just one digit on the right side of the decimal point which is without bar. So, we multiply both sides of x by 10 so that only the repeating decimal is left on the right side of the decimal point.

$\therefore 10x = 3.\bar{2}$

$\Rightarrow 10x = 3 + 0.\bar{2} \quad \left[\because 0.\bar{2} = \frac{2}{9}\right]$

$\Rightarrow 10x = 3 + \frac{2}{9} \Rightarrow 10x = \frac{9\times 3 + 2}{9} \Rightarrow 10x = \frac{29}{9} \Rightarrow x = \frac{29}{90}$

(ii) Let $x = 0.12\overline{3}$

Clearly, there are two digits on the right side of the decimal point which are without bar. So, we multiply both sides of x by $10^2 = 100$ so that only the repeating decimal is left on the right side of the decimal point.

$\therefore \quad 100x = 12.\overline{3}$

$$\Rightarrow \quad 100x = 12 + 0.\overline{3} \quad \Rightarrow \quad 100x = 12 + \frac{3}{9} \quad \Rightarrow \quad 100x = \frac{12 \times 9 + 3}{9}$$

$$\Rightarrow \quad 100x = \frac{108 + 3}{9} = \frac{111}{9} \quad \Rightarrow \quad x = \frac{111}{900} = \frac{37}{300}$$

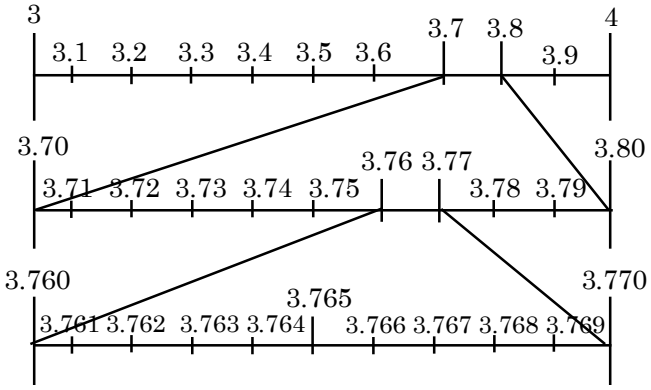
Representing Rational Numbers on the Number Line

Number line is a geometrical straight line with arbitrarily defined zero.

We understand the concept with the help of following examples.

Ex.15 Represent 3.765 on the number line.

Sol. This number lies between 3 and 4. The distance 3 and 4 is divided into 10 equal parts. Then the first mark to the right of 3 will represent 3.1 and second 3.2 and so on. Now, 3.765 lies between 3.7 and 3.8. We divide the distance between 3.7 and 3.8 into 10 equal parts 3.76 will be on the right of 3.7 at the sixth mark, and 3.77 will be on the right of 3.7 at the 7th mark and 3.765 will lie between 3.76 and 3.77 and so on.

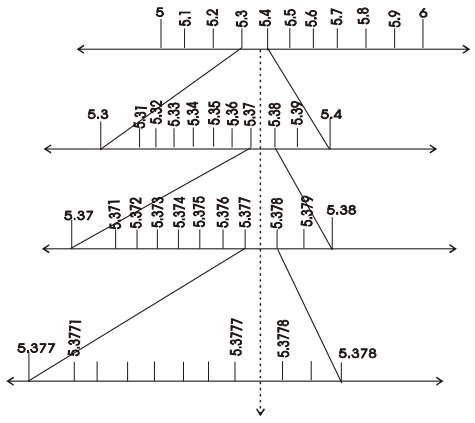


To mark 3.765 we have to use magnifying glass method

Ex.16 Visualize the representation of $5.3\overline{7}$ on the number line upto 5 decimal places.

Sol. We have, $5.3\overline{7} = 5.3777....$

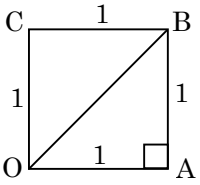
This number lies between 5.3 and 5.4. The distance between 5.3 and 5.4 is divided into 10 equal parts. Then the first mark to the right of 5.3 will represent 5.31 and second 5.32 and so on. Now, 5.3777 lies between 5.37 and 5.38. We divide the distance between 5.37 and 5.38 into 10 equal parts and so on.



Representing Irrational Numbers on the Number Line

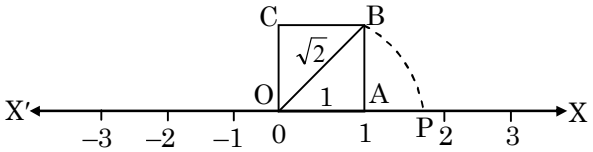
◈ Represent $\sqrt{2}$ & $\sqrt{3}$ on the number line

Greeks discovered this method. Consider a unit square OABC, with each side 1 unit in length. Then by using pythagoras theorem



$OB = \sqrt{1+1} = \sqrt{2}$

Now, transfer this square onto the number line making sure that the vertex O coincides with zero



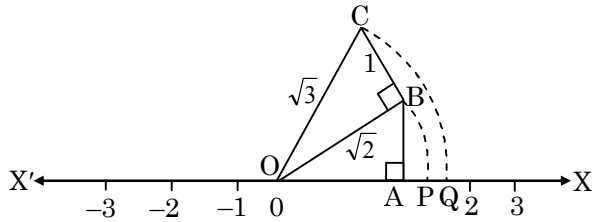
With O as centre & OB as radius, draw an arc, meeting OX at P. Then

$OB = OP = \sqrt{2}$ units

Then, the point P represents $\sqrt{2}$ on the number line.

Now draw, BC ⊥ OB such that BC = 1 unit, join OC. Then

$OC = \sqrt{(\sqrt{2})^2 + (1)^2} = \sqrt{3}$ units



With O as centre & OC as radius, draw an arc, meeting OX at Q. Then

$OQ = OC = \sqrt{3}$ units

Then, the point Q represents $\sqrt{3}$ on the number line.

Remark : In the same way, we can locate $\sqrt{n}$ for any positive integer n, after $\sqrt{n-1}$ has been located.

◈ Existence of $\sqrt{n}$ for a positive real number (Geometrical Representation)

Represent the value of $\sqrt{4.3}$ geometrically :

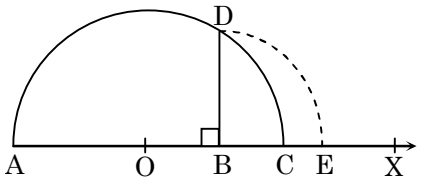
Draw a line segment AB = 4.3 units and extend it to C such that BC = 1 unit.

Find the midpoint O of AC by drawing the perpendicular bisector of AC.

With O as centre and OA a radius, draw a semicircle.

Now, draw BD ⊥ AC, intersecting the semicircle at D. Then, BD = $\sqrt{4.3}$ units.

With B as centre and BD as radius, draw an arc, meeting AC produced at E. Then, BE = BD = $\sqrt{4.3}$ units.



Surds or Radicals & Exponents

◈ Surds

An irrational number of the form $\sqrt[n]{a}$ is called Surd, where 'a' is called radicand and it should always be a rational number. The symbol $\sqrt[n]{\ }$ is called the radical sign and the index n is called order of the surd. $\sqrt[n]{a}$ is read as 'n^{th} root of a' and can also be written as $a^{\frac{1}{n}}$, where n is a natural number other then 1.

E.g. : $\sqrt{2}, \sqrt{3}, \sqrt{5}, \sqrt{21}$. etc. are irrational numbers, These are square roots (second roots), of some rational numbers, which can not be written as squares of any rational number.

⇒ Every surd is an irrational number but every irrational number is not a surd.

⇒ Surds having same irrational factors are called similar or like surds.

⇒ Only similar surds can be added or subtracted by adding or subtracting their rational parts

⇒ Surds of same order can be multiplied or divided

⇒ 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.

⇒ If the product of two surds is a rational number, then each one of them is called the rationalizing factor of the other.

◈ Laws of Radicals

For any positive integer 'n' and a positive rational number 'a'.

(a) $\left(\sqrt[n]{a}\right)^n = a$

(b) $\sqrt[n]{a} \times \sqrt[n]{b} = \sqrt[n]{ab}$ [one of either a or b should be non-negative integer]

(c) $\frac{\sqrt[n]{a}}{\sqrt[n]{b}} = \sqrt[n]{\frac{a}{b}}$ [one of either a or b should be non-negative integer]

(d) $\sqrt[m]{\sqrt[n]{a}} = \sqrt[mn]{a} = \sqrt[n]{\sqrt[m]{a}}$

(e) $\sqrt[m]{a^n} = \sqrt[mp]{a^{np}}$

Note :

(i) A surd consisting of one term only is called a **monomial surd**.

(ii) An expression consisting of the sum or difference of two monomial surds or the sum or difference of a monomial surd and a rational number is called **binomial surd**. e.g.

$\sqrt{2}+\sqrt{5}, \sqrt{3}+2, \sqrt{2}-\sqrt{3}$ etc. are binomial surds.

(iii) The binomial surds which differ only in sign (+ or –) between the terms connecting them, are called **conjugate surds** e.g. $\sqrt{3}+\sqrt{2}$ and $\sqrt{3}-\sqrt{2}$ or $2+\sqrt{5}$ and $2-\sqrt{5}$ are conjugate surds.

◈ Pure And Mixed Surds

(i) Pure Surd :

A surd which has unity only as rational factor, the other factor being irrational, is called a **pure surd**.

E.g. $\sqrt{3}, \sqrt[5]{2}, \sqrt[4]{3}$ are pure surds.

E.g. $\sqrt{6}, \sqrt[3]{12}$ are pure surds.

(ii) Mixed Surd : A surd which has a rational factor other than unity, the other factor being irrational, is called a **mixed surd**.

E.g. $2\sqrt{3}$, $5\sqrt[3]{12}$, $2\sqrt[4]{5}$ are mixed surds.

Type-I : On expressing of mixed surds into pure surds

Ex.17 Express each of the following as a pure surd.

(i) $2\sqrt{3}$ (ii) $2.\sqrt[3]{4}$ (iii) $\frac{3}{4}\sqrt{32}$ (iv) $\frac{3}{2}\sqrt[4]{\frac{32}{243}}$

Sol. (i) $2\sqrt{3} = 2\times3^{1/2} = (2^2)^{1/2}\times3^{1/2} = 4^{1/2}\times3^{1/2}$

$= (4\times3)^{1/2} = 12^{1/2} = \sqrt{12}$

(ii) $2.\sqrt[3]{4} = 2\times4^{1/3} = (2^3)^{1/3}\times4^{1/3} = 8^{1/3}\times4^{1/3}$

$= (8\times4)^{1/3} = (32)^{1/3} = \sqrt[3]{32}$

(iii) $\frac{3}{4}\sqrt{32} = \sqrt{\left(\frac{3}{4}\right)^2}\times\sqrt{32} = \sqrt{\left(\frac{3}{4}\right)^2\times32} = \sqrt{\frac{9}{16}\times32} = \sqrt{18}$

(iv) $\frac{3}{2}\cdot\sqrt[4]{\frac{32}{243}} = \frac{3}{2}\times\left(\frac{32}{243}\right)^{1/4} = \left(\left(\frac{3}{2}\right)^4\right)^{1/4}\times\left(\frac{32}{243}\right)^{1/4}$

$= \left(\frac{81}{16}\right)^{1/4}\times\left(\frac{32}{243}\right)^{1/4} = \left(\frac{81}{16}\times\frac{32}{243}\right)^{1/4} = \left(\frac{2}{3}\right)^{1/4} = \sqrt[4]{\frac{2}{3}}$

Ex.18 Express each of the following as pure surd :

(i) $a\sqrt{a+b}$ (ii) $a\sqrt[3]{b^2}$ (iii) $2ab\sqrt[3]{ab}$

Sol. (i) $a\sqrt{a+b} = a\times(a+b)^{1/2}$

$= (a^2)^{1/2}\times(a+b)^{1/2}$

$= [a^2\times(a+b)]^{1/2}$

$= (a^3+a^2b)^{1/2} = \sqrt{a^3+a^2b}$

(ii) $a\sqrt[3]{b^2} = (a^3)^{1/3}\times(b^2)^{1/3} = (a^3\times b^2)^{1/3} = \sqrt[3]{a^3b^2}$

(iii) $2ab.\sqrt[3]{ab} = \left((2ab)^3\right)^{1/3}\times(ab)^{1/3} = (8\,a^3b^3.ab)^{1/3} = (8\,a^4b^4)^{1/3} = \sqrt[3]{8a^4b^4}$

Type-II : On expressing given surds as mixed surds in the simplest form.

Ex.19 Express each of the following as mixed surd in its simplest form:

(i) $\sqrt[3]{72}$ (ii) $5.\sqrt[3]{135}$

Sol. (i) $\sqrt[3]{72} = \sqrt[3]{8\times9} = \sqrt[3]{2^3\times9} = \sqrt[3]{2^3}\times\sqrt[3]{9} = 2\sqrt[3]{9}$

(ii) $5.\sqrt[3]{135} = 5\sqrt[3]{27\times5} = 5\sqrt[3]{3^3\times5} = 5\sqrt[3]{3^3}\times\sqrt[3]{5} = 5\times3\times\sqrt[3]{5} = 15\sqrt[3]{5}$.

Operations on Surds & Exponents

- **Addition and Subtraction of Surds :**

  Addition and subtraction of surds are possible only when order and radicand are same i.e. only for like surds.

Ex.20 Simplify : $5\sqrt[3]{250} + 7\sqrt[3]{16} - 14\sqrt[3]{54}$

Sol. $5\sqrt[3]{250} + 7\sqrt[3]{16} - 14\sqrt[3]{54}$

$= 5\sqrt[3]{250} + 7\sqrt[3]{16} - 14\sqrt[3]{54}$

$= 5\times 5\sqrt[3]{2} + 7\times 2\sqrt[3]{2} - 14\times 3\times \sqrt[3]{2}$

$= (25 + 14 - 42)\sqrt[3]{2}$

$= -3\sqrt[3]{2}$

- **Multiplication and Division of Surds :**

Ex.21 State with reasons which of the following are surds and which are not :

(i) $\sqrt{64}$ (ii) $\sqrt{45}$ (iii) $\sqrt{20}\times\sqrt{45}$

(iv) $8\sqrt{10}\div 4\sqrt{15}$ (v) $3\sqrt{12}\div 6\sqrt{27}$ (vi) $\sqrt[3]{5}\times\sqrt[3]{25}$

Sol. (i) $\sqrt{64} = 8$

8 is a rational number, hence $\sqrt{64}$ is not a surd.

(ii) $\sqrt{45} = \sqrt{9\times 5} = 3\sqrt{5}$

Thus $\sqrt{45}$ is an irrational number.

Because the rational number 45 is not the square of any rational number, hence $\sqrt{45}$ is a surd.

(iii) We have $\sqrt{20}\times\sqrt{45} = \sqrt{900} = \sqrt{30\times 30} = \left(\sqrt{30}\right)^2 = 30$

Which is a rational number and therefore $\sqrt{20}\times\sqrt{45}$ is not a surd.

(iv) we have

$$8\sqrt{10} \div 4\sqrt{15} = \frac{8\sqrt{10}}{4\sqrt{15}}$$

$$= \frac{\left(\sqrt{8}\right)^2\left(\sqrt{10}\right)}{\left(\sqrt{4}\right)^2\left(\sqrt{15}\right)} \Rightarrow \frac{\sqrt{8}\times\sqrt{8}\times\sqrt{10}}{\sqrt{4}\times\sqrt{4}\times\sqrt{15}}$$

$$= \frac{\sqrt{8\times 8\times 10}}{\sqrt{4\times 4\times 15}} \Rightarrow \frac{\sqrt{640}}{\sqrt{240}}$$

$$\Rightarrow \frac{\sqrt{8}}{\sqrt{3}} = \sqrt{\frac{8}{3}}$$

Which is an irrational number.

Because the rational number $\frac{8}{3}$ is not the square of any rational number, hence the given expression is a surd.

(v) $3\sqrt{12} \div 6\sqrt{27} = \dfrac{3\sqrt{12}}{6\sqrt{27}} = \dfrac{\left(\sqrt{3}\right)^2\left(\sqrt{12}\right)}{\left(\sqrt{6}\right)^2\sqrt{27}}$

$= \dfrac{\sqrt{3}\times\sqrt{3}\times\sqrt{12}}{\sqrt{6}\times\sqrt{6}\times\sqrt{27}} \Rightarrow \dfrac{\sqrt{3\times3\times12}}{\sqrt{6\times6\times27}}$

$\Rightarrow \sqrt{\dfrac{108}{972}} \Rightarrow \sqrt{\dfrac{1}{9}} = \dfrac{1}{3}$

Since $\dfrac{1}{3}$ is a rational number, therefore $3\sqrt{12} \div 6\sqrt{27}$ is not a surd.

(vi) $\sqrt[3]{5} \times \sqrt[3]{25} = \sqrt[3]{5\times25} = \sqrt[3]{5\times5\times5} \Rightarrow \sqrt[3]{5^3} = 5$

Which is a rational number. Hence, $\sqrt[3]{5} \times \sqrt[3]{25}$ is not a surd.

Ex.22 Simplify each of the following:

(i) $\sqrt[3]{3} \cdot \sqrt[3]{4}$ (ii) $\sqrt[3]{128}$

Sol. (i) $\sqrt[3]{3} \cdot \sqrt[3]{4} = \sqrt[3]{3\times4} = \sqrt[3]{12}$

(ii) $\sqrt[3]{128} = \sqrt[3]{64\times2} = \sqrt[3]{64}\ \sqrt[3]{2}$

$= \sqrt[3]{4^3} \cdot \sqrt[3]{2} = 4\sqrt[3]{2}$

Ex.23 Simplify each of the following:

(i) $\sqrt[3]{\dfrac{8}{27}}$ (ii) $\dfrac{\sqrt[4]{3888}}{\sqrt[4]{48}}$

Sol. (i) $\sqrt[3]{\dfrac{8}{27}} = \dfrac{\sqrt[3]{8}}{\sqrt[3]{27}} = \dfrac{\sqrt[3]{2^3}}{\sqrt[3]{3^3}} = \dfrac{2}{3}$

(ii) $\dfrac{\sqrt[4]{3888}}{\sqrt[4]{48}} = \sqrt[4]{\dfrac{3888}{48}} = \sqrt[4]{81} = \sqrt[4]{3^4} = 3$

Ex.24 Find the value of x in each of the following:

(i) $\sqrt[3]{4x-7} - 5 = 0$ (ii) $\sqrt[4]{3x+1} = 2$

Sol. (i) $\sqrt[3]{4x-7} - 5 = 0$

$\Rightarrow \sqrt[3]{4x-7} = 5$

$\Rightarrow (\sqrt[3]{4x-7})^3 = 5^3$

$\Rightarrow 4x - 7 = 125 \qquad [(\sqrt[n]{a})^n = a]$

$\Rightarrow 4x = 132$

$\Rightarrow x = 33$

(ii) $\sqrt[4]{3x+1} = 2$

$\Rightarrow (\sqrt[4]{3x+1})^4 = 2^4$

$\Rightarrow 3x + 1 = 16 \qquad [(\sqrt[n]{a})^n = a]$

$\Rightarrow 3x = 15 \Rightarrow x = 5$

Rationalization of Surds

Rationalizing factor : If product of two surds is a rational number then each of them is called the **rationalizing factor (R.F.)** of the other. The process of converting a surd to a rational number by using an appropriate multiplier is known as **rationalization.**

When the denominator of an expression contains a term with a square root (or a number with radical sign), the process of converting it to an equivalent expression whose denominator is a rational number is called **rationalizing** the **denominator**.

Ex.25 Rationalize the denominator : $\frac{1}{\sqrt{162}}$

Sol. $\frac{1}{\sqrt{162}} = \frac{1}{\sqrt{81\times 2}} = \frac{1}{9\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = \frac{\sqrt{2}}{18}$

Ex.26 Rationalize the denominator . $\frac{1}{7+5\sqrt{3}}$

Sol. $\frac{1}{7+5\sqrt{3}} = \frac{1}{7+5\sqrt{3}} \times \frac{7-5\sqrt{3}}{7-5\sqrt{3}}$

$= \frac{7-5\sqrt{3}}{49-75} = \frac{7-5\sqrt{3}}{-26}$.

Ex.27 If both a and b are rational numbers, find the value of a and b in each of the following.

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

Sol. $\frac{3+\sqrt{5}}{3-\sqrt{5}}$

$3+\sqrt{5}$ is the rationalizing factor of $3-\sqrt{5}$.

$\therefore \frac{3+\sqrt{5}}{3-\sqrt{5}} = \frac{3+\sqrt{5}}{3-\sqrt{5}} \times \frac{3+\sqrt{5}}{3+\sqrt{5}} = \frac{(3+\sqrt{5})^2}{(3)^2-(\sqrt{5})^2}$

$= \frac{9+5+6\sqrt{5}}{9-5} = \frac{14+6\sqrt{5}}{4} = \frac{14}{4} + \frac{6}{4}\sqrt{5}$

$= \frac{7}{2} + \frac{3}{2}\sqrt{5} = a + b\sqrt{5}$

$\therefore a = \frac{7}{2}$ and $b = \frac{3}{2}$

Ex.28 Express $E = \frac{1}{\sqrt{5}+\sqrt{3}-\sqrt{8}}$ with a rational denominator.

Sol. The denominator is a trinomial surd, an expression having all the three terms as surds. We group any two of the three terms, say $\sqrt{5}$ and $\sqrt{3}$.

Thus $\sqrt{5}+\sqrt{3}-\sqrt{8}=(\sqrt{5}+\sqrt{3})-\sqrt{8}$.

Consider the product $[(\sqrt{5}+\sqrt{3})-\sqrt{8})\ [(\sqrt{5}+\sqrt{3})+\sqrt{8}]$

$= (\sqrt{5}+\sqrt{3})^2-(\sqrt{8})^2 = 5+3+2\sqrt{5}\ \sqrt{3}-8=2\sqrt{15}$

$\therefore\ \dfrac{1}{\sqrt{5}+\sqrt{3}-\sqrt{8}}=\dfrac{\sqrt{5}+\sqrt{3}+\sqrt{8}}{(\sqrt{5}+\sqrt{3}-\sqrt{8})\ (\sqrt{5}+\sqrt{3}+\sqrt{8})}=\dfrac{(\sqrt{5}+\sqrt{3}-\sqrt{8})}{2\sqrt{15}}$

Rationalizing the denominator $=\dfrac{\sqrt{5}+\sqrt{3}+\sqrt{8}}{2\sqrt{15}}\left(\dfrac{\sqrt{15}}{\sqrt{15}}\right)=\dfrac{5\sqrt{3}+3\sqrt{5}+2\sqrt{30}}{30}$

◈ Rational exponents of a real number

Principal of n^{th} Root of a Positive Real Numbers :

If **'a'** is a positive real number and **'n'** is a **positive integer**, then the principal **n^{th} root** of **a** is the unique positive real number **x** such that **$x^n = a$**.

The principal n^{th} root of a positive real number a is denoted by **$a^{1/n}$** or **$\sqrt[n]{a}$** .

Remark :

If 'a' is negative real number and 'n' is an even positive integer, then the principal nth root of a is not defined, because an even power of a real number is always positive. Therefore $(-9)^{1/2}$ is a meaningless quantity, if we confine ourselves to the set of real number, only.

Rules for Exponents

Let a, b > 0 be real numbers & p, q are rational numbers then

(i) $a^p.a^q = a^{p+q}$ (ii) $(a^p)^q = a^{pq}$

(iii) $\dfrac{a^p}{a^q} = a^{p-q}$ (iv) $(ab)^p = a^pb^p$

(v) $a^0 = 1$ (vi) $a^p = \dfrac{1}{a^{-p}}$ or $a^{-p} = \dfrac{1}{a^p}$

Ex.29 Find the value of the following :

(i) $\dfrac{(7)^3\times 21}{3}$ (ii) $\dfrac{(121)^3\times 33}{3}$ (iii) $\dfrac{(169)^2}{13^2}$ (iv) $\dfrac{(63)^4\times 144}{132\times 9}$ (v) $\dfrac{(2^0+3^0)5^2}{25}$

Sol. (i) $\dfrac{(7)^3\times 21}{3} = 7^3\times 7 = 7^{3+1} = 7^4$

(ii) $\dfrac{(121)^3\times 33}{3} = (11^2)^3\times 11 = 11^6\times 11^1 = 11^7$

(iii) $\dfrac{(169)^2}{13^2}=\dfrac{[(13)^2]^2}{13^2}=\dfrac{13^4}{13^2}$ $= 13^{4-2} = 13^2 = 169$

(iv) $\dfrac{(63)^4\times 144}{132\times 9} = \dfrac{(9\times 7)^4\times (12)^2}{(11\times 12)\times 3^2} = \dfrac{(3^2\times 7)^4\times (3\times 2^2)^2}{11\times 2^2\times 3\times 3^2} = \dfrac{(3^2)^4\times 7^4\times 3^2\times (2^2)^2}{11\times 2^2\times 3^{1+2}}$

$= \dfrac{3^8\times 7^4\times 3^2\times 2^4}{11\times 2^2\times 3^3} = \dfrac{2^4\times 3^{8+2}\times 7^4}{2^2\times 3^3\times 11} = \dfrac{2^{4-2}\times 3^{10-3}\times 7^4}{11} = \dfrac{2^2\times 3^7\times 7^4}{11}$

(v) $\dfrac{(2^0+3^0)5^2}{25} = \dfrac{(1+1).5^2}{5^2} = \dfrac{2}{5^{2-2}} = \dfrac{2}{5^0} = \dfrac{2}{1} = 2$

Ex.30 Find the value of x : $\left(\frac{3}{5}\right)^{x}\left(\frac{5}{3}\right)^{2x}=\frac{125}{27}$

Sol. $\left(\frac{3}{5}\right)^{x}\left(\frac{5}{3}\right)^{2x}=\frac{125}{27}$

$\left(\frac{5}{3}\right)^{-x}\left(\frac{5}{3}\right)^{2x}=\frac{125}{27}$

$\left(\frac{5}{3}\right)^{2x-x}=\frac{125}{27} \Rightarrow \left(\frac{5}{3}\right)^{x}=\left(\frac{5}{3}\right)^{3}$

Because the base is same, so comparing the powers.

x = 3.

COMPETITIVE LEVEL

Factors and Multiples

Factors : 'a' is a factor of **'b'** if there exists a relation such that **a × n = b**, where **'n'** is any natural number.

1 is a factor of all numbers as 1 × b = b.

The largest factor of a number is the number itself and the smallest factor is 1. The number of factors of a number are finite.

Multiples : 'a' is a multiple of **'b'** if there exists a relation such that **b × n = a**. Thus the multiples of 5 are 5, 10, 15, 20 and so on.

The smallest multiple of a number is the number itself and the number of multiples are infinite.

Factorisation : It is the process of splitting any number into a form where it is expressed only in terms of the most basic prime factors.

For example, $36 = 2^2 \times 3^2$. It is expressed in the factorised form in terms of its basic prime factors.

Number of factors : For any composite number C, which can be expressed as $C = a^p \times b^q \times c^r \times \ldots\ldots$, where a, b, c ..... are all prime factors and p, q, r are positive integers, the number of factors is equal to $(p + 1) \times (q + 1) \times (r + 1)\ldots.$

For example $36 = 2^2 \times 3^2$. So the factors of 36 = (2 +1) × (2 + 1) = 3 × 3 = 9.

Ex.31 If $N = 18^4 \times 2^3 \times 5^5$, find the total number of even factors of N.

Sol. The factorised form of N is $(3^2 \times 2)^4 \times 2^3 \times 5^5 \Rightarrow 3^8 \times 2^7 \times 5^5$.

Hence, the total number of factors of N is (8 + 1) (7 + 1) (5 + 1) = 9 × 8 × 6 = 432.

Some of these are odd and some are even. The odd are formed only with the combination of 3s and 5s.

So, the total number of odd factors is (8 + 1) (5 + 1) = 54.

Therefore, the number of even factors is 432 – 54 = 378.

Ex.32 A number N when factorised can be written $N = a^4 \times b^3 \times c^7$. Find the number of perfect squares which are factors of N (The three prime numbers a, b, c > 2).

Sol. In order that the perfect square divides N, the powers of 'a' can be 0, 2 or 4.

Powers of 'b' can be 0, 2. Power of 'c' can be 0, 2, 4 or 6.

Hence, a combination of these powers given 3 × 2 × 4 i.e. 24 numbers.

So, there are 24 perfect squares that divides N.

Remainders

Ex.33 In dividing a number by 585, a student employed the method of short division. He divided the number successively by 5, 9 and 13 (factors of 585) and got the remainders 4, 8 and 12. If he had divided number by 585, then find out the remainder.

Sol.

5	x	
9	y	4
13	z	8
	1	12

Now, 1169 when divided by 585 gives remainder = 584.

Ex.34 What is the remainder when 7^{38} is divided by 48.

Sol. $\frac{7^{38}}{48} = \frac{(7^2)^{19}}{48} = \frac{(49)^{19}}{48} = \frac{(48+1)^{19}}{48}$ so by using binomial expansion, we can say that 18 terms are completely divisible by 48 but the last term which is $\frac{(+1)^{19}}{48}$ is not divisible. So, = 1 is the remainder.

Ex.35 What is the remainder when $14^{15^{16}}$ is divided by 5 ?

Sol. $14^{15^{16}} = (15-1)^{odd} = 15n + (-1)^{odd}$, i.e. a (multiple of 5) –1.
Thus when divided by 5 the remainder will be (–1), i.e. 4.

Cyclicity

Cyclicity means a cycle or pattern or a period in the unit's place, ten's place, hundred' place and so on of a number.

Digit	Cyclicity
0, 1, 5 and 6	1
4 and 9	2
2, 3, 7 and 8	4

Ex.36 Find the last digit of the product $7^{23} \times 8^{13}$

Sol. Both 7 & 8 exhibit a cyclicity of 4 the last digit

$7^1 = 7$ $\quad$ $8^1 = 8$

$7^2 = 9$ $\quad$ $8^2 = 4$

$7^3 = 3$ $\quad$ $8^3 = 2$

$7^4 = 1$ $\quad$ $8^4 = 6$

$7^5 = 7$ $\quad$ $8^5 = 8$

$(7^4)^5 \times 7^3$ $\quad$ $(8^4)^3 \times 8^1$

7^3 i.e. = 3 $\quad$ 8^1 i.e. = 8

Hence last digit $3 \times 8 = 24$ i.e. 4 in unit digit.

Ex.37 Find the unit digit of 7^{157} ?

Sol. Since the exponent 157 is not divisible by 4, we need to find the remainder when 157 is divided by 4.
Remainder of (157/4) is 1
From general rule of cyclicity, unit digit of 7^{157} = unit digit of $(7^1) = 7$.

EXERCISE-1

➢ Very Short Answer Type Questions

Q.1 Write two irrational numbers between 0.2 and 0.21.

Q.2 Write three irrational numbers between 0.202002000200002...and 0.203003000300003...

Q.3 Write three irrational numbers between $\sqrt{3}$ and $\sqrt{5}$.

Q.4 Simplify : $\sqrt{m^2n^2} \times \sqrt[6]{m^2n^2} \times \sqrt[3]{m^2n^2}$

Q.5 If $\sqrt{3}$ = 1.732, find the value of $\frac{2}{\sqrt{3}}$.

➢ Short Answer Type Questions – Type I

Q.6 Simplify :

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

(iii) $(25)^{\frac{3}{2}}$ (iv) $(36)^{\frac{3}{2}}$

(v) $(49)^{-\frac{3}{2}}$ (vi) $(.0001)^{-\frac{3}{4}}$

Q.7 Simplify : $\sqrt[5]{\sqrt[4]{(2^4)^3}} - 5\sqrt[5]{8} + 2\sqrt[4]{\sqrt[5]{(2^3)^4}}$

Q.8 Given that $\sqrt{3}$ = 1.732, find the value of $\sqrt{75} + \frac{1}{2}\sqrt{48} - \sqrt{192}$.

Q.9 Determine a and b if $\frac{5+\sqrt{3}}{7-4\sqrt{3}} = 94\,a + 3\sqrt{3}\,b$.

Q.10 If $\sqrt{5}$ = 2.236 and $\sqrt{6}$ = 2.449, find the value of $\frac{1+\sqrt{2}}{\sqrt{5}+\sqrt{3}} + \frac{1-\sqrt{2}}{\sqrt{5}-\sqrt{3}}$.

➢ Short Answer Type Questions – Type II

Q.11 If $x = 7 + 4\sqrt{3}$, find the value of $\sqrt{x} + \frac{1}{\sqrt{x}}$.

Q.12 Express in $\frac{p}{q}$ form

(i) $2.\overline{124}$, (ii) $0.2\overline{37}$

Q.13 Express $\frac{1}{37}$ in decimal form and hence write the decimal expansion of $\frac{79}{37}$.

Q.14 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.15 Evaluate : $\sqrt{5+2\sqrt{6}}$.

Q.16 Visualize the position of 5.665 on the number line, through successive magnification.

Q.17 Visualize the representation of $1.\overline{3}$ on the number line upto 4 decimal places, that is, upto 1.3333. Further locate 1.33333.

Q.18 Express $\sqrt{5.42}$ geometrically and represent it on the number line.

Q.19 By taking π = 3.141 and $\sqrt{2} = 1.414$, evaluate $\frac{2\pi + 3\sqrt{2}}{5}$ upto three places of decimals

Q.20 If $a = 2 + \sqrt{3} + \sqrt{5}$ and $b = 3 + \sqrt{3} - \sqrt{5}$, prove that $a^2 + b^2 - 4a - 6b - 3 = 0$.

➢ Long Answer Type Questions

Q.21 If $x = \sqrt{3} + 2\sqrt{2}$ and $y = \sqrt{3} - 2\sqrt{2}$, evaluate $x^4 + y^4 + 6x^2y^2$.

Q.22 If $x = 1 - \sqrt{2}$, find the value of

(i) $x + \frac{1}{x}$ (ii) $x - \frac{1}{x}$

(iii) $x^2 + \frac{1}{x^2}$ (iv) $x^2 - \frac{1}{x^2}$

(v) $x^4 + \frac{1}{x^4}$ (vi) $x^4 - \frac{1}{x^4}$

Q.23 For the identity $\frac{7+\sqrt{5}}{7-\sqrt{5}} - \frac{7-\sqrt{5}}{7+\sqrt{5}}$

$= a + 7\sqrt{5}b$ determine the rational numbers a and b.

Q.24 Simplify the following expressions :

(i) $\frac{1}{\sqrt{2}+1} + \frac{1}{\sqrt{3}+\sqrt{2}} + \frac{1}{\sqrt{4}+\sqrt{3}} + \frac{1}{\sqrt{5}+\sqrt{4}}$

(ii) $\frac{1}{\sqrt{2}+1} + \frac{1}{\sqrt{3}+2} + \frac{2}{\sqrt{5}+3} + \frac{2}{\sqrt{5}-3}$

Q.25 If $a^x = b$, $b^y = c$ and $c^z = a$, then prove that $xyz = 1$. Here a, b, c are positive real numbers and x, y, z are rational numbers.

Q.26 The value of

$$\frac{1}{3-\sqrt{8}} - \frac{1}{\sqrt{8}-\sqrt{7}} + \frac{1}{\sqrt{7}-\sqrt{6}} - \frac{1}{\sqrt{6}-\sqrt{5}} + \frac{1}{\sqrt{5}-2}$$

Q.27 If $x = 3 + \sqrt{8}$ then find the value of $x^3 + \frac{1}{x^3}$.

Q.28 If $xyz = 1$, then simplify

$(1 + x + y^{-1}) \times (1 + y + z^{-1})^{-1} \times (1 + z + x^{-1})^{-1}$

Q.29 If $a = \frac{\sqrt{7}-\sqrt{6}}{\sqrt{7}+\sqrt{6}}$ and $b = \frac{\sqrt{7}+\sqrt{6}}{\sqrt{7}-\sqrt{6}}$, then find the value of $a^2 + b^2 + ab$.

Q.30 Simplify :

$$\frac{1}{1 + x^{b-a} + x^{c-a}} + \frac{1}{1 + x^{a-b} + x^{c-b}} + \frac{1}{1 + x^{a-c} + x^{b-c}}$$

EXERCISE-2

Q.1 What is the value of 4^{2x-2}, if $(16)^{2x+3} = (64)^{x+3}$?
(A) 64 (B) 256 (C) 32 (D) 512

Q.2 If $2^{-m} \times \frac{1}{2^{+m}} = \frac{1}{4}$, then
$\frac{1}{14}\left[(4^m)^{\frac{1}{2}} + \left(\frac{1}{5^m}\right)^{-1}\right] =$
(A) $\frac{1}{2}$ (B) 2 (C) 4 (D) $\frac{-1}{4}$

Q.3 $2\,[(16-15)^{-1} + 25\,(13-8)^{-2}]^{-1} + (1024)^{0} =$ _____
(A) 2 (B) 3 (C) 1 (D) 5

Q.4 If $\sqrt{13 - x\sqrt{10}} = \sqrt{8} + \sqrt{5}$, then what is the value of x ?
(A) –5 (B) –6 (C) –4 (D) –2

Q.5 If $\frac{5-\sqrt{3}}{2+\sqrt{3}} = x + y\sqrt{3}$, then (x, y) is :
(A) (13, –7) (B) (–13, 7)
(C) (–13, –7) (D) (13, 7)

Q.6 If $\frac{3-2\sqrt{5}}{6-\sqrt{5}} = a + b\sqrt{5}$ where a and b are rational numbers, then what are the values of a and b ?
(A) $\frac{8}{35}, \frac{-9}{35}$ (B) $\frac{8}{31}, \frac{-9}{31}$
(C) $\frac{-8}{31}, \frac{9}{31}$ (D) $\frac{-8}{35}, \frac{9}{35}$

Q.7 $\left[\left\{\left(\frac{1}{x^{a^2-b^2}}\right)^{\frac{1}{a-b}}\right\}^{a+b}\right]^{\frac{1}{(a+b)^2}} =$ _____
(A) x^2 (B) $\frac{1}{x}$
(C) 7^3 (D) $\frac{1}{x^2}$

Q.8 Simplify
$\left[(p^{-1}+q^{-1})(p^{-1}-q^{-1}) \div \left(\frac{1}{p^{-1}} - \frac{1}{q^{-1}}\right)\left(\frac{1}{p^{-1}} + \frac{1}{q^{-1}}\right)\right](pq)^2$
(A) $(pq)^2$ (B) –1
(C) $-(pq)^{-2}$ (D) 1

Q.9 If $x = \frac{2}{\sqrt{10}-\sqrt{8}}, y = \frac{2}{\sqrt{10}+2\sqrt{2}}$, then
$(x-y)^2 =$
(A) $4\sqrt{2}$ (B) 32 (C) $8\sqrt{2}$ (D) 64

Q.10 If $a = \sqrt{17} - \sqrt{16}$ and $b = \sqrt{16} - \sqrt{15}$ then :
(A) a < b (B) a > b
(C) a = b (D) none of these

Q.11 If $y = 3 - \sqrt{8}$, then $\left(y - \frac{1}{y}\right)^2 =$ _____
(A) 9 (B) 81 (C) 4 (D) 32

Q.12 If $x = \frac{2}{\sqrt{3}-\sqrt{5}}$ and $y = \frac{2}{\sqrt{3}+\sqrt{5}}$, then x + y =
(A) 3 (B) $4\sqrt{3}$
(C) $-2\sqrt{3}$ (D) 6

Q.13 If $x = \frac{1}{2-\sqrt{3}}$, the value of $x^3 - 2x^2 - 7x + 10$ is equal to :
(A) $2+\sqrt{3}$ (B) 10
(C) $7+2\sqrt{3}$ (D) 8

Q.14 If $2^x = 4^y = 8^z$ and $\left(\frac{1}{2x} + \frac{1}{4y} + \frac{1}{6z}\right) = \frac{24}{7}$, then the value of z is _____.
(A) 7/16 (B) 7/32 (C) 7/48 (D) 7/64

Q.15 If a = 1.1039, then the value of $3a - \sqrt{4a^2 - 4a + 1}$ is _____.
(A) 0.1039 (B) 0.2078
(C) 2.1039 (D) 1.1039

Q.16 If a, a + 2, and a + 4 are prime numbers, then the number of possible solution for a is :
(A) three (B) two
(C) one (D) more than three

Q.17 The number of prime factors of $(3 \times 5)^{12} (2 \times 7)^{10} (10)^{25}$ is :
(A) 47 (B) 60 (C) 72 (D) 94

Q.18 Find the square root of $7 - 4\sqrt{3}$.
(A) $2 - \sqrt{3}$ (B) $5 - \sqrt{3}$
(C) $2 - \sqrt{5}$ (D) None of these

Q.19 How many natural numbers between 200 and 400 are there which are divisible by
i. Both 4 and 5?
ii. 4 or 5 or 8 or 10 ?
(A) 9, 79 (B) 10, 80
(C) 10, 81 (D) None of these

Q.20 If $(2^{32} + 1)$ is divisible by a certain number then which of the following is also divisible by that number.
(A) $(2^{16} - 1)$ (B) $2^{16} + 1$
(C) $2^{96} + 1$ (D) None of these

Q.21 The largest number which exactly divides the product of any four consecutive natural numbers is :
(A) 6 (B) 12 (C) 24 (D) 120

Q.22 $7^{6n} - 6^{6n}$, where n is an integer > 0, is divisible
by :
(A) 13 (B) 127
(C) 559 (D) All of these

Q.23 How many three-digit numbers would you find, which when divided by 3, 4, 5, 6, 7 leave the remainders 1, 2, 3, 4, and 5 respectively ?
(A) 4 (B) 3 (C) 2 (D) 1

Q.24 The HCF of 2 numbers is 11 and their LCM is 693. If their sum is 176, find the numbers.
(A) 99,77 (B) 110, 66
(C) 88,77 (D) 121, 44

Q.25 If P is a prime number, then the LCM of P and (P + 1) is
(A) P(P +1) (B) (P + 2)P
(C) (P + 1)(P – 1) (D) None of these

Q.26 The LCM of two numbers is 567 and their HCF is 9. If the difference between the two numbers is 18, find the two numbers:
(A) 36 and 18 (B) 78 and 60
(C) 63 and 81 (D) 52 and 34

Q.27 P is a prime number greater than 5. What is the remainder when P is divided by 6?
(A) 5 (B) 1
(C) 1 or 5 (D) None of these

Q.28 What is the remainder when
$74^{13} - 41^{13} + 75^{13} - 42^{13}$ is divided by 66?
(A) 2 (B) 64
(C) 1 (D) 0

Q.29 Find the unit digit of $(7^{95} - 3^{58})$.
(A) 6 (B) 4
(C) 3 (D) None of these

Q.30 What is the highest power of 5 that divides of x = 100! = 100 × 99 × 98 × ..... × 3 × 2 × 1.
(A) 23 (B) 24
(C) 25 (D) 26

EXERCISE-3

(Previous Year Questions – NTSE, NSO, IJSO & NSTSE)

Q.1 P, Q and R are three natural numbers such that P and Q are primes and Q divides PR. Then out of the following the correct statement is :
(A) Q divides R
(B) P divides R
(C) P divides QR
(D) P divides PQ

Q.2 It is required to decide if 1107 is a prime number or not. The number of trials of division necessary is :
(A) 10 (B) 11 (C) 12 (D) 235

Q.3 The number of integers between $-\sqrt{8}$ and $\sqrt{32}$ is :
(A) 5 (B) 6 (C) 7 (D) 8

Q.4 When expanded, the number of zeros in 1000^{10} is :
(A) 13 (B) 30 (C) 4 (D) 10

Q.5 Let N = 28, the sum of All distinct factors of N is :
(A) 27 (B) 28 (C) 55 (D) 56

Q.6 The units digit of
$(1 + 9 + 9^2 + 9^3 + \text{---------} + 9^{2009})$ is :
(A) 0 (B) 1 (C) 9 (D) 3

Q.7 The biggest among the following is :
(A) $2^{1/2}$ (B) $3^{1/3}$ (C) $6^{1/6}$ (D) $8^{1/8}$

Q.8 If $2009 = p^a.q^b$, where "p" and "q" are prime numbers, then find the value of p + q.
(A) 3 (B) 48 (C) 51 (D) 2009

Q.9 If HCF (p, q) = 12 and p × q = 1800 n then LCM (p, q) is :
(A) 3600 (B) 900 (C) 150 (D) 90

Q.10 If a, b, c are positive, $\frac{a+c}{b+c}$ is :
(A) always smaller than $\frac{a}{b}$
(B) always greater than $\frac{a}{b}$
(C) greater than $\frac{a}{b}$ only if a > b.
(D) greater than $\frac{a}{b}$ only if a < b.

Q.11 If the eight digit number 2575d568 is divisible by 54 and 87, the value of the digit 'd' is :
(A) 4 (B) 7
(C) 0 (D) 8

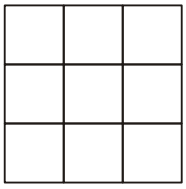
Q.12 What will be the remainder if the number 7^{2012} is divided by 25?
(A) 24 (B) 18
(C) 7 (D) 1

Q.13 If $\sqrt[x]{75} = \sqrt[y]{45} = \sqrt[z]{15} =$ a, then which of the statement is true -
(A) x + y = 2z (B) x + y = 3z
(C) x – y = 2z (D) x – y = 3Z

Q.14 The sum of 2 digits x and y is divisible by 7. What can one say about a 3 digit number formed by these two digits.
(A) xxy is divisible by 7
(B) xyx is divisible by 7
(C) xyx is divisible by 7^2
(D) yyx is divisible by 7

Q.15 Number plate of a vehicle consists of 4 digits. The first digit is the square of second. The third digit is thrice the second and the fourth digit is twice the second. The sum of all 4 digits is thrice the first. The number is
(A) 1132 (B) 4264
(C) 1642 (D) 9396

Q.16 Figure shows a square gird of order 3, which of the following is correct formula for the total number of squares in a similar grid of order n.



(A) $\frac{n(n+1)}{2}$ (B) $\frac{n^2(n+1)^2}{4}$

(C) $\frac{n(n+1)(2n+1)}{6}$ (D) $\frac{n(n+1)(n+2)}{6}$

Q.17 A number x is a rational number if there exists integers p and q such that x = p/q. This is definition of rational numbers in which,

(A) both p & q can be zero

(B) both p & q should not be zero

(C) q can be zero but not p

(D) p can be zero but not q

Q.18 The least positive integer, n, such that 2 divides n, 3 divides n + 1, 4 divides n + 2, 5 divides n + 3 and 6 divides n + 4 is

(A) 62 (B) 120 (C) 720 (D) 52

Q.19 Number plate of a vehicle consists of 4 digits. The first digit is the square of second. The third digit is thrice the second and the fourth digit is twice the second. The sum of all 4 digits is thrice the first. The number is -

(A) 1132 (B) 4264 (C) 1642 (D) 9396

Q.20 If $\sqrt{338}-\sqrt{288}$ = m then m is :

(A) $\sqrt{50}$ (B) $\sqrt{32}$ (C) $\sqrt{18}$ (D) $\sqrt{2}$

Q.21 $(41)^{16}$ - $(14)^{16}$ is a multiple of

(A) 1485 (B) 1584

(C) 1845 (D) 1854

Q.22 What will be the remainder if the number $(1000000)^3$ is divided by 143?

(A) 9 (B) 6 (C) 1 (D) 0

Q.23 What will be the remainder if the number 7^{2015} is divided by 25?

(A) 1 (B) 7 (C) 18 (D) 24

Q.24 The greatest number which can divide 1356, 1868 and 2764 leaving the same remainder 12 in each case, is.

(A) 64 (B) 124

(C) 156 (D) 260

Q.25 A student was asked to solve the fraction $\frac{\frac{7}{3}+1\frac{1}{2}\text{ of }\frac{5}{3}}{2+1\frac{1}{2}}$ and his answer was $\frac{1}{4}$. By how much was his answer wrong?

(A) 1/63 (B) 1/55

(C) 1/220 (D) 95/84

Q.26 If $x=\frac{\sqrt{a+2b}+\sqrt{a-2b}}{\sqrt{a+2b}-\sqrt{a-2b}}$, then value of bx^2 - ax + b is.

(A) 0 (B) 2

(C) 1 (D) None of these

Q.27 The statement "a is not less than 4" is correct represented by :

(A) $a < 4$ (B) $a > 4$ (C) $a \geq 4$ (D) $a \leq 4$

Q.28 The number $3^8(3^{10} + 6^5) + 2^3 (2^{12} + 6^7)$ is :

(A) A perfect square and a perfect cube

(B) Neither a perfect square nor a perfect cube

(C) A perfect cube but not a perfect square

(D) A perfect square but not a perfect cube

Q.29 Number of numbers less than 40 having exactly four divisors is -

(A) 15 (B) 12 (C) 11 (D) 14

Q.30 Number of integers n such that the number 1 + n is a divisor of the number $1 + n^2$ is -

(A) 0 (B) 1 (C) 4 (D) 2

Q.31 How many four digit numbers are there such that when they are divided by 101, they have 99 as remainder ?

(A) 90 (B) 98 (C) 100 (D) 101

Q.32 If $x = (\sqrt{21} - \sqrt{20})$ and $y = (\sqrt{18} - \sqrt{17})$, then -

(A) x = y (B) x < y

(C) x > y (D) x + y = 0

Q.33 By which smallest number we should divide 198396198 to get a perfect square ?
(A) 14 (B) 18 (C) 22 (D) 28

Q.34 If a and b are natural numbers such that $\left(\frac{1}{a}\right)^{\frac{1}{b}} = 0.\overline{3}$, then the value of ab is :
(A) 81 (B) 24 (C) 192 (D) 375

Q.35 If $5\frac{7}{x} \times y\frac{1}{13} = 12$, where fractions are in their lowest terms, then x – y is equal to
(A) 2 (B) 4 (C) 7 (D) 9

Q.36 Number of zero's in the product of $5 \times 10 \times 25 \times 40 \times 50 \times 55 \times 65 \times 125 \times 80$, is -
(A) 8 (B) 9 (C) 12 (D) 13

Q.37 The HCF of any two prime numbers a and b, is –
(A) a (B) ab (C) b (D) 1

Q.38 Which of the following is an irrational number?
(A) $\sqrt{41616}$
(B) 23.232323 ...
(C) $\frac{(1+\sqrt{3})^3 - (1-\sqrt{3})^3}{\sqrt{3}}$
(D) 23.10100100010000 ...

Q.39 On dividing a natural number by 13, the remainder is 3 and on dividing the same number by 21, the remainder is 11. If the number lies between 500 and 600, then the remainder on dividing the number by 19 is -
(A) 4 (B) 6 (C) 9 (D) 13

Q.40 Expressing $0.\overline{34} + 0.3\overline{4}$ as a single decimal, we get
(A) $0.67\overline{88}$ (B) $0.6\overline{89}$
(C) $0.6\overline{878}$ (D) $0.6\overline{87}$

Q.41 Which of the following is not an irrational number ?
(A) $2+\sqrt{5}$ (B) $\sqrt{2}$
(C) $\frac{7}{\sqrt{5}}$ (D) $\frac{2\sqrt{11}}{7\sqrt{11}}$

Q.42 The multiplication of all prime numbers between 1 and 10 is
(A) 105 (B) 945 (C) 210 (D) 1890

Q.43 If a : b = 2 : 3 and x : y = 3 : 4, then $\frac{2ax-25by}{3ay+4bx}$ is –
(A) $\frac{24}{5}$ (B) $\frac{5}{24}$ (C) $-\frac{24}{5}$ (D) $\frac{12}{13}$

Q.44 The expression $14^m - 6^m$ will always divisible by
(A) 8 (B) 20 (C) 14 (D) 6

Q.45 Number r is termed as Rational number if it can be expressed as $\frac{p}{q}$, where p and q are integers and,
(A) p = 0 (B) p ≠ 0 (C) q = 0 (D) q ≠ 0

Q.46 Product of any three consecutive even numbers is divisible by
(A) 2 (B) 4 (C) 16 (D) 12

Q.47 A person kept rolling a regular (six faced) die until one of the numbers appeared third time on the top. This happened in 12^{th} throw and the sum of all the numbers in 12 throws was 46. Which number appeared least number of times ?
(A) 6 (B) 4 (C) 2 (D) 1

Q.48 A 5 x 5 x 5 cube is built using unit cubes. How many different cuboids (that differ in at least one unit cube) can be formed using the same number of unit cubes ?
(A) 1000 (B) 1728 (C) 2730 (D) 3375

Q.49 Let n be a positive integer not divisible by 6. suppose n has 6 positive divisors. The number of positive divisors of 9n is
(A) 54 (B) 36 (C) 18 (D) 12

Q.50 The integer closest to $\sqrt{111...1-222...2}$, where there are 2018 ones and 1009 twos, is
(A) $\frac{10^{1009}-1}{3}$ (B) $\frac{10^{1009}-1}{9}$
(C) $\frac{10^{2018}-1}{3}$ (D) $\frac{10^{2018}-1}{9}$

ANSWER KEY

EXERCISE - 1

1. 0.2010010001..., 0.2020020002...

2. 0.20201001000100001..., 0.202020020002..., 0.202030030003...

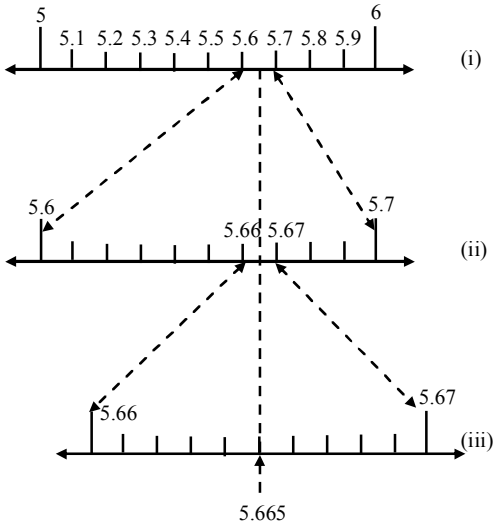
3. 1.8010010001..., 1.9010010001..., 2.010010001...

4. m^2n^2 **5.** 1.1547 **6.** (i) 27, (ii) $\frac{1}{27}$, (iii) 125, (iv) 216, (v) $\frac{1}{343}$, (vi) 1000

7. $-2.\sqrt[5]{8}$ **8.** – 1.732 **9.** $a = \frac{1}{2}$, b = 9 **10.** – 0.213 **11.** 4

12. (i) $\frac{2122}{999}$ (ii) $\frac{47}{198}$ **13.** $0.\overline{027}, 2.\overline{135}$ **14.** $\frac{y^2}{x^2}$ **15.** $\sqrt{3}+\sqrt{2}$

16.



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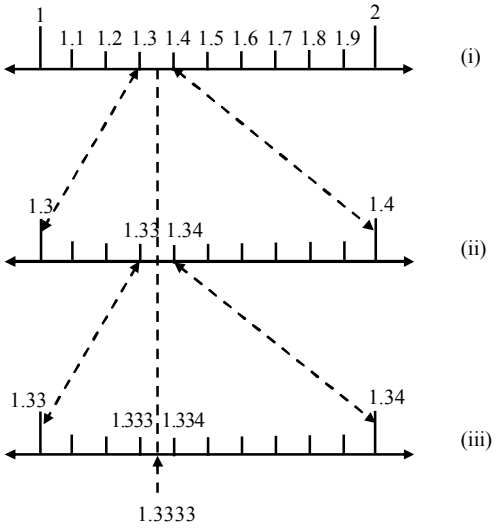

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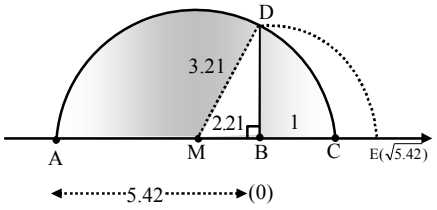


19. 2.105 (approx) **21.** 584

22. (i) $-2\sqrt{2}$, (ii) 2, (iii) 6, (iv) $-4\sqrt{2}$, (v) 34, (vi) $-24\sqrt{2}$ **23.** $a = 0, b = \frac{1}{11}$

24. (i) $\sqrt{5}-1$, (ii) $1+\sqrt{2}-\sqrt{3}-\sqrt{5}$ **26.** 5 **27.** 198

28. $\frac{1}{(1+y+xy)\ (1+z+yz)(1+x+zx)}$ **29.** 675 **30.** 1

EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	A	A	C	A	B	B	B	B	A	D	C	D	C	C
Ques.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	C	D	A	A	C	C	D	C	A	A	C	C	D	B	B

EXERCISE - 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A,D	B	D	B	D	A	B	B	B	D	B	D	B	B	D
Ques.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	C	D	A	D	D	A	C	C	A	D	A	C	C	D	C
Ques.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	A	B	C	A	C	B	D	D	A	D	D	C	C	A	D
Ques.	46	47	48	49	50										
Ans.	C	C,D	D	C	A										

EXERCISE-1

➢ Very Short Answer Type Questions

Sol.1 Irrational numbers between 0.2 and 0.21
0.201001000100001 - - - - -
0.202002000200002 - - - - -

Sol.2 Irrational numbers between
0.202002000200002 - - - - -
& 0.203003000300003 - - - - are
0.20201001000100001 - - - -
0.20202002000300004 - - - -
0.20203002000100005 - - - -

Sol.3 Irrational numbers between $\sqrt{3}$ and $\sqrt{5}$
a = $\sqrt{3}$ = 1.732
b = $\sqrt{5}$ = 2.25 are
1.801001001 - - - -
1.901000100001 - - - -
2.01001000100001 - - - -

Sol.4 $\sqrt{m^2.n^2}\ .\ \sqrt[6]{m^2n^2}\ .\ \sqrt[3]{m^2n^2}$
$= (m^2n^2)^{1/2} . (m^2n^2)^{1/6} . (m^2n^2)^{1/3}$
$= (m^2n^2)^{\frac{1}{2}+\frac{1}{6}+\frac{1}{3}} = (m^2n^2)^{\frac{3+1+2}{6}} = m^2n^2$

Sol.5 Given that $\sqrt{3}$ = 1.732,
Now, $\frac{2}{\sqrt{3}} = \frac{2}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$
$= \frac{2\sqrt{3}}{3} = \frac{2\times 1.732}{3}$
$= \frac{3.464}{3} = 1.15466...$

➢ Short Answer Type Questions – Type I

Sol.6 (i) $(3^2)^{3/2} = 3^3 = 27$
(ii) $9^{-3/2} = (3^2)^{-3/2} = 3^{-3} = \frac{1}{27}$
(iii) $25^{3/2} = (5^2)^{3/2} = 5^3 = 125$
(iv) $36^{3/2} = (6^2)^{3/2} = 6^3 = 216$
(v) $(49)^{-3/2} = (7^2)^{-3/2} = 7^{-3} = \frac{1}{343}$
(vi) $(0.0001)^{-3/4} = (10^{-4})^{-3/4} = 10^3 = 1000$

Sol.7 $\sqrt[5]{\sqrt[4]{(2^4)^3}} - 5.\sqrt[5]{8} + 2.\sqrt[4]{\sqrt[5]{(2^3)^4}}$
$= (2^{12})^{1/20} - 5.2^{3/5} + 2(2^{12})^{/20}$
$= 3.2^{12/20} - 5.2^{3/5} = 3.2^{3/5} - 5.2^{3/5}$
$= -2.2^{3/5} = -2^{1+3/5} = -2^{8/5}$
$= -\sqrt[5]{2^8} = -2.\sqrt[5]{8}$

Sol.8 Given that, $\sqrt{3}$ = 1.732,
$\sqrt{75} + \frac{1}{2}\sqrt{48} - \sqrt{192}$
$= 5\sqrt{3} + \frac{1}{2}.4\sqrt{3} - 8\sqrt{3}$
$= 5\sqrt{3} + 2\sqrt{3} - 8\sqrt{3} = 7\sqrt{3} - 8\sqrt{3} = -\sqrt{3}$
$= -1.732$

Sol.9 $\frac{5+\sqrt{3}}{7-4\sqrt{3}} = \frac{5+\sqrt{3}}{7-4\sqrt{3}} \times \frac{7+4\sqrt{3}}{7+4\sqrt{3}}$
$= \frac{35+20\sqrt{3}+7\sqrt{3}+12}{49-48}$
$= 47 + 27\sqrt{3}$
$47 + 27\sqrt{3} = 94a + 3\sqrt{3}\,b$
compare both surds,
$94a = 47$ and $3\sqrt{3}\,b = 27\sqrt{3}$
$a = \frac{1}{2}$ and b = 9

Sol.10 Given that $\sqrt{5} = 2.236$ and $\sqrt{6} = 2.449$
$\frac{1+\sqrt{2}}{\sqrt{5}+\sqrt{3}} + \frac{1-\sqrt{2}}{\sqrt{5}-\sqrt{3}}$
$= \frac{(1+\sqrt{2})(\sqrt{5}-\sqrt{3}) + (1-\sqrt{2})(\sqrt{5}+\sqrt{3})}{(\sqrt{5})^2 - (\sqrt{3})^2}$
$= \frac{(\sqrt{5}-\sqrt{3}) + (\sqrt{10}-\sqrt{6}) + (\sqrt{5}+\sqrt{3}) - (\sqrt{10}+\sqrt{6})}{5-3}$
$= \frac{2\sqrt{5}-2\sqrt{6}}{2} = \sqrt{5} - \sqrt{6}$
$= 2.236 - 2.449 = -0.213$

➢ Short Answer Type Questions – Type II

Sol.11 If $x = 7 + 4\sqrt{3}$, $\sqrt{x} + \frac{1}{\sqrt{x}} = ?$

$x = 2^2 + (\sqrt{3})^2 + 2.2\sqrt{3}$

$x = (2 + \sqrt{3})^2$

$\Rightarrow \sqrt{x} = 2 + \sqrt{3}$ and

$\frac{1}{\sqrt{x}} = \frac{1}{2+\sqrt{3}} = \frac{2-\sqrt{3}}{2^2-(\sqrt{3})^2} = \frac{2-\sqrt{3}}{1}$

$\Rightarrow \sqrt{x} + \frac{1}{\sqrt{x}} = (2 + \sqrt{3}) + (2 - \sqrt{3})$

$\Rightarrow \sqrt{x} + \frac{1}{\sqrt{x}} = 4$

Sol.12 (i) $x = 2.\overline{124}$

$x = 2.124\ 124\ 124$ ...(1)

$1000x = 2124.124$ ...(2)

Using (2) – (1)

$999x = 2122$

$x = \frac{2122}{999}$

(ii) $x = 0.2\overline{37}$

$x = 0.237373737$ ...(1)

$1000x = 237.373737$ ...(2)

& $10x = 2.373737$ ...(3)

Now, (2) – (3) gives us

$990x = 235$

$x = \frac{235}{990}$

Sol.13 $\frac{1}{37} = x$

$$
\begin{array}{r|l}
 & 0.027027 \\
\hline
37 & 100 \\
 & 74 \\
\hline
 & 260 \\
 & 259 \\
\hline
 & 100 \\
 & 74 \\
\hline
 & 260 \\
 & 259 \\
\hline
 & 1
\end{array}
$$

$\therefore x = \frac{1}{37} = 0.027027027$ .....

Now, $\frac{79}{37} = 2 + \frac{5}{37}$

$= 2 + 5(0.\overline{027})$

$= 2 + 0.\overline{135}$

$= 2.\overline{135} = 2.135\ 135\ 135$ .....

Sol.14 $\frac{\sqrt{x^2-y^2}+x}{\sqrt{x^2+y^2}+y} \div \frac{\sqrt{x^2+y^2}-y}{x-\sqrt{x^2-y^2}}$

$= \frac{\sqrt{x^2-y^2}+x}{\sqrt{x^2+y^2}+y} \times \frac{x-\sqrt{x^2-y^2}}{\sqrt{x^2+y^2}-y}$

$= \frac{(x)^2-(\sqrt{x^2-y^2})^2}{(\sqrt{x^2+y^2})^2-y^2}$

$= \frac{x^2-(x^2-y^2)}{x^2+y^2-y^2} = \frac{y^2}{x^2}$

Sol.15 $\sqrt{5+2\sqrt{6}}$

$= \sqrt{5+2.\sqrt{3}.\sqrt{2}}$

$= \sqrt{(\sqrt{3})^2+(\sqrt{2})^2+2.\sqrt{3}\sqrt{2}}$

$= \sqrt{(\sqrt{3}+\sqrt{2})^2}$

$= \sqrt{3}+\sqrt{2}$

Sol.19 Given that, $\pi = 3.141$, $\sqrt{2} = 1.414$

$\frac{2\pi+3\sqrt{2}}{5} = \frac{2\times3.141+3\times1.414}{5} = 2.105$

Sol.20 $a = 2 + \sqrt{3} + \sqrt{5}$, $b = 3 + \sqrt{3} - \sqrt{5}$

$a - 2 = \sqrt{3}+\sqrt{5}$, $b - 3 = \sqrt{3}-\sqrt{5}$

$(a-2)^2 = (\sqrt{3}+\sqrt{5})^2$, $(b-3)^2 = \left(\sqrt{3}-\sqrt{5}\right)^2$

Adding '+'

$a^2 + 4 - 4a = 3 + 5 + 2\sqrt{15}$

$b^2 + 9 - 6b = 3 + 5 - 2\sqrt{15}$

$a^2 + b^2 - 4a - 6b + 13 = 16$

$a^2 + b^2 - 4a - 6b - 3 = 0$

➢ Long Answer Type Questions

Sol.21 $x = \sqrt{3} + 2\sqrt{2}$

$y = \sqrt{3} - 2\sqrt{2}$

$x^4 + y^4 + 6x^2y^2 = ?$

$= (x^2 + y^2)^2 + 4x^2y^2$

$= 22^2 + 4.25$

$= 484 + 100$

$= 584$

$x^2 = (\sqrt{3} + 2\sqrt{2})^2$

$\Rightarrow x^2 = 3 + 8 + 4\sqrt{6}$

$\Rightarrow x^2 = 11 + 4\sqrt{6}$

& $y^2 = (\sqrt{3} - 2\sqrt{2})^2$

$y^2 = 3 + 8 - 4\sqrt{6}$

$y^2 = 11 - 4\sqrt{6}$

$\therefore x^2 + y^2 = 22$

& $x^2y^2 = 11^2 - 16 \times 6$

$= 121 - 96$

$= 25$

Sol.22 $x = 1 - \sqrt{2}$

$$\frac{1}{x} = \frac{1}{1-\sqrt{2}} = -\frac{1}{\sqrt{2}-1} \times \frac{\sqrt{2}+1}{\sqrt{2}+1}$$

$$\frac{1}{x} = -\frac{\sqrt{2}+1}{2-1} = -(1+\sqrt{2})$$

(i) $\therefore x + \frac{1}{x} = (1 - \sqrt{2}) - (1 + \sqrt{2})$

$x + \frac{1}{x} = -2\sqrt{2}$

(ii) $x - \frac{1}{x} = (1 - \sqrt{2}) - (-\sqrt{2} - 1) = 2$

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

$= (-2\sqrt{2})^2 - 2$

$= 8 - 2 = 6$

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

$= 2(-2\sqrt{2}) = -4\sqrt{2}$

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

$= 6^2 - 2 = 36 - 2 = 34$

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

$= 6.(-4\sqrt{2})$

$= -24\sqrt{2}$

Sol.23 $\frac{7+\sqrt{5}}{7-\sqrt{5}} - \frac{7-\sqrt{5}}{7+\sqrt{5}} = a + 7\sqrt{5}\, b$

$$= \frac{(7+\sqrt{5})^2 - (7-\sqrt{5})^2}{(7-\sqrt{5}).(7+\sqrt{5})}$$

$$= \frac{(49+5+14\sqrt{5}) - (49+5-14\sqrt{5})}{49-5}$$

$$= \frac{28\sqrt{5}}{44} = \frac{7\sqrt{5}}{11}$$

$\therefore a = 0$ and $b = \frac{1}{11}$

Sol.24 (i) $\frac{1}{\sqrt{2}+1} + \frac{1}{\sqrt{3}+\sqrt{2}} + \frac{1}{\sqrt{4}+\sqrt{3}} + \frac{1}{\sqrt{5}+\sqrt{4}}$

$= \frac{\sqrt{2}-1}{2-1} + \frac{\sqrt{3}-\sqrt{2}}{3-2} + \frac{\sqrt{4}-\sqrt{3}}{4-3} + \frac{\sqrt{5}-\sqrt{4}}{5-4}$

$= (\sqrt{2} - 1) + (\sqrt{3} - \sqrt{2}) + (\sqrt{4} - \sqrt{3})$

$+ (\sqrt{5} - \sqrt{4})$

$= \sqrt{5} - 1$

(ii) $\frac{1}{\sqrt{2}+1} + \frac{1}{\sqrt{3}+2} + \frac{2}{\sqrt{5}+3} + \frac{2}{\sqrt{5}-3}$

$= (\sqrt{2} - 1) + (2 - \sqrt{3}) + \left(\frac{3-\sqrt{5}}{4}\right).2$

$+ \left(\frac{\sqrt{5}+3}{-4}\right).2$

$= (\sqrt{2} - 1) + (2 - \sqrt{3})$

$+ \left(\frac{3-\sqrt{5}}{2}\right) - \left(\frac{3+\sqrt{5}}{2}\right)$

$= \sqrt{2} - \sqrt{3} + 1 - \sqrt{5}$

$= 1 + \sqrt{2} - \sqrt{3} - \sqrt{5}$

Sol.25 $a^x = b$ ...(1)

$b^y = c$ ...(2)

$c^z = a$ ...(3)

$(b^y)^z = a \Rightarrow b^{yz} = a$

$\Rightarrow (a^x)^{yz} = a$

$\Rightarrow a^{xyz} = a$

$\Rightarrow xyz = 1$

Sol.26 $\frac{1}{3-\sqrt{8}}-\frac{1}{\sqrt{8}-\sqrt{7}}+\frac{1}{\sqrt{7}-\sqrt{6}}-\frac{1}{\sqrt{6}-\sqrt{5}}+\frac{1}{\sqrt{5}-2}$

$= \left(\frac{3+\sqrt{8}}{9-8}\right)-\left(\frac{\sqrt{8}+\sqrt{7}}{8-7}\right)+\left(\frac{\sqrt{7}+\sqrt{6}}{7-6}\right)$

$-\left(\frac{\sqrt{6}+\sqrt{5}}{6-5}\right)+\left(\frac{\sqrt{5}+2}{5-4}\right)$

$= (3+\sqrt{8})-(\sqrt{8}+\sqrt{7})+(\sqrt{7}+\sqrt{6})$

$-(\sqrt{6}+\sqrt{5})+(\sqrt{5}+2)$

$= 3 + 2 = 5$

Sol.27 $x = 3 + \sqrt{8}$

$\frac{1}{x} = \frac{1}{3+\sqrt{8}} = \frac{3-\sqrt{8}}{9-8} = 3-\sqrt{8}$

$\therefore x + \frac{1}{x} = (3+\sqrt{8})+(3-\sqrt{8})$

$\Rightarrow x + \frac{1}{x} = 6 \quad \ldots.(1)$

Taking cube on both sides,

$\left(x+\frac{1}{x}\right)^3 = 6^3$

$x^3 + \frac{1}{x^3} + 3\left(x+\frac{1}{x}\right) = 216$

$x^3 + \frac{1}{x^3} + 3.6 = 216$

$x^3 + \frac{1}{x^3} = 216 - 18 \Rightarrow x^3 + \frac{1}{x^3} = 198$

Sol.28 $\left(1+x+\frac{1}{y}\right)^{-1}.\left(1+y+\frac{1}{z}\right)^{-1}\left(1+z+\frac{1}{x}\right)^{-1}$

$\frac{xyz}{(1+y+xy)(1+z+yz)(1+x+zx)} (\because xyz = 1)$

$= \frac{1}{(1+y+xy)(1+z+yz)(1+x+zx)}$

Sol.29 $a = \frac{\sqrt{7}-\sqrt{6}}{\sqrt{7}+\sqrt{6}}, b = \frac{\sqrt{7}+\sqrt{6}}{\sqrt{7}-\sqrt{6}}$

$a^2 + b^2 + ab = (a+b)^2 - ab$

$\therefore a + b = \frac{\sqrt{7}-\sqrt{6}}{\sqrt{7}+\sqrt{6}} + \frac{\sqrt{7}+\sqrt{6}}{\sqrt{7}-\sqrt{6}}$

$= \frac{(\sqrt{7}-\sqrt{6})^2+(\sqrt{7}+\sqrt{6})^2}{(\sqrt{7}+\sqrt{6})(\sqrt{7}-\sqrt{6})}$

$26 = \frac{(7+6-2\sqrt{42})+(7+6+2\sqrt{42})}{7-6}$

& $ab = \frac{\sqrt{7}-\sqrt{6}}{\sqrt{7}+\sqrt{6}}.\frac{\sqrt{7}+\sqrt{6}}{\sqrt{7}-\sqrt{6}} = 1$

$\therefore (a+b)^2 - ab = 26^2 - 1 = 676 - 1 = 675$

Sol.30

$\frac{1}{1+x^{b-a}+x^{c-a}}+\frac{1}{1+x^{a-b}+x^{c-b}}+\frac{1}{1+x^{a-c}+x^{b-c}}$

$= \frac{x^a}{x^a+x^b+x^c} + \frac{x^b}{x^b+x^a+x^c} + \frac{x^c}{x^c+x^a+x^b}$

$= \frac{x^a+x^b+x^c}{x^a+x^b+x^c} = 1$

EXERCISE-2

Sol.1 **[B]**

Given that

$16^{2x+3} = 64^{x+3}$

$\Rightarrow (2^4)^{2x+3} = (2^6)^{x+3}$

$\Rightarrow 2^{8x+12} = 2^{6x+18}$

$\Rightarrow 8x + 12 = 6x + 18$

$\Rightarrow 2x = 6$

$\Rightarrow x = 3$

$\therefore 4^{2x-2} = 4^{2\times3-2} = 4^{6-2} = 4^4 = 256$

Sol.2 **[A]**

$2^{-m}.\frac{1}{2^m} = \frac{1}{4} \Rightarrow 2^{-2m} = 2^{-2}$

$\Rightarrow -2m = -2 \Rightarrow m = 1$

$\therefore \frac{1}{14}\left[(4m)^{1/2}+\left(\frac{1}{5m}\right)^{-1}\right]$

$= \frac{1}{14}\left[4^{1/2}+\left(\frac{1}{5}\right)^{-1}\right]$

$= \frac{1}{14}\left[2^{2\times\frac{1}{2}}+5\right] = \frac{1}{14}(2+5) = \frac{7}{14} = \frac{1}{2}$

Sol.3 **[A]**

$2[(16-15)^{-1} + 25(13-8)^{-2}]^{-1} + 1024^0$

$= 2[1 + 25.(5)^{-2}]^{-1} + 1$

$= 2[1 + 25.\frac{1}{25}]^{-1} + 1 = 2 \times \frac{1}{2} + 1 = 2$

Sol.4 [C]

$\sqrt{13-x\sqrt{10}} = \sqrt{8}+\sqrt{5}$

By squaring on both sides, we get

$\Rightarrow 13 - x.\sqrt{10} = (\sqrt{8}+\sqrt{5})^2$

$\Rightarrow 13 - x\sqrt{10} = (\sqrt{8})^2 + (\sqrt{5})^2 + 2\sqrt{8}.\sqrt{5}$

$\Rightarrow 13 - x.\sqrt{10} = 8 + 5 + 2.2\sqrt{10}$

$\Rightarrow -x.\sqrt{10} = 4\sqrt{10}$

$\Rightarrow x = -4$

Sol.5 [A]

$\frac{5-\sqrt{3}}{2+\sqrt{3}} = x + y\sqrt{3},$

By rotionalizing the denominator, we get

$\frac{5-\sqrt{3}}{2+\sqrt{3}}.\left(\frac{2-\sqrt{3}}{2-\sqrt{3}}\right) = \frac{10-5\sqrt{3}-2\sqrt{3}+3}{(2)^2-(\sqrt{3})^2}$

$= \frac{13-5\sqrt{3}-2\sqrt{3}}{4-3} = \frac{13-7\sqrt{3}}{1}$

By comparizing on both sides

$\therefore x = 13, y = -7$

Sol.6 $\frac{3-2\sqrt{5}}{6-\sqrt{5}} = a + b\sqrt{5}$

upon rationalizing to denominator

$\frac{3-2\sqrt{5}}{6-\sqrt{5}} \times \frac{6+\sqrt{5}}{6+\sqrt{5}} = \frac{18+3\sqrt{5}-12\sqrt{5}-10}{36-5}$

$a + b\sqrt{5} = \frac{8-9\sqrt{5}}{31}$

Now, comparing on both sides

$a = \frac{8}{31}, b = -\frac{9}{31}$

Sol.7 [B]

$\left[\left\{\left(\frac{1}{x^{a^2-b^2}}\right)^{\frac{1}{a-b}}\right\}^{a+b}\right]^{\frac{1}{(a+b)^2}} = \left[\left(\frac{1}{x^{a^2-b^2}}\right)^{\frac{a+b}{a-b}}\right]^{\frac{1}{(a+b)^2}}$

$\frac{1}{x} = \frac{1}{\left(x^{a^2-b^2}\right)^{\frac{1}{a^2-b^2}}} = \left(\frac{1}{x^{a^2-b^2}}\right)^{\left(\frac{a+b}{a-b}\right).\frac{1}{(a+b)^2}}$

Sol.8 [B]

$\left[(p^{-1}+q^{-1})(p^{-1}-q^{-1}) \div \left(\frac{1}{p^{-1}}-\frac{1}{q^{-1}}\right)\left(\frac{1}{p^{-1}}+\frac{1}{q^{-1}}\right)\right](pq)^2$

$= \left[\left(\frac{1}{p}+\frac{1}{q}\right).\left(\frac{1}{p}-\frac{1}{q}\right) \div (p-q)(p+q)\right].(pq)^2$

$= \left[\left(\frac{p+q}{pq}\right)\left(\frac{q-p}{pq}\right) \times \frac{1}{(p+q)(p-q)}\right].(pq)^2$

$= -1$

Sol.9 [D]

$x = \frac{2}{\sqrt{10}-\sqrt{8}}, y = \frac{2}{\sqrt{10}+2\sqrt{2}},$

$(x-y)^2 = \left[\frac{2}{\sqrt{10}-\sqrt{8}} - \frac{2}{\sqrt{10}+2\sqrt{2}}\right]^2$

$= 4.\left[\frac{(\sqrt{10}+2\sqrt{2})-(\sqrt{10}-2\sqrt{2})}{(\sqrt{10}-\sqrt{8})(\sqrt{10}+\sqrt{8})}\right]^2$

$= 4.\left[\frac{4\sqrt{2}}{10-8}\right]^2 = 4.\frac{16\cdot 2}{2}$ 64

Sol.10 [A]

$a = \sqrt{17}-\sqrt{16}$, $b = \sqrt{16}-\sqrt{15}$

$a = \frac{1}{\sqrt{17}+\sqrt{16}}$, $b = \frac{1}{\sqrt{16}+\sqrt{15}}$

$\because \sqrt{17}+\sqrt{16} > \sqrt{16}+\sqrt{15}$

$\frac{1}{\sqrt{17}+\sqrt{16}} < \frac{1}{\sqrt{16}+\sqrt{15}}$

$a < b$

Sol.11 [D]

$y = 3-\sqrt{8}$

$\frac{1}{y} = \frac{1}{3-\sqrt{8}} = \frac{3+\sqrt{8}}{(3-\sqrt{8}).(3+\sqrt{8})} = \frac{3+\sqrt{8}}{9-8} = 3+\sqrt{8}$

$\therefore y + \frac{1}{y} = (3-\sqrt{8}) + (3+\sqrt{8})$

$y + \frac{1}{y} = 6$ & $y - \frac{1}{y} = (3-\sqrt{8}) - (3+\sqrt{8})$

$y - \frac{1}{y} = -2\sqrt{8}$

$\left(y-\frac{1}{y}\right)^2 = (-2\sqrt{8})^2 = 4 \times 8 = 32$

Sol.12 [C]

$$x = \frac{2}{\sqrt{3}-\sqrt{5}},\ y = \frac{2}{\sqrt{3}+\sqrt{5}}$$

$$x + y = \frac{2}{\sqrt{3}-\sqrt{5}} + \frac{2}{\sqrt{3}+\sqrt{5}}$$

$$x + y = 2\left[\frac{1}{\sqrt{3}-\sqrt{5}} + \frac{1}{\sqrt{3}+\sqrt{5}}\right]$$

$$= 2\left[\frac{(\sqrt{3}+\sqrt{5})+(\sqrt{3}-\sqrt{5})}{(\sqrt{3}-\sqrt{5})(\sqrt{3}+\sqrt{5})}\right]$$

$$x + y = 2.\left[\frac{2\sqrt{3}}{3-5}\right] = 2\left(\frac{2\sqrt{3}}{-2}\right) = -2\sqrt{3}$$

Sol.13 [D]

Given that,

$$x = \frac{1}{2-\sqrt{3}} = \frac{2+\sqrt{3}}{(2-\sqrt{3})(2+\sqrt{3})} = \frac{2+\sqrt{3}}{4-3}$$

$$x = 2+\sqrt{3}$$

$\Rightarrow (x-2)^2 = 3$

$\Rightarrow x^2 + 4 - 4x = 3$

$\Rightarrow x^2 - 4x + 1 = 0$

Now,

$$\begin{array}{r|l} & (x+2) \\ \hline x^2-4x+1 & x^3-2x^2-7x+10 \\ & x^3-4x^2+x \\ & \ -\quad +\quad - \\ \hline & 2x^2-8x+10 \\ & 2x^2-8x+2 \\ & \ -\quad +\quad - \\ \hline & 8 \end{array}$$

$x^3 - 2x^2 - 7x + 10$

$= (x^2 - 4x + 1)(x + 2) + 8$

$= 0 + 8$

$= 8$

Sol.14 [C]

Given that,

$2^x = 4^y = 8^z$

$2^x = 2^{2y}$ and $2^{2y} = 2^{3z}$ and $2^x = 2^{zy}$

$x = 2y$ and $2y = 3z$ $\quad x = 3z$

$$y = \frac{x}{2},\ y = \frac{3z}{2};\ z = \frac{x}{3}$$

Now,

$$\frac{1}{2x} + \frac{1}{4y} + \frac{1}{6z} = \frac{24}{7}$$

$$\Rightarrow \frac{1}{2x} + \frac{1}{4.\left(\frac{x}{2}\right)} + \frac{1}{6\left(\frac{x}{3}\right)} = \frac{24}{7}$$

$$\Rightarrow \frac{1}{2x} + \frac{1}{2x} + \frac{1}{2x} = \frac{24}{7}$$

$$\Rightarrow \frac{3}{2x} = \frac{24}{7} \Rightarrow x = \frac{7}{16}$$

$$\Rightarrow z = \frac{x}{3} = \frac{7}{16\cdot 3} = \frac{7}{48}$$

Sol.15 [C]

Given that $\quad a = 1.1039$

$3a - \sqrt{4a^2 - 4a + 1}$

$= 3a - \sqrt{(2a-1)^2}$

$= 3a - (2a - 1)$

$= a + 1 = 1.1039 + 1 = 2.1039$

Sol.16 [C]

Given that,

a, a + 2 and a + 4 are prime numbers.

a = 3 is the only possible way/solution to satisfy the above condition.

Sol.17 [D]

The no. of prime factors of

$N = (3 \times 5)^{12} \cdot (2 \times 7)^{10} \cdot 10^{25}$

$N = (3 \times 5)^{12} \cdot (2 \times 7)^{10} \cdot (2 \times 5)^{25}$

$N = 2^{35} \cdot 3^{12} \cdot 5^{37} \cdot 7^{10}$

$\therefore$ No. of prime factors = 35 + 12 + 37 + 10 = 94

Total no. of factors

$$= \left\{\begin{matrix} 2^1, 2^2, 2^3, 2^4, \ldots . 2^{35} \\ 3^1, 3^2, 3^3, \ldots\ldots\ldots 3^{12} \\ 5^1, 5^2, 5^3, \ldots\ldots\ldots 5^{37} \\ 7^1, 7^2, 7^3, \ldots\ldots\ldots 7^{10} \end{matrix}\right\} \{x^2 + 1\}$$

Sol.18 [A]

$$N = \sqrt{7 - 4\sqrt{3}}$$

$$= \sqrt{7 - 2.2.\sqrt{3}}$$

$$= \sqrt{(2)^2 + (\sqrt{3})^2 - 2.2.\sqrt{3}}$$

$$= \sqrt{(2-\sqrt{3})^2} = 2 - \sqrt{3}$$

Sol.19 [A]

Natural numbers between 200 and 400 which are division by

(i) Both 4 & 5

No. of natural nos. which are divisible by 4 = {204, 208, 212, ... 396}

n(no. div. by 4) = 49

n(no. div. by 5) = 49

{205, 210, 215, ... 395}

Numbers which are division by 4 or 5

220, 240, 260, ... 380

$\therefore$ No. of total natural numbers = 9

(ii) Natural numbers which are divisible by 4 or 5 or 8 or 10

= No. of natural numbers which are div. by 4 + No. of natural numbers which are div. by 5 – No. of natural nos. which are div. by 20 = 49 + 39 – 9 = 79

Sol.20 [C]

$2^{96} + 1 = (2^{32})^3 + 1 = (2^{32} + 1)(2^{64} - 2^{32} + 1)$

$(\because a^3 + b^3 = (a + b).(a^2 - ab + b^2)$

Sol.21 [C]

The product of any four consecutive natural numbers = n(n + 1)(n + 2)(n + 3)

The least value of the product = 1.2.3.4 = 24

$\therefore$ Any product of first four consecutive numbers will always be divisible by 24.

Sol.22 [D]

$7^{6n} - 6^{6n} = (7^2)^{3n} - (6^2)^{3n}$

$= 49^{3n} - 36^{3n}$

($a^n - b^n$ is always divisible by a – b if n $\in$ odd)

$\therefore$ $7^{6n} - 6^{6n}$ is div. by (49 – 36) = 13

$7^{6n} - 6^{6n} = (7^3)^{2n} - (6^3)^{2n}$

$= (343)^{2n} - (216)^{2n}$

($\because$ $a^{2n} - b^{2n}$ is always div. by a – b)

($\therefore$ $7^{6n} - 6^{6n}$ is div. by (343 – 216) = 127

Similarly, $7^{6n} - 6^{6n} = (7^6)^n - (6^6)^n$

$= [(7^3)^n - (6^3)^n][(7^3)^n + (6^3)^n]$

$= (343^n - 216^n).(343^n + 216^n)$

($\because$ $a^n + b^n$ is div. by n if n is an odd no.)

$\therefore$ $7^{6n} - 6^{6n}$ is div. by (343 + 216) = 559

Sol.23 [C]

$$\begin{cases} N = 3a + 1 & ....(1) \\ N = 4b + 2 & ....(2) \\ N = 5c + 3 & ....(3) \\ N = 6d + 4 & ....(4) \\ N = 7e + 5 & ....(5) \end{cases}$$

Now,

$$\begin{cases} N + 2 = 3a + 3 = 3(a + 1) \\ N + 2 = 4b + 4 = 4(b + 1) \\ N + 2 = 5c + 5 = 5(c + 1) \\ N + 2 = 6d + 6 = 6(d + 1) \\ N + 2 = 7c + 7 = 7(e + 1) \end{cases}$$

From the above equations, we can say that N + 2 is a multiple of 3, 4, 5, 6 & 7.

$\therefore$ N + 2 = k (LCM of (3, 4, 5, 6, 7))

$\Rightarrow$ N + 2 = 420 k $\Rightarrow$ N = 420 k – 2

Put k = 1, N = 420 – 2 = 418

k = 2, N = 420.2 – 2 = 838

Only 2 3-digit natural numbers are possible.

Sol.24 [A]

Let numbers are 11x, 11y, where x & y are co-prime numbers.

LCM × HCF = Product of numbers

$693 \times 11 = (11x).(11y)$ | Also, it is given that

$xy = \frac{693 \times 11}{11 \times 11}$ | $11x + 11y = 176$

$xy = 63$ ...(1) | $x + y = 16$ ...(2)

From eq. (1) & (2)

Possible values of x & y are 7 & 9

$\therefore$ numbers are

$11x = 11 \times 7 = 77$

$11y = 11 \times 9 = 99$

Sol.25 [A]

If P is a prime no. then

P and P + 1 both the numbers will be co-prime and the LCM between the numbers P & P + 1 = P(P + 1)

Sol.26 [C]

Given that, HCF between the two numbers = 9 & LCM = 567

Therefore numbers are 9x and 9y, where x and y are the co-prime numbers

Now, we know that,

Product of two numbers = LCM × HCF

$(9x).9y = 567 \times 9$

$xy = \frac{567 \times 9}{9 \times 9}$

$xy = 63$ ...(1)

Also, it is given that,

$9x - 9y = 18$

From eq. (1) & (2)

$x - y = 2$ ...(2)

$\therefore$ Possible values of x & y are 9 & 7

$\therefore$ Numbers are 9x, 9y

9.9 and 9.7 or 81 and 63

Sol.27 [C]

Given that, $P \geq 5$, where P is a prime no.
In general form P can be written as $6k \pm 1$
So, if it is divided by 6, then remainder will be
Either ± 1 i.e. 1 or 5.

Sol.28 [D]

$N = 74^{13} - 41^{13} + 75^{13} - 42^{13}$
$= (74^{13} - 41^{13}) + (75^{13} - 42^{13})$
(As we know that, $a^n - b^n$ is div. by $a - b$ if n is an odd no.)
$74^{13} - 41^{13}$ is div. by $(a - b) = (74 - 41) = 33$
$\therefore$ N is div. by 33
Also N is an even no. therefore number N is completely divisible by 66.
Hence remainder = 0.

Sol.29 [B]

Unit digit of $(7^{95} - 3^{58})$ $\quad \because \ 7^{95} > 3^{58}$
Now, Unit digit of $7^{95} = 7^{4 \times 23 + 3}$
$= (7^4)^{23}.7^3$
$= (2401)^{23} \ . \ 7^3$
Unit digit of $7^{95} \Rightarrow 1^{23} \times (343) \Rightarrow 3$
Similarly
Unit digit of $3^{58} \Rightarrow 3^{4 \times 14 + 2}$
$\Rightarrow (3^4)^{14} \ . \ 3^2 \ \Rightarrow (81)^{14}.9$
$\therefore$ Unit digit of $3^{58} \equiv 9$
$\therefore$ Unit digit of $7^{45} - 3^{58} \equiv (3 - 9)$
Unit digit of 7^{95} – Unit digit of $3^{58} \equiv -6$
($\because$ Unit digit can not be negative)
Correct unit digit $= -6 + 10 = 4$

Sol.30 [B]

$x = 100\ !$
Highest power of 5 in 100 !

$$= \left[\frac{100}{5}\right] + \left[\frac{100}{5^2}\right] + \left[\frac{100}{5^3}\right]$$

([α] Indicates the integral part of x)
$= 20 + 4 + 0 = 24$

EXERCISE-3

Sol.1 [A,D]

P, Q → prime number
PR is divisible by Q. R is a multiple of Q.
Option A → Q divides R is correct.
Option B → P is not a multiple or R.
$\therefore$ wrong
Option C →
Q is prime & R is not multiple of P
$\therefore$ wrong
Option D → P divides PQ is correct.

Sol.2 [B]

Let the given number be N
Let R be the integer nearest to the square root of N
Check whether N is divisible by the prime numbers in the range 2 to R. That is, start with 2 and proceed successively with 3, 5, 7, 11, 13 and so on. Stop as soon as N gets divided by any such prime.
If N is not divisible by any prime no. in the range 2 to R, then N is a prime no.
Now, N = 1107
Nearest integer to the square root of N is 33.
Hence R can be 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31 & 33.

Sol.3 [D]

No. of integers between $-\sqrt{8}$ and $\sqrt{32}$ is $-2\sqrt{2}$ to $4\sqrt{2}$ i.e. –2.8 to 5.6
$\therefore$ No. of integers = –2, –1, 0, 1, 2, 3, 4, 5
Total no. of integers = 8

Sol.4 [B]

$N = 1000^{10}$
$N = (10^3)^{10} = 10^{30}$
No. of zero's are 30

Sol.5 [D]

N = 28
Factors of N are 1, 2, 4, 7, 14, 28
Sum of all distinct factory
= 1 + 2 + 4 + 7 + 14 + 28 = 56

Sol.6 [A]

Unit digit of $N = 1 + 9 + 9^2 + 9^3 + ...$
Unit digit of $9^{odd} = 9$
or $9^{even} = 1$
Unit digit of $[1 + (1014 \times 1) + 1015 \times 9]$
$= 1 + 4 + 5 \equiv \underline{10}$
Unit digit of N is $\underline{0}$.

Sol.7 [B]

$2^{1/2}, 3^{1/3}, 6^{1/6}, 8^{1/8}$ ← Largest number
$a^{24} = (2^{1/2})^{24} = 2^{12} = 1024 \times 4 = 4096$
$b^{24} = (3^{1/3})^{24} = 3^8 = 6561$
$c^{24} = (6^{1/6})^{24} = 6^4 = 1296$
$d^{24} = (8^{1/8})^{24} = 8^3 = 512$
$\therefore \ b^{24} > a^{24} > c^{24} > d^{24}$
$\Rightarrow b > a > c > d$

Sol.8 [B]

$N = 2009 = 7^2.41 = p^a.q^b$
$\therefore \quad p = 7, \ q = 41$
$\Rightarrow p + q = 7 + 41 = 48$

Sol.9 [C]

HCF (p, q) = 12 and p × q = 1800

As we know that,

LCM × HCF = p × q

LCM × 12 = 1800

$\text{LCM} = \frac{1800}{12} \Rightarrow \text{LCM} = 150$

Sol.10 [D]

$N = \frac{a+c}{b+c} > \frac{a}{b}$

$\Rightarrow b(a + c) > a(b + c)$

$\Rightarrow ab + bc > ab + ac$

$\Rightarrow (b - a) . c > 0$

$\Rightarrow (b - a) > 0 \Rightarrow b > a$

Therefore, N is greater than $\frac{a}{b}$ only if b > a

Sol.11 [B]

N = 2575d568

$54 = 2 \times 3 \times 3 \times 3 = 2 \times 3^3$ & $87 = 3 \times 29$

The eight digit no. 2575d568 must be divisible by 2, 27 and 29.

So, as to make it div. by 27, it must be div. by 3 at least.

From the divisibility rule for 3, the total of the digits must be div. by 3.

Hence, 2 + 5 + 7 + 5 + d + 5 + 6 + 8 = 38 + d

d must be a single digit.

So d = 1, 4 or 7

But, if d = 1 and 4, then 25751568 and 25754568 are not div. by 29.

Hence d = 7

Sol.12 [D]

$R\left\{\frac{7^{2012}}{25}\right\}$

$\frac{(7^2)^{1006}}{25} = \frac{(49)^{1006}}{25} = \frac{(50-1)^{1006}}{25}$

Remainder $\Rightarrow \frac{(-1)^{1006}}{25} \Rightarrow \frac{1}{25}$

Remainder = 1

Sol.13 [B]

$\sqrt[x]{75} = \sqrt[y]{45} = \sqrt[z]{15} = k$

$75 = k^x \Rightarrow 15 \times 5 = k^x$ ...(1)

$45 = k^y \Rightarrow 15 \times 3 = k^y$ ...(2)

$15 = k^z \Rightarrow 3 \times 5 = k^z$ ...(3)

$k^x.k^y = 15.5.15.3 = 15^3$

$k^{x+y} = (k^z)^3 = k^{3z}$ [from eq. (3)]

x + y = 3z

Sol.14 [B]

Given that, x + y = 7k

Now, xxy = 100x + 10x + y

= 110x + y = 109x + (x + y)

∴ xxy is not div. by 7

xyx = 100x + 10y + x

= 101x + 10y

= 91x + 10(x + y)

= 13 × 7 × x + 10(7x) = 7[13x + 10x]

∴ xyx is div. by 7

Sol.15 [D]

Let N = xyzw

Given that, $x = y^2$, z = 3y, w = 2y

x + y + z + w = 3(x)

y + z + w = 2x

$\Rightarrow y + 3y + 2y = 2(y^2)$

$\Rightarrow 6y = 2y^2$ ∴ N = 9396

$\Rightarrow 2y^2 = 6y \Rightarrow y = 3$

Sol.16 [C]

Total no. of squares in a grid of order n

$= 1^2 + 2^2 + 3^2 + ... + n^2$

$= \frac{n(n+1)(2n+1)}{6}$

Sol.17 [D]

$x = \frac{p}{q}$

If x is a rational number then p and q both must be integer and co-prime such that $q \neq 0$.

Sol.18 [A]

2 | n, 3 | n + 1, 4 | n + 2, 5 | n + 3, 6 | n + 4

$\frac{n}{2} = a \Rightarrow n = 2a$

$\frac{n+1}{3} = b \Rightarrow n + 1 = 3b$

$\frac{n+2}{4} = c \Rightarrow n + 2 = 4c$

$\frac{n+3}{5} = d \Rightarrow n = 5d - 3$

$\frac{n+4}{6} = e \Rightarrow n = 6e - 4$

$\left.\begin{array}{l} n = 2a \\ n = 3b - 1 \\ n = 4c - 2 \\ n = 5d - 3 \\ n = 6c - 4 \end{array}\right\} \Rightarrow \left\{\begin{array}{l} n = 2a + 2 \\ n = 3b + 2 \\ n = 4c + 2 \\ n = 5d + 2 \\ n = 6e + 2 \end{array}\right.$

$\Rightarrow$ n – 2 is a multiple of 2, 3, 4, 5 & 6
$\Rightarrow$ n – 2 = k (LCM of 2, 3, 4, 5, 6)
$\Rightarrow$ n – 2 = k.(60)
$\Rightarrow$ n = 60k + 2
$\therefore$ Least positive integer = 60 + 2 if k = 1
= 62

Sol.19 [D]
abcd
$a = b^2$
$c = 3b$
$d = 2b$
$a + b + c + d = 3a$
$b + c + d = 2a$
$b + 3b + 2b = 2b^2$
$6b - 2b^2 = 0$
$2b(3 - b) = 0$
$b = 0$ or $b = 3$
$b = 3$, $a = 9$, $c = 9$, $d = 6$
No = 9396

Sol.20 [D]
$m = \sqrt{338} - \sqrt{288}$
$m = \sqrt{2\times169} - \sqrt{2\times144}$
$m = 13\sqrt{2} - 12\sqrt{2}$
$m = \sqrt{2}$

Sol.21 [A]
$(41)^{16} - (14)^{16}$
$(41^2)^8 - (14^2)^8$
$\Rightarrow \because a^n - b^n$ is divisible by a – b
$\therefore (41^2)^8 - (41^2)^8$
is divisible by
$(41^2)^8 - (14)^2 = (1681 - 196) = 1485$

Sol.22 [C]
$$\frac{(1000000)^3}{143}$$
$$\Rightarrow \frac{(999999+1)^3}{143}$$
$$\Rightarrow \frac{I^3}{143} = 1 \text{ Ans.}$$

Sol.23 [C]
$7^{2015} = 7.(7^{2014}) = 7(7^2)^{1007}$
$= 7.(50 - 1)^{1007}$
Remainder when divided by 25
$= 7.(-1)^{1007}$
$= -7$
$= -7 + 25$
$= 18$

Sol.24 [C]
$$\frac{1356}{N}, \frac{1868}{N}, \frac{2764}{N}$$
$1356 = x(N) + 12$ ...(1)
$1868 = y(N) + 12$ ...(2)
$2764 = z(N) + 12$ ...(3)
where x, y, z $\in$ Integers
Using (2) – (1), (3) – (2) & (3) – (1)
$(y - x).N = 512$
$(z - y).N = 896$
$(z - x).N = 1408$
$\therefore$ N is the HCF between the numbers 512, 896 & 1408
$$\begin{cases} 512 = 2^9 \\ 896 = 2^7 \times 7 \\ 1408 = 2^7.11 \end{cases}$$
$N = H.C.F = 2^7 = 128$

Sol.25 [D]
$$f = \frac{\frac{7}{3} + 1\frac{1}{2} \text{ of } \frac{5}{3}}{2 + 1\frac{1}{2}} = \frac{\frac{7}{3} + \frac{3}{2}\cdot\frac{5}{3}}{2 + \frac{3}{2}}$$
$$f = \frac{\frac{7}{3} + \frac{5}{2}}{\frac{7}{2}} = \frac{14+15}{6}\cdot\frac{2}{7} = \frac{29}{21}$$
Let actual ans is differing by x, then
$$\frac{1}{4} + x = \frac{29}{21}$$
$$x = \frac{29}{21} - \frac{1}{4}$$
$$x = \frac{29\times4 - 21}{84}$$
$$x = \frac{95}{84}$$

Sol.26 [A]
Given that,
$$\frac{x}{1} = \frac{\sqrt{a+2b} + \sqrt{a-2b}}{\sqrt{a+2b} - \sqrt{a-2b}},$$
$$\frac{x+1}{x-1} = \frac{2\sqrt{a+2b}}{2\sqrt{a-2b}} = \frac{\sqrt{a+2b}}{\sqrt{a-2b}}$$
$$\left(\frac{x+1}{x-1}\right)^2 = \frac{a+2b}{a-2b}$$
$$\frac{x^2+1+2x}{x^2+1-2x} = \frac{a+2b}{a-2b}$$

Again using componends & dividendo,

$$\frac{(x^2+1+2x)+(x^2+1-2x)}{(x^2+1+2x)-(x^2+1-2x)} = \frac{2a}{4b}$$

$$\frac{2(x^2+1)}{4x} = \frac{a}{2b}$$

$b(x^2 + 1) = ax$

$bx^2 - ax + b = 0$

Sol.27 [C]

"a is not less than 4" means a is greater than or equal to 4 i.e. $a \geq 4$

Sol.28 [C]

$3^8 (3^{10} + 6^5) + 2^3 (2^{12} + 6^7)$

$\Rightarrow 3^8 \times 3^{10} + 3^8 \times 2^5 \times 3^5 + 2^3 \times 2^{12} + 2^3 \times 2^7 \times 3^7$

$\Rightarrow 3^{18} + 3 \times 2^5 \times 3^6 \times 3^6 + 3 \times 2^5 \times 3^6 \times 2^5 + 2^{15}$

$\Rightarrow (3^6)^3 + 3.2^5.3^6(3^6 + 2^5) + (2^5)^3$

$\Rightarrow (3^6 + 2^5)^3$

Which is perfect cube but not perfect square.

Sol.29 [D]

Number less then 40 having 4 divisors will be of form p^3, $p_1 \times p_2$ (where p, p_1, p_2 are prime numbers)

Cubes less than 40 are

$2^3 = 8$, $3^3 = 27$

Number less than 40 and product of 2 distinct prime number

$6 = 3 \times 2$ $10 = 2 \times 5$ $14 = 2 \times 7$

$15 = 3 \times 5$ $21 = 3 \times 7$ $22 = 2 \times 11$

$26 = 13 \times 2$

$33 = 3 \times 11$ $34 = 2 \times 17$

$35 = 5 \times 7$ $38 = 2 \times 19$ $39 = 13 \times 3$

Total values = 14

Sol.30 [C]

$$\frac{n^2+1}{n+1} = n - 1 + \frac{2}{n+1}$$

$n + 1$ is a divisor of $n^2 + 1$

when $n + 1$ divides 2

So, $n + 1 = \pm 1, \pm 2$

$\Rightarrow n = 0, 1, -3, -2$

Sol.31 [A]

Minimum four digit number

= 1000 & maximum four digit number = 9999.

Now,

$$101\overline{)1000}\ 9$$
$$-909$$
$$91$$

$\therefore$ First number (a_1)

= 1000 – 91 + 99 = 1008 &

$$101\overline{)9999}\ 99$$
$$-909\downarrow$$
$$909$$
$$-909$$
$$\times$$

$\therefore$ Last number (a_n)

= 9999 – 2 = 9997

Here d = 101

$\therefore$ $a_n = a_1 + (n - 1)\, d$

$9997 = 1008 + (n - 1)(101)$

$8989 = (n - 1)\, 101$

$n - 1 = 89 \Rightarrow n = 90$

Sol.32 [B]

$x = \sqrt{21} - \sqrt{20}$

$$\frac{1}{x} = \frac{1}{\sqrt{21}-\sqrt{20}}$$

$$\frac{1}{x} = \frac{\sqrt{21}+\sqrt{20}}{21-20}$$

$$\frac{1}{x} = \sqrt{21} + \sqrt{20}$$

$y = \sqrt{18} - \sqrt{17}$

$$\frac{1}{y} = \frac{1}{\sqrt{18}-\sqrt{17}}$$

$$\frac{1}{y} = \frac{\sqrt{18}+\sqrt{17}}{18-17}$$

$$\frac{1}{y} = \sqrt{18} + \sqrt{17}$$

Here, $\sqrt{21} + \sqrt{20} > \sqrt{18} + \sqrt{17}$

$\Rightarrow \frac{1}{x} > \frac{1}{y} \Rightarrow x < y$

Sol.33 [C]

$198396198 = 2 \times \overline{3 \times 3} \times \overline{11 \times 11} \times 11 \times \overline{7 \times 7} \times \overline{13 \times 13}$

$\therefore$ The number should be divided by 2×11 i.e. 22 to make it a perfect square.

Sol.34 [A]

$$\left(\frac{1}{a}\right)^{\frac{1}{b}} = 0.\overline{3}$$

$$\frac{1}{a} = \left(\frac{1}{3}\right)^b \Rightarrow 3^b = a$$

ab is a multiple of 3, if b = 3, a = 27

$\therefore$ ab = 81

Sol.35 [C]

$5\frac{7}{x}.y\frac{1}{13} = 12$

$(5x + 7).(13y + 1) = 12 \times 13 \times x$

$\frac{5x+7}{x}.\frac{13y+1}{13} = 12 \Rightarrow \frac{52}{9}\times\frac{13y+1}{13} = 12$

$5x + 7 = 13(k)$ | $13y + 1 = 27$

$5x = 13k - 7$ | $y = 2$

$x = \frac{13k-7}{5}$

For lowest value of x, put k = 4

x = 9

$\therefore$ x – y = 9 – 2 = 7

Sol.36 [B]

No. of zero's in

$N = 5 \times 10 \times 25 \times 40 \times 50 \times 55 \times 65 \times 125 \times 80$

$N = 5 \times (2 \times 5) \times (5 \times 5) \times (5 \times 8) \times (5^2 \times 2) \times (5 \times 11) \times (13 \times 5) \times (5^3) \times (2^4 \times 5)$

$N = 5^{13} . 2^9 . 13 \times 11$

$\therefore$ No. of zeros in N = 9

Sol.38 [A]

$\sqrt{41616}$ = 204 (Rational no.)

(B) 23.232323 ... = $\frac{2323-23}{99} = \frac{2300}{99}$

(Rational no.)

(C) $\frac{(1+\sqrt{3})^3 - (1-\sqrt{3})^3}{\sqrt{3}}$

$= \frac{[(1+\sqrt{3})^2 - (1-\sqrt{3})^2 + (1+\sqrt{3})(1-\sqrt{3})]}{\sqrt{3}}$

$= \frac{[(1+3+2\sqrt{3}) + (1+3-2\sqrt{3}) + 1 - 3].[2\sqrt{3}]}{\sqrt{3}}$

$= \frac{6.2\sqrt{3}}{\sqrt{3}}$ = 12 (Rational no.)

(D) 23.10100100010000 ...

A real number which is non repeating and non-terminating, therefore it is an irrational number.

Sol.39 [A]

Given that,

N = 13x + 3 ...(1)

N = 21y + 11 ...(2)

Adding +10 on both the sides in eq.(1) & (2), we get

N + 10 = 13(x + 1)

N + 10 = 21(y + 1)

N + 10 is a multiple of 13 and 21

$\therefore$ N + 10 = k.LCM of (13, 21)

$\therefore$ N + 10 = 13.21.k

$\Rightarrow$ N + 10 = 273 k

$\Rightarrow$ N = 273 k – 10

put k = 2, N = 273 × 2 – 10

N = 536

Now, the remainder, when N is divided by 19 is

$$\begin{array}{r|l} & 28 \\ \hline 19 & 536 \\ & -38 \\ \hline & 156 \\ & \_152 \\ \hline & 4 \end{array}$$

$\therefore$ Remainder = 4

Sol.40 [D]

$N = 0.\overline{34} + 0.\overline{34}$

$N = \frac{34}{99} + \frac{34-3}{90}$

$N = \frac{34}{99} + \frac{31}{90}$

$N = \frac{34\times10 + 31\times11}{9\times11\times10}$

$N = \frac{340 + 341}{990}$

$N = \frac{681}{990} \Rightarrow N = 0.68\overline{7}$

Sol.41 [D]

$\frac{2\sqrt{11}}{7\sqrt{11}} = \frac{2}{7}$ is in form of $\frac{p}{q}$

Sol.42 [C]

Prime no. between 1 & 10 is 2, 3, 5, 7

= 2 × 3 × 5 × 7 = 210

Sol.43 [C]

$\frac{a}{b} = \frac{2}{3}, \frac{x}{y} = \frac{3}{4}$

$\frac{2ax - 25by}{3ay + 4bx}$ divide N^r and D^r by

$\frac{\frac{2ax - 25by}{by}}{\frac{3ay + 4bx}{by}} = \frac{\frac{2ax}{by} - 25}{\frac{3ay}{by} + \frac{4bx}{by}}$

$$= \frac{2\times\frac{a}{b}\times\frac{x}{y}-25}{3\times\frac{a}{b}+4\times\frac{x}{y}} = \frac{2\times\frac{2}{3}\times\frac{3}{4}-25}{3\times\frac{2}{3}+4\times\frac{3}{4}}$$

$$= \frac{1-25}{2+3} = \frac{-24}{5}$$

Sol.44 [A]

$14^m - 6^m$ $\because$ M is natural number

Let m = 1 $\Rightarrow$ 14 – 6 = 8

m = 2 $\Rightarrow$ $14^2 - 6^2 = 160$

m = 3 $\Rightarrow$ $14^3 - 6^3 = 2744 - 216 = 2528$

All numbers all divisible by 8

Sol.45 [D]

$q \neq 0$, if q = 0, number become not defined.

Sol.46 [C]

Let consecutive number are 2m, (2m + 2), (2m + 4)

product = 2m × (2m + 2) × (2m + 4)

= 2 × 2 × 2 × (m + 1) × (m + 2) × m

= 8 × m × (m + 1) × (m + 2)

where m, (m + 1) and (m + 2) all three consecutive natural number

= 8 × 1 × 2 × 3 = 16 × 3

divisible by 16

Sol.47 [C,D]

Case-1

Let 6 comes 3 times

6 $\rightarrow$ 3 times $\rightarrow$ 6 × 3 = 18

$\Rightarrow$ other 9 no. sum = 46 – 18 = 28

$\Rightarrow$ 2 (1 + 3 + 4 + 5) + 2 = 28

26 + 2 = 28

28 = 28

$\Rightarrow$ minimum times '2' comes on the top

Case-2

Let 5 comes 3 times

5 $\rightarrow$ 3 times $\rightarrow$ 5 × 3 = 15

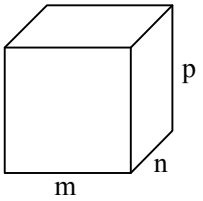
$\Rightarrow$ 9 no. sum = 46 – 15 = 31

$\Rightarrow$ 2 (2 + 3 + 4 + 6) + 1 = 31

31 = 31

$\Rightarrow$ minimum times '1' comes on the top

Sol.48 [D]



$$\frac{m(m+1)}{2}\times\frac{n(n+1)}{2}\times\frac{p(p+1)}{2}$$

$$\frac{5\times6}{2}\times\frac{5\times6}{2}\times\frac{5\times6}{2}$$

15 × 15 × 15 = 3375

Sol.49 [C]

The number which is divisible by 6, is not having 2 and 3 as factor

$\therefore$ $n = 2^2 \times 5$, which is having six positive divisor

$\therefore$ $9n = 9 \times 2^2 \times 5$

$= 3^2 \times 2^2 \times 5^1$

$\therefore$ No. of divisors = (2 + 1) (2 + 1) (1 + 1)

= 3 × 3 × 2 = 18

Sol.50 [A]

$$\sqrt{\frac{1}{9}(999.....9)-\frac{2}{9}(999.....9)}$$

$$\frac{1}{3}\sqrt{10^{2018}-1-2(10^{1009}-1)}$$

$$\Rightarrow \frac{1}{3}\sqrt{10^{2018}-1-2.10^{1009}+2}$$

$$\Rightarrow \frac{1}{3}\sqrt{10^{2018}-2.10^{1009}+1}$$

$$\Rightarrow \frac{1}{3}\sqrt{(10^{1009}-1)^2}$$

$$\Rightarrow \frac{10^{1009}-1}{3}$$

Chapter

1

NUMBER SERIES

Mental ability is the ability of mind to observe and understand things or patterns in a logical way and reach to a conclusion or judgment based on that logic.

It is the ability to distinguish between important, less important and more important.

Number Series problems deal with numbers. While attempting to solve the question, you have to check the pattern of the series. Series moves with certain mathematical operations like :

- Consecutive odd/even numbers.
- Consecutive prime / composite numbers.
- Squares/cubes of some numbers with/without variation of addition or subtraction of some number.
- Sum/product/difference of preceding number(s) .
- Addition/subtraction/multiplication/division by some number.
- Many more combinations of the relationship given above.

Type of questions asked in the examination:

(i) Find the missing term(s).

(ii) Find the wrong term(s).

◈ FIND THE MISSING TERM

Ex.1 7, 12, 19, ?, 39

(A) 29 (B) 28 (C) 26 (D) 24

Sol.(B) The given sequence follows the pattern:

+5, +7, +9 ... i.e., 7 + 5 = 12, 12 + 7 = 19, ...

∴ Missing number = 19 + 9 = 28

Ex.2 0, 6, 24, 60, 120, 210, ?

(A) 240 (B) 290 (C) 336 (D) 504

Sol.(C) The given series is

$1^3 - 1, 2^3 - 2, 3^3 - 3, 4^3 - 4, 5^3 - 5, 6^3 - 6.$

∴ Next number = $7^3 - 7 = 343 - 7 = 336$

Ex.3 4, 6, 12, 14, 28, 30, ?

(A) 32 (B) 60 (C) 62 (D) 64

Sol.(B) The given sequence is a combination of two series :

I. 4, 12, 28, ? and II. 6, 14, 30.

Now, the pattern followed in each of the above two series is : +8, +16, +32 ....

So, missing number = (28 + 32) = 60

Ex.4 1, 3, 3, 6, 7, 9, ?, 12, 21.

(A) 10 (B) 11 (C) 12 (D) 13

Sol.(D) The given sequence is a combination of two series :

I. 1, 3, 7, ?, 21 and II. 3, 6, 9, 12

The pattern followed in I is + 2, + 4, +6, +8 ... and the pattern followed in II is +3. Thus, missing number = 7 + 6 = 13.

Ex.5 $\frac{1}{2}, \frac{3}{4}, \frac{5}{8}, \frac{7}{16}, ?$

(A) $\frac{9}{32}$ (B) $\frac{10}{17}$ (C) $\frac{11}{34}$ (D) $\frac{12}{35}$

Sol.(A) Clearly, the numerators of the fractions in the given sequence form the series 1, 3, 5, 7, in which each term is obtained by adding 2 to the previous term. The denominators of the fractions form the series 2, 4, 8, 16

i.e. $2^1, 2^2, 2^3, 2^4$.

So, the numerator of the next fraction will be (7 + 2) i.e., 9 and the denominator will be 2^5 i.e. 32.

∴ The next term is $\frac{9}{32}$

Ex.6 94, 166, 258, ?, 4912

(A) 3610 (B) 2490

(C) 789 (D) 810

Sol.(A) Each number is in two parts. The first part is square of consecutive numbers 3, 4, 5, ……..

$(3)^2$ $(4)^2$ $(5)^2$ $(6)^2$ $(7)^2$

9 4 16 6 25 8 36 10 49 12

4 6 8 10 12

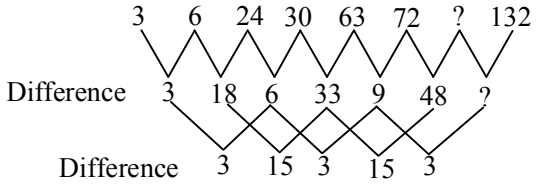
The second part is the sequence of number with difference +2, like 4, 6, 8, …….

Hence, the required number is 3610.

Ex.7 3, 6, 24, 30, 63, 72, ?, 132

(A) 128 (B) 122 (C) 120 (D) 124

Sol.(C) The difference between the terms is given below as:



Therefore, alternate difference between the difference is 3 and 15 respectively.

Hence, the next term would be 72 + 48 = 120.

Ex.8 6, 11, 21, 36, 56, ?

(A) 42 (B) 51 (C) 81 (D) 91

Sol.(C) The pattern is +5, +10, +15, + 20, ...

∴ Missing number = 56 + 25 = 81

Ex.9 1, 6, 13, 22, 33, ?

(A) 44 (B) 45 (C) 46 (D) 47

Sol.(C) The pattern is + 5, + 7, + 9, + 11, ...

∴ Missing number = 33 + 13 = 46

Ex.10 1, 9, 17, 33, 49, 73, ?

(A) 97 (B) 98 (C) 99 (D) 100

Sol.(A) The pattern is +8, +8, +16, +16, +24, ...

∴ Missing number = 73 + 24 = 97

Ex.11 3, 7, 15, 31, 63, ?

(A) 92 (B) 115 (C) 127 (D) 131

Sol.(C) Each number in the series is the preceding number multiplied by 2 and then increased by 1.

Thus, (3 × 2) + 1 = 7, (7 × 2) + 1 = 15,

(15 × 2) + 1 = 31 and so on.

∴ Missing number = (63 × 2) + 1 = 127

Ex.12 1, 6, 15, ?, 45, 66, 91

(A) 25 (B) 26 (C) 27 (D) 28

Sol.(D) The pattern is +5, +9, ..., +21, +25

∴ Missing number = 15 + 13 = 28

Ex.13 1, 2, 3, 5, 8, ?

(A) 9 (B) 11 (C) 13 (D) 15

Sol.(C) Each term in the series is the sum of the preceding two terms.

Thus, 1 + 2 = 3; 2 + 3 = 5; 3 + 5 = 8 and so on.

∴ Missing number = 5 + 8 = 13

Ex.14 77, 49, 36, 18, ?

(A) 8 (B) 9 (C) 4 (D) 12

Sol.(A) Next term in the series is the product of the digits of the previous term

7 × 7 = 49, 4 × 9 = 36, 3 × 6 = 18,

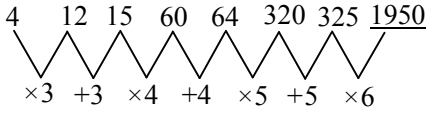
Thus, 1 × 8 = 8

Ex.15 4, 12, 15, 60, 64, 320, 325, ?

(A) 1950 (B) 1850

(C) 1935 (D) 1955

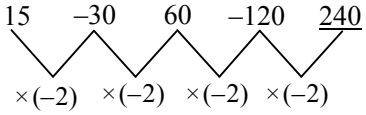
Sol.(A)



Ex.16 15, –30, 60, –120, ?

(A) 150 (B) 240 (C) 270 (D) 180

Sol.(B)



◈ FIND THE WRONG TERM

Ex.17 2, 5, 9, 11, 14

(A) 2 (B) 5 (C) 9 (D) 11

Sol. (C) Series : + 3, + 3, + 3, ...

The next term is got by adding 3 in the preceding term.

$\therefore$ 2 + 3 = 5, 5 + 3 = 8

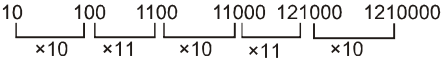
Hence, 9 is the wrong term.

Ex.18 10, 100, 1100, 11000, 111000, 1210000.

(A) 1210000 (B) 11000

(C) 100 (D) 111000

Sol. (D) Given series is :

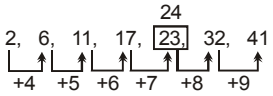


Hence, the wrong term is 111000.

Ex.19 2, 6, 11, 17, 23, 32, 41

(A) 6 (B) 17 (C) 23 (D) 32

Sol. (C) Given series is :



Hence, the wrong term is 23.

Ex.20 61, 52, 63, 95, 46, 18

(A) 95 (B) 63 (C) 46 (D) 52

Sol. (A) On interchanging the digits of each term, we get a number which is a perfect square of a natural number.

$4^2 = 16 \Rightarrow 61$, $5^2 = 25 \Rightarrow 52$, $6^2 = 36 \Rightarrow 63$,

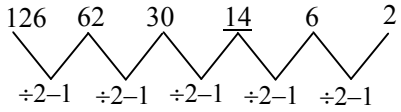
$7^2 = 49 \Rightarrow 94$,

Hence, the wrong term is 95.

Ex.21 126, 62, 30, 15, 6, 2

(A) 15 (B) 30 (C) 6 (D) 62

Sol. (A)



Hence, the wrong term is 15.

EXERCISE-1

Directions: (Q.1 to Q.15) Find the missing term.

Q.1 9, 7, 14, 11, 33, 28, ?, 133, 931
(A) 64 (B) 46 (C) 140 (D) 123

Q.2 6, 12, 23, 44, 85, ?
(A) 166 (B) 174 (C) 165 (D) 168

Q.3 92, 23, 27, 9, 12, 6, ?
(A) 20 (B) 16 (C) 8 (D) 10

Q.4 0, 5, 8, 17, 24, 37, 48, ?
(A) 65 (B) 67 (C) 56 (D) 71

Q.5 999, 730, 510, 345, 213, ?
(A) 122 (B) 126 (C) 68 (D) 128

Q.6 2, 5, 14, 7, 3, 20, 10, 4, ?
(A) 26 (B) 30 (C) 22 (D) 28

Q.7 3, 7, 35, 47, ? , 119
(A) 99 (B) 98 (C) 64 (D) 89

Q.8 23, 27, 43, 79, 143, ?
(A) 242 (B) 241 (C) 190 (D) 243

Q.9 870, 342, 132, ? , 12, 2
(A) 90 (B) 42 (C) 64 (D) 66

Q.10 9, 19, 35, 75, 143, ?
(A) 287 (B) 285 (C) 196 (D) 295

Q.11 2, 20, 110, 380, ?
(A) 424 (B) 650 (C) 982 (D) 992

Q.12 256, 125, 60, ? 12.5
(A) 26 (B) 40 (C) 28 (D) 25

Q.13 6, 15, 35, 77, 143, 221, 323, ?
(A) 437 (B) 427 (C) 384 (D) 365

Q.14 9, 9, 14, 34, 124, ?
(A) 576 (B) 532 (C) 448 (D) 604

Q.15 125, 215, 343, 511, 729, ?
(A) 754 (B) 683 (C) 845 (D) 999

Directions: (Q.16 to Q.25) Find the wrong term.

Q.16 10, 26, 74, 218, 654, 1946, 5834
(A) 26 (B) 74 (C) 218 (D) 654

Q.17 3, 7, 15, 39, 63, 127, 255, 511
(A) 15 (B) 39 (C) 63 (D) 127

Q.18 1236, 2346, 3456, 4566, 5686
(A) 1236 (B) 3456 (C) 4566 (D) 5686

Q.19 10, 15, 26, 35, 48, 63, 82
(A) 48 (B) 26 (C) 63 (D) 82

Q.20 445, 221, 109, 46, 25, 11, 4
(A) 25 (B) 46 (C) 109 (D) 221

Q.21 2, 6, 10, 20, 30, 42, 56
(A) 6 (B) 10 (C) 20 (D) 30

Q.22 3, 9, 27, 82, 243
(A) 27 (B) 54 (C) 82 (D) 162

Q.23 320, 254, 200, 155, 122, 100, 89
(A) 155 (B) 320 (C) 254 (D) 200

Q.24 15, 34, 71, 134, 223, 350
(A) 71 (B) 134 (C) 223 (D) 350

Q.25 5, 10, 40, 80, 320, 550, 2560
(A) 80 (B) 320 (C) 550 (D) 2560

EXERCISE-2

(Previous Year Questions - NTSE & NSO)

Directions: (Q.1 to Q.52) Find the missing term

Q.1 2, 3, 10, 15, 26, ?
(A) 34 (B) 35 (C) 36 (D) 37

Q.2 1, 4, 27, 16, 125, 36, ?
(A) 216 (B) 343 (C) 64 (D) 49

Q.3 336, 210, 120, ?, 24, 6, 0
(A) 40 (B) 50 (C) 60 (D) 70

Q.4 3, 4, 8, 17, 33, ?
(A) 58 (B) 69 (C) 49 (D) 98

Q.5 8, 13, 21, 34, 55, ?
(A) 60 (B) 68 (C) 89 (D) 76

Q.6 480, 480, 240, 80, 20, ?
(A) 4 (B) 1 (C) 5 (D) 10

Q.7 1, 1, 2, 2, 3, 4, 4, 8, 5, 16, ?
(A) 6 (B) 32 (C) 8 (D) 7

Q.8 2, 5, 11, 23, 47, ?
(A) 92 (B) 90 (C) 95 (D) 91

Q.9 12, 21, 23, 32, 34, 43, 45, ?
(A) 54 (B) 48 (C) 77 (D) 9

Q.10 14, 1, 21, 4, 28, 9, ?, ?
(A) 9, 42 (B) 16, 35
(C) 35, 16 (D) 16, 36

Q.11 5, 6, 13, 26, 45, ?
(A) 68 (B) 74 (C) 70 (D) 82

Q.12 190, 94, 46, 22, 10, 4, ?
(A) 3 (B) 2 (C) 1 (D) 0

Q.13 128, 110, 90, 68, ?
(A) 236 (B) 42 (C) 44 (D) 48

Q.14 1, 2, 4, 7, ?, 16
(A) 9 (B) 11 (C) 12 (D) 13

Q.15 6, 8, 9, 12, 14, 18, ?
(A) 21 (B) 19 (C) 23 (D) 20

Q.16 4, 9, 19, 34, 54, ?
(A) 66 (B) 75 (C) 79 (D) 84

Q.17 31, 29, 24, 22, 17, ?, ?
(A) 15, 13 (B) 10, 8 (C) 14, 12 (D) 15, 10

Q.18 3, 6, 11, 18, ?
(A) 19 (B) 27 (C) 30 (D) 37

Q.19 3, 8, 15, 24, ?
(A) 30 (B) 35 (C) 36 (D) 49

Q.20 4, 10, 23, 50, 105, ?
(A) 215 (B) 210 (C) 216 (D) 439

Q.21 912, 303, 102, 33, ?, 3, 2
(A) 12 (B) 10 (C) 8 (D) 6

Q.22 1, 4, 9, ?, 25, 36
(A) 11 (B) 19 (C) 21 (D) 16

Q.23 7, 12, 22, 37, ?, 82, 112
(A) 62 (B) 57 (C) 52 (D) 42

Q.24 11, 13, 17, 19, ?, 25
(A) 20 (B) 21 (C) 23 (D) 22

Q.25 5, 9, 17, 33, ?, 129
(A) 72 (B) 67 (C) 65 (D) 58

Q.26 2, 5, 4, 10, 7, 15, 11, 20, ?, ?
(A) 12, 21 (B) 16, 25
(C) 13, 25 (D) 17, 30

Q.27 0, 6, 24, 60, 120,?
(A) 180 (B) 224 (C) 196 (D) 210

Q.28 57, 54, 58, 55, 59, 56, 60, ?
(A) 64 (B) 63 (C) 58 (D) 57

Q.29 27, 31, 40, 56, 81, 117, ?
(A) 156 (B) 165 (C) 166 (D) 169

Q.30 55, 168, 57, 120, 60, 80, 62, 48, 65, 24, ?, ?
(A) 69, 11 (B) 67, 8 (C) 8, 71 (D) 6, 72

Q.31 8, 7, 16, 5, 32, 3, 64, 1, 128, ?
(A) 18 (B) 13 (C) –1 (D) 3

Q.32 16, 33, 65, 131, ?, 523
(A) 261 (B) 521 (C) 613 (D) 721

Q.33 5, 2, 17, 4, ?, 6, 47, 8, 65
(A) 29 (B) 30 (C) 31 (D) 32

Q.34 1, 2, 4, 8, ?, 32
(A) 10 (B) 12 (C) 14 (D) 16

Q.35 2, 3, 10, 15, 26, ?
(A) 36 (B) 35 (C) 39 (D) 48

Q.36 2, 30, 6, 20, 12, 12, ?
(A) 26 (B) 22 (C) 20 (D) 24

Q.37 6, 20, 36, 48, 50, ?, 0
(A) 36 (B) 40 (C) 46 (D) 56

Q.38 7, 15,28, 59, 114, ?
(A) 243 (B) 233 (C) 213 (D) 223

Q.39 25, 49, 89, 145, 217, ?
(A) 305 (B) 327 (C) 309 (D) 303

Q.40 0, 2, 2, 3, 3, 5, 8, 4, 10, ?, 5, 17
(A) 6 (B) 7 (C) 9 (D) 15

Q.41 0, 2, 24, 252, ?
(A) 620 (B) 1040 (C) 3120 (D) 5430

Q.42 6, 24, 60, 120, ?
(A) 180 (B) 210
(C) 240 (D) 360

Q.43 2, 10, 26, ?, 242
(A) 80 (B) 81
(C) 82 (D) 84

Q.44 5, 10, 17, 26, 37, 50, ?
(A) 70 (B) 66 (C) 65 (D) 64

Q.45 6, 25, 62, 123, ?, 341
(A) 216 (B) 214 (C) 215 (D) 217

Q.46 5, 3, 10, 8, 17, 15, ?, 24
(A) 26 (B) 27 (C) 29 (D) 36

Q.47 2, 6, 12, 20, 30 ?
(A) 40 (B) 42 (C) 44 (D) 46

Q.48 12, 22, 69, 272, 1365, ?
(A) 8196 (B) 8184 (C) 8195 (D) 6830

Q.49 65, 48, 64, 49, 63, ? .
(A) 53 (B) 52 (C) 51 (D) 50

Q.50 7, 23, ? , 79, 119.
(A) 47 (B) 49 (C) 44 (D) 46

Q.51 16, 8, 12, ? , 105.
(A) 6 (B) 30 (C) 24 (D) 35

Q.52 748, 737, 716, 685, 644, ? .
(A) 634 (B) 643 (C) 503 (D) 593

Directions: (Q.53 to Q.56)
In each of the question **53** to **56** some of the numbers are missing in the given series with one term missing shown by question mark (?). This terms is one of the alternatives among the four numbers given under it. Find the right alternative.

Q.53 8, 27, 64, ?, 216, 343
(A) 125 (B) 81 (C) 100 (D) 196

Q.54 5, 11, 19, ? , 41
(A) 28 (B) 29 (C) 30 (D) 35

Q.55 120, ?, 24, 6, 0
(A) 100 (B) 70 (C) 60 (D) 20

Q.56 729, 81, 9, 1, $\frac{1}{9}$, ? , $\frac{1}{729}$
(A) $\frac{1}{27}$ (B) $\frac{1}{81}$ (C) $\frac{1}{243}$ (D) $\frac{1}{486}$

Directions: (Q.57 to Q.79) Find the wrong term

Q.57 3, 7, 9, 21, 27, 66, 81, 189, 243
(A) 27 (B) 66 (C) 243 (D) 21

Q.58 27, 34, 40, 45, 49, 53, 54, 55
(A) 53 (B) 45 (C) 56 (D) 34

Q.59 0, 2, 3,6, 6, 20, 9, 54, 12
(A) 3 (B) 6 (C) 20 (D) 54

Q.60 0, 2, 10, 36, 68, 130
(A) 10 (B) 36 (C) 68 (D) 130

Q.61 9, 54, 44, 264, 254, 1520, 1514
(A) 1514 (B) 1520 (C) 264 (D) 44

Q.62 10, 15, 26, 35, 48, 63, 82
(A) 48 (B) 26 (C) 63 (D) 82

Q.63 3, 10, 30, 66, 127, 218
(A) 3 (B) 66 (C) 30 (D) 218

Q.64 7, 9, 17, 42, 91, 172, 293
(A) 91 (B) 42 (C) 17 (D) 9

Q.65 2, 12, 24, 34, 68, 78, 158, 166
(A) 68 (B) 78 (C) 158 (D) 166

Q.66 2, 6, 10, 20, 30, 42, 56
(A) 6 (B) 10 (C) 20 (D) 30

Q.67 7, 9, 16, 25, 41, 68, 107, 173
(A) 16 (B) 41 (C) 68 (D) 107

Q.68 3, 9, 27, 82, 243
(A) 27 (B) 54 (C) 82 (D) 162

Q.69 5, 9, 17, 35, 65, 129
(A) 65 (B) 35 (C) 17 (D) 9

Q.70 1, 5, 6, 11, 17, 27, 45, 73
(A) 27 (B) 45 (C) 17 (D) 11

Q.71 3, 6, 11, 18, 28, 38, 51, 66
(A) 18 (B) 28 (C) 38 (D) 51

Q.72 320, 254, 200, 155, 122, 100, 89
(A) 155 (B) 320 (C) 254 (D) 200

Q.73 6, 8, 9, 12, 14, 18, 22, 26, 30
(A) 12 (B) 22 (C) 26 (D) 30

Q.74 3, 7, 9, 28, 27, 84, 81, 448, 243
(A) 84 (B) 81 (C) 28 (D) 7

Q.75 190, 94, 46, 22, 10, 3
(A) 94 (B) 46 (C) 22 (D) 3

Q.76 0, 5, 15, 50, 128
(A) 5 (B) 15 (C) 50 (D) 128

Q.77 9, 63, 5, 35, 1, 8
(A) 63 (B) 5 (C) 35 (D) 8

Q.78 89, 78, 86, 80, 85, 82, 83
(A) 83 (B) 82 (C) 86 (D) 78

Q.79 1,1, 3, 9, 6, 36, 10, 100, 16, 225
(A) 225 (B) 16 (C) 10 (D) 9

Q.80 444, 300, 200, 136, 87, 84, 80
(A) 300 (B) 200 (C) 136 (D) 87

Q.81 8, 15, 31, 61, 123, 247, 491
(A) 247 (B) 491 (C) 121 (D) 61

Q.82 3, 6, 24, 30, 63, 72, 122, 132
(A) 132 (B) 30 (C) 122 (D) 72

Q.83 121, 144, 169, **?** , 225, 256.
(A) 196 (B) 296 (C) 220 (D) 222

Q.84 5, 10, 20, **?** , 80.
(A) 35 (B) 40 (C) 45 (D) 50

Q.85 4, 8, 9, 27, 16, **?** , 25, 125.
(A) 8 (B) 16 (C) 25 (D) 64

Q.86 2, 3, 5, 8, **?** , 17.
(A) 6 (B) 12 (C) 13 (D) 15

Q.87 4, 9, 25, ?, 121, 169.
(A) 36 (B) 49 (C) 64 (D) 81

Q.88 1, 3, 7, 13, 21, ?, 43, 57.
(A) 31 (B) 29 (C) 30 (D) 32

Q.89 5, 3, 10, 8, 17, 15, ?, 24.
(A) 25 (B) 23 (C) 26 (D) 27

Q.90 97, 77, 59, ?, 29, 17.
(A) 34 (B) 39 (C) 37 (D) 43

(Questions 91 – 98)
Instruction : In each of the question Nos. **91** to **98** a number series is given with one term missing shown by question mark (?). This term is one of the four alternatives given under it. Find the correct alternative.

Q.91 1, 2, 3, 15, ?, 56
(A) 31 (B) 40 (C) 37 (D) 45

Q.92 100, 50, $33\frac{1}{3}$, 25, 20, ?,
(A) 15 (B) $16\frac{1}{3}$ (C) $17\frac{2}{3}$ (D) $16\frac{2}{3}$

Q.93 17, 16, 8, _?_, – 83
(A) –1 (B) –8 (C) –19 (D) –26

Q.94 6, 24, 60, 120, _?_.
(A) 180 (B) 195 (C) 210 (D) 225

Q.95 49, 64, 56, 57, 63, _?_, 70, 43
(A) 64 (B) 50 (C) 52 (D) 166

Q.96 4, 13, 31, 67, _?_, 283
(A) 139 (B) 103 (C) 121 (D) 139

Q.97 1, 1, 2, 3, 5, 8, _?_, 21
(A) 11 (B) 12 (C) 13 (D) 14

Q.98 3, 24, 81, ?, 375, 648.
(A) 128 (B) 256 (C) 169 (D) 192

Direction (Q.99 to Q.103) Find the missing term in the series given below.

Q.99 2, 12, 30, ? , 90, 120
(A) 48 (B) 56 (C) 63 (D) 72

Q.100 10, 100, 200, 310, ?
(A) 400 (B) 410 (C) 420 (D) 430

Q.101 0, 5, 2, 4.5, 8, 12.5, ?
(A) 16 (B) 17 (C) 16.5 (D) 18

Q.102 109, 74, 46, 25, 11, ?
(A) 3 (B) 0 (C) 11 (D) 4

Q.103 $\frac{2}{3}, \frac{4}{7}, \frac{?}{?}, \frac{11}{21}, \frac{16}{31}$
(A) $\frac{6}{11}$ (B) $\frac{5}{9}$ (C) $\frac{9}{11}$ (D) $\frac{7}{13}$

Direction (Q. NO. 104 to 107) : In each of the following questions write which term in the sequence replaces the question mark.

Q.104 13 , 23 , 43 , 83 , 163 ,?
(A) 326 (B) 323 (C) 321 (D) 318

Q.105 12 , 15 , 21 , 24 , 30 , 33 ,?,?
(A) 36 , 41 (B) 37 , 42
(C) 38 , 47 (D) 39 , 51

Q.106 16 , 40 , 100 , 250 ,?
(A) 575 (B) 625 (C) 425 (D) 525

Q.107 23 , 29 , 47 , 75 ,?
(A) 87 (B) 93 (C) 110 (D) 117

Instruction: In each of the following question no. 108 to 117, a number series is given with missing of one termthe correct alternative that will continue the same pattern and replace the question mark (?) in the givens

Q.108 2,3,5,9,17
(A) 34 (B) 31 (C) 32 (D) 33

Q.109 2,7,12,17,?,27
(A) 18 (B) 22 (C) 19 (D) 23

Q.110 11,121, 1331,?
(A) 14641 (B) 14411
(C) 14141 (D) 14441

Q.111 656,432, 320, 264, 236,?
(A) 229 (B) 232 (C) 222 (D) 223

Q.112 3,19,97,391,?,2359
(A) 1177 (B) 1084 (C) 1711 (D) 1958

Q.113 2, 7, 24, 77, ?
(A) 1335 (B) 249 (C) 283 (D) 238

Q.114 11, 5, 13,1 0,15,15,17, ?, ?
(A) 5, 11 (B) 20,19
(C) 19,21 (D) 19,20

Q.115 1331,2197,4913,6859,?,24389
(A) 13824 (B) 9261
(C) 12167 (D) 15625

Q.116 97, 86, 99, 88, 101, ?, ?
(A) 90, 103 (B) 88,99
(C) 121,108 (D) 114,103

Q.117 77, 49, 36,18,?
(A) 10 (B) 12 (C) 8 (D) 16

ANSWER KEY

EXERCISE - 1

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

EXERCISE - 2

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	B	B	C	A	C	A	A	C	A	C	C	C	C	B	A	C	D	B	B	C
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	A	D	B	C	C	B	D	D	C	B	C	A	C	D	B	C	C	B	A	D
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	C	B	C	C	B	A	B	B	D	A	B	D	A	B	C	B	B	A	C	B
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	B	A	C	D	C	B	C	C	B	A	B	D	B	A	D	D	D	C	B	D
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	A	C	A	B	D	B	B	A	C	D	A	D	C	C	B	A	C	D	B	D
Que.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117			
Ans.	D	D	D	B	D	B	C	D	B	A	C	A	D	B	C	A	C			

SOLUTIONS

EXERCISE-1

Sol.1 **[C]**

9, 7, 14, 11, 33, 28, 140, 133, 931

2 3 5 7

difference is prime no.

Sol.2 **[A]**

$6 \times 2 + 0 = 12$

$12 \times 2 - 1 = 23$

$23 \times 2 - 2 = 44$

$85 \times 2 - 4 = 166$

Sol.3 **[A]**

92, 23, 27, 9, 12, 6, 8

÷4 +4 :4 +3 ÷3 +3

Sol.4 **[A]**

$1^2 - 1$ 0

$2^2 + 1 = 5$

$3^2 - 1 = 8$

$4^2 + 1 = 17$

$8^2 + 1 = 65$

Sol.5 **[D]**

$999 = 10^3 - 1$

$730 = 9^3 + 1$

$510 = 8^3 - 2$

$345 = 7^3 + 2$

$213 = 63 - 3$

$128 = 5^3 + 3$

Sol.6 **[A]**

$(2 + 5) \times 2 = 14$

$(7 + 13) \times 2 = 2$

$(10 + 4) \times 2 = 28$

Sol.7 **[A]**

$2^2 - 1 = 3$

$+3 \curvearrowright 3^2 - 2 = 7$

$6^2 - 1 = 35$

$+3 \curvearrowright 7^2 - 2 = 49$

$10^2 - 1 = 99$

Sol.8 **[D]**

23, 27, 43, 79, 143 —

2^2 4^2 6^2 8^2 10^2

Sol.9 **[B]**

$870 = 29^2 + 29$

$342 = 18^2 + 18$

$132 = 11^2 + 11$

$42 = 6^2 + 3$

$2^0 = 1^2 + 1$

Sol.10 **[D]**

$9 \times 2 + 1 = 18$, $18 \times 2 - 2 - 3 = 35$

$35 \times 2 + 5 = 75$, $75 \times 2 - 7 = 143$

$143 \times 2 + 9 = 295$

Sol.11 **[B]**

2, 20, 110, 380, 650

+18 +90 +270 +270

×5 ×3 ×1

Sol.12 **[C]**

256, 125, 60 ——, 12.5

$\frac{256-6}{2} = 125$

$\frac{256-5}{2} = 60 \Rightarrow \frac{60-4}{2} = 28$

Sol.13 **[A]**

$2 \times 3 = 6$

$3 \times 5 = 15$

$5 \times 7 = 35$

$7 \times 11 = 77$

$19 \times 23 = 437$

Sol.14 **[D]**

9, 9, 14, 34, 124 ——

$9 \times 2 - 4 = 14$

$14 \times 3 - 8 = 34$

$34 \times 4 - 12 = 124$

$124 \times 5 - 16 = 604$

Sol.15 **[D]**

125, 215, 343, 511, 729, 999

↑ ↑ ↑ ↑ ↑ ↑

5^3 $6^3 - 1$ 7^3 $8^3 - 1$ 9^3 $10^3 - 1$

Sol.16 **[D]**

Each term is 4 less than hence the preceding term.

50, 654 is wrong term, it must be $218 \times 3 - 4 = 650$

Sol.17 **[B]**
Each term is 1 mare than twice the preceding term
50, 39 us wrong term

Sol.18 **[D]**
unit place is range term place is increased by from first to tort term.
50, 5686 is wrong term

Sol.19 **[A]**
Logic is : $3^2 + 1$, $4^2 - 1$, $5^2 - 1$, $6^2 - 1$, $7^2 + 1$
so 48 is wrong term

Sol.20 **[B]**
2, 11, 25, 46, 109, 221, 445
+7 +14 +28 +56 112 224
×2 ×2 ×2 ×2 ×2
46 is wrong terms

Sol.21 **[B]**
2, 6, 10, 20, 30, 42, 55
+4 +6 +8 +10 +12 +14
10 is wrong term,

Sol.22 **[C]**
3^1, 3^2, 3^3, 3^4, 3^5
82 is wrong term,

Sol.23 **[D]**
320, 254, 200, 155, 122, 100, 89
–66 –55 –44 –33 –22 –11

Sol.24 **[D]**
1 + 5 = 6, 3 + 4 = 7, 7 + 1 = 8, 2 + 2 + 3 = 7
3 + 5 + 0 = 8
pattern after adding digital of number 67878 it should be 87876 such type of pattern is called palling drone

Sol.25 **[C]**
5, 10, 40, 80, 320, 550, 2560
×2 ×4 ×2 ×4 ×2 ×4
so, 550 is wrong term

EXERCISE-2

Sol.1 **[B]**
Pattern is $n^2 + 1$, $n^2 - 1$, where n = 1, 2, 3, 4, 5 ….
So next term is $6^2 - 1 = 35$

Sol.2 **[B]**
it is combination of two series : -
1.27, 125, …..
and
4, 16, 36, …..
pattern is n^2, n^3
So next term is $7^3 = 343$

Sol.3 **[C]**
Logic is $7^3 - 7$, $6^3 - 6$, $5^3 - 5$, …..
missing term $\Rightarrow 4^3 - 4 = 60$

Sol.4 **[A]**
3, 4, 8, 17, 33, ……
1 4 9 16
difference is 1^2, 2^2, 3^2, 4^2
next term = 33 $5^2 = 58$

Sol.5 **[C]**
Third term = first term + second terms
missing term = 34 + 55 = 89

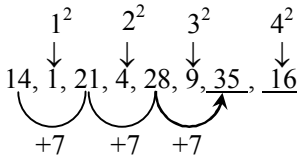
Sol.6 **[D]**
480, 480, 240, 80, 20, 4
÷1 ÷2 ÷3 ÷4 ÷5

Sol.7 **[A]**
1, 1, 2, 2, 3, 4, 4, 8, 5, 16, 6
+1 +1 +1 +1 +1

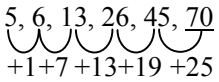
Sol.8 **[C]**
2, 5, 11, 23, 47, ……
2 × 8 + 1 = 5
5 × 2 + 1 = 11
so next term $\Rightarrow$ 47 × 2 + 1 = 95

Sol.9 **[A]**
+11 +11 +11
12, 21, 23, 32, 34, 43, 45, 54
+11 +11 +11

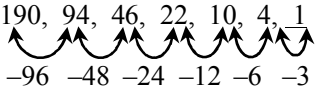
Sol.10 **[C]**



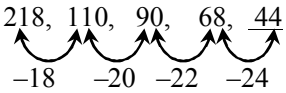
Sol.11 **[C]**



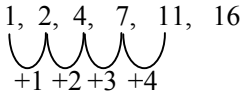
Sol.12 **[C]**



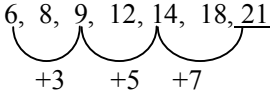
Sol.13 **[C]**



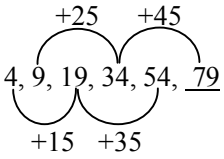
Sol.14 **[B]**



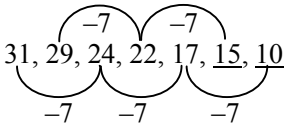
Sol.15 **[A]**



Sol.16 **[C]**



Sol.17 **[D]**



Sol.18 **[B]**

3, 6, 11, 18 ——

logic is $n^2 + 2$, n = 1, 2, 3, ……

missing term = $5^2 + 2 = 27$

Sol.19 **[B]**

Logic is $n^2 - 1$, n = 2, 3, 4, 5, …..

missing term $\Rightarrow 6^2 - 1 = 35$

Sol.20 **[C]**

$4 \times 2 + 2 = 10$

$10 \times 2 + 3 = 23$

$23 \times 2 + 4 = 50$

$50 \times 2 + 5 = 105$

$105 \times 2 + 6 = 216$

Sol.21 **[A]**

Logic is ÷ 3 – 1, ÷3 + 1, …..

$33 \div 3 + 1 = 12$

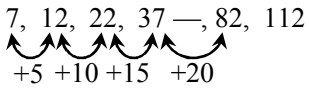
Sol.22 **[D]**

1, 4, 9 ——, 25, 36

all are perfect squares

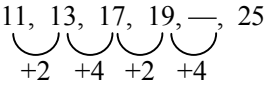
$4^2 = 16$

Sol.23 **[B]**



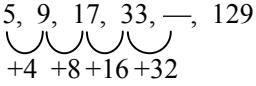
37 + 20 = 57

Sol.24 **[C]**



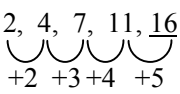
$\Rightarrow$ 19 + 4 = 23

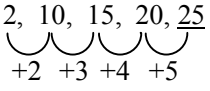
Sol.25 **[C]**



$\Rightarrow$ 33 + 32 = 65

Sol.26 **[B]**

First series = 

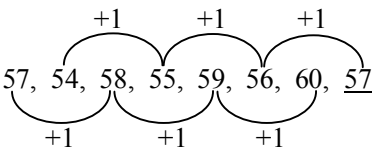
second series = 

Sol.27 **[D]**

Logic is: $n^3 - n$, n = 1, 2, 3, 4, …..

missing term $6^3 - 6 = 210$

Sol.28 **[D]**



Sol.29 **[C]**

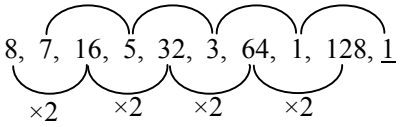
$27 + 2^2 = 31$
$31 + 3^2 = 40$
$40 + 4^2 = 56$
$56 + 5^2 = 81$
$81 + 6^2 = 117$
$117 + 7^2 = 166$

Sol.30 **[B]**

I: 55, 57, 60, 62, 65, 67
+2 +3 +2 +3 +2

II: 168, 120, 80, 48, 24, 8
–48 –40 –32 –24 –16

Sol.31 **[C]**



Sol.32 **[A]**

Logic is ×2 + 1, ×2 – 1, …..
⇒ 131 × 2 – 1 = 261

Sol.33 **[C]**

5, 2, 17, 4, —, 6, 47, 8, 65
+12 +14 +16 +18

⇒ 17 + 14 = 31

Sol.34 **[D]**

1, 2, 4, 8, —, 32
×2 ×2 ×2 ×2 ×2

⇒ 8 × 2 = 16

Sol.35 **[B]**

2, 3, 10, 15, 26, —
1^2+1 2^2-1 3^2+1 4^2-1 5^2+1 6^2-1

⇒ 36 – 1 = 35

Sol.36 **[C]**

It is combination of two series :
I. 2, 6, 12, —
II. 30, 20, 12,
pattern in I is $1^2 + 1$, $2^2 + 2$, $3^2 + 3$, ….
missing term = $4^2 + 4 = 20$

Sol.37 **[A]**

$1 \times 1 \times 6 = 6$
$2 \times 2 \times 5 = 20$
$3 \times 3 \times 4 = 36$
$4 \times 4 \times 3 = 48$
$5 \times 5 \times 2 = 50$
$6 \times 6 \times 1 = 36$
$7 \times 7 \times 0 = 0$

Sol.38 **[B]**

Logic is × 2 + 1, × 2 – 2, × 2 + 3,
missing term ⇒ 114 × 2 + 5 = 233

Sol.39 **[A]**

25, 49, 89, 145, 217, —
+24 +40 +56 +72 +88
+16 +16 +6/6 +16

217 + 88 = 305

Sol.40 **[D]**

It is combination of three series :
+3 +5 +7
I: 0, 3, 8, ?
II: 2, 3, 4, 5
III : 2, 5, 10, 17
messing term : 8 + 7 = 15

Sol.41 **[C]**

Logic is: $n^2 – n$, n = 1, 2, 3, 4,
$1^1 – 1 = 0$,
$2^2 – 2 = 2$
$5^5 – 5 = 3125 – 5 = 3120$

Sol.42 **[B]**

Logic is $n^3 – n$, n = 2, 3, 4, 5
so missing term = $6^3 – 6 = 210$

Sol.43 **[C]**

Logic is: $3^n – 1$, $3^n + 1$, $3^n – 1$, $3^n + 1$, …..
so missing term ⇒ $3^4 + 1 = 82$

Sol.44 **[C]**

5, 10, 17, 26, 37, 50, 65
+5 +7 +9 +11 +13 +15

Sol.45 **[B]**

Logic is $n^3 – 2$, n = 2, 3, 4, 5,…..
missing term ⇒ $6^3 – 2 = 214$

Sol.46 **[A]**

5, 3, 10, 8, 17, 15, —, 24

+5 +7 +9

missing term $\Rightarrow 17 + 9 = 26$

Sol.47 **[B]**

Logic is $n^2 - n$, n = 2, 3, 4, 5,….

missing term $\Rightarrow 7^2 - 7 = 42$

Sol.48 **[B]**

12, 22, 69, 272, 1365, 8184

×2–2 ×3+3 ×4–4 ×5+5 ×6–6

Sol.49 **[D]**

I : 65, 64, 63

II: 48, 49, 50

+1 +1

Sol.50 **[A]**

Logic is $n^2 - 2$, n = 3, 5, 7, 9, ……

missing term = $7^2 - 2 = 47$

Sol.51 **[B]**

16, 8, 12, —, 105

×0.5 ×1.5 ×2.5 ×3.5

missing number $\Rightarrow 12 \times 2.5 = 30$

Sol.52 **[D]**

–1 –1 –1 –1 –1

748, 737, 716, 685, 644, 593

–1 –2 –3 –4 –5

Sol.53 **[A]**

Logic is n^3, n = 2, 3, 4, 5, …..

missing number $5^3 = 125$

Sol.54 **[B]**

5, 11, 19, 29, 41

2^2+1 3^2+2 4^2+3 5^2+4 6^2+5

Sol.55 **[C]**

120, 60, 24, 6, 0

5^3-5 4^3-4 3^3-3 2^3-2 1^3-1

Sol.56 **[B]**

Logic is divide by 9

missing term $\frac{1}{9} \div 9 = \frac{1}{81}$

Sol.57 **[B]**

It concept of two series

I: 3, 9, 27, 81, 243

×3 ×3 ×3 ×3

II: 7, 21, 66, 189,

×3 ×3

$21 \times 3 = 63$

wrong term = 66

Sol.58 **[A]**

Logic is +7, +6, +5, +4, …… +1

53 is wrong term

Sol.59 **[C]**

I: 0, 3, 6, 9, 12

+3 +3 +3 +3

II: 2, 6, 20, 54

×3 ×3 ×3

So, 20 is wrong term

Sol.60 **[B]**

logic is $0^3 + 0$, $1^3 = 1$, $2^3 + 2^3 + 2$, $3^3 + 3$, …..

wrong term is 36

Sol.61 **[B]**

9, 54, 44, 264, 754, 1520, 1514

×6 –10 ×6 –10 ×6

$\Rightarrow 254 \times 6 = 1524$

wrong term is 1520

Sol.62 **[A]**

Sequence is :

3^2+1, 4^2-1, 5^2+1, 6^2-1, 7^2+1, 8^2-1,…….

so, 48 is wrong term and replaced by

Sol.63 **[C]**

The sequence is :

1^3+2, 2^3+2, 3^3+2, 4^3+2, ……..

so, 30 is wrong term

Sol.64 **[D]**

Difference between terms are : -

$+1^2$, $+3^2$, $+5^2$, $+7^2$, $+9^2$

so, 9 is wrong term

Sol.65 **[C]**
Sequence in the given relies terms
+10, ×2, +10, ×2, + 10, ×2, …….
so, 158 is wrong term

Sol.66 **[B]**
2, 6, 10, 20, 30, 42, 56
+4 +6 +8 +10 +12 +14
10 is wrong term

Sol.67 **[C]**
7 + 9 = 16, 9 + 16 = 25, 16 + 25 = 41
25 + 41 = 66
so 68 is wrong term

Sol.68 **[C]**
$3^1, 3^2, 3^3, 3^4, 3^5$
82 is wrong term

Sol.69 **[B]**
5 × 2 – 1 = 9
9 × 2 – 1 = 17
17 × 2 – = 33
so, 35 is wrong term

Sol.70 **[A]**
1 + 5 = 6, 6 + 5 =11, 11 + 6 = 17
17 + 11 = 28
so, 27 is wrong term

Sol.71 **[B]**
3, 6, 11, 18, 28, 38, 51, 61
+3 +5 +7 +9
28, is wrong term

Sol.72 **[D]**
320, 254, 200, 155, 122, 100, 89
+66 +55 +44 +33 +22 +11
200 is wrong term

Sol.73 **[D]**
I: 6, 9, 14, 22, 30
+3 +5 +7 +9
II: 8, 12, 18, 26
+4 +6 +8
22 is wrong term

Sol.74 **[A]**
I : 3, 9, 27, 81, 243
II: 7, 28, 84, 448
+4 +4 +4
28 × 4 = 112
so, 84 is wrong term

Sol.75 **[D]**
3, 10, 22, 46, 94, 190
×2 +2 ×2 +2 ×2 +2 ×2 +2 ×2 +2 ×2 +2
190 is wrong term

Sol.76 **[D]**
0, 5, 15, 50, 128
×1 +5 ×2 +5 ×3 +5 ×4 +5
128 is wrong term

Sol.77 **[D]**
9, 63, 5, 35, 1, 8
I: 9, 5, 1
63, 35, 8
8^2-1 6^2-1 4^2-1
8 is wrong term

Sol.78 **[C]**
I: 78, 80, 82
II: 89, 86, 85, 83
86 is wrong term

Sol.79 **[B]**
I: 1, 3, 6, 10, 16
+2 +3 +4 +5

Sol.80 **[D]**
440, 300, 200, 136, 87, 84, 80
144 100 64 4
12^2 10^2 8^2 2^2

Sol.81 **[A]**
8, 15, 31, 61, 123, 247, 491
×2–1 ×2+1 ×2–1 ×2+1 ×2–1 ×2+1

Sol.82 **[A]**
3 × 1 = 3, 3 × 2 = 6
6 × 4 = 24, 6 × 5 = 30
9 × 7 = 63, 9 × 8 = 92
12 × 10 = 120, 12 × 11 = 132

Sol.83 **[A]**
$11^2,\ 12^2,\ 13^2,\ 14^2,\ 15^2,\ 16^2$
missing term = 196

Sol.84 **[B]**
5, 10, 20, —, 80
×2 ×2 ×2 ×2
$20 \times 2 = 40$

Sol.85 **[D]**
$2^2,\ 2^3,\ 3^2,\ 3^3,\ 4^2,\ 4^3,\ 5^2,\ 5^3,$ …..
$4^3 = 64$

Sol.86 **[B]**
2, 3, 5, 8, —, 17
+1 +2 +3 +4 +5

Sol.87 **[B]**
Square of prime number
$7^2 = 49$

Sol.88 **[A]**
$1^2 - 0 = 1,\ 2^2 - 1 = 3,\ 3^2 - 2 = 7,\ 4^2 - 3 = 13,$….
$5^2 - 4 = 21,\ 6^2 - 5 = 31$

Sol.89 **[C]**
I: 5, 10, 17, —
+5 +7 +9
II: 3, 8, 15, 24
+5 +7 +9
17 + 9 = 26

Sol.90 **[D]**
Logic is: $10^2 - 3,\ 9^2 - 4,\ 8^2 - 5,\ 7^2 - 6,$ ……
missing term = $7^2 - 6 = 43$

Sol.91 **[A]**
1, 2, 6, 15, —, 56
$+1^2$ $+2^2$ $+3^2$ $+3^2$ $+5^2$
15 + 16 = 31
places do correction in question, in sequence replace 3 by 6

Sol.92 **[D]**

$100,\ 50,\ 33\frac{1}{3},\ 25,\ 20,$ —

$100 \div 1 = 100,\ 100 \div 2 = 50,\ 100 \div 3 = 33\frac{1}{2}$

So, …… $100 \div 6 = 16\frac{2}{3}$

Sol.93 **[C]**
17, 16, 8, —, –83
-1^3 -2^3 -3^3 -4^3
so, $8 - 3^3 = -19$

Sol.94 **[B]**
$n^3 - n,$ n = 2, 3, 4,…..
missing term $6^3 - 6 = 210$

Sol.95 **[B]**
I: 49, 56, 63, 70
+7 +7 +7
II: 64, 57, —, 43
–7 –7 –7
57 – 7 = 50

Sol.96 **[A]**
Logic is ×5 + 5
missing term is 67 × 2 + 5 = 139

Sol.97 **[C]**
1 + 1 = 2
2 + 1 = 3
3 + 5 = 8
5 + 8 = 13
missing term = 13

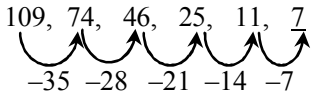
Sol.98 **[D]**
$1^3 \times 3 = 3$
$2^3 \times 3 = 24$
$3^3 \times 3 = 81$
$4^3 \times 3 = 192$

Sol.99 **[B]**
$2 \times 1 = 2$
$3 \times 4 = 12$
$5 \times 6 = 30$
$7 \times 8 = 56$
$9 \times 10 = 90$
$11 \times 12 = 132$

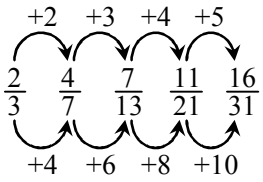
Sol.100 **[D]**
10, 100, 200, 310, —
+90 +100 +110 +120
$\Rightarrow 310 + 120 = 430$

Sol.101 **[D]**
0, 0.5, 2, 4.5, 8, 12.5, —
+0.5 +1.5 +3.5 +4.5 +5.5
12.5 + 5.5 = 18

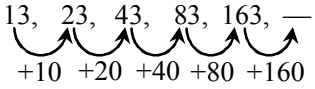
Sol.102 [D]



Sol.103 [D]



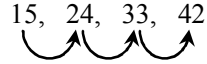
Sol.104 [C]



Sol.105 [D]

I: 12, 21, 30, 39

II: 15, 24, 33, 42



39, 42

do correction in option

Sol.106 [B]

$\frac{16\times5}{2}=40$

$\frac{40\times5}{2}=100$

$\frac{100\times5}{2}=250$

$\frac{250\times5}{2}=625$

Sol.107 [C]

$23 + 2 \times 3 = 29$

$29 + 2 \times 9 = 47$

$47 + 4 \times 7 = 75$

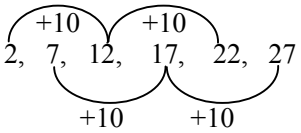
$75 + 7 \times 5 = 110$

Sol.108 [D]

$\times 2^{-1}$ is logic

$17 \times 2 - 1 = 33$

Sol.109 [B]



Sol.110 [A]

$11^1, 11^2, 11^3, 11^4$

$11^4 = 14641$

Sol.111 [C]

$\text{Logic is next term} = \frac{\text{revious term}}{2} + 104$

$\frac{656}{2} + 104 = 432$

$\frac{432}{2} + 104 = 320$

$\frac{236}{2} + 104 = 232$

Sol.112 [A]

$3 \times 6 + 1 = 19$

$19 \times 5 + 2 = 97$

$97 \times 4 + 3 = 391$

$391 \times 3 + 4 = 1177$

Sol.113 [D]

$2 \times 3 = 1 = 7$

$7 \times 2 + 3 = 21$

$77 \times 3 + 238$

Sol.114 [B]

I : 11, 13, 15, 17, 19

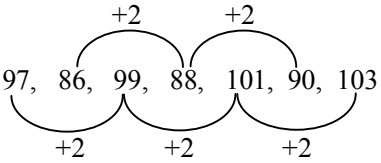
II: 5, 10, 15, 20

Sol.115 [C]

$11^3, 13^3, 17^3, 19^3, 23^3, 29^3$

$23^3 = 12167$

Sol.116 [A]



Sol.117 [C]

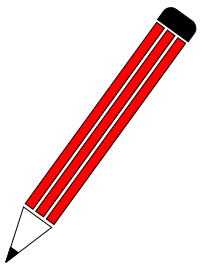
$7 \times 7 = 49$

$4 \times 9 = 36$

$3 \times 6 = 18$

$1 \times 8 = 8$

NOTES



Chapter

1

India Size And Location

Chapter Outline

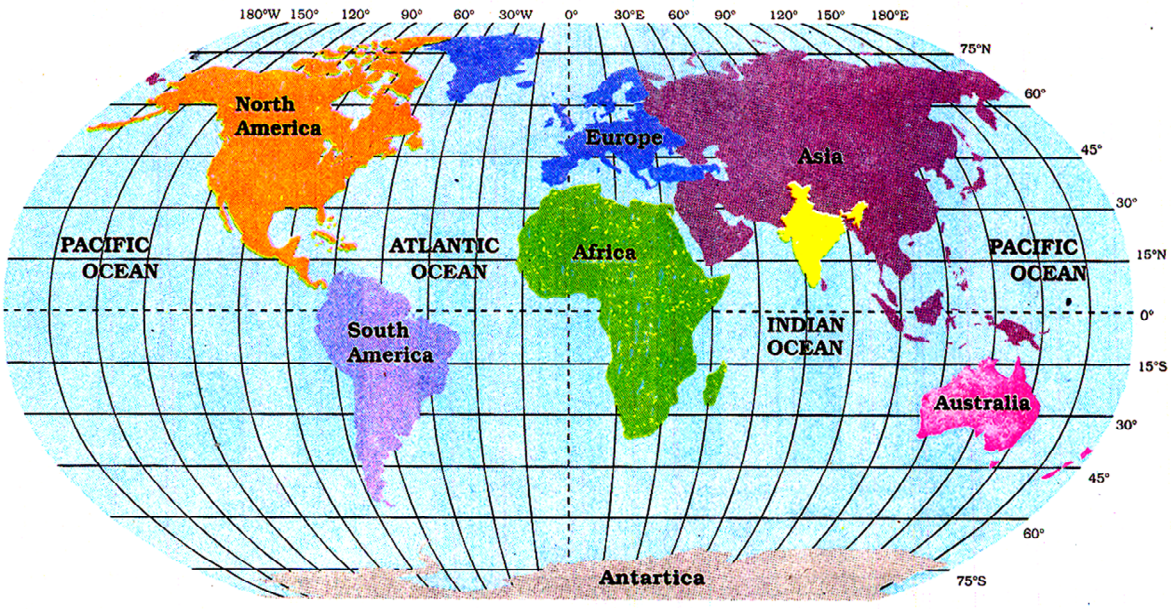
- **Location**
- **Size**
- **India and the World**
- **India's Neighbours**
- **Some Interesting Facts**

Location

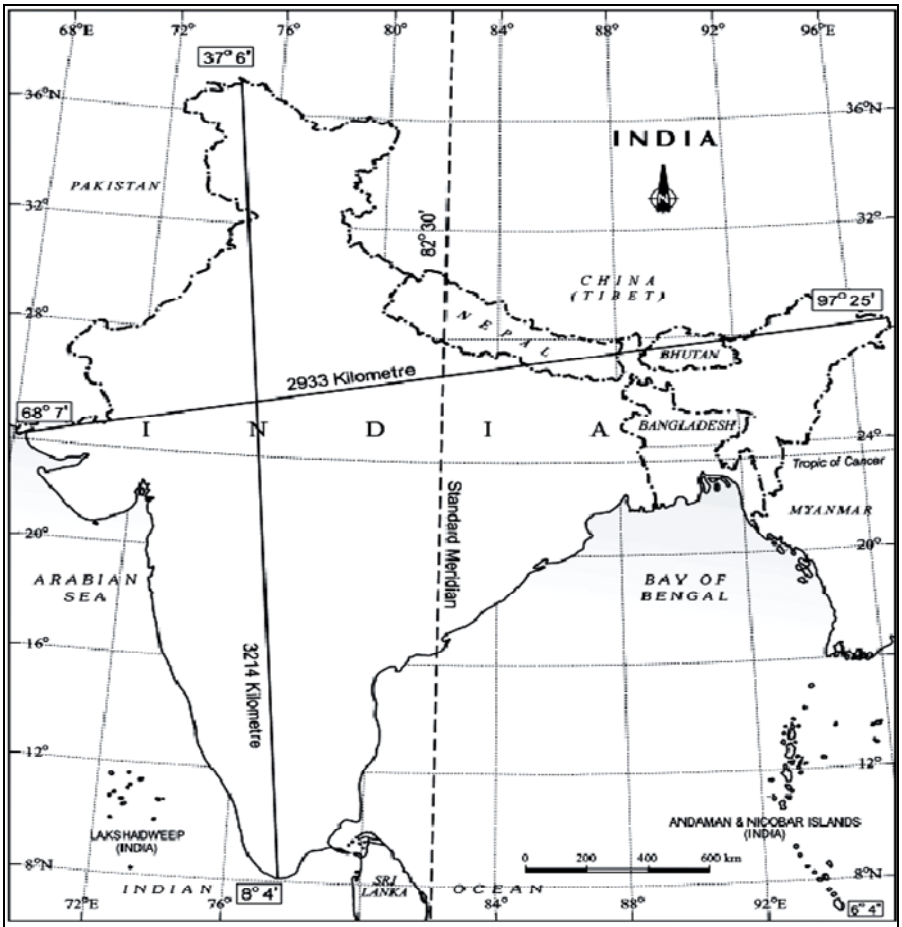
India is a vast country. Lying entirely in the Northern hemisphere the main land extends between latitudes 8° 4' N and 37° 6' N and longitudes 68° 7' E and 97° 25' E. The Tropic of Cancer (23° 30' N) divides the country into almost two equal parts. To the southeast and southwest of the mainland, lie the Andaman and Nicobar islands in Bay of Bengal and the Lakshadweep island in the Arabian Sea.

Size

1. India is a vast country which lies in the south of Asia.
2. It is the 7th largest country of the world after Russia, Canada, U.S.A., China, Brazil and Australia.
3. Its area is about 3.28 million sq. km and it is about 2.42 % of the total area of the world.
4. India has a land boundary about 15,200 km and the total length of the coast line of the main land including Andaman & Nicobar and Lakshadweep is 7,516.6 km.
5. India is bounded by young fold mountains in the northwest, north and north east.
6. South of about 22º north latitude, it begins to taper and extends towards the Indian Ocean, dividing it into two seas, the Arabian Sea on the west and Bay of Bengal on its east.



India in the World



India Extent and Standard Meridian

(a) India has a distinct physical and cultural identity :

Notwithstanding wide diversity, the Indian society has fostered unity and homogeneity. To a large extent this unity and homogeneity has been promoted by the geographical features of the country.

(1) On its north, India is bounded by lofty mountains. These mountains run east-west for thousands of kilometers. These provide a natural wall against all possible intrusions.

(2) On the south, India is surrounded by the seas and the ocean from three sides. It means, the land is protected from outside intrusions.

(b) "The north-south extent of India is larger than its east-west extent even though the country's latitudinal and longitudinal extent in degrees is of the same value."

The north-south distance between two successive latitudes remains the same or constant; and it is 3214 km in this case. But the east-west distance between the two successive longitudes goes on progressively-decreasing from the equator to the poles. This is because all the meridians merge into a single point at the poles. In India the maximum east-west extent therefore is much less than 3200 km. It is 2933km only.

(c) Standard Meridian of India :

The earth takes 24 hours to complete one rotation (360º) about its axis. It means the earth rotates at the pace of 15 per hour(360º/24). As the longitudinal extent of India is about 30º longitude, the time lag between easternmost and westernmost points of India is of two hours. When it is 6.00 a.m at eastern extremity. India it is still 4.00 a.m. at the westernmost point of India. To avoid this time confusion, time along the Standard Meridian of India (82º 30ºE) passing through Mirzapur (in Uttar Pradesh) is taken as the standard time for the whole country. The latitude with an odd value of 82º30'E has been selected as the Standard Meridian of India as.

(1) It is well divisible by 7º30', a standard adopted by almost all the countries of the world.

(2) It lies almost in the middle of India, and as such, it suits us the most.

(d) Impact of the Latitudinal extent of India :

Kanyakumari is situated near Equator. Here days and nights are almost equal, the maximum different is 45 minutes only. But as we move farther towards north or south of the Equator, the difference between the length of the day and night becomes progressively larger. In North Kashmir it is as much as 5 hours, as it is far away from the equator.

India and the world

(a) Significance of India's Location ;

(1) Very thickly populated parts of the world such as China, Japan and Southeast Asia lie very close to India. This has helped in developing trade and other relations with them.

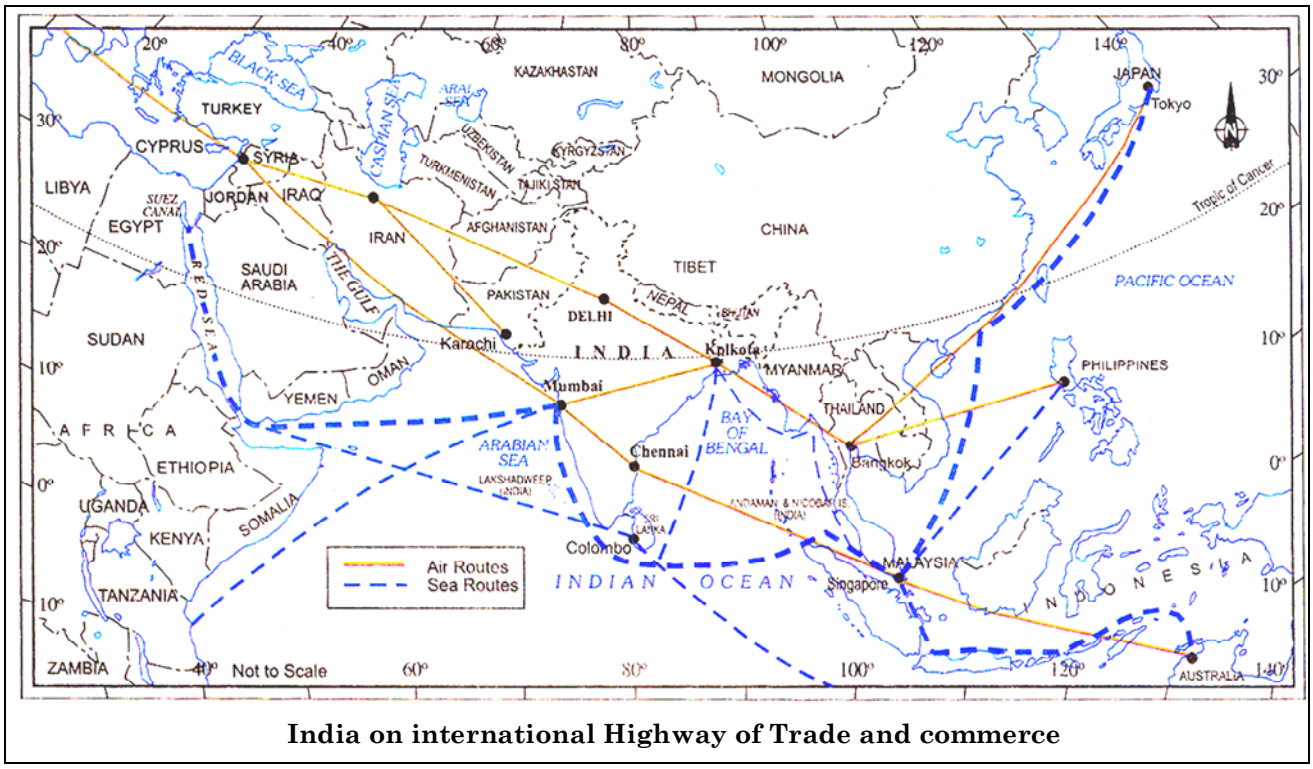
(2) The oil rich countries of the Persian Gulf are not far from us. We receive bulk of our supplies from them.

(3) Being at the head of the Indian Ocean, the country occupies a strategic position and commercially favourable location in respect of Africa, Asia and Australia.

(4) The Suez sea-route provides us the shortest route to industrial Europe and America.

(5) The busy air-routes pass through India, connecting east, South East Asia and Australia on the one hand and Europe and America on the other.

(6) The third largest ocean in the world came to be known as the Indian Ocean because the subcontinent of India stands at the head of this ocean. India was the favourite destination of the traders of the world.



India on international Highway of Trade and commerce

(b) India's Contacts with the Outside World in Ancient and Medieval Times:

India belongs to the Eastern Hemisphere, which contains the oriental world. In ancient times, the sea played an important role in determining the nature of interaction. The central location of India at the head of the Indian Ocean was of great advantage. Countries of East Africa, West Asia, South and South-East Asia, and East Asia could reached be through sea routes. Hence, India established close cultural and commercial contacts with these countries.

India's contacts with the outside world have continued through the ages:

(1) The exchange of ideas and commodities dates back to the ancient times.

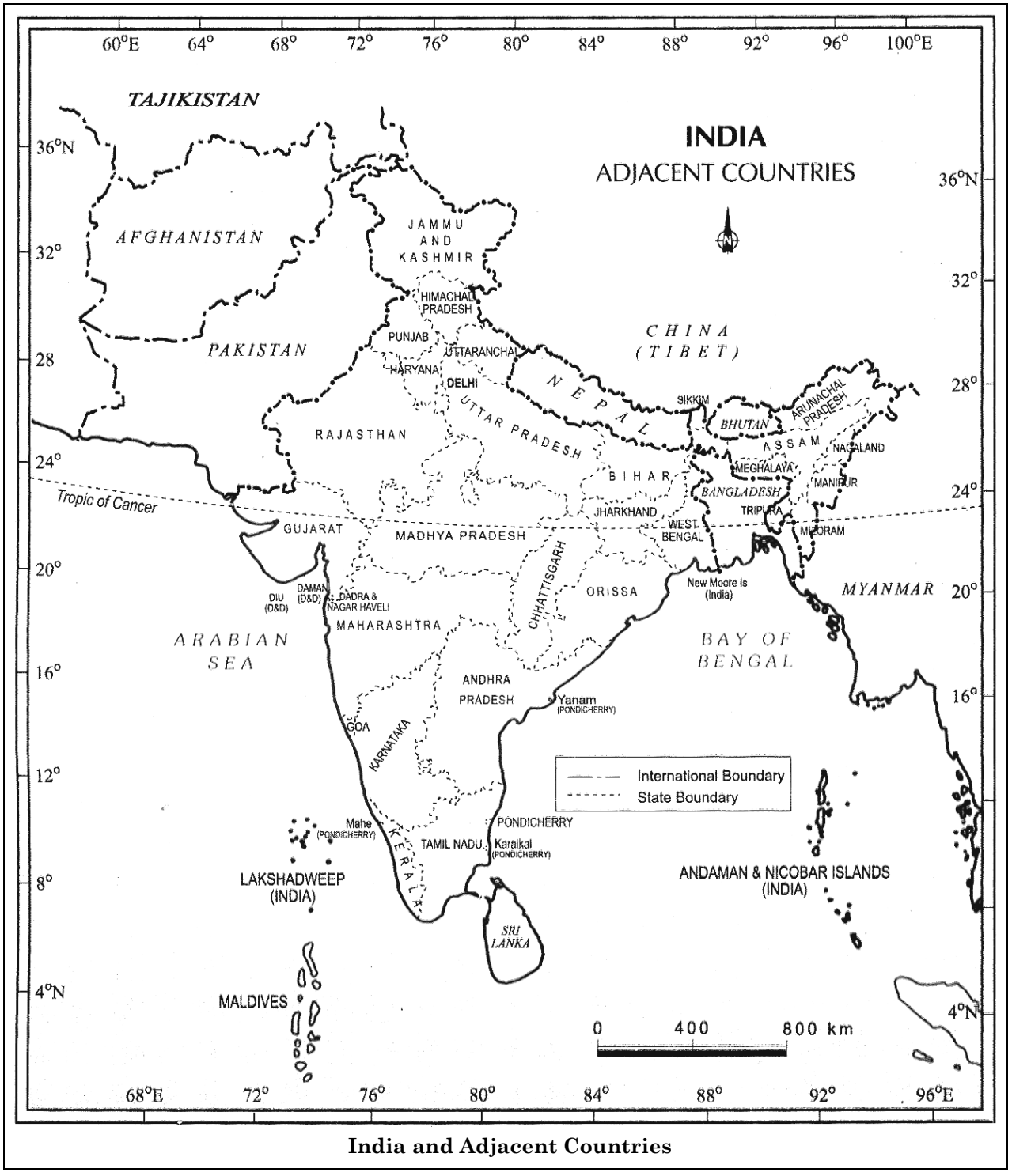
(2) The ideas of the Upanishads, and the Ramayana, the stories of Panchatantras, the Indian numerals and the decimal system could reach many parts of the world.

(3) The spices, muslin and other Indian goods were taken to different countries.

(4) The influence of Greek sculpture, and the architectural styles of dome and minarets from West Asia can be seen in India.

India Neighbours

To the north of India are China, Nepal and Bhutan, and to the east, Bangladesh and Myanmar, To the west and northwest are Pakistan and Afghanistan. In the south, separated from India by the Palk Strait, lies the island country of Sri Lanka. To the south of Lakshadweep lies Maldives. Not far from the Andaman and Nicobar Islands lie our closest South-East Asian neighbors : Indonesia, Malaysia and Thailand.



India and Adjacent Countries

(a) The Indian Subcontinent :

India is called a subcontinent because of its vastness and distinct physical and cultural identity. The countries that form the Indian subcontinent are Pakistan in the northwest, India at the core, Nepal in the north, Bhutan in the northeast and Bangladesh in the east.

Some Interesting Facts

(1) The southernmost point of the Indian Union - 'Indira Point' got submerged under the sea water in 2004 during the Tsunami.

(2) Since the opening of the **Suez Canal** in 1869, India's distance from Europe has been reduced by 7000 km.

(3) Before 1947, there were two types of states in India - the provinces and the Princely states. Provinces were ruled directly by British officials who were appointed by the Viceroy. Princely states were ruled by local, hereditary rulers, who acknowledged sovereignty in return for local autonomy.

GLOSSARY

1. **Equator :** It is an imaginary line which divides the earth into two equal hemisphere-Northern Hemisphere and Southern Hemisphere.
2. **Prime Meridian :** It is the main meridian which passes through Greenwich, near London. It is meridian from which longitude is measured.
3. **Latitude :** It is the distance of a place from the equator in the northern or the southern direction.
4. **Longitude :** It is the distance of place from the Prime Meridian in the eastern or the western direction.
5. **Sub continent :** A big geographical unit which stands out distinctly from the rest of the continent.
6. **Tropic of Cancer :** An imaginary line which runs parallel to the equator in the northern hemisphere of 23½ N Latitude.
7. **Standard Meridian of India :** The meridian of 82º30' E whose local time serves as the standard time for the whole country.
8. **Local Time :** Time of a place determined by the mid day sun.
9. **Standard Time :** The local time taken as the time for the whole country.
10. **Indian Union :** Federation of India comprised of 29 states and 7 union Territories.
11. **Indian mainland :** The stretch of continuous landmass extending from Jammu and Kashmir to Kanyakumari and from Gujarat to Arunachal Pradesh.
12. **Peninsula** : A land mass bounded by the sea on three sides.

EXERCISE-1

➢ Very Short Answer Type Questions

Q.1 What do you know about the location of the Indian subcontinent ?

Q.2 What is the latitudinal extent of India ?

Q.3 Which is the Standard Meridian of Indian ?

Q.4 What do you know about Tropic of Cancer ?

Q.5 In which hemisphere does India lie with reference to the Prime Meridian ? Mention the value of the Standard Meridian of India.

➢ Short Answer Type Questions

Q.6 The Tropic of Cancer runs almost half way through the country. What does this imply ?

Q.7 Account for the two hours time difference between the two eastern and western extremities of India.

Q.8 Give an account of India's size ?

Q.9 What is sub continent ? Name the countries which constitute the Indian sub continent ?

Q.10 Explain why Ahmedabad and Kolkata are able to see the noon sun exactly overhead in a year but not Delhi.

Q.11 The centre location of India at the head of the Indian occan is considered of great significance. Why ?

Q.12 What are the implications of India's latitudinal extent ?

Q.13 Answer the following questions briefly.

(i) Name the group of islands lying in the Arabian sea.

(ii) Which island group of India lies to its south-east ?

(iii) Which island countries are our southern neighbours ?

➢ Long Answer Type Questions

Q.14 Why do we need a standard meridian for India ? Explain ?

Q.15 What do you know about the situation of India ? How has it helped her in attaining an important place in the world market.

Q.16 Give an account of India's contact with the outside world.

Q.17 Describe the trade relation of India in ancient time.

EXERCISE-2

Q.1 In term of area which is India's largest state -
(A) Uttar Pradesh
(B) Maharashtra
(C) Rajasthan
(D) Madhya Pradesh

Q.2 Which of these countries does not have common boundary line with India ?
(A) Afghanistan (B) Sri Lanka
(C) Bhutan (D) Thailand

Q.3 Which one of the following cities never gets the vertical rays of the sun?
(A) Chandigarh (B) Kolkata
(C) Gandhinagar (D) Bhopal

Q.4 On which river's bank Allahabad, Kanpur, Varanasi, Lucknow, Patna and Kolkata are situated ?
(A) Yamuna (B) Ganga
(C) Hugali (D) Chambal

Q.5 Indian Standard Time or I.S.T. is how many hours ahead or behind of G.M.T. or Universal Time?
(A) 5 hrs. 30 min behind G.M.T.
(B) 15 hrs. ahead of G.M.T.
(C) 5 hrs. 30 min ahead of G.M.T.
(D) None of the above

Q.6 Which of the following has reduced India's distance from Europe by 7000 km ?
(A) Suez Canal
(B) Panama Canal
(C) Indira Gandhi Canal
(D) Buckingham Canal

Q.7 Which of the following influences the duration of the day and night, as one moves from south to north ?
(A) Longitudinal extent
(B) Latitudinal extent
(C) Standard Meridian
(D) All the above

Q.8 The Standard Meridian of India, 82°30'E passes through which of the following places?
(A) Kanniyakumari in Tamil Nadu
(B) Walong in Arunachal Pradesh
(C) Kachchh in Gujarat
(D) Mirzapur in Uttar Pradesh

Q.9 The sun rises two hours earlier in Arunachal Pradesh as compared to Gujarat. What time will the watch show in Gujarat if it is 6 am in Arunachal Pradesh?
(A) 4.16 am (B) 7.44 am
(C) 6 am (D) 5.44 am

Q.10 If the local time at Dwarka (69°1'E) in Gujarat to be the west of India is 6 am, what will be the local time at Dibrugarh (94°58'E approximately 95°), Assam in the east?
(A) 4.16 am (B) 6 am
(C) 7.44 am (D) 7.44 pm

Q.11 From Gujarat to Arunachal Pradesh there is a time lag of :
(A) 24 hours (B) 12 hours
(C) 2 hours (D) 30 minutes

Q.12 Both the latitudinal and longitudinal extent of India's mainland is about 30°. But on looking at the map of India, which of the following alternatives do you observe about India's size?
(A) East-west extent appears to be smaller than north-south extent
(B) East-west extent appears to be larger than north-south extent
(C) East-west and north-south extent appears equal
(D) North-south extent appears to be smaller than east-west extent

Q.13 Approximately what is the difference between latitudinal and longitudinal extant of the mainland of India ?
(A) 97° (B) 68°
(C) 30° (D) 8°

Q.14 Which geographical feature bounds India's mainland south of 22°N latitude?
(A) Young Fold Mountains
(B) Sandy Desert
(C) Lava Palteaus
(D) Seas and Ocean

Q.15 By which geographical feature is India bounded in the north-west, north and north-east ?
(A) Seas
(B) Lava Palteaus
(C) Young Fold Mountain
(D) Sandy Desert

Q.16 What is India's size with respect to other countries of the world ?
(A) First (B) Third
(C) Forth (D) Seventh

Q.17 What is the total area of India's landmass?
(A) 2.4 million square km
(B) 3.28 million square km
(C) 32.8 million square km
(D) 3.28 million km

Q.18 Which of the following group of islands belonging to Indian territory lies in the Arabian Sea ?
(A) Andaman and Nicobar Islands
(B) Sri Lanka
(C) Lakshdweep
(D) Maldives

Q.19 Which latitude passes through the southern-most point of India's mainland ?
(A) 8°4'N (B) 37°6'N
(C) 8°4'S (D) 82°30'E

Q.20 Which of the following is the western-most longitude of India ?
(A) 97°25'E (B) 68°7'N
(C) 68°7'E (D) 82°32'E

Q.21 The eastern-most longitude of India is
(A) 97°25'E (B) 68°7'E
(C) 77°6'E (D) 82°32'E

Q.22 The Tropic of Cancer does not pass through which of the following states ?
(A) Rajasthan (B) Orissa
(C) Chhattisgarh (D) Tripura

Q.23 Which of the following parallels of latitude divides India into almost two equal parts?
(A) Equator
(B) Tropic of Capricorn
(C) Tropic of Cancer
(D) Prime Meridian

Q.24 Which of the following is the longitudinal extent of India?
(A) 8°4'N and 37°6'N
(B) 68°7'N and 97°25'E
(C) 68°7'E and 97°25'E
(D) 8°4'E and 37°6'E

Q.25 How many states and Union Territories are there in India?
(A) 29 states and 7 Union Territories including Delhi
(B) 23 States and 12 Union Territories
(C) 26 States and 9 Union Territories
(D) 30 States and 5 Union Territories

Q.26 Mirzapur is located in the state of
(A) Andhra Pradesh
(B) Madhya Pradesh
(C) Uttar Pradesh.
(D) Arunachal Pradesh

Q.27 Longest river of India is
(A) Ganga (B) Brahmaputra
(C) Indus (D) Krishna

Q.28 Rann of Kuchchh is separated from Saurashtra by
(A) Palk Strait (B) Bass Strait
(C) Gulf of Kutchchh (D) Akashi Strait

Q.29 Largest delta in India is
(A) Godavari delta (B) Indus delta
(C) Sunderban delta (D) Kaveri delta

Q.30 The Princely states and Provinces were two types of
(A) districts in India
(B) Administrative divisions in India (During the British Period)
(C) cities in India
(D) towns in India

Q.31 India's northwestern neighbours are
(A) Nepal and Bhutan
(B) Sri Lanka and Maldives
(C) Pakistan and Afghanistan
(D) Myanmar and Bangladesh

Q.32 The water body to the east of India is
(A) Arabian Sea (B) Bay of Bengal
(C) Dead Sea (D) Caspian Sea

Q.33 Coldest place in India
(A) Gangtok (B) Shimla
(C) Srinagar (D) Drass

Q.34 The number of states in India which have coastal line is-
(A) 5 (B) 7
(C) 9 (D) 11

Q.35 Western most point in India is
(A) Rajasthan (B) Gir range
(C) Ghuar Mota (D) Lakhpal

Q.36 Daman and Diu is a -
(A) union territory of India
(B) state of India
(C) district of India
(D) city of India

Q.37 Largest state in India is
(A) Madhya Pradesh (B) Maharashtra
(C) West Bengal (D) Rajasthan

Q.38 Largest union territory of India is
(A) Dadar and Nagar Haveli
(B) Andaman and Nicobar Islands
(C) Lakshawdeep
(D) Pondicherry

Q.39 Smallest state in India is
(A) Goa (B) Kerela
(C) Mizoram (D) Sikkim

Q.40 Wettest place on Earth is
(A) Nongpoh (B) Mawsynram
(C) Jowai (D) Baghmara

Q.41 Eastern most point in India is
(A) Tirap (B) Lohit
(C) Tamang (D) Kibithu

Q.42 Northern most part in India is
(A) Gangotri glacier (B) Siachen glacier
(C) Baltoro glacier (D) Nubra glacier

Q.43 India bounded by the young fold mountains in the northwest are known as the
(A) Himalayas (B) Andes
(C) Alps (D) Rockies

Q.44 Suez Canal has reduced India's distance from Europe by
(A) 6,000 km. (B) 7,000 km.
(C) 8, 000 km. (D) 9,000km.

Q.45 The state with least population is
(A) Goa
(B) Arunachal Pradesh
(C) Sikkim
(D) Mizoram

Q.46 My friend hails from a state that receives the heaviest rainfall in the world. The state is
(A) Meghalaya
(B) Mizoram
(C) Manipur
(D) Arunachal Pradesh

Q.47 West Bengal, Meghalaya and Tripura share common boundaries with
(A) Nepal (B) Bangladesh
(C) Bhutan (D) Myanmar

Q.48 One of the southern neighbours of India is
(A) Bhutan (B) Nepal
(C) Sri Lanka (D) Myanmar

Q.49 The princely state that became a part of independent India after 1947 was
(A) Gujarat
(B) Bengal
(C) Sikkim
(D) Jammu & Kashmir

Q.50 Decimal system was developed by the
(A) Indians (B) Arabs
(C) Chinese (D) Europeans

EXERCISE-3

(Previous Year Questions - NTSE)

Q.1 Which state of India does not have common boundary with Myanmar?
(A) Meghalaya (B) Tripura
(C) Nagaland (D) Manipur

Q.2 Which of the following countries is not in Indian sub-continent?
(A) Maldives (B) Pakistan
(C) Bangladesh (D) Nepal

Q.3 Area wise what is the position of India in the world
(A) Third (B) Fourth
(C) Sixth (D) Seventh

Q.4 The Meridian Line for Indian standard time is
(A) 81° 30' E (B) 83° 30' E
(C) 82°30' E (D) 84° 30' E

Q.5 Out of the following statements which one is not right about 82°30'E longitude?
(A) This is standard meridian of India
(B) The local time of this meridian is 5.30 hours ahead of Greenwich
(C) This meridian passes through Andhra Pradesh
(D) This meridian divides India into almost two equal parts

Q.6 In which year the southernmost point of the India union-'Indira Point' submerged under the sea water.
(A) 2000 (B) 2002
(C) 1998 (D) 2004

Q.7 India's total area accounts_____ per cent of the total geographical area of the world.
(A) 5.0 (B) 4.0 (C) 2.4 (D) 2.8

Q.8 Which one of the following cities never gets the vertical rays of the sun?
(A) Mumbai (B) Simla
(C) Ahmedabad (D) Bhopal

Q.9 Tropic of Cancer does not pass through which of the following states –
(A) Rajasthan
(B) Gujarat
(C) Karnataka
(D) Madhya Pradesh

Q.10 Approximately at What degree of latitude the Gulf Stream (warm water current) and the Labrador current (cold water current) meet near Newfound land?
(A) 20°N (B) 45°N
(C) 20°S (D) 45°S

Q.11 The southern most point of India is -
(A) Kanya Kumari (B) Indira Point
(C) Point Calimer (D) Rameshwaram

Q.12 Which one of the following states has the longest coast line -
(A) Gujrat (B) Maharastra
(C) Kerla (D) West Bengal

Q.13 Name of group of islands of India lying in the Bay of bengal are :
(A) Lakshyadweep
(B) Andman-Nicobar islands
(C) Maldives
(D) Minicoy dweep

Q.14 Which line of axis divides India into two parts?
(A) The tropic of cancer
(B) The tropic of Capricorn
(C) Equator
(D) Greenwich line

Q.15 Which of the statement is correct with regard to equator?
(A) It passes through the Northern Hemisphere of India
(B) It passes through the southern Hemisphere of India
(C) It divides India in to two equal halves
(D) It does not pass through India

Q.16 Which country has 22nd December is the longest night and the shortest day?
(A) Saudi Arabia (B) Egypt
(C) Myanmar (D) Australia

Q.17 From where does 0º Longitude - Greenwich line passes?
(A) France-Japan (B) Germany
(C) England (D) Brazil

Q.18 In India the Tropic of Cancer touches how many states?
(A) 6 states (B) 7 states
(C) 8 states (D) 9 states

Q.19 In which part of India the difference between day and night temperature is very low
(A) Rajasthan
(B) Arunachal Pradesh
(C) Madhya Pradesh
(D) Andaman and Nicobar Island

Q.20 In India Tropic of cancer passes through the state of
(A) Bihar (B) Orissa
(C) Jharkhand (D) Uttar Pradesh

Q.21 Which of the following is correct about the Konkan coastal plain?
(A) Stretches from Mumbai to Goa
(B) Stretches from Daman to Goa
(C) Stretches from Goa to Mangalore
(D) Stretches from Mangalore to Kanya Kumari

Q.22 Which of the following fact is correct for straight line drawn between Arunchal Pradesh and Rann of Kachchh?
(A) 3293 kilometers (B) 2933 kilometers
(C) 2393 kilometers (D) 2923 kilometers

Q.23 How many islands are there in Andaman and Nicobar Islands?
(A) 385 (B) 209
(C) 436 (D) 572

Q.24 **Assertion (A) :** The latitudinal extent influences the duration of day and night, as one moves from south to north of India.
Reason (R) : From Gujarat to Arunachal Pradesh there is a time lag of two hours.
(A) Both A and R True and R is correct explanation of A
(B) Both A are R are True but R is not correct explanation of A
(C) A is True and R is False
(D) A is False and R is True

Q.25 The topic of Cancer passes through which of the following plateau?
(A) Only Malwa
(B) Only Chotanagpur
(C) Only Maghalaya
(D) Both Malwa and Chotanagar

Q.26 Approximately how much is land boundary of India ?
(A) 15200 km (B) 7516.6 km
(C) 6100 km (D) 2000 km

Q.27 Match **List-I** and **List-II** and choose the correct code from the following :

List-I	**List-II**
(a) Northern end	(i) 8º 4' N
(b) Southern end	(ii) 37º 6' N
(c) Eastern end	(iii) 68º 7' E
(d) Western end	(iv) 97º 25' E

Code :

	a	**b**	**c**	**d**
(A)	ii	iii	iv	i
(B)	i	ii	iv	iii
(C)	ii	i	iv	iii
(D)	iii	ii	i	iv

ANSWER KEY

EXERCISE - 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	D	A	B	C	A	B	D	A	C	C	A	C	C	C
Ques.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	D	B	C	A	A	B	B	C	C	A	C	A	D	D	B
Ques.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	C	B	D	B	C	A	D	B	A	B	D	B	A	B	C
Ques.	46	47	48	49	50										
Ans.	A	B	C	C	A										

EXERCISE - 3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	A	D	C	A	D	C	B	C	B	B	A	B	A	D
Ques.	16	17	18	19	20	21	22	23	24	25	26	27			
Ans.	D	C	C	D	C	A	B	D	B	D	A	C			

SOLUTIONS

EXERCISE-1

➢ Very Short Answer Type Questions

Sol.1 India is a vast country which lies in the south of Asia.

Sol.2 The latitudinal extent of India is 8° 4' N and 37° 6' N

Sol.3 Standard Meridian of India : The meridian of 82º30' E whose local time serves as the standard time for the whole country.

Sol.4 Tropic of Cancer : An imaginary line which runs parallel to the equator in the northern hemisphere of 23½ N Latitude.

Sol.5 India is a vast country. Lying entirely in the Northern hemisphere. The meridian of 82º30' E whose local time serves as the standard time for the whole country.

➢ Short Answer Type Questions

Sol.6 An imaginary line which runs parallel to the equator in the northern hemisphere of 23½ N Latitude. The Tropic of Cancer (23° 30' N) divides the country into almost two equal parts.

Sol.7 The earth takes 24 hours to complete one rotation (360º) about its axis. It means the earth rotates at the pace of 15 per hour (360º/24). As the longitudinal extent of India is about 30º longitude, the time lag between easternmost and westernmost points of India is of two hours. When it is 6.00 a.m at eastern extremity. India it is still 4.00 a.m. at the westernmost point of India.

Sol.8 It is the 7th largest country of the world after Russia, Canada, U.S.A., China, Brazil and Australia. Its area is about 3.28 million sq. km and it is about 2.42 % of the total area of the world. India has a land boundary about 15,200 km and the total length of the coast line of the main land including Andaman & Nicobar and Lakshadweep is 7,516.6 km.

Sol.9 India is called a subcontinent because of its vastness and distinct physical and cultural identity. The countries that form the Indian subcontinent are Pakistan in the northwest, India at the core, Nepal in the north, Bhutan in the northeast and Bangladesh in the east.

Sol.10 Kolkata and Ahmedabad is located very close to the Tropic of Cancer and as such both the places see the noon exactly overhead in a year. Delhi., on the other hand is located far north of the Tropic of Cancer and does not enjoy it.

Sol.11 On the south, India is surrounded by the seas and the ocean from three sides. It means, the land is protected from outside intrusions. Being at the head of the Indian Ocean, the country occupies a strategic position and commercially favourable location in respect of Africa, Asia and Australia.

Sol.12 Kanyakumari is situated near Equator. Here days and nights are almost equal, the maximum different is 45 minutes only. But as we move farther towards north or south of the Equator, the difference between the length of the day and night becomes progressively larger. In North Kashmir it is as much as 5 hours, as it is far away from the equator.

Sol.13 (i) Lakshyadweep
(ii) Andaman-Nicobar
(iii) Sri-Lanka & Maldives

➢ Long Answer Type Questions

Sol.14 The earth takes 24 hours to complete one rotation (360º) about its axis. It means the earth rotates at the pace of 15 per hour (360º/24). As the longitudinal extent of India is about 30º longitude, the time lag between easternmost and westernmost points of India is of two hours. When it is 6.00 a.m at eastern extremity.

India it is still 4.00 a.m. at the westernmost point of India. To avoid this time confusion, time along the Standard Meridian of India (82º 30ºE) passing through Mirzapur (in Uttar Pradesh) is taken as the standard time for the whole country. The latitude with an odd value of 82º30'E has been selected as the Standard Meridian of India as.

(1) It is well divisible by 7º30', a standard adopted by almost all the countries of the world.
(2) It lies almost in the middle of India, and as such, it suits us the most.

Sol.15

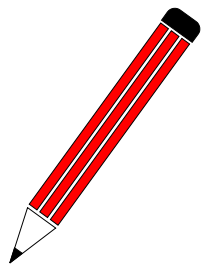
(1) Very thickly populated parts of the world such as China, Japan and Southeast Asia lie very close to India. This has helped in developing trade and other relations with them.
(2) The oil rich countries of the Persian Gulf are not far from us. We receive bulk of our supplies from them.
(3) Being at the head of the Indian Ocean, the country occupies a strategic position and commercially favourable location in respect of Africa, Asia and Australia.
(4) The Suez sea-route provides us the shortest route to industrial Europe and America.
(5) The busy air-routes pass through India, connecting east, South East Asia and Australia on the one hand and Europe and America on the other.

Sol.16 India belongs to the Eastern Hemisphere, which contains the oriental world. In ancient times, the sea played an important role in determining the nature of interaction. The central location of India at the head of the Indian Ocean was of great advantage. Countries of East Africa, West Asia, South and South-East Asia, and East Asia could reached be through sea routes. Hence, India established close cultural and commercial contacts with these countries.

Sol.17

(1) The exchange of ideas and commodities dates back to the ancient times.
(2) The ideas of the Upanishads, and the Ramayana, the stories of Panchatantras, the Indian numerals and the decimal system could reach many parts of the world.
(3) The spices, muslin and other Indian goods were taken to different countries.
(4) The influence of Greek sculpture, and the architectural styles of dome and minarets from West Asia can be seen in India

NOTES



Chapter 1

DIARY WRITING

Diary Entry

A diary is usually maintained by a person as his or her personal memoir. A diary entry, therefore, is a brief summary of what occurs in a person's life. Throughout history, we have seen great personalities keep diaries in which they record their daily happenings and other important activities. Thus, in a way, a diary gives a glimpse of the past incidents in their lives.

Diary writing is similar to an informal letter in terms of language. A diary is usually written in paragraphs. Go through the following examples -

Q.1 Imagine you have been selected as a member of Cricket Team of India. You have always wanted to be included in this team for long and this has happened. You are in the seventh heaven. **Write a diary page in 150 words about your great feelings at this moment.**

Ans. Saturday, 26th November, 2013

At last the great thing has happened. I couldn't believe my ears when I heard that I have been selected in Team India. Congratulatory calls started pouring in from friends and relatives. How desperately I wanted to see myself as a member of this team ! My parents' joy knew no bounds. My worthy teacher and coach always wanted me to see in this team. I can't forget his great efforts in teaching me the minutest tips of the game. I can't forget and shall never forget when I bowled with great swings in the last Ranji trophy matches. All my well-wishers wanted me to play in Team India. I know this gives me a lot of responsibility and my fellow-countrymen expect a lot from me. I must com up to their expectations and fulfil my duties to the great motherland. My parents are so happy that they have organised a Havan and a dinner today to celebrate my selection. I can't forget this day.

Q.2 You spent a part of your summer vacation with your friend Ashok in New Delhi. Since it was your first ever visit to the capital of the country, everything amazed you. **You are now back home in Chennai and write a diary page about your stay with Ashok. Write that diary page in 150 words about your stay with him.**

Ans. Sunday, 15th May, 2014

Now I am back from New Delhi but can't forget my visit to the capital and what I experienced there. First of all, the hot season and the endless crowd. Really, the hot season in Delhi kills all the energy of the people. People perspire profusely, yet go on as usual with their duties. The public transport, the vehicles on road and the non-compliance of the traffic rules make the city unparalleled. Metro service is superb. How good it is in carrying millions and millions of people in seconds ! Truly, it is lifeline of the city. My visit to the Raj Ghat, Red Fort, Nehru Planetarium, Qutub Minar, Dolls Museum, still fresh in my mind. The visit to Chandni Chowk and the Jama Masjid brings back the memories of the Mughal period. I really enjoyed my stay with Ashok and his family. Some evenings at India Gate removed all the tiredness of the day. I would like to visit the capital again. But now it is the trun of Ashok to see Chennai.

Q.3 You have wrongly been fined for making a noise by your teacher. You know who is the leader of the gang but you don't want to name him, though he got you fined by his acting. You feel greatly hurt as the teacher didn't even give you a chance to explain your side. **You write a diary page about this all.** Write that entry in 150 words.

Ans. Saturday, 15th October, 2013

I can't forget this day when my teacher fined me for making a noise despite my saying 'no' to it. But I feel much pained to write that I was not at fault. And I am not one of the gang who does all these mischiefs and always escapes. My fault was only this that I laughed when Mr. A pinched Mr. C from behind. The teacher looked at me shaking my hand and he instantly fined me Rs 50/-. It is most strange that he didn't give me a chance even to prove my innocence. The leader of the gang is known to all but all are afraid of him. No one dares to look at him even through he is always found wanting. My heart poins me very much at this insult and discrimination by the teacher. I think I need to justify the whole thing. So I am now going to talk to the Principal. And if he doesn't listen to me, I will tell my parents the whole truth. The teacher himself says that those who bear the injustice done to them are equally guilty. I think my parents should meet the Principal and the teacher to reveal the truth.

EXERCISE

Q.1 Parveen topped the list of successful candidates in class X examination of CBSE in the district. He was congratulated by all including his school Principal and teachers. This made him very happy and excited. He decided to write a diary page registering his feelings. Write this die entry on his behalf in 150 words.

Q.2 Manoj Kumar, a student of class IX, stood first in the declamation contest and was awarded the prize in the Annual Prize Distribution Function. Since it was his first ever achievement he falt greatly pleased, satisfied and excited. He decided to write a diary page about this, Write this diary entry for him in 150 words.

Q.3 Recently you got a chance to visit your ancestral village to attend a marriage . You were very excited but the journey to the village was not so pleasant. Bumpy roads, dilapidated roadways buses all dampened your spirit. Write your experience of that dreadful journey in the form of a diary entry in about 50-60 words. You are Priya/Priyank of Victor Public School.

Q.4 Last week while cleaning his cupboard, Rajat came across on old photograph. It was shot when teacher. The photograph revived old memories. Write your feelings as Rajat in the form of a diary entry in about 50-60 words.