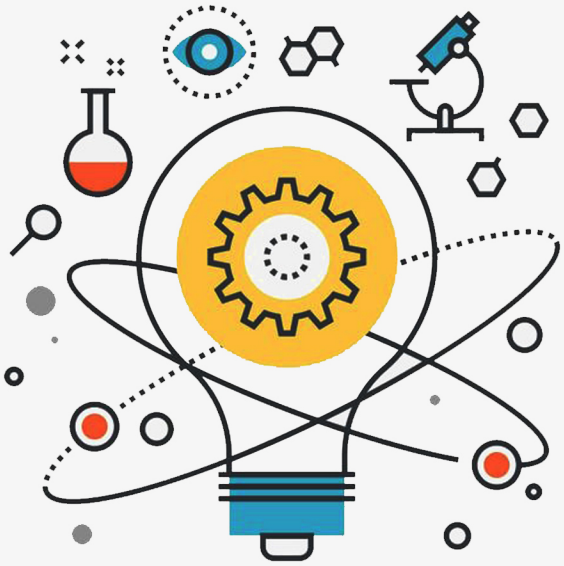
CLASS- 9th

FOUNDATION COURSE

- CBSE,ICSE & OTHER BOARD EXAM
- PRE JEE MAIN & ADVANCED
- PRE MEDICAL (NEET | AIIMS)
- NTSE,KVPY & OTHER COMPETITIVE EXAM



CP PUBLICATION

CAREER POINT

Study Material for Pre foundation Class 9

Prepared by Career Point Kota Experts

CONTENTS OF THE PACKAGE AT A GLANCE

Class IX

Physics	Chemistry	Biologoy
♦ Motion ♦ Force and Laws of Motion ♦ Gravitation ♦ Fluid ♦ Work and Energy ♦ Sound	♦ Matter in our Surroundings ♦ Is matter Around us Pure ♦ Atoms and molecules ♦ Structure of atom	♦ The Fundamental Unit of Life Cell ♦ Tissue ♦ Diversity in the Living Organisms ♦ Why do we Fall Ill ♦ Natural Resources ♦ Improvment in Food Resources

Mathematics [Set-1]	Mathematics [Set-2]	Mental Ability
♦ Number Systems ♦ Polynomials ♦ Coordinate Geometry ♦ Linear Equations in Two Variables ♦ Introduction to Euclid's Geometry ♦ Lines and Angles ♦ Triangles ♦ Quadrilaterals	♦ Areas of Parallelograms and Triangles ♦ Circles ♦ Constructions ♦ Heron's Formula ♦ Surface Areas And Volumes ♦ Statistics ♦ Probability	♦ Number series ♦ Alphabet & letter repeating series ♦ Missing Terms in figures ♦ Mathematical Operations ♦ Arithmetical Reasoning ♦ Alphabet test ♦ Coding-Decoding ♦ Sequential Output Tracing ♦ Direction Sense ♦ Seating Arrangement ♦ Ranking & Odering ♦ Blood Relation ♦ Puzzle test ♦ Venn diagram ♦ Syllogism ♦ Analogy ♦ Classification

Social Science [Set-1]	Social Science [Set-2]
Geography	**History**
♦ India Size and Location ♦ Physical Features of India ♦ Drainage ♦ Climate ♦ Natural Vegetation & Wild Life ♦ Population	♦ The French Revolution ♦ Socialism In Europe & The Russian Revolution ♦ Nazsim And The Rise Of Hitle ♦ Forest Society & Colonialism ♦ Pastoralists In the Modern World ♦ Peasants and Farmers

Civics	Economics
♦ Democracy in the Contemporary World ♦ What is Democracy, Why Democracy ♦ Constitutional Design ♦ Electoral Politic ♦ Working of Institutions ♦ Democratic Rights	♦ The Story of Village Palampur ♦ People As Resource ♦ Poverty As A Challenge ♦ Food Security in India

English [Set-1]	English [Set-2]
♦ Diary writing ♦ Article Writing ♦ Story Writing ♦ Integrated Grammar ♦ The Fun They Had (Beehive Fiction) ♦ The Sound of Music (Beehive Fiction) ♦ The little Girl (Beehive Fiction) ♦ A Truly Beautiful Mind (Beehive Fiction) ♦ The Snake and the minor (Beehive Fiction) ♦ The Road Not Taken (Beehive Poetry) ♦ Rain on the Roof (Beehive Poetry) ♦ Wind (Beehive Poetry) ♦ The Lake Isle of Innisfree (Beehive Poetry) ♦ A Legend of the Northland (Beehive Poetry) ♦ The Lost Child (Moments Fiction) ♦ The Adventure of Toto (Moments Fiction) ♦ Iswaran the Storyteller (Moments Fiction) ♦ In The Kingdom of Fools (Moments Fiction) ♦ The Happy Prince (Moments Fiction) ♦ My Childhood (Beehive Fiction) ♦ Packing (Beehive Fiction) ♦ Reach for the Top (Beehive Fiction) ♦ The Bond of Love (Beehive Fiction) ♦ Kathmandu (Beehive Fiction) ♦ If I Were You (Beehive Fiction) ♦ No Men Are Foreign (Beehive Poetry) ♦ The Duck and the Kangaroo (Beehive Poetry) ♦ On Killing a Tree (Beehive Poetry) ♦ The Snake Trying (Beehive Poetry) ♦ A Slumber did My Spirit Seal (Beehive Poetry) ♦ Weathering The Storm in Ersama (Moments Fiction) ♦ The Last Leaf (Moments Fiction) ♦ A House is Not a Home (Moments Fiction) ♦ The Accidental Tourist (Moments Fiction) ♦ The Beggar (Moments Fiction)	♦ Noun ♦ Pronoun ♦ Adjective ♦ Adverb ♦ Determiners ♦ Connectors ♦ Prepositions ♦ Tense ♦ Passivization ♦ Reported speech ♦ Modals ♦ Subject verb concord ♦ Conditionals ♦ Error spotting ♦ Comprehension ♦ Fillers ♦ Cloze test ♦ Synonyms & antonyms ♦ Idioms and phrases ♦ Phrasal verbs ♦ One word substitution ♦ Spelling

Note to the Students

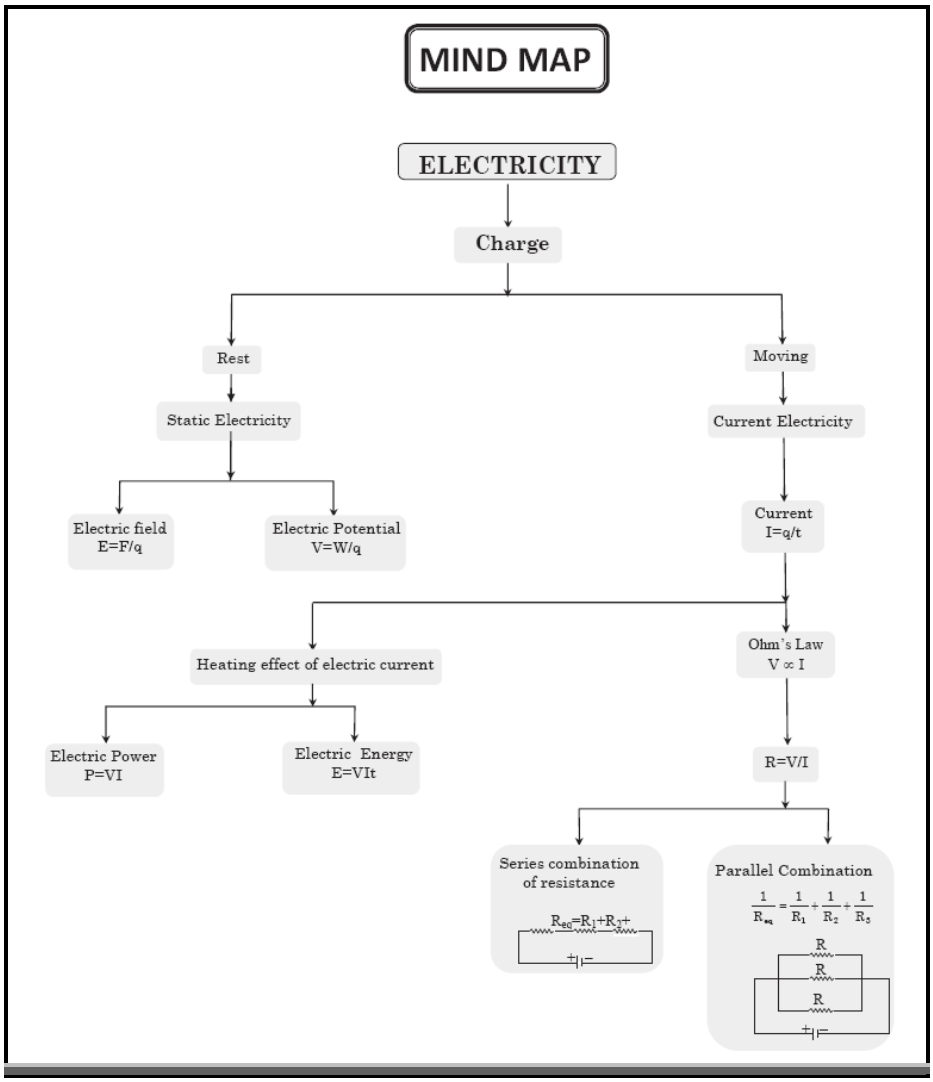
Career Point offers this must have Study Package in Physics, Chemistry and Mathematics to meet the complete curriculum needs of engineering aspirants. The set comprises of 18 books: **Physics** - set of 3 books for class 11 and set of 3 books for Class 12; **Chemistry** - set of 3 books for class 11 and set of 3 books for Class 12 and **Mathematics** - set of 3 books for class 11 and set of 3 books for Class 12. The set caters to the different requirements of students in classes XI and XII. It offers complete and systematic coverage of **JEE Main** and **JEE Advanced** syllabi and aims to provide firm foundation in learning and develop competitive edge in preparation of the JEE and other engineering entrance examinations.

COMPONENTS OF EACH CHAPTER

These books are designed with an engaging and preparation-focused pedagogy and offer a perfect balance of conceptual learning and problem solving skills.

Mind Map

Each chapter contains many articles (Concepts, Theories etc.). Mind map interconnect all these articles logically. By this student can understand whole chapter articles interconnectivity clearly in a single picture frame.



Theory & Concepts

Each chapter consist of exhaustive theory which gives conceptual clarity and command over topics. Appropriate explanation of theory with the help of images, diagrams, flowcharts, mind maps, info graphics, and tables.

MAGNETIC EFFECT OF ELECTRIC CURRENT

Magnet & Magnetism

◈ **Magnet**

The substance which attract Ni, Fe, Co, etc and align in geographical north south direction when suspended freely.

Two bodies even after being neutral (showing no electric interaction) may attract / repel strongly if they have a special property. This property is known as magnetism. This force is called magnetic force. Those bodies are called magnets.

- **Origin of the Magnet**

  Around 120 A.D. near Magnesia in Asia Minor, an ore of iron Fe_3O_4 was found in abundance. This ore of iron, which was found attracting small pieces of iron, was called Magnetite. Hence, the name 'magnet' was given to the pieces that exhibited this property.

- **Types of Magnet**

Magnet

1. Natural magnet
   e.g.: Fe_2O_4/magnetite/ black iron oxide/ lodestone
2. Artificial or man made magnet
   e.g.: Bar magnet, House shoe magnet, Ball ended magnet

Competitive Level

Competitive level is specially designed for competition exam rquirements and to better understanding the concepts, well explained theory, clearly explained formulas with good number of quality examples are given in this.

COMPETITIVE LEVEL

- **Magnitude of magnetic field produced by a straight current-carrying conductor:** The magnitude of magnetic field (or strength of magnetic field) B produced by an infinitely long conductor in vacuum at a distance r from it, is given by:

$$B = \frac{\mu_0 I}{2\pi r}$$

where, B = Magnetic field strength

μ_o = Permeability of vacuum (a constant)

I = Current (flowing in conductor) and

r = Distance from the conductor (where magnetic field is measured).

The SI unit of magnetic field B is Tesla which is denoted by the symbol T (1 tesla is equal to 1 newton per ampere per metre).

The CGS unit of magnetic field B is Gauss which is denoted by the symbol G. (1 Tesla = 10^4 Gauss)

Permeability of vacuum μ_o is $4\pi \times 10^{-7}$ tesla metre per ampere.

In Chapter Example

To understand the application of concepts, there is ***in chapter solved example*** are given. It contains large variety of all types of solved examples with explaination to ensure understanding the application of concepts.

Ex.31 Compute the heat generated while transferring 96000 coulomb of charge in one hour through a potential difference of 50 V.

Sol. The amount of heat (H) produced is given by the Joule's law of heating as H = VIt

where, Voltage, V = 50 V

Time, t = 1 h = 1 × 60 × 60 s = 3600 s

Amount of current, I = q/t = 96000 / 3600 = (80/3) A

$$H = 50 \times \frac{80}{3} \times 60 \times 60 = 4.8 \times 10^6 \text{ J}$$

Therefore, the heat generated is 4.8×10^6 J.

Ex.32 An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the heat developed in 30 s.

Sol. The amount of heat (*H*) produced is given by the Joule's law of heating as H = VIt

where, Current, *I* = 5 A

Practice Exercises

Includes three sets of exercises covering all the topics. Helps the students to assess their strengths and weaknesses and work on them accordingly. Separate exercises for subjective as well as objective questions and previous year competitive exams questions (NTSE, Olympiads)

EXERCISE-1

➢ Very Short Answer Type Questions

Q.1 What is represented by joule/coulomb?

Q.2 What is the function of electric switch in electric circuit?

Q.3 A wire of resistivity 10 ohm meter is stretched to double its length. What is its new resistivity?

Q.4 What is the SI unit of Power?

Q.5 A charge of 2C moves between two plates, maintained at a p.d of 1V. What is the energy acquired by the charge?

➢ Short Answer Type Questions – Type I

Q.6 Draw a schematic diagram of a typical electric circuit comprising a cell, an electric bulb, an ammeter and a plug key.

Q.7 What makes the electric charge to flow in a conducting metallic wire?

Q.8 Two wires of same material and same

Q.13 A TV set shoots out a beam of electrons. The beam current is 10μA.
(a) How many electrons strike the TV screen in each second?
(b) How much charge strikes the screen in a minute?

Q.14 (a) Why do copper or aluminium wires generally used for electrical transmission and distribution purposes?
(b) Two wires, one of copper and other of manganin, have equal lengths and equal resistances. Which wire is thicker? Given that resistivity of copper is lower than that of manganin.

Q.15 Two conductors X and Y of circular cross-section have radii in the ratio of 1: 2, length in the ratio 1: 3 and resistivities in the ratio of 3: 1, then in which ratio their resistances are?

Q.16 Given n resistors each of resistance r. How will you combine them to get the
(i) Maximum and
(ii) Minimum effective resistance? What is the ratio of the maximum to minimum resistance?

EXERCISE-2

Q.1 When a body is negatively charged by friction, it means
(A) the body has acquired excess of electrons
(B) the body has acquired excess of protons
(C) the body has lost some electrons
(D) the body has lost some neutrons

Q.2 When the distance between the charged particles is halved, the force between them becomes
(A) One-fourth (B) Half
(C) Double (D) Four times

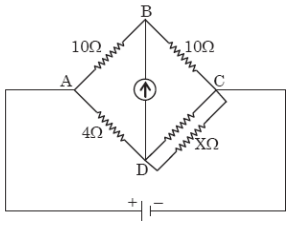
Q.8 Deutron and α – particle are put 1Å apart in air. Magnitude of intensity of electric field due to deutron at α-particle is
(A) Zero
(B) 2.88×10^{11} newton/coulomb
(C) 1.44×10^{11} newton/coulomb
(D) 1.44×10^{11} newton/coulomb

Q.9 What is not true for electric charge :
(A) Electric charge is scalar quantity
(B) Charge on a body may be + ve or – ve
(C) S.I. unit of charge is coulomb
(D) One coulomb is charge of one electron

EXERCISE-3

Q.1 In the given circuit diagram, the value of resistance X in ohm when the bridge is balanced will be

[Raj./ NTSE Stage-I/2005]



(A) 4 (B) 8
(C) 10 (D) 12

(A) high melting point and high specific resistance
(B) high melting point and low specific resistance
(C) low melting point and high specific resistance
(D) low melting point and high specific resistance

Q.5 A uniform wire when connected directly across a 220V line produces heat H per second. If the wire is divided into n-parts and all parts are connected in parallel across a 220 V line, the heat produced per second will be

[Haryana/NTSE Stage-I/2014]

(A) H/n (B) H/n^2

Answer key

Answer key is provided at the end of the exercise sheets.

ANSWER KEY

EXERCISE - 1

3. 40ω

5. 2 J

8. $\frac{R_1}{R_2} = \left(\frac{r_2}{r_1}\right)^2$

10. 1.44×10^6 J

12. $2qv/\ell$

13. (a) 6.25×10^{13} (b) 6×10^{-4}C

EXERCISE - 2

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

EXERCISE - 3

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

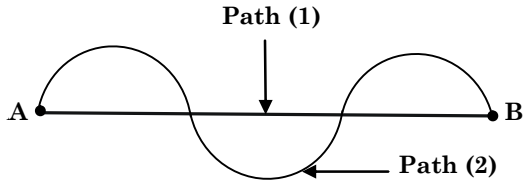
Chapter

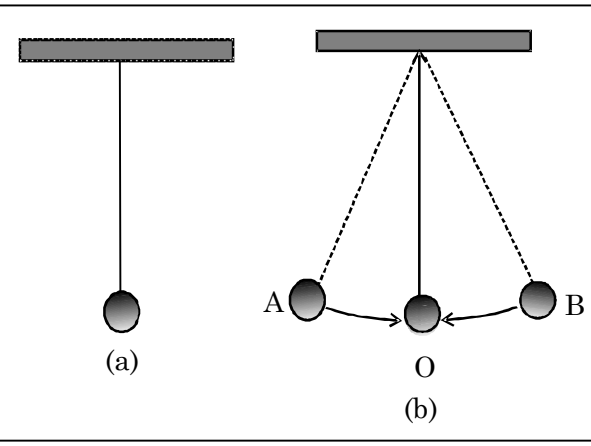
1

MOTION

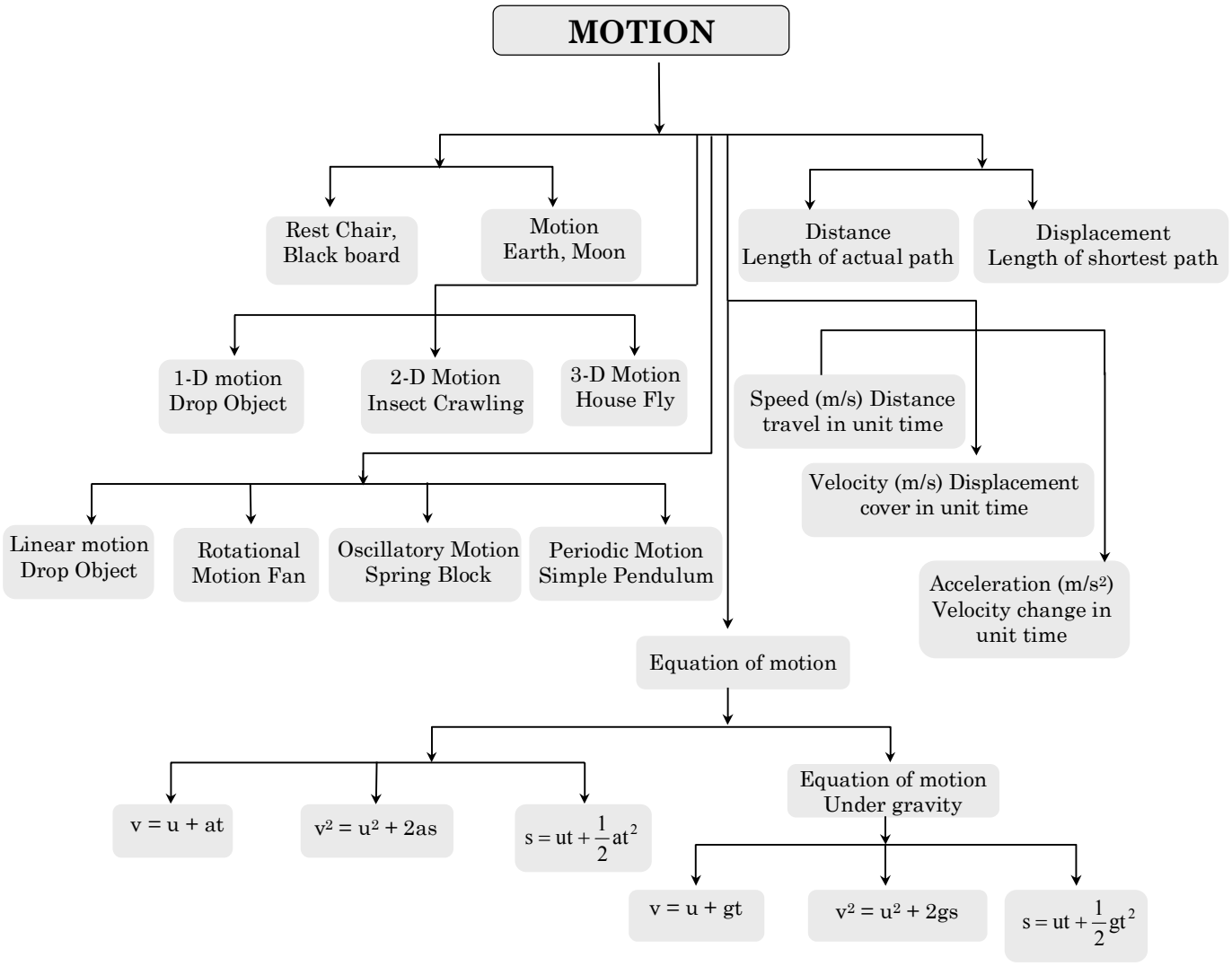
Chapter Outline

- 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

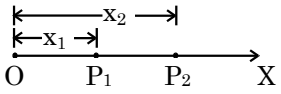
If only one of the three co-ordinates specifying the position of object changes w.r.t. time then its motion is known as 1D motion. In such a case the object moves along a straight line. This motion is also known as rectilinear or linear motion.

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

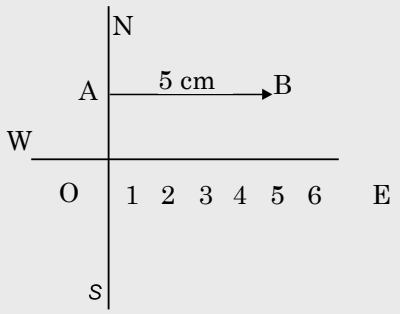
- **Representation of a vector:** A vector is represented by a directed line segment drawn in the given direction on a certain scale.The length of line shows its magnitude and arrow shows direction.

Tail ⟶ head

(symbolic representation)

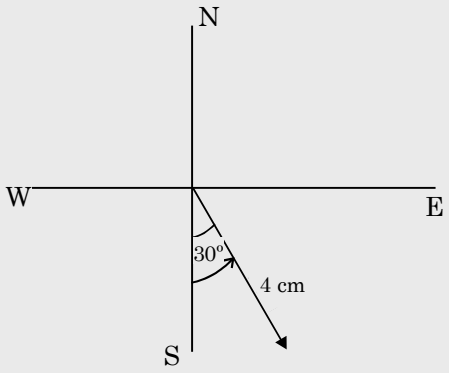
Ex.1 Represent a displacement of 50 m towards east.

Sol. Take the scale 10 m = 1 cm



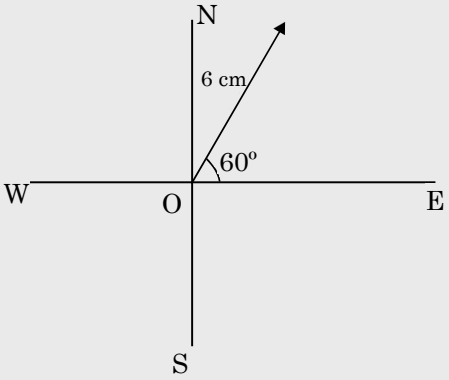
Ex.2 Represent a velocity of 20 km/h towards 30º east of south.

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:

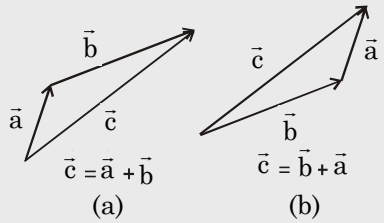
(i) triangle law

(ii) parallelogram law

(iii) polygon law

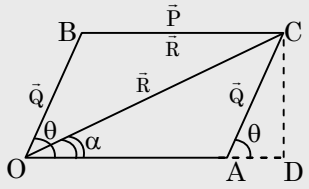
- **Triangle law of vector addition:** If two vectors are represented both in magnitude and direction by the two sides of a triangle taken in the same order, then the resultant of these two vectors is represented in magnitude and direction by the third side of the triangle taken in the opposite order.

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

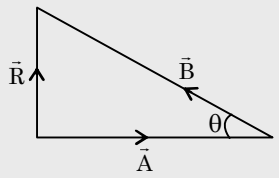
$= 2F_0^2(1 + \cos\theta) = 2F_0^2 \times 2\cos^2\dfrac{\theta}{2}$

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

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

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 $\pi - \theta$

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

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

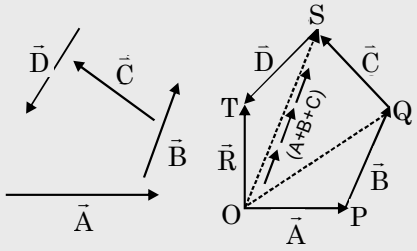
$\Rightarrow$ angle between A and B is 150^o.

◈ 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.

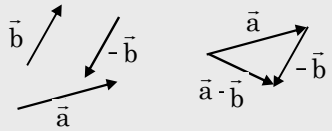
To find their resultant vector, coincide the tail of $\vec{B}$ with the head of $\vec{A}$, tail of $\vec{C}$ with the head of $\vec{B}$ and tail $\vec{D}$ with the head of $\vec{C}$. Then the single vector drawn form the tail of $\vec{A}$ to head of $\vec{D}$.



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

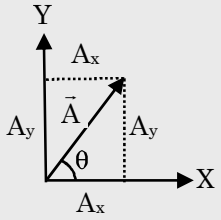


- **Resolution of A Vector:** It is the process of splitting a single vector into two or more vectors in different directions which together produce the same effect as is produced by the single vector alone. The vectors into which the given single vector is splited are called component vectors. Infect, 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 mutuallyperpendicular 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 $\hat{k}$;

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

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

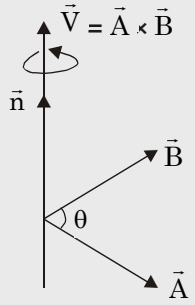
◈ Vector Product

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.



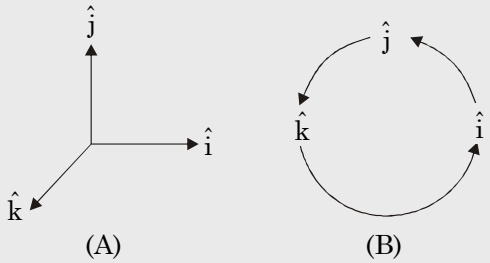
$\vec{A} \times \vec{A} = AA \sin 0^{o}\, \hat{n} = \vec{0}$.

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

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

$\vec{A} \times \vec{B} = \hat{i}\,(A_yB_z - A_z\,B_y) - \hat{j}\,(A_xB_z - A_z\,B_x) + \hat{k}\,(A_xB_y - A_y\,B_x)$

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

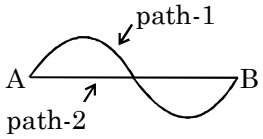
◈ **Distance:**

It is the actual length of path covered by a moving particle . It is a scalar quanitiy. 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.

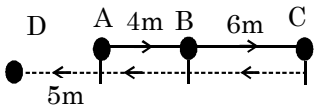
(ii) When an object moves towards left from origin its displacement consider as negative.

(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.

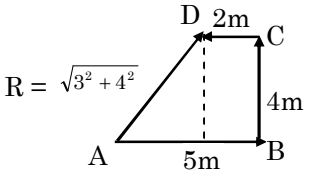
Ex.10 A person travels a distance of 5 m towards east, then 4 m towards north and then 2 m towards west.

(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.

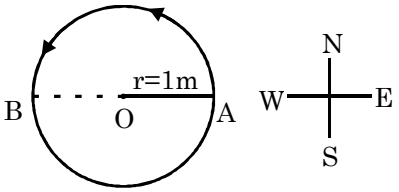


Ex.11 A person moves in a circular path centered at O. He starts from A and reaches diametrically opposite point B. Then find:

(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

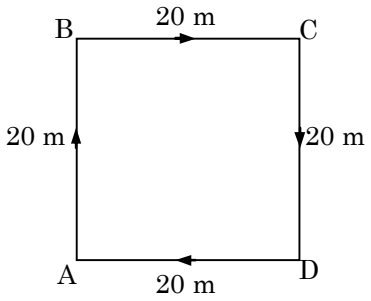
Ex.12 What does the odometer of an automobile measure?

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

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.

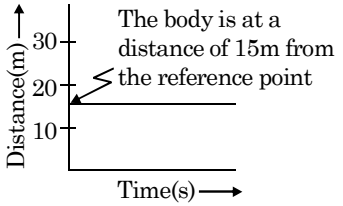
The distance–time graphs of a body under the following three conditions are described below:

(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

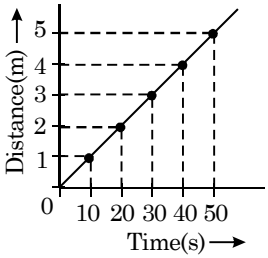
- Distance–time graph for a body at rest



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.

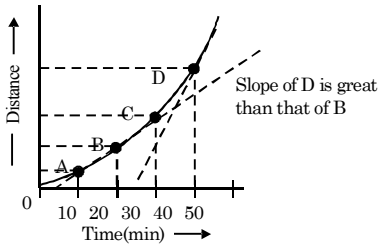
- Distance–time graph for a body moving with a non–uniform speed:

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.

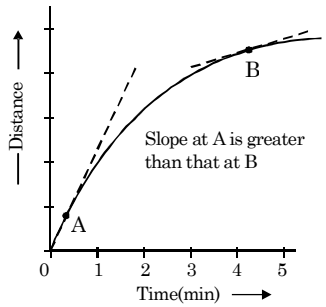
The shape of the distance–time graph for a body moving with non–uniform speed depends upon the way speed of the body changes with time. Two typical cases are described below:

(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).

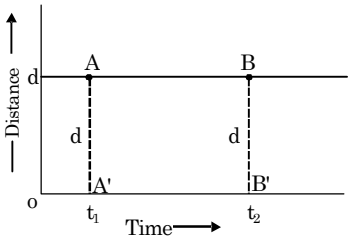


(ii) When the speed decreases with time: When the speed of a body decreases with time, the distance covered by it in one unit of time also decreases with time. Therefore, the distance–time graph for a body moving with a decreasing non–uniform speed is a curve whose slope decreases with time (Figure).



◈ 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.

0 to t = 5s, then moves at a constant speed from t = 5s to 10s and then decelerates to stop at t = 15 s.

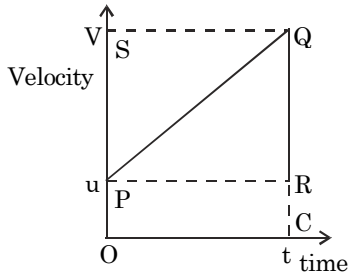
Note: *Distance covered by the body is shown by the area under speed–time graph.*

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



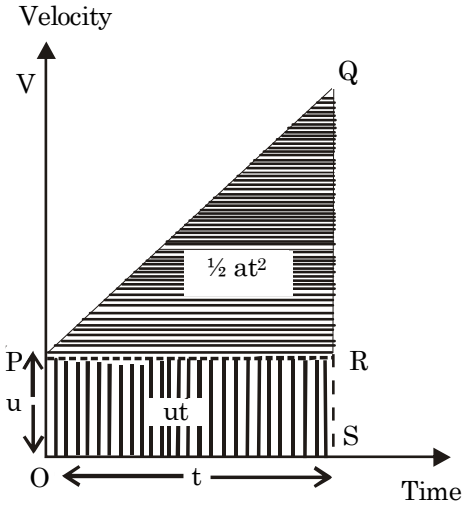
$a = \frac{QR}{RP} = \frac{SP}{RP}$

$\because$ 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,

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

$= u \times t + \frac{1}{2} at \times t$ ($\because$ 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

$v = 0 + 0.02 \times 3 = 0.06$ 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

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

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.

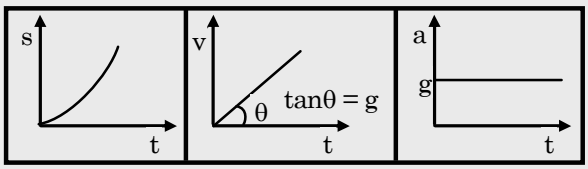
  (iv) Motion of a body is called free fall if only force acting on it is gravity (i.e. earth's attraction).

COMPETITIVE LEVEL

◈ Body Falling Freely Under Gravity

Assuming u = 0 for a freely falling body:

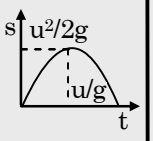
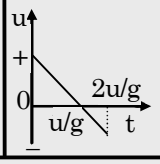
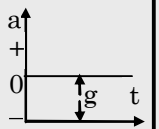
t is given	h is given	v is given
$v = gt$	$t = \sqrt{\frac{2h}{g}}$	$t = \frac{v}{g}$
$h = \frac{1}{2}gt^2$	$v = \sqrt{2gh}$	$h = \frac{v^2}{2g}$



- **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?

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.

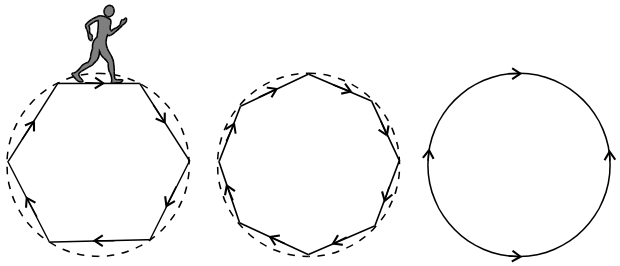
e.g.: Examples of uniform circular motion are:

(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.

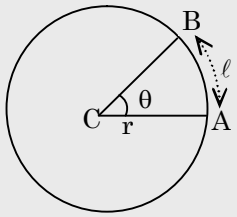
Then, $\theta = \frac{\ell}{r}$ radians.

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

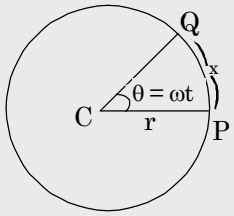
◈ Angular Displacement and Angular Velocity

- **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 $\omega_2 - \omega_1$

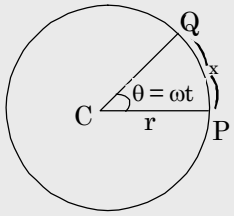
thus, rate of change of angular velocity = $\frac{\omega_2 - \omega_1}{t_2 - t_1}$

$\alpha = \frac{\Delta\omega}{\Delta t}$ (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.



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

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

(ii) Relation between linear velocity and angular velocity.

From (i) $x = r\theta$

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

(iii) Relation between linear acceleration and angular acceleration.

From (ii) $v = r\omega$

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

◈ 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.

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

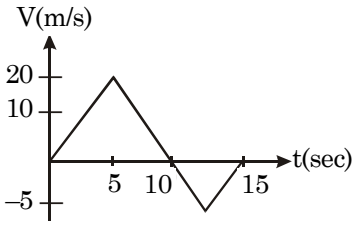
Q.6 Distance and displacement are equal in some cases. Give reasons.

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:



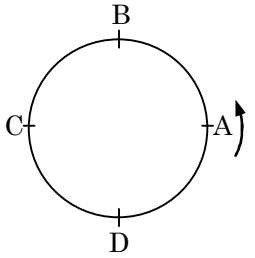
(i) Distance and displacement in 10 second.
(ii) Distance and displacement in 15 second.

➢ 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 anticlock-wise 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.

➢ Practical & Value Based Type Questions

Q.26 Manish was travelling from Delhi to Jaipur by his car for a meeting. He had to reach the destination in the given time. So he kept a track of the odometer and his watch all through the journey to decide upon his speed. This helps him to reach on time for the meeting.
(i) What measuring devices were used by Manish?
(ii) What qualities of Manish are worth appreciating?
(iii) Why did Manish measure the distance and time?

Q.27 Ravi is very fond of fast driving. His sister Veena keeps telling him the hazards of speed on road. Ravi, however does not want to pay need to her advice and never listens to her. Veena convinces him by narrating incidents of hazards caused by over speeding vehicles and reminds him, not to drive fast. Ravi is still reluctant to understand.
(i) Which values of Veena should be applauded?
(ii) Elaborate upon Ravi's values?
(iii) As a concerned neighbour, what suggestion would you give to Ravi's father to alert any unpleasant consequence?

Q.28 Raman and his sister Saniya go to school together in their car. Raman drives much faster than Saniya. Saniya tells Raman not to take the risk of over speeding. She tells him that time taken to reach the school would depend upon average speed. By over speeding for a little while, the risk involved is much greater compared to the little time saved.
(i) Which values are displayed by Saniya?
(ii) Is Saniya right in her statement?
(iii) How do you define average speed?

Q.29 Mehak was moving through the city roads towards her school by a car. She recorded the odometer reading of the car after every five minutes and plotted a graph for distance versus time. She then inferred about the type of motion and found average speed from the graph.
(i) Which qualities of Mehak are worth mentioning?
(ii) What type of motion would she have inferred?
(iii) How is average speed calculated from the graph?

Q.30 Shikhaj and Sharman went to Mathura through Yamuna-Expressway. Shikhaj started the car and accelerated so highly that the car was running at 108 km/h within 10 seconds. Sharman stopped him from doing so and told him that over speeding on road was a straight invitation to life staking situation. Though Shikhaj wanted the adventure of speeding, but he was convinced by Sharman.
(i) Why do you think it is dangerous to drive fast on road?
(ii) Which values of Sharman are worth appreciating?
(iii) What is the acceleration of the car?

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

EXERCISE-3

Q.1 Value of one Fermi is

[M.P./ NTSE Stage-I/2014]

(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

[Raj./ NTSE Stage-I/2007]

(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

[Raj./ NTSE Stage-I/2015]

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

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

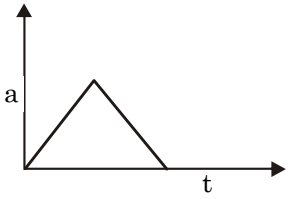
Q.4 A car travels 40 kms at an average speed of 80 km/h and then travels 40 kms at an average speed of 40 km/h. The average speed of the car for this 80 km trip is

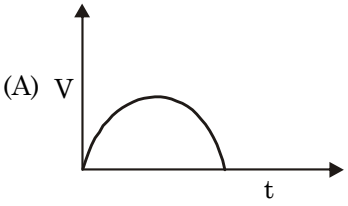
[Raj./ NTSE Stage-I/2016]

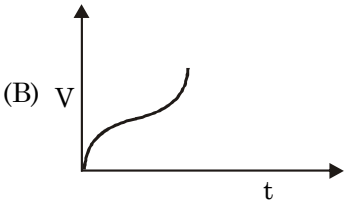
(A) 40 km/h (B) 45 km/h

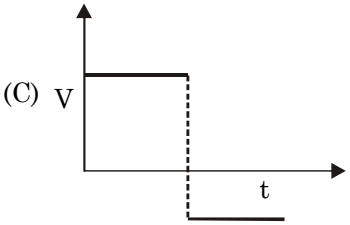
(C) 48 km/h (D) 53 km/h

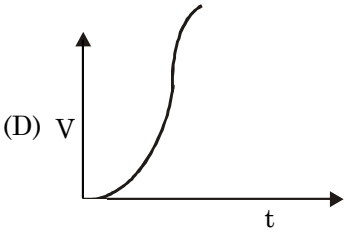
Q.5 The acceleration versus time graph of an object is as shown in figure. The corresponding velocity-time graph of the objects is **[Raj./NTSE Stage-I/2014]**



(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

[Raj./NTSE Stage-I/2014]

(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 **[Raj./ NTSE Stage-II/2017]**

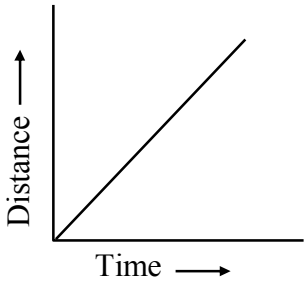
(A) 30 m (B) 36 m

(C) 25 m (D) 40 m

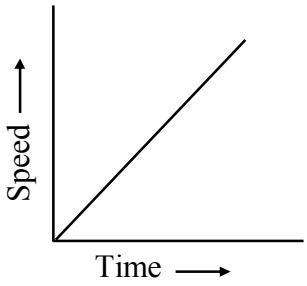
Q.8 Consider the following five graphs (note the axes carefully). Which of the following represents motion at constant speed?

[Raj./ NTSE Stage-II/2018]

(1)



(2)



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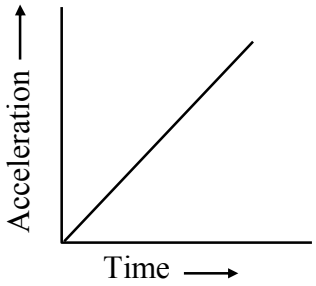
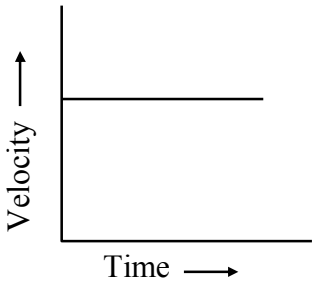
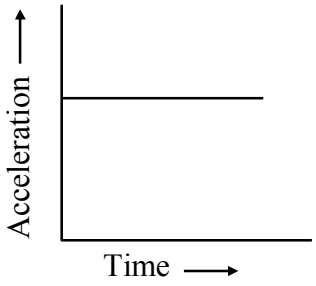


(4)



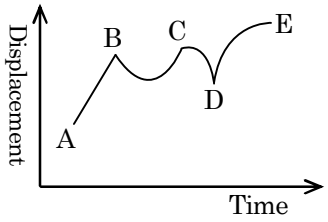
(5)



(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?

[Bihar/ NTSE Stage-I/2014]



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

Q.10 Correct relation is.....

[Madhya Pradesh/ NTSE Stage-I/2015]

(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

[Jharkhand/ NTSE Stage-I/2014]

(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

[Uttrakhand/ NTSE Stage-I/2014]

(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 **[Raj./ NTSE Stage-II/2015]**

(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? **[Raj./ NTSE Stage-II/2014]**

(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

[West Bengal/ NTSE Stage-I/2014]

(A) Zero

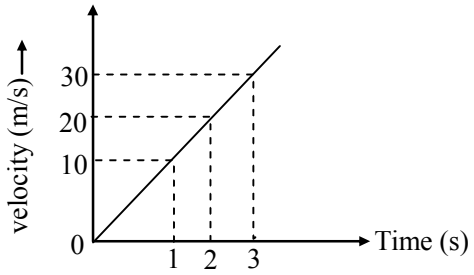
(B) 24m/s

(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

[West Bengal/ NTSE Stage-I/2019]



(A) 90 m (B) 45 m

(C) zero (D) 10 m

Q.17 A body starts from rest is accelerated uniformly for 30s. If ×1, ×2, ×3 are the distances travelled in first 10s; next 10s and last 10s respectively, then x1 : x2 :x3 is

[DELHI../ NTSE Stage-I/2019]

(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

[DELHI. / NTSE Stage-I/2019]

figure. Which of the following statements is true?

(A) The acceleration is constant and positive.

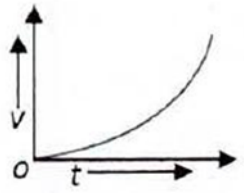
(B) The acceleration is constant and negative.

(C) The acceleration is increased and positive.

(D) The acceleration is decreasing and negative.

Q.19 The velocity – time graph of a moving body is shown in the figure. Which of the following statements is true?

[DELHI./ NTSE Stage-I/2019]



(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.20 If the distance travelled by an object is zero, then the displacement of the object is:

[MP./ NTSE Stage-I/2019]

(A) zero

(B) not zero

(C) negative

(D) May or may not be zero

Q.21 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)

[Maharashtra/NTSE Stage-I/2019]

(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

30. 3m/sec^2

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**	**21**									
Ans.	B	C	C	A	A	B									

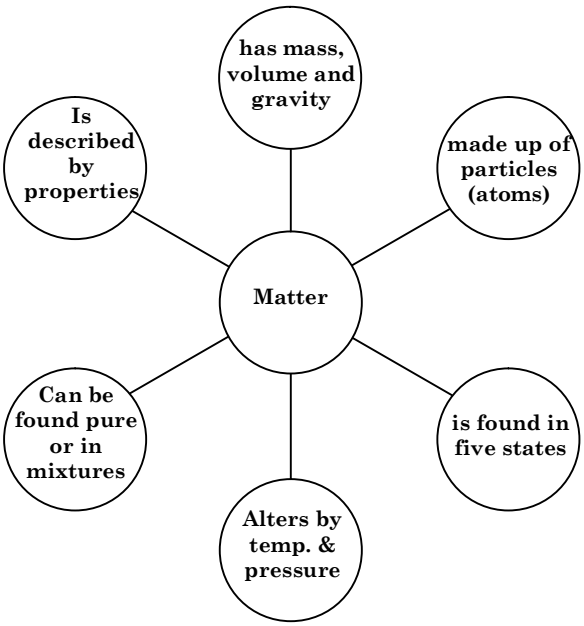
Chapter

1

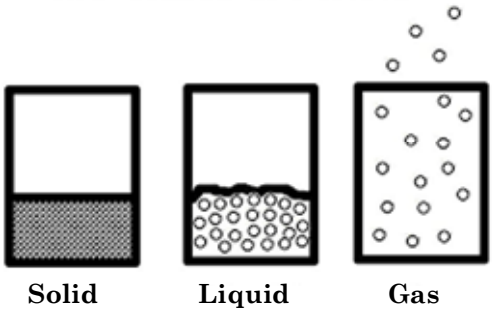
MATTER IN OUR SURROUNDINGS

Chapter Outline

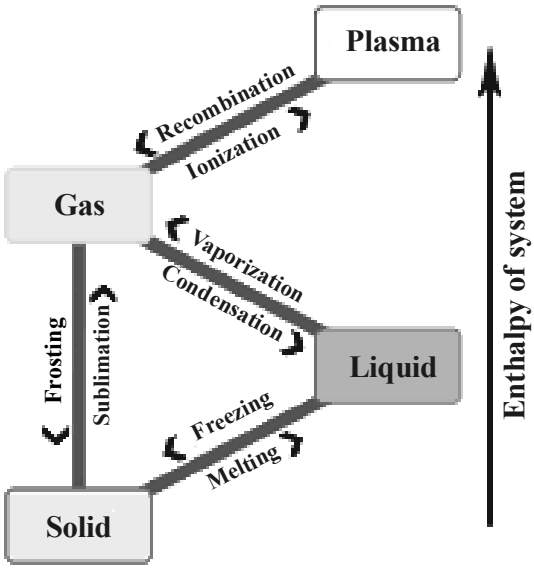
- ✧ Physical Nature of Matter
- ✧ Classification of Matter
- ✧ Properties of Solid, Liquid & Gas
- ✧ Fourth and Fifth State of Matter
- ✧ Interconversion of States of Matter
- ✧ Scales of Measuring Temperature
- ✧ Evaporation



Properties of matter

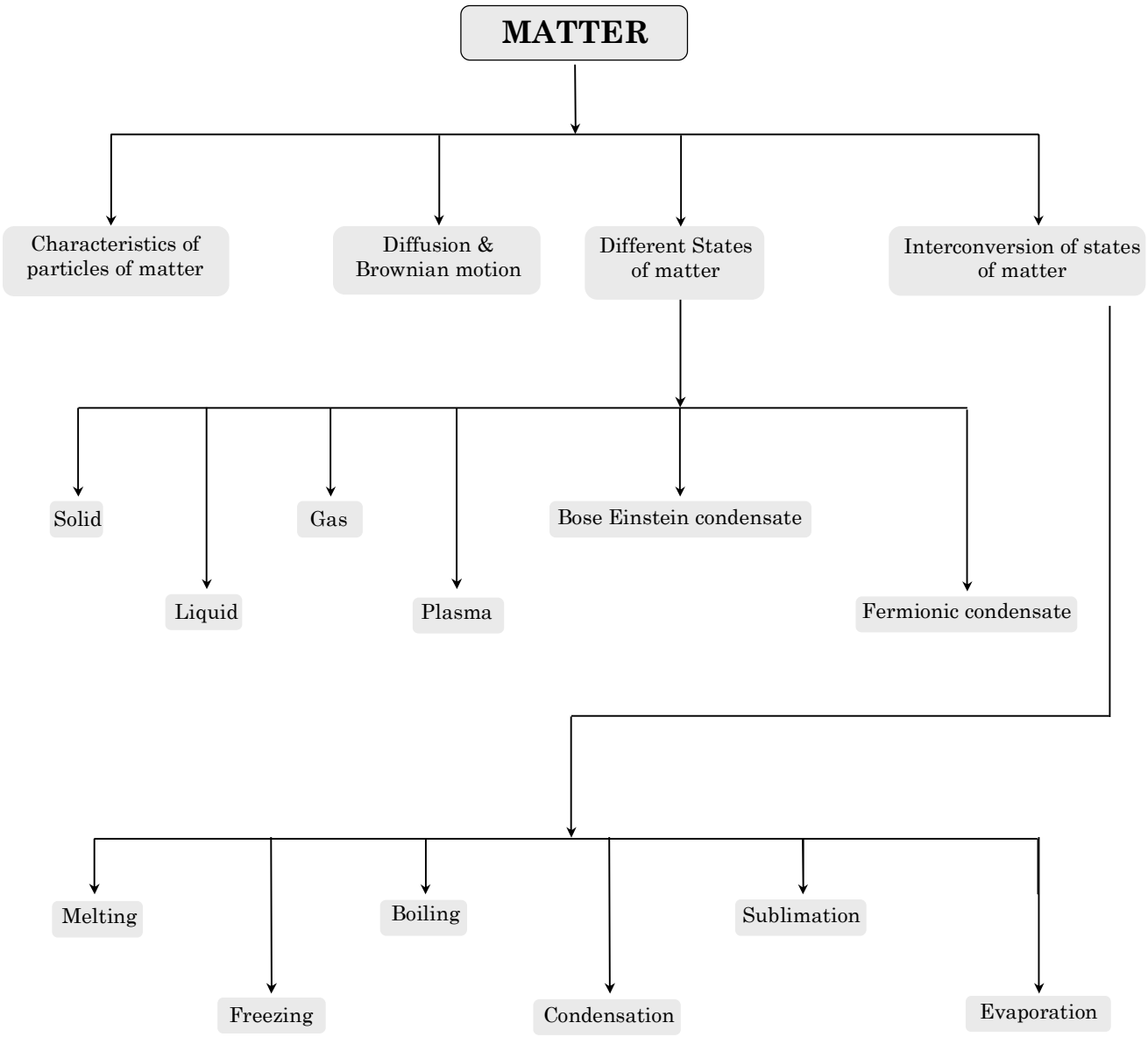


The States of Matter



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.

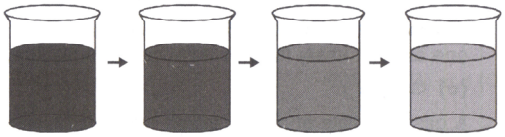
(3) The particles of matter are constantly moving.

(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.



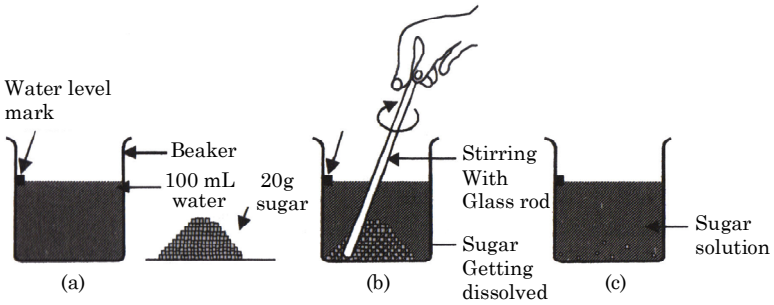
Just a few crystals of potassium permanganate can colour a huge volume of water

(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.

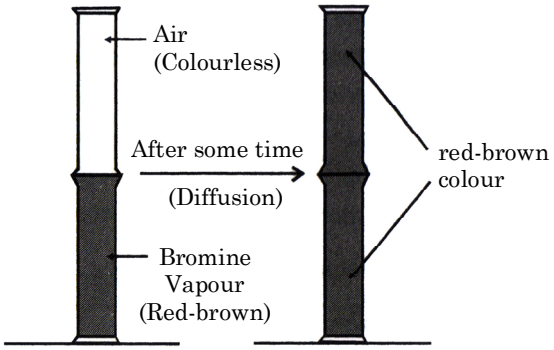
Diffusion is very commonly observed in our day-to-day life.

***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.

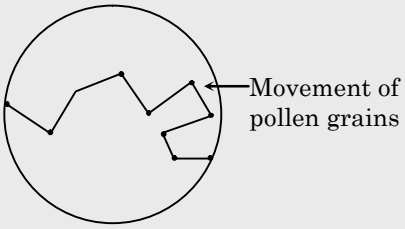
  (ii) If two metal blocks are bound together tightly and kept undisturbed for a few years, then the particles of one metal are found to have diffused into the other metal.

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.

(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.

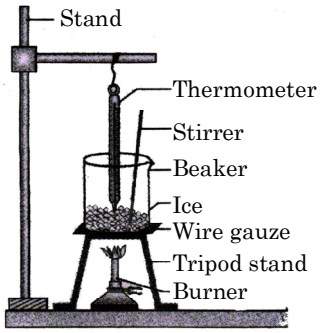
◆ **Activity:** To study the change of state from ice to water.

- **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.*

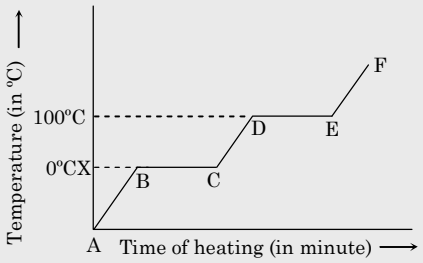
Condensation point of water vapour = Boiling point of water = 100°C (373.16 K)

- 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.

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:

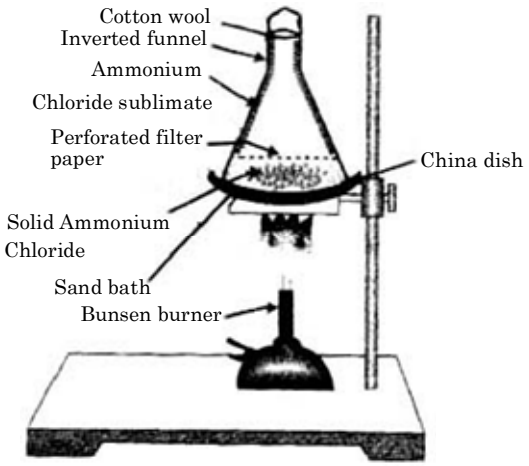
  Ammonium Chloride (NH_4Cl), iodine, camphor, naphthalene (moth balls) and anthracene solid CO_2.

- **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.

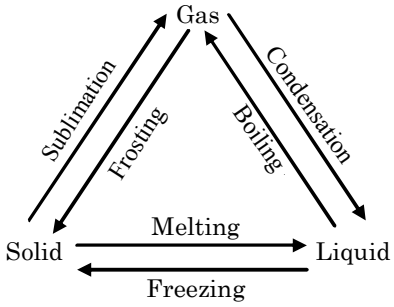


Sublimation of Ammonium Chloride

  - 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 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

EXERCISE-3

Q.1 Boiling point of water is –
[Raj. NTSE Stage-I/13]
(A) 273K (B) 0K
(C) 373K (D) 100K

Q.2 By which property are gases and liquids different from solid?
[Rajasthan NTSE Stage-I/14]
(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: [Delhi_NTSE Stage-I/15]
(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
[Rajasthan_NTSE Stage-I/15]
(A) –193 K (B) 193 K
(C) 353 K (D) – 353 K

Q.5 When the solid melts, its temperature:
[Haryana_NTSE Stage-I/15]
(A) increases
(B) decreases
(C) remain constant
(D) first increases then decrease

Q.6 The substance showing sublimation property among the following is
[Rajasthan_NTSE Stage-I/15]
(A) common salt
(B) copper sulphate
(C) potassium nitrate
(D) camphor

Q.7 The melting point of ice is --------
[Gujarat_NTSE Stage-I/15]
(A) 273.15 k (B) 173.15 k
(C) 373.5 k (D) 100 k

Q.8 Physical state of water at 0ºC is
[M.P._NTSE Stage-I/18]
(A) Solid
(B) Liquid
(C) Gas
(D) None of the above

ANSWER KEY

EXERCISE - 1

9. (i) 330 K, (ii) 286 K, 20. (i) 500ºC, (ii) 100ºC, (iii) -88ºC

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	D	A	B

EXERCISE - 3

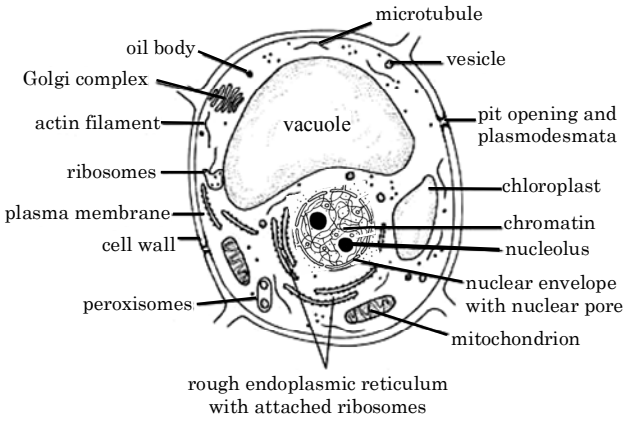
Ques.	1	2	3	4	5	6	7	8
Ans.	C	D	C	B	C	D	A	A

Chapter 1

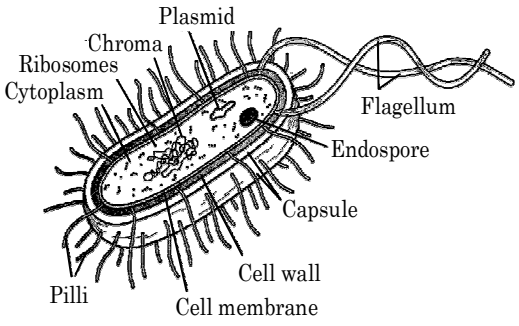
The Fundamental Unit of Life-Cell

Chapter Outline

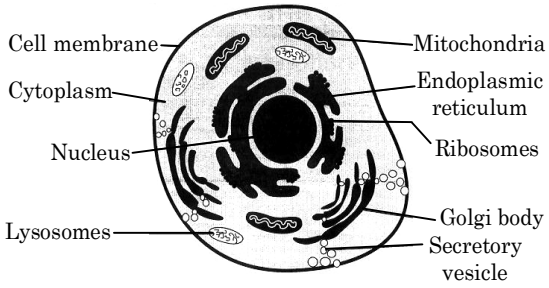
- Cell
- Microscope
- Cell theory
- Ultra structure of cell
- Cell organelles



Plant Cell

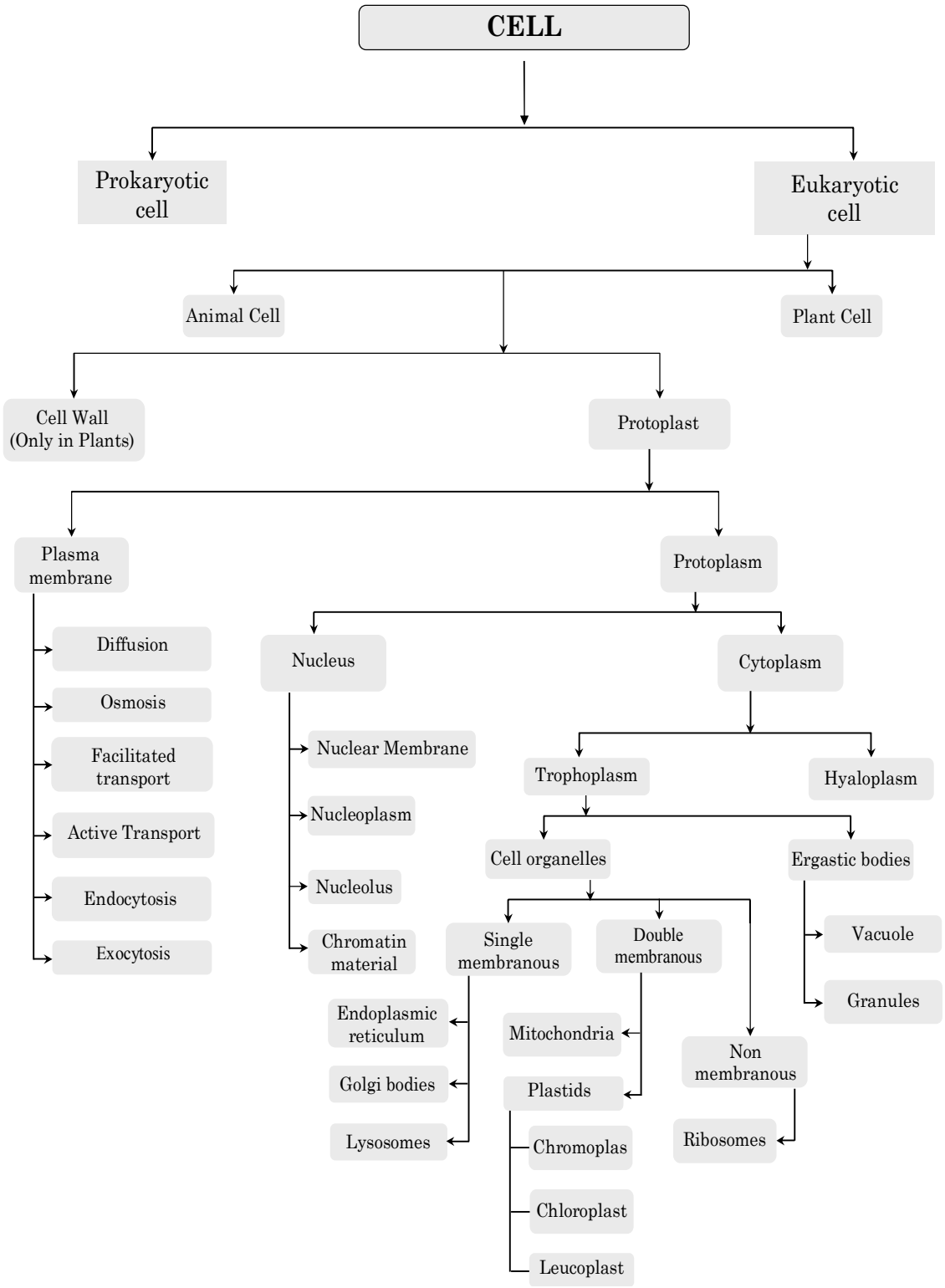


Bacterial Structure



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.

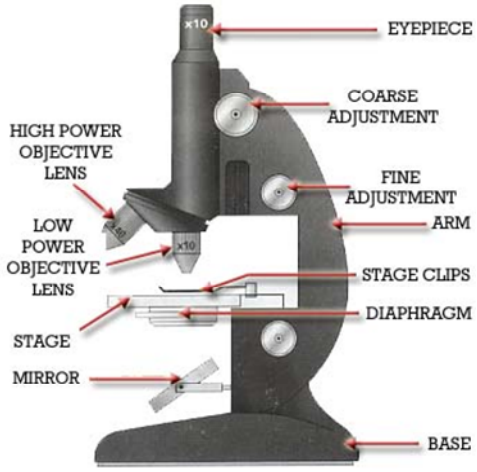
The cell may also defined as a small speck of nucleated protoplasm bounded by cell membrane or plasma membrane and is capable of independent existence and perpetuation.

◈ 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.

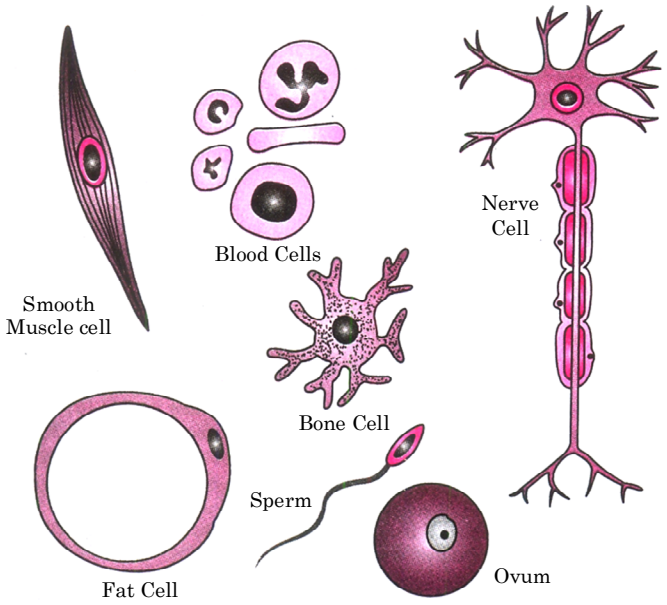


Fig. : Various Cells from the Human Body

- The size of different cells ranges between broad limits.
- Most cells are visible only with microscope.

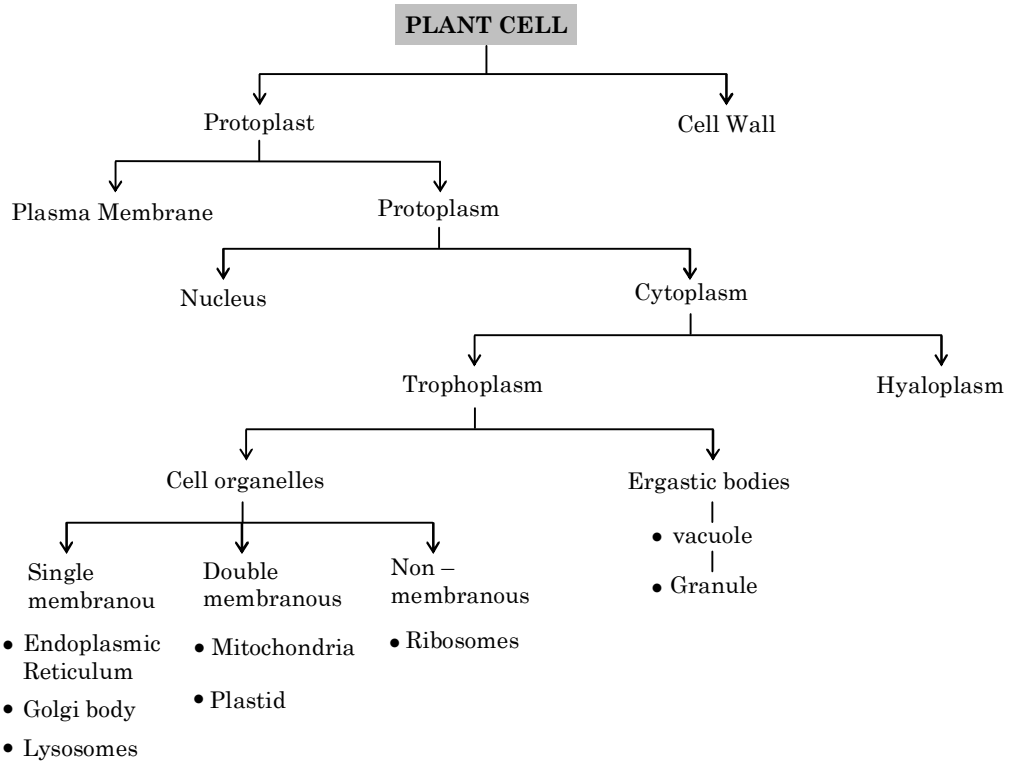
COMPETITIVE LEVEL

- 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.

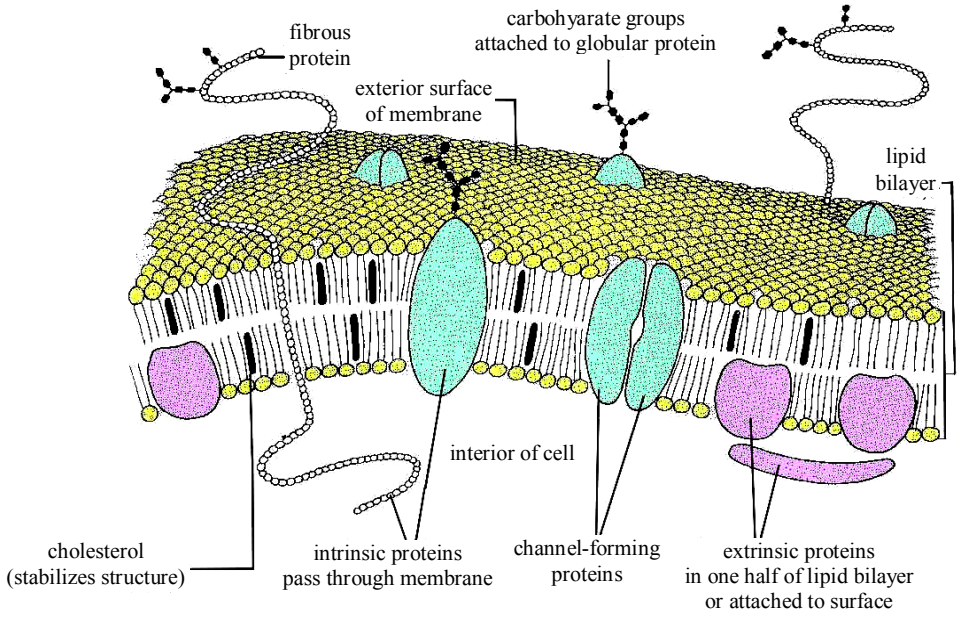


Fig. Fluid Mosaic Model of Plasma Membrane Structure

◈ 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

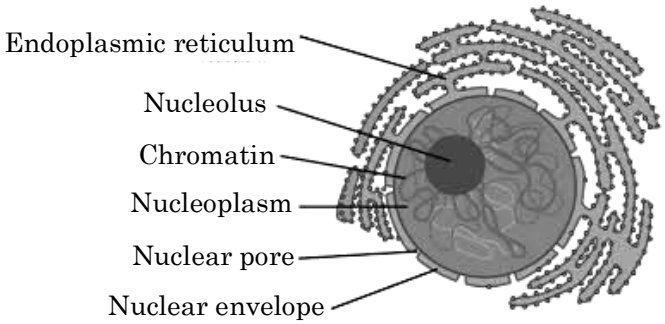


Fig. : Structure of Nucleus

- 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 :

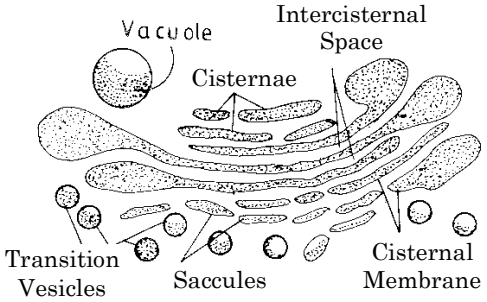


Fig. : Structure of Golgi Apparatus

- 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

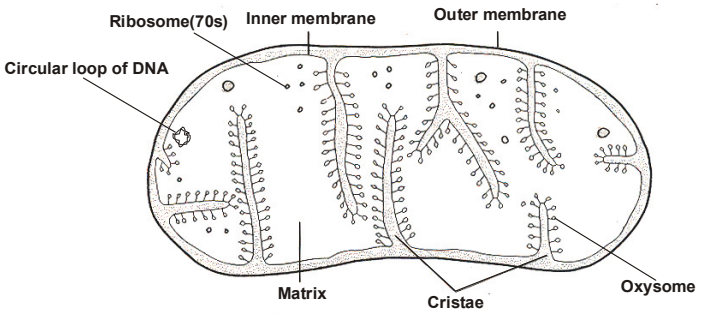


Fig. : Structure of Mitochondria

- 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 :

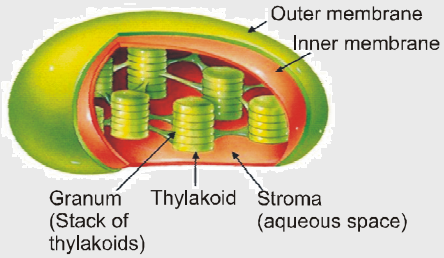


Fig. : Structure of Chloroplast

- 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.

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 ?

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

EXERCISE-3

Q.1 Cell organelle which differentiates plant cell from animal cell is –
(Raj./NTSE Stage-1/2013)
(A) Cell Membrane
(B) Plastids
(C) Nucleolus
(D) Vacuoles

Q.2 Example of cell organelle which do not have a unit membrane is
(Raj./NTSE Stage-1/2007)
(A) Mitochondria (B) Lysosome
(C) Ribosome (D) Plastid

Q.3 Mitochondria and chloroplasts are similar because **(Delhi/NTSE Stage-1/2013)**
(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.
(Haryana/NTSE Stage-1/2013)
(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 ?
(MP/NTSE Stage-1/2013)
(A) Endosmosis (B) Exosmosis
(C) Deplasmolysis (D) Imbibition

Q.6 Organisms lacking nuclear membrane and cell organelles is called as :
(MP/NTSE Stage-1/2013)
(A) Prokaryotes (B) Eukaryotes
(C) Protozoa (D) Fungi

Q.7 Ribosomes are the centre for:
(MP/NTSE Stage-1/2013)
(A) Respiration
(B) Protein sythesis
(C) Photosynthesis
(D) Fat synthesis

Q.8 Lipids and proteins constituting the cell membrane are synthesized at :
(Chandidarh/NTSE Stage-1/2013)
(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.
(Punjab/NTSE Stage-1/2013)
(A) Ribosomes (B) Chromosomes
(C) Cytoplasm (D) Nucleus

Q.10 Cell organelle 'Bioplast' was given another name by Benda, which is
(Raj./NTSE Stage-1/2013)
(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
(Raj./NTSE Stage-1/2013)
(A) Ribosome
(B) Plasma membrane
(C) Centrosome
(D) Golgi body

Q.12 Which cell organelle is known as "Suicidal bag"- **(M.P./NTSE Stage-1/2013)**
(A) Centrosome
(B) Mesosome
(C) Lysosome
(D) Chromosome

Q.13 Mitochondria and Plastids are able to synthesis some of their proteins because they have: **(Haryana/NTSE Stage-I/2015)**
(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
(Raj./NTSE Stage-I/2015)
(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:
(Bihar/NTSE Stage-I/2015)
(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 :
(Bihar/NTSE Stage-I/2015)
(A) Plasmolysis (B) Osmosis
(C) Imbibition (D) Dehydration

Q.17 The capsule present in Bacteria is mainly made of : **(Bihar/NTSE Stage-I/2015)**
(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 ? **(M.P./NTSE Stage-I/2015)**
(A) Amoeba (B) Bacteria
(C) Yeast (D) Euglena

Q.19 A cell will plasmolyse, if it is placed in:
(Delhi/NTSE Stage-I/2015)
(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 ? **(Gujarat/NTSE Stage-1/2015-16)**
(A) Centrosome (B) Mososomes
(C) Lysosomes (D) chromosome

Q.21 Number of mitotic divisions required to produce 128 cells from a single cell is –
(M.P./NTSE Stage-1/2015-16)
(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?
(Bihar/NTSE Stage-1/2015)
(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 ?
(Raj./NTSE Stage-I/2016-17)
(A) Lysosome
(B) Golgi bodies
(C) Endoplasmic reticulum
(D) Mitochondira

Q.24 Nucleus of the cell was discovered by
(Raj./NTSE Stage-I/2017-18)
(A) Robert Hooke (B) Leeuwenhoek
(C) Robert Brown (D) Virchow

Q.25 Turgidity of cell is maintained by
(Raj./NTSE Stage-I/2017-18)
(A) Vacuole (B) Lysosome
(C) Plastid (D) Golgi body

Q.26 The cell organelle discovered by de Duve is **(Raj./NTSE Stage-I/2018-19)**
(A) Plastid (B) Ribosome
(C) Lysosome (D) Centrosome

Q.27 DNA is not present in
(Delhi/NTSE Stage-I/2018-19)
(A) Chloroplast (B) Mitochondria
(C) Nucleus (D) Ribosome

Q.28 Cell division in plants is promoted by :
(Delhi/NTSE Stage-I/2018-19)
(A) Abscisic acid (B) Gibberllin
(C) Ethylene (D) Cytokinin

Q.29 An exception to cell theory is
(M.P./NTSE Stage-I/2018-19)
(A) Bacteria (B) Virus
(C) Algae (D) All

Q.30 Chemical composition of chromosome is
(M.P./NTSE Stage-I/2018-19)
(A) DNA and lipid
(B) DNA and carbohydrates
(C) Proteins and lipids
(D) DNA and proteins

Q.31 Cristae is associated with
(M.P./NTSE Stage-I/2018-19)
(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				
Ans.	A	B	C	C	B	D	C	B	B	A	B				

EXERCISE - 3

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

Chapter

2

POLYNOMIALS

Chapter Outline

- Polynomial
- Degree and types of Polynomial
- Value of a Polynomial
- Zeroes of a Polynomial
- Remainder Theorem & Factor Theorem
- Algebraic Identities
- Factorization & Methods of Factorization
- H.C.F. & L.C.M. of Polynomials

Common Types of Polynomials

Degree	Type	Standard Form
0	Constant	$f(x) = c$
1	Linear	$f(x) = ax + b$
2	Quadratic	$f(x) = ax^2 + bx + c$
3	Cubic	$f(x) = ax^3 + bx^2 + cx + d$
4	Quartic	$f(x) = ax^4 + bx^3 + cx^2 + dx + e$

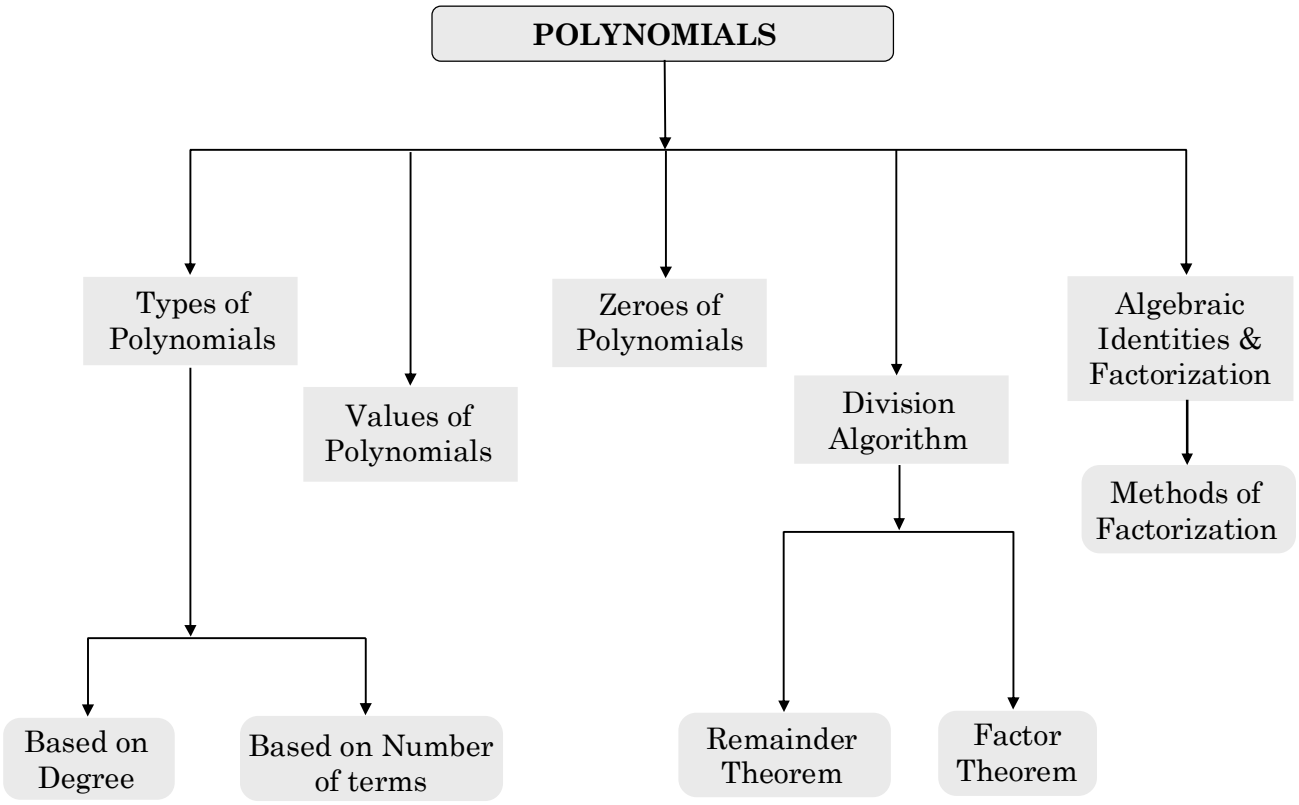
$$y = \underline{5x^3} + \underline{9x^2} + \underline{7x^1} + \underline{3}$$

VARIABLE TERMS — CONSTANT TERM

- Polynomials contain three types of terms :
  (1) monomial : A polynomial with one term
  (2) binomial : A polynomial with two terms.
  (3) Trinomial : A polynomial with three terms.

$3xy^2$	$5x - 1$	$3x + 5y^2 - 3$
Monomial (1 term)	Binomial (2 terms)	Trinomial (3 terms)

MIND MAP


POLYNOMIALS
Types of Polynomials
Values of Polynomials
Zeroes of Polynomials
Division Algorithm
Algebraic Identities & Factorization
Methods of Factorization
Based on Degree
Based on Number of terms
Remainder Theorem
Factor Theorem

POLYNOMIALS

Polynomial

An algebraic expression f(x) of the form $\mathbf{f(x) = a_0 + a_1x + a_2x^2 + \ldots\ldots\ldots + a_nx^n}$, where $\mathbf{a_0, a_1, a_2, \ldots\ldots a_n}$ are real numbers and all the index of **'x'** are non-negative integers is called a **polynomials** in x.

Identification of Polynomial :

For this, we have following examples :

(i) $\sqrt{3}x^2 + x - 5$ is a polynomial in variable x as all the exponents of x are non negative integers.

(ii) $\sqrt{3}x^2 + \sqrt{x} - 5x$ is not a polynomial as the exponent of second term ($\sqrt{x} = x^{1/2}$) is not a non–negative integer.

(iii) $5x^3 + 2x^2 + 3x - \frac{5}{x} + 6$ is not a polynomial as the exponent of fourth term $\left[-\frac{5}{x} = 5x^{-1}\right]$ is not a non–negative integer.

◈ Polynomial in one variable

The algebraic expression like p(x) = 8x, q(x) = 7x +3, r(y) =4y–3, f(z) =6 – z^2, s(y) = $3y^2$ + 8y + 9, etc. each of which involves only one variable (literal) are called polynomial in one variable.

◈ Polynomials in two or more variables

An algebraic expression, whose terms involve two to or more variables (literals) such that the exponent of each variable is a whole number, is called a polynomial in two or more variables.

For examples :

(a) p(x,y) =$3x^2 - 6xy + 8y^2$ is a polynomial in two variables x and y.

(b) p(x,y,z) =$x + xy^3 - 8x^2yz - 15$ is a polynomial in three variables x, y and z.

Ex.1 Find which of the following algebraic expression is a polynomial.

(i) $3x^2 - 5x$ (ii) $x + \frac{1}{x}$ (iii) $\sqrt{y} - 8$ (iv) $z^5 - \sqrt[3]{z} + 8$

Sol. (i) $3x^2 - 5x = 3x^2 - 5x^1$

It is a polynomial.

(ii) $x + \frac{1}{x} = x^1 + x^{-1}$

It is not a polynomial.

(iii) $\sqrt{y} - 8 = y^{1/2} - 8$

Since, the power of the first term ($\sqrt{y}$) is $\frac{1}{2}$, which is not a whole number.

Therefore it is not a polynomial.

(iv) $z^5 - \sqrt[3]{z} + 8 = z^5 - z^{1/3} + 8$

Since, the exponent of the second term is 1/3, which is not a whole number. Therefore, the given expression is not a polynomial.

Degree of a Polynomial

Highest index of **x** in algebraic expression is called the **degree of the polynomial**.

So the degree of polynomial

$\mathbf{f(x) = a_0 + a_1x + a_2x^2 + ...+ a_nx^n}$, will be n if $a_n \neq 0$

Ex.2 In the following polynomial find

(a) Degree of each term

(b) Degree of polynomial

Sol. (a) In polynomial $5x^2 - 8x^7 + 3x$:

(i) The degree of term $5x^2 = 2$

(ii) The degree of term $-8x^7 = 7$

(iii) The degree of term $3x = 1$

Since, the greatest power is 7, therefore degree of the polynomial $5x^2 - 8x^7 + 3x$ is 7

(b) The degree of polynomial :

(i) $4y^3 - 3y + 8$ is 3

(ii) $7p + 2$ is 1

(iii) $2m - 7m^8 + m^{13}$ is 13 and so on.

Types of Polynomial

Generally, we divide the polynomials in the following categories.

(i) Based on degree : There are following types of polynomials based on degree. These are listed below :

- **Zero degree polynomial :** Any non-zero number (constant) is regarded as a polynomial of degree zero or **zero degree polynomial**. i.e. $f(x) = a$, where $a \neq 0$, is a zero degree polynomial, since we can write $f(x) = a$ as $f(x) = ax^0$.
- **Linear Polynomial :** A polynomial of degree one is called a **linear polynomial**. The general form of linear polynomial is **ax + b**, where **a** and **b** are any real constant and $\mathbf{a \neq 0}$.
- **Quadratic Polynomial :** A polynomial of degree two is called a **quadratic polynomial**. The general form of a quadratic polynomial is $\mathbf{ax^2 + bx + c}$, where $\mathbf{a \neq 0}$.
- **Cubic Polynomial :** A polynomial of degree three is called a **cubic polynomial**. The general form of a cubic polynomial is $\mathbf{ax^3 + bx^2 + cx + d}$, where $\mathbf{a \neq 0}$.
- **Biquadratic Polynomials :** A polynomial of degree four is called a **biquadratic polynomial**. The general form of a biquadratic polynomial is

  $\mathbf{ax^4 + bx^3 + cx^2 + dx + e}$, where $\mathbf{a \neq 0}$.

  Note : A polynomial of degree five or more than five does not have any particular name. Such polynomials are usually called as polynomial of degree five or six or ..... etc.

(ii) Based on number of terms

There are following types of polynomials based on number of terms. These are as follows :

- **Monomial :** A polynomial is said to be a **monomial** if it has only one term. e.g. x, $9x^2$, $5x^3$ all are monomials.
- **Binomial :** A polynomial is said to be a **binomial** if it contains two terms. e.g. $2x^2 + 3x$, $3x + 5x^3$, $-8x^3 + 3$, all are binomials.
- **Trinomials :** A polynomial is said to be a **trinomial** if it contains three terms. e.g. $3x^3 - 8x - \frac{5}{3}$, $5 - 7x + 8x^9$, $x^{10} + 8x^4 - 3x^2$ are all trinomials.

Value of a Polynomial

The value of a polynomial **f(x)** at **x = α** is obtained by substituting x = α in the given polynomial and is denoted by **f(α)**.

Consider the polynomial $f(x) = x^3 - 6x^2 + 11x - 6$,

If we replace x by – 2 everywhere in f(x), we get

$f(-2) = (-2)^3 - 6(-2)^2 + 11(-2) - 6$

$f(-2) = -8 - 24 - 22 - 6$

$f(-2) = -60$.

So, we can say that value of f(x) at x = – 2 is – 60.

Similarly, the value of polynomial

$f(x) = 3x^2 - 4x + 2$,

(i) at x = –2 is $f(-2) = 3(-2)^2 - 4(-2) + 2$

$= 12 + 8 + 2 = 22$

(ii) at x = 0 is $f(0) = 3(0)^2 - 4(0) + 2$

$= 0 - 0 + 2 = 2$

(iii) at $x = \frac{1}{2}$ is $f\left(\frac{1}{2}\right) = 3\left(\frac{1}{2}\right)^2 - 4\left(\frac{1}{2}\right) + 2$

$= \frac{3}{4} - 2 + 2 = \frac{3}{4}$

Zeroes or Roots of a Polynomial

The real number **α** is a root or zero of a polynomial **f(x)**, if **f(α) = 0**.

Consider the polynomial $f(x) = 2x^3 + x^2 - 7x - 6$,

If we replace x by 2 everywhere in f(x), we get

$f(2) = 2(2)^3 + (2)^2 - 7(2) - 6 = 16 + 4 - 14 - 6 = 0$

Hence, x = 2 is a root of f(x).

For example :

(i) For polynomial p(x) = x – 2; p(2) = 2 – 2 = 0

∴ x = 2 or simply 2 is a zero of the polynomial

p(x) = x – 2.

(ii) For the polynomial $g(u) = u^2 - 5u + 6$;

$g(3) = (3)^2 - 5 \times 3 + 6 = 9 - 15 + 6 = 0$

∴ 3 is a zero of the polynomial g(u)

Also, $g(2) = (2)^2 - 5 \times 2 + 6 = 4 - 10 + 6 = 0$

∴ 2 is also a zero of the polynomial g(u)

Note :

(a) Every linear polynomial has one and only one zero.

(b) A given polynomial may have one or more than one zeroes.

(c) If the degree of a polynomial is n; the largest number of zeroes it can have is also n.

For example :

If the degree of a polynomial is 5, the polynomial can have at most 5 zeroes; if the degree of a polynomial is 8; largest number of zeroes it can have is 8.

(d) A zero of a polynomial need not to be 0.

For example : If $f(x) = x^2 - 4$,

then $f(2) = (2)^2 - 4 = 4 - 4 = 0$

Here, zero of the polynomial $f(x) = x^2 - 4$ is 2 which itself is not 0.

(e) 0 may be a zero of a polynomial.

For example : If $f(x) = x^2 - x$,

then $f(0) = 0^2 - 0 = 0$

Here 0 is the zero of polynomial $f(x) = x^2 - x$.

Ex.3 Find the zero of the polynomial in each of the following cases :

(i) $p(x) = x + 5$ (ii) $p(x) = 2x + 5$

(iii) $p(x) = 3x - 2$

Sol. To find the zero of a polynomial p(x) means to solve the polynomial equation $p(x) = 0$.

(i) For the zero of polynomial $p(x) = x + 5$

$p(x) = 0 \quad \Rightarrow x + 5 = 0 \quad \Rightarrow \quad x = -5$

$\therefore$ $x = -5$ is a zero of the polynomial $p(x) = x + 5$.

(ii) $p(x) = 0 \quad \Rightarrow 2x + 5 = 0$

$\Rightarrow \quad 2x = -5$ and $x = \dfrac{-5}{2}$

$\therefore \quad x = -\dfrac{5}{2}$ is a zero of $p(x) = 2x + 5$.

(iii) $p(x) = 0 \quad \Rightarrow \quad 3x - 2 = 0$

$\Rightarrow \quad 3x = 2$ and $x = \dfrac{2}{3}$.

$x = \dfrac{2}{3}$ is a zero of $p(x)=3x-2$

Ex.4 If $x = 2$ & $x = 0$ are two roots of the polynomial $f(x) = 2x^3 - 5x^2 + ax + b$. Find the values of a and b.

Sol. $f(2) = 2(2)^3 - 5(2)^2 + a(2) + b = 0$

$\Rightarrow 16 - 20 + 2a + b = 0$

$\Rightarrow 2a + b = 4$ ...(i)

$f(0) = 2(0)^3 - 5(0)2 + a(0) + b = 0$

$\Rightarrow b = 0$

Put $b = 0$ in eq. (i)

$\Rightarrow 2a + 0 = 4$

So, $2a = 4$

$\Rightarrow \quad a = 2.$

◈ Working Rule to Divide a Polynomial by Another Polynomial

Step 1 : First arrange the term of dividend and the divisor in the decreasing order of their degrees.

Step 2 : To obtain the first term of quotient divide the highest degree term of the dividend by the highest degree term of the divisor.

Step 3 : To obtain the second term of the quotient, divide the highest degree term of the new dividend obtained as remainder by the highest degree term of the divisor.

Step 4 : Continue this process till the degree of remainder is less than the degree of divisor.

• Division Algorithm for Polynomial

If p(x) and g(x) are any two polynomials with

$g(x) \neq 0$, then we can find polynomials q(x) and r(x) such that

$p(x) = q(x) \times g(x) + r(x)$

where $r(x) = 0$ or degree of $r(x)$ < degree of $g(x)$.

The result is called Division Algorithm for polynomials.

Dividend = Quotient × Divisor + Remainder

Ex.5 Divide $3x^3 + 16x^2 + 21x + 20$ by $x + 4$.

Sol.

$$
\begin{array}{r|l}
 & 3x^2 + 4x + 5 \\
\hline
x+4 & 3x^3 + 16x^2 + 21x + 20 \\
 & 3x^3 + 12x^2 \\
\hline
 & 4x^2 + 21x + 20 \\
 & 4x^2 + 16x \\
 & \text{– \quad –} \\
\hline
 & 5x + 20 \\
 & 5x + 20 \\
 & \text{– \quad –} \\
\hline
 & 0
\end{array}
$$

First term of $q(x) = \dfrac{3x^3}{x} = 3x^2$

Second term of $q(x) = \dfrac{4x^2}{x} = 4x$

Third term of $q(x) = \dfrac{5x}{x} = 5$

Quotient = $3x^2 + 4x + 5$

Remainder = 0

Ex.6 Check whether first polynomial is a factor of the second polynomial by applying the division algorithm.

$x^2 + 3x + 1$, $3x^4 + 5x^3 - 7x^2 + 2x + 2$

Sol. We divide $3x^4 + 5x^3 - 7x^2 + 2x + 2$ by $x^2 + 3x + 1$

$$
\begin{array}{r|l}
 & 3x^2 - 4x + 2 \\
\hline
x^2 + 3x + 1 & 3x^4 + 5x^3 - 7x^2 + 2x + 2 \\
 & 3x^4 + 9x^3 + 3x^2 \\
 & \text{– \quad – \quad –} \\
\hline
 & -4x^3 - 10x^2 + 2x + 2 \\
 & -4x^3 - 12x^2 - 4x \\
 & \text{+ \quad + \quad +} \\
\hline
 & 2x^2 + 6x + 2 \\
 & 2x^2 + 6x + 2 \\
 & \text{– \quad – \quad –} \\
\hline
 & 0
\end{array}
$$

Since, here remainder is zero.

Hence, $x^2 + 3x + 1$ is a factor of

$3x^4 + 5x^3 - 7x^2 + 2x + 2$.

Checking

$3x^4 + 5x^3 - 7x^2 + 2x + 2$

$= (3x^2 - 4x + 2)(x^2 + 3x + 1) + 0$

$= 3x^4 + 5x^3 - 7x^2 + 2x + 2$ = Dividend

Remainder Theorem

Remainder Theorem : Let p(x) be any polynomial of degree greater than or equal to one and let a be any real number. If p(x) is divided by the linear polynomial x – a, then the remainder is p(a).

Proof : Let p(x) be any polynomial with degree greater than or equal to 1. Suppose that when p(x) is divided by x – a, the quotient is q(x) and the remainder is r(x), i.e., $p(x) = (x - a)\, q(x) + r(x)$

Since the degree of x – a is 1 and the degree of r(x) is less than the degree of x – a, the degree of r(x) = 0. This means that r(x) is a constant, say r.

So, for every value of x, r(x) = r.

Therefore, $p(x) = (x - a)\, q(x) + r$

In particular, if x = a, this equation gives us

$$p(a) = (a - a)\, q(a) + r = r$$

which proves the theorem.

Ex.7 Find the remainder when $x^4 + x^3 - 2x^2 + x + 1$ is divided by x – 1.

Sol. Here, $p(x) = x^4 + x^3 - 2x^2 + x + 1$, and the zero of x – 1 is 1.

So, $p(1) = (1)^4 + (1)^3 - 2(1)^2 + 1 + 1 = 2$

So, by the Remainder Theorem, 2 is the remainder when $x^4 + x^3 - 2x^2 + x + 1$ is divided by x – 1.

Ex.8 Find the remainder when the polynomial $f(x) = 2x^4 - 6x^3 + 2x^2 - x + 2$ is divided by x + 2

Sol. We have, x + 2 = x – (–2). So, by remainder theorem, when f(x) is divided by (x–(–2)) the remainder is equal to f(–2).

Now, $f(x) = 2x^4 - 6x^3 + 2x^2 - x + 2$

$\Rightarrow$ $f(-2) = 2(-2)^4 - 6(-2)^3 + 2(-2)^2 - (-2) + 2$

$\Rightarrow$ $f(-2) = 2 \times 16 - 6 \times -8 + 2 \times 4 + 2 + 2$

$\Rightarrow$ $f(-2) = 32 + 48 + 8 + 2 + 2 = 92$

Hence, required remainder = 92

Ex.9 Find the remainder when $p(x) = 4x^3 - 12x^2 + 14x - 3$ is divided by $g(x) = x - \frac{1}{2}$

Sol. By remainder theorem, we know that p(x) when divided by $g(x) = \left(x - \frac{1}{2}\right)$ gives a remainder equal to $p\left(\frac{1}{2}\right)$.

Now, $p(x) = 4x^3 - 12x^2 + 14x - 3$

$\Rightarrow p\left(\frac{1}{2}\right) = 4\left(\frac{1}{2}\right)^3 - 12\left(\frac{1}{2}\right)^2 + 14\left(\frac{1}{2}\right) - 3$

$\Rightarrow p\left(\frac{1}{2}\right) = \frac{4}{8} - \frac{12}{4} + \frac{14}{2} - 3$

$\Rightarrow p\left(\frac{1}{2}\right) = \frac{1}{2} - 3 + 7 - 3 \Rightarrow p\left(\frac{1}{2}\right) = \frac{3}{2}$

Hence, required remainder = $p\left(\frac{1}{2}\right) = \frac{3}{2}$

Ex.10 If the polynomials $ax^3 + 4x^2 + 3x - 4$ and $x^3 - 4x + a$ leave the same remainder when divided by (x–3), find the value of a.

Sol. Let $p(x) = ax^3 + 4x^2 + 3x - 4$ and $q(x) = x^3 - 4x + a$ be the given polynomials. The remainders when p(x) and q(x) are divided by (x–3) are p(3) and q(3) respectively.

By the given condition, we have

$p(3) = q(3)$

$\Rightarrow a \times 3^3 + 4 \times 3^2 + 3 \times 3 - 4 = 3^3 - 4 \times 3 + a$

$\Rightarrow 27a + 36 + 9 - 4 = 27 - 12 + a$

$\Rightarrow 26a + 26 = 0$

$\Rightarrow 26a = -26 \Rightarrow a = -1$

Ex.11 Let R_1 and R_2 are the remainders when the polynomials $x^3 + 2x^2 - 5ax - 7$ and $x^3 + ax^2 - 12x + 6$ are divided by x + 1 and x – 2 respectively. If $2R_1 + R_2 = 6$, find the value of a.

Sol. Let $p(x) = x^3 + 2x^2 - 5ax - 7$ and

$q(x) = x^3 + ax^2 - 12x + 6$ be the given polynomials.

Now, R_1 = Remainder when p(x) is divided by x + 1

$\Rightarrow R_1 = p(-1)$

$\Rightarrow R_1 = (-1)^3 + 2(-1)^2 - 5a(-1) - 7$ $\quad [\because p(x) = x^3 + 2x^2 - 5ax - 7]$

$\Rightarrow R_1 = -1 + 2 + 5a - 7$

$\Rightarrow R_1 = 5a - 6$

And, R_2 = Remainder when q(x) is divided by x – 2

$\Rightarrow R_1 = q(2)$

$\Rightarrow R_2 = (2)^3 + a \times 2^2 - 12 \times 2 + 6$ $\quad [\because q(x) = x^3 + ax^2 - 12x - 6]$

$\Rightarrow R_2 = 8 + 4a - 24 + 6$

$\Rightarrow R_2 = 4a - 10$

Substituting the values of R_1 and R_2 in $2R_1 + R_2 = 6$, we get $2(5a - 6) + (4a - 10) = 6$

$\Rightarrow 10a - 12 + 4a - 10 = 6$

$\Rightarrow 14a - 22 = 6$

$\Rightarrow 14a = 28$

$\Rightarrow a = 2$

Factor Theorem

If p(x) is a polynomial of degree $n \geq 1$ and a is any real number, then (i) $x - a$ is a factor of p(x), if $p(a) = 0$, and (ii) $p(a) = 0$, if $x - a$ is a factor of p(x).

Proof : By the Remainder Theorem,

$p(x) = (x - a)\, q(x) + p(a)$.

(i) If $p(a) = 0$, then $p(x) = (x - a)\, q(x)$, which shows that $x - a$ is a factor of p(x).

(ii) Since $x - a$ is a factor of p(x), $p(x) = (x - a)\, g(x)$ for same polynomial g(x). In this case,
$p(a) = (a - a)\, g(a) = 0$.

Ex.12 Examine whether $x + 2$ is a factor of $x^3 + 3x^2 + 5x + 6$ and of $2x + 4$.

Sol. The zero of $x + 2$ is -2. Let $p(x) = x^3 + 3x^2 + 5x + 6$ and $s(x) = 2x + 4$

Then, $p(-2) = (-2)^3 + 3(-2)^2 + 5(-2) + 6 = -8 + 12 - 10 + 6 = 0$

So, by the Factor Theorem, $x + 2$ is a factor of $x^3 + 3x^2 + 5x + 6$.

Again, $s(-2) = 2(-2) + 4 = 0$

So, $x + 2$ is a factor of $2x + 4$.

Ex.13 Find the value of k, if $x + 3$ is a factor of $3x^2 + kx + 6$.

Sol. Let $p(x) = 3x^2 + kx + 6$ be the given polynomial. Then, $(x + 3)$ is a factor of p(x)

$\Rightarrow$ $p(-3) = 0$

$\Rightarrow$ $3(-3)^2 + k \times (-3) + 6 = 0$

$\Rightarrow$ $27 - 3k + 6 = 0$

$\Rightarrow$ $33 - 3k = 0 \Rightarrow k = 11$

Hence, $x + 3$ is a factor of $3x^2 + kx + 6$ if $k = 11$.

Ex.14 If $ax^3 + bx^2 + x - 6$ has $x + 2$ as a factor and leaves a remainder 4 when divided by $(x - 2)$, find the values of a and b.

Sol. Let $p(x) = ax^3 + bx^2 + x - 6$ be the given polynomial. Then, $(x + 2)$ is a factor of p(x)

$\Rightarrow$ $p(-2) = 0$ $\quad [x + 2 = 0 \Rightarrow x = -2]$

$\Rightarrow$ $a(-2)^3 + b(-2)^2 + (-2) - 6 = 0$

$\Rightarrow$ $-8a + 4b - 2 - 6 = 0 \quad \Rightarrow -8a + 4b = 8$

$\Rightarrow$ $-2a + b = 2$ $\quad$ ....(i)

It is given that p(x) leaves the remainder 4 when it is divided by $(x - 2)$. Therefore,

$p(2) = 4$ $\quad [x - 2 = 0 \Rightarrow x = 2]$

$\Rightarrow$ $a(2)^3 + b(2)^2 + 2 - 6 = 4$

$\Rightarrow$ $8a + 4b - 4 = 4 \Rightarrow 8a + 4b = 8$

$\Rightarrow$ $2a + b = 2$ $\quad$ ....(ii)

Adding (i) and (ii), we get

$2b = 4 \Rightarrow b = 2$

Putting $b = 2$ in (i), we get

$-2a + 2 = 2 \Rightarrow -2a = 0 \Rightarrow a = 0$.

Hence, $a = 0$ and $b = 2$.

Ex.15 If both $x - 2$ and $x - \frac{1}{2}$ are factors of $px^2 + 5x + r$, show that $p = r$.

Sol. Let $f(x) = px^2 + 5x + r$ be the given polynomial. Since $x - 2$ and $x - \frac{1}{2}$ are factors of $f(x)$. Therefore,

$f(2) = 0$ and $f\left(\frac{1}{2}\right) = 0$ $\left[\because x - 2 = 0 \Rightarrow x = 2 \text{ and } x - \frac{1}{2} = 0 \Rightarrow x = \frac{1}{2}\right]$

$\Rightarrow p \times 2^2 + 5 \times 2 + r = 0$ and $p\left(\frac{1}{2}\right)^2 + 5 \times \frac{1}{2} + r = 0$

$\Rightarrow \quad 4p + 10 + r = 0$ and $\frac{p}{4} + \frac{5}{2} + r = 0$

$\Rightarrow \quad 4p + r = -10$ and $\frac{p + 4r + 10}{4} = 0$

$\Rightarrow \quad 4p + r = -10$ and $p + 4r + 10 = 0$

$\Rightarrow \quad 4p + r = -10$ and $p + 4r = -10$

$\Rightarrow \quad 4p + r = p + 4r$ [$\because$ RHS of the two equations are equal]

$\Rightarrow \quad 3p = 3r \qquad \Rightarrow \qquad p = r$

Ex.16 If $x^2 - 1$ is a factor of $ax^4 + bx^3 + cx^2 + dx + e$, show that $a + c + e = b + d = 0$.

Sol. Let $p(x) = ax^4 + bx^3 + cx^2 + dx + e$ be the given polynomial. Then, $(x^2 - 1)$ is a factor of $p(x)$

$\Rightarrow \quad (x - 1)(x + 1)$ is a factor of $p(x)$

$\Rightarrow \quad (x - 1)$ and $(x + 1)$ are factors of $p(x)$

$\Rightarrow \quad p(1) = 0$ and $p(-1) = 0$ [$x - 1 = 0 \Rightarrow x = 1$ and $x + 1 = 0 \Rightarrow x = -1$]

$\Rightarrow a + b + c + d + e = 0$ and $a - b + c - d + e = 0$

Adding and subtracting these two equations, we get $2(a + c + e) = 0$ and $2(b + d) = 0$

$\Rightarrow \quad a + c + e = 0$ and $b + d = 0$

$\Rightarrow \quad a + c + e = b + d = 0$

Algebraic Identities

(i) $(a + b)^2 = a^2 + 2ab + b^2$

(ii) $(a - b)^2 = a^2 - 2ab + b^2$

(iii) $a^2 - b^2 = (a + b)(a - b)$

(iv) $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$

(v) $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$

(vi) $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$

(vii) $(a + b)^3 = a^3 + b^3 + 3ab(a + b)$

(viii) $(a - b)^3 = a^3 - b^3 - 3ab(a - b)$

(ix) $a^3 + b^3 + c^3 - 3abc = (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ac)$

Special case : if $a + b + c = 0$ then $a^3 + b^3 + c^3 = 3abc$.

Ex.17 Expand each of the following :

(i) $(3x - 4y)^2$ (ii) $\left(\frac{x}{2}+\frac{y}{3}\right)^2$

Sol. (i) We have,

$(3x - 4y)^2 = (3x)^2 - 2 \times 3x \times 4y + (4y)^2$

$= 9x^2 - 24xy + 16y^2$

(ii) We have,

$\left(\frac{x}{2}+\frac{y}{3}\right)^2 = \left(\frac{x}{2}\right)^2 + 2 \times \frac{x}{2} \times \frac{y}{3} + \left(\frac{y}{3}\right)^2$

$= \frac{x^2}{4} + \frac{1}{3}xy + \frac{y^2}{9}$

Ex.18 Find the products :

(i) $(2x + 3y)(2x - 3y)$ (ii) $\left(x - \frac{1}{x}\right)\left(x + \frac{1}{x}\right)\left(x^2 + \frac{1}{x^2}\right)\left(x^4 + \frac{1}{x^4}\right)$

Sol. (i) We have,

$(2x + 3y)(2x - 3y)$

$= (2x)^2 - (3y)^2$ [Using: $(a + b)(a - b) = a^2 - b^2$]

$= (2x)^2 - (3y)^2 = 4x^2 - 9y^2$

(ii) We have,

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

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

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

$= (x^4)^2 - \left(\frac{1}{x^4}\right)^2 = x^8 - \frac{1}{x^8}$

Ex.19 Evaluate each of the following by using identities :

(i) 103×97 (ii) 103×103

(iii) $(97)^2$ (iv) $185 \times 185 - 115 \times 115$

Sol. (i) We have,

$103 \times 97 = (100 + 3)(100 - 3)$

$= (100)^2 - (3)^2 = 10000 - 9 = 9991$

(ii) We have,

$103 \times 103 = (103)^2$

$= (100 + 3)^2 = (100)^2 + 2 \times 100 \times 3 + (3)^2$

$= 10000 + 600 + 9 = 10609$

Ex.55 Factorize, $2x^4 + x^3 - 14x^2 - 19x - 6$

Sol. Let $f(x) = 2x^4 + x^3 - 14x^2 - 19x - 6$ be the given polynomial. The factors of the constant term – 6 are ±1, ±2, ±3 and ±6, we have,

$f(-1) = 2(-1)^4 + (-1)^3 - 14(-1)^2 - 19(-1) - 6$

$= 2 - 1 - 14 + 19 - 6 = 21 - 21 = 0$

and,

$f(-2) = 2(-2)^4 + (-2)^3 - 14(-2)^2 - 19(-2) - 6 = 32 - 8 - 56 + 38 - 6 = 0$

So, $x + 1$ and $x + 2$ are factors of $f(x)$.

$\Rightarrow$ $(x + 1)(x + 2)$ is also a factor of $f(x)$

$\Rightarrow$ $x^2 + 3x + 2$ is a factor of $f(x)$

Now, we divide

$f(x) = 2x^4 + x^3 - 14x^2 - 19x - 6$ by

$x^2 + 3x + 2$ to get the other factors.

$$
\begin{array}{r|l}
x^2 + 3x + 2 & 2x^2 - 5x - 3 \\
\hline
 & 2x^4 + x^3 - 14x^2 - 19x - 6 \\
 & 2x^4 + 6x^3 + 4x^2 \\
 & - \quad - \quad - \\
\hline
 & -5x^3 - 18x^2 - 19x - 6 \\
 & -5x^3 - 15x^2 - 10x \\
 & + \quad + \quad + \\
\hline
 & -3x^2 - 9x - 6 \\
 & -3x^2 - 9x - 6 \\
 & + \quad + \quad + \\
\hline
 & 0
\end{array}
$$

$\therefore$ $2x^4 + x^3 - 14x^2 - 19x - 6$

$= (x^2 + 3x + 2)(2x^2 - 5x - 3)$

$= (x + 1)(x + 2)(2x^2 - 5x - 3)$

Now $2x^2 - 5x - 3 = 2x^2 - 6x + x - 3$

$= 2x(x - 3) + 1(x - 3)$

$= (x - 3)(2x + 1)$

Hence, $2x^4 + x^3 - 14x^2 - 19x - 6$

$= (x + 1)(x + 2)(x - 3)(2x + 1)$

Ex.56 Factorize $x^2 + 4 + 9z^2 + 4x - 6xz - 12z$

Sol. The presence of the three squares viz. x^2, $(2)^2$, and $(3z)^2$ gives a clue that identity (vii) could be used. So we write.

$A = x^2 + (2)^2 + (3z)^2 + 4x - 6xz - 12z$

We note that the last two of the product terms are negative and that both of these contain z. Hence we write A as

$A = x^2 + (2)^2 + (-3z)^2 + 2.2x - 2.x.(-3z) + 2.2(-3z) = (x + 2 - 3z)^2$

$= (x + 2 - 3z)(x + 2 - 3z)$

COMPETITIVE LEVEL

H.C.F. and L.C.M. of Polynomials

The relation between H.C.F. and L.C.M. of two polynomials is the product of the two polynomials is equal to the product of their H.C.F. and L.C.M.

If p(x) and q(x) are two polynomials, then p(x) · q(x) = {H.C.F. of p(x) and q(x)} x {L.C.M. of p(x) and q(x)}.

Ex. 57 Find the H.C.F. and L.C.M. of the expressions $a^2 - 12a + 35$ and $a^2 - 8a + 7$ by factorization.

Sol. First expression = $a^2 - 12a + 35 = a^2 - 7a - 5a + 35 = a(a - 7) - 5(a - 7) = (a - 7)(a - 5)$

Second expression = $a^2 - 8a + 7 = a^2 - 7a - a + 7 = a(a - 7) - 1(a - 7) = (a - 7)(a - 1)$

Therefore, the H.C.F. = (a – 7) and L.C.M. = (a – 7) (a – 5) (a – 1)

Note:

(i) The product of the two expressions is equal to the product of their factors.

(ii) The product of the two expressions is equal to the product of their H.C.F. and L.C.M.

Product of the two expressions $= (a^2 - 12a + 35)(a^2 - 8a + 7)$

$= (a - 7)(a - 5)(a - 7)(a - 1)$

$= (a - 7)(a - 7)(a - 5)(a - 1)$

= H.C.F. × L.C.M. of the two expressions

Ex.58 Find the L.C.M. of the two expressions $a^2 + 7a - 18$, $a^2 + 10a + 9$ with the help of their H.C.F.

Sol. First expression = $a^2 + 7a - 18 = a^2 + 9a - 2a - 18 = a(a + 9) - 2(a + 9) = (a + 9)(a - 2)$

Second expression = $a^2 + 10a + 9 = a^2 + 9a + a + 9 = a(a + 9) + 1(a + 9) = (a + 9)(a + 1)$

Therefore, the H.C.F. = (a + 9)

Therefore, L.C.M. = Product of the two expressions/H.C.F.

$$= \frac{(a^2 + 7a - 18)(a^2 + 10a + 9)}{(a + 9)} = \frac{(a + 9)(a - 2)(a + 9)(a + 1)}{(a + 9)} = (a - 2)(a + 9)(a + 1)$$

Ex.59 $m^2 - 5m - 14$ is an expression. Find out another similar expression such that their H.C.F. is (m – 7) and L.C.M. is $m^3 - 10m^2 + 11m + 70$.

Sol. According to the problem,

$$\text{Required Expression} = \frac{\text{L.C.M.} \times \text{H.C.F.}}{\text{Given expression}}$$

$$= \frac{(m^3 - 10m^2 + 11m + 70)(m - 7)}{m^2 - 5m - 14}$$

$$= \frac{(m^2 - 5m - 14)(m - 5)(m - 7)}{m^2 - 5m - 14}$$

$$\begin{array}{l} m^2 - 5m - 14 \;\big|\; m^3 - 10m^2 + 11m + 70 \;\big|\; m - 5 \\ \qquad\qquad\quad m^3 - 5m^2 - 14m \\ \qquad\qquad\quad - \quad + \quad + \\ \qquad\qquad\quad\; - 5m^2 + 25m + 70 \\ \qquad\qquad\quad\; - 5m^2 + 25m + 70 \\ \qquad\qquad\quad\; + \quad - \quad - \\ \qquad\qquad\qquad\qquad 0 \end{array}$$

$= (m - 5)(m - 7) = m^2 - 12m + 35$

Therefore, the required expression = $m^2 - 12m + 35$

EXERCISE-1

➢ Very Short Answer Type Questions

Q.1 Which are polynomial and why

(i) $\frac{1}{x} + x + x^2 + x^3 - x^4 + \frac{1}{5}x^5$

(ii) $\frac{2}{\sqrt{3}}x + 7x^2$

(iii) 1

(iv) $3\sqrt{x} + 5x - 3$

Q.2 Find the value of a, if $x - a$ is a factor of $x^3 - ax^2 + 2x + a - 1$.

Q.3 Find remainder, when p(x) is divided by q(x) in following questions. Using remainder theorem.

(i) $p(x) = 2x^2 - 5x + 7$, $q(x) = x - 1$

(ii) $p(x) = 2x^3 - 3x^2 + 4x - 1$, $q(x) = x + 2$

Q.4 If one of the factors of $x^2 + x - 20$ is $(x + 5)$, find other factor.

Q.5 For what value of k is $y^3 + ky + 2k - 2$ exactly divisible by $(y + 1)$?

➢ Short Answer Type Questions – Type I

Q.6 If $(3x - 1)^4 = a_4x^4 + a_3x^3 + a_2x^2 + a_1x + a_0$, then find the value of $a_4 + 3a_3 + 9a_2 + 27a_1 + 81a_0$.

Factorize each of the following expression

Q.7(a) (i) $6 - 5y - y^2$

(ii) $a^2 + 46a + 205$

(iii) $ab + ac - b^2 - bc$

(b) (i) $\sqrt{3}x^2 + 11x + 6\sqrt{3}$

(ii) $4\sqrt{3}x^2 + 5x - 2\sqrt{3}$

(c) (i) $x^2y^2 - xy - 72$

(ii) $x^4 - 5x^2 + 4$

(iii) $(x^2 - 4x)(x^2 - 4x - 1) - 20$

(d) (i) $2x^3 - 3x^2 - 17x + 30$

(ii) $x^3 - 6x^2 + 11x - 6$

(iii) $x^3 + x^2 - 4x - 4$

(iv) $3x^3 - x^2 - 3x + 1$

(v) $x^3 - 23x^2 + 142x - 120$

Q.8 If $a + b + c = 9$ and $ab + bc + ca = 40$, find $a^2 + b^2 + c^2$.

Q.9 Find positive square root of $36x^2 + 60x + 25$.

Q.10 Simplify : $\sqrt{2a^2 + 2\sqrt{6}ab + 3b^2}$

➢ Short Answer Type Questions – Type II

Q.11 Factorize : $4(x-y)^2 - 12(x - y)(x + y) + 9(x+y)^2$

Q.12 Find the value of $1 - a^2 + 14ab - 49b^2$.

Q.13 Prove that :

$$\frac{0.77 \times 0.77 \times 0.77 + 0.23 \times 0.23 \times 0.23}{0.77 \times 0.77 - 0.77 \times 0.23 + 0.23 \times 0.23} = 1$$

Q.14 Prove that

$(a + b)^3 + (b + c)^3 + (c + a)^3 - 3(a+b)(b+c)(c + a) = 2(a^3 + b^3 + c^3 - 3abc)$

Q.15 If $x + 1$ and $x - 1$ are factors of $mx^3 + x^2 - 2x + n$, find the value of m and n.

Q.16 Factorize : (i) $x^6 - y^6$ (ii) $x^{12} - y^{12}$

Q.17 If $x^4 + \frac{1}{x^4} = 47$. Find the value of $x^3 + \frac{1}{x^3}$.

Q.18 If $a + b = 10$ and $a^2 + b^2 = 58$, find the value of $a^3 + b^3$.

Q.19 If $a^2 + b^2 + c^2 - ab - bc - ca = 0$, prove that $a = b = c$.

Q.20 Let A and B are the remainders when the polynomial $y^3 + 2y^2 - 5ay - 7$ and $y^3 + ay^2 - 12y + 6$ are divided by $y + 1$ and $y - 2$ respectively. If $2A + B = 6$, find the value of a.

➢ Long Answer Type Questions

Q.21 If the polynomials $az^3 + 4z^2 + 3z - 4$ and $z^3 - 4z + a$ leave the same remainder when divided by $z - 3$, find the value of a.

Q.22 The polynomial $p(x) = x^4 - 2x^3 + 3x^2 - ax + 3a - 7$ when divided by $x + 1$ leaves the remainder 19. Find the values of a. Also find the remainder when p(x) is divided by $x + 2$.

Q.23 Without actual division, prove that $2x^4 - 5x^3 + 2x^2 - x + 2$ is divisible by $x^2 - 3x + 2$.

Q.24 Simplify $(2x - 5y)^3 - (2x + 5y)^3$.

Q.25 Multiply $x^2 + 4y^2 + z^2 + 2xy + xz - 2yz$ by $(-z + x - 2y)$.

Q.26 If a, b, c are all non-zero and $a + b + c = 0$, prove that $\frac{a^2}{bc} + \frac{b^2}{ca} + \frac{c^2}{ab} = 3$.

Q.27 If $a + b + c = 5$ and $ab + bc + ca = 10$, then prove that $a^3 + b^3 + c^3 - 3abc = -25$.

Q.28 Prove that $(a + b + c)^3 - a^3 - b^3 - c^3 = 3(a + b)(b + c)(c + a)$.

Q.29 A literacy compaign was organized by Class X girl students under NSS. Students made $(x - 5)$ rows and $(3x - 4)$ column for the rally.

(i) Write the total number of students in the form of polynomial.

(ii) Which values of students are depicted here ?

Q.30 Under tree plantation programme students of Class IX planted total $(3x^2 - 4x - 4)$ trees in school.

(i) If total number of students in the class are $(x - 2)$ then find out number of trees planted by each student. (Assuming each student planted equal number of trees).

(ii) What values of students are exhibited here?

EXERCISE-2

Q.1 Which one of the following is a polynomial?

(A) $\frac{x^2}{2}-\frac{2}{x^2}$ (B) $\sqrt{2x}-1$

(C) $x^2+\frac{3x^{\frac{3}{2}}}{\sqrt{x}}$ (D) $\frac{x-1}{x+1}$

Q.2 Degree of the polynomial $4x^4 + 0x^3 + 0x^5 + 5x + 7$ is :

(A) 4 (B) 5 (C) 3 (D) 7

Q.3 The value of the polynomial $5x - 4x^2 + 3$, when $x = -1$ is :

(A) – 6 (B) 6 (C) 2 (D) –2

Q.4 If $p(x) = x + 3$, then $p(x) + p(-x)$ is equal to :

(A) 3 (B) $2x$ (C) 0 (D) 6

Q.5 The polynomial $11a^2-12\sqrt{2}a+2$ on factorisation gives :

(A) $(11a+\sqrt{2})(a-\sqrt{2})$

(B) $(a-\sqrt{2})(11a-\sqrt{2})$

(C) $(a+11)(a+\sqrt{2})$

(D) $(11a-\sqrt{2})(a+\sqrt{2})$

Q.6 If $x^n + 1$ is divisible by x + 1, n must be :

(A) any natural number

(B) an odd natural number

(C) an even natural number

(D) None of these

Q.7 The polynomial $x^5 - a^2x^3 - x^2y^3 + a^2y^3$ on factorisation gives :

(A) $(x - y)(x - a)(x + a)(x^2 + y^2 + xy)$

(B) $(x + a)(x - y)(x - a)(x^2 - y^2 + xy)$

(C) $(x + a)(x + y)(x - a)(x^2 + y^2 + xy)$

(D) None of these

Q.8 If $x^{51} + 51$ is divided by (x + 1) the remainder is :

(A) 0 (B) 1 (C) 49 (D) 50

Q.9 Square root of the expression $\frac{1}{xyz}(x^2+y^2+z^2)+2\left(\frac{1}{x}+\frac{1}{y}+\frac{1}{z}\right)$ is -

(A) $\frac{x+y+z}{xyz}$

(B) $\sqrt{\frac{yz}{x}}+\sqrt{\frac{zx}{y}}+\sqrt{\frac{xy}{z}}$

(C) $\sqrt{x}+\sqrt{y}+\sqrt{z}$

(D) $\sqrt{\frac{x}{yz}}+\sqrt{\frac{y}{xz}}+\sqrt{\frac{z}{xy}}$

Q.10 If a + b + c = 0, show that $a^3 + b^3 + c^3 = 3abc$. The following are the steps involved in showing the above result. Arrange them in sequential order.

(a) $a^3 + b^3 + 3ab(-c) = -c^3$

(b) $(a + b)^3 = (-c)^3$

(c) $a + b + c = 0 \Rightarrow a + b = -c$

(d) $a^3 + b^3 + 3ab(a + b) = -c^3$

(e) $a^3 + b^3 + c^3 = 3abc$

(A) abdce (B) bcdae

(C) cbdae (D) cadbe

Q.11 Factorise : $a^3 + b^3 + 3ab - 1$.

(A) $(a + b - 1)(a^2 + b^2 + a + b + 1 - ab)$

(B) $(a + b - 1)(a^2 + b^2 + a + b - 1 + ab)$

(C) $(a + b - 1)(a^2 + b^2 - a - b + 1 + ab)$

(D) None of these

Q.12 Find the square root of $\frac{x^2}{9}+\frac{9}{4x^2}-\frac{x}{3}-\frac{3}{2x}+\frac{5}{4}$.

(A) $\frac{2x}{3}+\frac{3}{2x}-\frac{1}{2}$ (B) $\frac{x}{3}-\frac{3}{2x}+1$

(C) $\frac{3}{x}+\frac{2}{3x}-\frac{1}{2}$ (D) $\frac{x}{3}+\frac{3}{2x}-\frac{1}{2}$

Q.13 If $\sqrt{4x^4+12x^3+25x^2+24x+16}=ax^2+bx+c$, then which of the following is true?

(A) 2b = a – c (B) 2a = b + c

(C) 2b = a + c (D) 2b = c – a

EXERCISE-3

Q.1 When the polynomial $(6x^4 + 8x^3 + 17x^2 + 21x + 7)$ is divided by $(3x^2 + 4x + 1)$, the remainder is $(ax - b)$. Therefore : **[IJSO-2011]**

(A) a = 1, b = 2 (B) a = 1, b = – 2
(C) a = 2, b = 1 (D) a = –1, b = – 2

Q.2 If $2^{2x-1} + 2^{1-2x} = 2$, then the value of x is : **[IJSO-2011]**

(A) 0.5 (B) –0.5 (C) 1 (D) 0

Q.3 Given that a (a+b) = 36 and b (a + b) = 64, where a and b are positive, (a – b) equals: **[IJSO-2011]**

(A) 2.8 (B) 3.2 (C) –2.8 (D) –2.5

Q.4 Find $x^2 + y^2 + z^2$ if $x^2 + xy + xz = 135$, $y^2 + yz + yx = 351$ and $z^2 + zx + zy = 243$. **[IJSO-2012]**

(A) 225 (B) 250 (C) 275 (D) 300

Q.5 The number of real values of 'a' for which the cubic equation $x^3 - 3ax^2 + 3ax - a = 0$ has all real roots, one of which is a itself, is- **[IJSO-2013]**

(A) 0 (B) 1 (C) 2 (D) 3

Q.6 If $x^3 = a + 1$ and $x + (b/x) = a$; then x equals- **[IJSO-2013]**

(A) $\frac{a(b+1)}{a^2-b}$ (B) $\frac{ab+1}{a^2-b}$

(C) $\frac{ab+a+1}{a^2-b}$ (D) $\frac{ab-a-1}{a^2-b}$

Q.7 If $f(x) = x^4 - 2x^3 + 3x^2 - ax + b$ is a polynomial such that when it is divided by (x – 1) and (x + 1), the remainders are respectively 5 and 19. Determine the remainder when f(x) is divided by (x – 2). **[NSO]**

(A) 5 (B) –8 (C) 10 (D) 8

Q.8 In a polygon there are 6 right angles and the remaining angles are all equal to 200° each. The number of sides of the polygon is _____ **[NSO]**

(A) 15 (B) 12 (C) 9 (D) 23

Q.9 If $x^3 - 6x^2 + ax + b$ is exactly divisible by $x^2 - 3x + 2$, then values of a and b are _____ **[NSO]**

(A) a = 11, b = –5 (B) a = –11, b = –5
(C) a = 11, b = –6 (D) a = 11, b = 6

Q.10 The sum of two numbers is 13 and the sum of their cubes is 1066. Find the product of those two numbers : **[IJSO-2017]**

(A) 26 (B) 27 (C) 28 (D) 29

Q.11 If $x + \frac{1}{x} = a + b$, $x - \frac{1}{x} = a - b$ then **[Karnatka NTSE Stage-1/2012]**

(A) ab = 1 (B) ab = 2
(C) a + b = 0 (D) a = b

Q.12 What is the remainder when $(x^4 + 1)$ is divided by (x – 2)? **[Karnatka NTSE Stage-1/2012]**

(A) 17 (B) 15 (C) 7 (D) 1

Q.13 If $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}=\frac{1}{a+b+c}$ where$(a+b+c) \neq 0$ and $abc \neq 0$. What is the value of (a+b) (b+c) (c+a) ? **[Karnatka NTSE Stage-1/2012]**

(A) 0 (B) 1 (C) –1 (D) 2

Q.14 H.C.F. and L.C.M. of expressions $(x^3 - 1)$ and A are (x – 1) and $(x^6 - 1)$ respectively. Then the value of A is: **[Raj. NTSE Stage -1/2005]**

(A) $x^3 + 1$ (B) $x^4 - x^3 + x - 1$
(C) $(x - 1)(x^2 - x + 1)$ (D) $(x - 1)(x^2 + x + 1)$

Q.15 H.C.F. of $x^2 + 5x + 6$ and $x^3 + 27$ is : **[Raj. NTSE Stage-1/2006]**

(A) x + 2 (B) x – 2
(C) x – 3 (D) x + 3

Q.16 One of the factors of the expression $(2x - 3y)^2 - 7(2x - 3y) - 30$ is : **[Raj. NTSE Stage-1/2007]**

(A) 2x – 3y – 10 (B) 2x – 3y + 10
(C) 3x – 2y + 5 (D) 6x – 4y – 15

Q.17 L.C.M. of $x^3 + x^2 + x + 1$ and $x^3 - x^2 + x - 1$ is: **[Raj. NTSE Stage-1/2007]**

(A) $x^4 + 1$ (B) $x^4 - 1$

(C) $x^2 + 1$ (D) $x^2 - 1$

Q.18 If $x + \frac{1}{x} = 3$, then the value of $x^6 + \frac{1}{x^6}$ is : **[Raj. NTSE Stage-1/2013]**

(A) 927 (B) 114

(C) 364 (D) 322

Q.19 If a, b, c and d are natural numbers such that $a^5 = b^6$, $c^3 = d^4$, and d–a = 61, then the smallest value of c–b is : **[Harayana NTSE Stage-1/2013]**

(A) 61 (B) 122

(C) 239 (D) 593

Q.20 If x, y, z are positive real numbers and a, b, c are rational numbers, then the value of $\frac{1}{1+x^{b-a}+x^{c-a}} + \frac{1}{1+x^{a-b}+x^{c-b}} + \frac{1}{1+x^{b-c}+x^{a-c}}$ is **[Raj. NTSE Stage-1/2014]**

(A) – 1 (B) 0

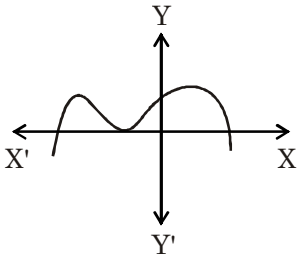
(C) 1 (D) None of these

Q.21 If x% of y is equal to 1% of z, y% of z is equal to 1% of x and z% of x is equal to 1% of y, then the value of xy + yz + zx is - **[Harayana NTSE Stage-1/2014]**

(A) 1 (B) 2

(C) 3 (D) 4

Q.22 The graph of y = p(x) is given below. The number of zeroes of polynomial p(x), is



[Raj. NTSE Stage-1/2015]

(A) 3 (B) 2

(C) 1 (D) 0

Q.23 If α, β are the zeros of polynomial $f(x) = x^2 - p(x + 1) - c$, then $(\alpha + 1)(\beta + 1) =$ **[NTSE-2014]**

(A) c – 1 (B) 1 – c

(C) c (D) 1 + c

Q.24 If the quotient obtained on dividing $(x^4 + 10^3 + 35x^2 + 50x + 29)$ by (x + 4) is $x^3 - ax^2 + bx + 6$, then the value of is $\frac{a+b}{a-b}$: **[Karnataka NTSE Stage-1/2014]**

(A) $\frac{25}{33}$ (B) $\frac{17}{5}$ (C) $\frac{-5}{17}$ (D) $\frac{53}{25}$

Q.25 If the value of quadratic polynomial p(x) is 0 only at x = –1 and p(–2) = 2 then the value of p(2) is **[NTSE Stage-2/2016]**

(A) 18 (B) 9 (C) 6 (D) 3

Q.26 In a polynomial $x^4 - 4x^2 + x^3 + 2x + 1$ is divided by x – 1, then remainder will be **[Rajasthan NTSE Stage-I 2019]**

(A) 0 (B) 1 (C) 9 (D) –1

Q.27 If $x^2 + 4y^2 + 9z^2 - 4xy - 12yz + 6xz = 0$, then **[Rajasthan NTSE Stage-I 2019]**

(A) x = 2y – 3z (B) x = y – 3z

(C) 2x = y – 3z (D) x = 3y – 2z

Q.28 If $x^2 - 3x + 2$ is a factor of $x^4 - px^2 + q$, then the value of p and q respectively are: **[Delhi NTSE Stage-I 2019]**

(A) –5, 4 (B) –5, –5

(C) 5, 4 (D) 5, –4

Q.29 If $x^2 + y^2 + \frac{1}{x^2} + \frac{1}{y^2} = 4$, then the value of $x^2 + y^2$ is **[Delhi NTSE Stage-I 2019]**

(A) 2 (B) 4 (C) 8 (D) 16

Q.30 If $\frac{1}{y+z} + \frac{1}{z+x} = \frac{2}{x+y}$, then what is the value of $x^2 + y^2$? **[Delhi NTSE Stage-I 2019]**

(A) 1 (B) $-2z^2$

(C) $2z^2$ (D) $y^2 + z^2$

Q.31 If $x^2 = y + z$, $y^2 = z + x$ and $z^2 = x + y$, then what is the value of $\frac{1}{x+1}+\frac{1}{y+1}+\frac{1}{z+1}$?

[Delhi NTSE Stage-I 2019]

(A) 1 (B) 0 (C) –1 (D) 2

Q.32 If one factor of the polynomial $x^3 + 4x^2 - 3x - 18$ is $x + 3$, then the order factor is

[Gujarat NTSE Stage-I 2019]

(A) $x^2 + x$ (B) $x^2 + x + 6$

(C) $x^2 + x - 6$ (D) $x^2 - x + 6$

Q.33 If $\sqrt{3}$ and $-\sqrt{3}$ are the zeros of a polynomial p(x), then ____ is not the factor of the p(x). **[Gujarat NTSE Stage-I 2019]**

(A) $x + \sqrt{3}$ (B) $x - \sqrt{3}$

(C) $x^2 - 3$ (D) $x^2 + 3$

Q.34 Zero of the polynomial $p(x) = 2x + 1$ is:

[MP NTSE Stage-I 2019]

(A) $-\frac{1}{2}$ (B) $\frac{1}{2}$ (C) 0 (D) ∞

Q.35 Remainder on dividing polynomial $3x^2 - x^3 - 3x + 5$ by $x - 1 - x^2$ is

[MP NTSE Stage-I 2019]

(A) 7 (B) 3

(C) 0 (D) $2x + 5$

Q.36 What is the largest value of the positive integer k such that k divides $n^2(n^2 - 1)(n^2 - n - 2)$ for every natural number n? **[IJSO Stage-I 2019]**

(A) 6 (B) 12 (C) 24 (D) 48

ANSWER KEY

EXERCISE - 1

1. (ii), (iii) ; Degree is whole number **2.** $\frac{1}{3}$ **3.(a) (i),** **(ii)** –37 **4.** (x – 4) **5.** 3

6. 0

7.(a) (i) (1 – y) (y + 6) **(ii)** (a + 41) (a + 5) **(iii)** (a – b) (b + c)

(b). (i) $(\sqrt{3}x+2)(x+3\sqrt{3})$ **(ii)** $(\sqrt{3}x+2)(4x-\sqrt{3})$

(c). (i) (xy – 9) (xy + 8) **(ii)** (x – 2) (x + 2) (x – 1) (x + 1) **(iii)** (x – 5) (x + 1) $(x-2)^2$

(d). (i) (x – 2) (x + 3) (2x – 5) **(ii)** (x – 1) (x – 2) (x – 3) **(iii)** (x + 1) (x + 2) (x – 2) **(iv)** (x – 1) (x + 1) (3x – 1)

(v) (x – 1) (x – 10) (x – 12)

8. 1 **9.** (6x + 5) **10.** $(\sqrt{2}a+\sqrt{3}b)$ **11.** $(x+5y)^2$ **12.** (1 + a – 7b) (1 – a + 7b) **15.** m = 2, n = –1

16. (i) $(x+y)(x-y)(x^2-xy+y^2)(x^2+xy+y^2)$

(ii) $(x-y)(x+y)(x^2+y^2)(x^4+y^4-x^2y^2)(x^2-xy+y^2)(x^2+xy+y^2)$

17. ± 18 **18.** 370 **20.** a = 2 **21.** –1 **22.** a = 5, 62

24. $(-10y)(12x^2+25y^2)$ **25.** $x^3-8y^3-z^3-6xyz$

29. (i) $3x^2-19x+20$

30. (i) (3x + 2)

EXERCISE - 2

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

EXERCISE - 3

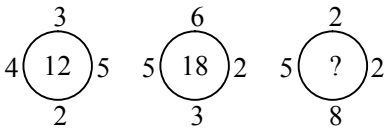
Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	A	C	C	C	C	C	A	C	D	A	A	A	B	D
Ques.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	A	B	D	D	C	A	A	B	C	A	B	A	C	A	C
Ques.	31	32	33	34	35	36									
Ans.	A	C	D	A	B	D									

Chapter 3

MISSING TERMS IN FIGURES

In such type of questions, a figure, a set of figures, an arrangement or a matrix is given each of which bears certain numbers, letters or a group or combination of letters or numbers, following a certain pattern. We have to observe the pattern and find the missing term.

◈ **FIND THE MISSING TERMS**

Ex.1 

(A) 12 (B) 14

(C) 16 (D) 18

Sol. **(C)** i.e. 16, because the numbers inside the first two circles are obtained by multiplying the outside numbers and dividing by 10, i.e.

$$\frac{5\times3\times4\times2}{10} = \frac{120}{10} = 12$$

The same follows for the second and third circles.

Ex.2

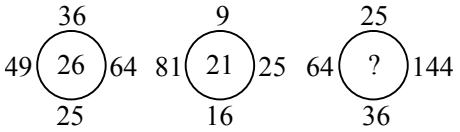
17	15	8
99	95	64
36	45	?

(A) 729 (B) 1331

(C) –729 (D) –343

Sol.(C) The rule is that in a row as $(17 - 15)^3 = 8$.

Therefore $(36 - 45)^3 = (-9)^3 = -729$

Ex.3 

(A) 24 (B) 25

(C) 23 (D) 31

Sol.(D) i.e. 31, because the numbers inside the first two circles are obtained by taking the sum of the square roots of the four numbers outside the circles, e.g.

$\sqrt{49} + \sqrt{64} + \sqrt{25} + \sqrt{36}$

$= 7 + 8 + 5 + 6 = 26$ (Ist Circle)

and $\sqrt{16} + \sqrt{25} + \sqrt{9} + \sqrt{81}$

$= 4 + 5 + 3 + 9 = 21$ (IInd Circle)

Ex.4

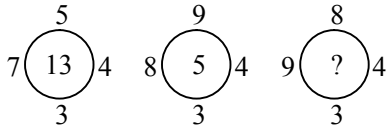
? / 108	2
18	3 / 6

(A) 1 (B) 36 (C) 216 (D) 1944

Sol.(D) The answer is 1944 as the numbers are arranged in the following way,

$2 \times 3 = 6$, $3 \times 6 = 18$, $6 \times 18 = 108$,

$18 \times 108 = 1944$

Ex.5 

(A) 4 (B) 8 (C) 12 (D) 15

Sol.(C) i.e. 12 because

$(7 \times 4) - (5 \times 3) = 28 - 15 = 13$ (Ist Circle)

$(8 \times 4) - (9 \times 3) = 32 - 27 = 05$ (IInd Circle)

So, $(9 \times 4) - (8 \times 3) = 36 - 24 = 12$ (IIIrd Circle)

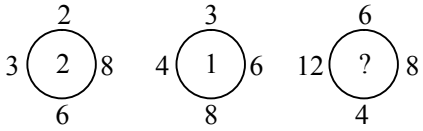
Ex.6

7	6	5
3	3	4
2	3	?

(A) 12 (B) 3 (C) 4 (D) 5

Sol.(A) The answer is 3 because the sum of the numbers in each column is 12.

Ex.7



(A) 3 (B) 4 (C) 5 (D) 6

Sol.(B) i.e. 4 because

$(3 \times 8) \div (2 \times 6) = 24 \div 12 = 2$ (I^{st} Circle)

$(4 \times 6) \div (8 \times 3) = 24 \div 24 = 1$ (II^{nd} Circle)

So, $(12 \times 8) \div (6 \times 4) = 96 \div 24 = 4$ (III^{rd} Circle)

Ex.8

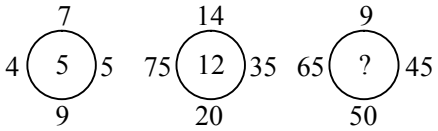
17	11	19
12	13	16
25	4	?

(A) 36 (B) 9 (C) 25 (D) 64

Sol.(B) In the first column $25 = (17 - 12)^2$ therefore

$(19 - 16)^2$ is 9

Ex.9



(A) 7 (B) 9 (C) 13 (D) 15

Sol.(C) i.e. 13 because

$\sqrt{4+7+5+9} = \sqrt{25} = 5$

$\sqrt{65+45+9+50} = \sqrt{169} = 13$ Ans.

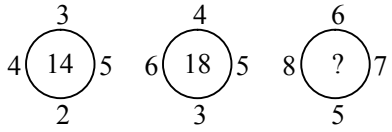
Ex.10

7	9	16
4	15	?
13	8	21

(A) 29 (B) 19 (C) 23 (D) 25

Sol.(B) The answer is 19 because the sum of the first two numbers in each row gives the third number, i.e. 7 + 9 = 16, 4 + 15 = 19, 13 + 8 = 21

Ex.11



(A) 24 (B) 26 (C) 28 (D) 22

Sol.(B) i.e. 26, because

$(5 \times 4) - (3 \times 2) = 14$ (I^{st} circle) and

$(5 \times 6) - (4 \times 3) = 18$ (II^{nd} circle)

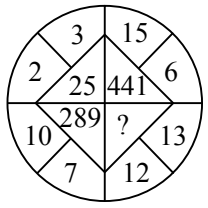
Ex.12

21	56	70
45	87	84
115	180	?

(A) 130 (B) 195 (C) 295 (D) 150

Sol.(A) The rule is that in each row the difference of first two numbers is doubled. i.e. $(56 - 21) \times 2 = 70$. Hence the required number $(180 - 115) \times 2 = 130$

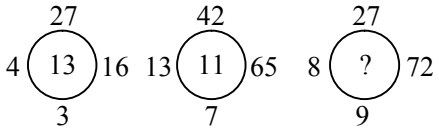
Ex.13



(A) 625 (B) 25 (C) 125 (D) 156

Sol.(A) Clearly, $(3 + 2)^2 = 25$; $(15 + 6)^2 = (21)^2 = 441$; $(10 + 7)^2 = (17)^2 = 289$. So, missing number $= (12 + 13)^2 = (25)^2 = 625$.

Ex.14



(A) 9 (B) 12 (C) 15 (D) 18

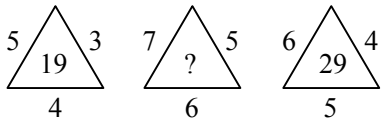
Sol.(B) i.e. 12, because

$(16 \div 4) + (27 \div 3) = 13$ (I^{st} Circle) and

$(65 \div 13) + (42 \div 7) = 5 + 6 = 11$ (II^{nd} Circle)

So, $(72 \div 8) + (27 \div 9) = 9 + 3 = 12$ (III^{rd} Circle)

Ex.15



(a) (b) (c)

(A) 25 (B) 37 (C) 41 (D) 47

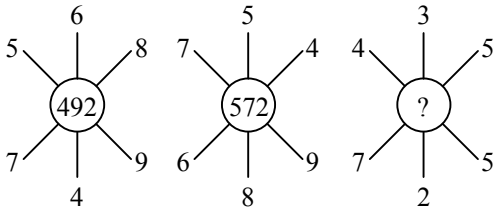
Sol.(C) Clearly, in fig. (a), $5 \times 3 + 4 = 19$.

In fig (c) $= 6 \times 4 + 5 = 29$.

$\therefore$ In fig.(b), missing number

$= 7 \times 5 + 6 = 35 + 6 = 41$.

Ex.16



A B C

(A) 115 (B) 130

(C) 135 (D) 140

Sol.(B) Clearly, the number inside the circle is equal to the sum of the product of the upper three numbers and the product of the lower three numbers. Thus,

In fig.

A, $(5 \times 6 \times 8) + (7 \times 4 \times 9) = 240 + 252 = 492$.

In fig.

B, $(7 \times 5 \times 4) + (6 \times 8 \times 9) = 140 + 432 = 572$.

$\therefore$ In fig C, missing number

$= (4 \times 3 \times 5) + (7 \times 2 \times 5) = 60 + 70 = 130$.

Ex.17

6	18	15
3	2	5
4	3	?
8	27	9

(A) 11 (B) 6 (C) 3 (D) 2

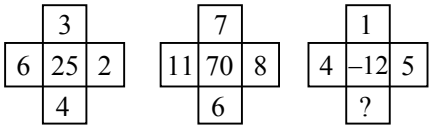
Sol.(C) Clearly, in the first column, $\frac{6 \times 4}{3} = \frac{24}{3} =$ 8.

In the second column, $\frac{18 \times 3}{2} = \frac{54}{2} = 27$.

Let the missing number in the third column be x.

Then, $\frac{15 \times x}{5} = 9$ or $15x = 45$ or $x = 3$.

Ex.18



A B C

(A) 10 (B) 6 (C) 2 (D) 1

Sol.(C) The arrangement is as follows :

In fig.

A, $(3^2 + 6^2) - (2^2 + 4^2) = (9 + 36) - (4 + 16)$

$= 45 - 20 = 25$.

In fig.

B, $(7^2 + 11^2) - (8^2 + 6^2) = (49 + 121) - (64 + 36)$

$= 170 - 100 = 70$.

In fig. (C), let the missing number be x.

Then, $(1^2 + 4^2) - (5^2 + x^2) = -12$

or $17 + 12 = (5^2 + x^2)$ or $x^2 = 29 - 25 = 4$

or $x = 2$.

Ex.19

3C	2B	4A
27A	?	64B
9C	4A	16B

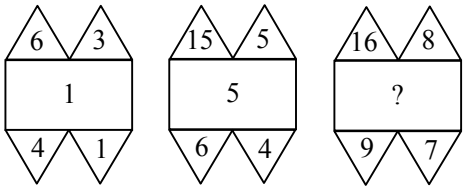
(A) 8C (B) 12B (C) 16C (D) 18C

Sol.(A) In each row, out of the letters A, B and C, each of these must appear once. Also, in each column, the product of first and third numbers is equal to the second number. So the missing number will be (2 × 4) i.e. 8 and the letter be C. Thus, the answer is 8C.

EXERCISE-1

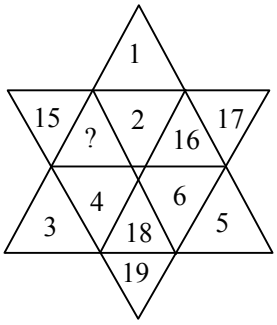
Directions: (Q.1 to Q.25) Find the missing terms.

Q.1



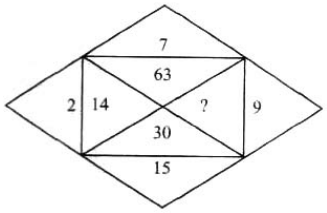
(A) 6 (B) 4 (C) 3 (D) 5

Q.2



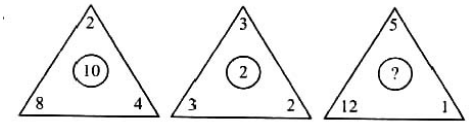
(A) 13 (B) 20 (C) 16 (D) 14

Q.3



(A) 33 (B) 135 (C) 145 (D) 65

Q.4



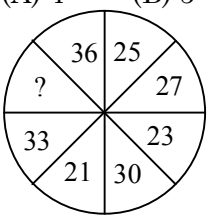
(A) 8 (B) 16 (C) 6 (D) 24

Q.5

17	8	5	5
13	7	5	4
6	12	6	3
10	6	4	?

(A) 4 (B) 5 (C) 6 (D) 7

Q.6



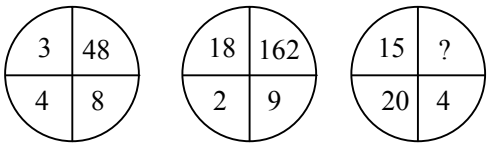
(A) 19 (B) 22 (C) 32 (D) 35

Q.7

11	12	13
14	15	16
2	3	4
39	57	?

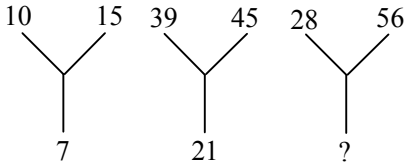
(A) 87 (B) 75
(C) 85 (D) 77

Q.8



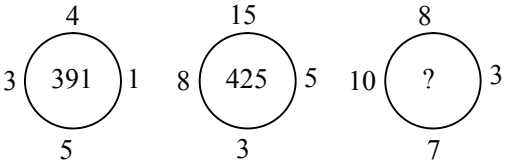
(A) 600 (B) 550
(C) 435 (D) 172

Q.9



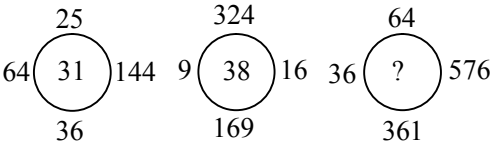
(A) 21 (B) 28
(C) 35 (D) 10

Q.10



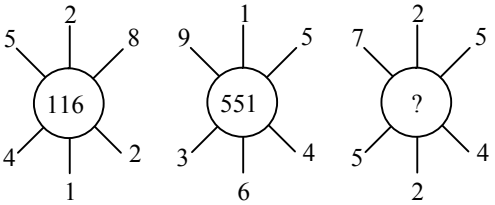
(A) 890 (B) 2236
(C) 975 (D) 3540

Q.11



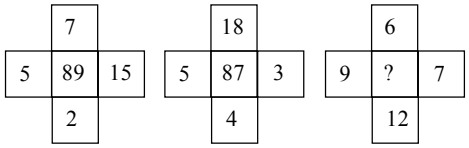
(A) 115 (B) 82
(C) 135 (D) 57

Q.12



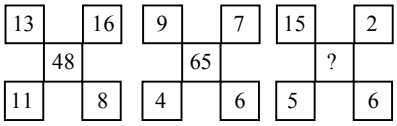
(A) 287 (B) 215
(C) 201 (D) 275

Q.13



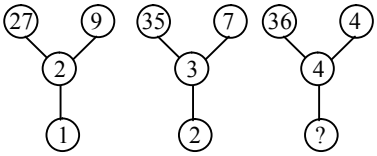
(A) 135 (B) 85
(C) 195 (D) 95

Q.14



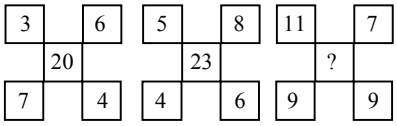
(A) 90 (B) 87
(C) 53 (D) 80

Q.15



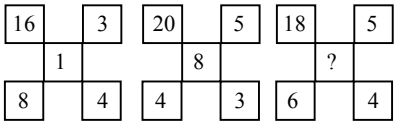
(A) 3 (B) 4
(C) 5 (D) 6

Q.16



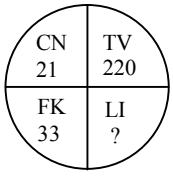
(A) 77 (B) 36
(C) 99 (D) 63

Q.17



(A) 3 (B) 10
(C) 15 (D) 60

Q.18



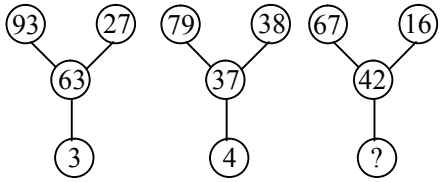
(A) 54 (B) 58
(C) 65 (D) 85

Q.19

4C	2B	3A
28A	?	45B
7C	8A	15B

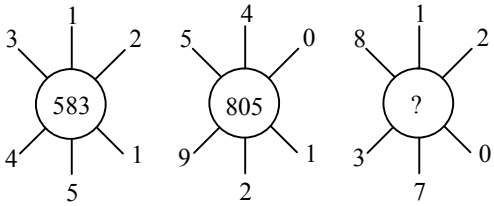
(A) 16C (B) 12C
(C) 13C (D) 7C

Q.20



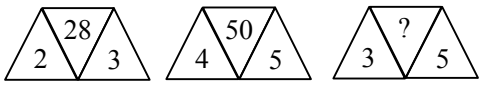
(A) 5 (B) 6
(C) 8 (D) 9

Q.21



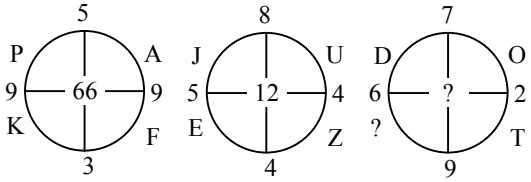
(A) 760 (B) 425
(C) 875 (D) 303

Q.22



(A) 35 (B) 40
(C) 49 (D) 53

Q.23



(A) 53 and Z (B) 51 and Y
(C) 50 and Y (D) 52 and U

Q.24

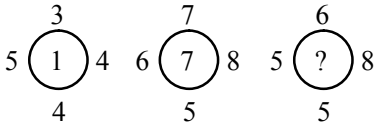
7	51	2
6	40	4
5	28	?

(A) 1 (B) 3
(C) 2 (D) 0

EXERCISE-2

Directions: (Q.1 to Q.68) Find the missing terms.

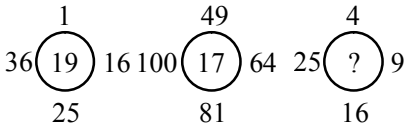
Q.1



[NTSE Stage-I/Raj. 2007]

(A) 3 (B) 4 (C) 5 (D) 6

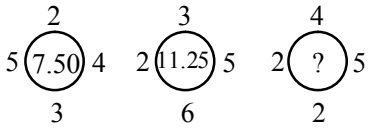
Q.2



[NTSE Stage-I/Raj. 2007]

(A) 6 (B) 7 (C) 8 (D) 9

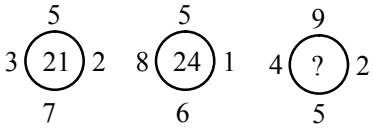
Q.3



[NTSE Stage-I/Raj. 2007]

(A) 4.5 (B) 5.0 (C) 8.5 (D) 7.0

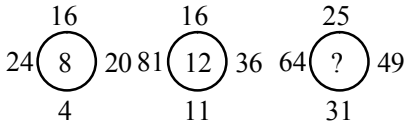
Q.4



[NTSE Stage-I/Raj. 2007]

(A) 36 (B) 38 (C) 48 (D) 42

Q.5



[NTSE Stage-I/Raj. 2007]

(A) 11 (B) 13 (C) 15 (D) 17

Q.6

11	12	13
18	15	16
25	?	21

[NTSE Stage-I/Raj.2007]

(A) 19 (B) 18 (C) 20 (D) 21

Q.7

13	8	10
16	22	31
21	?	9

[NTSE Stage-I/Raj. 2007]

(A) 20 (B) 21 (C) 22 (D) 23

Q.8

1	4	?
64	9	16
49	36	25

[NTSE Stage-I/Raj. 2007]

(A) 5 (B) 40 (C) 45 (D) 81

Q.9

24	3	15
?	0	48
80	63	35

[NTSE Stage-I/Raj. 2007]

(A) 7 (B) 8 (C) 9 (D) 10

Q.10

1	26	6
21	5	31
16	?	11

[NTSE Stage-I/Raj. 2007]

(A) 27 (B) 31 (C) 36 (D) 41

Q.11

B	Y	X
D	W	?
F	U	T

[NTSE Stage-II 2007]

(A) V (B) C (C) U (D) E

Q.12

Z	B	X
Y	C	V
?	D	T

[NTSE Stage-II 2007]

(A) W (B) X (C) Y (D) Z

Q.13

E	?	O
C	H	M
A	F	K

[NTSE Stage-II 2007]

(A) L (B) J (C) G (D) N

Q.14

N	O	P
S	R	?
T	U	V

[NTSE Stage-II 2007]

(A) T (B) K (C) F (D) Q

Q.15

6	21	36
9	45	81
7	(?)	49

[NTSE Stage-I/Raj. 2008]

(A) 32 (B) 28 (C) 35 (D) 56

Q.16

3	5	16
7	9	32
11	13	(?)

[NTSE Stage-I/Raj. 2008]

(A) 48 (B) 64 (C) 24 (D) 143

Q.17

1	5	9
4	8	12
7	(?)	15

[NTSE Stage-I/Raj. 2008]

(A) 11 (B) 12 (C) 13 (D) 16

Q.18

3	4	43
7	5	57
9	11	(?)

[NTSE Stage-I/Raj. 2008]

(A) 34 (B) 75 (C) 119 (D) 911

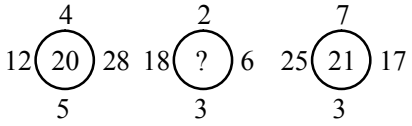
Q.19

8	11	15
25	34	46
74	101	(?)

[NTSE Stage-I/Raj. 2008]

(A) 138 (B) 139 (C) 140 (D) 137

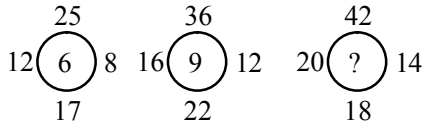
Q.20



[NTSE Stage-I/Raj. 2008]

(A) 9 (B) 15 (C) 18 (D) 12

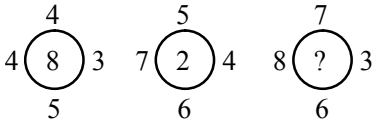
Q.21



[NTSE Stage-I/Raj. 2008]

(A) 6 (B) 15 (C) 30 (D) 47

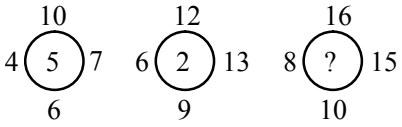
Q.22



[NTSE Stage-I/Raj. 2008]

(A) 2 (B) 38 (C) 27 (D) 18

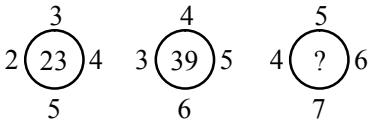
Q.23



[NTSE Stage-I/Raj. 2008]

(A) 3 (B) 2 (C) 5 (D) 4

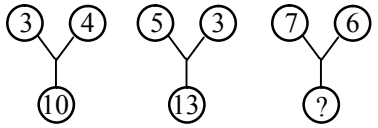
Q.24



[NTSE Stage-I/Raj. 2008]

(A) 120 (B) 59 (C) 62 (D) 22

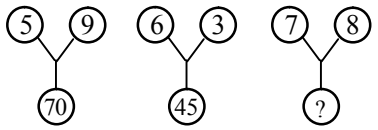
Q.25



[NTSE Stage-II 2008]

(A) 25 (B) 37 (C) 40 (D) 42

Q.26



[NTSE Stage-II 2008]

(A) 85 (B) 81 (C) 75 (D) 64

Chapter

1

India Size And Location

Chapter Outline

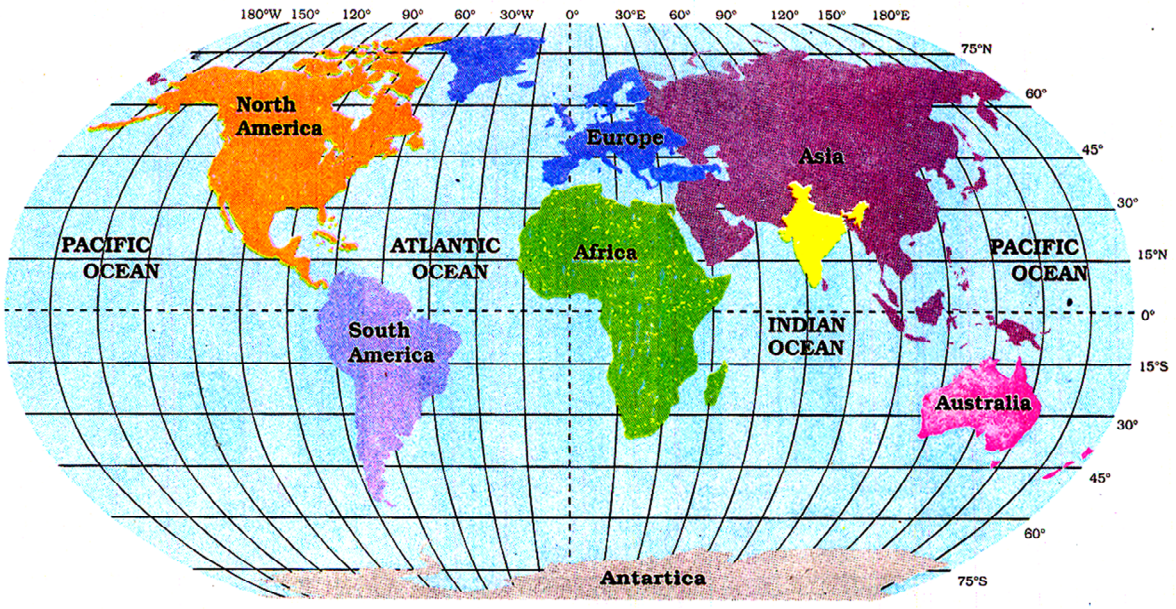
- Location
- Size
- India and the World
- India's Neighbours
- Some Interesting Facts

Location

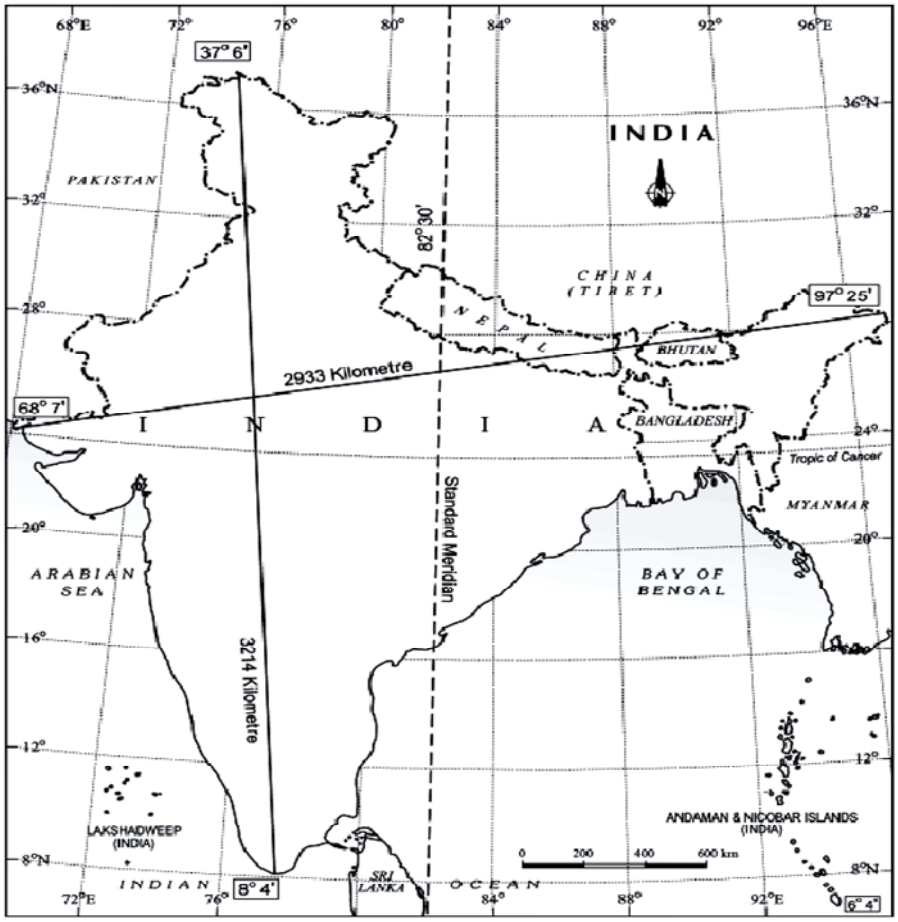
India is a vast country. Lying entirely in the Northern hemisphere the main land extends between latitudes 8° 4' N and 37° 6' N and longitudes 68° 7' E and 97° 25' E. The Tropic of Cancer (23° 30' N) divides the country into almost two equal parts. To the southeast and southwest of the mainland, lie 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.

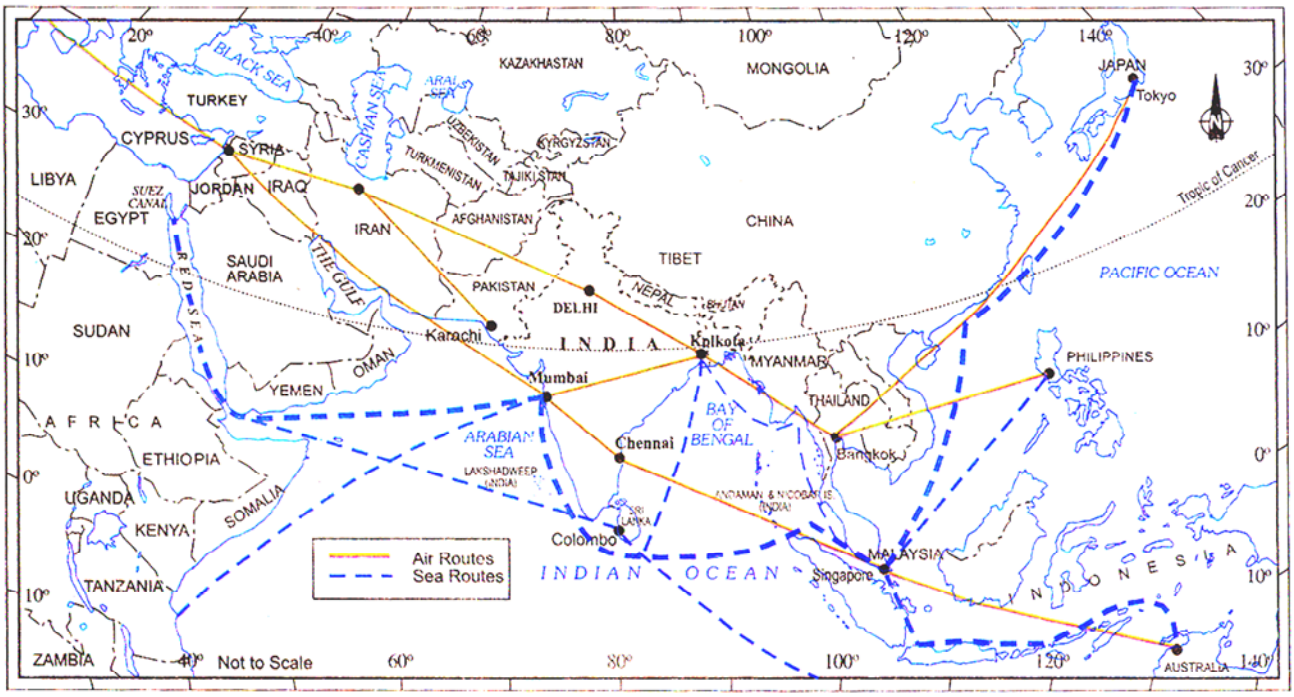
(2) The oil rich countries of the Persian Gulf are not far from us. We receive bulk of our supplies from them.

(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.

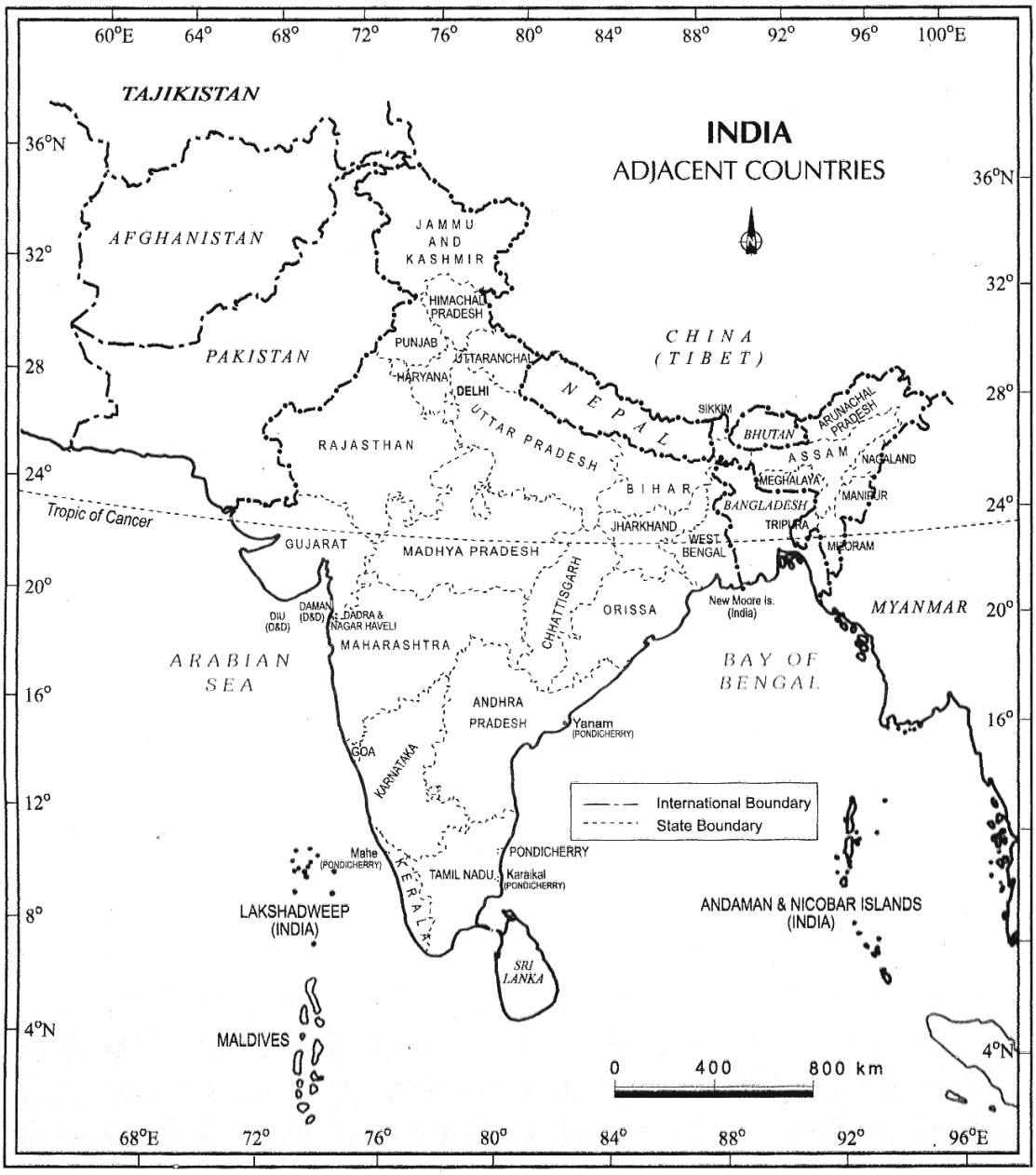
(3) The spices, muslin and other Indian goods were taken to different countries.

(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.

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 What is the longitudinal extent of our country ? State its significance.

Q.8 Account for the two hours time difference between the two eastern and western extremities of India.

Q.9 Give an account of India's size ?

Q.10 What is sub continent ? Name the countries which constitute the Indian sub continent ?

Q.11 Explain why Ahmedabad and Kolkata are able to see the noon sun exactly overhead in a year but not Delhi.

Q.12 The centre location of India at the head of the Indian occan is considered of great significance. Why ?

Q.13 What are the implications of India's latitudinal extent ?

Q.14 How far is Arunachal Pradesh befitting name for our easternmost state?

Q.15 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.16 Why do we need a standard meridian for India ? Explain ?

Q.17 What do you know about the situation of India ? How has it helped her in attaining an important place in the world market.

Q.18 Give an account of India's contact with the outside world.

Q.19 What are the implications of Tropic of Cancer ?

Q.20 Describe the trade relation of India in ancient time.

➢ Map Based Questions

Q.1 On the map of India, locate and label the following with appropriate symbols.
(i) A state in the Eastern region of India bordering three countries, but not bordering China.
(ii) The strait separating India from Sri Lanka

Q.2 On the map of India, locate and label the following with appropriate symbols.
(i) Tropic of Cancer.
(ii) The Southern most point of the mainland of India.

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

EXERCISE-3

Q.1 Which state of India does not have common boundary with Myanmar?
[M.P.-NTSE Stage-1/2013]
(A) Meghalaya (B) Tripura
(C) Nagaland (D) Manipur

Q.2 Which of the following countries is not in Indian sub-continent?
[M.P.-NTSE Stage-1/2013]
(A) Maldives (B) Pakistan
(C) Bangladesh (D) Nepal

Q.3 Area wise what is the position of India in the world **[M.P.-NTSE Stage-1/2013]**
(A) Third (B) Fourth
(C) Sixth (D) Seventh

Q.4 The Meridian Line for Indian standard time is **[M.P.-NTSE Stage-1/2013]**
(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?
[Haryana-NTSE Stage-1/2013]
(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.
[Chandigrah-NTSE Stage-1/2013]
(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. **[Chandigrah-NTSE Stage-1/2013]**
(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?
[Karnataka-NTSE Stage-1/2013]
(A) Mumbai (B) Simla
(C) Ahmedabad (D) Bhopal

Q.9 Tropic of Cancer does not pass through which of the following states –
[Punjab-NTSE Stage-1/2013]
(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?
[Punjab-NTSE Stage-1/2013]
(A) 20ºN (B) 45ºN
(C) 20ºS (D) 45ºS

Q.11 The southern most point of India is -
[Uttar Pradesh-NTSE Stage-1/2014]
(A) Kanya Kumari (B) Indira Point
(C) Point Calimer (D) Rameshwaram

Q.12 Which one of the following states has the longest coast line -
[Uttar Pradesh-NTSE Stage-1/2014]
(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 :
[Chhattisgarh-NTSE Stage-1/2014]
(A) Lakshyadweep
(B) Andman-Nicobar islands
(C) Maldives
(D) Minicoy dweep

Q.14 Which line of axis divides India into two parts? **[Chhattisgarh-NTSE Stage1/2014]**
(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?
[Chandigragh-NTSE Stage1/2014]
(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?
[Gujarat-NTSE Stage-1/2014]
(A) Saudi Arabia (B) Egypt
(C) Myanmar (D) Australia

Q.17 From where does 0º Longitude - Greenwich line passes?
[Gujarat-NTSE Stage-1/2014]
(A) France-Japan (B) Germany
(C) England (D) Brazil

Q.18 In India the Tropic of Cancer touches how many states?
[West Bengal-NTSE Stage-1/2014]
(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 **[West Bengal-NTSE Stage-1/2014]**
(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 **[Rajasthan-NTSE Stage-1/2015]**
(A) Bihar (B) Orissa
(C) Jharkhand (D) Uttar Pradesh

Q.21 Which of the following is correct about the Konkan coastal plain?
[Punjab-NTSE Stage-1/2015]
(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?
[Punjab-NTSE Stage-1/2015]
(A) 3293 kilometers (B) 2933 kilometers
(C) 2393 kilometers (D) 2923 kilometers

Q.23 How many islands are there in Andaman and Nicobar Islands?
[M.P.-NTSE Stage-1/2015]
(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.
[NTSE-Stage-2/2016]
(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?
[NTSE-Stage-2/2016]
(A) Only Malwa
(B) Only Chotanagpur
(C) Only Maghalaya
(D) Both Malwa and Chotanagar

Q.26 Approximately how much is land boundary of India ?
[Raj.-NTSE Stage-1/2017]
(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 :
[Raj.-NTSE Stage-1/2018]

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			

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.

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