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CHAPTER

1 Mechanics

Physical Quantities

Those quantities which can describe the laws of physics and possible to measure are called physical quantities.

The physical quantities which do not depend upon other physical quantities are called ***fundamental quantities***.

In Standard International (**S.I.**) system the fundamental quantities are mass, length, time, temperature, luminous intensity, electric current and amount of substance.

The physical quantities which depend on fundamental quantities are called ***derived quantities*** e.g. speed, acceleration, force, etc.

Units

The ***unit*** *of a physical quantity is the reference standard used to measure it.*

Types of Units

1. Fundamental Units

The units defined for the fundamental quantities are called fundamental or base units.

Fundamental Physical quantity	Mass (M)	Length (L)	Time (T)	Temperature (θ or K)	Electric current (I)	Luminous intensity	Amount of substance
Fundamental unit	kilogram (kg)	metre (m)	second (s)	kelvin (K)	ampere (A)	Candela (Cd)	mole (mol)

2. Derived Units

The units defined for the derived quantities are called derived units. e.g. unit of speed or velocity (metre per second), acceleration (metre per second^2) etc.

Dimensions

The limit of a derived quantity in terms of necessary basic units is called dimensional formula and the raised powers on the basic units are ***dimensions***.

S. No.	Physical Quantity	Formula	Dimensional Formula	SI Unit
1.	Area	Length × breadth	$L \times L = L^2 = M^0L^2T^0$	m^2
2.	Volume	Length × breadth × height	$L \times L \times L = L^3 = M^0L^3T^0$	m^3
3.	Density	Mass/volume	$M/L^3 = ML^{-3}T^0$	kg/m^3
4.	Speed or velocity	Distance/time	$L/T = M^0LT^{-1}$	m/s
5.	Linear momentum	Mass × velocity	MLT^{-1}	kg m/s
6.	Acceleration	$\frac{\text{Change in velocity}}{\text{time}}$	$\frac{LT^{-1}}{T} = M^0LT^{-2}$	m/s^2
7.	Force	Mass × acceleration	MLT^{-2}	newton (N)
8.	Impulse	Force × time	$MLT^{-2} \times T = MLT^{-1}$	Ns
9.	Pressure	Force/area	$MLT^{-2}/L^2 = ML^{-1}T^{-2}$	N/m^2
10.	Work	Force × displacement	$MLT^{-2} \times L = ML^2T^{-2}$	joule (J)
11.	Energy	mgh or $\frac{1}{2}mv^2$	ML^2T^{-2}	J
12.	Power	Work/time	$ML^2T^{-2}/T = ML^2T^{-3}$	watt (W)
13.	Moment of force	Force × distance	$MLT^{-2} \times L = ML^2T^{-2}$	N-m
14.	Universal gravitational constant	$G = \frac{Fr^2}{m_1m_2}$	$G = \frac{MLT^{-2} \times L^2}{M^2} = M^{-1}L^3T^{-2}$	Nm^2/kg^2
15.	Surface tension	Force/length	$MLT^{-2}/L = ML^0T^{-2}$	N/m
16.	Surface energy	Energy/area	$ML^2T^{-2}/L^2 = ML^0T^{-2}$	J/m^2

17.	Thrust, Tension	Force	MLT^{-2}	newton (N)
18.	Stress	Force/area	$MLT^{-2}/L^2 = ML^{-1}T^{-2}$	N/m^2
19.	Strain	$\frac{\text{Change in configuratrion}}{\text{Initial configuration}}$	$M^0L^0T^0$ (dimensionless)	No unit
20.	Modulus of elasticity	Stress/strain	$ML^{-1}T^{-2}$	N/m^2
21.	Radius of gyration	Length	M^0LT^0	m
22.	Moment of inertia	Mass × (distance)^2	ML^2T^0	kg m^2
23.	Angle	Length/radius	$M^0L^0T^0$	radian
24.	Angular velocity	$\frac{\text{Angular displacement}}{\text{Time}}$	$\frac{1}{T} = M^0L^0T^{-1}$	rad/s
25.	Angular acceleration	$\frac{\text{Angular velocity}}{\text{Time}}$	$\frac{M^0L^0T^{-1}}{T} = M^0L^0T^{-2}$	rad/s^2
26.	Angular momentum	Moment of inertia × angular velocity	ML^2T^{-1}	kg m^2/s
27.	Torque	Moment of inertia × angular acceleration	ML^2T^{-2}	N-m
28.	Wavelength	Length	M^0LT^0	m
29.	Frequency	No. of vibrations/s	$\frac{1}{T} = M^0L^0T^{-1}$	s^{-1}
30.	Velocity gradient	Velocity/distance	$\frac{LT^{-1}}{L} = M^0L^0T^{-1}$	s^{-1}

Rounding Off

Rules of Rounding off uncertain Digits

(a) The preceding digit is raised by 1 if the uncertain digit to be dropped is more than 5 and is left unchanged if the latter is less than 5.

Example : $x = 5.68\underline{6}$ is rounded off to 5.69 (as $6 > 5$)

$x = 3.46\underline{2}$ is rounded off to 3.46 (as $2 < 5$)

(b) If the uncertain digit to be dropped is 5, the preceeding digit raised by 1 if it is odd and is left unchanged if it is even digit.

Example : 7.735 is rounded off to three significant figures becomes 7.74 as preceeding digit is odd.

7.745 is rounded off to 7.74 as preceeding digit is even.

Path Length or Distance

The length of the actual path between initial and final positions of a particle in a given interval of time is called distance covered by the particle.

Displacement

The shortest distance from the initial position to the final position of the particle is called displacement.

Comparative Study of Displacement and Distance

S. No.	Displacement	Distance
1	It has single value between two points.	It may have more than one value between two points.
2	May be +ive, –ive or zero.	It is always > 0 (+ive)
3	It can decrease with time.	It can never decrease with time.
4	It is a vector quantity	It is a scalar quantity.

Speed and Velocity

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

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

$$\text{Instantaneous speed} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

$$\textit{Velocity} = \frac{\textit{Displacement}}{\textit{Time interval}}$$

$$\textit{Average velocity} = \frac{\textit{Displacement}}{\textit{Total time taken}}$$

$$\textit{Instantaneous velocity } \vec{V} = \underset{\Delta t \to 0}{Lt} \frac{\Delta \vec{x}}{\Delta t} = \frac{d\vec{x}}{dt}$$

Acceleration

$$\textit{Acceleration } (\vec{a}) = \frac{\textit{Change in velocity}}{\textit{Time interval}} = \frac{\vec{v}' - \vec{v}}{t' - t}$$

$$\textit{Average acceleration} = \frac{\textit{Total change in velocity}}{\textit{Total time taken}}$$

$$\vec{a}_{inst} = \lim_{\Delta t \to 0} \frac{\Delta \vec{v}}{\Delta t} = \frac{d\vec{v}}{dt}$$

Kinematic Equations for Uniformly Accelerated Motion

Motion under uniform acceleration is described by the following equations.

$$v = u + at\,; \quad s = ut + \frac{1}{2}at^2 \quad \text{and} \quad v^2 = u^2 + 2as$$

Distance Travelled in n^{th} Second of Uniformly Accelerated Motion

$$S_{n^{th}} = S_n - S_{n-1} = (u\,n + \frac{1}{2}\,a\,n^2) - [u(n-1) + \frac{1}{2}\,a(n-1)^2$$

So, $\boxed{S_{n^{th}} = u + \frac{a}{2}(2n-1)}$

Relative Velocity

If $\vec{v}_A$ and $\vec{v}_B$ be the respective velocities of object A and B then relative velocity of A w r.t. B is

$$\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$$

Similarly, relative velocity of B w r.t. A is

$$\vec{v}_{BA} = \vec{v}_B - \vec{v}_A$$

Scalars and Vectors

The physical quantities which require only magnitude to express, are called ***scalar quantities.*** **Ex.** Mass, distance, time, speed, volume, density, pressure, work, energy, power, charge, electric current, temperature, potential, specific heat, frequency, etc. Certain *physicsl quantities have both magnitude and direction, they are called* ***vector quantities.*** **Ex.** Displacement, velocity, acceleration, force, momentum, impulse, electric field, magnetic field, current density, etc.

Cross Product or Vector Product of Two Vectors

Cross product of $\vec{A}$ and $\vec{B}$ inclined to each other at an angle θ is defined as :

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

$\hat{n} \perp$ to plane of $\vec{A}$ and $\vec{B}$.

The vector product of unit orthogonal vectors $\hat{i}$, $\hat{j}$ and $\hat{k}$ have the following relations in the right-handed coordinate system.

(a) $\hat{i} \times \hat{j} = \hat{k}$ $\quad \hat{j} \times \hat{i} = -\hat{k}$

$\hat{j} \times \hat{k} = \hat{i}$ $\quad \hat{k} \times \hat{j} = -\hat{i}$

$\hat{k} \times \hat{i} = \hat{j}$ $\quad \hat{i} \times \hat{k} = -\hat{j}$

(b) $\hat{i} \times \hat{i} = 0 \quad \hat{j} \times \hat{j} = 0 \quad \hat{k} \times \hat{k} = 0$

Scalar Product or Dot Product of Two Vectors

If θ is the angle between $\vec{A}$ and $\vec{B}$.

Then $A\,(B\cos\theta) = \vec{A} \cdot \vec{B}$, A and B are the magnitudes of vectors $\vec{A}$ and $\vec{B}$.

$$\hat{i} \cdot \hat{j} = 0,\ \hat{j} \cdot \hat{k} = 0,\ \hat{k} \cdot \hat{i} = 0$$
$$\hat{i} \cdot \hat{i} = 1,\ \hat{j} \cdot \hat{j} = 1,\ \hat{k} \cdot \hat{k} = 1$$

Newton's Laws of Motion

1st law : *Every body continues to be in its state of rest or of uniform motion in a straight line unless compelled by an external force to change its state.* This fundamental property of the body is called **inertia**. This law is known as Newton's first law of motion or law of inertia.

Inertia

Inertia is the property of a body due to which it opposes the change in its state. Inertia of a body is measured by mass of the body. It is directly proportional to the mass of the body
i.e., Inertia ∝ mass.

Momentum

The linear momentum of a body $(\vec{p})$ is defined as the product of the mass of the body (m) and its velocity $(\vec{v})$. i.e., $\vec{p} = m\vec{v}$.

Relation between momentum and kinetic energy :
Consider a body of mass m moving with velocity v. Linear momentum of the body, $p = mv$.
KE of a particle can be expressed as

$$E = \frac{p^2}{2m} \quad \text{and} \quad p = \sqrt{2mE}$$

2nd law : *The rate of change of momentum of a body is directly proportional to the unbalanced external force applied on it.*

i.e., $\vec{F} \propto \frac{d\vec{p}}{dt}$ or, $\vec{F} = k\frac{d\vec{p}}{dt}$

or $\vec{F} = m\vec{a}$

Impulse :
If a large force acts on a body or particle for a smaller time, then impulse = product of force and time.

$$Impulse = \vec{F}\,\Delta t$$

3rd law : According to this law, *every action has equal and opposite reaction*. Action and reaction act on two different bodies and they are simultaneous. There can be no reaction without action.

Law of Conservation of Linear Momentum

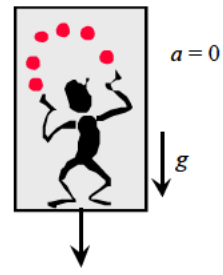
If the total external force acting on a system is equal to zero, then the final value of the total momentum of the system is equal to the initial value of the total momentum of the system.

$$\vec{p} = \text{constant} \quad \text{or} \quad \vec{p}_f = \vec{p}_i$$

Motion in a Lift

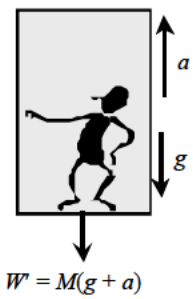
Let a man of weight $W = Mg$ be standing in a lift.

Case (a) : If the lift is moving with constant velocity v upwards or downwards.



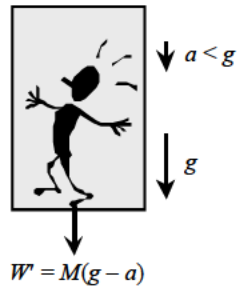
In this case there is no accelerated motion hence no pseudo force experienced by observer 'O' inside the lift.
So apparent weight, W' = actual weight W

Case (b) : If the lift is accelerated i.e., a = constant and in upward direction.



Then net forces acting on the man are
(i) weight $W = Mg$ downward
(ii) fictitious force $F_0 = Ma$ downward.
So apparent weight,
$W' = W + F_0 = Mg + Ma = M(g + a)$

Case (c) : If the lift is accelerated downward with acceleration $a < g$:



The fictitious force $F_0 = Ma$ acts upward while weight of a man $W = Mg$ always acts downward, therefore apparent weight, $W' = W + F_0 = Mg - Ma = M(g - a)$

Friction

Whenever a body moves or tends to move over the surface of another body, a force comes into play which acts parallel to the surface of contact and opposes the relative motion. This opposing force is called friction.

Laws of Limiting Friction

(i) It depends on the nature of the surfaces in contact and their state of polish.

(ii) It acts tangential to the two surfaces in contact and in a direction opposite to the direction of motion of the body.

(iii) The value of limiting friction is independent of the area of the surface in contact so long as the normal reaction remains the same.

(iv) The limiting friction ($f_{s\,max}$) is directly proportional to the normal reaction R between the two surfaces.

i.e., $f_{s\,max} \propto R$ or $f_{s\,max} \propto \mu_s R$

or $\mu_s = \dfrac{f_{s\,max}}{R} = \dfrac{\text{Limiting friction}}{\text{Normal reaction}}$

Centripetal force

The force directed towards the centre required for traversing a circular path is called centripetal force.

$$Centripetal\ force = F = \frac{mv^2}{r} = m\omega^2 r .$$

Motion of car on banked road.

- In a banked path with curvature (θ) with friction, the safe velocity is given by
  $v = \sqrt{[rg(\tan\theta + \mu)/(1 - \mu\tan\theta)]}$.
- The angle of banking, if small, is h/d where h- height to which outer edge of the road is raised and d- width of the road, $h/d = v^2/rg$, since for small angle, $\tan\theta = v^2/rg$.

  Bending of cyclist : In order to take a circular turn of radius r with speed v, the cyclist should bend himself through an angle θ from the vertical such that

$$\tan\theta = \frac{v^2}{rg}$$

Work

Work done by a force on a body is defined as *the product of force and the displacement of the body in the direction of force*. SI unit of work is joule.

Work done (W) by a constant force ($\vec{F}$) producing a displacement ($\vec{S}$) is

$W = \vec{F}.\vec{S} = FS\cos\theta$ where θ is the angle between $\vec{F}$ and $\vec{S}$.

Work done by a variable force $= \int_{x_1}^{x_2} F dx$, where $F = f(x)$ and x_1 and x_2 are initial and final positions.

Work done by a stretched spring $= W = \int kx\,dx = \frac{1}{2}kx^2$.

Power

Where k is spring constant.

Power is the rate of doing work.

$$\text{Power} = P = \frac{dW}{dt} = \frac{\vec{F}.d\vec{S}}{dt} = \vec{F}.\vec{v}$$

$$= Fv\cos\theta \quad \left[\because \quad \vec{v} = \frac{d\vec{S}}{dt}\right]$$

where θ is the angle between $\vec{F}$ and $\vec{v}$.

Its SI unit is watt.

1 Horse power [1HP] = 746 W, 1calorie = 4.2J and 1 kW h = 3.6×10^6 J

Energy

Energy is the capacity of doing work. It is also a scalar quantity. The SI unit is joule.

Work-energy theorem states that *the work done on a body is equal to the change in its kinetic energy*.

Kinetic energy : K.E. is the energy possessed by the body due to its motion.

$$\text{K.E.} = \frac{1}{2}mv^2$$

where v is the velocity of the body

$$\text{K.E. of rotation motion} = \frac{1}{2}I\omega^2$$

Potential energy : P.E. is the energy possessed by the body due to its position or shape.

Gravitational P.E. = mgh (due to change in position)

or $\text{P.E.} = \frac{1}{2}kx^2$ (due to change in shape). k is spring constant.

Law of conservation of energy states that energy can neither be created nor be destroyed but it can be transformed from one form to another.

Mass-energy equivalence: According to this theorem mass and energy are inter-convertible.

$$E = mc^2.$$

where $c = 3 \times 10^8\ ms^{-1}$ is velocity of light in vaccum or air.

Collision

If the path of a body is affected by another body when two bodies physically come in contact, then collision is said to have taken place.

Elastic collision: Both momentum and K.E. are conserved.

For elastic collision in one dimension,

Inelastic collision: Only momentum is conserved.

Coefficient of restitution is defined as *the ratio of velocity of separation to the velocity of approach*.

$$\text{Coefficient of restitution} = e = \frac{v_2 - v_1}{u_1 - u_2}$$

$e = 1$ for perfectly elastic collision

$e = 0$ for perfectly inelastic collision

Centre of Mass

It is an imaginary point at which the whole mass of a body is supposed to be concentrated.

Characteristics of centre of mass:

(i) It need not hold mass physically, e.g. for a hollow sphere, centre of mass is at the geometrical centre of the sphere although there is no mass present physically at the centre.

(ii) Location of centre of mass depends on the distribution of masses and their individual location. For regular geometrical shaped bodies, having uniform distribution of mass, the centre of mass is located at their centres.

(iii) When no external force acts on a body, centre of mass has constant velocity and constant angular momentum. Acceleration is zero.

If C.M. is the origin, then $\sum_{i=1}^{n} M_i \vec{r}_i = 0.$

Torque and Angular Momentum

Torque is the moment of force. It is the cross product of the force with the perpendicular distance between the axis of rotation and the point of application of force with the force.

Torque = $\vec{\tau} = \vec{r} \times \vec{F}$; S.I. unit is N – m

Angular momentum is the moment of linear momentum. It is also the product of the linear momentum and the perpendicular distance of the mass from the axis of rotation.

$\vec{\tau} = \vec{r} \times \vec{p}$ where $\vec{r}$ = position relative to origin $\vec{p}$ = linear momentum at position.

Angular momentum = $L = \vec{r} \times \vec{p}$: S.I unit kg m^2/s

Relation between torque and angular momentum,

$$\vec{\tau} = \frac{d\vec{L}}{dt}$$

Moment of Inertia

It is equivalent to mass in rotational motion. It is defined as *the sum of the product* of *the constituent masses and the square of their perpendicular distances from the axis of rotation.*

For an *n*-particle system having mass points $m_1, m_2, m_3, ...$, m_n at perpendicular distances $r_1, r_2, ..., r_n$, moment of inertia,

$$I = m_1 r_1^2 + m_2 r_2^2 + ... + m_n r_n^2 = \sum_{i=1}^{n} m_i r_i^2$$

S.I. unit is kgm^2 and it is a scalar quantity.

Radius of Gyration

It is the root mean square of the perpendicular distances of the constituent masses. *It is the perpendicular distance of the point where the whole mass is concentrated form the axis of rotation.*

Radius of gyration $= k = \sqrt{\frac{r_1^2 + r_2^2 + ... + r_n^2}{n}}$

Moment of inertia $I = Mk^2$

Moment of inertia of various objects:

Name of the object	Axis	Moment of inertia
(a) Rod	(i) about an axis passing through its C.M. and $\perp$ to its length	$Ml^2/12$
	(ii) about an axis passing through one edge of the rod	$Ml^2/3$
(b) Ring	(i) about an axis passing through C.M & $\perp$ to its plane	MR^2
	(ii) about any diameter	$MR^2/2$
	(iii) about a tangent in the plane of the ring	$\frac{3}{2}MR^2$
	(iv) about a tangent $\perp$ to the plane of the ring	$2MR^2$
(c) Disc	(i) about an axis passing through C.M. and $\perp$ to its plane	$MR^2/2$
	(ii) about its diameter	$MR^2/4$
(d) Solid cylinder	about its axis	$MR^2/2$
(e) Hollow cylinder	about its axis	MR^2
(f) Hollow sphere	about its diameter	$\frac{2}{3}MR^2$
(g) Solid sphere	about its diameter	$\frac{2}{5}MR^2$

Gravitation

It is the force of attraction between any two bodies.

Newton's Universal Law of Gravitation: Every body in this universe attracts every other body with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

$$F \propto m_1 m_2 \text{ and } F \propto \frac{1}{r^2} \Rightarrow F \propto \frac{m_1 m_2}{r^2}$$

$$\therefore F = G\frac{m_1 m_2}{r^2}$$

G = Universal gravitational constant

$= 6.67 \times 10^{-11}$ Nm^2/kg^2

Acceleration due to gravity: The acceleration produced in a body due to gravitational force of the earth is called acceleration due to gravity (g).

$g = \frac{GM_e}{R_e^2}$ (on the surface of the earth); M_e = mass on the earth and R_e = radius of the earth.

Mass and density of the earth:

$M_e = \frac{g R_e^2}{G} = 6 \times 10^{24}$ kg, $R_e = 6400$ km;

Density = $\rho = \frac{3g}{4\pi R_e G} = 5.5 \times 10^3$ kg/m^3

Variation of 'g':

(a) With height: $g' = g\left(1 - \frac{2h}{R}\right)$ when h << R;

$g' = g\left(\frac{R}{R+h}\right)^2$ when $h \approx R$

$\therefore$ g decreases with height.

(b) With depth: $g' = g\left(1 - \frac{d}{R}\right)$ $\therefore$ g decreases with depth.

At the centre of the earth $d = R$, $g' = 0$

(c) Effect of latitude:

$g' = g - R\omega^2 \cos^2\theta$

where $\theta \rightarrow$ latitude of the point

$\omega \rightarrow$ angular velocity of the earth.

(d) Effect of the shape of the earth:

The equatorial radius is 21 km (approx) greater than the polar radius.

$\because$ $g \propto \frac{1}{R^2}$ $\therefore$ g increases from equator to poles.

i.e., g is maximum at poles and least (zero) at equator.

Gravitational Potential

Gravitational Potential : Gravitational potential at a point in a gravitational field is defined as *the work done in taking a unit mass from infinity to the point*.

Gravitational potential = $V = \frac{-GM}{r}$

Gravitational P.E. = Gravitational potential

$\times$ mass of the object = $-\frac{GMm}{r}$

Escape Speed

Minimum speed required to escape the earth's gravitational pull.

$v_e = \sqrt{2gR} = \sqrt{2} \times v_o$ (For earth $v_e = 11.2$ km/s)

where v_0 = oribital speed

Satellite

It is a heavenly body or an artificial object which revolves round a planet in a particular orbit. The required centripetal force is provided by the gravitational force. Kepler's laws of planetary motion are applicable to them.

(a) Orbital velocity of a satellite: Velocity with which the satellite orbits around the planet.

$v_o = \sqrt{\frac{GM}{R+h}}$

$h \rightarrow$ height of the orbit from the surface of the planet;

$R \rightarrow$ Radius of the planet.

If $h << R$ $v_o = \sqrt{\frac{GM}{R}} = \sqrt{gR}$

(b) Time period of a satellite: Time taken by it to complete one revolution around the planet.

$T = \sqrt{\frac{3\pi(R+h)^3}{G\rho R^3}} = \frac{2\pi}{R}\sqrt{\frac{(R+h)^3}{g}}$

where $\rho \rightarrow$ mean density of the planet;

For $h << R$; $T = \sqrt{\frac{3\pi}{G\rho}}$

(c) Height of a satellite above the surface of the planet:

$H = \left(\frac{T^2R^2g}{4\pi^2}\right)^{1/3} - R$

(d) "Total energy of a satellite orbiting on a circular path is negative" with potential energy being negative but twice as the magnitude of positive kinetic energy.

(e) Binding energy of a satellite is the energy required to remove it from its orbit to infinity.

B.E. = $\frac{GMm}{2r}$ No energy is required to keep the satellite in its orbit.

Geostationary satellites : The satellites in a circular orbit around the earth in the equatorial plane with a time period of 24 hours, appears to be fixed from any point on earth are called geostationary satellite.

For geostationary satellite, height above the earth's surface = 35800 km and orbital velocity = 3.1 km/s.

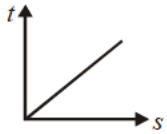
Polar Satellites : A satellite that revolves in a polar orbit along north-south direction while the earth rotates around its axis in east west direction.

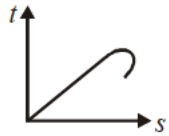
Weightlessness

A situation where the effective weight of the object becomes zero. An astronaut experiences weightlessness in space satellite because the astronaut as well as the satellite are in a free fall state towards the earth.

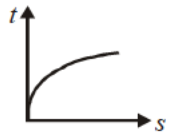
EXERCISE

1. Light year is
   (a) light emitted by the sun in one year.
   (b) time taken by light to travel from sun to earth.
   (c) the distance travelled by light in free space in one year.
   (d) time taken by earth to go once around the sun.
2. A passenger in a moving train tosses a coin. If the coin falls behind him, the train must be moving with
   (a) an acceleration (b) a deceleration
   (c) a uniform speed (d) any of the above
3. Watt–hour meter measures
   (a) current (b) voltage
   (c) power (d) electric energy
4. Which of the following time-displacement graph is not possible in nature?

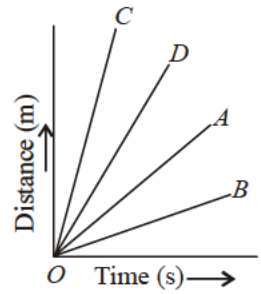
   (a) 

   (b) 

   (c) 

   (d) 

5. A car is moving on a road and rain is falling vertically. Select the correct answer.
   (a) The rain will strike the wind screen only
   (b) The rain will strike the front screen only
   (c) The rain will strike both the screens
   (d) The rain will not strike any of the screens
6. SI unit of pressure is
   (a) atmosphere (b) bar
   (c) pascal (d) mm of Hg
7. Dimensions of impulse are
   (a) $[MLT^{-1}]$ (b) $[MLT^{2}]$
   (c) $[MT^{-2}]$ (d) $[ML^{-1}T^{-3}]$
8. ML^2T^{-2} are dimensions of
   (a) force (b) moment of force
   (c) momentum (d) power
9. The number of significant figures in 0.00060 m is
   (a) 1 (b) 2
   (c) 3 (d) 4
10. A particle is moving in a circular path of radius r. The displacement after half a circle would be
    (a) zero (b) πr
    (c) 2r (d) 2πr
11. The numerical ratio of average velocity to average speed is
    (a) always less than one (b) always equal to one
    (c) always more than one (d) equal to or less than one
12. A vector quantity is a physical quantity which needs
    (a) magnitude (b) direction
    (c) both (a) and (b) (d) time
13. Which of the following are examples of uniform velocity?
    (a) Motion of moon around earth
    (b) Motion of planet around sun
    (c) Motion of car on crowded road
    (d) Motion of a moving fan
14. A person swims in a river aiming to reach exactly on the opposite point on the bank of a river. His speed of swimming is 0.5 m/s at an angle of 120° with the direction of flow of water. The speed of water is
    (a) 1.0 m/s (b) 0.5 m/s
    (c) 0.25 m/s (d) 0.43 m/s
15. When a body is stationary
    (a) there is no force acting on it
    (b) the force acting on it not in contact with it
    (c) the combination of forces acting on it balances each other
    (d) the body is in vacuum
16. Four cars *A*, *B*, *C* and *D* are moving on a levelled road. Their distance versus time graphs are shown in figure. Choose the correct statement.



    (a) Car *A* is faster than car *D*
    (b) Car *B* is the slowest.
    (c) Car *C* is faster than car *D*.
    (d) Car *C* is the lowest.
17. A man getting down a running bus, falls forward because
    (a) due to inertia of rest, road is left behind and man reaches forward
    (b) due to inertia of motion upper part of body continues to be in motion in forward direction while feet come to rest as soon as they touch the road
    (c) he leans forward as a matter of habit
    (d) of the combined effect of all the three factors stated in (a), (b) and (c)
18. The relative velocity v_{AB} or v_{BA} of two bodies *A* and *B* may be
    (1) greater than velocity of body *A*
    (2) greater than velocity of body *B*
    (3) less than the velocity of body *A*
    (4) less than the velocity of body *B*
    (a) (1) and (2) only
    (b) (3) and (4) only
    (c) (1), (2) and (3) only
    (d) (1), (2), (3) and (4).

19. A parrot is sitting on the floor of a closed glass cage which is in a boy's hand. If the parrot starts flying with a constant speed, the boy will feel the weight of the cage as
(a) unchanged (b) reduced
(c) increased (d) nothing can be said

20. A cannon after firing recoils due to
(a) conservation of energy
(b) backward thrust of gases produced
(c) Newton's third law of motion
(d) Newton's first law of motion

21. The force exerted by the floor of an elevator on the foot of a person standing there, is more than his weight, if the elevator is
(a) going down and slowing down
(b) going up and speeding up
(c) going up and slowing down
(d) either (a) or (b)

22. Consider an elevator moving downwards with an acceleration a, the force exerted by a passenger of mass m on the floor of the elevator is
(a) ma (b) $ma - mg$
(c) $mg - ma$ (d) $mg + ma$

23. A large truck and a car, both moving with a velocity of same magnitude have a head-on-collision. Car suffers more damage than the truck. This is because
(a) the material used in car is inferior than the material used in truck.
(b) car experience the greater force of impact than the truck.
(c) momentum transferred to the truck is greater than the momentum transferred to the car.
(d) momentum transferred to the car is greater than the momentum transferred to the truck.

24. Frictional force
(a) always acts opposite to the direction of motion
(b) always acts in the direction of motion
(c) may act in the direction of motion
(d) always acts perpendicular to the direction of motion

25. A coin is placed on a rotating disc and is stationary w r.t. the disc, then the direction of friction is
(a) along the direction of motion of the coin w.r.t. ground
(b) opposite to the direction of motion of the coin w.r.t. ground
(c) towards the centre of the disc
(d) away from the centre of the disc

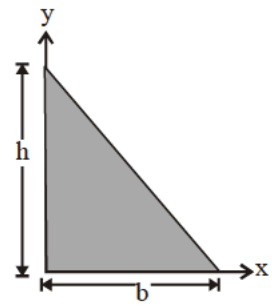
26. A monkey is climbing up a rope, then the tension in the rope
(a) must be equal to the force applied by the monkey on the rope.
(b) must be less than the force applied by the monkey on the rope.
(c) must be greater than the force applied by the monkey on the rope.
(d) may be equal to, less than or greater the force applied by the monkey on the rope.

27. Which of the following is NOT an illustration of Newton's third law ?
(a) Flight of a jet plane
(b) A cricket player lowering his hands while catching a cricket ball
(c) Walking on floor
(d) Rebounding of a rubber ball

28. Swimming is possible on account of
(a) first law of motion
(b) second law of motion
(c) third law of motion
(d) Newton's law of gravitation

29. 1 kilowatt hour is equal to
(a) 1 joule (b) 100 joule
(c) 36 joule (d) 3.6×10^3 kilo joule

30. The centre of mass of triangle shown in figure has coordinates



(a) $x = \frac{h}{2}, y = \frac{b}{2}$ (b) $x = \frac{b}{2}, y = \frac{h}{2}$
(c) $x = \frac{b}{3}, y = \frac{h}{3}$ (d) $x = \frac{h}{3}, y = \frac{b}{3}$

31. For a body falling freely under gravity from a height
(a) only the potential energy goes on increasing
(b) only the kinetic energy goes on increasing
(c) both kinetic energy as well as potential energy go on increasing
(d) the kinetic energy goes on increasing while potential energy goes on decreasing

32. A jet plane moves up in air because
(a) the gravity does not act on bodies moving with high speeds
(b) the thrust of the jet compensates for the force of gravity
(c) the flow of air around the wings causes an upward force, which compensates for the force of gravity
(d) the weight of air whose volume is equal to the volume of the plane is more than the weight of the plane

33. In an explosion, a body breaks up into two pieces of unequal masses. In this
(a) both parts will have numerically equal momentum
(b) lighter part will have more momentum
(c) heavier part will have more momentum
(d) both parts will have equal kinetic energy

34. For inelastic collision between two spherical rigid bodies
(a) the total kinetic energy is conserved
(b) the total mechanical energy is not conserved
(c) the linear momentum is not conserved
(d) the linear momentum is conserved

35. If a running boy jumps on a rotating table, which of the following is conserved?
(a) Linear momentum (b) KE
(c) Angular momentum (d) None of these

36. A gymnast takes turns with her arms and legs stretched. When she pulls her arms and legs
(a) the angular velocity decreases
(b) the moment of inertia decreases
(c) the angular velocity stays constant
(d) the angular momentum increases

37. Two bodies A and B have masses M and m respectively where $M > m$ and they are at a distance d apart. Equal force is applied to them so that they approach each other. The position where they hit each other is
(a) nearer to B
(b) nearer to A
(c) at equal distance from A and B
(d) cannot be determined

38. When a steady torque is acting on a body, the body
(a) continues in its state of rest or uniform motion along a straight line
(b) gets linear acceleration
(c) gets angular acceleration
(d) rotates at a constant speed

39. A couple produces a
(a) pure linear motion
(b) pure rotational motion
(c) no motion.
(d) both linear and rotational motion

40. A balloon filled with CO_2 released on earth would (neglect viscosity of air)
(a) climb with an acceleration 9.8 m/s^2
(b) fall with an acceleration 9.8 m/s^2
(c) fall with a constant acceleration 3.4 m/s^2
(d) fall with acceleration and then would attain a constant velocity

41. When a satellite is in the synchronous orbit above the equator, it stays in one place with reference to the earth by making each revolution in just the same time as it takes the earth to rotate once. What is the altitude of the synchronous orbit?
(a) 20000 km (b) 30000 km
(c) 32500 km (d) 36000 km

42. If the earth stops rotating about its axis, the acceleration due to gravity will remain unchanged at
(a) equator (b) latitude 45°
(c) latitutde 60° (d) poles

43. Time period of a simple pendulum inside a satellite orbiting earth is
(a) zero (b) ∞
(c) T (d) 2 T

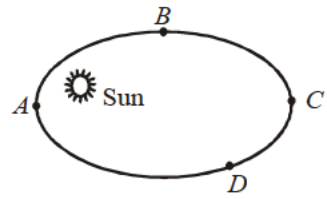
44. The escape velocity of a body depends upon mass as
(a) m^0 (b) m^1
(c) m^2 (d) m^3

45. There is no atmosphere on the moon because
(a) it is closer to the earth and also it has the inactive inert gases in it.
(b) it is too for from the sun and has very low pressure in its outer surface.
(c) escape velocity of gas molecules is greater than their root mean square velocity.
(d) escape velocity of gas molecules is less than their root mean square velocity.

46. A missile is launched with a velocity less than escape velocity. The sum of its kinetic and potential energies is
(a) zero
(b) negative
(c) positive
(d) may be positive, negative or zero

47. If the earth rotates faster than its present speed, the weight of an object will
(a) increase at the equator but remain unchaged at the poles
(b) decrease at the equator but remain unchanged at the poles
(c) remain unchaged at the equator but decrease at the poles
(d) remain unchanged at the equator but increase at the poles

48. The maximum kinetic energy of a planet moving around the sun is at a position
(a) A
(b) B
(c) C
(d) D



49. A man waves his arms while walking. This is to
(a) keep constant velocity
(b) ease the tension
(c) increase the velocity
(d) balance the effect of earth's gravity

50. A ball is dropped from a satellite revolving round the earth at a height of 120 km. The ball will
(a) continue to move with same speed along a straight line tangentially to the satellite at that time.
(b) continue to move with the same speed along the original orbit of satellite.
(c) fall down to earth gradually
(d) go far away in space

51. Two satellites of earth, S_1 and S_2 are moving in the same orbit. The mass of S_1 is four times the mass of S_2. Which one of the following statements is true?
(a) The potential energies of earth satellites in the two cases are equal.
(b) S_1 and S_2 are moving with the same speed.
(c) The kinetic energy of the two satellites are equal.
(d) The time period of S_1 is four times that of S_2.

52. If suddenly the gravitational force of attraction between the earth and a satellite revolving around it becomes zero, then the satellite will
(a) continue to move in its orbit with same speed
(b) move tangentially to the original orbit with same speed
(c) become stationary in its orbit
(d) move towards the earth

53. Which one of the following statements regarding artificial satellite of the earth is incorrect ?
(a) The orbital velocity depends on the mass of the satelllite
(b) A minimum velocity of 8 km/sec is required by a satellite to orbit quite close to the earth
(c) The period of revolution is large if the radius of its orbit is large
(d) The height of a geostationary satellite is about 36000 km from earth

54. Kepler's second law (law of area) is nothing but a statement of
(a) work energy theorem
(b) conservation of linear momentum
(c) conservation of angular momentum
(d) conservation of energy

55. A person sitting on a chair in a satellite feels weightless because
(a) the earth does not attract the objects in a satellite
(b) the normal force by the chair on the person balances the earth's attraction
(c) the normal force is zero
(d) the person in satellite is not accelerated

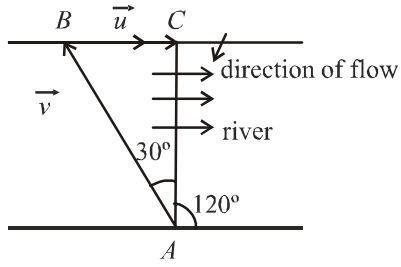
56. A hole is drilled through the earth along the diameter and a stone is dropped into it. When the stone is at the centre of earth, it possesses
(a) weight (b) mass
(c) acceleration (d) potential energy

ANSWER KEY											
1	(c)	**11**	(d)	**21**	(b)	**31**	(d)	**41**	(d)	**51**	(b)
2	(a)	**12**	(a, b)	**22**	(c)	**32**	(b)	**42**	(d)	**52**	(b)
3	(d)	**13**	(a, b)	**23**	(b, d)	**33**	(a)	**43**	(b)	**53**	(a)
4	(b)	**14**	(c)	**24**	(c)	**34**	(d)	**44**	(a)	**54**	(c)
5	(b)	**15**	(c)	**25**	(c)	**35**	(c)	**45**	(d)	**55**	(c)
6	(c)	**16**	(b, c)	**26**	(a)	**36**	(b)	**46**	(b)	**56**	(b)
7	(a)	**17**	(b)	**27**	(b)	**37**	(b)	**47**	(b)		
8	(b)	**18**	(d)	**28**	(c)	**38**	(c)	**48**	(a)		
9	(b)	**19**	(a)	**29**	(d)	**39**	(b)	**49**	(d)		
10	(c)	**20**	(c)	**30**	(c)	**40**	(c)	**50**	(b)		

HINTS AND SOLUTIONS

1. (c) 1 light year = speed of light in vacuum × no. of seconds in one year = $(3 \times 10^8) \times (365 \times 24 \times 60 \times 60)$ $= 9.467 \times 10^{15}$ m.
3. (d) W – hr is a unit of energy.
6. (c) 1 pascal = 1 N / m^2.
7. (a) Impulse = force × time = $MLT^{-2} \times T = [M^1LT^{-1}]$.
8. (b) Moment of force = $r \times F = [L]\,[MLT^{-2}] = [ML^2T^{-2}]$
9. (b) According to rules of significant figures.
11. (d) It is equal to or less than one.
14. (c) Here v = 0.5 m/sec. u = ?

So, $\sin\theta = \frac{u}{v} \Rightarrow \frac{u}{0.5} = \frac{1}{2}$ or $u = 0.25\ ms^{-1}$



18. (d) All options are correct :
(i) When two bodies A & B move in opposite directions then relative velocity between A & B either v_{AB} or v_{BA} both are greater than v_A & v_B.
(ii) When two bodies A & B move in parallel direction then $v_{AB} = v_A - v_B \Rightarrow v_{AB} < v_A$
$v_{BA} = v_B - v_A \Rightarrow v_{BA} < v_B$

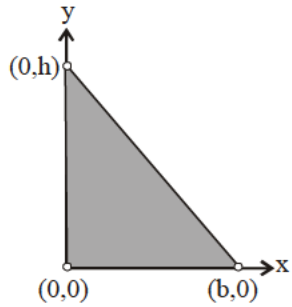
24. (c) Friction always apposes relative motion between surfaces in contact and hence can act in any direction to oppose the relative motion.
25. (c) Friction provides centripetal force to the coin, hence acts towards the centre of the disc.
27. (b) A cricketer lower his hands while catching a ball to increase the time so as to decrease the force exerted by the ball on cricketer's hands. This is not an example of Newton's third law of motion.
28. (c) When the swimmer push some water in backward direction, then he get some momentum in forward direction from water & starts to swim. This is according to Newton's third law. (action-reaction force).

30. (c) We can assume that three particles of equal mass m are placed at the corners of triangle

$\vec{r}_1 = 0\hat{i} + 0\hat{j}, \vec{r}_2 = b\hat{i} + 0\hat{j}$ and $\vec{r}_3 = 0\hat{i} + h\hat{j}$

$$\therefore \quad \overrightarrow{r_{cm}} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3}{m_1 + m_2 + m_3} = \frac{b}{3}\hat{i} + \frac{h}{3}\hat{j}$$

i.e. coordinates of centre of mass is $\left(\frac{b}{3}, \frac{h}{3}\right)$



32. (b) When jet plane flies, it ejects gases in backward direction at very high velocity. From Newton's third law, these gases provides the momentum to jet plane in forward direction plus compensates the force of gravity.

33. (a) Both part will have numerically equal momentum and lighter part will have more velocity.

34. (d) For inelastic collision between two spherical rigid bodies K.E. is not conserved as it is converted into other forms like heat, light sound etc. but total linear momentum is conserved.

35. (c) The boy does not exert a torque to rotating table by jumping, so angular momentum is conserved i.e.,

$$\frac{d\vec{L}}{dt} = 0 \Rightarrow \vec{L} = \text{constant.}$$

36. (b) Since no external torque act on gymnast, so angular momentum (L = Iw) is conserved. After pulling her arms & legs, the angular velocity increases but moment of inertia of gymnast, decreases in, such a way that angular momentum remains constant.

37. (b) As net external force on the system is zero therefore position of their centre of mass remains unaffected i.e. they will hit each other at the point of centre of mass. The centre of mass of the system lies nearer to A because $M_A > M_B$.

38. (c) $\tau = I\alpha$

39. (b) Two forces equal in magnitude but opposite in direction form a couple which tends to rotate the body.

40. (c) If B is upthrust of air on balloon, and a is downward acceleration, then

$$Mg - B = Ma$$

$$\Rightarrow \quad a = \frac{Mg - B}{M} = g - \frac{V\rho_{air}g}{V\rho_{CO_2}}$$

$$= \left(1 - \frac{V\rho_{air}}{V\rho_{CO_2}}\right)g = \left(1 - \frac{28.8}{44}\right) \times 9.8 \text{ m/s}^2$$

$$= 3.4 \text{ m/s}^2$$

41. (d) The period of revolution of the satellite must be exactly one day, or 86400s. The centripetal acceleration of the satellite must be $4\pi^2 r/T^2$, the gravitational field must be $g = g_0 (r_0/r)^2$. In free fall, $a = g$, so

$$r = \sqrt[3]{\frac{(9.8\text{m/s}^2)(6.4\times10^{-6}\text{m})^2(86400\text{s})^2}{4\pi^2}}$$

$$= 4.23 \times 10^7 \text{m}$$

To get the altitude, subtract the radius of the earth. The satellite must be at an altitude of 36000 km.

43. (b) Since, $T = 2\pi\sqrt{\frac{\ell}{g}}$

but inside the satellite g = 0

So, $T = \infty$

44. (a) $v_{esc} = \sqrt{2gR}$, where R is radius of the planet.

Hence escape velocity is independent of m.

47. (b) $g' = g - \omega^2 R\cos^2\lambda$.

50. (b) The orbital speed of satellite is independent of mass of satellite, so the ball will behave as a satellite and will continue to move with the same speed in the original orbit.

51. (b) Since orbital velocity of satellite is

$v_0 = \sqrt{\frac{GM}{r}}$, it does not depend upon the mass of the satellite.

Therefore, both satellites will move with same speed.

52. (b) Due to inertia of motion it will move tangentially to the original orbit with same velocity.

53. (a) $v_0 = \sqrt{gR}$ i.e., v_0 independent of mass of the satellite.

54. (c) From Kepler's 2nd law – The straight line joining the sun and the planet sweeps out equal areas in equal time intervals ($\frac{dA}{dt}$ = const; area swept)

Areal velocity of the satellite is given by

$$\frac{dA}{dt} = \frac{1}{2}\omega r^2 = \text{const.} = \frac{L}{2m}$$

where ω = angular velocity of the satellite

$L = mvr = m\omega r^2$ = const, showing that Kepler's 2nd law is a consequence of the conservation of angular momentum.

55. (c) The weightlessness inside a satellite is due to the fact that the surface does not exert any force on the body and hence its apparent weight is zero.

56. (b) At the centre of earth, weight is zero as g = 0 at center of earth.

weight = mg = 0 and Potential energy = mgh

But mass ≠ 0 as mass is the quantity of matter.

CHAPTER

2 Properties of Matter

Elasticity and Plasticity

The property of the body to regain its original configuration (length, or shape) when the deforming forces are removed is called ***elasticity***. On the other hand, *if the body does not have any tendency to regain its original configuration on removal of deforming force the body is called plastic body and this property is called* ***plasticity***.

Perfectly elastic body : A body which regains its original configuration immediately and completely after the removal of deforming force from it, is called perfectly elastic body. Quartz and phosphor bronze, are closed to perfectly plastic body.

Perfectly plastic body : A body which does not regain its original configuration at all on the removal of deforming force, however small the deforming force may be is called perfectly plastic body. Putty and mud are closed to perfectly plastic body.

Stress

The internal restoring force acting per unit area of a body is called stress.

i.e., *Stress = Restoring force/ Area*

Strain

The ratio of change in configuration to the original configuration is called strain.

$$i.e.,\ Strain = \frac{Change\ in\ configuration}{Original\ configuration}$$

Strain being the ratio of two like quantities has **no units** and **dimensions**.

Elastic Limit

Elastic limit is the upper limit of deforming force up to which, if deforming force is removed, the body regains its original form completely and beyond which, if deforming force is increased, the body loses its property of elasticity and gets permanently deformed.

Hooke's law

It states that *within the elastic limit stress is directly proportional to strain.*

i.e., $Stress \propto strain$

or $\text{Stress} = E \times \text{strain}$

or $$\frac{Stress}{Strain} = E = constant$$

Here E is the coefficient of proportionality and is called **modulus of elasticity** or **coefficient of elasticity** of a body.

Materials-Ductile, Brittle and Elastomers

(i) **Ductile materials :** *The materials which have large range of plastic extension* are called ductile materials. They can be drawn into thin wires, e.g., copper, silver, aluminium, iron, etc.

(ii) **Brittle materials :** *The materials which have very small range of plastic extension* are called brittle materials. These materials break as soon as the stress is increased beyond the elastic limit. e.g., glass, ceramics, cast iron, etc.

(iii) **Elastomers :** *The materials which can be stretched to large values of strain* are called elastomers. *e.g.*, rubber, elastic tissue of aorta, etc.

Young's modulus of elasticity (Y) : It is defined as *the ratio of normal stress to the longitudinal strain within the elastic limit.*

Thus, $$Y = \frac{Normal\ \ stress}{Longitudinal\ \ strain}$$

or, $$Y = \frac{F/\pi r^2}{\Delta\ell / L_0} = \frac{MgL_0}{\pi r^2 \Delta\ell}$$

Thermal Stress

When a rod is rigidly fixed at its two ends and its temperature is changed, then a thermal stress is set up in the rod. And the corresponding strain developed is called thermal strain.

$$Thermal\ stress = \frac{Force}{Area\ of\ cross\ section} = \frac{F}{A} = Y\alpha\,\Delta\theta.$$

where α = coefficient of linear expansion of the rod

$\Delta\theta$ = change in temperature.

Fluids

Fluids are the substances that can flow. Therefore liquids and gases both are fluids. The study of fluids at rest is called **fluid statics** or **hydrostatics** and the study of fluids in motion is called **fluid dynamics** or **hydrodynamics**. Both combined are called **fluid mechanics**.

Density (ρ)

Mass per unit volume is defined as density. So density at a point of a fluid is represented as

$$\rho = \lim_{\Delta V \to 0} \frac{\Delta m}{\Delta V} = \frac{dm}{dV}$$

where m is the mass and v is the volume of the fluid.

Relative Density

It is defined as the ratio of the density of the given fluid to the density of pure water at 4°C.

$$Relative\ density\ (R.D.) = \frac{Density\ of\ \ given\ liquid}{Density\ of\ \ pure\ water\ at\ 4°C}$$

The density of water is maximum at 4°C and is equal to $1.0 \times 10^3\ \text{kgm}^{-3}$

Pressure

If a uniform force is exerted normal to an area (A), then *average pressure (p_{av}) is defined as the normal force (F) per unit area.*

$$i.e.,\ p_{av} = \frac{F}{A}$$

In limiting sense, *pressure* $p = \lim_{\Delta A \to 0} \frac{\Delta F}{\Delta A}$. Pressure is a scalar quantity.

SI unit : pascal (Pa), $1\ Pa = 1\ N/m^2$

Practical units: atmospheric pressure (atm), bar and torr

$1\ atm = 1.01325 \times 10^5 Pa = 1.01325\ bar = 760\ torr = 760mm$ of Hg column pressure.

Pascal's Law of Transmission of Fluid Pressure

Pascal's law is stated in following ways :

- The pressure in a fluid at rest is same at all the points if gravity is ignored.
- A liquid exerts equal pressures in all directions.
- If the pressure in an enclosed fluid is changed at a particular point, the change is transmitted to every point of the fluid and to the walls of the container without being diminished in magnitude.

  Applications of Pascal's law : Hydraulic machines, lifts, presses and brakes, are based on the Pascal's law.

Atmospheric Pressure

Force exerted by air column on unit cross-section area of sea level is called atmospheric pressure (P_0)

$$P_0 = \frac{F}{A} = 101.3\ kN/m^2$$

Barometer is used to measure atmospheric pressure which was **discovered by Torricelli**.

Atmospheric pressure varies from place to place and at a particular place from time to time.

Buoyancy and Archimed Principle

If a body is partially or wholly immersed in a fluid, it experiences an upward force due to the fluid surrounding it. This phenomenon of force exerted by fluid on the body is called **buoyancy** and force is called **buoyant force** or **upthrust**.

Archimedes' Principle : *It states that the buoyant force on a body that is partially or totally immersed in a fluid equal to the weight of the fluid displaced by it.*

Bernoulli's Principle

When incompressible, non-viscous, irrotational liquid i.e., ideal liquid flow from one position to other in streamline path then in its path at every point, the sum of pressure energy, kinetic energy and potential energy per unit volume remains constant.

$$i.e.,\ P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$$

$$\therefore \quad P + \rho g h + \frac{\rho v^2}{2} = constant$$

Viscosity

The property of a fluid due to which it opposes the relative motion between its different layers is called viscosity (or fluid friction or internal friction) and the force between the layers opposing the relative motion is called **viscous force**.

According to Newton, the frictional force or viscous force between two layers depends upon the following factors :

$$F \propto A\frac{dv}{dy}$$

or $$F = -\eta A\frac{dv}{dy}$$

where, η is a constant called **coefficient of viscosity** or **simply viscosity** of fluid.

Factors Affecting Viscosity

(1) **Effect of temperature :** On increasing temperature viscosity of a liquid decreases. While it increases in the case of gases.

(2) **Effect of pressure :** On increasing pressure viscosity of a liquid increases but viscosity of water decreases. Viscosity of gases is independent of pressure.

Stoke's Law

According to stoke's law, the viscous drag force F on a spherical body of radius r moving through a fluid of viscosity η with a velocity called terminal velocity v is given by

$$F = 6\pi\eta r v$$

Terminal Velocity

It is maximum constant velocity acquired by the body while falling freely in a viscous medium.

$$V_T = \frac{2r^2(\rho - \sigma)g}{9\eta}$$

Surface Tension

Surface tension is basically a property of liquid. The liquid surface behaves like a stretched elastic membrane which has a natural tendency to contract and tends to have a minimum possible surface area. This property of liquid is called surface tension.

$$Surface\ tension\ T = \frac{Force\ F}{Length\ L}$$

Examples of surface tension

(i) Raindrops are spherical in shape.

(ii) The hair of a shaving brush cling together when taken out of water.

(iii) Oil spread on cold water but remains as a drop on hot water etc.

Angle of Contact (θ)

The angle enclosed between the tangent plane at the liquid surface and the tangent plane at the solid surface at the point of contact inside the liquid is termed as the ***angle of contact****.*

Angle of contact of various solid-liquid pairs

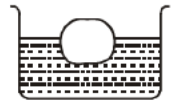
Solid - liquid pair	θ_C	
Glass -normal water	8°	Acute angle
Glass -distilled water	0°	
Glass - alcohol	0°	
Glass - mercury	135°	Obtuse angle
Paraffin wax - water	108°	
Silver - water	90°	Right angle

Capillarity

A glass tube with fine bore and open at both ends is known as **capillary tube**. *The property by virtue of which a liquid rise or fall in a capillary tube is known as* ***capillarity***. Rise or fall of liquid in tubes of narrow bore (capillary tube) is called capillary action. Rise of kerosene in lanterns, rise of ink in fountain pen etc. are due to capillary action.

EXERCISE

1. Kerosene oil rises up in a wick of a lantern because of
   (a) diffusion of the oil through the wick
   (b) surface tension
   (c) buoyant force of air
   (d) the gravitational pull of the wick
2. Two pieces of metal when immersed in a liquid have equal upthrust on them; then
   (a) both pieces must have equal weights
   (b) both pieces must have equal densities
   (c) both pieces must have equal volumes
   (d) both are floating to the same depth
3. If the force on the surface is doubled and area is reduced to half, pressure will
   (a) become 2 times (b) become 3 times
   (c) become 4 times (d) remain unchanged
4. Pressure at a point inside a liquid does not depend on
   (a) the depth of the point below the surface of the liquid
   (b) the nature of the liquid
   (c) the acceleration due to gravity at that point
   (d) the shape of the containing vessel
5. The bulk modulus for an incompressible liquid is
   (a) zero (b) unity
   (c) infinity (d) between 0 and 1
6. An egg when placed in ordinary water sinks but floats when placed in brine. This is because
   (a) density of brine is less than that of ordinary water
   (b) density of brine is equal to that of ordinary water
   (c) density of brine is greater than that of ordinary water
   (d) None of these
7. Water is flowing through a horizontal pipe in streamline flow. At the narrowest part of the pipe
   (a) Velocity is maximum and pressure is minimum
   (b) Pressure is maximum and velocity is minimum
   (c) Both the pressure and velocity are maximum
   (d) Both the velocity and pressure are minimum
8. The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied ?
   (a) Length = 50 cm , diameter = 0.5 mm
   (b) Length = 100 cm, diameter = 1 mm
   (c) Length = 200 cm, diameter = 2 mm
   (d) Length = 300 cm, diameter = 3 mm
9. A man is sitting in a boat which is floating in pond. If the man drinks some water from the pond, the level of water in the pond will
   (a) rise a little (b) fall a little
   (c) remain stationary (d) None of these
10. In solids, interatomic forces are
    (a) totally repulsive
    (b) totally attractive
    (c) combination of (a) and (b)
    (d) None of these
11. A body floats in a liquid containing in a beaker. The whole system as shown in Fig. is falling under gravity The upthrust on the body due to liquid is



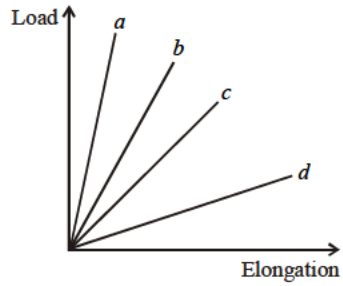
    (a) zero
    (b) equal to weight of body in air
    (c) equal to weight of liquid displaced
    (d) equal to weight of immersed part of the body
12. A water tank of height 10 m, completely filled with water is placed on a level ground. It has two holes one at 3 m and the other at 7 m from its base. The water ejecting from
    (a) both the holes will fall at the same spot
    (b) upper hole will fall farther than that from the lower hole
    (c) upper hole will fall closer than that from the lower hole
    (d) more information is required
13. The lift of an air plane is based on
    (a) Torricelli's theorem
    (b) bernoulli's theorem
    (c) law of gravitation
    (d) conservation of linear momentum
14. The rain drops falling from the sky neither injure us nor make holes on the ground because they move with
    (a) constant acceleration (b) variable acceleration
    (c) variable speed (d) constant terminal velocity
15. Two soap bubbles are held by a tube. What will happen ?
    (a) Air will travel from bigger to smaller bubble
    (b) Air will not travel
    (c) Air will travel through tube
    (d) Nothing can be said
16. With the increase of temperature, the surface tension of the liquid
    (a) may increase or decrease depending on the density of liquid
    (b) remains the same
    (c) always increases
    (d) always decreases
17. According to Hooke's law of elasticity, if stress is increased, then the ratio of stress to strain
    (a) becomes zero (b) remains constant
    (c) decreases (d) increases
18. Liquid pressure at a point in a liquid does not depend on the
    (a) density of liquid
    (b) shape of the vessel in which the liquid is kept
    (c) depth of the point from the surface
    (d) acceleration due to gravity
19. A container partly filled in a liquid is suspended from a spring balance. A small body is gently dropped in the container. The pointer of spring balance will
    (a) read less (b) oscillate
    (c) read the same (d) read more
20. Small droplets of a liquid are usually more spherical in shape than larger drops of the same liquid because
    (a) force of surface tension is equal and opposite to the force of gravity
    (b) force of surface tension predominates the force of gravity

(c) force of gravity predominates the force of surface tension
(d) force of gravity and force of surface tension act in the same direction and are equal

21. Which of the following materials is most elastic ?
(a) Rubber (b) Lead
(c) Wood (d) Steel

22. A stretched rubber has
(a) increased kinetic energy
(b) increased potential energy
(c) decreased kinetic energy
(d) decreased potential energy

23. The load verses elongation graph for four wires is shown. The thinnest wire is

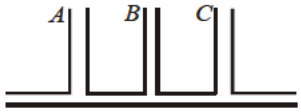


(a) *a* (b) *b*
(c) *c* (d) *d*

24. Elastomers are the materials which
(a) are not elastic at all
(b) have very small elastic range
(c) do not obey Hooke's law
(d) None of these

25. The lift in an aeroplane is based on
(a) Law of gravitation (b) Theorem of continuity
(c) Pascal's low (d) Bernoulli's theorem

26. In the figure below is shown the flow of the liquid through a horizontal pipe. Three tubes *A*, *B* and *C* are connected to the pipe. The radii of the tubes *A*, *B* and *C* at the junction are respectively 2 cm, 1 cm and 2 cms. It can be said that



(a) the height of the liquid in the tube *A* is maximum
(b) height of the liquid in the tube *A* and tube *B* is the same
(c) height of the liquid in all the three tubes is the same
(d) height of the liquid in tube *A* and *C* is the same

27. Houses far from the municipal water tank find it difficult to get water on the top floor even if their ceilings are lower than the level of water filled in tank. Its reason is
(a) pipes are more wide.
(b) pipes are less wide.
(c) when water flows there is loss of pressure.
(d) None of these

28. Working of atomizer is based on
(a) Boyle's law
(b) Bernoulli's law
(c) Newton's laws of motion
(d) Archimedes' principle

29. Ideal liquid is that liquid
(a) whose density is zero (b) whose viscosity is zero
(c) which is compressible (d) None of these

30. Water is flowing through a horizontal pipe line having a restriction. Then
(a) pressure will be the same throughout the length of the pipe.
(b) pressure will be greater at the restriction.
(c) pressure will be greater in the wider portion.
(d) None of these

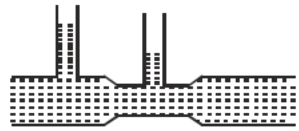
31 Paint-gun is based on
(a) Bernoulli's theorem (b) Archemedes' principle
(c) Boyle's law (d) Newton's laws of motion

32. A tank filled with water has a hole at a certain height from its bottom. The volume of water emerging out per second from the hole does not depend on
(a) the height of the level of liquid above the hole.
(b) the area of a hole.
(c) the density of a liquid.
(d) the acceleration due to gravity.

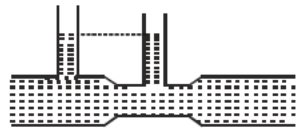
33. A boy carries a fish in one hand and a bucket of water in the other hand. If he places the fish in the bucket, the weight now carried by him.
(a) is less than before (b) is more than before
(c) is the same as before (d) depends upon his speed

34. A drop of oil is placed on the surface of water. Which of the following statements is correct?
(a) It will remain on it as a sphere
(b) It will spread as a thin layer
(c) It will partly be a spherical droplet and partly a thin film
(d) It will float as a distorted drop on the water surface

35. For a fluid which is flowing steadily, the level in the vertical tubes is best represented by

(a) 

(b) 

(c) 

(d) 

36. Surface tension of a liquid is due to
(a) gravitational force between molecules
(b) electrical force between molecules
(c) adhesive force between molecules
(d) cohesive force between molecules

37. A liquid rises in a capillary tube higher than water does. The difference may be due to the fact that
(a) diameter of the capillary may be different in the two cases
(b) temperature of liquid is higher than that of water
(c) surface tension of water is less than that of the liquid
(d) both (a) and (c)

38. Construction of submarines is based on
(a) Archimede's principle
(b) Bernoulli's theorem
(c) Pascal's law
(d) Newton's laws

39. The action of a nib split at the top is explained by
(a) gravity flow (b) diffusion of fluid
(c) capillary action (d) osmosis of liquid

40. Why the dam of water reservoir is thick at the bottom?
(a) Quantity of water increases with depth
(b) Density of water increases with depth
(c) Pressure of water increases with depth
(d) Temperature of water increases with depth

41. Hydraulic lift is based on the principle of
(a) Pascal's law
(b) Bernoulli's theorem
(c) Toricelli's theorem
(d) Stoke's law

42. A and B are two wires. The radius of A is twice that of B. They are stretched by the same load. Then the stress on B is
(a) equal to that on A (b) four times that on A
(c) two times that on A (d) half that on A

ANSWER KEY											
1	(b)	**8**	(a)	**15**	(a)	**22**	(b)	**29**	(b)	**36**	(d)
2	(c)	**9**	(c)	**16**	(d)	**23**	(b)	**30**	(c)	**37**	(c)
3	(c)	**10**	(c)	**17**	(b)	**24**	(c)	**31**	(a)	**38**	(a)
4	(d)	**11**	(a)	**18**	(b)	**25**	(d)	**32**	(c)	**39**	(c)
5	(c)	**12**	(a)	**19**	(d)	**26**	(d)	**33**	(c)	**40**	(c)
6	(c)	**13**	(b)	**20**	(b)	**27**	(c)	**34**	(b)	**41**	(a)
7	(a)	**14**	(b)	**21**	(d)	**28**	(b)	**35**	(a)	**42**	(b)

HINTS AND SOLUTIONS

5. (c) Bulk modulus $= \frac{\text{Pressure}}{\text{Volume Strain}} = \frac{\text{Pressure}}{0}$

Bulk modulus = ∞

[As liquid is uncompressible, $\Delta V = 0$]

6. (c) Brine due to its high density exerts an upthrust which can balance the weight of the egg.

8. (a) $Y = \frac{T/A}{\Delta\ell/\ell}$

$\Delta\ell = \frac{T \times \ell}{A \times Y} = \frac{T}{Y} \times \frac{\ell}{A}$

Hence, $\frac{T}{Y}$ is constant. Therefore, $\Delta\ell = \frac{\ell}{A}$

$\frac{\ell}{A}$ is largest in the first case.

12. (a) Velocity of water from hole

A = $v_1 = \sqrt{2gh}$

Velocity of water from hole B $= v_2 = \sqrt{2g(H_0 - h)}$

Time of reaching the ground from hole B

$= t_1 = \sqrt{2(H_0 - h)/g}$

Time of reaching the ground from hole A $= t_2 = \sqrt{2h/g}$

13. (b) Apply Bernoulli's theorem.)

15. (a) The excess pressure inside a soap bubble is given by, $p = \frac{4T}{r}$. As the excess of pressure is less in bigger bubble means pressure is more inside bigger bubble. So, air travels from bigger bubble to smaller.

16. (d) Surface-Tension is the property of liquid at rest. As we increase temperature, due to gain in kinetic energy of molecules, surface tension decreases.

17. (b) The ratio of stress to strain is always constant. If stress is increased, strain will also increase so that their ratio remains constant.

19. (d) The pointer of spring balance will read more. The increased reading will be equal to the upthrust given by Archimedes principle.

24. (c) Elastomers do not obey Hooke's law.

26. (d) The rise of water in capillary tube is inversely proportional to radius, $h = \frac{2T}{r\rho g}$. It is given that radius of *A* and *C* are same. So, height of the liquid in tube *A* and *C* is the same.

30. (c) A ↑ v ↑ P ↑ (Area A, Velocity v, Pressure P)

32. (c) Volume per second = $A\sqrt{2gh}$

34. (b) The surface tension of oil is less than that of water, so the oil spreads as a thin layer.

35. (a) From continuity equation, velocity at cross-section (1) is more than that at cross-section (2).
Hence, $P_1 < P_2$.

36. (d) Surface tension of a liquid is due to force of attraction between like molecules of a liquid i.e. cohesive force between the molecules.

37. (c) The height to which liquid rises in a capillary is given by, $h = \frac{2T}{r\rho g}$. Thus, if height to which liquid rises is more, the liquid have greater surface tension than water. Option (a) is not suitable because diameter of capillary tube containing liquid should be smaller than the capillary in which water rises. This is not mentioned clearly in the option (a).

40. (c) A torque is acting on the wall of the dam trying to make it topple. The bottom is made very broad so that the dam will be stable.

41. (a) Hydraulic lift is based on the principle of Pascal's law.

42. (b) Stress = $\frac{\text{force}}{\text{Area}} \therefore \text{Stress} \propto \frac{1}{\pi r^2}$

$\frac{S_B}{S_A} = \left(\frac{r_A}{r_B}\right)^2 = (2)^2 \Rightarrow S_B = 4S_A$

CHAPTER

3 Heat

Temperature and Heat

Temperature *is defined as the degree of hotness or coldness of a body.* It is a scalar quantity. **Its S.I. unit** is kelvin (K).

Heat *is a form of energy which causes sensation of hotness or coldness.* The flow of heat is always from higher temperature to lower temperature. No heat flows from one body to other, when both the bodies are at the same temperature. The two bodies are said to be in **thermal equilibrium.** The **SI unit** of heat is **joule**. Its **CGS unit** is **calorie**, 1 cal = 4.2 joule

Measurement of Temperature

A branch of science which deals with the measurement of temperature of a substance is called **thermometry.**

Thermometer is a device used to measure the temperature. Thermometer used for measuring very high temperatures are called **pyrometer**.

Relationship Between Different Scales of Temperature

$$\frac{C-0}{100}=\frac{F-32}{212-32}=\frac{K-273.16}{373.16-273.16}$$

$$=\frac{R-0}{80-0}=\frac{Ra-460}{672-460}$$

$$T°(K) = (t°C + 273.16)$$

Normal temperature of human body is 310.15 k (37°C = 98.6°F)

STP or NTP implies 273.15 K (0°C = 32°F)

Ideal-gas Equation and Absolute Temperature

The equation, $PV = nRT$

where, n = number of moles in the sample of gas

R = universal gas constant; (its value is 8.31 J mol^{-1} K^{-1}), is known as **ideal-gas equation**

It is the combination of following three laws

(i) Boyle's law : *When temperature is held constant, the pressure is inversely proportional to volume.*

i.e., $P \propto \frac{1}{V}$ (at constant temperature)

(ii) Charle's law : *When the pressure is held constant, the volume of the gas is directly porportional to the absolute temperature.*

i.e., $V \propto T$ (at constant pressure)

(iii) Avogadro's law : *When the pressure and temperature are kept constant, the volume is directly proportional to the number of moles of the ideal gas in the container.*

i.e., $V \propto n$ (at constant pressure and temperature)

Absolute Temperature

The lowest temperature of –273.16 °C at which a gas is supposed to have zero volume and zero pressure and at which entire molecular motion stops is called absolute zero temperature. A new scale of temperature starting with –273.16°C by Lord Kelvin as zero. This is called Kelvin scale or absolute scale of temperature.

$$T(K) = t°C + 273.16$$

Thermal Expansion

The increase in the dimensions of a body due to the increase in its temperature is called thermal expansion.

Linear expansion : *The fractional increase in length per ºC rise in temperature is called* ***coefficient of linear expansion****.*

Coefficient of linear expansion, $\alpha = \frac{\left(\frac{\Delta \ell}{\ell}\right)}{\Delta T} = \frac{d\ell}{\ell . dT}$

Superficial expansion : On increasing the temperature of a solid, its area increases. This increase in area is referred as **superficial expansion**.

Coefficient of superficial expansion *is defined as the fractional increase in area per ºC rise in temperature.*

i.e., Coefficient of a real expansion $\beta = \frac{\Delta A / A}{\Delta T} = \frac{dA}{A.dT}$

Cubical expansion : On increasing the temperature of a solid, its volume increases. This increase in volume with increase in temperature is called cubical or volume expansion.

Coefficient of volume expansion *is defined as the fractional increase in volume per ºC rise in temperature.*

i.e., Coefficient of volume expansion, $\gamma = \frac{\Delta V / V}{\Delta T} = \frac{dV}{V.dT}$

Relation between coefficient of linear expansion (α), coefficient of superficial expansion (β) and coefficient of cubical expansion (γ)

$$\alpha = \frac{\beta}{2} = \frac{\gamma}{3} \Rightarrow \alpha : \beta : \gamma = 1 : 2 : 3$$

Anomalous Expansion of Water

Almost all liquids expand on heating but water when heated from 0°C to 4°C its volume decreases and hence density increases until its temperature reaches 4°C. Its density is maximum at 4°C on further heating its density decreases. This behaviour of water is called anomalous behaviour of water.

Specific Heat Capacity

It is *the amount of heat energy needed to raise the temperature of unit mass of substance by 1°C (or 1K).*
It is denoted by **s or c**.

$$c = \frac{1}{m.}\frac{dQ}{dT}$$

Unit of specific heat capacity :
SI unit of specific heat capacity is joule/kg K
For example, the specific heat capacity of water is :
C_{water} = *1 cal/g °C = 1 cal/g K = 1 kcal/kg K=4200 joule/kg K*

Latent Heat or Hidden Heat

When state of a substance changes, change of state takes place at constant temperature (m.pt. or b.pt.) heat is released or absorbed and is given by,

$$Q = mL$$

where **L is latent heat**.
The **SI unit** of latent heat is J/kg

Change of State

Any state of a substance (solid/ liquid/ gas) can be changed into another by heating or cooling. The transition of a substance from one state to another is called a change of state.

Some common changes of states :

(i) Melting : When heat is supplied, solid substance changes into liquid, this change of state of substance is called melting.

$$\text{Solid} \xrightarrow{\text{Heat}} \text{Liquid}$$

The temperature at which the solid and the liquid states of a substance coexist in thermal equilibrium with each other is called its **melting point**.

(ii) Freezing : When heat is released, liquid changes into solid, this change of state of substance is called freezing.

$$\text{Liquid} \xrightarrow{\text{Cool}} \text{Solid}$$

(iii) Condensation : When vapour is cooled, it changes into liquid, this change of state is called condensation

$$\text{Vapour} \xrightarrow{\text{Cool}} \text{liquid}$$

(iv) Evaporation : Conversion of liquid into gaseous state at all the temperatures is called evaporation or boiling.

$$\text{Liquid} \xrightarrow{\text{Heat}} \text{Vapour}$$

The temperature at which the liquid and vapour states of a substance coexsist in thermal equilibrium with each other is called its **boiling point**.

It is a phenomenon that occurs at the surface of liquids. The rate of evaporation increases with rise in temperature. Heat required to change unit mass of liquid into vapour at a given temperature is called heat of evaporation at that temperature.

(v) Sublimation : It is the conversion of a solid directly into vapours.

$$\text{Solid} \xrightarrow{\text{Heat}} \text{Vapour}$$

Sublimation takes place when boiling point is less than the melting point.

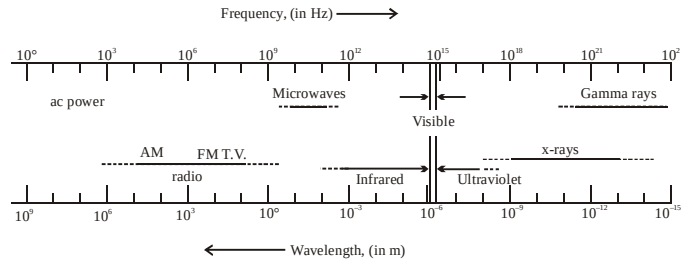
Heat transfer : Heat energy transfer from a body at higher temperature to a body at lower temperature by three different methods. They are conduction, convection and radiation.

Conduction : *Conduction is that mode of transmission of heat in which heat is transferred from a region of higher temperature to a region of lower temperature by the aid of particles of the body without their actual migration. Conduction requires material medium.*

Convection : Convection like conduction requires a material medium. *It is the process in which heat is transferred from one place to other by actual movement of heated material particles.*

Radiation : When a body is heated and placed in vacuum, it loses heat even when there is no medium surrounding it.
The process by which heat is lost in this case is called radiation. This does not require the presence of any material medium. It is by radiation that the heat from the sun reaches the earth.

The Electromagnetic Spectrum



Perfectly black body : *A black body is defined as one that will completely absorb all the radiations of whatever wavelength which falls on it.*
For perfectly black body, $a_\lambda = 1$.

Properties of perfectly black body :

(i) A perfectly black body absorbs all the radiant heat incident upon it. (i.e. $a = 1$)
(ii) A perfectly black body does not reflect or transmit the radiant heat incident upon it. (i.e. $t = 0, r = 0$)
(iii) The coefficient of emission of a perfectly black body is 1. It is very good emitter of heat.

Wien's displacement law.
According to Wien's displacement law

$$\lambda_m \times T = b$$

Here, constant b is known as Wien's constant

Newton's Law of Cooling

The rate of cooling of a body (rate of loss of heat) is directly proportional to the excess of temp. of the body over the surroundings, provided that this excess is small and loses of heat by radiation only.
If θ and θ_0 are the temperatures of the body and its surroundings respectively, then according to Newton's law of cooling,

$$\textit{Rate of loss of heat, } -\frac{dQ}{dt} \propto (\theta - \theta_0)$$

Thermodynamics

The **thermodynamics** *is the branch of science in which the conversion of heat into mechanical work and vice versa is studied.*

Triple point of water : The triple point of water represents the co-existence of all the three phases of water ice, water and water vapour in equilibrium. The pressure corresponding to triple point of water is 6.03×10^{-3} atmosphere or 4.58 mm of Hg and temperature corresponding to it is 273.16 K.

Zeroth Law of Thermodynamics

If objects A and B are separately in thermal equilibrium with a third object C then objects A and B are in thermal equilibrium with each other.

Heat : *It is energy in transit between two objects or system due to temperature difference between them.* It exists in the form of translational, rotational and vibrational motion of molecules of a substance. It depends on processess.

For constant pressure process $Q = nC_P \Delta T$ and

For constant volume process $Q = nC_v \Delta T$

For any other process $Q = nC \Delta T$,

where C is called molar specific heat for that process.

Internal energy : *Internal energy of a system is the energy possessed by the system due to molecular motion and molecular configuration.* The energy due to molecular motion is called **internal kinetic energy (U_k)** and that due to molecular configuration is called **internal potential energy (U_p)**.

$$dU = dU_k + dU_p$$

If there is no intermolecular forces, then $dU_p = 0$.

$$\therefore \quad dU = dU_k = mC_v\, dT$$

Work : *Work is energy transfer brought about by other means, such as moving the piston of a cylinder containing the gas, by raising or lowering some weight connected to it etc.*

First Law of Thermodynamics

If some quantity of heat is supplied to a system capable of doing external work, then the quantity of heat absorbed by the system is equal to the sum of the increase in the internal energy of the system and the external work done by the system.

i.e., $\delta Q = \delta U + \delta W$

The first law of thermodynamics is essentially a restatement of the law of conservation of energy, i.e., energy can neither be created nor be destroyed but may be converted from one form to another.

Different Types of Thermodynamic Processes

Quasi-static process : It is infinitely slow. So its variables (P, V, T) remains in thermal and mechanical equilibrium with its surroundings.

Isochoric or isometric process : *It is a thermodynamic process that takes place at constant volume of the system, but pressure and temperature varies for change in state of the system.*

Isobaric process : *It is a thermodynamic process that takes place at constant pressure, but volume and temperature varies for change in state of the system.*

Isothermal process : *It is a thermodynamic process in which the pressure and volume of system change but temperature remains constant.*

Adiabatic process : *It is that thermodynamic process in which pressure, volume and temperature of the system change but there is no exchange of heat between the system and the surroundings.*

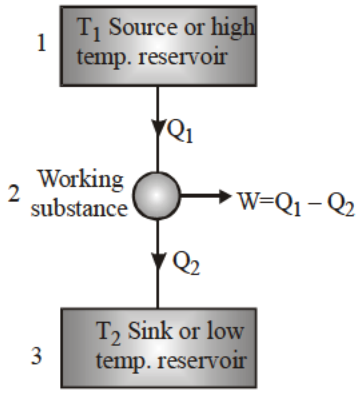
A process has to be sudden and quick to be adiabatic.

Equation of state : $PV = \mu RT$

Equation for adiabatic process PV^{γ} = constant

Heat Engines

Heat engine is a device which converts heat energy into work. A heat engine, in general, consists of three parts :

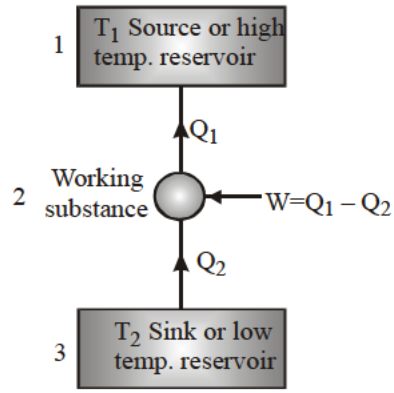


Efficiency of heat engine, $\eta = \dfrac{Work\ done\ (W)}{Heat\ taken\ from\ soruce\ (Q_1)}$

$$\eta = \frac{T_1 - T_2}{T_1} = \frac{Q_1 - Q_2}{Q_1} = 1 - \frac{Q_2}{Q_1}$$

Refrigerators and Heat Pumps

A refrigerator is the reverse of a heat engine. A heat pump is the same as a refrigerator.



The **coefficient of performance** of a refrigerator or heat pump.

$$\frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2} \qquad [\because\ W = Q_1 - Q_2]$$

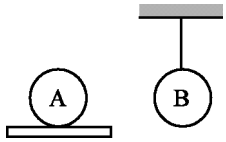
Carnot Theorem

No irreversible engine (I) can have efficiency greater than Carnot reversible engine (R) working between same hot and cold reservoirs.

$$\text{i.e.,}\quad \eta_R > \eta_I \quad \text{or} \quad 1 - \frac{T_2}{T_1} > 1 - \frac{Q_2}{Q_1}$$

EXERCISE

1. Woollen clothes are used in winter season because woollen clothes
   (a) are good sources for producing heat
   (b) absorb heat form surroundings
   (c) are bad conductors of heat
   (d) provide heat to body continuously
2. Water has maximum density at
   (a) 0°C (b) 32°F
   (c) –4°C (d) 4°C
3. Expansion during heating
   (a) occurs only in solids
   (b) increases the weight of a material
   (c) decreases the density of a material
   (d) occurs at the same rate for all liquids and solids
4. When a copper ball is heated, the largest percentage increase will occur in its
   (a) diameter (b) area
   (c) volume (d) density
5. If a liquid is heated in condition of weightlessness, the heat is transmitted through
   (a) conduction
   (b) convection
   (c) radiation
   (d) None, because the liquid cannot be heated in weightlessness
6. Heat travels through vacuum by
   (a) conduction (b) convection
   (c) radiation (d) both (a) and (b)
7. A bimetallic strip consists of brass and iron. When it is heated it bends into an arc with brass on the convex and iron on the concave side of the arc. This happens because
   (a) brass has a higher specific heat capacity than iron
   (b) density of brass is more than that of iron
   (c) it is easier to bend an iron strip than a brass strip of the same size
   (d) brass has a higher coefficient of linear expansion than iron
8. The earth radiates in the infra-red region of the spectrum. The spectrum is correctly given by
   (a) Wien's law
   (b) Rayleigh's law
   (c) Planck's law of radiation
   (d) Stefan's law of radiation
9. Good absorbers of heat are
   (a) poor emitters (b) non-emitters
   (c) good emitters (d) highly polished
10. Which of the following qualities suit for a cooking utensil?
   (a) High specific heat and low thermal conductivity
   (b) High specific heat and high thermal conductivity
   (c) Low specific heat and low thermal conductivity
   (d) Low specific heat and high thermal conductivity
11. 5g ice at 0°C is mixed with 5g of steam at 100°C . What is the final temperature?
   (a) 50°C (b) 100°C
   (c) 80°C (d) 150°C
12. By the first law of thermodynamics, for solids
   (a) $dQ = dU + dW$ (b) $dQ = dU$
   (c) $\delta Q = \delta W + dU$ (d) $\delta Q = \delta U / \delta W$
13. There are four objects A, B, C and D. It is observed that A and B are in thermal equilibrium and C and D are also in thermal equilibrium. However, A and C are not in thermal equilibrium. We can conclude that –
   (a) B and D are in thermal equilibrium
   (b) B and D could be in thermal equilibrium but might not be A and D
   (c) B and D cannot be in thermal equilibrium
   (d) the zeroth law of thermodynamics does not apply here because there are more than three objects
14. According to the kinetic theory of gases
   (a) all the atoms move horizontally with equal speeds
   (b) an atom moves faster during its downward motion than its upward motion
   (c) at any instant one-third of the total atoms are moving along *x*-axis
   (d) None of these
15. The fastest mode of transfer of heat is
   (a) conduction (b) convection
   (c) radiation (d) None of these
16. The wavelength of radiation emitted by a body depends upon
   (a) the nature of its surface
   (b) the area of its surface
   (c) the temperature of its surface
   (d) All of the above
17. The sprinkling of water slightly reduces the temperature of a closed room because
   (a) temperature of water is less than that of the room
   (b) specific heat of water is high
   (c) water has large latent heat of vaporisation
   (d) water is a bad conductor of heat
18. Which of the following is not close to a black body?
   (a) Black board paint (b) Green leaves
   (c) Black holes (d) Red roses
19. A solid cube and a solid sphere of the same material have equal surface area. Both are at the same temperture 120°C , then
   (a) both the cube and the sphere cool down at the same rate
   (b) the cube cools down faster than the sphere
   (c) the sphere cools down faster than the cube
   (d) whichever is having more mass will cool down faster
20. At a given temperature the internal energy of a substance
   (a) in liquid state is equal to that in gaseous state
   (b) in liquid state is less than that in gaseous state
   (c) in liquid state is more than that in gaseous state
   (d) is equal for the three states of matter
21. Consider two identical iron spheres , one which lie on a thermally insulating plate, while the other hangs from an insulatory thread. Equal amount of heat is supplied to the two spheres



(a) Temperature of *A* will be greater than *B*
(b) Temperature of *B* will be greater than *A*
(c) Their temperature will be equal
(d) Can't be predicted

22. Air conditioner is based on the principle of
(a) Carnot cycle
(b) refrigerator
(c) first low of thermodynamics
(d) None of these

23. Gases exert pressure on the walls of the container because the gas molecules
(a) possess momentum
(b) collide with each other
(c) have finite volume
(d) obey gas laws

24. Food in the pressure cooker is cooked faster, as
(a) the boiling point increases due to an increase in pressure
(b) the boiling point decreases due to an increase in pressure
(c) more steam is available at 100°C
(d) more pressure is available at 100°C

25. A metal sheet with a circular hole is heated. The hole
(a) gets larger
(b) gets smaller
(c) remains of the same size
(d) gets deformed

26. When water is heated from 0ºC to 10ºC, its volume
(a) increases
(b) decreases
(c) does not change
(d) first decreases and then increases

27. A: At high altitude regions the cooking of food becomes difficult.
B: Water boils at lower temperature when the pressure is low.
(a) Both *A* and *B* are wrong.
(b) *A* and *B* are correct and *B* is not the correct explanation of *A*.
(c) *A* and *B* are correct and *B* is the correct explanation of *A*.
(d) *A* is correct but *B* is wrong.

28. When vapour condenses into liquid
(a) it absorbs heat (b) it liberates heat
(c) its temperature rises (d) its temperature decreases

29. The temperature of the sun is measured with
(a) Platinum thermometer
(b) Gas theromometer
(c) Pyrometer
(d) Vapour pressure thermometer

30. Two spheres of same size are made of the same metal but one is hollow and the other is solid. They are heated to same temperature, then
(a) both spheres will expand equally
(b) hollow sphere will expand more than the solid one
(c) solid sphere will expand more than the hollow one
(d) None of the above

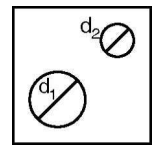
31. Heat is transmitted from higher to lower temperature through actual mass motion of the molecules in
(a) conduction (b) convection
(c) radiation (d) none of these

32. The temperature of a room is 77°F. What would it be on the Celsius scale?
(a) 25°C (b) 45°C
(c) 60°C (d) 350°C

33. Ventilators are provided at the top of room
(a) to bring oxygen for breathing
(b) so that sunlight may enter the room
(c) to maintain conventional currents to keep the air fresh in the room
(d) to provide an outlet for carbon dioxide

34. What temperature is the same on celsius scale as well as on Fahrenheit scale?
(a) $-212°C$ (b) $-40°C$
(c) $-32°C$ (d) 32°C

35. Two holes of unequal diameters d_1 and d_2 ($d_1 > d_2$) are cut in a metal sheet. If the sheet is heated,



(a) both d_1 and d_2 will decrease
(b) both d_1 and d_2 will increase
(c) d_1 will increase, d_2 will decrease
(d) d_1 will decrease, d_2 will increase

36. At 0°C a body emits
(a) no radiation
(b) only visible light
(c) only microwave radiation
(d) all wavelengths.

37. Triple point is the temperature at which
(a) matter may simultaneously exist in liquid and gaseous state.
(b) matter may simultaneously exist in liquid and solid state.
(c) matter may simultaneously exist in solid and gaseous state.
(d) matter may simultaneously exist in all the three forms.

38. In order that the heat flows from one part of a solid to another part, what is required?
(a) Uniform density (b) Temperature gradient
(c) Density gradient (d) Uniform temperature

39. At a common temperature, a block of wood and a block of metal feel equally cold or hot. The temperatures of block and wood are
(a) equal to the temperature of the body
(b) less than the temperature of the body
(c) greater than temperature of the body
(d) either (b) or (c)

40. The bulb of one thermometer is spherical, while that of other is cylindrical. If both of them have equal amount of mercury, which thermometer will respond quickly to the temperature?
(a) spherical bulb (b) cylindrical bulb
(c) elliptical bulb (d) both (a) and (c)

41. Consider the following statements.
(A) Some bodies may contract on heating
(B) Water shows anamolous expansion.
(a) (A) is true and (B) is false
(b) (A) is false and (B) is true.
(c) Both (A) and (B) are true.
(d) Both (A) and (B) are false.

42. The rate of flow of heat through a rod depends on:
(a) thermal conductivity of the rod.
(b) length of the rod.
(c) temperature difference across the rod.
(d) All of these

43. Which of the following represents convection ?
(a) Land breeze
(b) Exhaust fan
(c) Heating water by keeping the vessel on a flame
(d) All of these

ANSWER KEY											
1	(c)	**9**	(c)	**17**	(c)	**25**	(a)	**33**	(c)	**41**	(c)
2	(d)	**10**	(d)	**18**	(a)	**26**	(d)	**34**	(b)	**42**	(d)
3	(c)	**11**	(b)	**19**	(b)	**27**	(c)	**35**	(b)	**43**	(d)
4	(c)	**12**	(c)	**20**	(b)	**28**	(b)	**36**	(d)		
5	(a)	**13**	(c)	**21**	(b)	**29**	(c)	**37**	(d)		
6	(c)	**14**	(c)	**22**	(b)	**30**	(a)	**38**	(b)		
7	(d)	**15**	(c)	**23**	(a)	**31**	(b)	**39**	(a)		
8	(c)	**16**	(d)	**24**	(a)	**32**	(a)	**40**	(b)		

HINTS AND SOLUTIONS

1. (c) In winter, the temperature of surrounding is low compared to the body temperature (37.4°C). Since, woollen clothes are bad conductors of heat, so they keep the body warm.
2. (d) Water has maximum density at 4°C.
3. (c) Solids, liquids and gases all expand on being heated as a result density (= mass/volume) decreases.
4. (c) When a copper ball is heated, it's size increases. As volume $\propto$ (radius)^3 and Area $\propto$ (radius)^2, so percentage increase will be largest in it's volume. Density will decrease with rise in temperature.
5. (a) Convection is not possible in weightlessness. So the liquid will be heated through conduction.
6. (c) Heat radiations are electromagnetic waves of high wavelength.
7. (d) It is so because brass has a higher coefficient of linear expansion.
9. (c) Good absorbers are always good emitters of heat.
11. (b) Heat required by ice to raise its temperature to 100ºC,
$Q_1 = m_1L_1 + m_1c_1\Delta\theta_1 = 5 \times 80 + 5 \times 1 \times 100 = 400 + 500 = 900$ cal
Heat given by steam when condensed,
$Q_2 = m_2L_2 = 5 \times 536 = 2680$ cal
as $Q_2 > Q_1$.
This means that whole steam is not even condensed.
Hence temperature of mixture will remain at 100ºC.
13. (c) Thermal equilibrium means same temperature.
19. (b) Rate of cooling of a body $R = \frac{\Delta\theta}{t} = \frac{A\varepsilon\sigma(T^4 - T_0^4)}{mc}$

$\Rightarrow R \propto \frac{A}{m} \propto \frac{\text{Area}}{\text{Volume}}$ $[\text{m} = \rho \times \text{V}]$

$\Rightarrow$ For the same surface area. $R \propto \frac{1}{\text{Volume}}$

$\because$ Volume of cube < Volume of sphere

$\Rightarrow R_{\text{cube}} > R_{\text{Sphere}}$ i.e., cube, cools down with faster rate.

21. (b) Temperature of B will be higher because, due to expansion, centre of mass of B will come down. Same heat is supplied but in B, Potential energy is decreased therefore internal energy gain will be more.
34. (b) $\frac{C}{5} = \frac{F-32}{9}$ Here C = F

$\frac{C}{5} = \frac{F-32}{9} \quad \Rightarrow \quad 9C = 5C - 160$

$4C = -160 \quad \Rightarrow \quad C = -40°C.$

Thus at –40°C and –40° F the temperture is same.
35. (b) When a body is heated, the distance between any two points on it increases. The increase is in the same ratio for any set of two point.
36. (d) At any temperature other than zero K, each body emits all wavelengths.
37. (d) Triple point is the temperature where three states of matter can exist simultaneously.
38. (b) As heat flows from higher temperature to lower temperature, so a temperature gradient is required.
39. (a) The temperatures of the block and wood are equal to the temperature of the body as both feel equally hot or cold.
40. (b) As the surface area of cylindrical bulb is larger than a spherical bulb, heat will be transmitted quickly through a cylindrical bulb and it will respond quickly to the temperature.
41. (c) Some bodies like wood, rubber etc. have negative value of coefficient of thermal expansion, hence they contract on heating, hence (A) is true. (B) is also true.
42. (d) Rate of flow of heat through a rod,

$H = \frac{kA}{2}\Delta T$

43. (d) All the given phenomena are caused due to convection.

CHAPTER

4 Sound

Periodic Motion

Any motion that repeats itself in equal intervals of time is called periodic motion. A periodic motion can be represented in terms of sines and cosines, so it is called a harmonic motion. The uniformly rotating earth represents a periodic motion that repeats itself at every 24 hours.

Simple Harmonic Motion (S.H.M.)

Oscillatory motion in which the acceleration of the particle is directly proportional to the displacement and directs towards a fixed point in a direction opposite to displacement is called simple harmonic motion abbreviated as S.H.M.

If a particle performs oscillatory motion such that its acceleration (a) and displacement (x) are related as below

$$a \propto -x,$$

then the motion of particle is simple harmonic.

An oscillatory motion is always periodic but a periodic motion may not be oscillatory.

Examples of S.H.M. (i) clock pendulum, (ii) oscillating liquid in a U-tube, (iii) oscillating block in a liquid, (iv) oscillating frictionless piston fitted in a cylinder filled with ideal gas, etc.

Sound

Sound is a form of energy which produces a sensation of hearing in our ears.

Source of Sound and its Propagation

A source of vibration (vibration means a kind of rapid to and fro motion of an object) is normally a source of sound. When we pluck a string of guitar or sitar or veena it produces sound. Similarly vibrations of wings of bee or mosquito.

Sound is emitted by vibrating source and is transmitted through a material medium producing sensation of hearing in our ears. The motion of a vibrating source sets up waves in the surrounding medium.

Sound Needs a Material Medium for its Propagation

In the absence of medium (air) around the source, sound is not being propagated and light (electromagnetic) waves travel through the vacuum.

Mechanical Waves

A mechanical wave is a periodic disturbance which requires a material medium for its propagation. The properties of these waves depend on the medium so they are known as elastic waves, such as sound-waves, water waves, waves in stretched string. On the basis of motion of particles the mechanical waves are classified into two parts.

(a) Transverse wave : *When the particles of the medium vibrate in a direction perpendicular to the direction of propagation of the wave, the wave is known as the transverse wave. For example, waves produced in a stretched string, waves on the surface. These waves travel in form of crests and troughs. These waves can travel in solids and liquids only.*

(b) Longitudinal wave : *When the particles of the medium vibrate along the direction of propagation of the wave then the wave is known as the longitudinal wave. For example sound wave in air, waves in a solid rod produced by scrabbing etc*.

These waves travel in the form of compressions and rarefactions. These waves can travel in solids, liquids and gases.

Electromagnetic Waves

The waves which do not require medium for propagation are called electromagnetic waves. This means that these waves can travel through vacuum also. For example, light waves, X-rays, γ-rays, Infrared waves, radio waves, microwaves, etc. These waves of transverse type.

Difference between sound waves and electromagnetic waves

(i) Sound waves are longitudinal and electromagnetic waves are transverse.

(ii) Sound waves travel at a speed of 340 m/s whereas electromagnetic waves travel at a speed of 3×10^8 m/s

(iii) Sound waves do not pass through a vacuum but electromagnetic waves (light) do.

Characteristics of Sound Waves

Sound is characterised by three parameters :

(i) Pitch (ii) Loudness (iii) Quality

(i) Pitch : Pitch is the sensation (brain interpretation) of the frequency of an emitted sound and is the characteristic which distinguishes a shrill (or sharp) sound from a grave (or flat) sound.

(ii) Loudness : Loudness or softness of a sound wave is the sensation that depends upon its amplitude. The loudness of sound is a measure of the sound energy reaching the ear per second.

The loudness of sound is measured in '**decibel** dB'. The loudness of sound of people talking quietly is about 65 dB, the loudness of sound in a very noisy factory is about 100 dB.

(iii) Quality (Timber) : Quality or timber of a sound wave is that characteristic which helps us in distinguishing one sound from another having same pitch and loudness. We recognise a person (without seeing) by listening to his sound as it has a definite quality.

A pure sound of single frequency is called a tone.

An impure sound produced by mixture of many frequencies is called a note. It is pleasant to listen.

Reflection of Sound

When sound waves strike a surface, they return back into the same medium. This phenomenon is called reflection.

Laws of reflection of sound waves

(i) Angle of incidence is equal to the angle of reflection.

(ii) The incident wave, the reflected wave and the normal all lie in the same plane.

Echo

Phenomenon of hearing back our own sound is called an echo. It is due to successive reflection from the surface of obstacles of large size.

Conditions for the formation of Echoes

(i) The minimum distance between the source of sound and the reflecting body should be 17.2 metres.

(ii) The wavelength of sound should be less than the height of the reflecting body.

(iii) The intensity of sound should be sufficient so that it can be heard after reflection.

Reverberation

Persistence of sound after its production stopped, is called reverberation.

When a sound is produced in a big hall, its wave reflect from the walls and travel back and forth. Due to this energy does not reduce and the sound persist.

A short reverberation is desirable in a concert hall (where music is being played) because it gives 'life' to sound.

Speed of sound

Speed of sound through any medium depends upon elasticity and density of medium.

(i) In solids, $v = \sqrt{\frac{Y}{d}}$

(ii) In liquids, $v = \sqrt{\frac{B}{\rho}}$

(iii) In gases, $v = \sqrt{\frac{\gamma P}{\rho}}$, $v = \sqrt{\frac{\gamma RT}{M}}$; $\gamma = \frac{C_P}{C_v}$

EXERCISE

1. Ultrasonic waves have frequency
   (a) below 20 Hz
   (b) between 20 and 20,000 Hz
   (c) only above 20,000 Hz
   (d) only above 20,000 MHz
2. Voice of your friend can be recognized by its
   (a) pitch (b) quality
   (c) intensity (d) velocity
3. The ratio of the speed of a body to the speed of sound is called
   (a) Sonic index (b) Doppler ratio
   (c) Mach number (d) Refractive index
4. The velocity of sound is largest in
   (a) water (b) air
   (c) metal (d) vacuum
5. An underwater explosion is caused near the sea-shore. There are two observers, *X* under water and *Y* on land, each at a distance of 1 km from the point of explosion then
   (a) *X* will hear the sound earlier
   (b) *Y* will hear the sound earlier
   (c) Both will hear the sound at the same time
   (d) *Y* will not hear the sound at all
6. If you are at open-air concert and someone's head gets between you and the orchestra, you can still hear the orchestra because
   (a) sound waves pass easily through a head
   (b) a head is not very large compared with the wavelength of the sound
   (c) the sound is reflected from the head
   (d) the wavelength of the sound is much smaller than the head
7. A thunder clap is heard 5.5 second after the lightening flash. The distance of the flash is
   (velocity of sound in air = 330 m/s)
   (a) 1780 m (b) 1815 m
   (c) 300 m (d) 3560 m
8. Which of the following is carried by the waves from one place to another ?
   (a) Mass (b) Velocity
   (c) Wavelength (d) Energy
9. Human ears can sense sound waves travelling in air having wavelength of
   (a) 10^{-3} m (b) 10^{-2} m
   (c) 1m (d) 10^{2} m
10. The frequency of a wave travelling at a speed of 500 ms^{-1} is 25Hz. Its time period is
    (a) 20 s (b) 0.05 s
    (c) 25 s (d) 0.04 s
11. The velocity of sound in any gas depends upon
    (a) wavelength of sound only
    (b) density and elasticity of gas
    (c) intensity of sound waves only
    (d) amplitude and frequency of sound
12. What is the effect of humidity on sound waves when humidity increases?
    (a) Speed of sound waves is more
    (b) Speed of sound waves is less
    (c) Speed of sound waves remains same
    (d) Speed of sound waves becomes zero

13. Which of the following is used to find the depth of sea?
    (a) RADAR (b) SONAR
    (c) ECHO (d) None of these
14. Echo is a type of
    (a) reflected sound
    (b) refracted sound
    (c) neither reflected sound nor refracted sound
    (d) None of these
15. A shrill sound has a _____ pitch and a dull sound has a _____ pitch.
    (a) high, low (b) low, high
    (c) low, low (d) high, high
16. _____ is the characteristic of a musical sound by which a loud sound can be distinguished from a faint sound even though both have the same pitch.
    (a) Loundness (b) Pitch
    (c) Quality (d) None of these
17. If you go on increasing the stretching force on a wire in a guitar, its frequency.
    (a) increases (b) decreases
    (c) remains unchanged (d) None of these
18. A vibrating body
    (a) will always produce sound
    (b) may or may not produce sound if the amplitude of vibration is low
    (c) will produce sound which depends upon frequency
    (d) None of these
19. The wavelength of infrasonics in air is of the order of
    (a) 10^0 m (b) 10^1 m
    (c) 10^{-1} m (d) 10^{-2} m
20. When a sound wave goes from one medium to another, the quantity that remains unchanged is
    (a) frequency (b) amplitude
    (c) wavelength (d) speed
21. Resonance is an example of
    (a) tuning fork (b) forced vibration
    (c) free vibration (d) damped vibration
22. A hollow sphere is filled with water. It is hung by a long thread. As the water flows out of a hole at the bottom, the period of oscillation will
    (a) first increase and then decrease
    (b) first decrease and then increase
    (c) go on increasing
    (d) go on decreasing
23. If a tunnel is dug along the diameter of earth and a piece of stone is dropped into it, then the stone will
    (a) come out of the another end of the earth and will escape out in space
    (b) come to rest at the centre of the earth
    (c) start oscillating about the centre of the earth
    (d) stop at another end of the earth
24. Which of the following statements is incorrect regarding the time period of a simple pendulum oscillating with small amplitude? The time period of the pendulum
    (a) is inversely proportional to $\sqrt{g}$
    (b) is directly proportional to $\sqrt{\ell}$
    (c) does not depend upon the amplitude
    (d) depends upon its mass, material and shape
25. Range of audio-frequencies is
    (a) 1 – 15 Hz (b) 20 – 20, 000 Hz
    (c) $10^3 - 10^5$ Hz (d) $10^6 - 10^8$ Hz
26. The marching soldiers break steps while crossing a bridge because of
    (a) damped oscillations (b) resonance
    (c) echo (d) reverberation

ANSWER KEY											
1	(c)	**6**	(b)	**11**	(b)	**16**	(a)	**21**	(b)	**26**	(b)
2	(b)	**7**	(b)	**12**	(a)	**17**	(a)	**22**	(a)		
3	(c)	**8**	(d)	**13**	(b)	**18**	(c)	**23**	(c)		
4	(c)	**9**	(c)	**14**	(a)	**19**	(b)	**24**	(d)		
5	(a)	**10**	(d)	**15**	(a)	**20**	(a)	**25**	(b)		

HINTS AND SOLUTIONS

11. (b) Velocity of sound in any gas depends upon density and elasticity of gas.

12. (a) Velocity of sound = $\sqrt{\frac{\gamma RT}{M}}$

When water vapour are present in air average molecular weight of air decreases and hence velocity increases.

22. (a) Time period of simple pendulum $T = 2\pi\sqrt{\left(\frac{l}{g}\right)} \propto \sqrt{l}$

where l is effective length.

[i.e distance between centre of suspension and centre of gravity of bob]

Initially, centre of gravity is at the centre of sphere. When water leaks the centre of gravity goes down until it is half filled; then it begins to go up and finally it again goes at the centre. That is effective length first increases and then decreases. As $T \propto \sqrt{l}$, so time period first increases and then decreases.

24. (d) $T = 2\pi\sqrt{\frac{\ell}{g}}$

CHAPTER

5 Optics

Optics

The branch of physics which deals with the propagation, nature and behaviour of light is known as **optics**.

Light

Light is a form of energy which enables human beings and creatures to 'see' things. When light emitted from an object or reflected from the object enters our eyes we are able to see the object. We can't see an object in dark even if we are in light because there is no light coming from the object to our eyes.

Light is an electromagnetic radiation which exhibits properties like a wave as well as a particle. It always propagates in a straight line.

Light travels with a speed nearly equal to 3×10^8 m/s. According to current theories, no material particle can travel at a speed greater than the speed of light.

Luminous and Non-luminous Objects

Luminous objects are those which emit its own light e.g., sun, glowworm, burning candle, electric lights. *Non-luminous objects do not give out its own light but are visible only when light from a luminous object falls on it. e.g.*, moon, earth, table, paper, etc.

Transparent Translucent and Opaque materials

Transparent materials are those which allow most of light to pass through them. *Example* : Glass, water, air.

Translucent materials allow only a part of light to pass through it. We cannot see distinctly through them. *Example* : greased paper, paraffin wax, etc.

Opaque materials do not allow any light to pass through it. They reflect or absorb all the light that falls on them. *Example* : Books, desk, stone, rubber, trees, etc.

Reflection of Light

When light hits an opaque material, the light may be absorbed by the material and converted into heat energy. If light is not absorbed, it is bounced back or reflected at the surface of material.

The turning back of light in the same medium is called reflection of light.

Laws of reflection

1. The angle of incidence '*i*' is equal to the angle of reflection '*r*'.
2. At the point of incidence, the incident rays, the normal to the surface and the reflected ray all lie in the same plane.

Reflection by Plane Mirrors

Plane mirror is a looking glass which is highly polished on one surface and is silvered on the other surface. When a light ray strikes the polished surface, it is reflected by the silvered surface.

An 'image' is defined as the impression of an object carried over and formed by light reflected from it.

Use of plane mirrors

(a) Plane mirrors are primarily used as looking glasses.
(b) Since, a combination of mirrors can produce multiple images, they are used to provide false dimensions in showrooms.
(c) They are also used as reflectors in solar cookers.
(d) Plane mirrors are used in the construction of a periscope.

Images and their properties

An 'image' is defined as the impression of an object carried over and formed by light reflected from it. An image is said to be a **real image** if it can be caught on a screen, and a **virtual image** if it cannot be caught on the screen. For example, the image on the screen in a theatre is a real image and the image observed in a plane mirror is a virtual image.

Real image

1. When the rays of light actually meet, the image so formed is known as real image.
2. A real image can be caught on a screen since it is formed by actual meeting of rays.
3. A real image is always inverted.
4. A real image is formed by a convergent reflected beam.
5. In ray diagrams, for real image, the rays are represented by full lines.

Virtual image

1. When the rays of light appear to meet, the image so formed is known as virtual image.
2. A virtual image cannot be caught on a screen since it is formed by meeting of imaginary rays.
3. A virtual image is always erect.
4. A virtual image is formed by a divergent reflected beam.
5. In ray diagrams, for virtual image, the rays are generally represented by dotted lines.

Characteristics of images formed by a plane mirror

The image formed by a plane mirror is

(a) virtual (the image cannot be formed on a screen)
(b) upright
(c) laterally inverted (the left side of an image is formed by the right side of an object)
(d) the same size as the object
(e) the same distance behind the mirror as the object is in front of the mirror

Concave and Convex Mirror

Concave mirror : If the reflection takes place from the inner surface of a spherical mirror, then the mirror is called concave mirror.

Convex mirror : If the outer surface of the spherical mirror acts as a reflector then the mirror is called convex mirror.

Uses of concave mirrors :

(i) In torches, search-lights and vehicles headlights to get powerful beams of light.

(ii) As a shaving mirror to see a large image of the face.

(iii) As a dentists mirror to see large images of the teeth of patients.

(iv) Large sized concave mirror is used to concentrate sunlight to produce heat in solar furnaces.

Uses of convex mirrors :

(i) As a rear -view mirrors in vehicles.

(ii) For security purposes.

Mirror Formula

If an object is placed at a distance u from the pole of a mirror and its image is formed at a distance v (from the pole) then,

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

Magnification

If a thin object linear size O situated vertically on the axis of a mirror at a distance u from the pole and its image of size I is formed at a distance v (from the pole), magnification (transverse) is defined as

$$m=\left[\frac{I}{O}\right]=\left[\frac{v}{u}\right]$$

- (+ve means erect image)
- (–ve means inverted image)
- (|m| >1 means large image)
- (|m| < 1 means small image)

Refraction of Light

When a ray of light passes from one medium to another medium it bends – towards the normal when goes from rarer to denser and away from the normal when goes from denser to rarer medium. This phenomenon is called refraction of light.

Twinkling of stars, sun is visible to us about 2 minutes before the actual sunrise, and about 2 minutes after actual sunset etc. due to atmospheric refraction.

Refractive index

Refractive index of medium II with respect to medium I

$$\mu_{21}=\frac{Speed\ of\ light\ in\ medium\ I}{Speed\ of\ light\ in\ medium\ II}$$

Laws of Refraction

(i) **Snell's law :** For any two media and for light of a given wavelength, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.

i.e., $\frac{\sin i}{\sin r}$ =constant, where i = incidence angle, r = refraction angle.

(ii) The incident ray, the refracted ray and the normal at the incident point all lie in the same plane.

When object is in denser medium and observer is in rarer medium:

$$Refractive\ index\ \mu=\frac{Real\ depth}{Virtual\ depth}$$

Lens

A lens is a piece of transparent material with two refracting surfaces such that atleast one is curved and refractive index of used material is different from that of the surroundings.

Refraction through a thin lens (lens formula)

If an object is placed at a distance u from the optical centre of a lens and its images is formed at a distance v (from the optical centre) and focal length of this length is f then

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

This is called lens formula.

Power of a lens

The power of a lens is defined as $P=\frac{1}{f(\text{in } m)}$. The unit of power is diopter.

Focal length of a lens (lens maker's formula)

$$\frac{1}{f}=({}_m\mu_\ell-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

where ${}_m\mu_\ell$ refractive index of lens with respect to medium.

R_1 = radius of curvature of first surface of lens, R_2 = radius of curvature of second surface of lens.

Total Internal Reflection

When the object is placed in an optically denser medium and if the incident angle is greater than the critical angle then the ray of light gets reflected back to the originating medium. This phenomenon is called total internal reflection.

Critical angle (i_c) : When a ray passes from an optically denser medium to an optically rarer medium, the angle of refraction r is greater than the corresponding angle of incidence i. From Snell's law.

Let $\mu_1=\mu$ and $\mu_2=1$ and let for $i=i_c$, $r=90°$ then $\sin i_c=1/\mu$

$\therefore\ i_c=\sin^{-1}\frac{1}{\mu}$; i_c is called the critical angle.

This phenomenon takes place in shining of air bubble, sparkling of diamond, mirage, looming, in optical communication, endoscopy using optical fibre.

Dispersion of Light

When a white ray of light or sunlight passes through a prism it breakes into its seven constituents colours violet, indigo, blue, green, yellow, orange and red (VIBGYOR). This phenomenon is called ***dispersion of light***. The band of seven constituents colours is called **spectrum.** The deviation is maximum for violet colour and least for red colour.

The Rainbow

A rainbow is a spectrum of white light from the sun. This is a phenomenon due to combined effect of dispersion, refraction and reflection of sunlight by spherical water droplets of rain.

(i) **Primary rainbow:** It is formed due to two refractions and one total internal reflection of the light incident on the droplet. Sunlight is first refracted as it enters a raindrop which cause different colours of light to separate. The observer sees a rainbow with red colour on the top and violet on the bottom.

(ii) **Secondary rainbow:** It is formed due to two refractions and two total internal reflection of light incident on the water droplet. It is due to four - step process. The intensity of light is reduced at the second reflection and hence the secondary rainbow is fainter than the primary rainbow.

Scattering of Light

As sunlight travels through the earth's atmosphere it gets scattered by the small particles present in the atmosphere.
According to Rayleigh law, the amount of scattering is inversely proportional to the fourth power of the wavelength $\left(\frac{1}{\lambda^4}\right)$.

Phenomenon based on scattering of light

(i) **Blue colour of sky:** Blue colour has a shorter wavelength than red colour therefore blue colour is scattered strongly. Hence the bluish colour predominates in a clear sky.

(ii) **White colour of clouds:** Clouds contain large dust particles, water droplets or ice particles. These large sized Particles do not obey Rayleigh law of scattering. All wavelengths are scattered nearly equally. Hence clouds are generally white.

(iii) **Sun looks reddish at the Sunset or Sunrise:** At sunset or sunrise, the sun's rays have to pass through a larger distance in the atmosphere. Most of the blue and other shorter wavelengths are scattered. The least scattered light reaching our eyes, therefore the sun looks reddish.

Power of Accomodation of Eye

The ability of the lens to change its shape to focus near and distant objects is called accommodation.

A normal human eye can see objects clearly that are between 25 cm and infinity.

Defects of Vision and Their Correction

Nearsightedness: If the eyeball is too long or the lens too spherical, the image of distant objects is brought to a focus in front of the retina and is out of focus again before the light strikes the retina. Nearby objects can be seen more easily. Eyeglasses with concave lenses correct this problem by diverging the light rays before they enter the eye. Nearsightedness is called myopia.

Farsightedness: If the eyeball is too short or the lens too flat or inflexible, the light rays entering the eye — particularly those from nearby objects— will not be brought to a focus by the time they strike the retina. Eyeglasses with convex lenses can correct the problem. Farsightedness is called hypermetropia.

Astigmatism : Astigmatism is the most common refractive problem responsible for blurry vision. Most of the eyeball's focusing power occurs along the front surface of the eye, involving the tear film and cornea (the clear 'window' along the front of the eyeball).

The ideal cornea has a perfectly round surface. Anything other than perfectly round contributes to abnormal corneal curvature– this is astigmatism. Cylindrical lens is use to correct astigmatism.

Microscope

It is an optical instrument used to see magnified image of a tiny objects.

Resolving power (R.P.) of a microscope

Resolving power of a microscope is defined as the reciprocal of the least separation between two close objects, so that they appear just separated, when seen through the microscope.

$$\textit{Resolving power of a microscope} = \frac{1}{d} = \frac{2\mu \sin\theta}{\lambda}$$

θ = half angle of the cone of light from the point object

$\mu \sin\theta$ = numerical aperture

Telescope (Astronomical)

It is an optical instrument used to increase the visual angle of distant large objects.

It is used to see far off objects clearly.

Resolving power (R.P.) of a telescope

Resolving power of telescope is defined as the reciprocal of the smallest angular separation between two distant objects, so that they appear just separated, when seen through the telescope.

$$\textit{Resolving power of telescope} = \frac{D}{1.22\lambda}$$

Interference of Light Waves

The phenomenon of redistribution of light energy in a medium due to superposition of light waves from two coherent sources is called interference of light.

Conditions for sustained interference:

(i) Two sources must be coherent.

(ii) Amplitudes of waves should be either equal or approximately equal.

(iii) Light should be monochromatic.

Polarisation

It is the phenomenon of restricting the vibration of light in a particular plane.
Light waves are transverse in nature i.e., the electric field vector associated with light wave is always at right angles to the direction of propagation of the wave. When unpolarised light is incident on a polaroid (Nicol Prism), the light wave gets linearly polarised i.e., the vibration of electric field vector are along a single direction.

EXERCISE

1. When the distance between the object and the plane mirror increases
   (a) the image remains same
   (b) the size of the image will become less than the size of the object
   (c) the distance between the image and the plane mirror increases
   (d) the distance between the image and the plane mirror decreases
2. In lateral inversion
   (a) right side of the object will be right side of the image.
   (b) left side of the object will be left side of the image.
   (c) upside of the object will be down side of the object.
   (d) right side of the object will be left side of the image.
3. The sun is seen before the actual sunrise because of
   (a) reflection
   (b) refraction
   (c) scattering of light
   (d) rectilinear propagation of light
4. Butter paper is an example for ..... object.
   (a) a transparent (b) a translucent
   (c) an opaque (d) a luminous
5. Power of accommodation of eye implies
   (a) control intensity
   (b) prevent internal reflection of light
   (c) change of focal length of eye lens
   (d) All of the above
6. Which of the following parts of eye protects the eye and gives it shape?
   (a) Choroid (b) Sclera
   (c) Yellow spot (d) Ciliary muscles
7. The human eye forms the image of an object at its
   (a) cornea (b) iris
   (c) pupil (d) retina
8. Rainbow is caused due to
   (a) reflection of sun light from air particles
   (b) dispersion of sun light from water drops
   (c) interference of light
   (d) diffraction of sun rays from water drops
9. In the visible spectrum the colour having the shortest wavelength is
   (a) green (b) red
   (c) violet (d) blue
10. The splitting of white light into seven colours on passing through a glass prism is due to
   (a) refraction (b) reflection
   (c) interference (d) diffraction
11. At sunrise or at sunset the sun appears to be reddish while at mid-day it looks white. This is because
   (a) scattering due to dust particles and air molecules causes this phenomenon
   (b) the sun is cooler at sunrise or at sunset
   (c) refraction causes this phenomenon
   (d) diffraction sends red rays to the earth at these times
12. A person cannot see objects clearly which are nearer than 75 cm from his eyes, the disease he is suffering from is
   (a) astigmatism (b) myopia
   (c) hypermetropia (d) presbyopia
13. For seeing a cricket match, we prefer binoculars to the terrestrial telescope, because
   (a) binoculars give three-dimensional view
   (b) terrestrial telescope gives inverted image
   (c) to avoid chromatic aberration
   (d) to have larger magnification
14. Dispersion is the term used to describe
   (a) the propagation of light in straight lines
   (b) the splitting of a beam of light into component colours
   (c) the bending of a beam of light when it strikes a mirror
   (d) the change that takes place in white light after passage through red glass
15. Consider telecommunication through optical fibres. Which of the following statement is not true?
   (a) Optical fibres can be of graded refractive index
   (b) Optical fibres have extremely low transmission loss
   (c) Optical fibres are subject to electromagnetic interference from outside
   (d) Optical fibres may have homogeneous core with a suitable cladding
16. An optician while testing the eyes finds the vision of a patient to be 6/12. By this he means that
   (a) the person can read the letters of 6 inches from a distance of 12 m
   (b) the person can read the letters of 12 inches from 6 m
   (c) the person can read the letters of 6 m which the normal eye can read from 12 m
   (d) the focal length of eye lens had become half that of the normal eye
17. A mirage occurs because
   (a) the refractive index of atmosphere increases with height
   (b) the refractive index of atmosphere decreases with height
   (c) the hot ground acts like a mirror
   (d) refractive index remains constant with height
18. A well cut diamond appears bright because
   (a) of reflection of light
   (b) of dispersion of light
   (c) of the total internal reflection
   (d) of refraction of light

19. Twinkling of stars is on account of
(a) large distance of stars and storms in air
(b) small size of stars
(c) large size of stars
(d) large distance of stars and fluctuations in the density of air

20. A coin in a beaker filled with water appears raised. This phenomenon occurs because of the property of
(a) reflection of light
(b) refraction of light
(c) total internal reflection of light
(d) interference of light

21. A spherical air bubble is embedded in a piece of glass. For a ray of light passing through the bubble, it behaves like a
(a) converging lens (b) diverging lens
(c) plano-converging lens (d) plano-diverging lens

22. 'The stars seem to be higher on the sky than they actually are'. This can be explained by
(a) atmospheric refraction (b) dispersion of light
(c) total internal reflection (d) diffraction of light

23. Yellow colour light is used as fog light because yellow colour
(a) light is most scattered by fog
(b) has the longest wavelength among all colours
(c) has the longest wavelength among all colours except red and orange but the red colour is already used for brake light and stop light whereas orange colour is avoided due to its similarity with red
(d) has the shortest wavelength among all colours

24. The mirror used for the head light of a car is
(a) spherical concave (b) plane
(c) cylindrical (d) parabolic concave

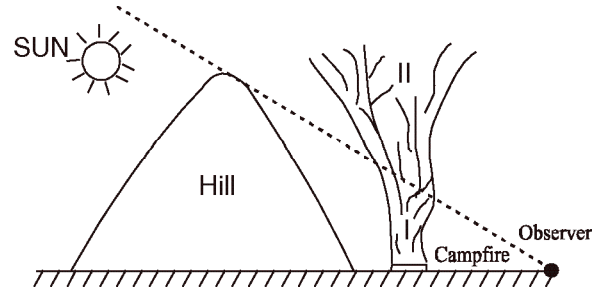
25. Soap bubble looks coloured due to
(a) dispersion (b) reflection
(c) interference (d) Any one of these

26. A star is emitting yellow light. If it is accelerated towards earth then to an observer on earth, it will appear
(a) shinning yellow
(b) gradually changing to violet
(c) gradually changing to red
(d) unchanged

27. What should be refractive index of a transparent medium to be invisible in vacuum?
(a) 1 (b) < 1
(c) > 1 (d) None of these

28. When a drop of oil is spread on a water surface, it displays beautiful colours in daylight because of
(a) dispersion of light (b) reflection of light
(c) polarization of light (d) interference of light

29. Smoke emerging from a campfire at the bottom of a hill is being observed by a person at some distance, as shown in the figure. It is evening and the sun has just set behind the hill. Consider regions I and II of the smoke going up the sky



(a) region I will be slightly brighter than the hill and region II will be slightly brighter than the sky
(b) region I will be slightly darker than the hill and region II will be slightly brighter than the sky
(c) region I will be slightly brighter than the hill and region II will be slightly darker than the sky
(d) region I will be slightly darker than the hill and region II will be slightly darker than the sky

30. The ability of an optical instrument to show the images of two adjacent point objects as separate is called
(a) dispersive power (b) magnifying power
(c) resolving power (d) None of these

31. Total internal reflection can take place only if
(a) light goes from optically rarer medium to optically denser medium
(b) light goes from optically denser medium to rarer medium
(c) the refractive indices of the two media are close to different
(d) the refractive indices of the two media are widely different

32. The least distance of distinct vision of a normal eye of an adult is
(a) 25 m (b) 25 cm
(c) 25 mm (d) None of these

33. Rear-view mirror used in a vehicle is a
(a) concave mirror (b) convex mirror
(c) plane mirror (d) None of these

34. Magnification produced by a rear view mirror fitted in vehicles
(a) is less than one
(b) is more than one
(c) is equal to one
(d) can be more than or less than one depending upon the position of the object in front of it

35. A child is standing in front of a magic mirror. She finds the image of her head bigger, the middle portion of her body of the same size and that of the legs smaller. The following is the order of combinations for the magic mirror from the top.
(a) Plane, convex and concave
(b) Convex, concave and plane
(c) Concave, plane and convex
(d) Convex, plane and concave

36. When a CD (compact disc used in audio and video systems) is seen in sunlight, rainbow like colours are seen. This can be explained on the basis of the phenomenon of
(a) reflection and diffraction
(b) reflection and transmission
(c) diffraction and transmission
(d) refraction, diffraction and transmission

37. A watch shows times as 3 : 25 when seen through a mirror, time appeared will be
(a) 8 : 35 (b) 9 : 35
(c) 7 : 35 (d) 8 : 25

38. The fine powder of a coloured glass is seen as
(a) coloured (b) white
(c) black (d) that of the glass colour

39. For which wavelength of light is our eye most sensitives
(a) 3.00 nm (b) 555 nm
(c) 200 nm (d) 800 nm

40. The acronym for LASER is
(a) Light Amplification by Stimulated Emission of Radiation
(b) Low Amplitude Stimulated Emission of Radiation
(c) Low Amplitude Short Energy Radiation
(d) Light Amplification by Short Energy Radiation

ANSWER KEY											
1	(c)	**8**	(b)	**15**	(c)	**22**	(a)	**29**	(c)	**36**	(d)
2	(d)	**9**	(c)	**16**	(c)	**23**	(c)	**30**	(c)	**37**	(a)
3	(b)	**10**	(a)	**17**	(a)	**24**	(d)	**31**	(b)	**38**	(b)
4	(b)	**11**	(a)	**18**	(c)	**25**	(c)	**32**	(b)	**39**	(b)
5	(c)	**12**	(c)	**19**	(d)	**26**	(b)	**33**	(b)	**40**	(a)
6	(b)	**13**	(a)	**20**	(b)	**27**	(a)	**34**	(a)		
7	(d)	**14**	(b)	**21**	(b)	**28**	(d)	**35**	(c)		

HINTS AND SOLUTIONS

10. (a) Disperssion arises because of basic phenomenon refraction.

20. (b) We know that, the apparent depth is μ times less than the actual depth. i.e.,

$$d_{apparent} = \frac{d_{actual}}{\mu}$$

21. (b) Bubble will behave as diverging lens because refrective index of air is less than that of a glass.

22. (a) Due to atmospheric refraction the twinkling of star, and their position appear higher than the normal.

23. (c) Yellow colour is used as fog light because of its longest wavelength it 63.33 penetrates well through dense fog.

24. (d) Parabolic reflectors are used to collect energy from a distant source (for example sound waves or incoming star light) and bring it to a common focal point, thus correcting spherical aberration found in simpler spherical reflectors. Since the principles of reflection are reversible, parabolic reflectors can also be used to project energy of a source at its focus outward in a parallel beam, used in devices such as spotlights and car headlights.

25. (c) Interference at thin films causes colouring of soap bubble.

26. (b) As the star is accelerated towards earth, its apparent frequency increases, apparent wavelength decreases. Therefore, colour of light changes gradually to violet.

27. (a) To be invisible in vacuum, μ of medium must be equal to μ of vacuum, which is 1.

28. (d) The colours are seen due to interference of light. The colours seen in reflected light are complementary with the colours seen in transmitted light.

30. (c) This ability refers to resolving power of the instrument.

31. (b) According to Snell's Law

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$$

where $r = 90^o$ for particular incidence angle called critical angle. When the incidence angle is equal to or greater then i_c, then total internal reflection occurs. It take place when ray of light travels from optically denser medium ($\mu_1 > \mu_2$)to optically rarer medium.

36. (d) The reason CDs reflect rainbow colors is because they have a clear plastic coating on top of a mirrorized surface. Light refracts (bends) when it moves from one medium (such as air) to another with a different optical density (such as the clear plastic surface of a CD). Different wavelengths of light (every color has a different wavelength) travel at different speeds, so that full spectrum appears when white light passes from the air through the plastic surface of a CD, separated light rays which are then reflected back to us by the mirrorized center surface of a CD. Here the diffraction and transmission also takes place because diffraction of light rays occur when it strikes the surface of CD and transmission is obvious when light enters from one medium to another. The thickness of the different optical media, angle of source light, and brightness of source light all affect which rainbow patterns are visible on a CD.

37. (a) Subtract the given time from 11: 60.

38. (b) All colours are reflected.

39. (b) Our eye can see wavelength of light range 4000Å to 7800Å

CHAPTER

6 Electricity

Electric Charges

Charge is something associated with matter due to which it produces and experiences electric and magnetic effects.

The study of charges at rest is called **static electricity** or **electrostatics** while the study of charges in motion is called **current electricity**. There are two types of electric charge :

(i) *Positive charge* and (ii) *Negative charge*

The magnitude of elementary positive or negative charge is same and is equal to 1.6×10^{-19} C.

Charge is a scalar quantity and its **SI unit** is ampere second or **coulomb** (C).

Basic Properties of Electric Charge

(1) *Similar charges repel and opposite charges attract.*

(2) *A charged body attracts light uncharged bodies.*

(3) *Accelerated charge radiates energy.*

Conductors and Insulators

The materials which allow electric charge (or electricity) to flow freely through them are called **conductors**. Metals are very good conductors of electric charge. Silver, copper and aluminium are some of the good conductors of electricity.

The materials which do not allow electric charge to flow through them are called **nonconductors** *or* **insulators**.

For example, most plastics, rubber, non-metals (except graphite), dry wood, wax, mica, porcelain, dry air etc., are insulators.

Coulomb's Law

It states that, *the electrostatic force of interaction (repulsion or attraction) between two electric charges q_1 and q_2 separated by a distance r, is directly proportional to the product of the charges and inversely proportional to the square of distance between them.*

i.e., $F \propto q_1 q_2$ and $F \propto 1/r^2$ or $F = k\frac{q_1 q_2}{r^2}$

$$K = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \frac{Nm^2}{coul^2} \Rightarrow \varepsilon_0 = 8.85 \times 10^{-12} \frac{coul^2}{Nm^2}$$

Electric Field

The region surrounding an electric charge or a group of charges in which another charge experiences a force of attraction or repulsion is called 'electric field'.

$$\vec{E} = \frac{\vec{F}}{q_0}, \quad \vec{E} = \lim_{q_0 \to 0} \frac{\vec{F}}{q_0}$$

The **S.I. unit** of electric field intensity is N/coul or volt/metre.

Electric Lines of Force

An electric line of force is that imaginary smooth curve drawn in an electric field along which a free isolated unit positive charge moves.

Two lines of force never intersect. If they are assumed to intersect, there will be two directions of electric field at the point of intersection, which is impossible.

Electric Flux (ϕ)

The total number of electric lines of force through a given area is called the electric flux.

(a) For open surface, $\phi_0 = \int d\phi = \int \vec{E} \cdot d\vec{s}$

(b) For closed surface, $\phi_c = \oint \vec{E} \cdot d\vec{s}$

Gauss's Law

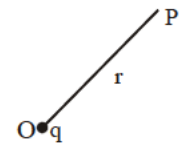
The total electric flux linked with a closed surface is $\left(\frac{1}{\varepsilon_0}\right)$ *times the charge enclosed by the closed surface (Gaussian surface). i.e.* $\oint \vec{E}.d\vec{s} = \frac{q}{\varepsilon_0}$

Electrostatic Potential

Potential at a point can be physically interpreted as the work done by the field in displacing a unit + ve charge from some reference point to the given point.

i.e., $V = \frac{w}{q_0}$

$$V = -\int_{\infty}^{r} \vec{E}.d\vec{s} \text{ i.e. } E = -\frac{dv}{dr}$$



It is a scalar quantity.

Its **dimensions :** $[M L^2 T^{-3} A^{-1}]$

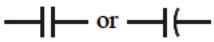
Its **SI unit** is volt or joule coulomb^{-1}.

Equipotential Surfaces

For a given charge distribution, locus of all points having same potential is called equipotential surfaces.

Capacitors and Capacitance

A capacitor or condenser *is a device that stores electrical energy. It consists of conductors of any shape and size carrying charges of equal magnitude and opposite signs and separated by an insulating medium*

The symbol of a capacitor is  or

The net charge on a capacitor is zero.

Capacitance or **capacity** *of a capacitor is a measure of ability of the capacitor to store charge on it.*

When a conductor is charged then its potential rises. The increase in potential is directly proportional to the charge given to the conductor.

i.e., $Q \propto V$ or $Q = CV$ or, $C = \frac{Q}{V}$

The constant C is known as the **capacitance of the conductor.**

Its **SI unit** is farad (F) or coulomb/volt

Capacitance of the conductor depends upon :

(i) Size of conductor

(ii) Surrounding medium

(iii) Presence of other conductors nearby

Equivalent Capacitance of Capacitors

In series : $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + ... + \frac{1}{C_n}$

In parallel : $C_{eq} = C_1 + C_2 + ... + C_n$

Van de Graff Generator (High Voltage Generator)

R.J. Van de Graff in 1931 designed an electrostatic generator capable of generating very high potential of the order of 5×10^6 V, which was then made use of an accelerating charged particles so as to carry out nuclear reactions.

Principle : It is based on the following two electrostatic phenomena

(i) The electric discharge takes place in air or gases readily at pointed conductors.

(ii) If a hollow conductor is in contact with an other conductor, then as charge is supplied to the conductor, the hollow conductor continues accepting the charge irrespective of the fact, howsoever large its potential may grow.

Electric Current

The time rate of flow of charge through any cross-section is called electric current. If Δq charge passes through a cross-section in time Δt then, *average current* $I_{av} = \frac{\Delta q}{\Delta t}$

Instantaneous current $I = \lim_{\Delta t \to 0} \frac{\Delta q}{\Delta t} = \frac{dq}{dt}$

Electric current is measured in **ampere (A).**

Types of electric current :

(a) Direct current : *The current whose magnitude and direction does not vary with time is called direct current (dc).* The various sources are cells, dc dynamo, etc.

It's symbol is 

(b) Alternating current : *The current whose magnitude continuously changes with time and periodically changes its direction is called alternating current.* It has constant amplitude and has alternate positive and negative halves. It is produced by ac dynamo.

It's symbol is 

Resistance, Conductance and Resistivity

Resistance (R) : *It is the property of a substance due to which it opposes the flow of current through it.*

Its **SI unit** volt/ampere called **ohm (Ω).**

$$R \propto L \text{ and } R \propto \frac{1}{A} \text{ so, } R \propto \frac{L}{A} \text{ or } R = \rho\frac{L}{A}$$

where L = length, A = area of cross-section of wire and ρ is called **resistivity** or **specific resistance**.

The reciprocal of specific resistance is conductance i.e. $\sigma = \frac{1}{\rho}$

Superconductors

At a very low temperature, the resistance of the conductor may vanish completely. When it happens, the conductor is called a **superconductor**. For example, helium is a super conductor at 4.2 K (–268.8°C).

Ohm's Law

It states that if the physical state i.e. temperature, nature of material and dimensions of a conductor remain unchanged then the ratio of potential difference applied across its ends to current flowing through it remains constant.

i.e., $V \propto I$ or $V = IR$, where $R = \frac{V}{I}$ is the resistance of conductor.

Combination of Resistors – Series and Parallel

Series Combination of Resistors

Resistances are said to be connected in series between two points if they provide only a single path between two points.

$$R_s = R_1 + R_2 + R_3 + ... + R_n$$

Parallel Combination of Resistors

Resistances are said to be connected in parallel between two points, if it is possible to proceed from one point to another along different paths.

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

Electrical Energy, Power

When a current is passed through a resistor energy is wasted in overcoming the resistance of the wire. This energy is converted into heat.

The heat generated (in joule) when a current of I ampere flows through a resistance of R ohm for T second is given by :

$$H = I^2RT = VIt = \frac{V^2}{R}t \text{ joule} = \frac{I^2RT}{4.2} \text{ calorie}$$

This is the joule's law of heating

1 *unit of electrical energy*

$$= 1 \text{ Kilowatt hour } (1 \text{ KWh}) = 3.6 \times 10^6 \text{ joule}$$

This is known as **Board of trade (B.O.T)** unit of electrical energy.

Energy liberated per second is called its ***power.*** The electrical power P delivered or consumed by an electrical device is given by P = VI, where V = Potential difference across the device and I = current.

Ammeter

An ammeter is a low resistance galvanometer used to measure strength of current in an electrical circuit.

An ammeter is always connected in series in a circuit because, when an ammeter is connected in series it does not appreciably change the resistance of circuit and hence the main current flowing through the circuit.

Conversion of galvanometer into ammeter :

A galvanometer can be converted to an ammeter by connecting a low resistance or shunt in parallel to coil of galvanometer.

Voltmeter

A voltmeter is a high resistance galvanometer used to measure potential difference.

A voltmeter is connected in parallel to a circuit element because, when connected in parallel it draws least current from the main current. So it measures nearly accurate potential difference.

Conversion of galvanometer into voltmeter :

A galvanometer is converted to a voltmeter by connecting a high resistance in series with the coil of galvanometer.

Alternating Current

When an alternating voltage is applied across a coil or a bulb, it sends a similar varying current (i.e., of the same nature as that of voltage) through the coil. The current is called alternating current (A.C.).

The current flowing in only one direction in a circuit is called direct current (D.C.). Batteries, thermocouples and solar cells are some of the sources of direct current.

Advantages of Alternating Current Over Direct Current

(i) A.C. can be obtained over a wide range of voltages. These voltages can be easily stepped up or stepped down with the help of transformers.

(ii) The generation of A.C. is found to be economical than that of D.C.

(iii) Alternating current can be controlled by using a choke coil without any significant wastage of electrical energy.

(iv) Alternating current may be transmitted at a high voltage from the power house to any place where it can again be brought down to low voltage. The cost in such a transmission is low and energy losses are minimized. Transformers cannot be used for D.C. Hence the cost of D.C. transmission from one place to other is quite high.

(v) A.C. equipments such as electric motors etc are more durable and convenient as compared to D.C. equipments.

Transformers

It is a device used for transforming a low alternating voltage of high current into a high alternating voltage of low current and vice versa, without increasing power or changing frequency.

Principle : It works on the phenomenon of mutual induction.

If a low voltage is to be transformed into a high voltage, then the number of turns in secondary is more than those in primary. The transformer is called a **step up transformer.**

If a high voltage is to be transformed into a low voltage, then the number of turns in secondary is less than those in primary. The transformer is called a **step-down transformer.**

Transformation ratio of the transformer,

$$K = \frac{Number\ of\ turns\ in\ secondary\ (N_s)}{Number\ of\ turns\ in\ primary\ (N_p)}$$

K > 1, for step-up transformer.

K < 1, for step-down transformer.

input power = output power

i.e., $E_p \times I_p = E_s \times I_s$ or, $\frac{I_p}{I_s} = \frac{E_s}{E_p} = \frac{N_s}{N_p}$

Uses of Transformer

A transformer is used in almost all ac operation.

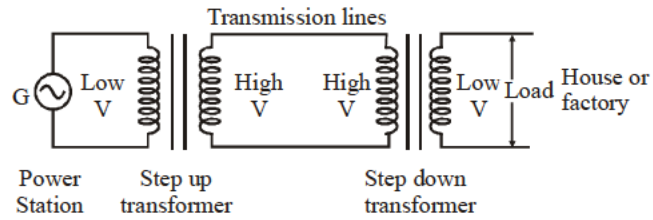
(i) In voltage regulators for TV, refrigerator, computer, air conditioner etc.

(ii) In the induction furnaces.

(iii) Step down transformer is used for welding purposes.

(iv) In the transmission of ac over long distance.

(v) Step down and step up transformers are used in electrical power distribution.



(vi) Audio frequency transformers are used in radiography, television, radio, telephone etc.

(vii) Radio frequency transformers are used in radio communication.

Faraday's Laws of Electromagnetic Induction

Faraday gave two laws of electromagnetic induction.

First law : *Whenever there is change in the magnetic flux associated with a circuit, an e.m.f. is induced in the circuit. This is also known as* ***Neumann's law.***

Second law : *The magnitude of the induced e.m.f. (e) is directly proportional to the time rate of change of the magnetic flux through the circuit.*

i.e., $e \propto \frac{\Delta\phi}{\Delta t}$ or, $e = k\frac{\Delta\phi}{\Delta t}$

In the **S.I. system**, emf 'e' is measured in volt and $\frac{d\phi}{dt}$ in Wb/sec.

Lenz's law and Conservation of Energy

According to Lenz's law, *the direction of the induced current is such that it opposes the change in the magnetic flux that causes the induced current or e.m.f.* i.e., induced current tries to maintain flux.

On combining Lenz's law with Faraday's laws $e = -\frac{d\phi}{dt}$

The Lenz's law is consistent with the law of conservation of energy.

Eddy Currents

The induced circulating current produced in a metal itself due to change in magnetic flux linked with the metal are called eddy current.

The direction of eddy currents is given by Lenz's law.

Applications of Eddy Currents

(1) Dead beat galvanometer.
(2) Energy meter.
(3) Speedometer.
(4) Electric brakes.
(5) Single phase AC motor.
(6) Induction furnace.

Self Inductance

*Production of induced e.m.f. in a coil due to the changes in current in the same coil, is called **self induction**.*

The magnetic flux (ϕ) linked with the coil is directly proportional to the current (I) flowing through it.

i.e. $\phi \propto I \quad \therefore \quad \phi = L I$

The constant L is called **coefficient of self induction** or **self inductance of the coil.**

The **S.I. unit** of self inductance or inductance is henry (H).

Self-Inductance of a Solenoid

$$L = \frac{\mu_0 N^2 A}{\ell}$$

Factors on which self inductance depends :

If no iron or similar material is nearby, then the value of self-inductance depends only on the geometrical factors (length, cross-sectional area, number of turns and magnetic permeability of free space).

Mutual Inductance

*Production of induced e.m.f. in a coil due to the changes of current in a neighboring coil, is called **mutual induction**.*

Coefficient of mutual induction or mutual inductance :

Let ϕ_s = magnetic flux linked with the secondary coil when a current I_p flows through the primary coil.

Then, $\phi_s \propto I_p$ or $\phi_s = M I_p$ .....(1)

M = constant of proportionality called **mutual inductance** or **coefficient of mutual induction.**

AC Generator/Dynamo/Alternator

An electrical machine used to convert mechanical energy into electrical energy is knownm as AC generator/alternator or dynamo.

Principle : It works on the principle of electromagnetic induction, i.e., when a coil is rotated in uniform magnetic field, an induced emf is produced in it.

DC Motor

A D.C. motor converts direct current energy from a battery into mechanical energy of rotation.

Principle : It is based on the fact that when a coil carrying current is held in a magnetic field, it experiences a torque, which rotates the coil.

Efficiency of the d.c. motor :

$$\eta = \frac{EI}{VI} = \frac{E}{V} = \frac{Back\ e.m.f.}{Applied\ e.m.f.}$$

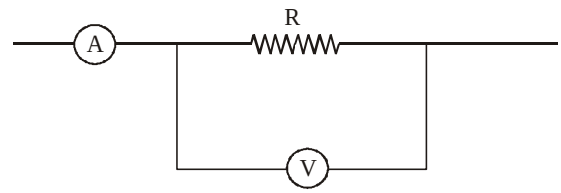
Uses of D.C Motor

1. The D.C. motors are used in D.C. fans (exhaust, ceiling or table) for cooling and ventilation.
2. They are used for pumping water.
3. Big D.C. motors are used for running tram-cars and even trains.

EXERCISE

1. The charge given to any conductor resides on its outer surface, because
   (a) the free charge tends to be in its minimum potential energy state
   (b) the free charge tends to be in its minimum kinetic energy state
   (c) the free charge tends to be in its maximum potential energy state.
   (d) the free charge tends to be in its maximum kinetic energy state
2. Two identical conducting balls having positive charges q_1 and q_2 are separated by a distance r.If they are made to touch each other and then separated to the same distance, the force between them will be
   (a) less than before (b) same as before
   (c) more than before (d) zero
3. Potential at any point inside a charged hollow sphere
   (a) increases with distance
   (b) is a constant
   (c) decreases with distance from centre
   (d) is zero
4. Three bulbs of 40 W, 60 W and 100 W are connected in series to a current source of 200 V. Which of the following statements is true ?
   (a) 40 W bulb glows brightest
   (b) 60 W bulb glows brightest
   (c) 100 W bulb glows brightest
   (d) All bulbs glow with same brightness
5. A voltmeter essentially consists of
   (a) a high resistance, in series with a galvanometer
   (b) a low resistance, in series with a galvanometer
   (c) a high resistance in parallel with a galvanometer
   (d) a low resistance in parallel with a galvanometer

6. Eddy currents are produced when
   (a) a metal is kept in varying magnetic field
   (b) a metal is kept in steady magnetic field
   (c) a circular coil is placed in a magnetic field
   (d) through a circular coil, current is passed
7. An AC generator of 220 V having internal resistance r = 10Ω and external resistance R = 100Ω. What is the power developed in the external circuit?
   (a) 484 W (b) 400 W
   (c) 441 W (d) 369 W
8. Choke coil works on the principle of
   (a) transient current (b) self induction
   (c) mutual induction (d) wattless current
9. In an a.c. circuit, the r m.s. value of current, I_{rms} is related to the peak current, I_0 by the relation
   (a) $I_{rms} = \sqrt{2}\, I_0$ (b) $I_{rms} = \pi I_0$
   (c) $I_{rms} = \frac{1}{\pi} I_0$ (d) $I_{rms} = \frac{1}{\sqrt{2}} I_0$
10. The frequency of A.C. mains in India is
   (a) 30 c/s (b) 50 c/s
   (c) 60 c/s (d) 120 c/s
11. A bulb and a capacitor are connected in series to a source of alternating current. If its frequency is increased, while keeping the voltage of the source constant, then bulb will
   (a) give more intense light
   (b) give less intense light
   (c) give light of same intensity before
   (d) stop radiating light
12. In an A.C. circuit with voltage V and current I the power dissipated is
   (a) $\frac{1}{\sqrt{2}} VI$ (b) $\frac{1}{2} VI$
   (c) VI
   (d) dependent on the phase between V and I
13. Alternating current cannot be measured by D.C. ammeter because
   (a) average value of current for complete cycle is zero
   (b) A.C. changes direction
   (c) A.C. cannot pass through D.C. ammeter
   (d) D.C. ammeter will get damaged
14. The core of a transformer is laminated because
   (a) the weight of the transformer may be reduced
   (b) rusting of the core may be prevented
   (c) ratio of voltage in primary and secondary may be increased
   (d) energy losses due to eddy currents may be minimised
15. When a body is charged by induction, then the body
   (a) becomes neutral
   (b) does not lose any charge
   (c) loses whole of the charge on it
   (d) loses part of the charge on it
16. If a body is positively charged, then it has
   (a) excess of electrons
   (b) excess of protons
   (c) deficiency of electrons
   (d) deficiency of neutrons
17. On charging by conduction, mass of a body may
   (a) increase (b) decreases
   (c) increase or decrease (d) none of these
18. Coulomb's law is true for
   (a) atomic distances (= 10^{-11} *m*)
   (b) nuclear distances (= 10^{-15} *m*)
   (c) charged as well as uncharged particles
   (d) all the distances
19. Which of the following is the best insulator of electricity?
   (a) Carbon (b) Paper
   (c) Graphite (d) Ebonite
20. Two spheres A and B of exactly same mass are given equal positive and negative charges respectively. Their masses after charging
   (a) remains unaffected (b) mass of A > mass of B
   (c) mass of A < mass of B (d) nothing can be said
21. What happens when some charge is placed on a soap bubble?
   (a) Its radius decreases (b) Its radius increases
   (c) The bubble collapses (d) None of these
22. If a body is charged by rubbing it, its weight
   (a) remains precisely constant
   (b) increases slightly
   (c) decreases slightly
   (d) may increase slightly or may decrease slightly
23. Electric flux at a point in an electric field is
   (a) positive (b) negative
   (c) zero (d) none of these
24. The length of a wire is doubled and the radius is doubled. By what factor does the resistance change?
   (a) 4 times as large (b) Twice as large
   (c) Unchanged (d) Half as large
25. According to international convention of colour coding in a wire
   (a) live is red, neutral is black and earth is green
   (b) live is red, neutral is green and earth is black
   (c) live is brown, neutral is blue and earth is black
   (d) live is red, neutral is black and earth is green
26. The resistivity of a wire depends on
   (a) length
   (b) area of cross-section
   (c) material
   (d) all of these
27. In the circuits shown below the ammeter A reads 4 amp. and the voltmeter V reads 20 volts. The value of the resistance R is



   (a) slightly more than 5 ohms
   (b) slightly less than 5 ohms
   (c) exactly 5 ohms
   (d) None of these
28. Gases are good conductors of electricity at
   (a) high pressure (b) low pressure
   (c) low temperature (d) high temperature

29. The resistance of a thin wire in comparison of a thick wire of the same material
    (a) is low
    (b) is equal
    (c) depends upon the metal of the wire
    (d) is high
30. Conductivity increases in the order of
    (a) Al, Ag, Cu (b) Al, Cu, Ag
    (c) Cu, Al, Ag (d) Ag, Cu, Al
31. Kilowatt-hour is the unit of
    (a) potential difference (b) electric power
    (c) electrical energy (d) charge
32. An electric bulb is filled with
    (a) hydrogen (b) oxygen and hydrogen
    (c) ammonia (d) nitrogen and argon
33. When current is passed through an electric bulb, its filament glows, but the wire leading current to the bulb does not glow because
    (a) less current flows in the leading wire as compared to that in the filament
    (b) the leading wire has more resistance than the filament
    (c) the leading wire has less resistance than the filament
    (d) filament has coating of fluorescent material over it
34. From a power station, the power is transmitted at a very high voltage because –
    (a) it is generated only at high voltage
    (b) it is cheaper to produce electricity at high voltage
    (c) electricity at high voltage is less dangerous
    (d) there is less loss of energy in transmission at high voltage
35. When a fuse is rated 8A, it means
    (a) it will not work if current is less than 8A
    (b) it has a resistance of 8 ohm
    (c) it will work only if current is 8A
    (d) it will burn if current exceeds 8A
36. Fuse wire is made of
    (a) platinum (b) copper
    (c) aluminium (d) alloy of tin and lead
37. Which is not a device based on the heating effect of electricity?
    (a) Heater (b) Toaster
    (c) Refrigerator (d) Press
38. The primary cell which is used in daily life is
    (a) Leclanche cell (b) Dry cell
    (c) Daniel cell (d) Simple voltaic cell
39. The filament of an electric bulb is of tungsten because
    (a) its resistance is negligible
    (b) it is cheaper
    (c) its melting point is high
    (d) filament is easily made
40. Which one of the following heater element is used in electric press?
    (a) Copper wire (b) Nichrome wire
    (c) Lead wire (d) Iron wire
41. What should be the characteristic of fuse wire?
    (a) High melting point, high specific resistance
    (b) Low melting point, low specific resistance
    (c) High melting point, low specific resistance
    (d) Low melting point, high specific resistance
42. The heating element of an electric heater should be made with a material, which should have
    (a) high specific resistance and high melting point
    (b) high specific resistance and low melting point
    (c) low specific resistance and low melting point
    (d) low specific resistance and high melting point
43. In charging a battery of motor car, the following effect of electric current is used
    (a) magnetic (b) heating
    (c) chemical (d) induction
44. For electroplating a spoon, it is placed in the voltameter at
    (a) the position of anode
    (b) the position of cathode
    (c) exactly in the middle of anode and cathode
    (d) anywhere in the electrolyte
45. Electroplating does not help in
    (a) fine finish to the surface
    (b) shining appearance
    (c) metals to become hard
    (d) protect metals against corrosion
46. Faraday's laws are consequence of conservation of
    (a) energy
    (b) energy and magnetic field
    (c) charge
    (d) magnetic field
47. Lenz's law is a consequence of the law of conservation of
    (a) charge (b) mass
    (c) energy (d) momentum
48. The laws of electromagnetic induction have been used in the construction of a
    (a) galvanometer (b) voltmeter
    (c) electric motor (d) generator
49. Whenever, current is changed in a coil, an induced e.m f. is produced in the same coil. This property of the coil is due to
    (a) mutual induction (b) self induction
    (c) eddy currents (d) hysteresis
50. Alternating current is converted to direct current by
    (a) rectifier (b) dynamo
    (c) transformer (d) motor
51. To convert mechanical energy into electrical energy, one can use
    (a) DC dynamo (b) AC dynamo
    (c) motor (d) (a) & (b)
52. Transformers are used
    (a) in DC circuits only
    (b) in AC circuits only
    (c) in both DC and AC circuits
    (d) neither in DC nor in AC circuits
53. The essential difference between an AC generator and a DC generator is that
    (a) AC generator has an electromagnet while a DC generator has permanent magnet
    (b) DC generator will generate a higher voltage
    (c) AC generator will generate a higher voltage
    (d) AC generator has slip rings while the DC generator has a commutator
54. At the time of short circuit, the current in the circuit
    (a) reduces substantially (b) does not change
    (c) increases heavily (d) vary continuously

55. In an electric motor, conversion takes place of
(a) chemical energy into electrical energy
(b) electrical energy into mechanical energy
(c) electrical energy into light energy
(d) electrical energy into chemical energy

56. The current in a generator armature is AC because
(a) the magnetic field reverses at intervals
(b) the current in the field coils is AC
(c) the rotation of the armature causes the field through it to reverse
(d) the commutator feeds current into it in opposite directions at every half cycle

57. The current in the armature of a motor is reversed at every half cycle due to the action of a(n)
(a) armature (b) field coil
(c) brush (d) commutator

58. For dynamo which one of the following statements is correct?
(a) It converts the electrical energy into light energy
(b) It converts the kinetic energy into heat energy
(c) It converts the mechanical energy into electrical energy
(d) It converts the electrical energy into mechanical energy

ANSWER KEY

1	(a)	**6**	(a)	**11**	(a)	**16**	(c)	**21**	(b)	**26**	(c)	**31**	(c)	**36**	(c)	**41**	(d)	**46**	(a)	**51**	(d)	**56**	(c)
2	(c)	**7**	(b)	**12**	(d)	**17**	(c)	**22**	(d)	**27**	(a)	**32**	(d)	**37**	(b)	**42**	(a)	**47**	(c)	**52**	(b)	**57**	(d)
3	(b)	**8**	(b)	**13**	(a)	**18**	(d)	**23**	(c)	**28**	(b)	**33**	(c)	**38**	(c)	**43**	(c)	**48**	(d)	**53**	(d)	**58**	(c)
4	(a)	**9**	(d)	**14**	(d)	**19**	(d)	**24**	(d)	**29**	(d)	**34**	(b)	**39**	(c)	**44**	(b)	**49**	(b)	**54**	(c)		
5	(a)	**10**	(b)	**15**	(b)	**20**	(c)	**25**	(d)	**30**	(b)	**35**	(a)	**40**	(a)	**45**	(c)	**50**	(a)	**55**	(b)		

HINTS AND SOLUTIONS

3. (b) As, $E = -\frac{dV}{dr}$ or, $0 = -\frac{dV}{dr}$
because electric field inside a charged hollow sphere is zero.
or, v = constant

4. (a) Current through each bulb is same because these are connected in series.
since $\left(R = \frac{V^2}{P}\right)$, resistance of 40 W bulb is more, hence greater heat is produced in the 40 W bulb, it glows brightest
$H = I^2 R t$

5. (a) For conversion of a Galvanometer to a voltmeter, we connect a large resistance R in series with the galvanometer.

7. (b) $V = 200V$; $r = 10\Omega$
$R' = 10 + 100\Omega = 110\Omega$
$$I = \frac{V}{R'} = \frac{220}{100} = 2A$$
$$P = I^2R = 4 \times 100 = 400\ W$$

12. (d) Power dissipated = E_{rms}. I_{rms} = (E_{rms}) (I_{rms}) cosθ
Hence, power dissipated depends upon phase difference.

13. (a) D.C. ammeter measures average current in AC current, average current is zero for complete cycle. Hence reading will be zero.

14. (d) When there is change of flux in the core of a transformer due to change in current round it, eddy current is produced. The direction of this current is opposite to the current which produces it, so it will reduce the main current. We laminate the core so that flux is reduced resulting in the reduced production of eddy current.

15. (b) Charging by induction involves transfer of charges from one part to the other of the body. No loss of charge is involved.

16. (c) Positive charge is due to deficiency of electrons.

17. (c) On charging by conduction, body may gain mass, if it acquires negative charge. It may lose mass, if it acquires positive charge.

18. (d) Coulomb's law is true for all distances small and large. Hence it is called a long range force.

19. (d) Ebonite is the best insulator.

20. (c) A loses electrons and B gains electrons. Therefore, mass of A < mass of B.

21. (b) The radius of soap bubble increases because of outward force acting on the bubble due to charging.

22. (d) The weight can be increased slightly, if it acquire negative charge & weight can be decreased slightly, if it acquires positive charge.

23. (c) As area of a point is zero,
$\therefore \quad \phi = E\ (ds) \cos\theta = E \cos\theta \times 0 = \text{Zero.}$

30. (b) Silver is the best conductor of electricity.

41. (d) Fuse wire should be such that it melts immediatley when strong current flows through the circuit. The same is possible if its melting point is low and resistivity is high.

42. (a) A heating wire should be such that it produces more heat when current is passed through it and also does not melt. It will be so if it has high specific resistance and high melting point.

43. (c) Chemical effect of current is used in charging a car battery.

44. (b) In electroplating, the metallic ions are positive, which are deposited on cathode.

45. (c) Electroplating does not help in making the metals become hard.

46. (a) Faraday's laws are based on the conversion of electrical energy into mechanical energy; which is in accordance with the law of conservation of energy.

CHAPTER

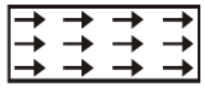
7 Magnetism

Magnetism

*The phenomenon of attracting magnetic substances like iron, cobalt, nickel etc. is called **magnetism**. A body possessing the property of magnetism is called **magnet**.*

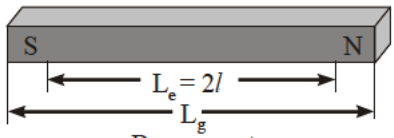
Lodestone or **magnetite** is natural magnet. Earth is also a natural magnet.

In magnetised substance all the atomic magnets are aligned in same direction and thus resultant magnetism is non-zero.



Bar Magnet

A bar magnet consists of two equal and opposite magnetic poles separated by a small distance. Poles are not exactly at the ends. The shortest distance between two poles is called effective length (L_e) and is less than its geometric length (L_g). For bar magnet $L_e = 2l$ and $L_e = (5/6)\, L_g$.



Bar magnet

Properties of Magnet

(i) **Attractive property :** When a magnet is dipped into iron fillings it is found that the concentration of iron filings, i.e., attracting power of the magnet is maximum at two points near the ends and minimum at the centre. The places where its attracting power is maximum are called **poles**.

(ii) **Directive property :** When a magnet is suspended its length becomes parallel to N-S direction. The pole pointing north is called the north pole while the other pointing in the geographical south is called the south pole of the magnet. The line joining the two poles of a magnet is called **magnetic axis** and the vertical plane passing through the axis of a freely suspended or pivoted magnet is called **magnetic meridian**.

(iii) **Poles of a magnet always exist in pairs :** In a magnet the two poles are found to be equal in strength and opposite in nature. If a magnet is broken into number of pieces, each piece becomes a magnet with two equal and opposite poles. This shows that monopole do not exist.

(iv) **Repulsive property :** A pole of a magnet attracts the opposite pole while repels similar pole.

Demagnetisation of Magnet

A magnet gets demagnetised, i.e., loses its power of attraction if it is *heated*, *hammered* or *alternating current is passed through a wire wound over it*.

Permanent and Temporary Magnets (Electromagnets)

The **permanent artificial magnets** are made of some metals and alloys like Carbon-steel, Alnico, Platinum-cobalt, Alcomax, Ticonal etc. The permanent magnets are made of ferromagnetic substances with large coercivity and retentivity

The **temporary artificial magnets** like electromagnets are prepared by passing current through coil wound on soft iron core. These cannot retain its strength for a long time. These are made from soft iron, non-metal and alloy. Electromagnets are stronger than permanent magnet.

Some Applications of Electromagnets

(i) Electric motors

(ii) Doorbells

(iii) In scrapyards to separate iron from other metals

Coulomb's Law in Magnetism

If two magnetic poles of strengths m_1 and m_2 are kept at a distance r apart then force of attraction or repulsion between the two poles is directly proportional to the product of their pole strengths and inversely proportional to the square of the distance between them

$$i.e.,\ F \propto \frac{m_1 m_2}{r^2} \qquad \text{or} \qquad F = \frac{\mu_0}{4\pi}\,\frac{m_1 m_2}{r^2}$$

where $F = \frac{\mu_0}{4\pi} = 10^{-7}$ Wb A^{-1} $m^{-1} = 10^{-7}$ henry/m

μ_0 is permeability of free space or absolute permeability

Magnetic Field

The space around a magnet (or a current carrying conductor) in which its magnetic effect can be experienced is called the magnetic field.

If a magnet is cut into two equal parts along the length then pole strength is reduced to half and length remains unchanged.

New magnetic dipole moment $M' = m'(2\ell) = \frac{m}{2} \times 2\ell = \frac{M}{2}$

If a magnet is cut into two equal parts transverse to the length then pole strength remains unchanged and length is reduced to half.

New magnetic dipole moment $M' = m\left(\frac{2\ell}{2}\right) = \frac{M}{2}$

Magnetic Lines of Force

Magnetic line of force is an imaginary curve tangent to which at a point gives the direction of magnetic field at that point or the magnetic field line is the imaginary path along which an isolated north pole will tend to move if it is free to do so.

Magnetic lines of force do not intersect each other. Because if they do, there will be two directions of magnetic field which is not possible.

Gauss's Law in Magnetism

The surface integral of magnetic field $\vec{B}$ over a closed surface S is always zero.

Mathematically, $\oint_S \vec{B} \cdot \vec{da} = 0$

The Earth's Magnetism

The branch of Physics which deals with the study of earth's magnetic field is called **terrestrial magnetism**.

William Gilbert suggested that earth itself behaves like a huge magnet.

(a) A freely suspended magnet always comes to rest in N-S direction.

(b) A piece of soft iron buried in N-S direction inside the earth acquires magnetism.

Geographic meridian : It is a vertical plane passing through geographic north and south pole of the earth.

Geographic equator : A great circle on the surface of the earth in a plane perpendicular to geographical axis is called geographic equator. All places on geographic equator are at equal distances from geographical poles.

Magnetic meridian : It is a vertical plane passing through the magnetic north and south pole of the earth.

Magnetic equator : A great circle on the surface of the earth in a plane perpendicular to magnetic axis is called magnetic equator. All places on magnetic euqator are at equal distance from magnetic poles.

Magnetic Elements

The physical quantities which determine the intensity of earth's total magnetic field completely both in magnitude and direction are called magnetic elements.

Angle of declination (ϕ) : *The angle between the magnetic meridian and geographical meridian at a place is called angle of declination.*

Angle of dip or inclination (θ) : *The angle through which the N pole dips down with reference to horizontal is called the angle of dip.* At magnetic north and south pole angle of dip is 90°. At magnetic equator the angle of dip is 0°.

Horizontal component of earth's magnetic field : The total intensity of the earth's magnetic field makes an angle θ with horizontal. It has

(i) component in horizontal plane called **horizontal component B_H**.

(ii) component in vertical plane called **vertical component B_V**.

$B_V = B \sin\theta$ $\qquad$ $B_H = B\cos\theta$

so, $\frac{B_V}{B_H} = \tan\theta$ and $\qquad B = \sqrt{B_H^2 + B_V^2}$

Intensity of Magnetisation

It is defined as the magnetic dipole moment developed per unit volume when a magnetic material is subjected to magnetising field.

Intensity of magnetisation,

$$I = \frac{Magnetic\ \ dipole\ \ moment}{Volume} = \frac{M}{V}$$

Magnetic Susceptibility

The magnetic susceptibility of a magnetic substance is defined as the ratio of the intensity of magnetisation to magnetic intensity.

i.e., $\chi_m = \frac{I}{H}$

The value of χ_m **depends on nature of material and temperature.**

Magnetic Permeability

The magnetic permeability of a magnetic substance is defined as the ratio of the magnetic induction to the magnetic intensity.

i.e., $\mu = \frac{B}{H}$

Hysteresis

The lagging of intensity of magnetisation (I) or magnetic induction (B) behind the magnetising field (H) during the process of magnetisation and demagnetisation of a ferromagnetic material is called hysteresis.

Retentivity : *The value of I (or B) of a material when the magnetising field is reduced to zero is called retentivity or residual magnetism of the material.*

Coercivity : *The value of reverse magnetising field required to reduce residual magnetism to zero is called coercivity of the material.*

Comparison of properties of soft iron and steel :

(1) The area of hysteresis loop for soft iron is much smaller than for steel, so energy loss per unit volume per cycle for soft iron is smaller than steel.

(2) The retentivity of soft iron is greater than that of steel.

(3) The coercivity of steel is much larger than that of soft iron.

(4) The magnetisation and demagnetisation is easier in soft iron than steel.

(5) Soft iron acquires saturation magnetisation for quite low value of magnetising field than in case of steel or soft iron is much strongly magnetised than steel.

Diamagnetic Substances : *The substances which when placed in a magnetic field are feebly magnetised in a direction opposite to that of the magnetising field are called diamagnetic substances.*

Some diamagnetic substances are Cu, Zn, Bi, Ag, Au, Pb, He, Ar, NaCl, H_2O, marble, glass, etc.

Paramagnetic Substances : *The substances which when placed in a magnetic field are feebly magnetised in the direction of magnetising field are called paramagnetic substances.*

Some paramagnetic substances are Al, Na, Sb, Pt, $CuCl_2$, Mn, Cr, liquid oxygen, etc.

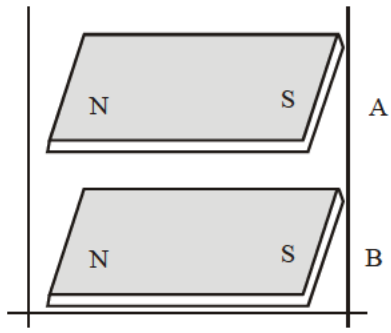
Ferromagnetic Substances : *The substances which when placed in a magnetic field are strongly magnetised in the direction of the magnetising field are called ferromagnetic substances.*

Iron, cobalt, nickel, etc. are some examples of ferromagnetic substance.

EXERCISE

1. The magnetism of magnet is due to
   (a) the spin motion of electron
   (b) earth
   (c) pressure of big magnet inside the earth
   (d) cosmic rays
2. Which of the following is the most suitable material for making permanent magnet ?
   (a) Steel (b) Soft iron
   (c) Copper (d) Nickel
3. The permanent magnet is made from which one of the following substances?
   (a) Diamagnetic (b) Paramagnetic
   (c) Ferromagnetic (d) Electromagnetic
4. Demagnetisation of magnets can be done by
   (a) rough handling
   (b) heating
   (c) magnetising in the opposite direction
   (d) All of the above
5. Which of the following is most suitable for the core of electromagnets?
   (a) Soft iron (b) Steel
   (c) Copper-nickel alloy (d) Air
6. A magnetic needle is kept in a non-uniform magnetic field. It experiences
   (a) neither a force nor a torque
   (b) a torque but not a force
   (c) a force but not a torque
   (d) a force and a torque
7. Out of the following, diamagnetic substance is
   (a) iron (b) copper
   (c) lead (d) silver
8. The magnetic compass is not useful for navigation near the magnetic poles. Since
   (a) $R = 0$ (b) $V = 0$
   (c) $H = 0$ (d) $\theta = 0^\circ$
9. Metals getting magnetised by orientation of atomic magnetic moments in external magnetic field are called
   (a) diamagnetics (b) paramagnetics
   (c) ferromagnetics (d) antimagnetics
10. At magnetic poles, the angle of dip is
    (a) 45° (b) 30°
    (c) zero (d) 90°
11. Curie temperature is the temperature above which
    (a) a ferromagnetic material becomes paramagenetic
    (b) a paramagnetic material becomes diamagnetic
    (c) a ferromagnetic material becomes diamagnetic
    (d) a paramagnetic m aterial becomes ferromagnetic
12. Electromagnets are made of soft iron because soft iron has
    (a) low retentivity and high coercive force
    (b) high retentivity and high coercive force
    (c) low retentivity and low coercive force
    (d) high retentivity and low coercive force
13. To shield an instrument from external magnetic field, it is placed inside a cabin made from
    (a) wood (b) ebonite
    (c) iron (d) diamagnetic substance
14. The force which makes maglev move
    (a) gravitational field (b) magnetic field
    (c) nuclear forces (d) air drag
15. A conducting wire can give magnetic poles when it
    (a) bent into the form of a circular ring
    (b) placed in an external magnetic field
    (c) suspended freely in air
    (d) All of the above
16. Which of the following is an artificial magnet?
    (a) Bar magnet
    (b) Horse-shoe magnet
    (c) Magnetic needle
    (d) All of the above
17. The distance between two magnetic poles is doubled and their pole-strength is also doubled. The force between them
    (a) increases to four times
    (b) decreases by half
    (c) remains unchanged
    (d) increases to two times
18. Earth's magnetic field always has a horizontal component except at
    (a) magnetic equator
    (b) magnetic pole
    (c) geographical north pole
    (d) at an altitude of 45°
19. When an iron bar is moved over a bar magnet along its length the attractive force
    (a) increases first and then decreases
    (b) decreases first and then increases
    (c) remains same
    (d) cannot say
20. When the S–pole of a magnet is placed near an unknown pole of another magnet, the two magnets
    (a) repel each other because the unknown pole is N–pole
    (b) repel each other because the unknown pole is S–pole
    (c) attract each other because the unknown pole is S–pole
    (d) can either attract or repel

21 Two magnets A and B are placed with like poles having one above another. What will happen?



(a) A will stuck to B
(b) A will remain as in figure
(c) A will move side ways
(d) Can't say

22. A compass which is allowed to move in a horizontal plane is taken to a geomagnetic pole. It
(a) will stay in north-south direction only
(b) will stay in east-west direction only
(c) will stay in any position
(d) None of these

23. Magnetic meridian is a
(a) point (b) horizontal plane
(c) vertical plane (d) line along N-S

24. Due to the earth's magnetic field, charged cosmic ray particles
(a) require greater kinetic energy to reach the equator than the poles
(b) require less kinetic energy to reach the equator than the poles
(c) can never reach the equator
(d) can never reach the poles

25. Which one of the following is a non-magnetic substance?
(a) Iron (b) Cobalt
(c) Nickel (d) Brass

26. The universal properties of all substances is
(a) diamagnetism (b) ferromagnetism
(c) paramagnetism (d) All of these

ANSWER KEY											
1	(a)	**6**	(d)	**11**	(a)	**16**	(d)	**21**	(b)	**26**	(a)
2	(a)	**7**	(b)	**12**	(d)	**17**	(b)	**22**	(c)		
3	(c)	**8**	(c)	**13**	(c)	**18**	(b)	**23**	(c)		
4	(d)	**9**	(b)	**14**	(b)	**19**	(b)	**24**	(c)		
5	(a)	**10**	(d)	**15**	(a)	**20**	(b)	**25**	(d)		

HINTS AND SOLUTIONS

5. (a) Soft iron is highly ferromagnetic.
6. (d) A magnetic needle kept in non uniform magnetic field experience a force and torque due to unequal forces acting on poles.
7. (b) Copper has negative susceptibility (*i.e.* $\chi = -0.96$). Hence, it is diamagnetic.
8. (c) Near the magnetic poles, $H = 0$, therefore, magnetic compass will not work.
9. (b) In paramagnetic metals, magnetism is acquired by orientation of atomic dipoles.
10. (d) At poles, $\delta = 90°$.
12. (d) Soft iron has high retentivity and low coercive force.
13. (c) The cabin is made up of iron because maximum magnetic lines of forces pass through it.
14. (b) The magnetic force will pull the vehicle.
21. (b) Unlike poles repel. The repulsive magnetic force will not allow the like poles to get stuck.
22. (c) At geomagnetic poles, there is no horizontal component of earth field and so compass needle may stay at any position.

CHAPTER

8 Semiconductor Electronics

Metals, Semiconductors and Insulators

On the basis of electrical conductivity (σ) or resistivity ($\rho = 1/\sigma$) the solids are classified as

(i) **Metals** – have low resistivity
$\rho \sim 10^{-2}$ to 10^{-8} Ωm
$\sigma \sim 10^{2}$ to 10^{8} Sm^{-1}

(ii) **Semiconductors** – have intermediate resistivity
$\rho \sim 10^{5}$ to 10^{0} Ωm
$\sigma \sim 10^{-5}$ to 10^{0} Sm^{-1}

(iii) **Insulators** – have high resistivity
$\rho \sim 10^{8}$ Ωm
$\sigma \sim 10^{-8}$ Sm^{-1}

i.e. the **Semiconductors** are the materials whose conductivity is more than insulators but less than conductors.

Types of Semiconductors

Intrinsic semiconductors or Pure semiconductors

In semiconductors forbidden energy gap Eg is more than metals or conductors and less than insulators.

Silicon (Si) and Germanium (Ge) are the examples of pure semiconductors.

In pure or intrinsic semiconductor,

$n_e = n_h = n_i$ where, n_e = no. of electrons; n_h = no. of holes and n_i = no. of intrinsic carrier concentration.

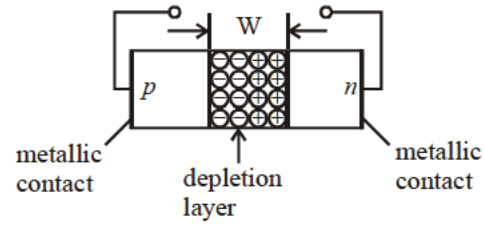
Impurity like pentavalent (As, Sb, P) or trivalent (In, B, Al) are added to increase conductivity. Depending on doping type we have

(a) n – type semiconductor and
(b) p – type semiconductor

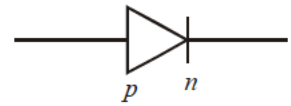
(a) ***n* – type semiconductor:** Si or Ge with pentavalent doping. An atom of valency +5 occupies the position of parent atom in crystal lattice. Four valence electrons form 4 covalent bonds but 5th electron is free and weakly bound to parent atom. The ionisation energy (~ 0.01V for Ge and 0.05V for Si) is small and even at room temperature the electron jumps to conduction band. The dopant is called **donor** impurity (positively charged).

(b) ***p* - type semiconductor:** Si or Ge with trivalent doping means one less electron in the 4 covalent bonds, so the 4th neighbour has a vacancy or hole that can be occupied by an electron from another site. Thus a hole is available for conduction. The trivalent atom is **negatively** charged as it acquires an electron and is called **acceptor** atom or impurity.

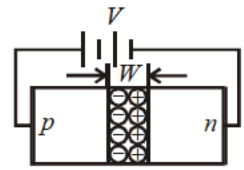
Formation of *p* – *n* junction: Part of p-type can be converted into n – type by adding pentavalent impurity. There is concentration gradient between p and n sides, holes diffuse from p side to n side ($p \rightarrow n$) and electrons move from ($n \rightarrow p$) creating a layer of positive and negative charges on n and p side respectively called **depletion layer**. External bias is applied to cause charges to flow.



Symbol of *p*-*n* junction diode

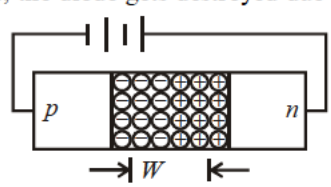


***p* – *n* junction under forward bias:** *When p – side is connected to positive terminal and n – side to negative terminal of external voltage, it is said to be* **forward biased.**



The applied voltage V is opposite to built in potential V_0, hence depletion layer width decreases and barrier height is reduced to $(V_0 - V)$. There is minority carrier injection, hence charges begin to flow. Current is in the order of mA.

(c) ***p* – *n* junction under reverse bias:** When p-side of p-n junction is connected to $-ve$ terminal and n-side to $+ve$ terminal of the battery, the diode is said to be reverse biased. The direction of applied voltage is same as direction of barrier potential, so barrier height increases to $(V_0 + V)$. This suppresses flow of electrons from $n \rightarrow p$ and holes from $p \rightarrow n$. Diffusion current decreases but drift of electrons and holes under the electric field affect remains. This drift current is few μA. The current under reverse bias is independent of applied voltage upto a critical value known as breakdown voltage (V_{br}) when $V = V_{br}$ diode reverse current increases sharply. If the reverse current is not limited below this, the diode gets destroyed due to overheating.



Special purpose $p - n$ junction diode:

Zener diode: It is fabricated by heavy doping of p and n sides of $p - n$ junction. Depletion region is thin $< 10^{-6}$ m. Electric field of junction is high $\sim 5 \times 10^6$ V/m. Reverse bias $\sim$ 5V.

It is used as **voltage regulator**.

p-n junction diode is used as a **rectifier**.

Rectifier is a device which converts A.C. into D.C.

Inverter converts D.C. into A.C.

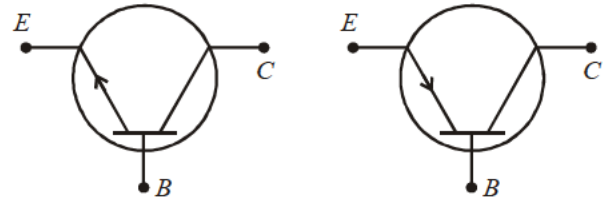
Optoelectronic junction devices:

(a) **Photodiode:** It is a $p - n$ junction fabricated with a transparent window to allow light photons to fall on it. These photons generate electron hole pairs upon absorption. The generation of electron hole pair is near the junction and due to junction field they remain separated till external load is connected. The electron are collected on n–side and holes on p–side near junction and give rise to an emf.
When external load is connected, current flows. The magnitude of current depends on intensity of incident radiation.

(b) **Light emitting diode (LED) :** It consists of heavily doped $p - n$ junction in forward bias. Electrons move from $n \rightarrow p$ and holes from $p \rightarrow n$ (minority carriers). Thus, near junction, minority carrier concentration increases (under no bias it is less) and they combine with majority carriers near the junction to release energy in form of photons with energy equal to or less than band gap energy. As forward bias increases, current increases till light intensity reaches maximum.

Junction Transistor:

Types: (i) n-p-n type, (ii) p-n-p type.
Structure: (i) Emitter (E), (ii) Base (B), (iii) Collector (C)
Symbol:



n-p-n type $\qquad$ p-n-p type

AC parameters:

(i) $\text{Input resistance} = \dfrac{\text{Change in base-emitter voltage}}{\text{Base current}}$

$\Rightarrow r_i = \dfrac{\Delta V_{BE}}{\Delta I_B} \rightarrow$ dynamic resistance

(ii) Output resistance, $r_0 = \left(\dfrac{\Delta V_{CE}}{\Delta I_C}\right)_{I_B}$

(iii) Current amplification factor (β)

$$\beta_{ac} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}} ; \beta_{dc} = \frac{I_C}{I_B} \Rightarrow \beta_{ac} \simeq \beta_{dc}$$

Uses of Transistor :
As a switch, an amplifier, an oscillator, etc.

EXERCISE

1. In a p-n junction
   (a) the potential of p & n sides becomes higher alternately
   (b) the p side is at higher electrical potential than n side
   (c) the n side is at higher electric potential than p side
   (d) both p & n sides are at same potential
2. Barrier potential of a p-n junction diode does not depend on
   (a) doping density (b) diode design
   (c) temperature (d) forward bias
3. The energy band gap is maximum in
   (a) metals
   (b) superconductors
   (c) insulators
   (d) semiconductors
4. The part of a transistor which is most heavily doped to produce large number of majority carriers is
   (a) emmiter
   (b) base
   (c) collector
   (d) can be any of the above three
5. When n-p-n transistor is used as an amplifier
   (a) electrons move from collector to base
   (b) holes move from emitter to base
   (c) electrons move from base to collector
   (d) holes move from base to emitter
6. In a common base amplifier the phase difference between the input signal voltage and the output voltage is
   (a) 0 (b) $\pi/4$
   (c) $\pi/2$ (d) π
7. Inverter converts
   (a) alternating current into direct current
   (b) direct current into alternating current
   (c) current at low voltage to current at high voltage
   (d) None of these
8. The Donor level in a semiconductor is placed
   (a) half-way in the forbidden energy gap
   (b) in the forbidden energy gap close to the upper edge of the valence band

(c) in the conduction band close to the lower edge to the conduction band
(d) in the forbidden energy gap close to the lower edge of the conduction band

9. If the distance between the conduction band and valence band is 1 eV. This combination is
(a) semiconductor (b) conductor
(c) metal (d) insulator

10. Carbon, silicon and germanium have four valence electrons each. These are characterised by valence and conduction bands separated by energy band gap respectively equal to $(E_g)_C$, $(E_g)_{Si}$ and $(E_g)_{Ge}$. Which of the following statements is true?
(a) $(E_g)_{Si} < (E_g)_{Ge} < (E_g)_C$ (b) $(E_g)_C < (E_g)_{Ge} < (E_g)_{Si}$
(c) $(E_g)_C > (E_g)_{Si} > (E_g)_{Ge}$ (d) $(E_g)_C = (E_g)_{Si} = (E_g)_{Ge}$

11. In an unbiased *p*-*n* junction, holes diffuse from the *p*-region to *n*-region because
(a) free electrons in the *n*-region attract them.
(b) they move across the junction by the potential difference.
(c) hole concentration in *p*-region is more as compared to *n*-region.
(d) all the above

12. For a transistor amplifier, the voltage gain
(a) remains constant for all frequencies.
(b) is high at high and low frequencies and constant in the middle frequency range.
(c) is low at high and low frequencies and constant at mid frequencies.
(d) none of the above

13. *p*-*n* junction diode works as a insulator, if connected
(a) to A.C. (b) in forward bias
(c) in reverse bias (d) None of these

14. In an *n*-type silicon, which of the following statement is true?
(a) Electrons are majority carriers and trivalent atoms are the dopants.
(b) Electrons are minority carriers and pentavalent atoms are the dopants.
(c) Holes are minority carriers and pentavalent atoms are the dopants.
(d) Holes are majority carriers and trivalent atoms are the dopants.

15. Which of the statements is true for *p*-type semiconductos?
(a) Electrons are majority carriers and trivalent atoms are the dopants.
(b) Electrons are minority carriers and pentavalent atoms are the dopants.
(c) Holes are minority carriers and pentavalent atoms are the dopants.
(d) Holes are majority carriers and trivalent atoms are the dopants.

16. When a forward bias is applied to a *p*-*n* junction, it
(a) raises the potential barrier.
(b) reduces the majority carrier current to zero.
(c) lowers the potential barrier.
(d) None of these

17. The potential barrier, in the depletion layer, is due to
(a) ions (b) holes
(c) electrons (d) both (b) and (c)

18. Zener diode is used as
(a) half wave rectifier (b) full wave rectifier
(c) A.C. voltage stabilizer (d) D.C. voltage stabilizer

19. For a transistor amplifier, the voltage gain
(a) remains constant for all frequencies
(b) is high at high and low frequencies and constant in the middle frequency range
(c) is low at high and low frequencies and constant at mid frequencies
(d) None of these

20. In a semiconductor, the concentration of electrons is $8 \times 10^{14}/cm^3$ and that of the holes is 5×10^{12} cm^3. The semiconductor is
(a) *p*-type (b) *n*-type
(c) intrinsic (d) Cannot say

21. When a semiconductor is heated, its resistance
(a) decreases (b) increases
(c) remains unchanged (d) either (b) or (c)

22. The forbidden gap in the energy bands of germanium at room temperature is about
(a) 1.1 eV (b) 0.1 eV
(c) 0.67 eV (d) 6.7 eV

23. To obtain a *p*-type germanium semiconductor, it must be doped with
(a) arsenic (b) antimony
(c) indium (d) phosphorus

24. Which impurity is doped in Si to form *n*-type semiconductors?
(a) Al (b) B
(c) As (d) None of these

25. In extrinsic semiconductors
(a) the conduction band and valence band overlap
(b) the gap between conduction band and valence band is more than 16 eV
(c) the gap between conduction band and valence band is near about 1 eV
(d) the gap between conduction band and valence band will be 100 eV and more

26. Function of rectifier is
(a) to convert A.C. into D.C.
(b) to convert D.C. into A.C.
(c) Both (a) and (b)
(d) None of these

27. Zener breakdown takes place if
(a) doped impurity is low
(b) doped impurity is high
(c) less impurity in *n*-part
(d) less impurity in *p*-part

28. Which one of the following is not a correct statement about semiconductors?
    (a) The electrons and holes have different mobilities in a semiconductor
    (b) In an *n*-type semiconductor, the Fermi level lies closer to the conduction band edge
    (c) Silicon is a direct band gap semiconductor
    (d) Silicon is has diamond structure
29. The energy band gap is minimum in
    (a) metals (b) superconductors
    (c) insulators (d) semiconductors.
30. An oscillator is nothing but an amplifer with
    (a) positive feedback (b) negative feedback
    (c) large gain (d) no feedback
31. When a solid with a band gap has a donor level just below its empty energy band, the solid is
    (a) an insulator
    (b) a conductor
    (c) *p*-type semiconductor
    (d) *n*-type semiconductor
32. Regarding a semiconductor which one of the following is wrong?
    (a) There are no free electrons at room temperature
    (b) There are no free electrons at 0K
    (c) The number of free electrons increases with rise of temperature
    (d) The charge carriers are electrons and holes
33. *p-n* junction is said to be forward biased, when
    (a) the positive pole of the battery is joined to the *p*-semiconductor and negative pole to the *n*-semiconductor
    (b) the positive pole of the battery is joined to the *n*-semiconductor and *p*-semiconductor
    (c) the positive pole of the battery is connected to *n*- semiconductor and *p*- semiconductor
    (d) a mechanical force is applied in the forward direction
34. At absolute zero, Si acts as
    (a) non-metal (b) metal
    (c) insulator (d) None of these
35. When *n*-type semiconductor is heated
    (a) number of electrons increases while that of holes decreases
    (b) number of holes increases while that of electrons decreases
    (c) number of electrons and holes remain same
    (d) number of electrons and holes increases equally
36. To use a transistor as an amplifier
    (a) The emitter base junction is forward biased and the base collector junction is reverse biased
    (b) no bias voltage is required
    (c) both junctions are forward biased
    (d) both junctions are reverse biased
37. The part of the transistor which is heavily doped to produce large number of majority carriers is
    (a) emitter
    (b) base
    (c) collector
    (d) any of the above depending upon the nature of transistor
38. When a *p-n* junction diode is reverse biased the flow of current across the junction is mainly due to
    (a) diffusion of charges
    (b) drift of charges
    (c) depends on the nature of material
    (d) both drift and diffusion of charges
39. When an *n–p–n* transistor is used as an amplifier then
    (a) electrons flow from emitter to collector
    (b) holes flow from emitter to collector
    (c) electrons flow from collector to emitter
    (d) electrons flow from battery to emitter
40. An *n-p-n* transistor conducts when
    (a) both collector and emitter are negative with respect to the base
    (b) both collector and emitter are positive with respect to the base
    (c) collector is positive and emitter is negative with respect to the base
    (d) collector is positive and emitter is at same potential as the base
41. Reverse bias applied to a junction diode
    (a) increases the minority carrier current
    (b) lowers the potential barrier
    (c) raises the potential barrier
    (d) increases the majority carrier current
42. In semiconductors, at room temperature
    (a) the conduction band is completely empty
    (b) the valence band is partially empty and the conduction band is partially filled
    (c) the valence band is completely filled and the conduction band is partially filled
    (d) the valence band is completely filled
43. Application of a forward bias to a *p–n* junction
    (a) widens the depletion zone.
    (b) increases the potential difference across the depletion zone.
    (c) increases the number of donors on the n side.
    (d) increases the electric field in the depletion zone.
44. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of
    (a) each of them increases
    (b) each of them decreases
    (c) copper increases and germanium decreases
    (d) copper decreases and germanium increases
45. In an intrinsic semiconductor
    (a) only electrons are responsible for flow of current
    (b) both holes and electrons carry current
    (c) both holes and electrons carry current with electrons being majority carriers
    (d) only holes are responsible for flow of current
46. If the conductivity of a semiconductor is only due to break up of the covalent bonds due to thermal excitation, then the semiconductor is called
    (a) intrinsic (b) extrinsic
    (c) donor (d) acceptor
47. The mobility of conduction electrons is greater than that of holes, since electrons
    (a) are lighter
    (b) are negatively charged
    (c) require smaller energy for moving through crystal lattice
    (d) undergo smaller number of collisions

48. In the symbol of a transistor , the arrow head points in the direction of flow of
(a) holes (b) electrons
(c) majority carriers (d) minority carriers

49. Transistors are essentially
(a) power driven devices
(b) current driven devices
(c) voltage driven devices
(d) resistance driven devices

50. In a transistor
(a) emitter is more highly doped than collector
(b) collector is more highly doped than emitter
(c) both are equally doped
(d) None of the above

51. One way in which the operation of an *n-p-n* transistor differs from that of a *p-n-p*
(a) the emitter junction is reverse biased in *n-p-n*.
(b) the emitter junction injects minority carriers into base region of the *p-n-p*
(c) the emitter injects holes into the base of the *p-n-p* and electrons into the base region *n-p-n*
(d) the emitter injects holes into the base of *n-p-n*

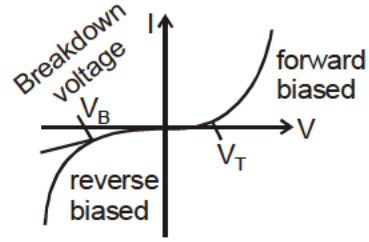
52. *n-p-n* transistors are preferred to *p-n-p* transistors because:
(a) they have low cost
(b) they have low dissipation energy
(c) they are capable of handling large power
(d) electrons have high mobility than holes and hence high mobility of energy

53. An alternating current can be converted into direct current by a
(a) rectifier (b) transformer
(c) dynamo (d) motor

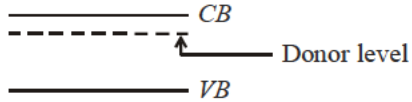
ANSWER KEY											
1	(b)	**11**	(c)	**21**	(a)	**31**	(d)	**41**	(c)	**51**	(c)
2	(b)	**12**	(c)	**22**	(c)	**32**	(a)	**42**	(c)	**52**	(d)
3	(c)	**13**	(c)	**23**	(c)	**33**	(a)	**43**	(c)	**53**	(a)
4	(a)	**14**	(c)	**24**	(c)	**34**	(c)	**44**	(d)		
5	(d)	**15**	(d)	**25**	(c)	**35**	(d)	**45**	(b)		
6	(a)	**16**	(c)	**26**	(a)	**36**	(a)	**46**	(a)		
7	(b)	**17**	(a)	**27**	(b)	**37**	(a)	**47**	(c)		
8	(d)	**18**	(c)	**28**	(c)	**38**	(b)	**48**	(a)		
9	(a)	**19**	(c)	**29**	(a)	**39**	(a)	**49**	(b)		
10	(c)	**20**	(b)	**30**	(a)	**40**	(c)	**50**	(a)		

HINTS AND SOLUTIONS

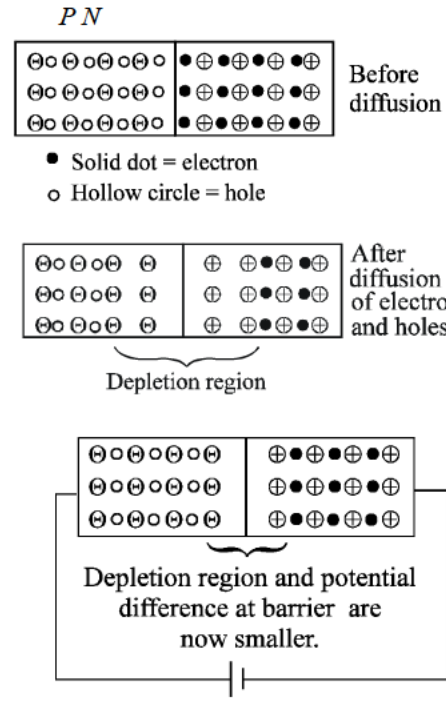
1. (b) **[Hint :** For easy flow of current the *p*-side must be connected to +ive terminal of battery *i.e.*, it is connected to higher potential in comparison to *n*. This connection is called forward biased. In this case the input resistance is very low.
In reverse-biased, the *p*-side is connected to –ive terminal & *n*-side to (+ive) terminal to battery. In this case input resistance is very high.



2. (b) **[Hint** : Barrier potential depends on, doping density, temperature, forward/reverse bias but does not depend on diode design.]
3. (c) Maximum in insulators and overlaping in metals.
5. (d) Holes move from base to emitter.
6. (a) The phase difference between output voltage and input signal voltage in common base transistor circuit is zero
7. (b) Inverter converts a.c. into d.c.
9. (a) Distance between conduction band and valence band = Fermi gap energy = 1eV.
Since there is a small gap between the conduction and valence band so it is semiconductor.
13. (c) In reverse bias no current flows.
18. (c) For a wide range of values of load resistance, the current in the Zener diode may change but the voltage across it remains unaffected. Thus the output voltage across the Zener diode is a regulated voltage.
20. (b) Since, $n_e > n_h$, the semiconductor is *n*-type.
22. (c) $\Delta E_{g(Germanium)} = 0.67$ eV.
23. (c) For *p*-type semiconductor the doping impurity should be trivalent.
24. (c) Because As is pentavalent impurity.
26. (a) AC $\rightarrow$ Rectifier $\rightarrow$ DC
27. (b) Zener breakdown can occur in heavily doped diodes. In lightly doped diodes the necessary voltage is higher, and avalanche multiplication is then the chief process involved.
28. (c) Silicon is an indirect-band gap semi-conductor.



29. (a) Maximum in insulators and minimum in metals.
30. (a) A positive feedback from output to input in an amplifier provides oscillations of constant amplitude.
31. (d) Donor level close to energy band is in case of *n*-type semi-conductor.
32. (a) At room temperature, few bonds breaks and electron hole pair generates inside the semiconductor.
33. (a) For forward biasing of *p*-*n* junction, the positive terminal of external battery is to be connected to *p*-semiconductor and negative terminal of battery to the *n*-semiconductor.
34. (c) Semiconductors are insulators at room temperature.
35. (d) Due to heating, when a free electron is produced then simultaneously a hole is also produced.
36. (a) To use a transistor as an amplifier the emitter base junction is forward biased while the collector base junction is reverse biased.
37. (a) The function of emitter is to supply the majority carriers. So, it is heavily doped.
38. (b) When *p*-*n* junction is reverse biased, the flow of current is due to drifting of minority charge carriers across the junction.
39. (a) In an *n*-*p*-*n* transistor, the charge carriers, are free electrons in the transistor as well as in external circuit; these electrons flow from emitter to collector.
40. (c) When the collector is positive and emitter is negative w.r.t. base, it causes the forward biasing for each junction, which causes conduction of current.
41. (c) In reverse biasing, the conduction across the *p*-*n* junction does not take place due to majority carriers but takes place due to minority carriers if the voltage of external battery is large. The size of the depletion region increases thereby increasing the potential barrier.
42. (c) In semiconductros, the conduction is empty and the valence band is completely filled at 0 K. No electron from valence band can cross over to conduction band at 0K. But at room temperature some electrons in the valence band jump over to the conduction band due to the small forbidden gap, *i.e.* 1 eV.
43. (c)



Number of donors is more because electrons from – ve terminal of the cell pushes (enters) the *n*-side and decreases the number of uncompensated pentavalent ion due to which potential barrier is reduced. The neutralised pentavalent atom are again in position to donate electrons.

CHAPTER

1 Nature of Matter

1. **Substance (or chemical substance) :** A **"substance"** is a kind of matter that can not be separated into other kinds of matter by any physical process. e.g. gold, silver, iron, sodium chloride, calcium carbonate etc.
2. **Pure substance:** is one that is a *single substance* and has a *uniform composition*. Such a substance always have the *same texture* and *taste*. e.g. water, salt, sugar etc.
3. **Testing the purity of a substance :** The purity of substance can easily be checked by checking its melting points in case of a solid substance or by checking its boiling points in case of a liquid substance.
4. **Types of pure substances :** Two different types of pure substances are
   (i) **Element:** An element is a substance which can not be split up into two or more simpler substances by usual chemical methods of applying heat, light or electric energy. e. g. hydrogen, oxygen, sodium, chlorine etc.
   (ii) **Compound:** A compound is a substance made up of two or more elements chemically combined in a fixed ratio by weight e.g. H_2O (water), NaCl (sodium chloride) etc.
5. **Mixture :** A mixture is a substance which consists of two or more elements or compounds not chemically combined together. e.g. Air is a mixture of nitrogen, oxygen, inert gases, water vapour, carbon dioxide etc.
6. **Types of mixtures :** Mixtures are *impure substances*. They are of two types:
   (i) **Homogeneous mixture:** It has a uniform composition throughout and its components can not be distinguished visually.
   e.g. a well mixed sample of vinegar.
   (ii) **Heterogeneous mixture:** It is one that is not uniform throughout. Different samples of a heterogeneous mixture may have different composition. e.g. a mixture of salt and pepper.
7. **Solution :** It is a homogeneous mixture of two or more substances whose composition can be varied. e.g. solution of common salt in water, solution of ammonia in water. Some other examples are lemonade, coke, pepsi etc.
8. **Separating the components of a mixture :** Various methods are used for separating the constituents of a mixture. Depending upon the type of mixture (i.e. whether it is a homogeneous mixture or heterogeneous mixture) different methods used are given below :

	Mixture	Separation Method
1.	Insoluble solid in solvent	*Sedimentation* followed by *filtration*. In case of a fine solid *centrifugation* is used instead of filtration
2.	Solution of solid in liquid	Evaporation, crystallization, distillation
3.	Miscible mixture of liquids.	Fractional distillation
4.	Immiscible mixture of liquids.	Separating funnel
5.	Mixture of two solids one of which is sublime	Sublimation
6.	Mixture of substances in solution.	Chromatography

9. **Solute :** The component of solution that is dissolved and present in smaller quantities in a solution is known as solute. e.g. **common salt** in case of solution of common salt in water and **ammonia** in case of solution of ammonia in water.
10. **Solvent :** The component of solution in which solute is dissolved is known as solvent. It is always present in larger amount in a solution. e.g. water in case of the solution of common salt or ammonia in water.
11. **Saturated Solution :** A solution in which no more solute can be dissolved at the same temperature is called *Saturated solution*.
12. **Unsaturated Solution :** It is a solution in which more solute can be dissolved at the same temperature.
13. **Super-saturated Solution :** It is a solution which contains more mass of the dissolved solute than the saturated solution at the same temperature and pressure.
14. **Alloys :** Alloys are homogeneous mixtures of metal and can not separated into their components by physical methods.
    e.g. **Brass** is a mixture of copper (Cu) and zinc (Zn).

15. **Concentration of a solution :** *Concentration of a solution* is the amount of solute present in a given amount (mass or volume) of a solution or the amount of solute dissolved in a given mass or volume of a solvent.

$$\text{Concentration} = \frac{\text{Amount of solute}}{\text{Amount of solvent}}$$

16. **Solubility :** It is defined as the amount of solute dissolved in 100g of solvent to form a saturated solution.

17. **Suspension :** It is a non-homogeneous mixture in which *solids are dispersed in liquids.* In it the solute particles do not dissolve but remains suspended through out the bulk of the medium.

18. **Colloids or colloidal solution : Colloid** is a *heterogeneous mixture.* The size of particles of a colloid is intermediate between *true solutions* and *suspensions* (i.e between 1nm and 100 nm). The particles of a colloid can not be seen with naked eye.

19. **Types of colloidal solution :** Since colloidal solution is heterogeneous mixture it consists of two *phases*. These are

    (i) *dispersed phase* (colloidal particles)

    (ii) *dispersion medium* (The medium in which colloidal particles are dispersed.)

20. **Emulsion :** Emulsions are liquid-liquid colloids.

21. **Types of Emulsion :** Emulsions are of two types :

    (i) water in oil (ii) oil in water

22. **Emulsifiers** are those substances that help in forming stable emulsions of oil and water, e.g. milk, cod-liver oil, cold creams, vanishing creams, moisturising cream, paints, etc.

23. **Physical change :** During such a change no new substances is formed and there is no change in the chemical properties of the substances.

24. **Chemical change :** Such a change is accompanied by change in chemical properties and formation of new substances.

25. **Elements** are a type of pure substances. An element is a substance that can **not** be split into two or more simpler substances by usual chemical methods of applying heat, light or electric energy.

    Types of elements : Elements have been divided into **metals** and **non-metals**. All metals (except mercury) are solids. mercury is a liquid, e.g. sodium, potassuim, gold, silver etc.

    All non-metals are solids or gases (Bromine is an exception as it is a *liquid* non-metal) e.g. hydrogen, oxygen, carbon, bromine, chlorine, iodine etc.

26. **Compound :** A compound is a substance made up of two or more elements chemically combined in a fixed ratio by weight. e.g. water (H_2O) is a compound made up of two elements *Hydrogen* and *Oxygen* chemically combined in a fixed proportion of 1: 8 by weight.

EXERCISE

1. Air is regarded as a mixture because
   (a) its pressure may very
   (b) its temperature may change
   (c) its volume changes under different conditions
   (d) its composition may vary
2. Which of the following is a compound ?
   (a) Stainless steel (b) Bronze
   (c) Graphite (d) Hydrogen sulphide
3. The process used to separate oil and water is
   (a) distillation (b) sublimation
   (c) separating funnel (d) chromatography
4. In which of the following the constituents are present in any ratio?
   (a) Mixture (b) Compound
   (c) Solution (d) Colloid
5. A mixture of common salt, sulphur, sand and iron filings is shaken with carbon disulphide and filtered through a filter paper. The filtrate is evaporated to dryness in a china dish. What will be left in the dish after evaporation?
   (a) Sand (b) Sulphur
   (c) Iron filings (d) Common salt
6. Two substances A and B when brought together form a substance C with the evolution of heat. The properties of C are entirely different from those of A and B. The substance C is
   (a) a compound (b) an element
   (c) a mixture (d) none of these.
7. Camphor can be purified by
   (a) distillation (b) filtration
   (c) sedimentation (d) sublimation
8. Which one of the following will result in the formation of a mixture?
   (a) Crushing of a marble tile into small particles
   (b) Breaking of ice cubes into small pieces
   (c) Adding sodium metal to water
   (d) Adding milk in water
9. Purity of a solid substance can be checked by its
   (a) boiling point (b) melting point
   (c) solubility in water (d) solubility in alcohol
10. A mixture of ethanol and water can be separated by
    (a) filtration (b) decantation
    (c) fractional distillation (d) sublimation
11. Salt can be obtained from sea water by
    (a) filtration (b) decantation
    (c) evaporation (d) sublimation
12. A sample contains two substances and has uniform properties. The sample is
    (a) a compound (b) a heterogeneous mixture
    (c) an element (d) a homogeneous mixture
13. Which of the following is considered to be a pure substance?
    (a) Granite (b) Sodium chloride
    (c) Muddy water (d) Milk of magnesia
14. Physical properties of a mixture
    (a) vary with the amount of substance.
    (b) depend on the volume of the substance
    (c) depend on the organization of the substance
    (d) vary depending upon its components
15. Compounds
    (a) are the same as mixtures
    (b) can be separated by their physical properties
    (c) contain only one type of element
    (d) are different kinds of atoms chemically combined with each other.
16. White gold is used in jewelry and contains two elements, gold and palladium. A jeweler has two different samples that are both identical in appearance and have a uniform composition throughout. What can be said about the samples?
    (a) They are homogeneous mixtures and be classified as metallic alloys.
    (b) The materials are heterogeneous mixtures and can be classified by their components
    (c) The samples have variable compositions and are classified as metallic solutions.
    (d) The samples are heterogeneous mixtures that can be separated using magnetic properties.
17. Which of the following is an example of a heterogeneous substance?
    (a) Bottled water (b) Table salt
    (c) Pieces of copper (d) Candle
18. Which of the following is an example of a homogeneous substance?
    (a) Granite (b) Copper sulphate
    (c) Oil-water solution (d) Muddy water
19. Filtration can be used to separate
    (a) solids from solids (b) liquids from solids
    (c) liquids from liquids (d) liquids from gases
20. Melting points can separate materials because
    (a) substances melt at different temperatures
    (b) molecules vibrate rapidly when heated
    (c) heat causes molecules to disintegrate
    (d) many substances fuse at the melting point
21. Distillation is a good separation technique for
    (a) solids (b) liquids
    (c) solid alloys (d) gases
22. Solubility is a good separation technique for
    (a) pure metals (b) noble gases
    (c) different salts (d) metallic alloys
23. Magnetism is most beneficial for separating
    (a) gases and non-metallic liquids
    (b) magnetic solids and solids such as sulfur
    (c) non-metallic solids and solids such as sulfur
    (d) non-magnetic solids from non-magnetic liquids
24. Select the one that is a chemical change.
    (a) Melting of wax (b) Freezing of water
    (c) Cooking of food (d) None of these

25. Select the one that is a physical change.
(a) Digestion of food (b) Growth of plant
(c) Rusting of iron (d) None of these

26. On passing through a colloidal solution, the beam of light gets .....
(a) reflected (b) refracted
(c) scattered (d) absorbed

27. The size of colloidal particles usually lies in the range
(a) 10^{-5} - 10^{-7} cm (b) 10^{-7} - 10^{-9} cm
(c) 10^{-3} - 10^{-5} cm (d) 10^{-2} - 10^{-6} cm

28. Brass is an example of
(a) compound (b) element
(c) homogeneous mixture (d) heterogeneous mixture

29. Select the one that is not a chemical change ?
(a) Dissolution of ammonia in water.
(b) Dissolution of carbon dioxide in water.
(c) Dissolution of oxygen in water.
(d) None of these is a chemical change.

30. A change is said to be a chemical change when
(a) it is accompanied by energy change
(b) it is accompanied by formation of new substances
(c) it is accompanied by change in physical properties
(d) All the above are correct

31. Solutions with low concentrations of solutes are
(a) concentrated (b) dilute
(c) solvents (d) None of these

32. Which of the following statements is true about a colloidal system?
(a) It carries a net electric charge
(b) It consists of one phase only
(c) It can be made out of two gases
(d) It is electrically neutral as a whole

33. Cloud or fog is an example of colloidal system of
(a) liquid dispersed in gas (b) gas dispersed in gas
(c) solid dispersed in gas (d) solid dispersed in liquid

34. Normal solution is :
(a) inert solution
(b) acidic solution
(c) one litre containing one equivalent
(d) basic solution

35. Which of the following is a colloid ?
(a) Sugar solution (b) Urea solution
(c) Silicic acid (d) NaCl solution

36. When dispersed phase is liquid and dispersion medium is gas then the colloidal system is called
(a) smoke (b) clouds
(c) jellies (d) emulsions

ANSWER KEY

1	(d)	**7**	(d)	**13**	(b)	**19**	(b)	**25**	(d)	**31**	(b)
2	(d)	**8**	(d)	**14**	(d)	**20**	(a)	**26**	(c)	**32**	(d)
3	(c)	**9**	(b)	**15**	(d)	**21**	(b)	**27**	(a)	**33**	(a)
4	(a)	**10**	(c)	**16**	(a)	**22**	(c)	**28**	(c)	**34**	(c)
5	(b)	**11**	(c)	**17**	(d)	**23**	(b)	**29**	(c)	**35**	(c)
6	(a)	**12**	(d)	**18**	(b)	**24**	(c)	**30**	(d)	**36**	(b)

HINTS AND SOLUTIONS

1. (d) Air is a mixture of different gases like N_2, O_2, CO_2 etc. Its general composition is N_2 = 78%, O_2 = 21% and traces of few other gases but there may be variation in its composition from place to place and at different height.
2. (d) Hydrogen sulphide (H_2S) is a compound of hydrogen and sulphur. Stainless steel and bronze are alloys whereas graphite is allotropic form of element carbon.
3. (c) As oil being less denser than water it forms upper layer. Thus mixture of oil and water can be separated by using separating funnel.
5. (b) Sulphur will left behind. As in given mixture only sulphur gets dissolved in carbon disulphide.
6. (a) C is a compund which is formed as a result of reaction between A and B.
7. (d) Camphor being a sublime substance can be purified by sublimation.
9. (b) Every pure solid has a fixed melting point.
10. (c) Mixture of ethanol and water can be separated by fractional distillation as they have different boiling points.
11. (c) Sea water is a solution of salt and water.During evaporation water gets evaporated off and salt left as a residue.
12. (d) Homogeneous mixture is a solution having uniform composition and properties throughout.
13. (b) Sodium chloride being compound is a pure substance. Granite, muddy water and milk of magnesia all are mixtures.
14. (d) Physical properties of mixtures are same as of its components.
15. (d) In a compund the elements are present in a fixed ratio by weight.
16. (a) As they have uniform composition throughout they are considered as homogeneous mixture. Both samples are mixture of two metals (gold and palladium) thus are alloys.
17. (d) Candle is a heterogeneous mixture of wax and thread. Copper is element while bottled water and table salt are compounds.
18. (b) It is a compound.
20. (a) Different pure solid substances melts at a different temperatures.
21. (b) Distillation is a separation technique used for separation of miscible liquids having different boiling point.
22. (c) Different salts have different solubility in a particular solvent. Thus on this basis mixture of different salts can be separated.
23. (b) Magnetism is useful for separation of magnetic and non-magnetic substances.
24. (c) Chemical changes are irrerversible in nature.
25. (d) Each of the process given in options are irreversible and involve change in chemical properties hence all are chemical changes.
26. (c) This is due to Tyndall effect.
27. (a) The size of colloidal particles usually lie in range of one nm to 100 nm. i.e., 10^{-5} to 10^{-7} cm
or $1nm = 10^{-7}$ $\therefore$ $100\ nm = 10^{-5}cm$
28. (c) Brass is an alloy which is a homogeneous substance.
29. (c) Oxygen is insoluble in water.
31. (b) dilute solutions have low concentration of solid.
33. (a) Fog is a colloidal system consisting water droplets dispersed in air.
34. (c) The solution which has one gram equivalent in one litre is called normal solution.
35. (c) Those substances which can not pass through membrane are termed as colloids e.g., silicic acid. Whereas sugar solution, urea and NaCl can pass through the membrane.
36. (b) Clouds consists of fine droplets of water suspended in air.

CHAPTER

2 Structure of Atom

1. **Law of conservation of mass :**This law was stated by **Lavoisier** in 1744. It states that "*In all physical and chemical changes, the total mass of reactants is equal to total mass of products*."
2. **Law of constant proportions (or constant composition) :** This law was first stated by **Proust** in 1797. According to the law "*a chemical compound is always found to be made up of the same elements combined together in the same proportions by weight*" e.g. the ratio of hydrogen and oxygen in pure water is always 1 : 8 by weight. This law is also called **law of definite proportions.**
3. **Law of multiple proportions :** This law was given by **John Dalton (1803)** and states that "when two elements combine to form two or more compounds, the different mass of one of the elements and the fixed mass of the one with which it combines always form a whole number ratio". This law explains the concept of formation of more than one compound by two elements.
4. **Dalton's Atomic theory :** *Postulates of Dalton's Atomic Theory*
   (i) Matter is made up of extremely small indivisible particles called **atoms**.
   (ii) Atoms of the same substance are identical in all respects i.e., they possess same *size, shape, mass, chemical properties* etc.
   (iii) Atoms of different substances are different in all respects i.e., they possess different size, shape, mass etc.
   (iv) Atom is the smallest particle that takes part in a chemical reaction.
   (v) Atoms of different elements may combine with each other in a fixed simple, whole number ratio to form **compound atoms**.
   (vi) Atoms can neither be created nor destroyed i.e., atoms are indestructible.
5. **Atom :** It is the smallest particle of an element which can take part in a chemical change. It may or may not be capable of independent existence.
6. **Symbol :** The abbreviation used for lengthy names of elements are termed as their symbols.
   The symbol of an element is the **first letter** or the first and another letter of English name or Latin name of the element.
   While writing a symbol, the first letter is always **capital** and the second is always **small.**
7. **Molecule :** It is the smallest particle of an element or compound that is capable of independent existence and shows all the properties of that substance.
   [The molecules of an element is made up of only one and same type of atoms, while the molecule of a compound is made up of dissimilar atoms]
8. **Atomicity :** The number of atoms present in a molecule of an element or a compound is known as its atomicity. e.g. the atomicity of oxygen is 2 while atomicity ozone is 3.
9. **Ion :** It is an electrically charged atom or group of atom. It is formed by the loss or gain of electrons by an atom. Ions are of two types :
   (i) **Cation :** It is positively charged ion and is formed by the loss of electron from an atom e.g. H^+, Na^+, Ca^{2+}, Al^{3+}, NH_4^+ etc.
   (ii) **Anion :** It is negatively charged ion and is formed by the gain of electrons by an atom, e.g.
   Cl^-, O^{2-}, C^-, F^-, CO_3^{2-} PO_4^{3-} etc.
10. **Valency :** The **combining power** (or **capacity**) of an element is known as its valency.
11. **Formula of simple and molecular compounds**
    Binary compounds are those compounds which are made up of two different elements e.g. NaCl, KBr, CaO etc. Following rules are to be followed for writing the formula.
    (i) The valencies or charges on the ions must be balanced.
    (ii) For a compound made up of a **metal** and a **non-metal** the symbol of metal is written first.
    (iii) In compounds formed with polyatomic ions, the ion is enclosed in a bracket before writing the number to indicate the ratio.
12. **Sub-Atomic Particles**
    (i) **Electrons:** Electron was discovered in cathode ray experiment.
    (ii) The term electron was coined by **G.J. Stoney**
    (iii) **Protons** were discovered in anode ray experiment. Anode rays are also called **positive rays** or **canal rays**. Protons was discovered by **Wilhelm Wien** in 1902. It was identified by J.J. Thomson.
    (iv) Neutron was discovered by **James Chadwick** in 1932.

13. Valency : The electrons present in the outermost shell of an atom are known as **valence electrons**. These electrons determine the valency of an atom.

Valency is equal to the number of valence electrons.

In case the number of valence electrons is close to its full capacity. Then,

$$\text{Valency} = 8 - \text{valence electrons}$$

If outermost shell is completely filled then valency is **zero**. Valency is the combining capacity of an atom.

14. Atomic number (Z) : Atomic number of an element is equal to the number of protons present in the nucleus of an atom.

Atomic number (**Z**) = number of protons
= number of electrons.

15. Mass number (A) : It refers to the total number of neutrons and protons (i.e., sum of protons and neutrons) called collectively as **nucleus**, present in an atom.

Mass number (**A**) = number of protons + number of neutron

16. Isotopes : Atoms of the same element having same atomic number but different mass numbers are known as **Isotopes**

e.g. $^{35}_{17}Cl$ and $^{36}_{17}Cl$, $^{1}_{1}H$ and $^{2}_{1}H$, $^{12}_{6}C$ and $^{14}_{6}C$ etc.

17. Applications of Isotopes : Isotopes are used in various fields. For example.

(i) Isotope of uranium is used as a fuel in nuclear reactor
(ii) Isotope of cobalt is used in treatment of cancer
(iii) Isotope of iodine is used in treatment of goitre.

18. Isobars : Atoms of different elements having same mass numbers are known as **Isobars**, e.g K-40 and Ar-40

19. The discovery of cathode rays was done by **J.J. Thomson** an English physicist.

Properties of cathode rays :

- The cathode rays are constituted by fast moving *electrons.*
- These rays travel in a *straight line.*
- These rays posses *mechanical energy.*
- These rays *produce heat* when focussed on metals.
- These rays produce *flourescenes* when focussed on metals.
- They affects the photographic plate.
- They are deflected by electric and magnetic field.
- They ionize the gases through which they pass.
- They travel in a *straight line.*
- They can produce *mechanical effects.*
- Anode rays are *positively charged.*
- The nature of anode rays depends upon the gas taken in the discharge tube.
- The mass of anode rays particles is almost equal to the mass of an atom from which it is formed.

Sub-atomic Particles :

Electron, proton and *neutron* are subatomic particles.

The credit for discovery of these particles goes to **Electron — J.J. Thomson** and **Proton — E. Goldstein**

Another subatomic particle which is *neutral* and has a mass approx. equal to that of a proton was called **neutron** and was discovered by **Chadwick**. The neutron is a neutral particle found in the nucleus of an atoms. Atom of all elements contain neutron (except hydrogen atom which does not contain neutron). The relative mass of neutron is 1 amu and it carries no charge (i.e., it is neutral)

Properties of atomic particles (Comparative)

Particle	Electron	Proton	Neutron
(i) Symbol	e or e^-	p	n
(ii) Nature	Negatively charged	Positively charged	neutral (no charge)
(iii) (a) Charge	(a) -1.6×10^{-19}C	(a) $+1.6 \times 10^{-19}$C	0
(b) Unit charge	(b) –1	(b) + 1	0
(iv) Mass (a) amu	(a) 0.0005486 amu	(a) 1.00753 amu	(a) 1.00893 amu
(b) kg	(b) 9.1×10^{-31}kg	(b) 1.67265×10^{-27} kg	(b) 1.67495×10^{-27} kg
(v) Location	Extra nuclear space	nucleus	nucleus
(vi) Notation	$_{-1}e^0$	$^{1}_{1}p$	$_{0}n^1$
(vii) Relative mass	1/1840	1	1

EXERCISE

1. The formation of SO_2 and SO_3 explain
   (a) the law of conservation of mass
   (b) the law of multiple proportions
   (c) the law of definite properties
   (d) Boyle's law
2. One gram of which of the following contains largest number of oxygen atoms?
   (a) O (b) O_2
   (c) O_3 (d) All contains same
3. The law of definite proportions was given by –
   (a) John Dalton (b) Humphry Davy
   (c) Proust (d) Michael Faraday
4. Molecular mass is defined as the
   (a) mass of one atom compared with the mass of one molecule
   (b) mass of one atom compared with the mass of one atom of hydrogen
   (c) mass of one molecule of any substance compared with the mass of one atom of C-12
   (d) None of these
5. The chemical symbol for barium is
   (a) B (b) Ba
   (c) Be (d) Bi
6. A group of atoms chemically bonded together is a (an)
   (a) molecule (b) ion
   (c) salt (d) element
7. Adding electrons to an atom will result in a (an)
   (a) molecule (b) anion
   (c) cation (d) salt
8. When an atom loses electrons, it is called a (an) _____ and has a _____ charge.
   (a) anion, positive (b) cation, positive
   (c) anion, negative (d) cation, positive
9. The molecular formula P_2O_5 means that
   (a) a molecule contains 2 atoms of P and 5 atoms of O
   (b) the ratio of the mass of P to the mass of O in the molecule is 2:5
   (c) there are twice as many P atoms in the molecule as there are O atoms
   (d) the ratio of the mass of P to the mass of O in the molecule is 5 : 2
10. The percentage of copper and oxygen in samples of CuO obtained by different methods were found to be the same. The illustrate the law of
    (a) constant proportions (b) conservation of mass
    (c) multiple proportions (d) reciprocal proportions
11. The total number of atoms represented by the compound $CuSO_4.5H_2O$ is
    (a) 27 (b) 21
    (c) 5 (d) 8
12. The correct symbol for silver is
    (a) Ag (b) Si
    (c) Ar (d) Al
13. The cathode ray experiment was done for the first time by
    (a) J.J. Thomson (b) John Dalton
    (c) Goldstein (d) Rutherford
14. The nucleus of an atom contains
    (a) protons (b) electrons
    (c) protons and neutrons (d) neutrons
15. By whom was neutron discovered?
    (a) Bohr (b) Chadwick
    (c) Rutherford (d) Dalton
16. In an atom valence electron are present in
    (a) outermost orbit (b) next to outermost orbit
    (c) first orbit (d) any one of its orbit
17. Which of the following statements is *incorrect* for cathode rays?
    (a) They move in straight line
    (b) Their nature depends upon the nature of gas present in the discharge tube.
    (c) They cost shadow of solid objects placed in their path
    (d) They get deflected towards positive charge.
18. The isotopes of an element have
    (a) same number of neutrons
    (b) same atomic number
    (c) same mass number
    (d) None of these
19. Which of the following pairs are isotopes?
    (a) Oxygen and ozone
    (b) Ice and steam
    (c) Nitric oxide and nitrogen dioxide
    (d) Hydrogen and deuterium
20. Which of the following have equal number of neutrons and protons?
    (a) Hydrogen (b) Deuterium
    (c) Fluorine (d) Chlorine
21. The number of electrons in an element with atomic number X and atomic mass Y will be
    (a) (X – Y) (b) (Y – X)
    (c) (X + Y) (d) X
22. Which of the following has a charge of +1 and a mass of 1 amu ?
    (a) A neutron (b) A proton
    (c) An electron (d) A helium nucleus
23. Which of the following describes an isotope with a mass number of 99 that contains 56 neutrons in its nucleus ?
    (a) $^{99}_{56}Ba$ (b) $^{43}_{56}Ba$
    (c) $^{99}_{43}Tc$ (d) $^{56}_{43}Tc$
24. Which of the following isotopes is used as the standard for atomic mass ?
    (a) ^{12}C (b) ^{16}O
    (c) ^{13}C (d) ^{1}H
25. Which of the following is not a basic particle of an element?
    (a) An atom (b) A molecule
    (c) An ion (d) None of these

26. Members of which of the following have similar chemical properties ?
(a) Isotope
(b) Isobars
(c) Allotropes
(d) Both isotopes and allotropes

27. While performing cathode ray experiments, it was observed that there was no passage of electric current under normal conditions. Which of the following can account for this observation ?
(a) Dust particles are present in air
(b) Carbon dioxide is present in air
(c) Air is a poor conductor of electricity under normal conditions
(d) None of these

28. Which one of the following statement is not true ?
(a) Most of the space in an atom is empty
(b) The total number of neutrons and protons is always equal in a neutral atom
(c) The total number of electrons and protons in an atom is always equal
(d) The total number of electrons in any energy level can be calculated by the formula $2n^2$

29. Dalton's atomic theory successfully explained
(i) Law of conservation of mass
(ii) Law of constant composition
(iii) Law of radioactivity
(iv) Law of multiple proportion
(a) (i), (ii) and (iii) (b) (i), (iii) and (iv)
(c) (ii), (iii) and (iv) (d) (i), (ii) and (iv)

30. Which one of the following laws explains the formation of carbon monoxide and carbon dioxide from carbon and oxygen?
(a) Law of conservation of mass
(b) Law of multiple proportions
(c) Law of reciprocal proportions
(d) Law of difinite proportions

31. The atomic weights are expressed in terms of atomic mass unit. Which one of the following is used as a standard?
(a) $^{1}H_{1}$ (b) $^{12}C_{6}$
(c) $^{16}O_{8}$ (d) $^{35}Cl_{17}$

32. Which would be the electrical charge on a sulphur atom containing 18 electrons ?
(a) 2– (b) 1–
(c) 0 (d) 2+

33. The atomic number of an element is 11 and its mass number is 23. The correct order representing the number of electrons, protons and neutrons respectively in this atom is
(a) 11, 11, 12 (b) 11, 12, 11
(c) 12, 11, 11 (d) 23, 11, 23.

34. In an atom valence electron are present in
(a) outermost orbit (b) next to outermost orbit
(c) first orbit (d) any one of its orbit

35. In a chemical change the total weight of the reacting substances compared to total weight of products is
(a) never the same (b) always less
(c) always more (d) always the same

ANSWER KEY											
1	(b)	**7**	(b)	**13**	(a)	**19**	(d)	**25**	(b)	**31**	(b)
2	(c)	**8**	(b)	**14**	(c)	**20**	(b)	**26**	(c)	**32**	(a)
3	(c)	**9**	(a)	**15**	(b)	**21**	(d)	**27**	(c)	**33**	(a)
4	(c)	**10**	(a)	**16**	(a)	**22**	(b)	**28**	(b)	**34**	(a)
5	(b)	**11**	(b)	**17**	(b)	**23**	(c)	**29**	(d)	**35**	(d)
6	(a)	**12**	(a)	**18**	(b)	**24**	(a)	**30**	(b)		

HINTS AND SOLUTIONS

1. (b) In the same weight of SO_2 and SO_3 weight of oxygen is in the simple ratio of 2 : 3
2. (c) The no. of atoms in O_3 is maximum i.e., 3
3. (c) 4. (c) 5. (b)
6. (a) In a molecule two or more than two atoms are convalently bonded with each other.
7. (b) e.g., $Cl + e^- \longrightarrow Cl^-$ (anion)
8. (b) e.g., $Na \longrightarrow \underset{\text{(cation)}}{Na^+} + e^-$
10. (a) Constant proportions according to which *"a pure chemical compound always contains same elements combined together in the same definite proportion of weight."*
11. (b) 1 atom of Cu^{+1} atom of sulphur + 9 atoms of oxygen + 10 atoms of hydrogen. Total number of atoms in compound is 21.
14. (c) The nucleus contains protons and neutrons whereas electrons revolves around the nucleus in circular orbits.
18. (b) Isotopes have same atomic number but different mass number e.g., $_{17}Cl^{35}$ and $_{17}Cl^{36}$.
20. (b) In $_{1}H^{2}$ – no. of p = 1 and no. of n = 2 – 1 = 1
21. (d) No. of electrons = no. of protons = Atomic number = X
23. (c) Given mass number (Z) = 99
no. of neutrons = 56
$\therefore$ no. of protons = atomic number = 99 – 56 = 43
i.e., $_{43}Tc^{99}$
28. (b) e.g., In $_{17}Cl^{35}$ no. of p = 17
but no. of n = 35 – 17 = 18
30. (b) Law of multiple proportions explains the formation of CO and CO_2, in these same weight of carbon that combines with weights of oxygen are in simple rate of 1 : 2.
31. (b) $^{12}C_6$ used as a standard in the expression of atomic weights in term of amu.
32. (a) S(16) = 2, 8, 6
hence S(18) need two or more electron to complete its octet i.e $S + 2e^- \rightarrow S^{--}$
33. (a) no. of proton = At no.= number of e^- = 11
no. of p + no. of n = Atomic mass
$\therefore$ no. of n = 13 – 11 = 12
35. (d) Law of conservation of mass.

CHAPTER

3 Classification of Elements and Periodicity in Properties

1. **Classification** means identifying similar species and grouping them together.
2. **Lavoisier** divided elements into two main types known as **metals** and **non-metals**.
3. **Doberiner's Law of triads:**

   According to this law, *"in certain triads (group of three elements) the atomic mass of the central element was the arithmetic mean of the atomic masses of the other two elements."* But in some triads all the three elements possessed nearly the same atomic masses, therefore the law was rejected.

   e.g., atomic masses of Li, Na and K are respectively 7, 23 and 39, thus the mean of atomic masses of 1st and 3rd element is = 7 + 39 = 23

   Limitations of Doberiner's Triads: He could identify only a few such triads and so the law could not gain importance. In the triad of Fe, Co, Ni, all the three elements have a nearly equal atomic mass and thus does not follow the above law.
4. **Newland's Law of octaves:**

   According to this law *"the elements are arranged in such a way that the eighth element starting from a given one has properties which are a repetition of those of the first if arranged in order of increasing atomic weight like the eight note of musical scale."*

   Drawback of Newland's law of octaves:

   (i) According to Newland only 56 elements exists in nature and no more elements would be discovered in the future. But later on several new element were discovered whose properties did not fit into law of octaves.

   (ii) In order to fit new elements into his table Newland adjust two elements in the same column, but put some unlike elements under the same column.

   Thus, Newland's classification was not accepted.
5. **Mendeleev's periodic table :**

   Mendeleev arranged 63 elements known at that time in the periodic table. According to Mendeleev "*the properties of the elements are a periodic function of their atomic masses.*" The table consists of eight vertical column called '*groups*' and horizontal rows called '*periods*'.

   Merits of Mendeleev's periodic table:

   (i) At some places the order of atomic weight was changed in order to justify the chemical and physical nature.

   (ii) Mendeleev left some gap for new elements which were not discovered at that time.

   (iii) One of the strengths of Mendeleev's periodic table was that, when inert gases were discovered they could be placed in a new group without disturbing the existing order.

Characteristics of the periodic table : Its main characteristics are :

(i) In the periodic table, the elements are arranged in vertical rows called **groups** and horizontal rows called **periods**.

(ii) There are **eight groups** indicated by Roman Numerals I, II, III, IV, V, VI, VII, VIII. The elements belonging to first seven groups have been divided into **sub-groups** designated as **A** and **B** on the *basis of similarities*. The elements that are present on the left hand side in each group constitute sub-group A while those on the right hand side form sub-group B. Group VIII consists of nine elements arranged in **three triads**.

(iii) There are **six periods** (numbered 1, 2, 3, 4, 5 and 6). In order to accomodate more elements, the periods 4, 5, 6 are divided into two halves. The first half of the elements are placed in the upper left corners and the second half occupy lower right corners in each box.

Achievements of Mendeleev's periodic table

(i) The arrangement of elements in groups and periods *made the study of elements quite systematic* in the sense that if properties of one element in a particular group are known, those of the others can be easily predicted.

(ii) **Prediction of new elements and their properties :** Many gaps were left in this table for undiscovered elements. However, properties of these elements could be predicted in advance from their expected position. This helped in the discovery of these elements. The elements *silicon, gallium* and *germanium* were discovered in this manner.

(iii) **Correction of doubtful atomic masses :** Mendeleev corrected the atomic masses of certain elements with the help of their expected positions and properties.

Limitations of Mendeleev's classification :

(i) He could not assign a correct position of hydrogen in his periodic table, as the properties of hydrogen resembles both with alkali metals as well as with halogens.

(ii) The isotopes of the same element will be given different position if atomic number is taken as basis, which will disturb the symmetry of the periodic table.

(iii) The atomic masses do not increases in a regular manner in going from one elements to the next. So it was not possible to predict how many elements could be discovered between two elements.

6. Modern periodic law : This law was given by **Henry Moseley** in 1913. It states, "*Properties of the elements are the periodic function of their atomic numbers*".

Cause of periodicity : *Periodicity* may be defined as the *repetition of the similar properties of the elements placed in a group and separated by certain definite gap of atomic numbers.*

The *cause of periodicity* is the resemblance in properties of the elements is the *repetition of the same valence shell electronic configuration.*

7. Modern periodic table

Moseley proposed this modern periodic table and according to which "*the physical and chemical properties of elements are periodic function of their atomic number and not the atomic weight."*

(i) The modern periodic table has 18 vertical columns called "*groups*" and seven horizontal rows called "*periods*". The groups have been numbered 1, 2, 3.....18 from left to right.

(ii) The elements belonging to a particular group make a family and usually named after the first member. In a group all the elements contain the same number of valence electrons.

(iii) In a period all the elements contain the same number of shells, but as we move from left to right the number of valence shell electrons increases by one unit.

The maximum number of electrons that can be accommodated in a shell can be calculated by the formula $2n^2$ where n is the number of the given shell from the nucleus.

8. Trends in modern periodic table : The trends observed in some important properties of the elements in *moving down the group* (from top to bottom of the table) and *across a period* (from left to right in a period) are discussed below :

(i) **Valency :** Valency may be defined as "*the combining capacity of the atom of an element with atoms of other elements in order to acquire the stable configuration (i.e. 8 electron in valence shell. In some special cases it is 2 electrons).*"

(ii) **Atomic size :** It refers to the distance between the centre of nucleus of an isolated atom to its outermost shell containing electrons.

The atomic radius decreases on moving from left to right along a period. This is due to an increase in nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom.

In a group atomic size decreases from top to bottom due to increase in number of shells.

(iii) **Metallic and non-metallic properties :** In a period from left to right metallic nature decreases while non-metallic character increases.

In a group metallic character increases from top to bottom while non-metallic character decrease.

(iv) **Electronegativity :** The relative tendency of an atom to attract the shared pair of electrons towards itself is called **electronegativity.**

In a period from left to right, the value of electronegativity increases while in a group from top to bottom the value of electronegativity decreases.

EXERCISE

1. The early attempt to classify elements as metals and non-metals was made by
   (a) Mendeleev (b) Lother Meyer
   (c) Lavoisier (d) Henry Moseley
2. Newlands could classify elements only upto
   (a) copper (b) chlorine
   (c) calcium (d) chromium
3. Mendeleev classified elements in
   (a) increasing order of atomic groups
   (b) eight periods and eight groups
   (c) seven periods and eight groups
   (d) eight periods and seven groups
4. The long form of periodic table consists of
   (a) seven periods and eight groups
   (b) seven periods and eighteen groups
   (c) eight periods and eighteen groups
   (d) eighteen periods and eight groups
5. All the members in a group in long form of periodic table have the same
   (a) valence
   (b) number of valence electrons
   (c) chemical properties
   (d) All of these
6. Which of the following properties generally decrease along a period?
   (a) Atomic size
   (b) Non-metallic character
   (c) Metallic character
   (d) Both (a) and (c)
7. An element 'M' has an atomic number 9 and its atomic mass 19. The ion of M will be represented by
   (a) M (b) M^{2+}
   (c) M^{-} (d) M^{2-}
8. The element with smallest size in group 13 is
   (a) beryllium (b) carbon
   (c) aluminium (d) boron
9. The elements with atomic numbers 2, 10, 18, 36, 54 and 86 are all
   (a) halogen (b) noble gases
   (c) noble metals (d) light metals
10. The number of elements in the third period of periodic table is
    (a) 2 (b) 8
    (c) 18 (d) 32
11. Which of these choices is not a family of elements?
    (a) Halogens (b) Metals
    (c) Inert gases (d) All of these
12. The element which has least tendency to lose electron is
    (a) H (b) Li
    (c) He (d) Na
13. The most metallic element in the fourth period is
    (a) Ca (b) K
    (c) S (d) P
14. The elements of group sixteen are called
    (a) halogens (b) chalcogens
    (c) pnicogens (d) noble gases
15. Which of the following is correct set of Dobereiner Triads?
    (a) Na, Si, Cl (b) Be, Mg, Ca
    (c) F, Cl, I (d) Li, Na, Be
16. The metal which is hard and has high m.p. and used in electric bulbs is
    (a) Ni (b) Pt
    (c) Fe (d) W
17. The lightest liquid metal is
    (a) Hg (b) Ga
    (c) Cs (d) Fr
18. Which is not true about noble gases?
    (a) They are non-metallic in nature
    (b) They exist in atomic form
    (c) They are radioactive in nature
    (d) Xenon is the most reactive among them
19. Elements of which group form anions most readily?
    (a) Oxygen family (b) Nitrogen family
    (c) Halogens (d) Alkali metals
20. On moving horizontally across a period, the number of electrons in the outermost shell increases from ..... to ..... .
    (a) 2, 8 (b) 2, 18
    (c) 1, 8 (d) 1, 18
21. Which of the following is not a representative element?
    (a) Fe (b) K
    (c) Ba (d) N
22. The scientist who made maximum contribution towards periodic table was
    (a) Chadwick (b) Rutherford
    (c) Dalton (d) Mendeleev
23. Which of the following elements A, B, C, D and E with atomic number 3, 11, 15, 18 and 19 respectively belong to the same group?
    (a) A, B, C (b) B, C, D
    (c) A, D, E (d) A, B, E
24. Element A belongs to Group VII in *p*-block and element B belongs to Group I in *s*-block of the periodic table. Out of the following assumptions, the correct one is :
    (a) A and B are metals
    (b) A and B are non-metals
    (c) A is a metal and B is a non-metal
    (d) A is a non-metal and B is a metal
25. The element with atomic number 14 is hard and forms acidic oxide and a covalent halide. To which of the following categories does the element belong?
    (a) Metal (b) Metalloid
    (c) Non-metal (d) Left-hand side element

26. Which of the following properties do not match elements of halogen family ?
(a) They have seven electrons in their valence shell
(b) They are diatomic in their molecular form
(c) They are highly reactive chemically
(d) They are metallic in nature

27. Which fact is not valid for Dobereiner's triads?
(a) The atomic weight of middle element is roughly average of the other two elements
(b) The properties of middle element is roughly average of the other two elements
(c) The elements of triads belong to the same group of modern periodic table
(d) The elements of triads have same valency electrons.

28. Which of the following statements is incorrect from the point of view of modern periodic table ?
(a) Elements are arranged in the order of increasing atomic number
(b) There are eighteen vertical columns called groups
(c) Transition elements fit in the middle of long periods
(d) Noble gases are arbitrarily placed in eighteenth group

29. Which of the following group of elements belongs to alkali metals?
(a) 1, 12, 30, 4, 62 (b) 37, 19, 3, 55
(c) 9, 17, 35, 53 (d) 12, 20, 56, 88

30. Which of the following elements will form acidic oxide?
(a) Sodium (b) Magnesium
(c) Aluminium (d) Sulphur

31. Which one of the following is most electropositive element?
(a) Sodium (b) Calcium
(c) Aluminium (d) Silicon

32. The atomic number of an element tells you the number of ..... in a neutral atom.
(a) positrons (b) neutrons
(c) electrons (d) All of these

33. As you move down the group, the alkali metals become
(a) brighter (b) hotter
(c) more reactive (d) less reactive

34. Which is a metalloid?
(a) Pb (b) Sb
(c) Bi (d) Zn

35. Which one of the following elements exhibit maximum number of valence electrons?
(a) Na (b) Al
(c) Si (d) P

36. Which of the following elements does not lose an electron easily?
(a) Na (b) F
(c) Mg (d) Al

37. To which block is related an element having electronic configuration $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^{10}\ 4s^1$ in the periodic table–
(a) *s*–block (b) *p*–block
(c) *d*–block (d) *f*–block

38. If the valene shell electronic configuration for an element is ns^2np^5, this element will belong to the group of –
(a) alkali metals (b) inert metals
(c) noble gases (d) halogens

39. Which shows variable valency –
(a) *s*–block elements (b) *p*–block elements
(c) *d*–block elements (d) Radioactive elements

40. The noble gases are unreactive because
(a) they react with sodium
(b) they have a full outer shell of electrons
(c) they have a half outer shell of neutrons
(d) they are too thin

41. Which scientist came up with the concept of a periodic table that included all of the known elements?
(a) Joseph Priestly (b) Dmitri Mendeleev
(c) Antoine Lavoisier (d) Albert Einstein

42. If the two members of a Dobereiner triad are phosphorus and antimony, the third member of this triad is –
(a) arsenic (b) sulphur
(c) iodine (d) calcium

ANSWER KEY									
1	(c)	**11**	(b)	**21**	(a)	**31**	(a)	**41**	(b)
2	(c)	**12**	(c)	**22**	(d)	**32**	(c)	**42**	(a)
3	(c)	**13**	(b)	**23**	(d)	**33**	(c)		
4	(b)	**14**	(b)	**24**	(d)	**34**	(b)		
5	(d)	**15**	(b)	**25**	(b)	**35**	(d)		
6	(d)	**16**	(d)	**26**	(d)	**36**	(b)		
7	(c)	**17**	(c)	**27**	(b)	**37**	(a)		
8	(d)	**18**	(c)	**28**	(d)	**38**	(d)		
9	(b)	**19**	(c)	**29**	(b)	**39**	(c)		
10	(b)	**20**	(c)	**30**	(d)	**40**	(b)		

HINTS AND SOLUTIONS

3. (c) Mendeleev's periodic table consists of seven periods and eight groups.
5. (d) Because of the presence of same number of valence electrons the elements of same group have similar chemical properties.
6. (d) As atomic size decreases along a period valence electrons becomes more firmly held with nucleus. Thus more amount of energy is required to remove valence electrons which reduces metallic character
7. (c) The electronic configuration of M is 2, 7. It needs one electron to complete its octet. It has a strong tendency to gain 1 electron and so its ion will be M^-.
8. (d) In group 13, boron is above aluminium. Rest of elements not belong to group 13.
9. (b) All these are noble gases with completely filled outermost shell.
11. (b) A family of elements consists of elements present in a group of the periodic table.
12. (c) He is an inert gas.
13. (b) The fourth period contains elements with atomic number 19 to 36. K (Z = 19) is the first member and so it is most metallic.
14. (b) Elements of oxygen family are known as chalcogens.
16. (d) Tungsten (W) is used in electric bulbs.
17. (c) Cs is a metal. It is liquid at room temperature. It is lighter than Hg (also a liquid metal).
18. (c) Only Radon (Rn) is radioactive whereas other noble gases (i.e., He, Ne, Ar, Kr, Xe) are non-radioactive.
19. (c) Halogens are most electronegative elements i.e., they are likely to form anions most readily.
21. (a) Fe is a transition element.
23. (d) A(Z = 3); B(Z = 11) and E(Z = 19) are all alkali metals.
24. (d) Element A belong to halogens (Group VII) group and is a non-metal. While element B belongs to alkali metal group (Group I) and is a metal.
25. (b) The given element belongs to carbon family.
26. (d) The members of the halogen family are non-metallic in nature. However, iodine and astatine are crystalline solids and have lustre just like metals.
29. (b) Alkali metals have 1 electron in valence shell.
30. (d) Oxides of non-metals are acidic.
31. (a) Alkali metals are most electropositive in their respective period. i.e. they have maximum tendency to lose electron and form a cation.
35. (d) P is in group 5 and has 5 valence electron.
Number of valence electrons in Na, Al and Si are 1, 3 and 4.
36. (b) F has a tendency to gain an electron.
41. (b). Dmitri Mendeleev is credited with designing the modern periodic table. Joseph Priestly and Antoine Lavoisier were both chemists. Albert Einstein developed theories on photoelectric effect.

CHAPTER

4 Acids, Bases and Salts

1. The term acid, in fact, comes from the latin term acere, which means "Sour". In everyday life we come across many compounds that chemists classify as acids.

Bases are compounds which taste bitter eg. milk of magnesia.

Salts also have wide applications for example ammonium chloride is used as electrolyte in dry cells, sodium bicarbonote (baking powder) in the manufacture of glass etc.

2. Properties of acids and bases

A. Properties of acids

Chemical properties :

(i) **Action of metals**

Metals generally react with dilute acids to form their respective salt and hydrogen.

$$\text{Metal} + \text{Acid} \longrightarrow \text{Salt} + \text{Hydrogen}$$

(ii) **Action with metal oxides (Basic oxides)**

Metal oxides are generally basic oxides. These oxides get *neutralised* when they react with acids. These reactions are mostly carried upon heating e.g.

$$\text{Basic oxide} + \text{Acid} \longrightarrow \text{Salt} + \text{Water}$$
(neutralisation reaction)

(iii) **Action with metal carbonates and metal hydrogen carbonates**

Acids react with carbonates and hydrogen carbonates to form their respective salts, water and carbon dioxide gas.

$$\text{Carbonate/bicarbonate} + \text{Acid} \longrightarrow \text{Salt} + \text{water} + \text{carbon dioxide.}$$

B. Properties of bases

Chemical Properties :

(i) **Reaction of metals with bases :** Metals (e.g. Zn, Al, Sn) dissolve in NaOH (an alkali) to liberate hydrogen gas.

$$Zn + 2NaOH \longrightarrow \underset{\text{Sod. Zincate}}{Na_2ZnO_2} + H_2$$

(ii) **Action with acids :** Bases combine with acids to form salt and water only. It is a *neutralisation reaction.*

$$\text{Base} + \text{Acid} \longrightarrow \text{Salt} + \text{Water}$$

Non - metallic oxides react in the same way hence *non-metallic oxides are acidic in nature.*

3. Strength of Acids and Bases

The strength of an acid or a base can be easily estimated by making use of **universal indicator** which is a *mixture of several indicators.* The universal indicator show different colours at different concentrations of hydrogen ions in solution.

4. pH Scale : It is a scale that is used for measuring H^+ion (Hydrogen ion) concentration of a solution.

The term pH stands for "potential" of "hydrogen". It is the *amount of hydrogen ions in a particular solution.*

For acids pH < 7

For bases pH > 7

For neutral substances pH = 7

5. Importance of pH in Daily Life

(i) **Blood pH :** For proper functioning our body needs to maintain blood pH between 7.35 and 7.45. Values of blood pH greater than 7.8 or less than 6.8 often results in death.

(ii) **Acid rain :** When pH of rain water is less than 5.6, it is called acid rain, when acid rain flows into rivers, it lowers the pH of river water.

(iii) **pH in our digestive system :** We know that hydrochloric acid (HCl) produced in our stomach helps in digestion of food without harming stomach. However excess of acid causes indigestion and leads to pain as well as irritation. To get rid of this people use bases called "antacids".

(iv) **pH of the soil :** For their healthy growth plants require a specific pH. Soils with high peat content or iron minerals or with rotting vegetation tend to become acidic and the soil pH can reach as low as 4.

(v) **pH change as the cause of tooth decay :** Tooth decay starts when the pH of mouth is lower than 5.5.

(vi) **Self defence by animals and plants through chemical warfare :** Bee-sting leaves an acid (formic acid or methanoic acid, HCOOH) which causes pains and irritation. Use of mild base like baking soda on the stung area gives relley

6. Salts : A **salt** is an *ionic compound* which dissociates to yield a positive ion other than hydrogen ion (H^+) and negative ion other than hydroxyl ion (OH^-) e.g. NaCl

Salts are formed by the reaction of acid and base which is also known as neutralisation.

(i) **Sodium hydroxide (NaOH) or Caustic soda :** It is prepared on commercial scale by the electrolysis of strong solution of sodium chloride (NaCl) also called **brine.** The process is called **chlor-alkali process.**

The overall reaction taking place is :

$2NaCl\,(aq) + 2\,H_2O(l) \longrightarrow H_2(g) + Cl_2(g) + 2NaOH\,(aq)$

Uses :

(a) Sodium hydroxide is most used base in the laboratory.

(b) It is used in many industries, mostly as strong chemical base in manufacture of pulp and paper, textiles, drinking water, soap and detergents etc.

(ii) Baking soda, Sodium hydrogen carbonate, ($NaHCO_3$)

$NaCl + H_2O + CO_2 + NH_3 \longrightarrow NH_4Cl + NaHCO_3$

When heated the following reaction occurs

$$2\,NaHCO_3 \xrightarrow{\text{heat}} Na_2CO_3 + H_2O + CO_2$$

The above reaction occurs when baking soda is heated during cooking.

Uses :

(a) **In baking powder :** The most practical use of baking soda is as a *leavening agent in baking.*

(b) **As an antacid :** Baking soda reacts with acid due to its alkaline nature and neutralizes acidity (i.e. acts as an antacid)

(c) **In fire extinguishers :** It is used in *soda-acid fire extinguisher*

(iii) **Washing soda, Na_2CO_3. $10H_2O$, Sodium carbonate**

Sodium carbonate can be obtained by heating baking soda; recrystallisation of sodium carbonate gives washing soda. It is also a basic salt.

$Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3 \cdot 10H_2O$

Sodium carbonate — Hydrated sodium carbonate (Washing soda),

Uses :

(a) Sodium carbonate (washing soda) is used in glass, soap and paper industries.

(b) It is used for removing permanent hardness of water.

(iv) **Bleaching powder :** Calcium hypochlorite is a chemical compound with formula $CaOCl_2$. It is a yellowish powder with smell of chlorine. It is widely used for water treatment and as a bleaching agent (bleaching powder)

$2\,Ca(OH)_2 + 2Cl_2 \longrightarrow CaOCl_2 + CaCl_2 + 2H_2O$

Calcium hypochlorite is used for the disinfection of drinking water or swimming pool water.

(v) **Plaster of Paris, $CaSO_4$ .1/2 H_2O**

It can be obtained by heating gypsum ($CaSO_4$. $2H_2O$)

$$(CaSO_4.\,2H_2O) + \text{heat} \longrightarrow (CaSO_4.\,\frac{1}{2}H_2O) + \frac{3}{2}\,H_2O$$

Plaster of paris is a white powder and on mixing with water it changes to gypsum once again giving a hard solid mass

$$CaSO_4 \cdot \frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4.\,2H_2O.$$

Uses : It is used

(a) for making moulds or casts for toys, pottery, cermics etc.

(b) in surgical bandages for setting fractured bones.

EXERCISE

1. Bleaching powder is soluble in cold water giving a milky solution due to –
   (a) available chlorine
   (b) lime present in it
   (c) calcium carbonate formation
   (d) the absorption of carbon dioxide from atmosphere
2. The acid used in making of vinegar is –
   (a) formic acid (b) acetic acid
   (c) sulphuric acid (d) nitric acid
3. Reaction of an acid with a base is known as –
   (a) decomposition (b) combination
   (c) redox reaction (d) neutralization
4. Antacids contain –
   (a) weak base (b) weak acid
   (c) strong base (d) strong acid
5. Bleaching powder gives smell of chlorine because it –
   (a) is unstable
   (b) gives chlorine on exposure to atmosphere
   (c) is a mixture of chlorine and slaked lime
   (d) contains excess of chlorine
6. Plaster of paris is made from –
   (a) lime stone (b) slaked lime
   (c) quick lime (d) gypsum
7. Chemical formula of baking soda is –
   (a) $MgSO_4$ (b) Na_2CO_3
   (c) $NaHCO_3$ (d) $MgCO_3$
8. Washing soda has the formula –
   (a) $Na_2CO_3.7H_2O$ (b) $Na_2CO_3.10H_2O$
   (c) $Na_2CO_3.H_2O$ (d) Na_2CO_3
9. Plaster of Paris hardens by –
   (a) giving of CO_2 (b) changing into $CaCO_3$
   (c) combining with water (d) giving out water
10. A solution reacts with crushed egg–shells to give a gas that turns lime–water milky. The solution contains
    (a) NaCl (b) HCl
    (c) LiCl (d) KCl
11. Which of the following is acidic in nature –
    (a) apple juice (b) soap solution
    (c) slaked lime (d) lime
12. Which of the following acid is present in sour milk ?
    (a) glycolic acid (b) lactic acid
    (c) citrus acid (d) tartaric acid
13. Acid turn blue litmus –
    (a) green (b) red
    (c) yellow (d) orange
14. The reaction of metal with acid results in the formation of–
    (a) only hydrogen gas
    (b) only salt
    (c) both salt and hydrogen gas
    (d) none of these
15. 'Alum' is an example of –
    (a) single salt (b) double salt
    (c) acids (d) none of these
16. Which of the following is 'quicklime' –
    (a) CaO (b) $Ca(OH)_2$
    (c) $CaCO_3$ (d) $CaCl_2.6H_2O$
17. Slaked lime is prepared by adding water to –
    (a) bleaching powder (b) lime water
    (c) milk of lime (d) quicklime
18. Plaster of paris has the formula –
    (a) $CaSO_4.½H_2O$ (b) $CaSO_4.H_2O$
    (c) $CaSO_4.1½H_2O$ (d) $CaSO_4.2H_2O$
19. Plaster of paris is obtained –
    (a) by adding water to calcium sulphate
    (b) by adding sulphuric acid to calcium hydroxide
    (c) by heating gypsum to a very high temperature
    (d) by heating gypsum to 373 K.
20. Which of the following is considered a mineral acid ?
    (a) Oxalic acid (b) Lactic acid
    (c) Citric acid (d) Phosphoric acid
21. Which of the following is an alkali ?
    (a) $Ca(OH)_2$ (b) KOH
    (c) $Mg(OH)_2$ (d) $CaCO_3$
22. When the stopper of a bottle containing colourless liquid was removed, the bottle gave smell like that of vinegar. The liquid in the bottle could be
    (a) hydrochloric acid
    (b) sodium hydroxide solution
    (c) acetic acid solution
    (d) saturated sodium hydrogen carbonate solution
23. Which of the following is not required to find the pH of a given sample ?
    (a) pH paper (b) Litmus paper
    (c) Universal indicator (d) Standard pH chart
24. Universal indicator solution is named as such because
    (a) it is available universally
    (b) it has a universal appearance
    (c) it can be used for entire pH range
    (d) all the above are correct
25. Select the one that is having pH < 7.
    (a) lime juice (b) lime water
    (c) human blood (d) antacid.
26. Acids and bases are important because of
    (a) their use in industry
    (b) their effects on human health
    (c) their effect on farmer's crop
    (d) all the above are correct.
27. Which of the following is a weak base ?
    (a) NaOH (b) KOH
    (c) NH_4OH (d) none of these

28. Which of the following compounds is basic in nature ?
(a) $Ca(OH)_2$ (b) $CaCl_2.6H_2O$
(c) NaCl (d) $CuSO_4.5H_2O$

29. If pH of A, B, C and D are 9.5, 2.5, 3.5 and 5.5 respectively, then strongest acid is
(a) A (b) C
(c) D (d) B

30. Aqueous solution of which of the following salt will change the colour of red litmus to blue?
(a) Na_2CO_3 (b) $Na_2CO_3.10H_2O$
(c) Both (a) and (b) (d) None of these

31. Which of the following is known as dead burnt plaster?
(a) Quick lime (b) Slaked lime
(c) Lime stone (d) Gypsum

32. Which of the following pairs of substances are chemically same?
(a) Lime water and milk of lime
(b) Dead burnt plaster and gypsum
(c) Both the above
(d) None of the above

33. Baking powder is
(a) a mixture (b) a compound
(c) an element (d) a salt

34. The chemical name of bleaching powder is
(a) calcium chloride
(b) calcium oxychloride
(c) calcium chloroxide
(d) none of above

35. Which of the following is not a hydrated salt?
(a) Blue vitriol (b) Baking soda
(c) Washing soda (d) Epsom salt

36. Which of the following is a strong acid:
(a) Acetic acid (b) Citric acid
(c) Nitric acid (d) Tartaric acid

37. The presence of which of the following acid causes indigestion:
(a) Citric acid (b) Oxalic acid
(c) Acetic acid (d) Hydrochloric acid

38. When few drops of lemon are mixed with milk
(i) it turns sour
(ii) no change takes place
(iii) properties of milk are changed
(iv) properties of milk remain same
Which of the above statements is/are correct?
(a) (ii) and (iii) (b) (i) and (ii)
(c) (i) and (iii) (d) (i) only

39. Which of the following is a strong base?
(a) Ammonium hydroxide (NH_4OH)
(b) Sodium hydroxide (NaOH)
(c) Water (H_2O)
(d) Sulfuric acid (H_2SO_4)

40. Acids are ..... in taste while bases are ..... in taste
(a) sweet, salty (b) sweet, sour
(c) sour, salty (d) sour, bitter

41. A base which dissolves in water is called
(a) soluble base (b) alkali
(c) acid (d) oxide

42. Acid rain is caused due to .....
(a) CO_2, O_2, SO_2 (b) CO_2, NO_2, H_2
(c) SO_2 N_2, O_2 (d) CO_2, SO_2, NO_2

43. Acid contained in the sting of an ant is.....
(a) acetic acid (b) formic acid
(c) lactic acid (d) ascorbic acid

44. Natural indicator litmus is extracted from
(a) lichens (b) earthworms
(c) ants (d) algae

45. When vinegar reacts with baking soda the gas evolved is
(a) hydrogen (b) oxygen
(c) carbon dioxide (d) nitrogen dioxide

46. On which of the following acid rain has adverse effects?
(a) Marble structures (b) Historical monuments
(c) Aquatic life (d) All of these

47. pH of human body varies within the range of
(a) 6.0 to 6.5 (b) 5.5 to 5.8
(c) 7.0 to 7.8 (d) 7.0 to 11.0

48. Calamine solution contains
(a) zinc hydroxide
(b) zinc carbonate
(c) sodium hydrogen carbonate
(d) magnesium hydroxide

49. Why bases are kept in glass bottles?
(a) Bases produce OH^- ions in aqueous solutions
(b) Basic solutions are conducting in nature
(c) Bases are corrosive in nature
(d) Basis have soapy texture

50. Which of the following statement regarding bases is false?
(a) Bases produce hydroxide ions when dissolved in water
(b) Bases are soapy to touch
(c) Bases are extremly corrosive in nature
(d) Basic solutions are non conducting in nature

51. Which of the following statement is true?
(a) Acids are bitter in taste
(b) Bases are sour in taste
(c) The reaction between acid and a base is exothermic reaction
(d) The reaction between an acid and a base is endothermic reaction.

52. Common salt besides being used in kitchen can also be used as the raw material for making
(i) washing soda (ii) bleaching powder
(iii) baking soda (iv) slaked lime
(a) (i) and (ii) (b) (i), (ii) and (iv)
(c) (i) and (iii) (d) (i), (iii) and (iv)

53. To protect tooth decay we are advised to brush our teeth regularly. The nature of the tooth paste commonly used is
(a) acidic (b) neutral
(c) basic (d) corrosive

ANSWER KEY											
1	(b)	11	(a)	21	(b)	31	(b)	41	(b)	51	(c)
2	(b)	12	(b)	22	(c)	32	(a)	42	(d)	52	(c)
3	(d)	13	(b)	23	(b)	33	(a)	43	(b)	53	(c)
4	(a)	14	(c)	24	(c)	34	(b)	44	(a)		
5	(b)	15	(b)	25	(a)	35	(b)	45	(c)		
6	(d)	16	(a)	26	(d)	36	(c)	46	(d)		
7	(c)	17	(d)	27	(c)	37	(d)	47	(c)		
8	(b)	18	(a)	28	(a)	38	(c)	48	(b)		
9	(c)	19	(d)	29	(d)	39	(b)	49	(c)		
10	(b)	20	(d)	30	(c)	40	(d)	50	(d)		

HINTS AND SOLUTIONS

1. (b) Bleaching powder is actually a mixture of calcium hypochlorite $CaOCl_2$ and the basic chloride $CaCl_2$ with some slaked, $Ca(OH)_2$.
2. (b) 6 - 12% acetic acid is known as vinegar.
3. (d) In a neutralization reaction an acid reacts with a base and forms salt and water.
4. (a) Antacids are weak bases which are given when a patient is suffering from acidity. These antacids neutralises the acid and give relief to patient.

9. (c) $CaSO_4.\frac{1}{2}H_2O + \frac{3}{2}H_2O \longrightarrow CaSO_4.2H_2O$

10. (b) The egg-shells are made up of calcium carbonate. When it reacts with HCl it liberates CO_2 gas which turns lime water milky

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$$

11. (a) Soaps are sodium salts of higher fatty acids.

14. (c) e.g. $Na + HCl \longrightarrow NaCl + \frac{1}{2}H_2$

15. (b) $K_2SO_4 + Al_2(SO_4)_3.24H_2O \longrightarrow$ Alum

17. (d) $CaO + H_2O \longrightarrow Ca(OH)_2$

19. (d) $CaSO_4.2H_2O \xrightarrow{\Delta} CaSO_4.\frac{1}{2}H_2O + \frac{3}{2}H_2O$

21. (b) KOH; Alkali is a base which are water soluble.
22. (c) acetic acid solutions
23. (b) Litmus paper
[Hint : Litmus paper does not give any information about the pH values].
24. (c) It can be for entire pH range.
25. (a) Lime juice
[Hint : Lime juice is acidic so its pH < 7.].
26. (d) All the above are correct.
27. (c) NH_4OH as it is not get completely ionized in aqueous solution.
29. (d) Less the pH, more acidic is the solution. The pH of acid B is 2.5 which is minimum.
35. (b) Baking soda is $NaHCO_3$
36. (c) As HNO_3 is a mineral acid.
38. (c) When lemon juice is mixed with milk the milk turns sour and changes into 'paneer'. The properties of milk are completely different from that of 'paneer'.
39. (b) Sodium hydroxide (NaOH) is a strong base while ammonium hydroxide (NH_4OH) is a weak base. Water is neutral in nature, neither acidic nor basic.
40. (d) All acids are sour in taste, like tartaric acid in tamarind and acetic acid in vinegar while all bases are bitter in taste like baking soda.
41. (b) Bases soluble in water are called alkalis. Only the oxides of sodium, potassium, and calcium are soluble in water, so these form sodium hydroxide potassium hydroxide and calcium hydroxide. These are the strongest bases.
42. (d) Acid rain is caused due to increased pollution in the air. The poisonous gases like sulphur dioxide, carbon dioxide and nitrogen dioxide react with water to form sulphuric acid, carbonic acid and nitric acid respectively.
43. (b) The sting of an ant contains formic acid. Its effect can be neutralized by rubbing moist baking soda on the affected part.
44. (a) Natural indicator is obtained from lichens and is purple in colour. It turns acidic solution red and basic solution blue.
45. (c) Vinegar is acetic acid and baking soda is sodium hydrogen carbonate (a base). Whenever an acid reacts with a metal carbonate it produces carbon dioxide gas.

$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2$$

46. (d) Acid rain effects all of them. Acid rain corrodes historical monuments and marble structures. Acid rain alter the pH of water bodies by making it more acidic thus affects acquatic plants and animals.
50. (d) Basic solutions are conducting in nature. Conduction depends on the number of hydroxide ions produced when dissolved in water.
51. (c) This reaction is exothermic i.e. Heat is evolved

$$HCl + NaOH \rightarrow NaCl + H_2O + Heat$$

52. (c) $NaCl + H_2O + CO_2 + NH_3 \longrightarrow \underset{\text{Baking soda}}{NH_4Cl + NaHCO_3}$

$$2NaHCO_3 \xrightarrow{heat} Na_2CO_3 + H_2O + CO_2$$

$$\underset{\text{Sodium carbonate}}{Na_2CO_3} + 10\,H_2O \longrightarrow \underset{\substack{\text{Hydrated sodium carbonate} \\ \text{(washing soda)}}}{Na_2CO_3.10\,H_2O}$$

CHAPTER

5 Metals and Non-metals

1. **Metals and Non-metals :** There are more than 114 elements present in the periodic table. These elements can be broadly classified into two categories i.e., metals and non-metals. Out of 114 elements, 22 are non-metals.
2. **Physical properties of metals :**
   (i) They are usually shiny i.e. have a metallic luster.
   (ii) Metals have a high density
   (iii) Metals are ductile i.e. they can be drawn into wires.
   (iv) Metals are malleable i.e. they can be founded into thin sheets.
   (v) Metals are good conductors of electricity.
   (vi) Metals have high melting point and are generally in solid state at room temperature.
   (vii) Metals are good conductors of heat and sound.
3. **Uses of mxetals :**
   (i) Metals are very important for modern humans it is not possible to imagine our life without them.
   (ii) Metals are used in manufacturing of bridges, railways, aeroplanes, diesel mobile units (DMU), electric mobile units (EMU), motor cars, electric motors, telephones, televisions, interplanetary space vehicles, or even common articles like cooking utensils and coins.
   (iii) Metals are very important for the economy of a country. Some metals, such as titanium, chromium, manganese and zirconium are strategic metals. These metals and their alloys find wide applications in atomic energy, space science projects, jet engines and high grade steels.
   (iv) Gold and silver ornaments are obtained from small pieces of metals by hammering.
4. **Noble metal :** Noble metals are metals that are resistant to corrosion or oxidation, unlike most base metals. Examples include tantalum, gold, platinum, and rhodium.
5. **Precious metal :** A precious metal is a rare metallic chemical element of high economic value precious metals include the platinum group metals: ruthenium, rhodium, palladium, osmium, iridium, and platinum, of which platinum is the most widely traded.
6. **Alloy :** An alloy is a mixture of two or more elements in solid solution in which the major component is a metal. Most pure metals are either too soft, brittle or chemically reactive for practical use. Combining different ratios of metals as alloys modify the properties of pure metals to produce desirable characteristics. The aim of making alloys is generally to make them less brittle, harder, resistant to corrosion, or have a more desirable color and luster. Examples of alloys are steel (iron and carbon), brass (copper and zinc), bronze (copper and tin), and duralumin (aluminium and copper).

	Alloy	Composition	Uses
1.	Brass	Cu = 80%, Zn = 20%	For making utensils and cartridges.
2.	Bronze	Cu = 90%, Sn = 10%	For making statues, medals, ships, coins and machines
3.	Solder	Sn = 50%, Pb = 50%	For joining metals, solding wire and electronic components etc.
4.	Duralumin	Al = 95.5%, Cu = 3%, Mn = 1.0%, Mg = 0.5%	Used in bodies of aircrafts, kitchen ware and automobile parts etc.
5.	German Silver	Cu = 60%, Zn = 20%, Ni = 20%	For making utensils and ornaments
6.	Gun metal	Cu = 90%, Sn = 10%	For Gears and castings etc.
7.	Bell metal	Cu = 80%, Sn = 20%	For bells, gangs etc.
8.	Magnalium	Al = 90%, Mg = 10%	For balance beams, light instruments.
9.	Type metal	Pb = 82%, Sb = 15%, Sn = 3%	For casting type
10.	Stainless steel	Fe, Ni, Cr, C	For utensils, cutlery etc.

7. Physical properties of non-metals :

(i) They are dull, however diamond, graphite and iodine are lustrous.

(ii) They are poor conductors of heat and electricity. Graphite is a good conductor.

(iii) They are weak and brittle (they easily break or shatter).

(iv) They have a low density (they feel light for their size).

(v) They do not make a ringing sound when they are hit.

(vi) Melting points and boiling points are usually low.

(vii) Non-metals are usually soft. (Diamond is an exception, it is quite hard. It is a crystalline solid).

(viii) They exist in allotropic forms.

8. Uses of Non-Metals

(i) Oxygen is essential for survival of life.

(ii) Hydrogen is used to convert vegetable oil into vegetable ghee by hydrogenation.

(iii) Nitrogen is used to preserve food and for manufacturing proteins by plants.

(iv) Carbon in the form of diamond is used for cutting rocks and in the form of graphite as electrode and in manufacturing of lead pencils.

(v) Sulphur is used in vulcanization of rubber, as fungicide and in manufacture of dyes, gun powder etc.

(vi) Chlorine is used as water disinfectant and in the manufacture of pesticides like gammaxene.

9. Extraction of Metals

(i) **Minerals:** The natural substance in which the metals or their compounds occur in the earth is called minerals.

(ii) **Ores:** The minerals from which the metals can be conveniently and economically extracted are called ores.

(iii) **Native ores:** These ores contain metals in the free state, *e.g.*, silver, gold, platinum, etc.

(iv) **Metallurgy:** The whole process of obtaining a pure metal from one of its ore is known as metallurgy.

(v) **Gangue or matrix:** Ores usually contain soil, sand, stones and others useless silicates. These undesired impurities present in ores are called gangue or matrix.

(vi) The removal of unwanted earthy and silicious impurities from the ore is called **ore-dressing or concentration of ores** and the process used to concentrate an ore is called the **benefication process**.

(vii) Concentration of ore is achieved by

(a) physical methods, and

(b) chemical methods

(viii) **Physical methods are:**

(a) **Hand-picking:** It is used in the case when the impurities are quite distinct from the ore so that these may be differentiated by naked eye.

(b) **Hydraulic washing or Levigation or Gravity separation:** The separation is based on the difference in the specific gravities of the gangue particles and the ore particles.

(c) **Electromagnetic separation:** When one component either the ore or impurity is magnetic in nature, this method can be used for separation.

(d) **Froth floatation process:** This method is used for the concentration of sulphide ores.

(ix) **Chemical method (Leaching)** involves the treatment of the ore with a suitable reagent as to make it soluble while impurities remain insoluble. The ore is recovered from the solution by suitable chemical method.

(x) **Extraction** process used to obtain metals in free state from concentrated ores is called extraction.

(xi) **Extraction of crude metal from the concentrated ore involves following chemical processes.**

(a) **Conversion of ore into metallic oxides.**

- Calcination involves heating the ore below its fusion temperature in the absence of air. It can remove moisture from hydrated oxide or CO_2 from carbonates. It makes the ore porous.
- Roasting is the heating of the ore in the presence of air below its fusion temperature.

(b) **Reduction to free metal:**

- **Smelting:** This involves the reduction of the ore to the molten metal at a high temperature. For the extraction of electropositive metals such as Pb, Fe, Sn, powerful reducing agent like C, H_2 CO, Al, Mg, etc., are used.
- **Self reduction process :** These processes are also called auto-reduction process.
- **Electrolytic process:** The oxides of highly electropositive metals like Na, K, Mg, Ca, Al, etc., are extracted by electrolysis of their oxides, hydroxides or chlorides in fused state. For example, Al is obtained by the electrolysis of alumina mixed with cryolite.

(xii) **Refining** is the process of purifying the extracted metals.

(xiii) **Chromatography** is based on the principle that the different components of a mixture are adsorbed to different extents on an adsorbent.

The table given here lists some common ores of some metals

Sl. No.	*Name of the ore*	*Formula of the ore*	*Type of ore*	*Metal obtained from the ore*
1.	Bauxite	$Al_2O_3.2H_2O$	Oxide	Aluminium (Al)
2.	Haematite	Fe_2O_3	Oxide	Iron (Fe)
3.	Magnetite	Fe_3O_4	Oxide	Iron (Fe)
4.	Zincite	ZnO	Oxide	Zinc (Zn)
5.	Cuprite	Cu_2O	Oxide	Copper (Cu)
6.	Litharge	PbO	Oxide	Lead (Pb)
7.	Malachite	$CuCO_3.Cu(OH)_2$	Carbonate	Copper (Cu)
8.	Magnesite	$MgCO_3$	Carbonate	Magnesium (Mg)
9.	Lime stone	$CaCO_3$	Carbonate	Calcium (Ca)
10.	Cinnabar	HgS	Sulphide	Mercury (Hg)
11.	Chalcopyrite	$CuFeS_2$	Sulphide	Copper (Cu)
12.	Zinc blende	ZnS	Sulphide	Zinc (Zn)
13.	Galena	PbS	Sulphide	Lead (Pb)
14.	Common salt	NaCl	Chloride (Halide)	Sodium (Na)
15.	Fluorspar	CaF_2	Fluoride (Halide)	Calcium (Ca)
16.	Horn silver	AgCl	Chloride (Halide)	Silver (Ag)
17.	Chalcocite	Cu_2S	Sulphide	Copper (Cu)

10. Corrosion of Metals : Corrosion is an oxidation reaction with atmospheric oxygen in the presence of water on the surface of a metal. Rusting is

$$Fe(s) + \frac{3}{2}O_2(g) + xH_2O(\ell) \longrightarrow Fe_2O_3.xH_2O(s)$$

i.e., rust is hydrated iron (III) oxide.

11. Prevention of Corrosion : Iron and steel (alloy of iron) are most easily protected by paint which provides a barrier between the metal and air/water. Moving parts on machines can be protected by a water repellent oil or grease layer. Other important methods are

(i) Alloying : Iron or steel along with other metals can also be protected by 'alloying' or mixing with other metals (e.g., chromium) to make non-rusting alloys.

(ii) Galvanizing : Coating iron or steel with a thin zinc layer is called 'galvanizing'.

12. Purity of Gold :

24-Carat gold : The carat (abbreviation ct or Kt) is a measure of the purity of gold alloys. Carat is used to refer to the measure of mass for gemstones.

EXERCISE

1. The most abundant metal in the earth's crust is -
   (a) iron (b) copper
   (c) aluminium (d) mercury
2. The only metal that is liquid at room temperature is -
   (a) mercury (b) sodium
   (c) zinc (d) tungsten
3. Chemically rust is
   (a) hydrated ferric oxide only
   (b) hydrated ferrous oxide only
   (c) ferric oxide only
   (d) ferrous oxide only
4. Alumina is chief ore of which of the following metal?
   (a) Na (b) K
   (c) Ca (d) Al
5. Horn silver is
   (a) an oxide ore of silver
   (b) a sulphite ore of silver
   (c) a carbonate ore of silver
   (d) a chloride ore of silver
6. Naturally occuring substances from which a metal can be profitably (or economically) extracted are called?
   (a) Minerals (b) Ores
   (c) Gangue (d) Salts
7. Cinnabar is an ore of
   (a) Hg (b) Cu
   (c) Pb (d) Zn
8. Which of the following is not an ore ?
   (a) Bauxite (b) Malachite
   (c) Zinc blende (d) Pig iron
9. Which of the following mineral does not contain Al ?
   (a) Cryolite (b) Mica
   (c) Feldspar (d) Fluorspar
10. Formula of magnetite is
   (a) Fe_2O_3 (b) FeS_2
   (c) $FeCO_3$ (d) Fe_3O_4
11. Which ore contains both iron and copper?
   (a) Cuprite (b) Chalcocite
   (c) Chalcopyrite (d) Malachite
12. Calcination is the process of heating the ore
   (a) in a blast furnace (b) in absence of air
   (c) in presence of air (d) none of these
13. Which of the following is an oxide ore?
   (a) Bauxite (b) Cuprite
   (c) Haematite (d) All of these
14. Removal of impurities from ore is known as -
   (a) crushing and grinding
   (b) concentration of ore
   (c) calcination
   (d) roasting
15. Which reducing agent is used in chemical reduction?
   (a) C (b) CO
   (c) Al (d) All of these
16. Aluminium is used in thermite welding because -
   (a) aluminium is a light metal
   (b) aluminium has more affinity for oxygen
   (c) aluminium is a strong oxidising agent
   (d) aluminium is a reactive metal
17. The process of extraction of metal from its ores, is known as
   (a) concentration (b) calcination
   (c) purification (d) metallurgy
18. The process to heat the ore in the presence of excess supply of air below its melting point is called
   (a) roasting (b) calcination
   (c) smelting (d) liquation
19. Brass is a mixture of
   (a) copper and zinc
   (b) copper and tin
   (c) copper, nickel and zinc
   (d) aluminium, copper and traces of Mg and Mn
20. Sodium is obtained by the electrolysis of
   (a) an aqueous solution of sodium chloride
   (b) an aqueous solution of sodium hydroxide
   (c) fused sodium chloride
   (d) fused sodium sulphate
21. The chief ore of aluminium is
   (a) bauxite (b) cryolite
   (c) alunite (d) feldspar
22. One of the constituents of amalgam is
   (a) aluminium (b) copper
   (c) iron (d) mercury
23. The metal used to built bridges is
   (a) gold (b) silver
   (c) platinum (d) iron
24. Which of the following is a good conductors of heat and electricity?
   (a) Graphite (b) Oxygen
   (c) Chlorine (d) Nitrogen

25. Metals are
(a) malleable (b) ductile
(c) Both (a) and (b) (d) Neither (a) nor (b)

26. Which of the following have low melting and boiling points?
(a) Phosphorus (b) Sodium
(c) Iron (d) Both (a) and (b)

27. Which of the following non-metals has shining lustrous surfaces?
(a) Graphite and phosphorus
(b) Graphite and iodine
(c) Iodine and phosphorus
(d) Phosphorus and chlorine

28. Metals like Gold, Platinum which do not easily react are called
(a) active metals (b) dull metals
(c) noble metals (d) bright metals

29. The metalloids include the elements
(a) Boron, Silicon (b) Arsenic, Antimony
(c) Germanium, Tellurium (d) All of these

30. Select the property that is associated with non-metals.
(a) Low density
(b) Low melting point
(c) Poor conductor of electricity
(d) All of the above

31. Which of the following non-metals sublimes on heating ?
(a) Fluorine (b) Chlorine
(c) Bromine (d) Iodine

32. Which of the following statement regarding metals is true?
(a) All metals are solid in nature.
(b) Metals can be used to make handle of cooking utensils
(c) Generally most of metals have high melting and boiling points.
(d) Gold is used generally to make electrical wires.

33. Which of the following statement is false?
(a) Metals are good conductors of heat and electricity.
(b) Gold, Silver and Zinc are most malleable metals.
(c) Mercury is the only liquid metal.
(d) Bromine is the only liquid non-metal.

34. Which of the following statement regarding non-metals is true?
(a) Non-metals are of two types only solids and gases.
(b) Non-metals reacts with oxygen to form basic oxides generally.
(c) Non-metals are non-lustrous with dull apppearence. Graphite, an allotrope of carbon and iodine have shining lustrous surfaces.
(d) Non-metals replace hydrogen from acids.

35. Which of the following statements regarding non-metals is false?
(a) 11 non-metals are in gaseous state.
(b) Gas carbon is a good conductor of heat and electricity.
(c) The black material inside a pencil is metal lead.
(d) All non-metals are non-sonorous in nature.

36. Consider the following elements:
(i) Copper (ii) Gold
(iii) Platinum (iv) Silver
Which of the above elements exist free in nature?
(a) (i) and (ii) (b) (ii) and (iii)
(c) (i), (ii) and (iv) (d) (iii) and (iv)

37. Consider the following statements:
Nitrogen is an essential constituent of
(i) soils (ii) animals
(iii) plants
Which of the statements given above is/are correct ?
(a) (iii) only (b) (i) and (iii) only
(c) (i) and (ii) only (d) (i), (ii) and (iii)

38. When iron is left exposed in open air, it gets rusted. Which constituent(s) of air is /are responsible for rusting iron?
(i) Oxygen gas present in air
(ii) Moisture present in air
(iii) Carbon dioxide gas present in air
Select the correct answer using the code given below :
(a) (i) only (b) (ii) only
(c) (i) and (ii) (d) (ii) and (iii)

39. Aluminium is used for making cooking utensils. Which of the following properties of aluminium are responsible for the same ?
(i) Good thermal conductivity
(ii) Good electrical conductivity
(iii) Ductility
(iv) High melting point
(a) (i) and (ii) (b) (i) and (iii)
(c) (ii) and (iii) (d) (i) and (iv)

40. Silicon is used in –
(a) solar energy devices (b) semiconductors
(c) transistors (d) all of these

41. Which of the following is not a atomic characteristics of metal –
(a) malleable (b) electropositive nature
(c) ductile (d) none of these

42. Pure gold is –
(a) 24 carats (b) 22 carats
(c) 20 carats (d) 18 carats

43. What is anode mud –
(a) fan of anode
(b) metal of anode
(c) impurities collected at anode in electrolysis during purification of metals
(d) all of these

44. The best mealleable metal is –
(a) aluminium (b) silver
(c) gold (d) lead

45. German silver is a mixture of –
(a) copper and zinc
(b) copper and tin
(c) copper, nickel and zinc
(d) aluminium, copper and traces of Mg and Mn.

46. Graphite is a/an –
(a) alloy (b) metal
(c) metalloid (d) non-metal

47. Which of the following metals constitutes the alloy magnalium –
(a) Al, Cu (b) Al, Fe
(c) Al, Mg (d) Al, Mn

ANSWER KEY									
1	(c)	**11**	(c)	**21**	(a)	**31**	(d)	**41**	(d)
2	(a)	**12**	(b)	**22**	(d)	**32**	(c)	**42**	(a)
3	(a)	**13**	(d)	**23**	(d)	**33**	(b)	**43**	(c)
4	(d)	**14**	(b)	**24**	(a)	**34**	(c)	**44**	(c)
5	(d)	**15**	(d)	**25**	(c)	**35**	(c)	**45**	(c)
6	(b)	**16**	(b)	**26**	(d)	**36**	(c)	**46**	(d)
7	(a)	**17**	(d)	**27**	(b)	**37**	(d)	**47**	(c)
8	(d)	**18**	(a)	**28**	(c)	**38**	(c)		
9	(d)	**19**	(a)	**29**	(a)	**39**	(d)		
10	(d)	**20**	(c)	**30**	(d)	**40**	(d)		

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2. (a) Mercury is the only element even being metal is liquid at room temperature.
3. (a) As the chemical formula of rust is $Fe_2O_3 . xH_2O$
5. (d) Chemical formula of horn silver is AgCl.
7. (a) Cinnabar (HgS) is a sulphide ore of mercury
8. (d) Pig iron $\rightarrow$ It is the most impure form of iron and contains highest proportion of carbon (2.5–4%). Rest all are ore.
   Malachite $\rightarrow Cu(OH)_2.CuCO_3$,
   Zinc blende $\rightarrow$ ZnS,
   Bauxite $\rightarrow Al_2O_3.2H_2O$
9. (d) Fluorspar (CaF_2), Cryolite (Na_3AlF_6), Feldspar ($KAlSi_3O_8$) and Mica ($K_2O.3Al_2O_3.6SiO_2.2H_2O$)
11. (c) Among cuprite [Cu_2O], Chalcocite [Cu_2S], Chalcopyrite [$CuFeS_2$] and Malachite [$Cu(OH)_2\ CuCO_3$], only Chalcopyrite is an ore which contains both Fe and Cu.
13. (d) Bauxite – Al_2O_3 Halmatite – Fe_2O_3
    Cuprite – Cu_2O
16. (b) $Fe_2O_3(s) + 2Al(s) \longrightarrow Al_2O_3(s) + 2Fe(l)$
19. (a) Brass is a maxture of 80% Cu & 20% Zn.
21. (a) Bauxite is $Al_2O_3.2H_2O$.
23. (d) Steel an alloy of iron and carbon is used for manufacturing bridges.
24. (a) Graphite is the only non-metal, which is a good conductor of heat and electricity.
25. (c) Metals are both melleable and ductile. Metals can be drawn into thin sheets and wires.
26. (d) Phosphorus is a non-metal and non-metals have low melting and boiling points. Although, sodium is a metal, it has low melting and boiling point.
27. (b) Graphite which is crystalline form of carbon and iodine are the only two non-metals which has shining lustrous surfaces.
28. (c) Noble metals are those metals which do not react easily and lie at the bottom of the activity series.
29. (a) Both boron and silicon are metalloids.
31. (d) Iodine is a sublime substance
32. (c) Mercury being a metal is liquid at room temperature. Metals are good conductor of heat therefore cannot be used to make handle it will result into burns. Gold cannot be used to make electrical wires it is very expensive therefore metals like copper is used for it.
33. (b) Gold and Silver are most malleable metals whereas zinc metal is non-malleable and brittle.
35. (c) The black material inside a pencil is not metal lead. Actually it is graphite, a non-metal.
36. (c) Cu, Au, Ag are known as coinage metals and occur free in nature. Becuase of nobility they are frequently found in their natives state.
37. (d) Nitrogen is a essential constituent of all vegetables and animal proteins. Soil contains nitrogen as ammonium salts.
38. (c) Both oxygen and moisture present in air cause rusting of iron.
41. (d) All are characteristics of metal.
45. (c) German silver is a mixture of Cu (60%), Zn (20%) and Ni (20%).
47. (c) Magnalium is a mixture of 90% Al and 10% Mg.

CHAPTER

6 Environmental Pollution

1. The pollutants may be inorganic, biological or radiological in nature.

(i) Bio-degradable pollutants are domestic wastes which are rapidly decomposed by micro-organisms.

(ii) Non-biodegradable pollutants include chemicals, mercuric salts, lead compounds, pesticides, etc.

(iii) Natural pollution is caused by radioactive substances, volcanic eruptions, forests and mines fires floods, etc.

(iv) Artificial pollution is caused by industries, thermal plants, automobile, exhausts, sewage, etc.

2. Environment : The conditions existing around animal or human life.

Atmosphere: The gaseous envelop surrounding the earth. It has been classified into following regions:-

(i) Stratosphere : The layer of the earth's atmosphere above the troposphere and below the mesosphere.

(ii) Troposphere : The lowest region of the atmosphere extending from earth's surface to the lower boundary of the stratosphere. In this region, human beings along with other organisms live. It contains water vapour and is greatly affected by air pollution.

Note : The other two layers are Thermosphere and Mesosphere.

3. Air pollution : The major air pollutants are

(i) Carbon monoxide (CO) : It is produced by incomplete combustion of gasoline in motor vehicles, wood, coal, inceneration and forest fires.

It is treacherous and deadly poisonous gas. It induces headache, visual difficulty coma and death. It blocks the normal transport of oxygen from the lungs to other parts of the body.

(ii) Sulphur dioxide (SO_2) : It is produced by petrol combustion, coal combustion, petrol refining and smelting operations.

It hinders the movement of air in and out of lungs. It is particularly poisonous to trees causing chlorosis and dwarfing. In presence of air it is oxidised to SO_3 which is also irritant.

$$2SO_2 + O_2 \text{ (air)} \longrightarrow 2SO_3$$

In presence of moisture SO_3 is converted into highly corrosive sulphuric acid.

$$SO_3 + H_2O \text{ (moisture)} \longrightarrow H_2SO_4$$

It attacks marble, limestone,vegetation, paper and textiles and injurious to human beings.

(iii) Oxides of nitrogen : NO_2 and NO, Source - combustion of coal, gasoline, natural gas, petroleum refining, chemical plants, manufacturing explosives and fertilizers, tobacco smoke.

Breathing NO_2 causes chlorosis to plants and chronic lung conditions leading to death. NO_2 reacts with moisture to form acids.

$$2NO_2 + H_2O \longrightarrow HNO_2 + HNO_3,$$

$$3HNO_2 \longrightarrow 2NO + HNO_3 + H_2O$$

(iv) Smoke, dust :

Sources : cement works, iron and steel works, gas works, power generating stations.

Smog : It is a mixture of smoke and fog in suspended droplet form. It is of two types :

(a) London smog or classical smog : It is coal smoke plus fog. The fog part is mainly SO_2 and SO_3. It has sulphuric acid aerosol. It causes bronchial irritation and acid rain. It is reducing in nature.

(b) Photochemical smog or Los Angeles smog : The oxidised hydrocarbons and ozone in presence of humidity cause photochemical smog.

Hydrocarbons + O_2, NO_2, NO, O, O_3 $\rightarrow$ Peroxides, formaldehyde, peroxyacetylnitrate (PAN), acrolein etc. It is oxidising in nature and causes irritation to eyes, lungs, nose, asthamatic attack and damage plants.

Acid rain : The oxides of C, N and S present in the atmosphere, dissolve in water and produce acids and lower the pH of water below 5.5.

$$H_2O + CO_2 \longrightarrow H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-}$$

$$2H_2O + 2SO_2 + O_2 \rightarrow 2H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$$

$$2H_2O + 4NO_2 + O_2 \rightarrow 4HNO_3 \rightleftharpoons H^+ + NO_3^-$$

The acids are toxic to vegetation, react with marble and damage buildings.

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2$$

Acids corrode water pipes and produce salts with heavy metals ions viz Cu, Pb, Hg and Al toxic in nature.

(v) Green House effect : The retention of heat by the earth and atmosphere from the sun and its prevention to escape into

the outer space is known as green house effect.

Global warming is average increase in the temperature of earth due to increase in concentration of green house gases (CO_2, O_3, NO_x etc).

Consequences of global warming :

(i) Global warming would result in rise in sea level due to increased rate of melting of glaciers and floods.

(ii) Increase in infectious diseases like malaria, dengue, etc.

(vi) Ozone layer and its depletion : The ozone layer, existing between 20 to 35 km above the earth's surface, shield the earth from the harmful U. V. radiations from the sun. The U. V. radiations cause skin cancer, cataract of eye, and harm to vegetation.

Depletion of ozone is caused by oxides of nitrogen

$$N_2O + h\upsilon \longrightarrow NO + N$$

reactive nitric oxide

$$NO + O_3 \longrightarrow NO_2 + O_2,$$

$$O_3 + h\upsilon \longrightarrow O_2 + O,$$

$$NO_2 + O \longrightarrow NO + O_2$$

$$2O_3 + h\upsilon \longrightarrow 3O_2 \text{ (Net reaction)}$$

The presence of chlorofluorocarbons also increase the decomposition of O_3.

$$CF_2Cl_2 + h\upsilon \longrightarrow CF_2Cl + Cl$$

$$CFCl_3 + h\upsilon \longrightarrow CFCl_2 + Cl,$$

$$Cl + O_3 \longrightarrow ClO + O,$$

$$ClO + O \longrightarrow Cl + O_2$$

$$O_3 + O \longrightarrow 2O_2 \text{ (Net reaction)}$$

(vii) Control of air pollution : It can be controlled by

1. Dissolving HCl, HF, SiF_4 in water and SO_2, Cl_2, H_2S in alkaline solution.
2. Adsorbing gas and liquid molecules over activated charcoal and silica gel.
3. Chemical reactions.
4. Use of precipitators to settle charge particles.
5. Use of settling chambers under the action of gravity.
6. Use of natural gas in place of diesel, petrol, etc.

4. Water pollution : The contamination of water by foreign substances which would constitute a health hazard and make it harmful for all purposes (domestic, industrial or agriculture etc.) is known as water pollution. The polluted water may have offensive odour, bad taste, unpleasant colour, murky oily, etc.

(i) Sources of water pollution

(a) ***Domestic sewage :*** Discharges from kitchens, baths, lavatories, etc.

(b) ***Industrial waters :*** Wastes from manufacturing processes which includes acids, alkalines, pesticides, insecticides, metals like copper, Zinc, lead, mercury, fungicides, etc.

(c) ***Oil :*** From oil spills or washings of automobiles.

(d) ***Atomic explosion*** and processing of radioactive materials.

(e) ***Suspended particles*** (organic or inorganic) viruses, bacterias, algae, protozoa, etc.

(f) ***Wastes from fertilizer*** plants such as phosphates, nitrates ammonia, etc.

(g) ***Clay :*** Ores, minerals, fine particles of soil.

(ii) Aerobic and anaerobic oxidation : The oxidation of organic compounds present in sewage in presence of good amount of dissolved or free oxygen (approx. 8.5 ml/l) by aerobic bacterials is called *aerobic oxidation*. When dissolved or free oxygen is below a certain value the sewage is called *stale*. Anaerobic bacterias bring out putrefaction producing H_2S, NH_3, CH_4, $(NH_4)_2S$, etc. This type of oxidation is called *anaerobic* oxidation.

(iii) Biological Oxygen Demand (BOD) : It is defined as the amount of free oxygen required for biological oxidation of the organic matter by aerobic conditions at 20°C for a period of five days. Its unit is mg/*l* or ppm. An average sewage has BOD of 100 to 150 mg/*l*.

(iv) Chemical Oxygen Demand (COD) : It is a measure of all types of oxidisable impurities present in the sewage. COD values are higher than BOD values.

5. Soil pollution : The addition of substances in an indefinite proportion changing the productivity of the soil is known as soil or land pollution.

Sources of soil pollution :

(i) ***Agricultural pollutants :*** Chemicals like pesticides, fertilizers, bacteriacides, fumigants, insecticides, herbicides, fungicides.

(ii) ***Domestic refuge*** and industrial wastes.

(iii) ***Radioactive wastes*** from research centres, and hospitals.

(iv) ***Soil conditioners*** containing toxic metals like Hg, Pb, As, Cd, etc.

(v) ***Farm wastes*** from poultries, dairies and piggery farms.

(vi) ***Improper disposal*** of human and animal extreta.

(vii) ***Pollutants*** present in air from chemical works.

6. Pesticides : The chemical substances used to kill or stop the growth of unwanted organisms are called pesticides. They are further classified as

(i) ***Insecticides :*** They are used to kill insects. The most common insecticides are

(i) D.D.T (ii) BHC, 666, game xene
(iii) Baygon (iv) Sevin Carbaryl
(v) Parathion (vi) Methoxychlor
(vii) Aldrin

(ii) ***Herbicides :*** They are used to kill weeds

(i) 2, 4-dichlorophenoxy acid
(ii) Triazines
(iii) $NaClO_3$ Sodium chlorate
(iv) Na_3AsO_3 Sodium arsenite

The (iii) and (iv) are not used now-a-days.

Addition of phosphate fertilizers to water leads to nutrient enrichment (eutrophication).

EXERCISE

1. Dinitrogen and dioxygen are main constituents of air but these do not react with each other to form oxides of nitrogen because _____.
   (a) the reaction is endothermic and requires very high temperature.
   (b) the reaction can be initiated only in presence of a catalyst.
   (c) oxides of nitrogen are unstable.
   (d) N_2 and O_2 are unreactive.
2. The pollutants which came directly in the air from sources are called primary pollutants. Primary pollutants are sometimes converted into secondary pollutants. Which of the following belongs to secondary air pollutants?
   (a) CO (b) Hydrocarbon
   (c) Peroxyacetyl nitrate (d) NO
3. Which of the following is not a consequence of greenhouse effect?
   (a) Climatic conditions will be changed
   (b) Plants in warmer climates with adequate rainfall would grow faster
   (c) The incidence of infectious diseases is likely to increase
   (d) Malaria will be controlled as the mosquitoes will not survive.
4. Which of the following gases is not a green house gas?
   (a) CO (b) O_3
   (c) CH_4 (d) H_2O vapour
5. The substance having the largest concentration in acid rain?
   (a) H_2CO_3 (b) HNO_3
   (c) HCl (d) H_2SO_4
6. The non-viable particulate is among the following is
   (a) Dust (b) Bacteria
   (c) Moulds (d) Fungi
7. Which of the following statements is not true about classical smog?
   (a) Its main components are produced by the action of sunlight on emissions of automobiles and factories.
   (b) Produced in cold and humid climate.
   (c) It contains compounds of reducing nature.
   (d) It contains smoke fog and sulphur dioxide
8. Which of the following statements about photochemical smog is wrong?
   (a) It has high concentration of oxidising agents
   (b) It has low concentration of oxidising agent
   (c) It can be controlled by controlling the release of NO_2, hydrocarbons ozone, etc.
   (d) Plantation of some plants like pinus helps in controlling photochemical smog.
9. Which of the following statements is wrong?
   (a) Ozone is not responsible for green house effect.
   (b) Ozone can oxidise sulphur dioxide present in the atmosphere to sulphur trioxide.
   (c) Ozone hole is thinning of ozone layer present in stratosphere.
   (d) Ozone is produced in upper stratosphere by the action of UV rays on oxygen.
10. Which of the following statements is correct?
   (a) Ozone hole is a hole formed in stratosphere from which ozone oozes out.
   (b) Ozone hole is a hole formed in the troposphere from which ozone oozes out.
   (c) Ozone hole is thinning of ozone layer of stratosphere at some places.
   (d) Ozone hole means vanishing of ozone layer around the earth completely.
11. Biochemical Oxygen Demand, (BOD) is a measure of organic material present in water. BOD value less than 5 ppm indicates a water sample to be _____.
   (a) rich in dissolved oxygen
   (b) poor in dissolved oxygen
   (c) highly polluted
   (d) not suitable for aquatic life
12. Photochemical smog occurs in warm, dry and sunny climate. One of the following is not amongst the components of photochemical smog, identify it.
   (a) NO_2
   (b) O_3
   (c) SO_2
   (d) Unsaturated hydrocarbon
13. Phosphate pollution is caused by
   (a) sewage and agricultural fertilizers
   (b) weathering of phosphate rocks only
   (c) agriculutral fertilizers only
   (d) phosphate rocks and sewage
14. The type of pollution caused by spraying of DDT
   (a) Air and soil (b) Air and water
   (c) Air (d) Air, water and soil
15. Which among the following statements is *false*?
   (a) Oil slick in sea water increases D.O. value.
   (b) The main reason for river water pollution is industrial and domestic sewage discharge.
   (c) Surface water contains a lot of organic matter mineral nutrients and radioactive materials.
   (d) Oil spill in sea water causes heavy damage to fishery.
16. Sewage containing organic waste should not be disposed in water bodies because it causes major water pollution. Fishes in such a polluted water die because of
   (a) large number of mosquitoes
   (b) increase in the amount of dissolved oxygen
   (c) decrease in the amount of dissolved oxygen in water
   (d) clogging of gills by mud

17. Which of the following practices will not come under green chemistry?
(a) If possible, making use of soap made of vegetable oils instead of using synthetic detergents.
(b) Using H_2O_2 for bleaching purpose instead of using chlorine based bleaching agents.
(c) Using bicycle for travelling small distances instead of using petrol/ diesel based vehicles.
(d) Using plastic cans for neatly storing substances.

18. Identify the wrong statement in the following:
(a) Chlorofluorocarbons are responsible for ozone layer depletion.
(b) Greenhouse effect is responsible for global warming.
(c) Acid rain is mostly because of oxides of nitrogen and sulphur.
(d) Ozone layer does not permit infrared radiation from the sun to reach the earth.

19. Water is often treated with chlorine to
(a) remove hardness
(b) increase oxygen content
(c) kill germs
(d) remove suspended particles

20. The greenhouse effect is because of the
(a) presence of gases, which in general are strong infrared absorbers, in the atmosphere
(b) presence of CO_2 only in the atmosphere
(c) pressure of O_3 and CH_4 in the atmosphere
(d) N_2O and chlorofluorohydrocarbons in the atmosphere

21. Which of the following is/are the hazardous pollutant(s) present in automobile exhaust gases?
(i) N_2 (ii) CO
(iii) CH_4 (iv) Oxides of nitrogen
(a) (ii) and (iii) (b) (i) and (ii)
(c) (ii) and (iv) (d) (i) and (iii)

22. Green chemistry means such reactions which
(a) produce colour during reactions
(b) reduce the use and production of hazardous chemicals
(c) are related to the depletion of ozone layer
(d) study the reactions in plants

23. Which one of the following statement is not true?
(a) pH of drinking water should be between 5.5 – 9.5.
(b) Concentration of DO below 6 ppm is good for the growth of fish.
(c) Clean water would have a BOD value of less than 5 ppm.
(d) Oxides of sulphur, nitrogen and carbon are the most widespread air pollutant.

24. Frequent occurrence of water blooms in a lake indicates
(a) nutrient deficiency
(b) oxygen deficiency
(c) excessive nutrient availability
(d) absence of herbivores in the lake

25. When rain is accompanied by a thunderstorm, the collected rain water will have a pH value
(a) slightly lower than that of rain water without thunderstorm
(b) slightly higher than that when the thunderstorm is not there
(c) uninfluenced by occurrence of thunderstorm
(d) which depends upon the amount of dust in air

26. The smog is essentially caused by the presence of
(a) Oxides of sulphur and nitrogen
(b) O_2 and N_2
(c) O_2 and O_3
(d) O_3 and N_2

27. Identify the wrong statement in the following.
(a) Chlorofluorocarbons are responsible for ozone layer depletion.
(b) Greenhouse effect is responsible for global warming.
(c) Ozone layer does not permit infrared radiation from the sun to reach the earth.
(d) Acid rain is mostly because of oxides of nitrogen and sulphur.

28. Identify the incorrect statement from the following.
(a) Ozone absorbs the intense ultraviolet radiation of the sun.
(b) Depletion of ozone layer is because of its chemical reactions with chlorofluoro alkanes.
(c) Ozone absorbs infrared radiation.
(d) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer.

29. What is DDT among the following ?
(a) Greenhouse gas
(b) A fertilizer
(c) Biodegradable pollutant
(d) Non-biodegradable pollutant

30. The gas leaked from a storage tank of the Union Carbide plant in Bhopal gas tragedy was
(a) Methyl isocyanate (b) Methylamine
(c) Ammonia (d) Phosgene

31. The substance which is not regarded as a pollutant?
(a) NO_2 (b) CO_2
(c) O_3 (d) Hydrocarbons

32. The greatest affinity for haemoglobin is shown by which of the following :
(a) NO (b) CO
(c) O_2 (d) CO_2

33. Which of the following is not involved in the formation of photochemical smog?
(a) Hydrocarbon (b) NO
(c) SO_2 (d) O_3

34. The false statement among the followings :
(a) The average residence time of NO is one month
(b) Limestone acts as a sink for SO_x
(c) SO_x can be removed from flue gases by passing through a solution of citrate ions
(d) Ammonia acts as a sink for NO_x

35. The statement which is not correct about control of particulate pollution
    (a) In electrostatic precipitator, the particulates are made to acquire positive charge which are then attracted by the negative electrode and removed
    (b) Gravity settling chamber removes larger particles from the air
    (c) Cyclone collector removes fine particles in the diameter range 5-20 microns
    (d) Wet scrubbers are used to wash away all types of particulates
36. Which of the following statements about polar stratosphere clouds (PSCs) is not correct?
    (a) PSCs do not react with chlorine nitrate and HCl
    (b) Type I clouds are formed at about –77°C and contain solid $HNO_3 . 3H_2O$
    (c) Type II clouds are formed at about –85°C and contain some ice
    (d) A tight whirlpool of wind called Polar Vortex is formed which surrounds Antarctica
37. Minamata disease is due to pollution of
    (a) aresenic into the atmosphere
    (b) organic waste into drinking water
    (c) oil spill in water
    (d) industrial waste mercury into fishing water
38. BOD is connected with
    (a) microbes and organic matter
    (b) organic matter
    (c) microbes
    (d) None of these
39. Eutrophication causes reduction in
    (a) dissolved oxygen (b) nutrients
    (c) dissolved salts (d) All of these
40. Which among the following statements is *false*?
    (a) Oil slick in sea water increases D.O. value
    (b) The main reason for river water pollution is industrial and domestic sewage discharge
    (c) Surface water contains a lot of organic matter mineral nutrients and radioactive materials
    (d) Oil spill in sea water causes heavy damage to fishery
41. Presence of which of the following fuel gas in the exhaust fumes shows incomplete combustion of fuel?
    (a) Sulphur dioxide
    (b) Carbon monoxide and water vapour
    (c) Carbon monoxide
    (d) Nitrogen dioxide
42. Which one of the following statements about ozone and ozone layer is true?
    (a) Ozone layer is beneficial to us because ozone cuts out the ultraviolet radiation of the sun
    (b) The conversion of ozone to oxygen is an endothermic reaction
    (c) Ozone has a triatomic linear molecule
    (d) None of these

ANSWER KEY													
1	(a)	**7**	(a)	**13**	(a)	**19**	(c)	**25**	(a)	**31**	(b)	**37**	(d)
2	(c)	**8**	(b)	**14**	(d)	**20**	(a)	**26**	(a)	**32**	(a)	**38**	(a)
3	(d)	**9**	(a)	**15**	(a)	**21**	(c)	**27**	(c)	**33**	(c)	**39**	(a)
4	(a)	**10**	(c)	**16**	(c)	**22**	(b)	**28**	(c)	**34**	(a)	**40**	(a)
5	(d)	**11**	(a)	**17**	(d)	**23**	(b)	**29**	(d)	**35**	(a)	**41**	(c)
6	(a)	**12**	(c)	**18**	(d)	**24**	(b)	**30**	(a)	**36**	(a)	**42**	(a)

HINTS AND SOLUTIONS

3. (d) The mosquitoes will increase their population and spread malaria.

5. (d) Acid rain contains $H_2SO_4 > HNO_3 > HCl$.

6. (a) Dust

13. (a) Phosphate pollution is caused by sewage and agricultural fertilizers.

14. (d) DDT causes water, air and soil pollution.

15. (a) Oil slick in sea water decreases D.O value.

18. (d) Ozone layer acts as a shield and does not allow ultraviolet radiation from sun to reach earth. It does not prevent infra-red radiation from sun to reach earth, thus option (d) is wrong statement and so it is the correct answer.

19. (c) water is often treated with Cl_2 to kill germs.

20. (a) Green house gases such as CO_2, ozone, methane, the chlorofluorocarbon compounds and water vapour form a thick cover around the earth which prevents the IR rays emitted by the earth to escape. It gradually leads to increase in temperature of atmosphere.

21. (c) CO and oxides of Nitrogen are poisnous gases present in automobile exhaust gases.

22. (b) Green chemistry may be defined as the programme of developing new chemical products and chemical processes or making improvements in the already existing compounds and processes so as to make less harmful to human health and environment. This means the same as to reduce the use and production of hazardous chemicals.

i.e. correct answer is option (b).

23. (b) The ideal value of D.O for growth of fishes is 8 mg/ℓ. 7mg /ℓ is desirable range, below this value fishes get susceptible to disease. A value of 2 mg/ ℓ or below is lethal for fishes.

25. (a) Normal rain water has pH 5.6 Thunderstorm results in the formation NO and HNO_3 which lowers the pH.

26. (a) Smog is caused by oxides of sulphur and nitrogen.

27. (c) Ozone layer acts as a shield and does not allow ultraviolet radiation from sun to reach earth. It does not prevent infra-red radiation from sun to reach earth. Thus option (c) is wrong statement and so it is the correct answer.

28. (c) The ozone layer, existing between 20 to 35 km above the earth's surface, shield the earth from the harmful U. V. radiations from the sun.

Depletion of ozone is caused by oxides of nitrogen

$$N_2O + h\upsilon \longrightarrow NO + N$$

reactive nitric oxide

$$NO + O_3 \longrightarrow NO_2 + O_2$$

$$O_3 + h\upsilon \longrightarrow O_2 + O$$

$$NO_2 + O \longrightarrow NO + O_2$$

$$2O_3 + h\upsilon \longrightarrow 3O_2 \text{ (Net reaction)}$$

The presence of oxides of nitrogen increase the decomposition of O_3.

29. (d) DDT is a non-biodegradable pollutant.

30. (a) Methyl isocyanate, $CH_3 - N = C = O$

31. (b) CO_2 is generally not regarded as an pollutant.

32. (a) Haemoglobin has great affinity for NO.

33. (c) Photochemical smog does not involve SO_2.

34. (a) The average residence time of NO is 4 days.

35. (a) Particulates acquire negative charge and are attracted by the positive electrode.

36. (a) PSCs react with chlorine nitrate and HCl to give HOCl and Cl_2.

37. (d) Minamata is caused by Hg poisoning.

38. (a) BOD is connected with microbes and organic matter.

39. (a) Eutrophication causes reduction in D.O.

40. (a) Oil slick in sea water decreases D.O value.

41. (c) Presence of CO in the exhaust fumes shows incomplete combustion.

CHAPTER

7 General Concepts of Chemistry

1. Definition

Chemistry is a branch of science which deals with study of matter and various changes it undergoes. It deals with the preparation, properties, reactions and structures of chemical elements and compounds.

For convenience the study of chemistry is sub-divided into various branches such as:

(i) Inorganic chemistry
(ii) Organic chemistry
(iii) Physical chemistry
(iv) Analytical chemistry
(v) Industrial chemistry

2. Valency

During the formation of molecules of compounds, atoms combine in certain fixed proportions. This is because of the fact that different atoms have different combining capacities.

The combining capacity of an atom or radical is known as its **valency.**

3. Ions or radicals

In addition to atoms and molecules, a third type of particles occurs in substances. These particles, called ions, or atoms or group of atoms that carry an electrical charge.

An **ion** is formed when electrons are removed from or added to an atoms or group of atoms.

When electrons is/are removed the resulting ion is called a **cation or basic radical.** A cation is positively charged ion. (e.g. Na^+).

When electron is/are added the resulting ion is called an **anion or acidic radicals.** An anion is negatively charged ion (e.g. , Cl^- , O_2^{2-})

An ion or radical is classified as monovalent, divalent, trivalent or tetravalent when the number of charges over it is 1, 2, 3 or 4 respectively.

4. Formula of Elements and Compounds

Formula of elements: The molecule of an element is denoted by writing the symbol of the element and, to the right and below it, a number expressing the number of atoms in the molecule.

Formula of compound : A molecule of a compound may be made up of atom of different elements linked up together chemically and in definite proportion by weight.

5. Chemical formula : It is of two types :

(i) Molecular formulae : Chemical formulae that indicate the actual number and type of atoms in a molecule is called molecular formulae.

(ii) Empirical formulae : Chemical formulae that indicate only the relative number of atoms of each type in a molecule is called empirical formulae.

6. Equivalent weight

(i) Equivalent weight of element

$$= \frac{\text{Atomic weight of element}}{\text{Valency of element}}$$

(ii) Eq. wt of an acid/base

$$= \frac{\text{Molecular mass}}{\text{Basicity of acid / Acidity of base}}$$

(iii) Eq. wt of salts

$$= \frac{\text{Formula mass}}{(\text{Valency of cation})(\text{No. of cations})}$$

7. Expression of strength /concentration of Solution

(i) Mass percent $= \frac{\text{Weight of solute (gm)}}{\text{Weight of solution (gm)}} \times 100$

(ii) Normality $= \frac{\text{Number of gram equivalents of solute}}{\text{Volume of solution (lit.)}}$

(iii) Molarity $= \frac{\text{Number of gram moles of solute}}{\text{volume of solution (lit.)}}$

(iv) Molality $= \frac{\text{Gram moles of solute}}{\text{Weight of solvent (kg)}}$

(v) Mole fraction : Mole fraction of solute

$$= X_A = \frac{n_A}{n_A + n_B}$$

$$\text{Mole fraction of solvent} = X_B = \frac{n_B}{n_A + n_B}$$

$$X_A + X_B = 1$$

8. **Chemical reaction :** The process in which a substance undergoes change to produce new substances with new properties are known as chemical reaction. For example magnesium carbonate when heated produces magnesium oxide and carbon dioxide (i.e. new substances with new properties).
   A chemical change is generally accompanied by a *change of state*, *change of colour*, *evolution of a gas* or *change of temperature* etc.
9. **Chemical equation :** The qualitative representation of a chemical reaction in a short hand or concise form in term of symbols and formulae, is called a chemical equation.
10. **Skeletal chemical equation or symbol equation :** A chemical equation written in the form of symbols and formulae is called a skeletal chemical equation.
11. **Balanced chemical equation :** A chemical equation in which number of atoms of each elements on L.H.S. (i.e. reactants) and R.H.S. (i.e.products) is equal is called a balanced chemical equation.
12. **Balancing of chemical equations :** The process of making the number of different elements on both side of the equation equal is known as balancing of chemical equation.
13. **Types of chemical reactions**
    Various types of chemical reactions are :-
    (i) Combination reactions : Combination reactions are those in which one element reacts with another to form a compound. This type of reactions are also known as synthesis reaction. For example, hydrogen combines with oxygen to give water.

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell)$$

    (ii) Decomposition reactions : Decomposition reactions are those reactions in which a compound breaks down into simpler compounds (or substances). This type of reaction is simply the reverse of combination reactions. These reactions require energy in the form of heat, light, electricity, etc.
    (iii) Simple displacement reaction and simple substitutions : A displacement reaction is a reaction in which an atom, or group of atoms, present in a molecule is displaced by another atom. This type of reaction can be represented as follows:

$$AB + C \longrightarrow AC + B$$

(Compound) (New compound)

    (iv) Double displacement reactions or Double decomposition : The reactions in which mutual exchange of radicals takes place are known as double decomposition reactions. As a result of double decomposition reactions two new substances are formed.

Examples :

$$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$$

Double-displacement reactions can be further classified as **precipitation,** gas **formation,** and **acid-base neutralization reactions.**

Precipitation reactions : A precipitation reaction occurs when two solutions are mixed together and a solid separates from the solution. The solid part that forms and separates form the solutions is called the precipitate the reaction given above is a precipitation reaction.

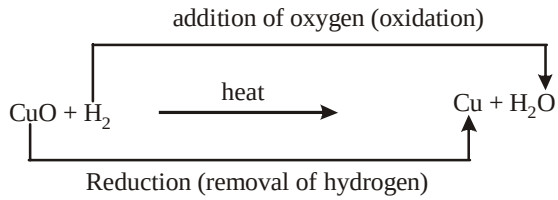
(v) Oxidation-Reduction Reactions

Oxidation : Oxidation is defined as a process which involve addition of oxygen or removal of hydrogen.

Reduction : The term reduction is defined as a process which involve the removal of oxygen or addition of hydrogen.

(vi) Redox reactions : Those reactions in which oxidation and reduction takes place simultaneously, are known as redox reactions.

Example :



(vii) Exothermic and endothermic reaction : Chemical reactions usually proceed with either liberation of heat or the absorption of heat.

When a chemical reaction liberates heat to the surroundings, it is said to be 'exothermic reaction' and when it absorbs the heat from the surroundings, it is said to be endothermic reaction.

$$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$$

+ energy (Exothermic)

$$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g) \text{(Endothermic)}$$

14. **Corrosion (erosion by chemical action) :** Corrosion is the degradation of metals and generally called rust.
    Corrosion causes damage to car bodies, iron railings, ships and to all objects made of metals, specially those of iron.
    Corrosion of iron is a serious problem.
15. **Rancidity :** The most important cause of deterioration in fats and fatty foods is oxidation of fats. What we perceive is an unpleasant change in the flavour and odour of a food, called rancidity.

EXERCISE

1. $Na_2S_2O_3$ represent the compound
   (a) sodium sulphate (b) sodium sulphite
   (c) sodium thiosulphate (d) None of these
2. Which one is a bivalent ion?
   (a) sodium (b) calcium
   (c) sulphide (d) Both (b) and (c)
3. The chromate and dicharomate ions are respectively
   (a) CrO_4^{2-} and $Cr_2O_7^{2-}$ (b) $Cr_2O_7^{2-}$ and CrO_4^{-}
   (c) CrO_4^{-} and CrO_5^{-} (d) CrO_4^{2-} and $Cr_2O_5^{2-}$
4. The formula of sodium pyrophosphate is
   (a) $Na_2P_2O_7$ (b) Na_3PO_4
   (c) $Na_4P_2O_7$ (d) Na_3PO_3
5. The branch of chemistry which deals with study of physical properties and conditions is
   (a) physical chemistry
   (b) analytical chemistry
   (c) nuclear chemistry
   (d) pharmaceutical chemistry
6. The branch of chemistry which deals with study of the methods of detection and determination of elements and compounds is
   (a) Physical chemistry (b) Nuclear chemistry
   (c) Analytical chemistry (d) Bio chemistry
7. Valency of an atom or radicals is
   (a) ionisation energy (b) electron affinity of atom
   (c) its combining capacity (d) size of atom
8. When electrons are added the resulting ion is called
   (a) basic radical (b) acidic radicals
   (c) neutral radical (d) None of these
9. Which of the following is most unreactive ?
   (a) Mg
   (b) Mg^+
   (c) Mg^{2+}
   (d) All above species are inert
10. Chemical formula of Aluminium sulphate is
    (a) $Al_2(SO_4)_3$ (b) $AlSO_4$
    (c) $Al_3(SO_4)_2$ (d) None of these
11. Select the one that represents a displacement reaction.
    (a) $NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$
    (b) $Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$
    (c) $HCl + NaOH \longrightarrow NaCl + H_2O$
    (d) $C + O_2 \longrightarrow CO_2$
12. Which one is a combination reaction ?
    (a) Formation of a mixture of carbon monoxide and hydrogen. When steam is passed over red hot iron.
    (b) Reaction of water with sodium metal to form sodium hydroxide and hydrogen.
    (c) $Ca(OH)_2 + Na_2CO_3 \longrightarrow 2NaOH + CaCO_3\downarrow$
    (d) Preparation of stannic chloride (Tin (iv) chloride) by passing chlorine gas into molten tin (Sn).
13. Which of the following involves combination of two elements?
    (a) $CaO + CO_2 \longrightarrow CaCO_3$
    (b) $4Na + O_2 \longrightarrow 2Na_2O$
    (c) $2SO_2 + O_2 \longrightarrow 2SO_3$
    (d) $NH_3 + HCl \longrightarrow NH_4Cl$
14. When hydrogen sulphide gas is passed through a blue solution of copper sulphate, a black precipitate of copper sulphide is formed. This is an example of
    (a) combination reaction
    (b) displacement reaction
    (c) decomposition reaction
    (d) double decomposition reaction
15. Which one is a decomposition reaction ?
    (a) $2HgO \xrightarrow{heat} 2Hg + O_2$
    (b) $CaCO_3 \xrightarrow{heat} CaO + CO_2$
    (c) $2H_2O \xrightarrow{Electrolysis} 2H_2 + O_2$
    (d) All the above reactions are decomposition reaction
16. The reactions in which two compounds exchange their radicals to form two new compounds are called
    (a) displacement reaction
    (b) decomposition reaction
    (c) double displacement reaction
    (d) isomerisation reaction
17. $CuO + H_2 \longrightarrow Cu + H_2O$
    Above reaction is an example of
    (a) Redox reaction
    (b) synthesis reaction
    (c) neutralisation reaction
    (d) decomposition reaction
18. In the reaction :
    $PbO + C \longrightarrow Pb + CO$
    (a) PbO is oxidised (b) PbO is oxidant
    (c) C is reductant (d) Both (b) and (c)
19. Chemical equations are balanced in accordance with the
    (a) Dalton's law
    (b) Law of conservation of mass
    (c) Law of definite composition
    (d) None of these
20. Which is not a balanced equation ?
    (a) $NaOH + HCl \longrightarrow NaCl + H_2O$
    (b) $Mg + CuSO_4 \longrightarrow MgSO_4 + Cu$
    (c) $Fe + Cl_2 \longrightarrow FeCl_3$
    (d) $Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2$
21. Which of the following statements is true about chemical equation ?
    (a) Mass is conserved
    (b) Atoms are conserved
    (c) Mass as well as atoms are conserved
    (d) Molecules are conserved

22. A molal solution is one that contains 1 mole of a solute in
(a) one litre of the solvent
(b) 1000 g of the solvent
(c) one litre of the solution
(d) 22.4 litres of the solution

23. The total number of atoms represented by the compound $CuSO_4.5H_2O$ is
(a) 27 (b) 21
(c) 5 (d) 8

24. The molecular formula P_2O_5 means that
(a) a molecule contains 2 atoms of P and 5 atoms of O
(b) the ratio of the mass of P to the mass of O in the molecule is 2:5
(c) there are twice as many P atoms in the molecule as there are O atoms
(d) the ratio of the mass of P to the mass of O in the molecule is 5 : 2

25. The empirical formula and molecular mass of a compound are CH_2O and 180 g respectively. What will be the molecular formula of the compound ?
(a) $C_9H_{18}O_9$ (b) CH_2O
(c) $C_6H_{12}O_6$ (d) $C_2H_4O_2$

26. The empirical formula of a compound is CH_2. One mole of this compound has a mass of 42 grams. Its molecular formula is :
(a) C_3H_6 (b) C_3H_8
(c) CH_2 (d) C_2H_2

27. Which of the following statements is not correct?
(a) A chemical equations tells us about the substances involved in a reaction.
(b) A chemical equations informs us about the symbols and formula of substances involved in a reaction
(c) A chemical equations tells us about the atom or molecules of the reactants and products involved in a reaction
(d) All are correct

28. $AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$
Above reaction is -
(a) precipitation reaction
(b) double displacement reaction
(c) combination reaction
(d) Both (a) and (b)

29. A redox reaction is one in which -
(a) both the substance are reduced
(b) both the substance are oxidised
(c) an acid is neutralised by the base
(d) one substance is oxidised while the other is reduced

30. An organic compound containing C, H and N gave the following analysis :
C = 40% ; H = 13.33% ; N = 46.67%
Its empirical formula would be
(a) $C_2H_7N_2$ (b) CH_5N
(c) CH_4N (d) C_2H_7N

31. An organic compound containing C, H and O gave on analysis C – 40% and H – 6.66%. Its empirical formula would be
(a) C_3H_6O (b) CHO
(c) CH_2O (d) CH_4O

32. Slow eating away of iron articles in the presence of moist air is called
(a) galvanisation (b) crystallisation
(c) rusting (d) neutralisation

33. Which of the following reaction is endothermic?
(a) $C + O_2 \longrightarrow CO_2$
(b) $CaCO_3 \longrightarrow CaO + CO_2$
(c) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
(d) $CaO + H_2O \longrightarrow Ca(OH)_2$

34. The observation that does not indicate a chemical reaction is
(a) change of temperature
(b) change of colour
(c) evolution of a gas
(d) None of these

35. Which one of the following is not an exothermic reaction ?
(a) Respiration
(b) Slaking of lime
(c) Burning of a candle
(d) Dipping of iron block in water

36. Which of the following statement is not correct ? To prevent food from getting rancid, we
(a) store the food in air-tight containers
(b) add antioxidants
(c) flush bags of chips with an inert gas
(d) increase the temperature of the food

37. In the following equations :
$NaCO_3 + xHCl \longrightarrow 2NaCl + CO_2 + H_2O$,
the value *x* is
(a) 1 (b) 2
(c) 3 (d) 4

38. Which of the following is not an endothermic process?
(a) Boiling of water
(b) Dissolving salts in water
(c) Dissolving conc. H_2SO_4 in water
(d) Evaporation of water

39. Rusting of an iron is an example of
(a) reduction (b) ionization
(c) oxidation (d) dissociation

40. Which of the following does not corrode when exposed to the atmosphere?
(a) Iron (b) Copper
(c) Gold (d) Silver

ANSWER KEY													
1	(c)	**7**	(c)	**13**	(b)	**19**	(b)	**25**	(c)	**31**	(c)	**37**	(b)
2	(d)	**8**	(b)	**14**	(d)	**20**	(c)	**26**	(a)	**32**	(c)	**38**	(c)
3	(a)	**9**	(c)	**15**	(d)	**21**	(c)	**27**	(d)	**33**	(b)	**39**	(c)
4	(c)	**10**	(a)	**16**	(c)	**22**	(b)	**28**	(d)	**34**	(d)	**40**	(c)
5	(a)	**11**	(b)	**17**	(a)	**23**	(b)	**29**	(d)	**35**	(d)		
6	(c)	**12**	(d)	**18**	(d)	**24**	(a)	**30**	(c)	**36**	(d)		

HINTS AND SOLUTIONS

2. (d) Ca^{++} and S^{--}
8. (b) $Cl + e^- \longrightarrow Cl^-$ (acidic radicals)
9. (c) Mg^{++} $(12 - 2 = 10e^-) = 2, 8$ hence have complete octel hence inert.
12. (d) $Sn + 2Cl_2 \longrightarrow SnCl_4$.
13. (b) Both Na and O_2 are elements.
14. (d) $CuSO_4 + H_2S \longrightarrow \underset{\text{(Black)}}{CuS\downarrow} + H_2SO_4$
(Blue)
15. (d) In all these reactions the reactants decompose to form simpler products.
17. (a) It involves oxidation and reduction.
18. (d) In this carbon reduces PbO to Pb so carbon (C) is reducing agent (reductant) PbO acts as oxidising agent (oxidant) as it oxidises C to CO.
20. (c) $2Fe + 3Cl_2 \longrightarrow 2FeCl_3$ (balanced chemical eqn.)
22. (b) Molal solution contains 1 mole of solute in 1000 g solvent.
23. (b) 1 atom of Cu + 1 atom of sulphur + 9 atoms of oxygen + 10 atoms of hydrogen. Total number of atoms in compound is 21.
25. (c) $n = \dfrac{180}{\text{Molecular mass of } CH_2O} = \dfrac{180}{30}$

$n = 6$
26. (a) Empirical formula of compound = CH_2
Molecular mass of the compound = 42
$\therefore\ n = 42/14 = 3$
$\therefore$ Hence molecular formula = C_3H_6
28. (d) This reaction is double displacement and precipitation as well because insoluble silver chloride gets precipitated.
30. (c) As the sum of the percentage of C, H & N is 100. Thus it does not contains O atom.

Table for empirical formula

Element	%	At. wt.	Rel. Number	Ratio
C	40.00	12	$\frac{40}{12} = 3.66$	$\frac{3.66}{3.33} = 1.09 \sim 1$
H	13.33	1	$\frac{13.33}{1} = 13.33$	$\frac{13.33}{3.33} = 4$
N	46.67	14	$\frac{46.67}{14} = 3.33$	$\frac{3.33}{3.33} = 1$

Hence empirical formula = CH_4N

31. (c)

Element	%	At.wt	Relative number	Ratio
C	40	12	$\frac{40}{12} = 3.33$	$\frac{3.33}{3.33} = 1$
H	6.66	1	$\frac{6.66}{1} = 6.66$	$\frac{6.66}{3.33} = 2$
O	53.34	16	$\frac{53.34}{16} = 3.33$	$\frac{3.33}{3.33} = 1$

(% of O in organic compound
$= 100 - (40 + 6.66) = 53.34\%$)
Empirical formula of organic compound = CH_2O.
32. (c) Rusting is a process in which iron gets converted into hydrated iron oxide in presence of moisture.

$$2Fe + \frac{3}{2}O_2 + xH_2O \longrightarrow \underset{\text{rust}}{Fe_2O_3.xH_2O}$$

33. (b) Heat is required to decompose calcium carbonate. Thus this reaction proceeds with absorption of heat therefore it is endothermic reaction.
34. (d) A chemical reaction is generally accompanied by a change of temperature, colour or evolution of a gas.
35. (d) No reaction occurs in this case.
36. (d) Increase the temperature of the food.
37. (b) $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2 + H_2O$
38. (c) Dissolution of conc. H_2SO_4 in water produces a lot of heat.
39. (c) Rusting results in formation of iron oxide.
40. (c) Gold is a noble metal.

CHAPTER

8 Some Important Man made Materials

Chemistry has helped significantly in meeting human needs by providing chemical fertilizers, improved varieties of insecticides and pesticides to increase the yield of crops and fruits. It has given us a large number of life saving drugs. Also chemical industries manufacturing polymers, soaps, detergents, glass, ceramics etc.

Industrially Important Compounds

1. Glass

It consists of a mixture of two or more silicates.

Preparation of glass :

Common glass (or soft glass) : It is used to make bottles, glass wares etc. and is obtained by heating together silica (in the form of sand), sodium carbonate or sodium sulphate and chalk or lime stone (calcium carbonate). Some broken glass and a little coke are usually added. The glass so prepared consists of silicates of sodium and calcium.

$$Na_2CO_3(s) + SiO_2(s) \rightarrow Na_2SiO_3(s) + CO_2(g)$$

(silica)

$$Na_2SO_4(s) + SiO_2(s) \rightarrow Na_2SiO_3(s) + SO_3(g)$$

$$CaCO_3(s) + SiO_2(s) \rightarrow CaSiO_3(s) + CO_2(g)$$

Hard glass : For preparation of hard glass K_2CO_3 is used in place of Na_2CO_3. It consists of a mixture of calcium and potassium silicates.

Physical properties of glass : Hard, rigid, high viscosity, bad conductor of heat and electricity, brittle, etc.

Blowing : It is a method to cast the molten glass into different moulds. There are two different methods of glass blowing

(i) Free blowing and (ii) Mould blowing

Free blowing : It involves the blowing of air to inflate the molten glass which is gathered at one end of the blow pipe to give the desired shape.

Mould blowing : This method was developed after the technique of free blowing. In this method, molten glass is inflated into a wooden or metal carved mould with the help of blow pipe which gives the molten glass the shape and design of the interior of the mould.

Chemical properties of glass

(1) It is resistant to action of air and acids except hydroflouric acid.

(2) It is alkaline in nature.

(3) It slowly reacts with water to form alkaline solution.

Types of Glass

(i) Silica glass : For this type of glass the raw material used is 100% pure form of *quartz*. It is quite *expensive*. It is used in the manufacture of laboratory apparatus. It has low thermal expansion. Its softening point is very high and it is resistant to a wide variety of chemicals.

(ii) Alkali silicate glass : For it the raw materials used are sand and soda. It is also called **water glass** because it is soluble in water and used only as a solution. It is generally used to make gums and adhesives.

(iii) Lead glass : For this type of glass lead oxide is added to ordinary glass. The addition of lead oxide increases the density and also the refractive index. This type of glass is used for the manufacture of ornamental glass ware, decorative articles etc.

(iv) Optical glass : This type of glass is used in the manufacture of optical instruments like binoculars, spectacles, lenses, prisons, telescopes, microscopes etc. It is transparent and can be grounded into the required shape. It generally contains phosphorus, and lead silicates with little cerium oxide which absorbs UV radiations.

(v) Processed glass : The properties and applications of glass also depend upon the processing of glass.

Some types of processed glass and their applications are given here :

Processed glass	Applications
1. Laminated glass	Used for doors and windows of automobiles. (It has high strength).
2. Fibre glass	Used for reinforcing purpose (It has enough tensile strength)
3. Foam glass	Used for civil construction and insulation purposes (it is light weight).
4. Opaque glass	In it non-transparent glass filters the light entering into it. Thus provides an aesthetic look.

(vi) Borosilicate glass : It contains silica and Boron oxide and small amount of oxides of sodium and aluminium. It is resistant to a wide variety of chemicals due to this property it is used in the manufacture of laboratory ware.

2. Fertilizers

Fertilizers are chemical compounds which when added to the soil increase their fertility and directly supply the need of essential elements [N, P, K] of primary importance.

Classification : Chemical fertilizers are broadly classified into the following three types :

(i) **Nitrogenous fertilizers :** Ammonium sulphate, urea etc.

(ii) **Phosphatic fertilizers :** Super phosphate, ammonium phosphate

(iii) **Potash fertilizers :** Potassium chloride, potassium sulphate.

3. Soaps and detergents

Soap : Fatty acid salts of sodium and potassium are known as soaps. These are prepared by the action of fatty acids with sodium hydroxide or potassium hydroxide.

Fatty acid + sodium hydroxide $\rightarrow$ Soap + glycerol.

Detergents are sodium salt of long chain sulphonic acids or alkyl hydrogen sulphate.

Advantages of detergents over soaps

(i) Detergents can be used for laundering even with hard water as they are soluble even in hard water.

(ii) Detergents possess better cleansing properties than soaps.

Disadvantages of detergents over soap : Detergents are prepared from hydrocarbons, while soaps are prepared from edible fatty oils. Thus they are non biodegradable.

Saponification : It is the process of making of soap by the hydrolysis of fats and oils with alkalis.

Both soaps and detergents are soluble in water and act as **surfactants** which reduce the surface tension of water to a great extent. This increases the water - fabric interaction as a consequence of which dirt particles, grease spots etc are washed away effectively. In other words soaps and detergents enhance the cleansing action of water.

4. Portland cement : It was first discovered in England. It is essentially a mixture of lime stone and clay. It was called Portland cement because in presence of water it sets to a hard stone-like mass resembling with the famous Portland rock. The approximate composition of Portland cement is

Calcium oxide (CaO)	62%
Silica (SiO_2)	22%
Alumina (Al_2O_3)	7.5%
Magnesia (MgO)	2.5%
Ferric oxide (Fe_2O_3)	2.5%

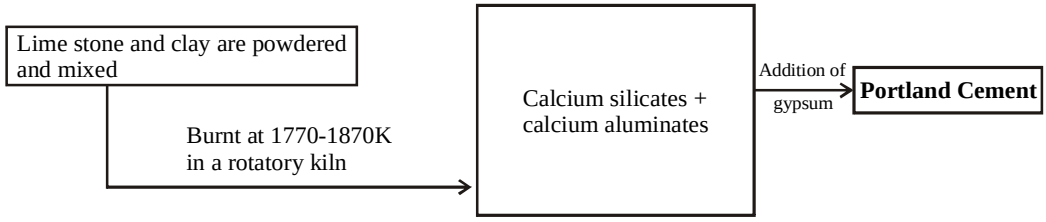
The above compounds are provided by the two raw materials, namely lime stone (which provides CaO) and clay (which provides SiO_2, Al_2O_3 and Fe_2O_3). In cement, almost entire amount of lime in present in the combined state as calcium silicate ($2CaO.SiO_2$ and $3CaO.SiO_2$) and calcium aluminates ($3CaO.Al_2O_3$ and $4CaO.Al_2O_3$).

(i) Cement containing excess amount of lime cracks during setting; while cement containing less amount of lime is weak in strength.

(ii) Cement with excess of silica is slow-setting and that having an excess of alumina is quick-setting.

(iii) Cement containing no iron is white but hard to burn.

Cement is manufactured by two processes, viz. wet and dry. A small amount (2–3%) of gypsum is added to slow down the setting of the cement so that it gets sufficiently hardened. Setting of cement is an exothermic process and involves hydration of calcium aluminates and calcium silicates.



Important Biomolecules

Vitamins

Vitamin generic descriptor name	Solublility	Deficiency disease	Overdose disease
Vitamin A	Fat	Nightblindness and Keratomalacia	Hypervitaminosis
Vitamin B_1	Water	Beriberi, Wernicke-Korsakoff syndrome	Drowsiness of music relaxation with large doses
Vitamin B_2	Water	Ariboflavinosis	
Vitamin B_3	Water	Pellagra	Liver damage (doses > 2g/day) and other problems
Vitamin B_5	Water	Paresthesia	Diarrohea; possibly nausea and heartburn
Vitamin B_6	Water	Anemia peripheral neuropathy nerve damage (dose > 100 mg/day)	Impairment of proprioception
Vitamin B_7	Water	Dematitis, enteritis	
Vitamin B_9	Water	Deficiency during pregnancy is deficiency, other effects	May mask symptoms of vitamine$_{12}$ associated with birth defects, such as neural tube defects
Vitamin B_{12}	Water	Megaloblastic anemia	No known toxicity
Vitamin C	Water	Scurvy	Vitamin C megadosage
Vitamin D	Fat	Rickets and Osteomalancia	Hypervitamin osis D
Vitamin E	Fat	Deficiency is very rare; mild hemolytic anemia in newborn	Increased congestive heart failure seen in one large
Vitamin K	Fat	Bleeding diathesis	Increases coagulation in patients taking warfarin.

EXERCISE

1. Deficiency of vitamin A results in
   (a) lose in apetite (b) skin diseases
   (c) sterility (d) retarted growth
2. Which one of the following contains cobalt ?
   (a) Riboflavin (b) Vitamin B_{12}
   (c) Vitamin A (d) Vitamin B_6
3. Night-blindness is caused due to the deficiency of
   (a) Vitamin D (b) Vitamin A
   (c) Vitamin C (d) Vitamin B
4. Alkaline hydrolysis of esters is known as
   (a) esterification (b) saponification
   (c) dehydration (d) alkalination
5. Deficiency of vitamin E causes
   (a) Beriberi (b) Scurvy
   (c) Hemolytic anemia (d) None of these
6. Scurvy is caused due to the deficiency of vitamin
   (a) B_1 (b) C
   (c) K (d) A
7. Which of the following statements, is not correct, about glass?
   (a) Because of its high viscosity glass exists in solid state
   (b) There is no definite melting point for glass.
   (c) The silicate units in glass are arranged in a way that is quite similar to the arrangement found in liquids.
   (d) Glass is a solid because it has a regular crystalline arrangement.
8. The property of plasticity is shown by clay , when it is
   (a) mixed with proper proportion of water
   (b) heated strongly
   (c) dried at room temperature after kneading
   (d) glazed
9. One of the properties of glass is its transparency. This property of glass is due to
   (a) its high viscosity.
   (b) regular arrangement of silicate units in glass.
   (c) irregular arrangement of silicate units in glass.
   (d) its high coefficient of thermal expansion.

10. Washing soaps are potassium and sodium salts of
(a) dicarboxylic acids (b) fatty acids
(c) mineral acids (d) None of these

11. When glass is heated, it
(a) does not melt at a fixed temperature
(b) vapourises
(c) melts only above 1000°C
(d) None of these

12. Glass is a transparent substance obtained by heating silica with oxides or carbonates of metals. Glass is a mixture of
(a) phosphates (b) sulphates
(c) oxides (d) silicates

13. Potash (Potassium carbonate) is used as a fertilizer. It is also known as
(a) azo compound (b) oil of vitriol
(c) pearl ash (d) Glauber's salt

14. Soft soaps are
(a) sodium and potassium salt
(b) sodium salt of fatty acids
(c) potassium salt of fatty acids
(d) potassium salt of sulphonic acids

15. Soaps are
(a) sodium salts of sulphuric acids containing carbon atoms 10 to 16
(b) sodium salts of fatty acids containing carbon atoms 16 to 18
(c) sodium salts of trihydroxy alcohols
(d) none of these

16. Soaps are sodium salts of fatty acids. Which of the following fatty acid does not form soap?
(a) Butyric acid (b) Oleic acid
(c) Palmitic acid (d) Stearic acid

17. Which one of the following is not contained in portland cement ?
(a) $Ca_3Al_2O_6$ (b) Ca_3SiO_5
(c) Ca_2SiO_4 (d) $Ca_3(PO_4)_2$

18. What is the reason for white cement to be white?
(a) It does not contain carbon
(b) It does not contain silicon
(c) It does not contain iron
(d) It does not contain calcium

19. Which one of the following is **not** present in cement?
(a) Clay (b) Alumina
(c) Alum (d) Gypsum

20. Which substance is used to retard the setting action of cement?
(a) CaO (b) Al_2O_3
(c) $CaSO_4, 2H_2O$ (d) $Na_2O + K_2O$

21. Which of the statements about glass are correct?
1. Glass is a super-cooled liquid having infinite viscosity.
2. Violet coloured glass is obtained by adding MnO_2.
3. Glass is a man-made silicate.
4. Glass is a crystalline substance.
Select the correct answer using the codes given below.
(a) 1, 2 and 4 (b) 2, 3 and 4
(c) 1, 2 and 3 (d) 1 and 3

22. Which one among the following is the main ingredient in cement?
(a) Gypsum (b) Limestone
(c) Clay (d) Ash

23. Glass is actually
(a) a crystalline solid (b) an ionic solid
(c) an elastic solid (d) a vitrified liquid

24. The major component used in preparation of different types of glasses is
(a) silica (b) sodium borate
(c) calcium silicate (d) sodium silicate

25. The reaction that takes place in soap making is called saponification. Basically soap is sodium or potassium salts of
(a) long chain monocarboxylic acids
(b) glycerol
(c) long chain dicarboxylic acids
(d) long chain tricarboxylic acids

26. The most important raw materials used in the manufacture of cement are
(a) potassium nitrate, charcoal and sulphur
(b) limestone, clay and gypsum
(c) transition metal oxides, sodium hydroxide or potassium hydroxide
(d) limestone, sodium carbonate and silica

27. Given below is an approximate composition of a substance :

CaO	60-70%
SiO_2	20-25%
Al_2O_3	5-10%
Fe_2O_3	2-3%

The substance is
(a) plaster of Paris (b) cement
(c) marble stone (d) quartz

28. The principle of cleaning by soap is
(a) surface tension (b) floatation
(c) viscosity (d) elasticity

29. By which one among the following mechanisms, soap removes dirt (soil) from cloth?
(a) Soap dissolves the soil as such
(b) Soap reacts with soil and converts them into soluble silicates
(c) Soap takes away the oily part of the soil and thus separates the soil from the cloth
(d) The soap molecules bind with the soil, lift the soil and keep it suspended which can then be rinsed away

30. Consider the following statements
1. Soap cannot be used in acidic water.
2 Ionic part of a soap is $—COO^- \cdot Na^+$.
3. Soap dissolves in water faster then detergent.
Which of the statements given above is/are correct?
(a) 1 and 2 (b) 2 and 3
(c) 3 only (d) 1 only

31. What is the composition of nitrolim – a chemical fertilizer ?
(a) Nitrogen and limestone
(b) Calcium carbide and nitrogen
(c) Calcium carbide and carbon
(d) None of these

32. Which one of the following correctly defines the state of glass?
(a) Crystalline solid (b) Super cooled liquid
(c) Condensed gas (d) Liquid crystal

33. Flint glass is obtained from which of the following ?
(a) Zinc and barium borosilicate
(b) Sand, red lead and potassium carbonate
(c) Sodium aluminum borosilicate
(d) Pure silica and zinc oxide

34. Which of the following statements about vitamin B_{12} is incorrect ?
(a) It has a cobalt atom
(b) It occurs in plants
(c) It is also present in rain water
(d) It is needed for human body in very small amounts

35. Washing soap can be prepared by saponification with alkali of which of the following oil
(a) Rose oil (b) Paraffin oil
(c) Groundnut oil (d) Kerosene oil

36. The aqueous solution of one of the following vitamins is dark in colour
(a) B_1 (b) B_2
(c) B_6 (d) B_{12}

37. Which one of the following is a vitamin?
(a) Benzoic acid (b) Ascorbic acid
(c) Oxalic acid (d) Formic acid

ANSWER KEY													
1	(d)	**7**	(d)	**13**	(c)	**19**	(c)	**25**	(d)	**31**	(d)	**37**	(b)
2	(b)	**8**	(a)	**14**	(c)	**20**	(c)	**26**	(b)	**32**	(b)		
3	(b)	**9**	(c)	**15**	(b)	**21**	(d)	**27**	(b)	**33**	(b)		
4	(b)	**10**	(b)	**16**	(a)	**22**	(b)	**28**	(a)	**34**	(c)		
5	(c)	**11**	(a)	**17**	(d)	**23**	(c)	**29**	(d)	**35**	(c)		
6	(b)	**12**	(d)	**18**	(c)	**24**	(a)	**30**	(a)	**36**	(d)		

HINTS AND SOLUTIONS

1. (d) In childhood, lack of vitamin A retards growth and hence like other vitamins, it is also said to be a growth promoting factor. In mild deficiency it leads to night blindness. Its prolonged deficiency leads to xerophthalmia.

2. (b) Vitamin B_{12} (Cyanocobalamines) : Cobalamine has by far the most complicated structure of all the vitamins. It has cobalt atom in the centre. It also has – CN groups in its structure. It is a pink coloured crystalline, water soluble vitamin.

3. (b) Night-blindness is caused due to the deficiency of vitamin A.

4. (b) Alkaline hydrolysis of esters is known as saponification.

$$R - COOR' + NaOH \longrightarrow R'OH + RCOONa$$

6. (b) Scurvy (bleeding of gums) is caused due to deficiency of vitamin 'C' (ascorbic acid).

17. (d) A typical composition for portland cement is CaO, SiO_2, Al_2O_3, Fe_2O_3, $CaSO_4.2H_2O$.
$\therefore$ $Ca_3(PO_4)_2$ is not contained in portland cement.

18. (c) White cement is white since it does not contain iron.

19. (c) Gypsum is added in calculated quantity in order to adjust the rate of setting of cement. Alum is NOT present in cement.

20. (c) $CaSO_4.2H_2O$ (**gypsum**) is added to cement **clinker** to retard setting action of cement.

21. (d) Glass is an amorphous substance.

22. (b) The composition of cement is CaO (lime) or limestone 62%, silica (SiO_2) 22%, alumina (Al_2O_3) 7.5%, magnesia (MgO) 2.5%, etc. Thus, limestone is the major raw material for cement.

23. (c) Glass is actually an elastic solid. H_2O and aqueous NaOH can be differentiated with the help of red litmus.

24. (a) The major component used in the preparation of different types of glasses is silica.

25. (d) Vegetable oils and animal fats are the main materials that are saponified. These greasy materials, triesters called triglycerides, are mixture derived from diverse long chain tricarboxylic acid.

26. (b) Cement is manufactured with limestone, clay and gypsum.

27. (b) Cement is made up of calcium oxide, silicon dioxide, aluminium tetra oxide and iron tetra oxide.

28. (a) Soaps form surface films, reduce surface tension of solution and help in removing dirt and dust by emulsifying grease.

29. (d) The soap molecules form micelle around the dirt particles prevents them from coming together and form aggregates, which form emulsion in water. The hand rubbing or the agitation cause dispersion of the dirt particles throughout the soapy water. These are washed away with water along with dust particles. In this way dirt are removed from the surface of the cloth.

30. (a) Detergent dissolves in water faster than soap.

31. (d) Calcium cyanamide ($CaCN_2$) mixed with carbon (C) is called **nitrolim.**

$$\underset{\text{Cal.Carbide}}{CaC_2} + N_2 \longrightarrow \underbrace{CaCN_2 + C}_{\text{Nitrolim}}$$

32. (b) Glass is an amorphous, hard, brittle, super cooled liquid.

33. (b) Flint glass is obtained from red lead and potatassium carbonate.

34. (c) It is found in liver, egg, milk, meat, and fish. Minute amounts are probably present in all animal cells. Peculiarly, unlike other vitamins, B_{12} is not found in significant amounts in green plants.

35. (c) Any oils which are good for eating or cooking, can be used in making soap. One of the best is said to be Coconut oil. Groundnut, shea butter, cocoa butter, sun flower and many other vegetable oils are also used.

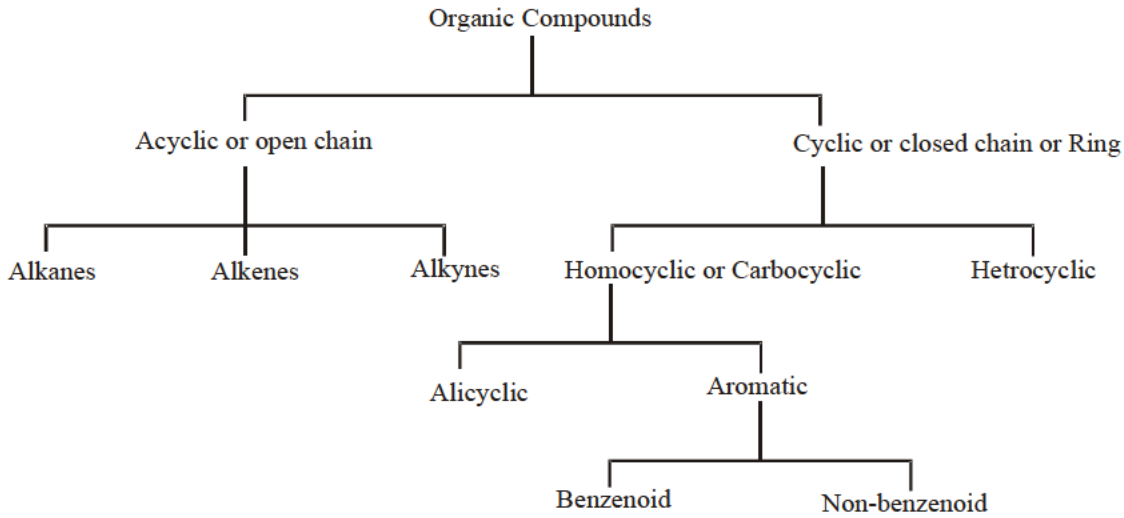
36. (d) The aqueous solution of vitamin B_{12} is dark in colour.

37. (b) Vitamin C is chemically ascorbic acid.

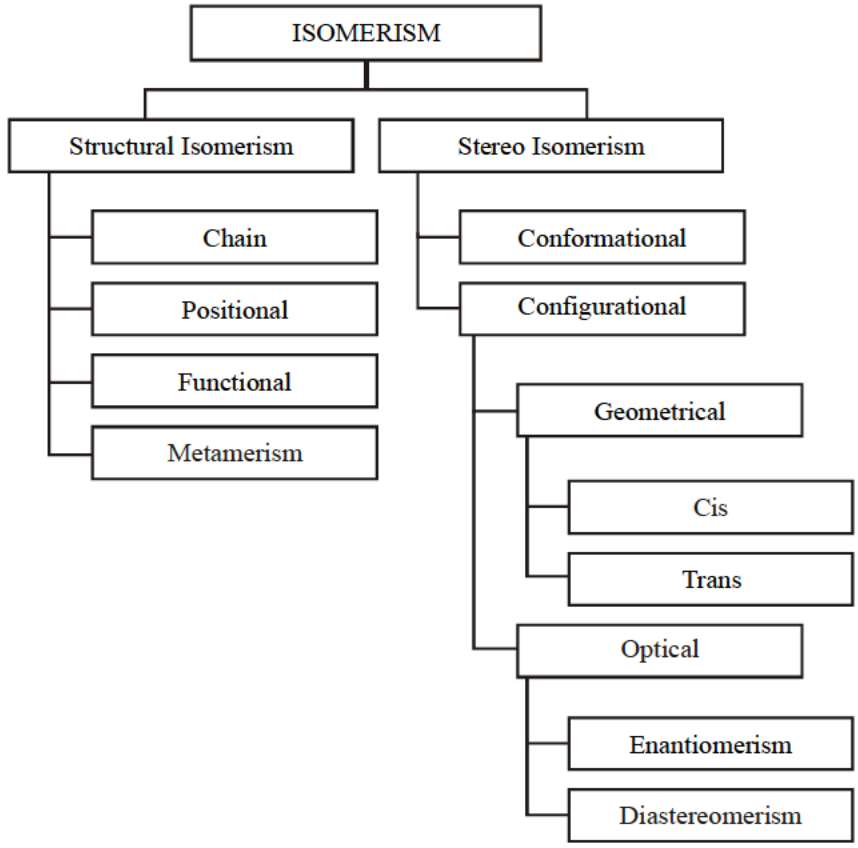
CHAPTER

9 General Organic Chemistry

1. **Wohler** prepared the first organic compound urea while preparing ammonium cyanate.
2. **Classification of organic compounds:**



3. **Isomerism**. The existence of two or more chemical compounds with the same molecular formula but having different properties owing to different arrangement of atoms within the molecule is termed as isomerism.

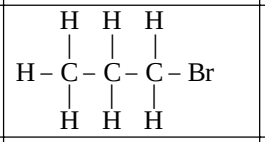
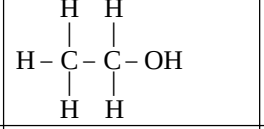


4. **Hydrocarbons :** All those compounds which contain just carbon and hydrogen are called hydrocarbons.
5. **Functional group :** The atom or group of atoms which determine the properties of a compound is known as functional group. e.g. –OH (alcohol), –CHO (aldehyde), > C = C < (alkene), – C ≡ C – (alkyne), etc.
6. **Homologous Series :** A series of compounds in which the same functional group substitutes hydrogen in a carbon chain is called a homologous series. e.g. CH_3Cl and C_2H_5Cl differ by a $–CH_2$ unit.
7. **Nomenclature :** Chemists developed a set of rules, for naming organic compounds based on their structures which is known as IUPAC rules.

   The IUPAC name of an organic compounds consists of three parts.

   Prefix – word root – Suffix

   Word root : A word root indicates the nature of basic carbon skeleton.
   - In case a functional group is present, it is indicated in the name of the compound with either as a prefix or as a suffix.
   - While adding the suffix to the word root the terminal 'e' of carbon chain is removed
   - If the carbon chain is unsaturated then the final 'ane' in the name of the carbon chain is substituted by 'ene' or 'yne' respectively for double and triple bonds.

Functional group	Prefix/Suffix	Functional group	Example	IUPAC Name
1. Halogen	Chloro, bromo, Iodo	–Cl, – Br, – I		– Bromopropane
2.Alcohol	–ol	–OH		– Ethanol
3. Aldehyde	–al	–CHO	$CH_3CH_2CH_2CHO$	– Butanal
4. Ketone	–one	–CO	CH_3COCH_3	– Propanone
5. Carboxylic acid	–oic acid	–COOH	CH_3CH_2COOH	– Propanoicacid
6. Amine	Amino	$–NH_2$	$CH_3CH_2NH_2$	– Amino ethane
7. Ester	oate –	–COOR	CH_3COOCH_3	– Methyl ethanoate
8. Double bond	ene		$CH_3 – CH = CH_2$	– Propene
9. Triple bond	yne		$CH_3 – CH_2 – C \equiv CH$	– Butyne

8. **Chemical Properties of Carbon Compounds**

   (i) Combustion : Carbon compound undergo combustion reaction to produce CO_2 and H_2O with the evolution of heat and light.

   $$CH_4 + O_2 \longrightarrow CO_2 + H_2O + \text{heat and light}$$

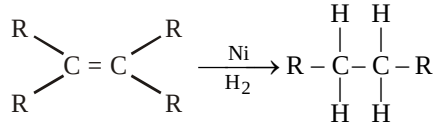
   (ii) Oxidation :

   $$\underset{\text{ethanol}}{CH_3CH_2OH} \xrightarrow{\text{alk. } KMnO_4 / \Delta} \underset{\text{ethanoic acid}}{CH_3COOH}$$

   The substance which are used for oxidation are known as oxidising agent. e.g alkaline $KMnO_4$, acidified $K_2Cr_2O_7$.

   (iii) Addition reaction :

   Unsaturated hydrocarbons (alkenes and alkynes undergo addition reaction in presence of catalysts e.g.

   (iv) Substitution reaction : Saturated hydrocarbons give substitution reaction e.g. methane in presence of sunlight undergo chlorination.

EXERCISE

1. Two adjacent members of a homologous series have :
   (a) a difference of $-CH_2$ in their structure
   (b) a difference of 14 a.m.u. in molecular mass
   (c) same general methods of preparation
   (d) all of the above
2. Alkenes are characterized by
   (a) C – C bonds (b) C = C bonds
   (c) C ≡ C bonds (d) cyclic structure
3. Which of the following contains carbonyl group?
   (a) Ketones (b) Aldehydes
   (c) Esters (d) All of these
4. The functional group present in $CH_3COOC_2H_5$ is
   (a) ketonic (b) aldehydic
   (c) ester (d) carboxylic
5. Butanone is a four-carbon compound with the functional group
   (a) carboxylic acid (b) aldehyde
   (c) ketone (d) alcohol
6. Which of the following is incorrectly matched?
   (a) Vinegar → carboxylic acid
   (b) C_2H_6 → alkane
   (c) Ethanol → alcohol
   (d) Methanol → ketone
7. If a hydrocarbon has any double bond, it is
   (a) alkyne (b) alkane
   (c) alkene (d) All the above
8. Alkynes are characterized by –
   (a) C – C bonds (b) C = C bonds
   (c) C ≡ C bonds (d) cyclic structure
9. How many different isomers are possible for a hydrocarbon with the molecular formula C_4H_{10}?
   (a) 1 (b) 2
   (c) 3 (d) 5
10. The general formula $C_nH_{2n}O_2$ could be for open chain
    (a) diketones (b) carboxylic acids
    (c) diols (d) dialdehydes
11. The IUPAC name of CH_3CH_2COCl is
    (a) propanoyl chloride (b) ethanoyl chloride
    (c) acetyl chloride (d) chloroethane
12. General formula of alkenes and alkyl radicals are respectively:
    (a) C_nH_{2n} and C_nH_{2n+1} (b) C_nH_{2n} and C_nH_{2n+2}
    (c) C_nH_{2n-1} and C_nH_{2n} (d) C_nH_{2n+1} and C_nH_{2n+2}
13. The IUPAC name of $CH_3COOC_2H_5$ will be –
    (a) ethyl acetate (b) ethyl ethanoate
    (c) methyl propanoate (d) none of these
14. While cooking, if the bottom of the vessel is getting blackened on the outside, it means that
    (a) the food is not cooked completely.
    (b) the fuel is not burning completely.
    (c) the fuel is wet.
    (d) the fuel is burning completely.
16. Which is a general formula of alkenes?
    (a) C_nH_{2n+2} (b) C_nH_{2n}
    (c) C_nH_{2n-2} (a) None of these
17. Organic compounds will always contain
    (a) carbon (b) hydrogen
    (c) nitrogen (d) sulphur
18. Methane, ethane and propane are said to form a homologous series because all are
    (a) hydrocarbons
    (b) saturated compounds
    (c) aliphatic compounds
    (d) differ from each other by a CH_2 group
19. General formula of alkyne is
    (a) C_nH_{2n+2} (b) C_nH_{2n}
    (c) C_nH_{2n-2} (d) C_nH_n
20. Which among the following are unsaturated hydrocarbons?

    (i) $H_3C-CH_2-CH_2-CH_3$

    (ii) $H_3C-C\equiv C-CH_3$

    (iii) $H_3C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$

    (iv) $H_3C-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH_2$

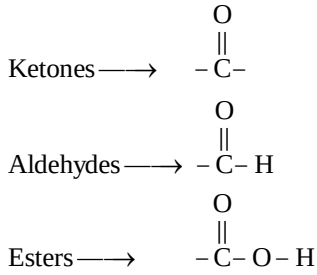
    (a) (i) and (iii) (b) (ii) and (iii)
    (c) (ii) and (iv) (d) (iii) and (iv)
21. Pentane has the molecular formula C_5H_{12}. It has
    (a) 5 covalent bonds (b) 12 covalent bonds
    (c) 16 covalent bonds (d) 17 covalent bonds
22. The heteroatoms present in
    $CH_3-CH_2-O-CH_2-CH_2Cl$ are
    (i) oxygen (ii) carbon
    (iii) hydrogen (iv) chlorine
    (a) (i) and (ii) (b) (ii) and (iii)
    (c) (iii) and (iv) (d) (i) and (iv)
23. Isomers of a substance must have the same
    (a) structural formula
    (b) physical properties
    (c) chemical properties
    (d) molecular formula

ANSWER KEY							
1	(d)	**7**	(c)	**13**	(b)	**19**	(c)
2	(b)	**8**	(c)	**14**	(b)	**20**	(c)
3	(d)	**9**	(b)	**15**	(b)	**21**	(c)
4	(c)	**10**	(b)	**16**	(a)	**22**	(d)
5	(c)	**11**	(a)	**17**	(a)	**23**	(d)
6	(d)	**12**	(a)	**18**	(d)		

HINTS AND SOLUTIONS

2. (b) Alkanes are saturated compounds in which all the four electrons of carbon are covalently bonded with other carbon atoms through single bond

3. (d) All contains carbonyl $(>C=O)$ compounds.



4. (c) $CH_3-\underbrace{C(=O)-O-H}_{\text{ester group}}$

5. (c) $CH_3-CH_2-C(=O)-CH_3$
Butanone or methyl ethyl ketone

6. (d) Methanol is an alcohol.

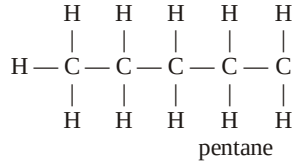
7. (c) Alkenes have double bond.

9. (b) $\underset{\text{normal butane}}{CH_3-CH_2-CH_2-CH_3}$ $\underset{\text{iso butane (chain isomers)}}{CH_3-CH(CH_3)-CH_3}$

10. (b) General formula

18. (d) They belong to homologus series as they succesively have a difference of a $-CH_2$ group.

20. (c) Unsaturated hydrocarbons have double or triple bond.

21. (c) 
pentane
i.e., 16 covalent bonds.

23. (d) Organic compounds having same molecular formula but differ from each other in physical properties or chemical properties or both are known as isomers.

CHAPTER 1

Diversity in Living Organisms

- **Biodiversity** refers number and types of wide variety of plants and animals present on earth.
- In 1773, Swedish botanist **Carolus Linnaeus** formulated the system of Binomial Nomenclature in his book '*Species plantarum*'. In binomial system, each name is expressed in two parts *i.e.*, **generic** name and **specific** name.
- **Taxonomy** is the branch of biology that deals with the framing of laws and principles for classifying the organisms on the basis of their characteristics and evolutionary relationships.
- The hierarchial system of classification was introduced by **Linnaeus**.

  Kingdom → Phylum or Division → Class → Order → Family → Genus → Species
- **Species** is defined as "the smallest real basic unit of taxonomy which is reproductively isolated from other group of individuals".
- **Genus** is a group of closely related species that are alike in broad features of their organisation.
- **Family** is a group of related genera having several common characters.
- Generally, **Order** and other higher taxonomic categories are identified based on the aggregates of characters.
- A **Class** is made of one or more related orders.
- The term **Phylum** is used for animals while **Division** is commonly employed for plants.
- **Kingdom** is the highest taxonomic category. All plants are included in Kingdom Plantae. All animals are included in Kingdom Animalia.
- **Herbarium** is a collection of pressed and dried plant specimens that are preserved on paper sheets.
- In **Botanical garden**, various plants groups are grown for scientific study, conservation, public education, aesthetics, and recreation. The famous botanical gardens are at **Kew (England), Indian Botanical Garden, Howrah (India)** and **National Botanical Research Institute, Lucknow (India).**
- **Museum** is a building used for the preservation, storage and exhibition of inanimate objects.
- **Zoological park** or zoological garden or zoo is a place where wild animals are kept in protected environment under human care. These animals are kept for public exhibition.

History of Classification

- **Biological classification** was first proposed by **Aristotle** who used simple morphological characters to classify plants and animals.
- **Linnaeus** initially separated plants and animals in **two Kingdoms** *i.e.*, Kingdom Plantae and Kingdom Animalia.
- Most accepted System of classification is **Five system classification** which was given by **Whittaker**.

Basic Features of Whittaker's Five Kingdoms

	Kingdom	Cellular Organisation	Movement	Nutrition	Reproduction
1.	**Monera** (All Prokaryotes)	Unicellular, without nucleus or membranous organelle.	By flagella (tubulin-dynein system)	Absorptive or photosynthetic	Asexual
2.	**Protista** (Protozoans, unicellular algae)	Unicellular, eukaryote with nucleus and membranous organelles.	By flagella, cillia, pseudopodia and mucilage propulsion	Absorptive, photosynthetic & holozoic	Both sexual and asexual
3.	**Fungi** (Multicellular decomposers)	Multicellular eukaryote coenocytic, no plastids, cells wall of cellulose, chitin.	Non-motile	Heterotrophic (saprophytic/ parasitic)	Asexual and sexual both
4.	**Plantae** (All plants)	Multicellular, higher organisation eukaryotes, cellulosic cell wall, plastids present.	Non-motile	Autotrophic or photosynthetic	Asexual and sexual both
5.	**Animalia** (All animals)	Multicellular, higher organization, eukaryotes without cell wall and chlorophyll.	Highly motile with all type of motile machinery	Heterotrophic (holozoic or saprozoic)	Both sexual and asexual but in higher forms only sexual

Types of Classification

- **Artificial classification system :** It was used by **Linneaus**. The artificial classification system was based on vegetative characters or on the androecium structure.
- **Natural classification system :** It was based on natural affinities among organisms. Both external and internal features were taken into account. It was used by **George Bentham** and **Joseph Dalton Hooker**.
- **Phylogenetic classification system :** This system of classification is based upon evolutionary relationship and uses morphological characters, origin and evolution of the different organisms. It was proposed by **Hutchinson**.

Viruses

- The term 'virus' has been derived from latin, which means poison or venom or viscous fluid. They are obligate parasites, *i.e*., can live inside living host only. They have either RNA or DNA. They have character of both living and non-living.

Plant Kingdom

TABLE : Divisions of Algae and their Main Characteristics

Classes Name	Common	Major Pigments Food	Stored	Cell Wall	Flagellar Number and Position of Insertions	Habitat
Chlorophyceae	Green algae	Chlorophyll *a, b*	Starch	Cellulose	2-8, equal, apical	Fresh water, brackish and salt water.
Phaeophyceae	Brown algae	Chlorophyll *a, c*, fucoxanthin	Mannitol, laminarin	Cellulose and algin	2, unequal, lateral	Fresh water (rare), brackish water, salt water
Rhodophyceae	Red algae	Chlorophyll *a, d*, phycoerythrin	Floridean starch	Cellulose	Absent	Fresh water (some) brackish water, salt water (most)

Bryophytes

- Bryophytes are also called **amphibians of the plant kingdom** because these plants can live in soil but are dependent on water for sexual reproduction. They usually occur in damp, humid and shaded localities.
- Species of *Sphagnum*, a moss, provide peat that have long been used as fuel, and because of their capacity to hold water as packing material for trans-shipment of living material.

Pteridophytes

- Evolutionarily, they are the first terrestrial plants to possess vascular tissues – xylem and phloem.
- The main plant body is a sporophyte which is differentiated into true root, stem and leaves. These organs possess well-differentiated vascular tissues. Examples are *Psilotum*, *Equisetum*, *Dryopteris*, *Marsilea*, etc.

Gymnosperms

- Gymnosperms are plants which bear naked seeds *i.e*., the ovules and the seeds that develop from these ovules after fertilization are not enclosed in fruit wall.
- Roots in some genera have fungal association in the form of **mycorrhiza** (*Pinus*), while in some other (*Cycas*) small specialised roots called **coralloid roots** are associated with N_2– fixing cyanobacteria.

Angiosperms (Flowering Plants)

- Angiosperms are seed bearing, flowering vascular plants in which seeds are enclosed in fruits.
- The flower is the most characteristic structure of the angiosperms. The male sex organ in a flower is the **stamen**. Each stamen consists of a slender **filament** with an **anther** at the tip. The anthers, following meiosis, produce pollen grains.
- The female sex organ in a flower is the **pistil** or the **carpel**. Pistil consists of an ovary enclosing one to many ovules. Within ovules are present highly reduced female gametophytes termed **embryo sacs.**
  Each embryo-sac has a seven-celled **egg apparatus** – one **egg cell** and two **synergids,** three **antipodal** cells and two **polar nuclei**. The polar nuclei eventually fuse to produce a diploid secondary nucleus.
- Pollen grain, after dispersal from the anthers, are carried by wind or various other agencies to the stigma of a pistil. This is termed as **pollination**.
- The pollen tubes enter the embryo-sac where two male gametes are discharged. One of the male gametes fuses with the egg cell to form a zygote (**syngamy**). The other male gamete fuses with the diploid secondary nucleus to produce the **triploid primary endosperm nucleus (PEN)**. Because of the involvement of two fusions, this event is termed as **double fertilisation**, and event unique to angiosperms.

Animal Kingdom

- Animals are the most diverse groups of organisms. Multicellular, heterotrophs characterised by mobility, sensory and nervous systems.

Phylum-Porifera

- Sponges are aquatic, mostly marine, solitary or colonial and sessile.
- Examples of some sponges are : *Sycon* (scypha), *Spongilla* (fresh water sponge) and *Euspongia* (bath sponge).

Phylum-Coelenterata (Cnidaria)

- All are aquatic and are mostly marine (exception-*Hydra* are found in fresh-water), solitary or colonial, sessile, or free-swimming and radially symmetrical animals.
- Example-*Physalia* (Portuguese man of war), *Adamsia* (Sea anemone), *Pennatula* (Sea-pen), *Gorgonia* (Sea-fan) and *Meandrina* (Brain coral).

Phylum-Ctenophora

- These are diploblastic, radial symmetrical animals with tissue level of organization.
- Examples–*Hormiphora* (sea walnut), *Pleurobranchia* (sea gooseberry), *Cestum* (venus girdle), *Beroe*.

Phylum-Platyhelminthes

- These are mostly endoparasites, bilateral symmetrical, triploblastic and acoelomate animals with organ level of organisation.
- Examples– *Taenia* (Tape worm), *Fasciola* (liver fluke).

Phylum-Aschelminthes

- They may be free-living, aquatic and terrestrial or parasitic in plants and animals.
- Examples: *Ascaris* (Round worm), *Wuchereria* (filarial worm), *Ancylostoma* (Hook worm), *Enterobius* (Pin worm).

Phylum-Annelida

- It is characterised by metameric segmentation forming ring like segments.
- Example: *Neries*, *Pheretima* (Earthworm) and *Hirudinaria* (Blood sucking leech).

Phylum-Arthropoda

- They are bilateral symmetry, triploblastic animals, which have organ-system level of organisation.
- Example: *Apis* (Honey bee), *Bombyx* (Silkworm), *Laccifer* (Lac insect).

Phylum-Mollusca

- They are aquatic (marine or fresh water), or terrestrial having an organ-system level of organisation.
- Ex. *Pila*, *Octopus* (devil fish), *Loligo* (sea squid).

Phylum-Echinodermata

- All existing echinoderms are marine, generally live at sea bottom.
- Ex. *Asterias* (star fish), *Cucumaria* (commonly called as sea cucumber), *Antedon* (water lily or feather star).

Phylum-Hemichordata

- They are bilaterally symmetrical, triploblastic, and entrocoelous animals.
- Ex. *Balanoglossus* (acorn worm or tongue worm), *Saccoglossus*.

Phylum-Chordata

- The fundamental four characters of phylum chordata are presence of notochord, a dorsal hollow nerve cord, paired pharyngeal gill slits and post anal tail either in the embryonic or adult stage.
- Examples: *Herdmania* (sea squirt), *Branchiostoma*.

Subphylum vertebrata is divided into two sections:

Section 1 Agnatha (The jawless vertebrates)

Class : Cyclostomata

- Mouth jawless suctorial and round.
- All living members are ectoparasites on some fishes.
  Ex. *Petromyzon* (lamprey), *Myxine* (hag fish).

Section 2 Gnathostomata (The jawed vertebrates)

Superclass : Pisces (Bear fins)

Class : Chondrichthyes

- They have a cartilagenous skeleton.
- Some of them possess electric organs *e.g.* Torpedo.
- Examples: *Scoliodon* (Dog fish), *Trygon* (Sting ray).

Class : Osteichthyes

- They have a bony skeleton.
- Examples : Marine – *Exocoetus* (Flying fish), *Hippocampus* (Sea horse), *Lophius* (Angler fish), Fresh water fishes – *Labeo* (Rohu), *Catla* (Katla).

Superclass : Tetrapoda (Bear Limbs)

Class : Amphibia

- Adapted for both water and land life.
- They are oviparous and development indirect through distinct larval stage called tadpole. Exambles : *Bufo* (Toad), *Rana* (Frog), *Hyla* (Tree frog), *Salamandra* (Salamander), *Ichthyophis* (Limbless amphibia).

Class: Reptilia

- The class name refers to their creeping or crawling mode of locomotion.
- They are oviparous ; Development direct.
  Examples: *Crocodilus* (Crocodile), *Bangarus* (Krait)

Class: Aves

- Birds are bipedal feathered animals.
- Endoskeleton is fully ossified (bony) and the long bones are hollow with air cavities (pneumatic).
  Examples : *Corvus* (crow), *Pavo* (Peacock).

Class: Mammalia

- These are warm blooded (homiothermous) animals having hair and mammary glands.
- They are viviparous with few exceptions and development is direct.
  Example : Oviparous – *Tachyglossus* = *Echidna* (spiny Anteater). Viviparous – *Pteropus* (Flying fox), *Camelus* (Camel), *Macaca* (Monkey).

Plant Morphology

The Root

- It is the underground system, usually below the soil and originates from the radicle.
- The primary functions of root are fixation of plant firmly on soil, absorption of water and conduction of mineral nutrients.

Modified Tap Roots

- **Fusiform :** *e.g.* radish.
- **Napiform :** *e.g.* sugar beet.
- **Conical :** *e.g.* carrot.
- **Tuberous root :** *e.g.* tapioca.
- **Nodulated :** *e.g. Rhizobium*.

Modified Branched Root

- **Pneumatophores :** Pneumatophores or respiratory roots are short, vertical and negatively geotropic (grow in an upward direction) that occur in certain halophytes, which grow in saline marshes (mangroves). *e.g. Rhizophora*.

Modified for Mechanical Functions

- **Prop root :** *e.g.* banyan.
- **Stilt root :** *e.g.* screwpine.
- **Climbing root :** *e.g.* betel.
- **Clinging root :** *e.g.* orchid.
- **Floating root :** *e.g., Jussiaea*.
- **Contractile root :** *e.g.,* onion.
- **Root thorn :** *e.g.,* coconut.

Modified Adventitious Root

Modified for Physiological Functions

- **Parasitic root :** *e.g., Cuscuta*.
- **Epiphytic root :** *e.g.,* Orchids.
- **Tuberous root :** *e.g.,* sweet potato.

Shoot System

- It is negatively geotropic and positively phototropic.
- Stem facilitates conduction of water, mineral and food material. It also produces and supports leaves and reproductive structure.

Modified Stems

Underground

- **Tuber:** *e.g.* potato.
- **Bulb :** *e.g.* onion.
- **Rhizome :** *e.g.* ginger.
- **Corm :***e.g. Amorphophallus*.

Sub-aerial

- **Runner :** *e.g. Oxalis*.
- **Offset :** *e.g. Pistia*.
- **Stolon :** *e.g. Mentha*.
- **Sucker :** *e.g. Chrysanthemum*.

Aerial or Metamorphosed

- **Thorn :** *e.g. Duranta*.
- **Stem-tendril :** *e.g.* grape.
- **Phylloclade :** *e.g. Opuntia*.

Leaf

The leaf is a specialised organ of photosynthesis, transpiration and gaseous exchange.

Venation

Venation is the arrangement of the veins and the veinlets in a leaf.

- **Reticulate Venation:** The veins are arranged in a net like manner, *e.g.*, dicots.
- **Parallel Venation:** Here the veins are arranged parallel to each other, *e.g.*, monocots.

Modifications of Leaves

Leaf tendrils	Leaf spines	Scale leaves	Phyllode	Pitcher	Bladder
e.g. Pisum sativum, Gloriosa	*e.g. Opuntia, Barberry*	*e.g. Asparagus*	*e.g. Australian acacia*	*e.g. Nepenthes*	*e.g. Utricularia*

Phyllotaxy (Arrangement of Leaves)

Alternate :	Opposite :	Whorled :
Only one leaf is borne at each node in alternate manner *e.g.* Mustard, Sunflower	two leaves occur at each node.	When more than two leaves occur at a node, *e.g. Nerium, Hydrilla*.

Inflorescence

- An inflorescence is the mode of arrangement of flowers on peduncle or mother axis.

Types of Inflorescence

I. Racemose (Indefinite)	II. Cymose (Definite)
(Main axis grows indefinitely bearing flowers in Acropetal order)	(Main axis terminates into flower & flowers arise in Basipetal order)

Fruit = Ripened Ovary

FRUIT

Flesh Simple Fruit
(Pericarp fleshy)

- **Berry :** *e.g.* tomato, guava.
- **Hesperidium :** *e.g.* lemon, orange
- **Pepo :** Epicarp makes a hard rind, *e.g.* cucumber, watermelon
- **Pome :** *e.g.* apple, pear.

Dry Simple Fruit
(Pericarp dry)

Indehiscent

- **Achene :** *e.g.*, Hogweed (*Boerhaavia*), *Mirabilis jalapa*
- **Caryopsis :** *e.g.*, rice, wheat, maize
- **Cypsela :** *e.g.*, sunflower, marigold
- **Nut :** *e.g.*, water chestnut, oak, cashew-nut, litchi

Dehiscent

- **Follicle :** *e.g.*, *Caloptropis*.
- **Legume or Pod :** *e.g.*, *pea*.
- **Siliqua :** *e.g.* mustard to expose replum with attached seeds (*Brassica*)
- **Capsule :** *e.g.*, lady finger.

Schizocarpic

Dehiscing into one seeded parts :

- **Lomentum :** *e.g.*, *Acacia*, *Mimosa*.
- **Cremocarp :** *e.g. Coriander*, Fennel.
- **Regma :** *e.g. Castor*, *Geranium*
- **Double samra :** *e.g. Acer* (Maple)

EXERCISE

1. Study of form and structure of organisms is
   (a) Ecology (b) Taxonomy
   (c) Anatomy (d) Morphology
2. Group of organisms that closely resemble each other and freely interbreed in nature, constitute a
   (a) species (b) genus
   (c) family (d) taxon
3. Herbarium is
   (a) a garden where medicinal plants are grown
   (b) garden where herbaceous plants are grown
   (c) dry garden
   (d) chemical to kill plants
4. Organisms which display properties of both living and non-living are
   (a) Viruses (b) Diatoms
   (c) Lichens (d) Bacteria
5. The taxonomic unit 'Phylum' in the classification of animals is equivalent to which hierachial level in classification of plants
   (a) Class (b) Order
   (c) Division (d) Family
6. Whittaker is famous for
   (a) Two kingdom classification
   (b) Four kingdom classification
   (c) Five kingdom classification
   (d) Distinguishing in Bacteria & Blue green algae
7. Which bacteria is utilized in gober gas plant?
   (a) Methanogens
   (b) Nitrifying bacteria
   (c) Ammonifying bacteria
   (d) Denitrifying bacteria
8. Which one of the following statements about viruses is correct?
   (a) Viruses possess their own metabolic system.
   (b) Viruses contain either DNA or RNA.
   (c) Viruses are facultative parasites.
   (d) Viruses are readily killed by antibiotics.
9. Which one of the following organisms is not an example of eukaryotic cells ?
   (a) *Paramoecium caudatum*
   (b) *Escherichia coli*
   (c) *Euglena viridis*
   (d) *Amoeba proteus*
10. Which of the following does not contain chlorophyll?
    (a) Fungi (b) Algae
    (c) Bryophyta (d) Pteridophyta
11. Which of the following is called amphibians of plant kingdom?
    (a) Bryophytes (b) Pteridophytes
    (c) Gymnosperms (d) Algae
12. The plant group that produces spores and embryo but lacks vascular tissues and seeds is
    (a) Pteridophyta (b) Rhodophyta
    (c) Bryophyta (d) Phaeophyta

13. A plant having seeds but lacking flowers and fruits belongs to
(a) Pteridophytes (b) Mosses
(c) Ferns (d) Gymnosperms

14. Agar is commercially obtained from
(a) red algae (b) green algae
(c) brown algae (d) blue-green algae

15. An alga very rich in protein is
(a) *Spirogyra* (b) *Ulothrix*
(c) *Oscillatoria* (d) *Chlorella*

16. The largest flower found is known as
(a) *Rafflesia* (b) *Tecoma*
(c) *Musa* (d) *Cauliflower*

17. A common characteristic of all vertebrates is
(a) presence of skull
(b) division of body into head, neck, trunk and tail
(c) presence of two pairs of functional appendages
(d) body is covered with an exoskeleton

18. The long bones are hollow and connected by air passages these are characteristics of
(a) Mammals (b) Reptiles
(c) Birds (d) All land vertebrates

19. In which one of the following sets of animals do all the four give birth to young ones?
(a) Platypus, Penguin, Bat, Hippopotamus
(b) Shrew, Bat, Cat, Kiwi
(c) Kangaroo, Hedgehog, Dolphin, , Loris
(d) Lion, Bat, Whale, Ostrich

20. Which of the following animal is not a insect ?
(a) Ticks (b) Honey bee
(c) Beetle (d) Wasp

21. Which of the following group of animals maintains high and constant body temperature such as mammals ?
(a) Reptiles (b) Amphibians
(c) Birds (d) Fishes

22. Insects have
(a) 2 pairs of legs (b) 3 pairs of legs
(c) 4 pairs of legs (d) 1 pair of legs

23. Cymose is
(a) thalamus (b) fruit
(c) inflorescence (d) ovary

24. Which is not a stem modification ?
(a) Rhizome of ginger (b) Corm of *Colocasia*
(c) Pitcher of *Nepenthes* (d) Tuber of potato

25. A modification of leaf is
(a) Tendrils (b) Phylloclade
(c) Cladode (d) Corm

26. Artificial system of classification was first used by
(a) Linnaeus (b) De Candolle
(c) Pliny the Edler (d) Bentham and Hooker

27. Binomial Nomenclature was given by
(a) Lamarck (b) Ernst Mayr
(c) Carolus Linneaus (d) Cuvier

28. Which of the following is not a pteridophyte?
(a) *Ginkgo* (b) *Selaginella*
(c) *Polypodium* (d) *Azolla*

29. The famous botanical garden 'Kew' is located in
(a) England (b) Lucknow
(c) Berlin (d) Australia

30. Which of the following groups of plants play an important role in plant succession on bare rocks/soil?
(a) Algae (b) Bryophytes
(c) Pteridophytes (d) Gymnosperms

31. Which of the following groups of plants are propagated through underground root?
(a) *Bryophyllum* and *Kalanchoe*
(b) Ginger, Potato, Onion and Zamikand
(c) *Pistia*, *Chrysanthemum* and Pineapple
(d) Sweet potato, *Asparagus*, Tapioca and Dahlia

32. ICBN stands for
(a) International Code of Botanical Nomenclature
(b) International Congress of Biological Names
(c) Indian Code of Botanical Nomenclature
(d) Indian Congress of Biological Names.

33. Leaves of dicotyledonous plants possess _____ venation, while _____ venation is the characteristic of most monocotyledons.
(a) reticulate and parallel respectively
(b) parallel and reticulate respectively
(c) reticulate and perpendicular respectively
(d) obliquely and parallel respectively.

34. In class of Amphibia, respiration occurs through
(a) gills (b) lungs
(c) skin (d) All of these

35. Which of the following class of algae mostly found in salt water?
(a) Phaeophyceae (b) Rhodophyceae
(c) Chlorophyceae (d) Both (a) and (b)

36. Which of the following are correctly matched with respect to their taxonomic classification?
(a) Centipede, Millipede, Spider, Scorpion-Insecta
(b) House fly, Butterfly, Tse tse fly, Silverfish-Insecta
(c) Spiny Anteater, Sea urchin, Sea cucumber-Echinodermata
(d) Flying fish, Cuttlefish, Silverfish-Pisces

37. During the post-fertilisation period the ovules develop into _____ and the ovary matures into a _____.
(a) A – seeds; B – fruit
(b) A – fruit; B – seeds
(c) A – flower; B – seed
(d) A – seeds; B – flower

38. One of the following is a very unique feature of the mammalian body
(a) Presence of diaphragm
(b) Four chambered heart
(c) Rib cage
(d) Homeothermy

39. Which one of the following groups of animals is correctly matched with its one characteristic feature without even a single exception ?
(a) Reptilia : possess 3 - chambered heart with one incompletely divided ventricle
(b) Chordata : possess a mouth provided with an upper and lower jaw
(c) Chondrichthyes : possess cartilagious endoskeleton
(d) Mammalia : give birth to young one.

40. Which of the following plants is growing in swampy areas, where many roots come out of the ground and grow vertically upwards?
(a) Potato (b) *Opuntia*
(c) *Rhizophora* (d) Grass

ANSWER KEY							
1	(d)	**11**	(a)	**21**	(c)	**31**	(d)
2	(a)	**12**	(c)	**22**	(b)	**32**	(a)
3	(c)	**13**	(d)	**23**	(c)	**33**	(a)
4	(a)	**14**	(a)	**24**	(c)	**34**	(d)
5	(c)	**15**	(d)	**25**	(a)	**35**	(a)
6	(c)	**16**	(a)	**26**	(c)	**36**	(b)
7	(a)	**17**	(a)	**27**	(c)	**37**	(a)
8	(b)	**18**	(c)	**28**	(a)	**38**	(a)
9	(b)	**19**	(c)	**29**	(a)	**39**	(c)
10	(a)	**20**	(a)	**30**	(b)	**40**	(c)

HINTS AND SOLUTIONS

3. (c) Herbarium is dry garden.
7. (a) *Methanobacillus* (methanogen) occurs in marshes and also in dung. It produces CH_4 gas under anaerobic condition and is utilized in gobar gas plant.
8. (b) Viruses have either DNA or RNA as the genetic material. Viruses having RNA as the genetic material are known as Retroviruses.
9. (b) *E. coli* is a prokaryotic celled gram negative bacterium.
12. (c) Bryophytes are the plants which produces spores and embryo but no vascular tissues are present, although primitive type of conducting tissues are present in the form of hadrome and leptome.
13. (d) Gymnosperms are vascular land plants having naked ovules *i.e.*, ovules are not enclosed in a ovary hence, flower is absent. Ovules after fertilization produces naked seeds. Pteridophytes (ferns) and mosses do not produce seeds.
14. (a) The Agar is obtained from several members of red algae such as *Gracilaria*, *Gelidium*, *Chondrus* etc. Agar gels are extensively used for growing micro-organisms.
15. (d) *Chlorella* can be grown to provide human food rich in proteins, lipids, carbohydrates, vitamins and minerals.
16. (a) *Rafflesia* or Corpse flower is a total root parasite. It obtains the total nourishment from the roots of the host plant.
17. (a) Vertebrates are also known as Craniata due to presence of skull in all its members.
18. (c) Hollow bones are characteristic adaptive features of birds. It reduces their body weight and is a major flight adaptation.
19. (c) Penguin, kiwi & ostrich all belong to class Aves of chordata (*i.e.* birds) and they do not give birth to their young ones, they are oviparous while kangaroo, hedgehog, dolphin, loris all belong to class mammalia and are viviparous.
21. (c) Animals which maintain high and constant body temperature are called warm blooded animals. They are also called homeothermic animals. Birds are the first vertebrate to have warm blood. They are homeothermous.
22. (b) Class insecta has 3 pairs of legs located on the thoracic segments. It is the characteristic feature of class Insecta.
26. (c) Pliny the Edler introduced first artificial system of classification in his book *Historia Naturalis*.
28. (a) *Ginkgo* is a gymnosperm.
32. (a) ICBN (International Code of Botanical Nomenclature) - It is one of the code of nomenclature which is independent of zoological and bacteriological nomenclature. The code applies equally to names of taxonomic groups treated as plants whether or not these groups were originally so treated.
39. (c) Chondrichthyes are the cartilaginous fish with a flexible skeleton made of cartilage rather than bone.

CHAPTER

2 Cells and Tissues

Cell is a basic structural and functional unit of life.

- **Robert Hooke** in 1665 coined the word 'cell'.
- **Anton von Leeuwenhoek** first saw and described a live cell.
- **Robert Brown** later had discovered the nucleus.
- Cell theory was proposed by **Schleiden** and **Schwann** in 1855 to explain the concept of the cellular nature of living organism.

Prokaryotic Cells

- Prokaryotic cells are morphologically most primitive.
- Prokaryotic cells are devoid of membrane bound organelles like plastids, mitochondria and advanced (9+2) flagella.
- Prokaryotic cells are represented by bacteria, cyanobacteria (blue green algae) mycoplasma and PPLO (pleuro-pneumonia like organisms).

Eukaryotic Cells

- A eukaryotic cell consists of the following components:

Cell Wall

- The cell wall is a non-living, semi-rigid, external protective covering of the cell.
- Cell wall is entirely lacking in animals.
- It is made up of cellulose secreted by the cell itself.

Cell Mebrane

- The cell membrane is a living, thin, elastic and semi-permeable membranous covering of plant and animal cells.

Fluid mosaic model of plasma membrane

- **S.J.Singer** and **G. Nicolson** in 1972 proposed the most accepted model of membrane structure. The plasma membrane is a lipid-bilayer with proteins embedded in it.
- Lipids are amphipathic, *i.e.*, they are structurally asymmetric with polar hydrophilic and non-polar hydrophobic group.
- One of the most important function of plasma membrane is the transport of the molecules across it.

Endoplasmic Reticulum (ER)

There are two types of endoplasmic reticulum *i.e.*,

- **Smooth or agranular ER** – They do not have attached ribosomes on their surface.
- **Rough or granular ER** – They bear ribosomes on their surface, for protein synthesis.

Golgi Apparatus

- Golgi apparatus or Golgi complex is a stack of flattened, membrane bounded, parallely arranged organelles that occur in the association of endoplasmic reticulum in the cytoplasmic matrix.
- The golgi apparatus principally performs the function of packaging materials to be delivered either to the intra-cellular targets or secreted outside the cell.

Lysosomes

- Lysosomes are popularly called "suicide bags".

Vacuoles

- In plant cells, the vacuoles can occupy up to 90 percent of the volume of the cell. The vacuole is bound by a single membrane called **tonoplast**. They are responsible for maintenance of turgour pressure.

Mitochondria

- Mitochondria are also called as powerhouse of cells.

Plastids

- Plastids are found in plants and few protists *Euglena*.

Ribosomes

- Ribosomes are smallest cell organelles. They are protein synthesising factories.
  There are two types of ribosomes *viz.*,
  - Prokaryotic or 70S ribosomes
  - Eukaryotic or 80S ribosomes

Nucleus

- Nucleus is centrally located, spherical and largest component of the all eukaryotic cell. It contains the genetic material of the cell.

Structure of Nucleus

- A typical nucleus consists of four structures: (i) nuclear membrane, (ii) nucleoplasm (iii) chromatin and (iv) the nucleolus.

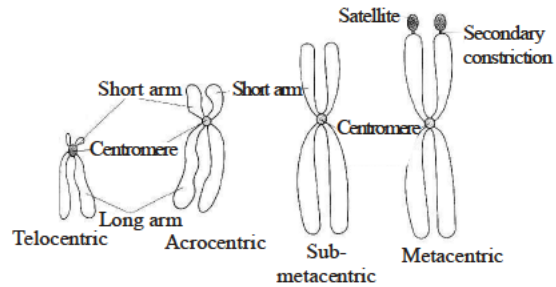


Fig. : Types of chromosomes based on the position of centromere

Nucleolus

- It is present inside the nucleus.
- It is the site of active ribosomal RNA synthesis.

Cell Cycle

- Cell cycle consists of two basic phases.There is a long non-dividing growing I-phase (Inter-phase) and a short-dividing M-phase.

Phases of Cell Cycle

Interphase :

- It has following three sub-phases:
- **G_1 phase:** It (G stands for gap) includes the synthesis of substrate and enzyme necessary for DNA synthesis.
- **S phase:** During this phase the amount of DNA per cell doubles.
- **G_2 phase:** Proteins are synthesized in preparation for mitosis while cell growth continues.
- **G_0 phase :** Cells that do not divide further exit G_1 phase to enter an inactive stage known as G_0.

M Phase (Mitosis Phase)

It is also called as equational division as the number of chromosomes in the parent and progeny cells is the same. The 4 Stages of M phase are : (usually divided into several stages or phases)

Prophase : Initiation of assembly of spindle formation begins.

Metaphase : Chromosomes align at the equatorial plate of cells.

Anaphase : The two daughter chromatids, now free of each other, move towards their respective poles.

Telophase : The nucleolus condense and reappear. The spindle fibres disperse. The nuclear envelope is assembled around the chromatin mass endoplasmic reticulum reform again.

Cytokinesis : Karyokinesis (division of nucleus into two) is followed by cytokinesis *i.e.*, division of cytoplasm into two daughter cells.

Meiosis

It occurs in reproductive cells and has two parts:

Meiosis I

Prophase I : It is the longest stage and includes 5 stges : –

Leptotene : The chromosomes become gradually visible under the light microscope.

Zygotene : The pairing of homologous chromosomes takes place.

Pachytene : Crossing over is the exchange of genetic material between two homologous chromosomes.

Diplotene : The participating chromatids of the paired homologous chromosomes physically joined at one or more discrete points having X-shaped structure called **chiasmata**.

Diakinesis : During diakinesis, the terminalisation of chiasmata take place.

Metaphase I : Spindle fibres attach themselves to chromosomes and chromosomes align at the equator.

Anaphase I : Homologous chromosome with its two chromatids moves towards the opposite poles of the cell and separate from each other.

Telophase I : The nuclear membrane and nucleolus reappear.

Meiosis II

Prophase II : The nuclear membrane and the nucleolus disappear. The chromosomes condense further.

Metaphase II : The chromosomes get arranged on the equator of the spindle.

Anaphase II : The daughter chromosomes move towards the opposite poles.

Telophase II : Cytoplasm divides and 4 haploid daughter cells arise.

Tissues

A group of structurally similar or dissimilar cells that perform a common function and have a common origin is called a **tissue**.

Simple Permanent Plant Tissue

These tissues are of 3 types:

Parenchyma : The cell wall is thin and made up of cellulose. It helps in storage of food, conduction of substances, provides turgidity to softer parts of plants.

Collenchyma : It provides mechanical support to the organs and resists bending in wind.

Sclerenchyma : These are dead, mechanical and act as skeleton in plants. It is hardest plant tissue, madeup of highly thick walled cells with no nucleus and no cytoplasm. This uniform thicknening is made up of mainly lignin and cellulose or both.

Conducting tissue in plants

- **Xylem cells** conduct water and minerals from roots to shoots.
- **Phloem cells** transport food or photosynthates from leaves to all parts of plants.

Animal Tissues

The structure of the cells vary according to their function. Therefore, the tissues are different and are broadly classified into four types:

Epithelial Tissue

- **Classification**
  - Covering
    - simple
      - **squamous** (alveoli, capillaries)
      - **cuboidal** (tubules and ducts)
      - **columnar**
        - simple
        - ciliated
        - microvilli
    - stratified
      - **keratinised squamous** (skin)
      - **unkeratinised squamous** (lining mouth, vagina)
    - transitional (urinary bladder)
  - Glandular
    - endocrine
    - exocrine
      - unicellular (goblet cells)
      - multicellular
        - simple
        - compound (tubular and alveolar)

Connective Tissue

- **Connective tissue**
  - loose : general connective tissue of body
  - reticular : supports lymphoid tissue
  - dense fibrous : strong, forms tendons, ligaments, etc.
  - elastic : possesses extension and recoil properties, *e.g.* lungs
- **Adipose tissue**
  - composition
    - adipocytes (fat cells)
    - loose connective tissue matrix
  - functions as
    - protective packing material, *e.g.* kidneys
    - heat insulator (skin)
    - energy store
- **Cartilage**
  - composition
    - matrix
    - chondrocytes (cartilage cells)
    - fibres
  - type
    - hyaline : covers articular surfaces, forms framework, *e.g.* larynx elastic, ear.
    - fibrocartilage, *e.g.* intervertebral discs
- **Haemopoietic tissue**
  - red bone marrow : produces blood cells
  - circulating blood : blood cells suspended in blood plasma

- **Blood**
  - Plasma
  - Formed Elements of blood
    - Erythrocytes (RBC)
    - Leucocytes (WBC)
      - Granulocytes
        - Eosinophils
        - Basophils
        - Neutrophils
      - Agranulocytes
        - Monocytes
        - Lymphocytes
    - Blood Platelets

Muscle Tissue

(i) Skeletal muscle

- **Morphology**
  - Cells are long, cylindrical fibres
  - Fibres are cross-striated, due to arrangement of contractile proteins
  - Fibres are multinucleated (syncitium)
  - Tubular systems
    - Thick filaments (myosin; M line in centre)
    - Thin filaments (Z line in centre)
      - actin
      - troponin
      - tropomyosin
  - Sarcomere – distance between two Z lines

(ii) Cardiac muscle

Location : Cardiac wall
Function : Pumps blood
Contraction : Comparable to skeletal muscle, but slower
Regneration : None

(iii) Smooth muscle

Location : Walls of hollow organs, eye, skin, etc.
Function : Contraction of hollow muscular organs

Morphology – Non-striated fibres shorter with single nucleus; Contractile proteins = actin and myosin

Fibre types – Visceral smooth muscle (contains pacemaker; occurs in hollow organs); Multi-unit smooth muscle (no pacemakers; occurs in iris, blood vessels, etc.)

EXERCISE

1. Difference between the prokaryotic and eukaryotic cells is in having
   (a) cell wall (b) nuclear membrane
   (c) ribosome (d) None of these
2. The function of nucleolus is the synthesis of
   (a) DNA (b) m-RNA
   (c) r-RNA (d) t-RNA
3. Which one of the following has its own DNA?
   (a) Mitochondria (b) Dictyosome
   (c) Lysosome (d) Peroxisome
4. Regarding the sequence of cell cycle, which one is correct
   (a) G_1, G_2, S and M (b) S, G_1, G_2 and M
   (c) G_1, S, G_2 and M (d) G_2, S, G_1 and M
5. The exchange of genetic material between chromatids of paired homologous chromosomes during first meiotic division is called
   (a) transformation (b) chiasmata
   (c) crossing over (d) synapsis
6. Chloroplast containing parenchyma is called
   (a) chlorenchyma (b) collenchyma
   (c) aerenchyma (d) amylanchyma
7. Chromosomes contain hereditary units called
   (a) genes (b) ribosomes
   (c) DNA (d) RNA
8. Which cell organelle is known as the control centre of the cell ?
   (a) Nucleus (b) Chloroplast
   (c) Mitochondria (d) Endoplasmic reticulum
9. Who observed and coined the word 'cell' for the first time?
   (a) Robert Cook (b) Robert Brown
   (c) Robert Hooke (d) Leeuwenhoek
10. What part of the cell serves as the intracellular highway?
    (a) Endoplasmic reticulum (b) Golgi apparatus
    (c) Cell membrane (d) Mitochondria
11. Which of the following would you not find in a bacterial cell ?
    (a) DNA (b) Cell membrane
    (c) Golgi apparatus (d) Ribosomes
12. Which of the following could be found in both the nucleus and the cytoplasm?
    (a) Nucleolus (b) Ribosomes
    (c) RNA (d) Both RNA & ribosomes
13. Which one of the following structures is an organelle within an organelle?
    (a) Ribosome (b) Peroxisome
    (c) ER (d) Mesosome
14. The process of mitosis is divided into 4 phases. Identify the correct order in which these phases appear in mitosis
    (a) Anaphase, metaphase, telophase and prophase
    (b) Telophase, anaphase, metaphase and prophase
    (c) Metaphase, prophase, anaphase and telophase
    (d) Prophase, metaphase, anaphase and telophase
15. Which of the following cells is found in the cartilagineous tissue of the body?
    (a) Mast cells (b) Basophils
    (c) Osteocytes (d) Chondrocytes
16. Survival of plants in terrestrial environment has been made possible by the presence of
    (a) intercalary meristem (b) conducting tissue
    (c) apical meristem (d) parenchymatous tissue
17. The tissues that helps in the movement of our body is
    (a) muscular tissue (b) skeletal tissue
    (c) nervous tissue (d) All of these
18. The connective tissue that connects muscle to bone is called
    (a) ligament (b) tendon
    (c) cartilage (d) areolar

19. Cartilage and bone are types of
(a) muscular tissue (b) connective tissue
(c) skeletal tissue (d) epithelial tissue

20. Intercalated disc is present in
(a) striated muscle (b) smooth muscle
(c) cardiac muscle (d) Both (b) and (c)

21. Cells which take part in secondary growth are named as
(a) phloem (b) xylem
(c) cambium (d) medullary ray

22. Which of the following is responsible for mechanical support and enzyme transport ?
(a) Dictyosome (b) Cell membrane
(c) ER (d) Mitochondria

23. Cell wall in higher plants is made up of
(a) Cellulose + lignin (b) Cellulose + pectin
(c) Cellulose + suberin (d) Cellulose + lipid

24. ATP molecule is a
(a) Nucleosome (b) Nucleoside
(c) Nucleotide (d) Deoxyribose sugar

25. Which one is not a carbohydrate?
(a) Chitin (b) Methionine
(c) Glycogen (d) Starch

26. Branches of botany dealing with the internal organization of plants known as
(a) Physiology (b) Ecology
(c) Anatomy (d) Cytology

27. Xylem functions as a conducting tissue for water and minerals from _____to the _____and_____.
(a) roots, stems, leaves (b) stems, roots, leaves
(c) leaves, stems, roots (d) leaves, stems, leaves

28. Most diverse macromolecules, found in the cell both physically and chemically are
(a) proteins (b) carbohydrates
(c) nucleic acids (d) lipids.

29. Lipids are insoluble in water because lipid molecules are
(a) hydrophilic (b) hydrophobic
(c) neutral (d) zwitter ions

30. Which one is the most abundant protein in the animal world?
(a) Trypsin (b) Haemoglobin
(c) Collagen (d) Insulin

ANSWER KEY

1	(b)	**9**	(c)	**17**	(d)	**25**	(b)
2	(c)	**10**	(a)	**18**	(b)	**26**	(c)
3	(a)	**11**	(c)	**19**	(b)	**27**	(a)
4	(c)	**12**	(d)	**20**	(c)	**28**	(a)
5	(c)	**13**	(a)	**21**	(c)	**29**	(b)
6	(a)	**14**	(d)	**22**	(c)	**30**	(c)
7	(a)	**15**	(d)	**23**	(b)		
8	(a)	**16**	(b)	**24**	(c)		

HINTS AND SOLUTIONS

1. (b) The prokaryotic cells do not have nuclear membrane while eukaryotic cell have well organised nuclear membrane.

3. (a) Mitochondria has its own DNA. It is as structure within cytoplasm of eukaryotic cells that carries out aerobic respiration. It is the site of Kreb's cycle and ETS. Therefore, it is also called as cell's energy production site.

5. (c) The points of attachment between homologous chromosomes after their separation in diplotene are called chiasmata. The process of pairing of homologous chromosomes is called synapsis, the phenomenon by which DNA isolated from one type of cell, when introduced into another type, is able to bestow some of the properties of the former to the latter is known as transformation.

6. (a) Chloroplast containing parenchyma (chlorenchyma) are mostly present in leaf.

13. (a) Ribosomes are small protein complexes made of r-RNA and proteins. Ribosomes are also seen in the organelles like mitochondria and chloroplasts.

27. (a) Xylem is a complex permanent tissue mainly responsible for conduction of water and minerals from the roots to the top of plants (unidirectional).

28. (a) Proteins are polymers of amino acids. There are only 20 amino acids which can be arranged in different orders in a polypeptide chain to form a wide array of proteins.

29. (b) Water attracting molecules are called hydrophilic. Water repelling molecules are called hydrophobic. Amino acids carry simultaneously positive and negative charges. Such molecules are called zwitter ions. Lipids are compounds of C, H, O but the ratio of H and O is more than 2 : 1 that is the ratio of oxygen is lesser than carbohydrates. Lipids are insoluble in water but soluble in non-polar solvents such as benzene, chloroform etc.
Commonest lipid found in a cell is phospholipid. It contains a hydrophilic (polar) head and a hydrophobic (non- polar tail).

30. (c) Collagen is the most abundant protein of animal world. Rubisco (ribulose biphosphte carboxylase - oxygenase) is not only the most abundant protein in plants but also the whole biosphere.

CHAPTER

3 Plant Physiology

Means of Transport

- **Diffusion** is a random movement of individual molecules from a region of higher concentration to a region of lower concentration. Diffusion rates are affected by concentration gradient, membrane permeability, temperature and pressure.
- The substance that have a hydrophilic moiety, find it difficult to pass through membrane. The movement of such molecules are facilitate, for which proteins provide site at which such molecule cross membrane. This is called as **facilitated diffusion**.
- **Active transport** uses energy to pump molecules against a concentration gradient.

Plants-Water Relations

Water Potential : The potential energy of water is referred to as water potential. It is measured in term of pressure.

$$\Psi_w = \Psi_s + \Psi_p$$

Osmosis : It is the diffusion of water through a semi-permeable membrane. It depends on two factors

(i) concentration of dissolved solutes in a solution

(ii) pressure difference.

Plasmolysis : If a turgid cell is placed in a solution that has more solutes, it exerts a higher osmotic pressure and water will move out.

- **Isotonic solution :** When concentration of outer solution (in which cell is placed) is equal to concentration of cell sap.
- **Hypotonic solution :** When concentration of outer solution is lower than concentration of cell sap.
- **Hypertonic solution :** When concentration of outer solution is higher than concentration of cell sap.

Imbibition : It is a type of diffusion by which movement of water takes place along a diffusion gradient. Factors influencing the rate of imbibition are nature of imbibant, surface area of imbibant, temperature, concentration of solutes, pH of imbibant

Cohesion Theory :

- Proposed by **Henry Dixon** 1914.
- Evaporation of water from the leaf to atmosphere decreases the water potential of the epidermal cells.

Transpiration

- Loss of water in the form of water vapour from plant through the small pores (stomata) present on leaves is called transpiration.

The Pressure Flow or Mass Flow Hypothesis

- It was put forward by **Munch (1930).** According to this hypothesis, organic substances move from the region of high osmotic pressure to the region of low osmotic pressure in a mass flow due to the development of a gradient of turgor pressure.
- **Hydroponics :** The system of growing plants in soilless culture (also called solution culture or tank farming) is known as hydroponics.

Role of Essential Elements (Macro and Micro) and their Deficiency Symptoms

S. No.	NAME OF ELEMENT	IN WHICH FORM THEY ARE ABSORBED	FUNCTIONS	DEFICIENCY SYMPTOMS
1.	Nitrogen	NO_2^-, NO_3^- or NH_4^+	Major constituent of proteins, nucleic acids, vitamins and minerals.	Chlorosis (yellowing of older leaves)
2.	Phosphorous	($H_2PO_4^{2-}$, or HPO_4^{2-})	Constituent of cell membrane, nucleic acids, nucleotides and some proteins.	Delay in seed germination purple or red spots on leaves
3.	Potassium	K^+	Involved in protein synthesis, closing & opening of stomata. Maintenance of turgidity of cells.	Chlorosis in intervernial area, loss of apical dominance
4.	Calcium	Ca^{++}	Used in synthesis of cell wall (middle lamella)	Stunted growth, necrosis of meristematic regions.
5.	Magnesium	Mg^{++}	Activate enzymes in respiration, photo -synthesis, DNA and RNA synthesis. Constituents of the porphyrin ring of chlorophyll structure.	Chlorosis between leaf veins, necrosis on older leaves.
6.	Boron	BO_3^{3-} and $B_4O_7^{2-}$	Necessary for uptake and utilization of Ca^{2+}, pollen generation.	Death of root and shoot tips, abscission of flowers.
7.	Chlorine	Cl^-	Determine solute concentration (with Na^+ and K^+) and anion-cation balance in cells, essential for photolysis of water.	Stunted root growth, reduced fruiting.

Metabolism of Nitrogen :

Fixation of N_2

- Ammonia is rapidly converted first to nitrites (by *Nitrobacter*) by the process *nitrification.*

$$2NH_3 + 3O_2 \rightarrow 2NO_2^- + 2H^+ + 2H_2O$$

$$2NO_2^- + O_2 \rightarrow 2NO_3^-$$

- Nitrate is then either available to the plant, or converted to nitrogen gas in the process of denitrification (by *Pseudomonas*).
- Fixation is done by both free living *e.g. Azotobacters, Clostridium*, Cyanobacteria like *Nostoc, Anabaena* and symbiotic bacteria *Rhizobium*.
- Nodules act as the site for N_2 fixation. It contains **leghaemoglobin** (a pink pigment) and enzyme **nitrogenase** (Mo-Fe protein).
- During this process, the N_2 atmospheric(dinitrogen) is reduced by the addition of hydrogen atoms to ammonia.

$$N_2 + 8e^- + 8H^+ + 16\,ATP \rightarrow 2NH_3 + H_2 + 16ADP + 16Pi$$

Photosynthesis

- It is actually **oxidation reduction process** in which water is oxidised and CO_2 is reduced to carbohydrates.
- The reduction of CO_2 to carbohydrates needs **assimilatory powers,** *i.e.*, **ATP** and **$NADPH_2$**.
- Photosynthesis occurs particularly in specialised cells called mesophyll cell. These cells contain chloroplast, which is the actual sites for photosynthesis.
- The two forms of chlorophyll '*a*' are chl *a* 683 (P_{680}) and chl *a* 703 (P_{700}) with peak absorption at 683 and 703 respectively are anchored in thylakoids membranes. They are the **reaction centres**.

Electron Transport : It was first formulated by **Hill** (1939). It is a series of electron carrier over which electrons pass in a downhill journey releasing energy at every step that is used in generating an electrochemical proton gradient which helps in synthesising ATP.

Photorespiration : Light stimulated oxidation of photosynthetic intermediates to CO_2 is known as photorespiration. The course of photorespiration is related to chloroplasts, peroxisomes and mitochondria. This is a wasteful process & occurs in C_3 plants.

Respiration : The phenomenon of breaking of the C–C bond of complex organic molecules through oxidation and releasing of energy for cellular use, is called respiration.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy (2870 kg)}$$

Glycolysis : The scheme of glycolysis was given by Gustav **Embden**, Otto **Meyerhof** and **J. Parnas**, hence it is referred to as the EMP pathway. It occurs in the cytoplasm of the cell.

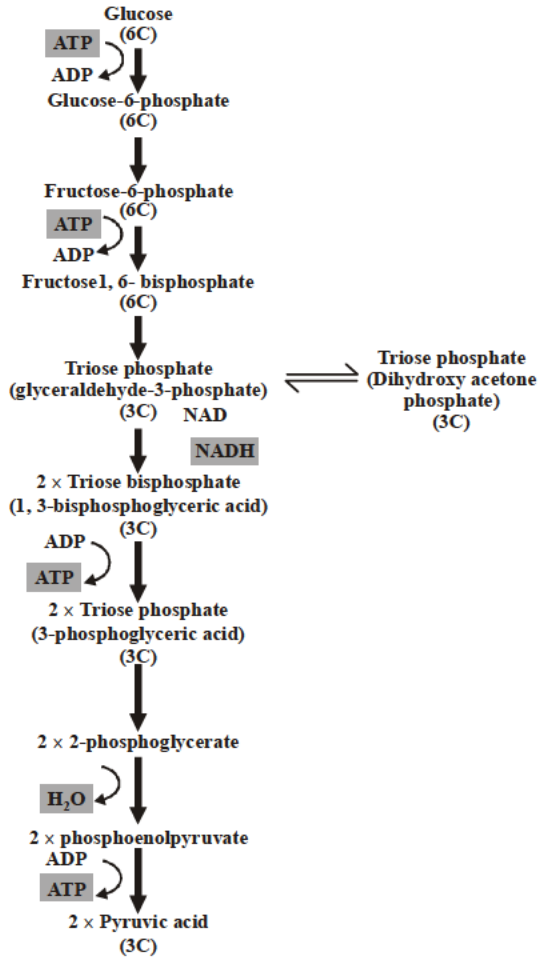


Fig. Steps of Glycolysis

Fermentation : When O_2 is limiting, NADH and pyruvic acid begin to accumulate. Under this condition, plants carry out fermentation (anaerobic respiration), leading to the formation of CO_2 and either ethanol or lactic acid.

Citric acid cycle or tricarboxylic acid cycle or kreb's cycle : It occurs in mitochondrial matrix.

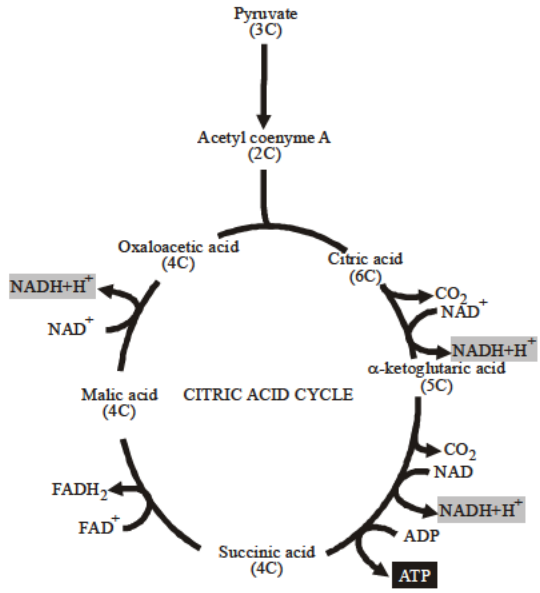


Fig. The Citric acid cycle

Growth

- It can be broadly defined as "permanent and irreversible increase in size of living structure which is accompanied by an increase in dry weight and the amount of protoplasm".
- Growth rate can show two types of increase *i.e.*, arithmatic increase and geometrical growth.

Arithmatic Increase

$L_t = L_0 + rt$ where, L_t = length at time 't'; L_0 = length at time 'zero'; r = growth rate /elongation per unit time; t = time of growth.

Geometrical Growth

$W_1 = W_0 e^{rt}$ where, W_1 = Final size (weight, height, number etc.); W_0 = Initial size at the beginning of the period; e = base of natural logarithms; r = growth rate; t = time of growth.

Development is growth accompanied by differentiation.

Differentiation: The cells are derived from root apical and shoot apical meristems and cambium differentiate and mature to perform specific functions.

Dedifferentiation : The living differentiated cells loose their capacity of division. These cells may regain their capacity to divide under certain conditions.

Redifferentiation : The products of dedifferentiated cells which lose the capability to divide but mature to perform specific functions are called redifferentiated cells.

Plant Growth Regulators

Auxins

- Auxins induce elongation in shoot cells and inhibition of elongation of root cells.
- Synthetic auxins are indole butyric acid (IBA), indole propionic acid (IPA), 2,4- dichlorophenoxy acetic acid-(2,4 D); naphthalene acetic acid (NAA).
- At the removal of apical bud the lateral buds grow vigorously. It shows that apical bud suppresses the growth of lateral bud (axillary bud) just below it. This is known as **apical dominance**.
- Initiating and promoting cell division in certain tissues such as cambium.
- Promotes elongation of stem and coleoptile.
- Auxin generally inhibits flowering but in case of pineapple spray of auxins induces early flowering.

Gibberellins

- GA_3 was one of the first gibberellin to be discovered and remains the most intensively studied form. All GAs are acidic in nature. They occur in various plant organs such as roots, stems, leaves, buds, immature seeds and callus tissues of higher plants.
- The most typical and striking effect of gibberellin is on the elongation of stem. The internodes increase in length.
- Gibberellin causes the plants to bolt and flower.
- Gibberellins have been found be more effective than auxins in causing parthenocarpic development of fruits *e.g.*, tomatos, apples and pears.

Cytokinins

- **Miller** in 1954 isolated the first crystals of a 'cell division inducing substance' from the autoclaved herring sperm DNA. Since this substance has specific effect on cytokinesis it is called as kinetin (a modified form of adenine).

- Permanent cell division occurs only in presence of cytokinins. It also plays important role in causing expansion of cells.
- Cytokinins not only breaks dormancy but also promotes the germination of seeds.

Abscisic Acid

- **Carns** and **Addicott** (1963) isolated two substances Abscisin I and Abscisin II from the cotton balls, that were responsible for accelerated abscission of leaves.
- ABA inhibits seed germination and growth of excised embryos.
- ABA stimulates stomatal closure by inhibiting the K^+ uptake by guard cell.
- ABA increases tolerance of plants to various kinds of stresses.

Ethylene

- Ethylene is only **gaseous hormone** ($CH_2 = CH_2$) that is synthesized in large amounts by tissues undergoing senescence and ripening fruits.
- Ethylene inhibits elongation of stem, causes swelling of nodes and nullifies geotropism.
- It is highly effective in inducing fruit ripening when it is produced in large amount which coincides with respiratory **climactric** *i.e.*, a brief rise to a very high level of respiration. This rise indicates the beginning of senescence and death.

Photoperiodism

- The term photoperiodism is used by **Garner** and **Allard**, 1920 for the ability of plant to detect and respond the relative length of day and night to which the plant is exposed. The site of perception of light/dark duration are leaves.
- Most of the plants are short day plants that include *Cosmos*, *Dahlia*, *Chrysanthemum*, rice, etc. The long day plants are wheat, barley, sugar beat, larkspur, etc. Cucumber, sunflower, tobacco, tomato etc. are some examples of intermediate day plants.

Vernalisation

- In some plants early flowering is induced by pretreatment of seeds with a certain low temperature.

Seed Dormancy

- **Dormancy** may be defined as the inactive state of the seed in which the growth of the embryo is temporarily suspended for a specific length of time.

Flower

- Flowers are highly modified shoots, bearing nodes and modified floral leaves, which are meant essentially for sexual reproduction in plant.
- A typical mature embryo sac of angiosperm is 7-celled, 8 nucleate structure *i.e.*, **3 antipodal cells**, **3-egg apparatus cells (consists of 2 synergids and 1 egg cell) and one central cell (2 polar nuclei)**.

Double Fertilization

- Fusion of male and female gametes is called fertilization.
- One of these male gametes fuses with egg to form diploid zygote (2n) while the other fuses with two polar nuclei of the central cell to produce triploid primary endosperm nucleus (PEN) (3n). Since, the latter involves fusion of three haploid nucleus, therefore it is called **triple fusion**.
- In some angiosperms, two types of fusion occur in the same embryo sac "syngamy" leading to the formation of zygote & "triple fusion" forming primary endosperm cell, this phenomenon is called "**double-fertilization**".
- Endosperm is the nutritive tissue which provides nourishment to the embryo in seed plant.
- Seed is a fertilized ovule. After fertilization ovary begins to grow and gradually matures into fruit.
- **Polyembryony** - Given by **Leeuwenhoek** (1917) in Orange More than one embryo in a seed.

EXERCISE

1. The physical process involved in the release of molecular oxygen from leaves is
   (a) diffusion (b) transpiration
   (c) osmosis (d) capillarity
2. If a cell swells, after being placed in solution, the solution is
   (a) neutral (b) hypotonic
   (c) hypertonic (d) isotonic
3. Chlorophyll is present
   (a) in the grana of chloroplasts
   (b) on the surface of chloroplasts
   (c) dispersed through out the chloroplasts
   (d) in the stroma of chloroplasts
4. Translocation of carbohydrate nutrients usually occurs in the form of
   (a) glucose (b) maltose
   (c) starch (d) sucrose
5. Hydroponics is a technique in which plants are grown in
   (a) green house
   (b) water saturated sand
   (c) balanced nutrient solution
   (d) purified distilled water
6. Respiration in plants
   (a) occurs only during day
   (b) results in the formation of vitamins
   (c) is characteristic of all living cells
   (d) often requires CO_2
7. Chief function of leaves are
   (a) transpiration and photosynthesis
   (b) respiration and photosynthesis
   (c) respiration and digestion
   (d) respiration and transpiration

8. Which element is required in comparatively least quantity for the growth of plant?
(a) Zn (b) N
(c) P (d) Ca

9. End product of glycolysis is
(a) acetyl CoA (b) pyruvic acid
(c) glucose-1-phosphate (d) fructose-1-phosphate

10. The ultimate gain of light reaction is
(a) ATP and $NADPH_2$ (b) $NADPH_2$
(c) only ATP (d) only O_2

11. End product of fermentation of sugars is
(a) H_2O and CO_2 (b) CO_2
(c) alcohol and CO_2 (d) alcohol

12. Stomata open and close due to
(a) circadian rhythm
(b) genetic clock
(c) pressure of gases inside the leaves
(d) turgor pressure of guard cells

13. Which of the following plant is found to have minimum transpiration ?
(a) Cactus (b) *Hydrilla*
(c) Mango (d) Guava

14. Photosynthetically active radiation is represented by the range of wavelength of
(a) 340 – 450 nm (b) 400 – 700 nm
(c) 500 – 600 nm (d) 400 – 950 nm

15. Which of the following is not performed by root hairs ?
(a) Water uptake (b) Oxygen uptake
(c) Mineral uptake (d) CO_2 uptake

16. In rainy season, door gets swelled due to
(a) imbibition (b) diffusion
(c) transpiration (d) respiration

17. The force responsible for upward conduction of water against gravity comes from
(a) transpiration (b) translocation
(c) respiration (d) photosynthesis

18. Double fertilization means
(a) fusion of male gametes and ovum
(b) fusion of two polar bodies
(c) a male gamete fused with egg and second male gamete fused with secondary nucleus
(d) all the above

19. Which of the following is not caused by deficiency of mineral nutrition?
(a) Necrosis (b) Chlorosis
(c) Etiolation (d) Shortening of internodes

20. Generally plants absorbed N_2 in the form of
(a) NO_2^- (b) NO_3^-
(c) $N \equiv N$ (d) HNO_2

21. Which of the following element is a constituent of protein ?
(a) Sulphur (b) Potassium
(c) Lead (d) Phosphorus

22. Haploid, diploid and triploid conditions respectively can be traced in
(a) egg, nucellus, endosperm
(b) antipodal, egg, endosperm
(c) endosperm, nucellus, synergids
(d) antipodal, synergids and integuments

23. $N_2 + 8e^- + 8H^+ + 16\,ATP \rightarrow 2NH_4 + H_2 + 16ADP + 16Pi$
The above equation refers to
(a) ammonification (b) nitrification
(c) nitrogen fixation (d) denitrification

24. In PS-I the reaction centre Chl *a* has absorption maxima at _____, while in PS-II the reaction centre Chl *a* has absorption maxima at _____.
(a) P_{680}, P_{700} (b) P_{700}, P_{680}
(c) P_{800}, P_{600} (d) P_{700}, P_{900}

25. Ethylene gas is used for
(a) growth of plants.
(b) delaying fruit's abscission.
(c) ripening of fruits.
(d) stopping the leaf abscission.

26. Which one is the correct summary equation of photosynthesis?
(a) $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy}$
(b) $C_6H_{12}O_6 + 6O_2 + 6H_2O \longrightarrow 6CO_2 + 12H_2O + \text{energy}$
(c) $6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} 6H_2O + C_6H_{12}O_6$
(d) $6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} 6O_2 + C_6H_{12}O_6 + 6H_2O$

27. Which one of the following is primarily concerned with cell division ?
(a) GA_3 (b) IAA
(c) Cytokinin (d) Ethylene

28. Growth is primarily affected by two climatic factors which are –
(a) Light and temperature
(b) Temperature and relative humidity
(c) Light and wind
(d) Rainfall and temperature

29. The hormone reducing transpiration rate by inducing stomatal closure is
(a) ABA (b) ethylene
(c) cytokinin (d) auxin

30. Which part of the plant do not perform photosynthesis?
(a) Cactus stem (b) Guard cell of stomata
(c) Mesophyll cells of leaf (d) Leaf epidermis

31. Effect of low temperature which shortens vegetative period and hasten flowering is
(a) photoperiodism (b) transpiration
(c) vernalization (d) photolysis

32. Which of the following elements is not required by plants for their normal healthy growth?
(a) Calcium (b) Magnesium
(c) Lead (d) Iron

33. The hormone responsible for phototropism is
(a) Ethylene (b) Abscisic acid
(c) Auxin (d) Gibberellic acid

34. In which part of a flower do both meiosis and fertilization occur?
(a) Ovule (b) Stigma
(c) Anther (d) Petal

35. Bidirectional translocation of minerals takes place in
(a) Xylem (b) Phloem
(c) Parenchyma (d) Cambium

36. Soil can easily become deficient in _____ because these ions are negatively charged and do not stick to negatively charged clay particles.
(a) Nitrate (b) Calcium
(c) Ammonium (d) Magnesium

37. In an anaerobic condition, yeast cells breakdown glucose to
(a) $CO_2 + H_2O$ (b) C_2H_5OH and CO_2
(c) CO_2 + Lactic acid (d) CO_2 + Pyruvic acid

38. Two pigment system theory of photosynthesis was proposed by or Concept of evidence for existence of two photosystems in photosynthesis was given by
(a) Hill (b) Blackman
(c) Emerson (d) Arnon

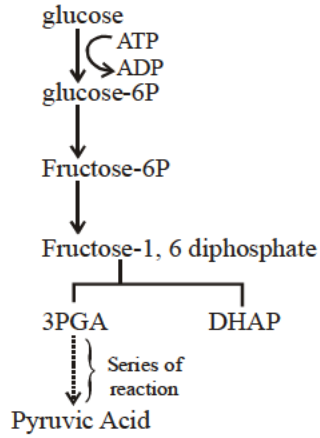
39. Which mineral nutrients are called critical element for crops?
(a) N, P, K (b) C, H, O
(c) N, S, Mg (d) K, Ca, Fe

40. Which of the following would not have an effect on flowering of a particular plant species?
(a) Plant age (b) Nutritional status
(c) Temperature (d) Prevailing wind

ANSWER KEY															
1	(a)	6	(c)	11	(c)	16	(a)	21	(a)	26	(d)	31	(c)	36	(a)
2	(b)	7	(a)	12	(d)	17	(a)	22	(a)	27	(c)	32	(c)	37	(b)
3	(a)	8	(a)	13	(a)	18	(c)	23	(c)	28	(a)	33	(c)	38	(c)
4	(d)	9	(b)	14	(b)	19	(c)	24	(b)	29	(a)	34	(a)	39	(a)
5	(c)	10	(a)	15	(d)	20	(b)	25	(c)	30	(d)	35	(b)	40	(d)

HINTS AND SOLUTIONS

2. (b) If a cell swells, after being placed in solution, the solution is called Hypotonic.
3. (a) Chlorophyll is present in the grana of chloroplasts.
4. (d) Translocation of organic solutes occur through sieve tubes in the form of sucrose. Transportable form of sugar is sucrose.
7. (a) Leaves show transpiration & photosynthesis.
9. (b) Pyruvic acid is the end product of glycolysis.



10. (a) The ultimate gain of light reaction is ATP & $NADPH_2$.
11. (c) The end product of fermentation of sugars is alcohol and CO_2. Sugars are the most common substrate of fermentation, and typical examples of fermentation products are ethanol, lactic acid, and hydrogen. However, more exotic compounds can be produced by fermentation, such as butyric acid and acetone. Yeast carries out fermentation in the production of ethanol in beers, wines and other alcoholic drinks, along with the production of large quantities of carbon dioxide. Fermentation occurs in mammalian muscle during periods of intense exercise where oxygen supply becomes limited, resulting in the creation of lactic acid.
12. (d) Turgor pressure is the pressure that develops in a cell due to osmotic diffusion of water inside it and is responsible for pushing the membrane against cell wall. Stomata open under conditions of increased turgor pressure of guard cell and stomata get closed under conditions of decreased turgor pressure of guard cells. When turgid, they swell and bend outward. As a result, the stomatal aperture opens. When they are flaccid, the tension from the wall is released and stomatal aperture closes.
13. (a) Cactus is a xerophytic plant and have sunken stomata to reduce the rate of transpiration, confined to lower epidermis.
14. (b) Photosynthesis takes place only in the visible part (400 – 700 nm wavelength) of electromagnetic radiations. Hence this component comprises the photosynthe-tically active radiation.
16. (a) In rainy season, door gets swelled due to the phenomenon of imbibition. It is the process of absorption of water without forming a solution.
18. (c) Double fertilization means, a male gamete fused with egg and second male gamete fused with secondary nucleus.
32. (c) Lead are toxic even in smaller concentration.
36. (a) NO_3^-, is negatively charged and not tightly bound to soil particles.
38. (c) The discovery of Emerson effect stated that one group of pigments absorbs light of both shorter and longer wavelengths (more than 680 nm) and another group of pigment absorbs light on only shorter wavelengths (less than 680 nm). These two groups of pigments are known as pigment systems or photosystem.

CHAPTER

4 Human Physiology

- The food that we consume must be broken down into simpler absorbable forms so that they can be easily absorbed and transported to various parts of our body through blood. This task is accomplished by the digestive system.

Dental formula for adult human

$$\frac{\text{Upper jaw}}{\text{Lower jaw}} = \frac{\text{I C Pm M}}{\text{I C Pm M}} = \frac{\mathbf{2123}}{\mathbf{2123}}$$

Digestion of Food

Name of the Digestive	Name of the enzymes	Substrate	End product
Saliva	Ptyalin (Salivary amylase)	Starch	Maltose
Pancreatic iuice	Amylopsin (pancreatic amylase)	Starch, Glycogen	Maltose and Glucose
Intestinal juice	Sucrase (invertase), Maltase, Lactase	Sucrose; Maltose, Lactose	Glucose and fructose, Glucose, Glucose and galactose
Gastric iuice	Pepsin, Rennin	Proteins, Casein	Proteoses and peptones, Calcium caseinate
Pancreatic iuice	Trypsin, Chymotrypsin, Carboxyl peptidases	Proteins, Proteins Peptides	Proteoses and peptides Peptides Amino acid.
Intestinal juice	Amino peptidase, Dipeptidase	Peptides	Amino acids, Amino acids

Vitamin required by the body

Vitamin	Chemical Name	Function In Body	Deficiency Disease
B_1	Thiamine pyrophosphate	Part of coenzyme for respiration	**Beri-beri:** nerve and heart disorders
B_2	Riboflavin	Part of coenzyme FAD needed for respiration	**Ariboflavinosis:** skin and eye disorders
B_{12}	Cyanocobalamin	Coenzyme needed for making red blood cells, bone, blood and nerve changes	**Pernicious anaemia**
B_5	Nicotinic acid ('niacin')	Part of coenzymes NAD, NADP used in respiration	**Pellagra:** skin, gut and nerve disorders
C	Ascorbic acid	Not precisely known	**Scurvy:** degeneration of skin teeth and blood vessels.
A	Retinol	Not fully known but forms part of visual pigment, rhodopsin	**Xeropthalmia:** 'dry eyes'
D	Cholecalciferol	Stimulates calcium absorption by small intestine, needed for proper bone growth	**Rickets:** bone deformity
E	Tocopherol	Not precisely known	**Infertility**
K	Phylloquinone	Involved in blood clotting	**Possible haemorrage**

Inorganic Elements in the Human Diet

Element	Common ions	Functions in human body
Calcium	Ca^{2+}	Calcium ions are needed for stability of cell membranes, as cofactors for some enzymes and are involved in muscle contraction and blood clotting.
Phosphorus	H_2PO_4	Bones component of many organic molecules like DNA, RNA and ATP.
Potassium Sodium Chlorine	K^+ Na^+ Cl^-	These ions are important in determining the balance of electrical charges in body fluids.
Iron	Fe^{2+}, Fe^{3+}	Component of haemoglobin and cytochrome molecules.
Iodine	I^-	Component of hormone thyroxin.
Copper Manganes Zinc	Cu^{2+} Mn^{2+} Zn^{2+}	Trace elements as enzyme cofactors, for example, Cu^{2+} is co-factor for cytochrome oxidase.

- Marasmus is produced by a simultaneous deficiency of proteins and calories. In Marasmus, protein deficiency impairs growth and replacement of tissue proteins; extreme emaciation of the body and thinning of limbs results, the skin becomes dry, thin and wrinkled. Growth rate and body weight decline considerably.
- Kwashiorkar is produced by protein deficiency unaccompanied by calorie deficiency. Like marasmus, kwashiorkor shows wasting of muscles, thinning of limbs, failure of growth and brain development.

Human Respiratory System

- Human respiratory system consists of external nostrils, nasal cavity, nasopharynx, larynx, trachea, bronchiole and lungs.

Transport of gases

- 97% of oxygen is transported from the lungs to the tissues in combination with haemoglobin ($Hb + O_2 \longrightarrow HbO_2$, oxyhaemoglobin). 3% is transported in dissolved condition by the plasma.

There are three ways of transport of CO_2.

- 5%–7% (approximately) of CO_2 is transported, being dissolved in the plasma of blood.
- CO_2 react with the water to form *carbonic acid* (H_2CO_3) by the enzyme carbonic anhydrase (present in RBC).
- CO_2 reacts with amine radicals (NH_2) of haemoglobin molecule and forms a carbamino–haemoglobin ($HbCO_2$) molecule. Nearly 23% of CO_2 is transported through this mode.

Disorders of respiratory system

Bronchial Asthma : It is characterised by the spasm of smooth muscles of the wall of bronchiole.

Emphysema : It is an inflation of bronchiole, which results into loss of elasticity of these parts.

Occupational Lung Disease : It is caused because of the exposure of potentially harmful substances persuntion in the environment, where people work. Two common occupational diseases are – silicosis and asbestosis.

Blood Groups

- **ABO grouping :** It is based on the presence or absence of two surface antigens on the RBCs namely A and B.

Table : Blood Groups and Donor Compatibility

Blood Group	Antigens on RBCs	Antibodies in Plasma	Donor's Group
A	A	anti-B	A, O
B	B	anti-A	B, O
AB	A, B	nil	AB, A, B, O
O	nil	anti-A, B	O

Rh Grouping : Another antigen, the Rh antigen are also observed on the surface of RBCs of majority of humans (Rh^+ individuals). A special case of Rh incompatibility has been observed between Rh^- blood of a pregnant mother with Rh^+ blood of foetus.

Circulatory Pathways

The circulatory patterns are of two types –

- **Open circulatory system** is present in arthropods and molluscs in which blood pumped by the heart passes through large vessels into open spaces or body cavities called sinuses. Annelids and chordates have a **closed circulatory system** in which the blood pumped by the heart is always circulated through a closed network of blood vessels. All vertebrates possess a muscular chambered heart. Fishes have a 2-chambered heart with an atrium and a ventricle. Amphibians and the reptiles (except crocodiles) have a 3-chambered heart with two atria and a single ventricle, whereas crocodiles, birds and mammals possess a 4-chambered heart with two artia and two ventricles.

Heart Beat and Pulse

- The human heart beats at the rate of about 72-80 per minute in the resting condition.

Electrocardiograph

- ECG is the graphic record of electronic current produced by the excitation of cardiac muscles.
- A normal electrocardiogram is composed of a P wave, QRS complex and T wave. P wave indicate the depolarisation of the atria. QRS complex expresses the ventricular depolarisation. T wave indicate an repolarisation of ventrcle.

Disorders of Circulatory System

Hypertension

- A continuous or sustained rise in arterial pressure is known as hypertension. High blood pressure compels heart to work excessive and then can tend to congestive heart disease.

Atherosclerosis

- In this, calcium salts precipitated with cholesterol of the forming or formed opaque making the wall of arteries stiff and rigid and is referred to as the hardening of the arteries. It may lead to heart attack and death.

Excretion

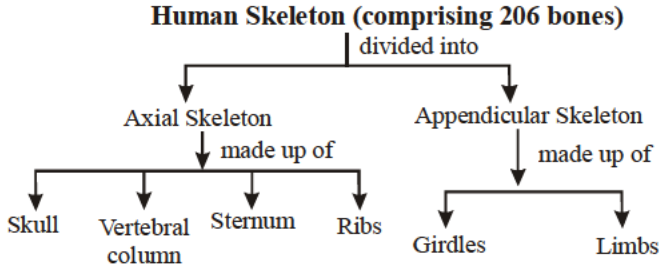
- The process of excreting ammonia is -**Ammonotelism**. Kidney plays a minor role in the elimination of ammonia *e.g.*, teleost fishes, tadpoles, aquatic soft bodied invertebrates. Organism undergoing ammonotelism are called **ammonotelic**.
- The process of excreting urea is - **Ureotelism**. Examples are mammals, many terrestrial adult amphibians and cartilaginous fishes (shark).
- The process of elimination of uric acid is -**Uricotelism** Examples are land snails, insects, birds and many reptiles.
- Each kidney has nearly one million complex tubular structures called **nephrons**, which are the functional units of kidney. These filter the blood to produce urine.

Disorders of the Excretory System

- Malfunctioning of kidneys can lead to accumulation of urea in blood, a condition called **uremia**, which is highly harmful and may lead to kidney failure.

- In such patients, urea can be removed by a process called **hemodialysis**. Blood drained from a convenient artery is pumped into a dialysing unit called **artificial kidney**.
- **Renal calculi :** Stone or insoluble mass of crystallized salts (oxalates, *etc*.) formed within the kidney.
- **Glomerulonephritis :** Inflammation of glomeruli of kidney.

Skeletal System



Axial Skeleton : Skeleton which occurs in the mid axial or longitudinal part of the body.

(i) **Skull** is made up of 29 bones. It is composed of
- **Cranium (8 bones)** : Frontal - 1; Parietal - 2; Occipital - 1; Temporal - 2; Sphenoid - 1; Ethmoid - 1.
- **Facial bones (14 in number)** : Nasal - 2; Maxillae - 2; Zygomatic - 2; Lacrymals - 2; Mandibles - 1; Inferior turbinals - 2; Vomer - 1; Palatines - 2. Hyoid Tongue bone - 1
- **Ear ossicles (6 bones)** : Malleus -2; Incus - 2; Stapes - 2.

(ii) **Vertebral column :** 33 in babies, 26 in adults. Grouped into 5 categories :
Cervical - 7; Thoracic - 12; Lumber - 5; Sacral - 5; Coccygeal - 4 (fused in adults).

(iii) **Sternum** : Composed of 3 parts → Manubrium, body of sternum and xiphoid process .

(iv) **Ribs** : They are twelve pairs. First seven pairs are true ribs. The 8th, 9th and 10th ribs are called false ribs or vertebrochondrial ribs. The last 11th and 12th pairs are called floating ribs.

Appendicular Skeleton : Present laterally or attached to the axial skeleton.

(i) **Girdles :** 2 types - pectoral and pelvic.
Pectoral girdle : made of two parts - clavicle and scapula.
Pelvic girdle : made of three bones - ilium, pubis and ischium.

(ii) **Limb bones** : Hind limbs and fore limbs - both made up of 30 bones each.
Fore limbs : Humerus (1); Radius-Ulna (2); Carpals (8); Metacarpals (5); Phalanges (14); Phalanges formula = 2, 3, 3, 3, 3. **Hind limbs** : Femur (1); Tibia-Fibula (2); Patella (1); Tarsals (7); Metatarsals (5); Phalanges (14).

Joints

- A joint is a location at which two bones make contact and is essential for all types of movements, involving the bony parts of the body.

Synovial Joints - Movable Joints : They are characterised by the presence of a closed space or **cavity** between the bones.

- This kind of joint are classified into six major categories.
  - **Plane** (gliding joint) : Present between carpals. Only sliding motion in all direction is allowed.
  - **Hinge joint** : Present between Knee joint
  - **Pivot joint** : Present between atlas and axis
  - **Saddle joint** : Present between carpal and metacarpal
  - **Ball and Socket joint** : Present between humerus and pectoral girdle.

Disorders of Muscular and Skeletal System

- **Myasthenia gravis** - Autoimmune disorder. It affects neuromuscular transmission.
- **Muscular dystrophy** - Progressive skeletal muscle weakness, defects in muscle proteins, the death of muscle cells and tissue.
- **Rheumatoid Arthritis :** Inflammation of synovial membrane.
- **Osteoarthritis :** Degeneration of articular cartilage.
- **Gout :** Caused by excess formation of uric acid and their deposition in the joints.
- **Osteoporosis :** Low bone mass, increased fragility and proneness to fracture.

Neural Control and Coordination

- The neural sysem is the control system of the body which consists of highly specialized cells called **neurons**.
- A neuron consists of main cell body and cytoplasmic processes arising from it.

The human brain is divisible into three parts:

- **Forebrain :** It comprises the olfactory lobes, cerebrum and diencephalon.
  Cerebrum is the largest and complex part. It consists of the left and right hemispheres connected by a bundle of myelinated fibres, called corpus callosum. The outer layer of the cerebrum is called the cortex.
- **Diencephalon :** The main parts of the diencephalon are epithalamus, thalamus and hypothalamus.
- The hypothalamus is the highest centre of autonomic nervous system. It governs emotional reactions and exercise control over sleep mechanism.
- **Midbrain :** It is formed of corpora quadrigemina and cerebral peduncles. Cerebral penduncles are bundles of fibres connecting the cerebral cortex with other parts of brain and spinal cord.
- **Hind brain :** It comprises of :
  - **Cerebellum :** It controls the balance and posture of the body.
  - **Pons varolii** - The pons is concered with maintenance of normal rhythm of respiration.
  - **Medulla oblongata** - Medullary centres (reflex centres) are present for controlling the functions of important organs, *e.g.*, cardiac centres (heart), respiratory centre, vasomotor centre (for regulating diameter of blood vessels) and reflex centres (for swallowing, vomiting, peristalsis, secretion and activity of alimentary canal, salivation, coughing etc.)

Chemical Coordination in Animal (Hormones)

Endocrine Gland	Hormone	Principal action	Disorders
Thyroid	Thyroxine (T_4) and Triiodothyronine (T_3) Calcitonin	Maintains calcium level normal in the body. Increases rate of metabolism in the body.	Cretinism, myxoedema goiter
Parathyroid	Parathormone (PTH)	Increases plasma calcium	Parathyroid tetany osteoporosis
Adrenal gland (medulla)	Adrenaline and Noradrenaline	Increases heart beat, blood sugar and also constricts blood vessel	
Adrenal cortex	Mineralocorticoids (aldosterone)	Increases reabsorption of sodium and excertion of potassium	Addison's disease Adrenal virilism
	Glucocorticoids (cortisol)	Increases blood sugar and affects carbohydrate, fat and protein metabolism	Cushing's syndrome
Hypothalamus	ARH	Regulates corticotropin secretion	
	TRH	Thyrotropin secretion	
	SRH	Stimulates secretion of gonadotropins	
	(Growth hormone releaing factor)	Regulates secretion of prolactin	
	(Prolactir releasing hormone) and (Prolactin inhibitory hormone)	Control secretion of MSH	
Pituitary gland anterior lobe	Pituitary gland anterior lobe	Stimulates general growth	Pituitary dwarfism, gigantism, Acromegaly
	Prolactin	Stimulates milk production and secretion	
	(Follicle stimulating hormone)	Stimulates ovarian follicle and spermatogenesis	
	(Lutemizing hormone)	Stimulates corpus luteum and ovulation in females and interstitial cell in males	
	(Thyroid stimulating hormone)	Stimulates thyroid gland to secrete hormones	
	Adrenocorticotropic hormone	Stimulates adrenal cortex to secrete glucocorticoids	
Intermediate lobe	Melanocyte stimulating hormone	Growth and development of melanocyte	
Posterior lobe	Oxytocin	Contraction of uterine muscles and mammary gland cells	
	Vasopressin (ADH)	Promotes reabsorption of water from collecting ducts of kidneys	Diabetes insipidus

Pancreas

- Located posterior to stomach, close to duodenum.
- **Endocrine Pancreas :** Consists of islets of Langerhans. The islet of Langerhans have two main types of cells.

ENDOCRINE PANCREATIC SECRETIONS :

	NAME OF THE CELLS	PRODUCT	FUNCTION
1.	Beta (β) cells	Insulin and Amylin	Lower blood sugar level.
2.	Alpha (α) cells	Glucagon	Raise blood sugar level.

Testes

Function : Produces a group of hormones called androgens mainly testosterone.

- Androgen regulates the development, maturation and functions of the male accessory sex organs.

Ovary

Functions : Ovary produces one ovum during each menstrual cycle. It produces 2 groups of steroid hormones called.

(i) **Estrogen**

(ii) **Progesterone**

- Stimulating growth and activities of female secondary sex organs.
  - Supports Pregnancy.
  - Also regulates female sexual behaviour.
  - Production of milk.

Reproduction

- It is the ability of living organisms to produce a new offspring similar to themselves.
- The major reproductive events in human beings are
  (i) **Gametogenesis** – Formation of gametes.
  (ii) **Insemination** – Transfer of sperms into female genital tract.
  (iii) **Fertilisation** – Fusion of male and female gametes leading to formation of zygote.
  (iv) **Implantation** – Formation and development of blastocyst and its attachment to the uterine wall.
  (v) **Gestation** – Embryonic development; gestation is the time from conception to birth.
  (vi) **Parturition** – Delivery of baby (the process of birth).

EXERCISE

1. Which part of the alimentary canal does not secrete any enzyme?
   (a) Mouth (b) Oesophagus
   (c) Stomach (d) Duodenum
2. The food that gives more calories per unit mass of food is
   (a) protein (b) carbohydrates
   (c) fat (d) water
3. Percentage of oxygen supplied by haemoglobin is
   (a) 97% (b) 100%
   (c) 49% (d) 3%
4. Which one of the following correctly represents the normal adult human dental formula ?
   (a) $\frac{3}{3},\frac{1}{1},\frac{3}{2},\frac{1}{1}$ (b) $\frac{2}{2},\frac{1}{1},\frac{3}{2},\frac{3}{3}$
   (c) $\frac{2}{2},\frac{1}{1},\frac{2}{2},\frac{3}{3}$ (d) $\frac{3}{3},\frac{1}{1},\frac{3}{3},\frac{3}{3}$
5. In expiration, diaphragm becomes
   (a) flattened (b) relaxed
   (c) straightened (d) arched
6. Elbow joint is an example of
   (a) hinge joint (b) gliding joint
   (c) ball and socket joint (d) pivot joint
7. The toxic effect of CO is due to its greater affinity for haemoglobin as compared to O_2 approximately by
   (a) 2 times (b) 20 times
   (c) 200 times (d) 1000 times
8. A patient is generally advised to specially, consume more meat, lentils, milk and eggs in diet only when he suffers from
   (a) Scurvy (b) Kwashiorkor
   (c) Rickets (d) Anaemia
9. In which of the following reptiles four chambered heart is present ?
   (a) Lizard (b) Snake
   (c) Scorpion (d) Crocodile
10. Melatonin is produced by
    (a) thymus (b) skin
    (c) pituitary (d) pineal gland
11. Child death may occur in the marriage between
    (a) Rh^+ man and Rh^+ woman
    (b) Rh^+ man and Rh^- woman
    (c) Rh^- man and Rh^- woman
    (d) Rh^- man and Rh^+ woman
12. Which one of the following organs in the human body is most affected due to shortage of oxygen?
    (a) Intestine (b) Skin
    (c) Kidney (d) Brain
13. The pH of blood is
    (a) between 7-8 (b) between 2-4
    (c) between 12-14 (d) between 2-5
14. Antibodies are
    (a) carbohydrates (b) immunoglobulins
    (c) globular proteins (d) extrinsic proteins
15. Air is breathed through
    (a) Trachea — lungs — larynx — pharynx — alveoli
    (b) Nose — larynx — pharynx — bronchus — alveoli — bronchioles
    (c) Nostrils — pharynx — larynx — trachea — bronchi — bronchioles — alveoli
    (d) Nose — mouth — lungs
16. Which of the following disease is not concerned with disorders of circulatory system?
    (a) Heart failure
    (b) Angina
    (c) Coronary artery disease
    (d) Uremia

17. Neurons receive signals through their _____ and send signals to other neurons through their _____.
(a) dendrites ... receptors
(b) end feet ... cell bodies and dendrites
(c) cell bodies and dendrites ... axons
(d) transmitter vesicles ... axons

18. Functional and structural unit of kidney is
(a) nephron (b) seminiferous tubule
(c) acini (d) None of these

19. Asthma is caused due to
(a) Infection of lungs
(b) Spasm in bronchial muscles
(c) Bleeding into pleural cavity
(d) infection of trachea

20. Dialysis is done in the condition when person is suffering from
(a) diabetes (b) uremia
(c) polyuria (d) haemoptysis

21. Which part of human brain is concerned with the regulation of body temperature?
(a) Cerebellum (b) Cerebrum
(c) Hypothalamus (d) Medulla Oblongata

22. Which of the following organs can be called as a sort of "blood bank" ?
(a) Lungs (b) Heart
(c) Liver (d) Spleen

23. Universal blood recipient is
(a) blood group O (b) blood group AB
(c) blood group A (d) blood group B

24. Bones are mainly made up of
(a) calcium and phosphorous
(b) calcium and sulphur
(c) calcium and magnesium
(d) calcium and iron

25. ECG records
(a) rate of heart beat
(b) potential difference
(c) ventricular concentration
(d) volume of blood pumped

26. During strenuous exercise, glucose is converted into
(a) glycogen (b) pyruvic acid
(c) starch (d) lactic acid

27. In human testosterone is produced by
(a) tunica albuginea (b) leydig cell
(c) seminiferous tubule (d) sertoli cell

28. In adult, normal blood pressure is
(a) 80/120 mm Hg (b) 100/80 mm Hg
(c) 120/80 mm Hg (d) 100/120 mm Hg

29. Thoracic cage is made up of
(a) ribs, vertebral column & diaphragm
(b) ribs, diaphragm & sternum
(c) vertebral column, diaphragm & sternum
(d) ribs, vertebral column & sternum

30. The junction between an axon and dendrite is called
(a) cyton (b) synapse
(c) relay (d) conduction zone

31. A certain road accident patient with unknown blood group needs immediate blood transfusion. His one doctor friend at once offers his blood.What was the blood group of the donor?
(a) Blood group B (b) Blood group AB
(c) Blood group O (d) Blood group A

32. Which one is not a reflex action?
(a) Closing of eye lids against fricking
(b) Release of saliva on seeing sweets
(c) Perspiration due to heat
(d) Obeying the order to run

33. Which one is not correct ?
(a) Humans - Uriotelic (b) Birds - Uricotelic
(c) Lizards - Uricotelic (d) Whale - Ammonotelics

34. Main similarity between hormone and enzyme is
(a) both act at particular pH
(b) both are proteins
(c) both are required in small amounts
(d) both can be used again and again

35. Which of the following commonly called emergency gland of body?
(a) Thymus (b) Testis
(c) Adrenal (d) Pituitary

36. Other function performed by kidney apart from excretion is
(a) Osmoregulation (b) Temperature regulation
(c) Hormonal regulation (d) Spermatogenesis

37. Appearance of facial hairs in a woman may be due to the effect of
(a) temperature (b) ultraviolet radiation
(c) hormone (d) pollution

38. Glucagon is secreted by
(a) β (beta) cells of islets of langerhans
(b) α (alpha) cells of islets of langerhans
(c) β cells of pancreas
(d) adrenal cortex

39. Parathormone deficiency produces muscle ramps or tetany as a result of
(a) lowered blood Ca^{2+}
(b) enhanced blood Na^{+}
(c) enhanced blood glucose
(d) enhanced blood Ca^{2+}

40. Thymosin stimulates
(a) milk secretion (b) erythrocytes
(c) T-lymphocytes (d) melanocytes

ANSWER KEY															
1	(b)	**6**	(a)	**11**	(b)	**16**	(d)	**21**	(c)	**26**	(d)	**31**	(c)	**36**	(a)
2	(c)	**7**	(c)	**12**	(d)	**17**	(c)	**22**	(d)	**27**	(b)	**32**	(c)	**37**	(c)
3	(a)	**8**	(b)	**13**	(a)	**18**	(a)	**23**	(b)	**28**	(c)	**33**	(d)	**38**	(b)
4	(c)	**9**	(d)	**14**	(b)	**19**	(b)	**24**	(a)	**29**	(d)	**34**	(c)	**39**	(a)
5	(d)	**10**	(d)	**15**	(c)	**20**	(b)	**25**	(b)	**30**	(b)	**35**	(c)	**40**	(c)

HINTS AND SOLUTIONS

3. (a) About 97% of oxygen is carried in combination with haemoglobin of the erythrocytes to form oxyhaemoglobin.

4. (c) The adult dental formula of human is Incisor $\frac{2}{2}$, Canine $\frac{1}{1}$, Premolar $\frac{2}{2}$, Molar $\frac{3}{3}$.

6. (a) Elbow joint is an example of hinge joint. The elbow is a hinge joint; it can open and close like a door. Hinge joint allows angular movement in one plane only, increasing or decreasing the angle between the bones *e.g.* elbow joint, knee joint etc.

8. (b) A child may have a diet containing sufficient carbohydrates and fats but still suffers a serious form of malnutrition. This form of malnutrition is known as Kwashiorkar. It develops in children whose diets are deficient in protein.

10. (d) Melatonin is secreted by pineal gland present between the cerebral hemispheres. Melatonin concentration in blood follows a diurnal cycle, it rises in the evening and drops at noon. Melatonin lightens skin colour in certain animals and regulates working of gonads.

11. (b) Rh factor was discovered by Karl Landsteiner. A child of Rh^+ man will be Rh^+ whether the mother is Rh^+ or Rh^-. If the mother is Rh^+ then there will be no problem but if mother is Rh^- so when the blood of Rh^+ child (in womb) mixes with the blood of Rh^- mother then some antibodies in mother's blood are formed against Rh^+ factor which coagulate the womb blood causing death. If birth takes place then there is a possibility of child death in early years. This in known as *erythroblastosis foetalis.* In most cases the first pregnancy may succeed but after that it fails.

12. (d) Brain is the most vital organ. It stops functioning in the absence of O_2.

13. (a) Blood is an opaque, mobile connective tissue fluid which has salty taste. pH of blood is between 7-8. Hence, the blood possesses slightly alkaline pH.

14. (b) Antibodies are immunoglobulins (Igs) which are produced in response to antigenic stimulation.

15. (c) The pathway of inhaled air is - Nostrils - pharynx (common passage for food & air) - larynx (voice box) - trachea (the wind pipe) - bronchi (2 for each side lungs) - bronchioles (give arise to alveolar ducts) - alveoli (the exchange site for gases in the form of small sacs or pouches).

17. (c) Dendrites generally receive inputs and conduct signals toward the cell body, whereas axons conduct signals away from the cell body.

23. (b) Blood group AB individuals have both A and B antigens on the surface of their RBCs, and their blood plasma does not contain any antibodies against either A or B antigen. Therefore, an individual with type AB blood can receive blood from any group with AB being preferable. Hence, blood group AB is known as universal recipient.

24. (a) Bone is the solid rigid strong connective tissue. Its matrix consists of ossein protein and mineralization of matrix occurs by calcium- phosphate salts. This gives rigidity and strength to bones.

29. (d) Rib cage consists of vertebral column (dorsal), sternum (ventral) and ribs (lateral).

30. (b) The junction between an axon and dendrite is known as synapses through which nerve impulse is transmitted from one neuron to other. A synapse consists of swelling at the end of nerve fibre called synaptic knob and small synaptic vesicle containing neuro-transmitter–acetylcholine for the transmission of nerve impulse.

31. (c) Blood group O acts as universal donor.

32. (c) Reflex action is the immediate involuntary response to stimulus. It includes sudden action of body parts due to heat stimulus, burn stimulus, pricking, sneezing, coughing yawning, etc. Perspiration is not a reflex action. It is also known as sweating. Sweating is loss of water from sweat glands of the skin. Sweat includes some salts and urea. Its for temperature regulation.

33. (d) Whale is ureotelic.

35. (c) Adrenal or suprarenal glands are called emergency gland of the body. The medullary portion of these glands secretes hormones adrenaline and nor adrenaline. Their secretion is stimulated by the sympathetic nervous system. These hormones are secreted in emergancy conditions like anger, injury, cold, emotional stress, fear etc, hence also called hormones for fight or flight.

36. (a) Besides removing the metabolic wastes and impurities from the blood the kidney also perform the important function of osmoregulation (regulation of osmolality) by regulating the amount of water in body fluids.

39. (a) Parathormone released by the parathyroid gland elevates the level of Ca^{2+} in blood. The deficiency of this hormone lowers blood Ca^{2+}. As a result, the excitability of muscles and nerves increases producing tetany sustained contraction.

CHAPTER

5 Genetics and Evolution

Study of heredity and variation is called **genetics**.

- Term genetics was given by - **Bateson**.
- Father of genetics - **Gregor Johann Mendel**.
- Father of experimental genetics - **Thomas Hunt Morgan**.
- Father of human genetics - **Archibald Garrod**.

Some Terms in Genetics

Gene : It is segment of DNA. It is basic unit of heredity.

Back cross : It is cross which is performed between hybrid and one of its parents.

Test cross : Test cross is crossing of offspring with unknown dominant phenotype with the individual homozygous recessive for the trait.

Monohybrid cross : It is a cross between two organisms of a species which is made to study the inheritance of a single pair of alleles or factors of a character.

Monohybrid ratio : Monohybrid ratio is usually 3 : 1 (phenotypic ratio) or 1 : 2 : 1 (genotype ratio) in which 25% of the individuals carry the recessive trait, 25% pure dominant and 50% have hybrid dominant trait.

Dihybrid cross : It is a cross between two organisms of a species which is made to study the inheritance of two pairs of factors or alleles of two genes.

Dihybrid ratio : Dihybrid ratio is 9 : 3 : 3 : 1 (phenotypic ratio) where 9/16 first recessive and second dominant and 1/16 carry both the recessive traits.

- Mendel conducted cross hybridization experiments on Garden Pea plant (*Pisum sativum*). The first was the **Principle of segregation**, which claimed that each trait was specified by paired hereditary determinants (alleles of genes) that separate from each other during gamete formation. This law is also called **Law of purity of gametes or Law of splitting of hybrids.**
- **Gregor Mendel** was the first individual to apply a modern scientific approach to the study of heredity. Mendel proposed two basic principles of trasmission genetics.
- Mendel's second basic conclusion was the **Principle of independent assortment**, which stated that the segregation of one pair of genes-controlling a given trait - was not influenced by the segregation of other gene pairs. The chormosome theory provided a physical basis for the principle of independent assortment. Genes located on different chromosomes move to gametes independently of each other during meiosis.

Human Blood Groups and Multiple Allele

- The system of blood groups in humans was discovered by Karl Landsteiner in 1900 s.
- There are four phenotypes of Blood namely **A, B, AB** and **O** produced by three different alleles I^A, I^B **and i** of a gene.
- The allele I^A and I^B are equally dominant and do not interfere with expression of each other hence the allele $I^A I^B$ are said to be co-dominant because both are expressed in the phenotype **AB.**
- **Linkage** is the phenomenon of certain genes staying together during inheritance through generations without any change or separation due to their being present on the same chromosomes.
- Linkage in the genes can be identified by test cross.
- The rearrangements of linked genes due to crossing over is known as **recombination**. Recombination also occurs due to chance separation of chromosomes during gametogenesis and their random coming together during fertilization.

Sex Determination

- **Henking** discovered X body in spermatogenesis of few insects and it was given name of X chromosome. Due to involvment of X and Y chromosomes in determination of sex, they were called **sex chromosomes.**
- Rest of the chromosomes which determine other metabolic character of the body are called **autosomes**.

Mutation

- Phenomenon that results in alteration of DNA sequence and consequently results in change in genotype and phenotype of an organism is called **mutation**.
- **Mutagens** are various chemical and physical factors that induce mutations, *e.g.*, UV radiations, carcinogenic chemicals like nicotine, nitric oxide (NO).

Genetic Disorder

- A genetic disorder is a disease that is caused by an abnormality in an individual's DNA.

Haemophilia

- A protein involved in clotting of blood is affected in an affected individual; if person gets a cut, will result in non-stop bleeding.
- Females are heterozygous and carriers of haemophilia.

Sickle Cell Anaemia

- It is due to inheritance of defective allele coding for β-globin. It results in the transformation of Hb^A into Hb^S in which glutamic acid is replaced by valine at 6th position in each of two β-chains of haemoglobin.
- It is an excellent example of single mutation.

Phenylketonuria

- Affected individual lacks enzyme phenylalanine hydroxylase that converts amino acid phenylalanine to tyrosine.
- It is characterized by severe mental retardation, hypopigmentation of skin & hair, eczema, etc.

Chromosomal Mutation

Name of disorder or syndrome	Chromosomal Alteration involved	Symptoms or Associated Traits
Down's Syndrome	Trisomy 21	Characteristic facial features, short stature, heart defects, respiratory infections, mental retardation.
Klinefelter's Syndrome	XXX (or XXYY, XXXY, etc)	Sterility, small testes, feminine body contours, normal intelligence or mental retardation.
Turner's Syndrome	Monosomy X (XO)	Short stature, sex organs do not mature, no secondary sex characteristics, normal intelligence.
Cri du chat Syndrome	Deletion in Chromosome 5	Mental retardation, small head, unusual cry.

Deoxyribonucleic Acid

- DNA is a long chain polymer of deoxyribonucleotides.
- Nucleotide is made up of 3 chemical groups →

$$\underbrace{\text{A nitrogen base moiety + pentose sugar}}_{\text{Nucleoside}}$$

+ phosphate group

- Nitrogenous base are of two types – **purines** (9 membered double rings with nitrogen at 1, 3, 7 & 9^{th} positions) and **pyrimidines** (6 membered rings with nitrogen at 1 and 3^{rd} position).
- Purines are of **two types** – adenine (A) and guanine (G) and pyrimidines are of **three types** – thymine (T), cytosine (C) and uracil (U).
- A characteristics that differentiate DNA from RNA is that DNA contains all of the nitrogen bases except uracil and RNA contains all of the nitrogen bases except thymine.
- **Wilkins-Franklin** carried out X ray diffraction (X-ray crystallography) on the basis of which **Watson and Crick** suggested secondary structure of DNA in 1953.
- 2 DNA strands are organized in antiparallel and complementary arrangement [*i.e.*, 2 strands run in opposite orientation (one in 5' – 3' and allies in 3' – 5')].
- Adenine pairs with thymine with 2 hydrogen bonds and guanine pairs with cytosine with three hydrogen bonds.
- The helix is generally right handed *i.e.* its turn run clockwise looking along the helix axis. The pitch of helix is **3.4 nm** (1 nm = 10^{-9}m) and there are **10bp** in each turn.
- The concept of central dogma in molecular biology was proposed by **Francis Crick** (1958). It proposes unidirectional or one way flow of information from DNA to RNA & then to protein.

$$\text{DNA} \xrightarrow{\text{Transcription}} \text{mRNA} \xrightarrow{\text{Translation}} \text{Polypeptide (protein)}$$

Evolution

- It is the formation of newer types of organisms from the pre-existing ones through modification. Evolution is therefore, often called descent with modification.
- Earth originated 4600 million years ago.
- Life appeared 3.7 billion years ago. This is indicated by the discovery of microfossils of cyanobacteria like organisms.
- **Theory of spontaneous generation (Abiogenesis/ autogenesis)**
  - Given by **Aristotle**.
  - Life originated from non-living things in spontaneous manner.
- **Theory of Biogenesis**
  - Life originated from pre-existing life.
  - Given by **Francesco Redi**.
  - **Oparin – Haldane** theory was supported experimentally by **Miller-Urey** experiment in 1953.

    Discharge Apparatus – a large flask containing mixture of CH_4, NH_3, H_2 and H_2O with electric source and boiling of water for a week.
  - Miller observed dark condensed liquid which was analysed. Analysis reports concluded, that it was a mixture of amino acids like alanine, glycine, glutamic acid, aspartic acid, valine and leucine and number of other organic compounds like HCN, aldehyde and cyanocompounds.

Theories of Evolution

Darwinism

- Darwinism is the term coined for the explanation offered by **Darwin** for the origin of species by **Natural selection** in 1858.
- Darwinism or theory of natural selection is a theory of organic evolution which states that new species evolve over a long period of time through accumulation of small variations which provide the organism with structural and functional superiority over others in their survival and differential reproduction.

Genetic Equilibrium (Hardy Weinberg Law)

- Law states that "both gene frequency and genotype frequency" will remain constant from generation to generation in an infinitely large interbreeding population in which mating is random and no selection, migration or mutation occurs.
- **Hardy Weinberg formula or binomial expression is given as**
  $p^2 + 2pq + q^2 = 1$ for two alleles A and a.
- **Genetic drift** refers to chance elimination of gene(s) of certain traits when a section of population migrates or dies of natural calamity. It eliminates certain alleles and fixes other alleles.
- Genetic drift in a new colony is called **founder effect**.
- Natural calamity like earthquake greatly reduces the size of population, killing the individuals randomly. The genetic pool of surviving population decreases. This condition of reduced genetic variability is called **bottleneck effect**.

Vestigial Organs

- The useless and functionless degenerate structures which were large and functional in some other animals.
- Examples : Vermiform appendix, coccyx, pinna muscle, wisdom tooth in humans, rudiments of hindlimbs in python.

Adaptive radiation

- It is a special evolutionary pattern, characterized by a rapid increase in number of kinds of closely related species.
- A **good example of adaptive radiation** is found among the **Finches of Galapagos Islands**. Another example is **Australian Marsupials**.

Biological evolution

- It is the process of change over time, in the heritable characteristics, or traits of a population organisms.
- Many experts believe that *Australopithecus garhi* or a similar species gave rise to the genus *Homo*.
- Early hominids–members of the genus *Homo*–lived contemporaneously with *Australopithecines* for perhaps a half million years.
- The oldest fossil remains of a member of the genus *Homo* were discovered in Tanzania. It was named *H. habilis*.
- *Homo erectus* is the only other known extinct species of the genus *Homo*.
- *H. erectus* was replaced in tropical regions by *Homo sapiens* about 200,000 years ago.

EXERCISE

1. Mutation rates are affected by
   (a) temperature
   (b) X-rays
   (c) gamma and beta radiation
   (d) All of the above
2. A dihybrid condition is
   (a) tt Rr (b) Tt rr
   (c) tt rr (d) Tt Rr
3. In case of incomplete dominance the monohybrid ratio of phenotypes in F_2 generation is
   (a) 1 : 2 : 1 (b) 3 : 1 : 1
   (c) 9 : 3 : 3 : 1 (d) 2 : 3 : 1
4. The number of autosomes in human female ovum is
   (a) 11 (b) 12
   (c) 22 (d) 23
5. Which one of the following represents a test cross ?
   (a) Ww × WW (b) Ww × Ww
   (c) Ww × ww (d) WW × WW
6. How many different kinds of gametes will be produced by a plant having the genotype AABbCC?
   (a) Nine (b) Two
   (c) Three (d) Four
7. How many pairs of contrasting characters in pea pod were chosen by Mendel?
   (a) 2 (b) 3
   (c) 4 (d) 7
8. From a cross AABb x aaBb, the genotypes AaBB : AaBb : Aabb : aabb will be obtained in the following ratio
   (a) 1: 1 : 1 : 1 (b) 1: 2 : 1 : 0
   (c) 0: 3 : 1 : 0 (d) 1: 1 : 1 : 0
9. A nucleotide is formed of
   (a) purine, pyrimidine and phosphate
   (b) purine, sugar and phosphate
   (c) nitrogenous bases, sugar and phosphate
   (d) pyrimidine, sugar and phosphate
10. The process of translation is
    (a) ribosome synthesis
    (b) protein synthesis
    (c) DNA synthesis
    (d) RNA synthesis

11. Which one of the following pairs of nitrogenous bases of nucleic acids, is wrongly matched with the category mentioned against it?
    (a) Thymine, Uracil - Pyrimidines
    (b) Uracil, Cytosine - Pyrimidines
    (c) Guanine, Adenine - Purines
    (d) Adenine, Thymine - Purines
12. Ligase helps in
    (a) removal of few genes
    (b) translation
    (c) inserting few genes in DNA
    (d) bringing transversion in chromosomes
13. A nucleoside differs from a nucleotide in not having
    (a) phosphate
    (b) sugar
    (c) nitrogen base
    (d) phosphate and sugar
14. Nucleotide arrangement in DNA can be seen by
    (a) X-ray crystallography
    (b) Electron microscope
    (c) Ultracentrifuge
    (d) Light microscope
15. Scientific name of man is
    (a) *Canis familiaris* (b) *Homo habilis*
    (c) *Homo erectus* (d) *Homo sapiens*
16. The primitive atmosphere of earth contained water vapours, hydrogen, ammonia and
    (a) CO_2 (b) O_2
    (c) N_2 (d) CH_4
17. The book 'Origin of Species' is written by
    (a) Aristotle (b) Darwin
    (c) Watson (d) Lamarck
18. Which was absent in the atmosphere at the time of origin of life ?
    (a) NH_3 (b) H_2
    (c) O_2 (d) CH_4
19. Homologous organs are
    (a) wings of insects and bat
    (b) gills of fish and lungs of rabbit
    (c) pectoral fins of fish and fore limbs of horse
    (d) wings of grosshopper and crow
20. The kind of evolution in which two species of different geneology come to resemble one another closely, is termed as
    (a) progressive evolution
    (b) convergent evolution
    (c) parallel evolution
    (d) retrogressive evolution
21. Which one is linked to evolution?
    (a) Extinction (b) Competition
    (c) Variation (d) Reproduction
22. Genetic variation in a population arises due to
    (a) Mutations only
    (b) Recombination only
    (c) Mutations as well as recombination
    (d) Reproductive isolation and selection
23. The first organisms were
    (a) Chemoautotrophs
    (b) Chemoheterotrophs
    (c) Autotrophs
    (d) Eukaryotes
24. What was the most significant trend in evolution of modern man (*Homo sapiens*) from his ancestors ?
    (a) Upright posture
    (b) Shortening of jaws
    (c) Binocular vision
    (d) lncreasing brain capacity
25. The factors which represent the contrasting pairs of characters are called
    (a) dominant and recessive
    (b) alleles
    (c) homologous pairs
    (d) determinants
26. Who proved that DNA is basic genetic material?
    (a) Griffith
    (b) Watson
    (c) Boveri and Sutton
    (d) Hershey and Chase
27. The two strands of DNA are held together by
    (a) peptide bonds (b) phosphodiester bonds
    (c) hydrogen bonds (d) S – S bonds
28. According to special creation theory the earth is about
    (a) 4000 yrs old (b) 4.5 M yrs old
    (c) 4.5 B yrs old (d) 10000 yrs old
29. Which of the following is not a part of Darwin's theory of evolution?
    (a) Genetic drift
    (b) Natural selection
    (c) Survival of the fittest
    (d) Struggle for existence
30. In Down's syndrome of a male child, the sex complement is
    (a) XO (b) XY
    (c) XX (d) XXY

ANSWER KEY											
1	(d)	**6**	(b)	**11**	(d)	**16**	(d)	**21**	(c)	**26**	(d)
2	(d)	**7**	(d)	**12**	(c)	**17**	(b)	**22**	(c)	**27**	(c)
3	(a)	**8**	(b)	**13**	(a)	**18**	(c)	**23**	(b)	**28**	(a)
4	(c)	**9**	(c)	**14**	(a)	**19**	(c)	**24**	(d)	**29**	(a)
5	(c)	**10**	(b)	**15**	(d)	**20**	(b)	**25**	(b)	**30**	(b)

HINTS AND SOLUTIONS

2. (d) Dihybrid condition involves simultaneous inheritance of two pairs of mendelian factors or genes.
4. (c) In human female ovum, number of autosome are 22 pairs.
7. (d) Mendel in his experiment considered total 7 characters (3 characters of seed i.e., seed shape, seed colour, cotyledon colour, 2 characters of pod i.e., plant height and position of pods on the stem).
8. (b) AABb × aaBb

AB	Ab	AB	Ab	
aB	AaBB	AaBb	AaBB	AaBb
ab	AaBb	Aabb	AaBb	Aabb
aB	AaBB	AaBb	AaBB	AaBb
ab	AaBb	Aabb	AaBb	Aabb

AaBB : AaBb: Aabb: aabb
4 : 8 : 4 : 0
AaBB = 1; AaBb = 2; Aabb = 1; aabb = 0
9. (c) Nucleotide is a unit of DNA, which is formed of nitrogenous bases (purines & pyrimidines), sugar (pentose) & phosphate.
10. (b) Protein synthesis occurs over ribosomes which are also referred to as protein factories.
11. (d) Purine is an organic nitrogenous base sparingly soluble in water, that gives rise to a group of biologically important derivatives, notably adenine and guanine, which occur in nucleotides and nucleic acids (DNA and RNA).
12. (c) Ligase helps in inserting few genes in DNA.
13. (a) In a nucleotide, purine or pyrimidine nitrogenous base is joined by deoxyribose pentose sugar (D), which is further linked with phosphate (P) group to form nucleotides.
14. (a) In 1953 Wilkins obtained very fine X-ray crystallographic pictures of DNA from which Watson and Crick developed the double helix model of DNA.
16. (d) The primitive atmosphere of the earth contained : H_2O, H_2, NH_3 & CH_4. The ratio was (2 : 2 : 1) of : NH_3, CH_4 and hydrogen.
17. (b) 'Origin of Species' book was written by Charles Robert Darwin. During his world journey (1831–1936) as a naturalist in H.M.S. Beagle ship, he visitied many parts of the world. On the basis of the observations of this journey, he wrote the book thereby describing his theory of natural selection.
18. (c) Oxygen gas was not present due to reducing atmosphere, it only came to existence after the evolution of photosynthesis process.
19. (c) Organs that are similar in fundamental structure but different in functions are "homologous organs", Richard Owen, introduced the term homologous. Pectoral fins of fish and fore limbs of horse similar in structure but different in functions are homologous organs.
Rest of the organs compared in the question are analogous organs.
20. (b) Progressive evolution is development of organisms with more elaborate and specialized structures from those having less elaborate features e.g. amphibians from reptiles. Retrogressive or degenerative evolution is development of simpler forms from more complex ones. Such evolution has occurred in case of vestigial organs, parasitic forms, and in reduction of overspecialized structures such as wings in flightless birds. Parallel evolution is formation of similar traits in related groups of organisms independently due to similar requirement e.g. running of two toed deer and one toed horse. Evolution of wings in insects and birds serve as example of convergent evolution.
21. (c) Organic evolution is process of cumulative change of living populations and in the descendant populations of organisms. According to Darwin, variations are differences among individuals. Variations which help the individual to fit in its surroundings are passed on to the next generation while others disappear. Thus, variation plays an important role in evolution.
22. (c) Crossing over leads to recombination of genetic material on the two chromosomes. Mutation results in alternation of DNA sequences and consequently results in change in the genotype and the phenotype of an organism. In addition to recombination, mutation is another phenomenon that leads to variation in DNA.
23. (b) Chemoheterotrophs were first organisms. They were prokaryotic like bacteria, anaerobes, as molecular oxygen was absent. They obtained energy by fermentation of some of the organic molecules present in the broth. Thus they absorbed organic molecules from outside for body building and energy.
    - Chemoautotrophs - Organisms that are capable to synthesize organic molecules from inorganic molecules.
      E.g., Nitrifying bacteria, sulphur reducing bacteria etc.
    - Autotrophs are photosynthesizing plants / organisms.
24. (d) The most significant trend in evolution of modern man (*Homo sapiens*) from his ancestors is development of brain capacity.

CHAPTER

6 Biology in Human Welfare

- The strategies for enhancement in food production aim at
  - increasing the amount of food obtained from animals.
  - increasing the yield of agricultural crops.

Animal Husbandry

- Animal husbandry deals with the care, breeding & management of domesticated animals that are useful to humans.

Poultry Farming

- Poultry is a rearing of domesticated fowls (chickens), ducks, geese, turkeys, guinea fowls and pigeons.
- Poultry birds exclusively grown for meat are called **broilers, layers** are for egg production, **cockerel** for young male fowls and **rooster** are mature male fowls.

Fisheries

- **Pisciculture** is the rearing, breeding and catching of fishes.
- **Aquaculture** is rearing and management of useful aquatic plants and animals like fishes, oysters, mussels and prawns, etc.

Bee keeping or Apiculture

- Apiculture is rearing and breeding of honeybees for the production of honey.
- The commonest species of honeybee is *Apis indica*.

Animal Breeding

- Animal breeding is the production of new breeds of domesticated animals with improved traits.
  - **Inbreeding :** Mating between the closely related animals of same breed.
  - **Out-breeding :** Mating between the animals which are not closely related.
  - **Out-crossing :** Mating between the animals of the same breed which do not have a common ancestor.
  - **Cross-breeding :** Mating between the superior animals of different breeds of the same species.
- **MOET (Multiple Ovulation Embryo Transfer)** technique is a programme which improves the chances of successful production of hybrids.

Plant Breeding

- **Plant breeding** refers to the modification and improvement of genetic material of plants resulting in the development of crops which are more beneficial to human beings.

	Crop	Variety	Resistance to diseases
1.	Wheat	Himgiri	Hill bunt & leaf and stripe rust
2.	Cauliflower	Pusa snowball K-1 Pusa shubra	Blight black rot Black rot and curl
3.	*Brassica*	Pusa Swarnim (Karan rai)	White rust
4.	Cowpea	Pusa Komal	Bacterial blight
5.	Chilli	Pusa Sadabahar	Chilly mosaic virus, Tobacco mosaic virus and leaf curl.

Table : Crop varieties bred by hybridization and selection for disease resistance to fungi, bacteria and viral disease.

- Examples of insect pest resistance crops bred by hybridization are
  (i) **Pusa Gaurav** variety of *Brassica* is resistant to aphids.
  (ii) **Pusa Sawani and Pusa A-4** varieties of Okra (Bhindi) are resistant to shoot and fruit borer.
  (iii) **Pusa sem 2** and **Pusa sem 3** varieties of flat bean are resistance to aphids and fruit borer.

Single Cell Protein (SCP)

- Single cell protein refers to the dried microbial cells or total protein extracted from pure microbial cell culture (algae, bacteria, yeasts and filamentous fungi) which can be used as food supplement to humans or animals.

Tissue Culture

- Plant cells and plant organs can be cultured *in vitro* (e.g., in test tube or any other container) on a suitable medium (*e.g.*, agar medium), is called plant tissue culture.
- A plant part excised from its original location and used for initiating a culture is known as **explant**. The explants, media, vessels and instruments used in tissue culture must be sterilised to make them free from any microbes.

Microbes in Human Welfare

- Microbes can be grown on culture nutritive media to form colonies which are used for mass production of certain desirable products and for scientific study of metabolism, genetics and structure of micro-organisms.

Lactobacillus lacti : Milk fermentation
Lactobacillus acidophilus : Cheese production
Streptococcus thermophilus : Yoghurt production

Streptokinase –	*Streptococcus*	Dissolution of blood clots
Streptodornase		
Insulin, Interferon	Recombinant DNA variety of *E. coli*	Human therapy
• Baker's yeast, beer, wine, bread	*Saccharomyces cerevisiae*	Baking and brewing industry
• SCP [single cell protein]	*S. lipolytica*	Food supplement
• Citric acid	*Aspergillus niger*	Food product preservative
• Invertase	*Mucor*	Preparation of adhesives, candy making

- **Antibiotics** are chemical substances, which are produced by some microbes and can kill or retard growth of other disease causing microbes.
- **Alexander Flemming** while working on *Staphylococci* plates observed that in one of unwashed culture plate, it could not grow because of chemical produced by mould *Penicillium notatum* grown on it which produces chemical **penicillin**.

Microbes in Production of Biogas

- Produced by **methanogens**, which are anaerobic bacteria growing on cellulosic material and produce large amount of methane alongwith CO_2 and H_2 *e.g.*, *Methanococcus, Methanobacterium.*
- ***Bt* Cotton** is genetically modified cotton having *Bacillus thuringiensis* genes. Bacterium *Bacillus thuringiensis* (*Bt*) is used as microbial control agent in order to control butterfly caterpillars.

Microbe as Biofertilisers

- ***Rhizobium*** species in root nodules of leguminous plant.
- *Azospirillium* and *Azotobacter* are free living species in soil.
- Cyanobacteria such as *Anabaena*, *Nostoc* and *Oscillatoria* (autotrophic micorbes) in paddy field.

Biotechnology

- It deals with large scale production and marketing of products and processes using living organisms, cells or enzymes.
- **Examples of Biotechnology** are GMO [Genetically modified organisms], IVF (*in vitro* fertilization), Test tube babies, DNA vaccines and gene therapy.
- **Genetic engineering** can be defined as the generation of new combination of heritable material by the insertion of desired genes or DNA sequences, produced by whatever means outside the cell, into any carrier system so as to allow their incorporation into a host organism in which they do not normally occur but in which they are able to perform normal behaviour and propagation.
- **Three techniques** of genetic engineering are:
  (i) rDNA (recombinant DNA technology)
  (ii) Gene cloning/gene amplification
  (iii) Gene therapy
- **Tools of (recombinant DNA technology) rDNA** technology are
  (i) Vector – Plasmid, Bacteriophage, Cosmid, BAC, YAC
  (ii) Host – with Ori C [origin of replication]
  (iii) Restriction endonuclease – with well defined recognition site
- **Vectors** are cloning vehicles required to transfer DNA of interest from one organism to another.
- **Plasmids** are extra-chromosomal, circular, double stranded autonomously replicating sequence in bacterial cell.
- **Bacteriophage** is virus which infect bacteria. They have special sticky "*cos*" site to accept foreign DNA.
- **Cosmid** can be defined as the hybrid vectors derived from plasmids which contain *cos* site of phage 1.
- **BAC** (Bacterial Artificial Chromosome) : Episome + Foreign DNA.
- **YAC** (Yeast Artificial Chromosome) : Yeast DNA + Marker gene from competent bacteria.
- **Marker sequences** are the ones whose phenotype gives observable change, *e.g.*, Tetracycline resistance gene, alcohol fermentation gene.
- **Palindromic** sequence are the ones which read same in one orientation on both the strands.
  For e.g., 5' — GAATTC — 3'
  3' — CTTAAG — 5'
  is palindrome as it reads same on both strand in 5' → 3' direction. Same is true for 3' → 5' direction.

Restriction Enzymes

- Enzymes that recognizes a specific sequence of double stranded DNA and cut the DNA at that site are called **restriction enzymes**. They are often referred as **molecular scissors**.
- **Restriction endonuclease** was found by **Arber** in 1963 in bacteria. First was *EcoRI* found in colon bacterium ***Escherichia coli***. Recognition sequence of *EcoRI* is 5' — GAATTC — 3'.
- ***Agrobacterium tumefaciens*** is cloning vector for plants which is **T-DNA** (transforming DNA) to transform normal plant cell into tumour and direct them to form mass of cells called **galls** which start secreting chemical required by bacteria.

Applications of Biotechnology are

- GM crop production
- Transgenics < Animals / Plants
- Therapeutics
- Gene therapy
- Molecular diagnosis

GM Crop Production – Genetically Modified Crop

(i) Purpose of introduction of GM crop was to minimise use of fertilisers and chemicals so that their harmful effect on environment could be reduced.

(iii) Examples GM crops are **Bt cotton** and **Pest resistant plants.**

Bt cotton : It is a pest resistant plant which resist attack of *Lepidopterans* insects. The plant Bt toxin gene which cause death of insect larvae by causing cell lysis and swelling of epithelium of midgut.

- *Bt* toxin is biologically produced by bacterium called *Bacillus thuringiensis* (*Bt*). This toxin is insecticidal protein crystal produced in bacteria (inactive form in bacteria) during a particular phase of growth.
- Transgenic plants are organisms containing a foreign gene from a different species received by genetic engineering .
- **Examples of Transgenic plants are**

Transgenic plants	Character introduced
Flavr savr tomato	Long shelf life
Soyabean, corn	Herbicide tolerance
Brinjal, tomato	Insect resistance
Tobacco, potato	Viral resistance
Golden rice	Rich in vitamin A

Therapeutics

Insulin production

- Insulin is a hormone used for diabetics patient.
- Insulin was extracted from pancreas of cattle, pigs in limited quantity.
- **PCR** is a gene amplification technique that has found wide spread use in medicine & molecular biology.
- **ELISA** is a laboratory test, which can quickly determine antigen or antibody levels in blood or other fluids.
- A single stranded DNA/RNA attached with radioactive molecule is called **molecular probe**. Molecular probe are used for detection of gene by complementary hybridising in cloned cell, followed by **autoradiography**.

Biopiracy

- **Biopiracy** is use of bioresource by multinational companies and other organisation without proper authorization from countries and people concerned without compensatory payment.

EXERCISE

1. The animal husbandry deals with the care, breeding and management of
   (a) Domesticated animals
   (b) Fishes
   (c) Honey bees and silk worms
   (d) All of these
2. Murrah, Mehsana, Jaffarbadi are breeds of
   (a) Buffalo (b) Cow
   (c) Cattle (d) Horse
3. The most common species for bee-keeping in India is
   (a) *Apis florae* (b) *Apis mellifera*
   (c) *Apis dorsata* (d) *Apis indica*
4. Blue revolution is related to the following field
   (a) Dairy products (b) Fisheries
   (c) Egg production (d) Agriculture
5. Three crops that contribute maximum to global food grain production are
   (a) Wheat, rice and maize
   (b) Wheat, rice and barley
   (c) Wheat, maize and sorghum
   (d) Rice, maize and sorghum
6. Jaya and Ratna developed for green revolution in India are the varieties of
   (a) maize (b) rice
   (c) wheat (d) bajra
7. Yeast *Saccharomyces cervisiae* is used in the industrial production of
   (a) butanol (b) citric acid
   (c) tetracycline (d) ethanol
8. Most of eubacterial antibiotics are obtained from
   (a) *Rhizobium* (b) *Bacillus*
   (c) *Streptomyces* (d) *Cephalosporium*
9. Which gas is responsible for the puffed-up appearance of dough ?
   (a) CO_2 (b) O_2
   (c) SO_2 (d) NO_2
10. Streptokinase which is used as a 'clot buster' obtained from
    (a) *Streptococcus* (b) *Staphylococcus*
    (c) *Lactobacillus* (d) *Saccharomyces*
11. Ganga and Yamuna action plan is initiated by
    (a) Ministry of environment and forest.
    (b) Ministry of agriculture.
    (c) Ministry of wild-life conservation.
    (d) None of these
12. BOD refers to
    (a) Bacteria Oxygen Demand
    (b) Biochemical Oxygen Demand
    (c) Biochemical Operation Demand
    (d) Biological Organism Demand
13. The technology of biogas production was developed in India mainly due to the efforts of
    (a) Indian Agricultural/ Research Institute (IARI) and Khadi and Village Industries Commission (KVIC)
    (b) National Botanical Research Institute (NBR1)
    (c) Indian Council of Medical Research (ICMR)
    (d) Indian Council of Agricultural Research (ICAR)
14. Cheese and Yogurt are products obtained by
    (a) distillation (b) pasteurization
    (c) fermentation (d) dehydration
15. Two microbes found to be very useful in genetic engineering are
    (a) *Vibrio cholerae* and a tailed bacteriophage
    (b) *Diplococcus* sp. and *Pseudomonas* sp.
    (c) Crown gall bacterium and *Caenorhabditis elegans*
    (d) *Escherichia coli* and *Agrobacterium tumefaciens*

16. Domestication of honey bees is called
(a) Sericulture (b) Apiculture
(c) Tissue culture (d) Pisciculture

17. Silk worm is a
(a) fly (b) worm
(c) moth (d) beetle

18. Which one of the following statement is true?
(a) The greater the BOD of waste water, more is its polluting potential.
(b) The greater the BOD of waste water, less is its polluting potential.
(c) The lesser the BOD of waste water, more is its polluting potential.
(d) The lesser the BOD of waste water, less is its polluting potential.

19. The example of non-renewable source of energy is
(a) alcohol fuel (b) petroleum
(c) biogas (d) fuel wood

20. The term antibiotic was coined by
(a) Alexander Flemming
(b) S. Waksman
(c) Louis Pasteur
(d) Edward Jenner

21. Important objective of biotechnology in agriculture section is
(a) to produce pest resistant varieties of plant
(b) to increase the nitrogen content
(c) to decrease the seed number
(d) to increase the plant weight

22. Which of the following is the pair of biofertilizers?
(a) *Azolla* and blue green algae
(b) *Nostoc* and legume
(c) *Rhizobium* and grasses
(d) *Salmonella* and *E. coli*

23. First cloned animal
(a) Dolly sheep (b) Polly sheep
(c) Molly sheep (d) Dog

24. Which one of the following is not an antibiotic ?
(a) Streptomycin
(b) Citric acid
(c) Griseofulvin
(d) Cephalosporin

25. *Jatropha* is a
(a) biodiesel crop
(b) biopetro crop
(c) fibre crop
(d) food crop

26. IPM is
(a) International Pest Management Programme.
(b) International Pesticide Management Programme.
(c) Integrated Pest Management Programme.
(d) Internal Pest Management Programme.

27. What are the advantage of gobar gas over conventional utilization?
(a) More efficient source of energy
(b) Used as good fertilizer
(c) Reduces the chances of spreading of pathogens
(d) All of the above

28. Organic farming is the technique of raising crops through use of
(a) Manures (b) Resistant varieties
(c) Biofertilisers (d) All of these

29. Chemically, the silk is
(a) Cellulose (b) Resin
(c) Protein (d) Lipid

30. Biogas consists of
(a) carbon monoxide, methane and hydrogen.
(b) carbon dioxide, methane and hydrogen.
(c) carbon monoxide, ethane and hydrogen.
(d) carbon dioxide, ethane and hydrogen.

ANSWER KEY											
1	(d)	**6**	(b)	**11**	(a)	**16**	(b)	**21**	(a)	**26**	(c)
2	(a)	**7**	(d)	**12**	(b)	**17**	(c)	**22**	(a)	**27**	(d)
3	(d)	**8**	(b)	**13**	(a)	**18**	(a)	**23**	(a)	**28**	(d)
4	(b)	**9**	(a)	**14**	(c)	**19**	(b)	**24**	(b)	**29**	(c)
5	(a)	**10**	(a)	**15**	(d)	**20**	(b)	**25**	(a)	**30**	(b)

HINTS AND SOLUTIONS

5. (a) Three crops that contribute maximum to global food grain production are wheat, rice and maize, which belong to the family *Poaceae* (*Graminae*).

6. (b) Jaya and Ratna are two rice varieties developed for green revolution in India.

7. (d) Commercial ethanol or ethyl alcohol is produced by yeast *Saccharomyces cerevisiae.*

8. (b) *Bacillus subtilis* is used to extract antibiotics substilin or Bacitracin.

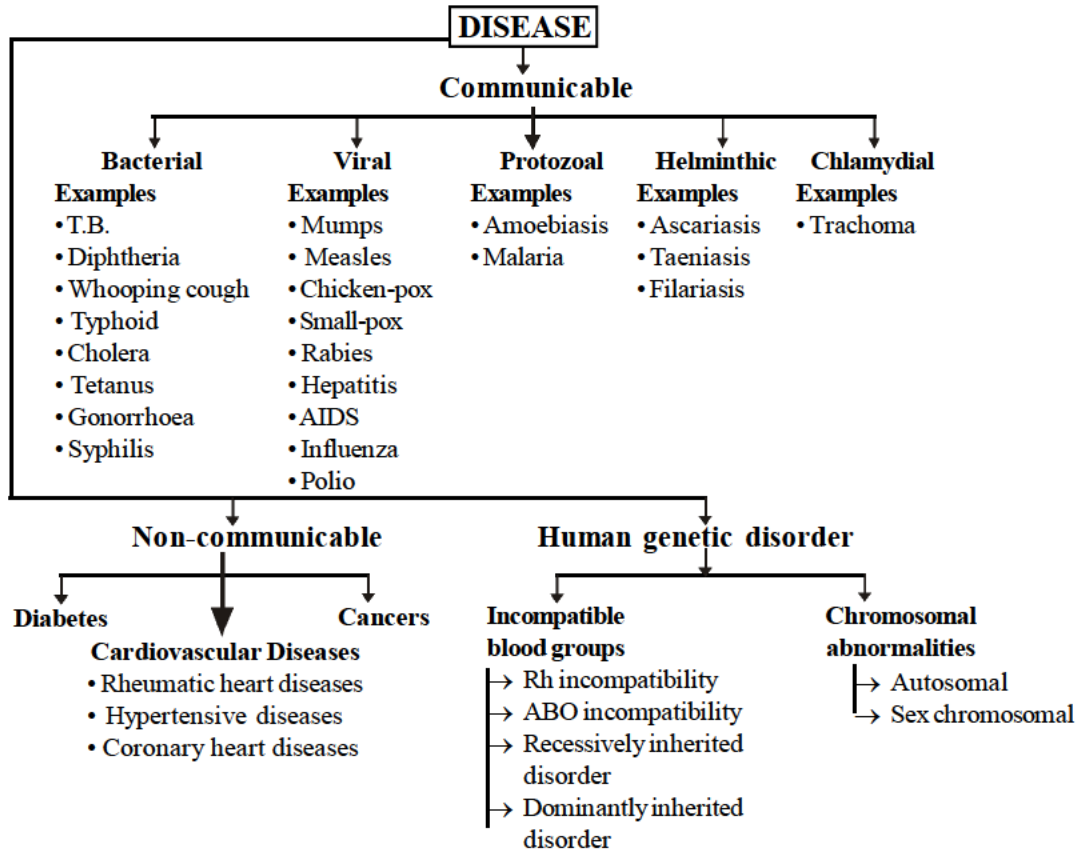
15. (d) *Escherichia coli* is a bacterium found in human colon. On this bacterium scientists have made extensive genetic experiments to make some vital chemicals like insulin. Another bacterium is *Agrobacterium tumefaciens* which causes crown gall in plants. It is extensively used for genetic experiments.

25. (a) *Jatropha* is a genus of flowering plants in the spurge family, euphorbiaceae. Currently the oil from *Jatropha curcas* seeds is used for making biodiesel fuel in Phillippines and in Brazil.

CHAPTER

7 Diseases and their Defence Mechanism

- **Health** is a state of complete physical, social and mental well being and not merely the absence of disease or infirmity.
- **Disease** is any condition which interferes with the normal structure and function of the body that is manifested by a characteristics sets of symptoms and sign.



Bacterial Diseases

- **Typhoid :** Typhoid is caused by *Salmonella typhi*. Typhoid spreads through food, milk and water contaminated with intestinal discharges either directly or through flies and personal hygiene. Typhoid is diagonsed with **widal test**.
- **Pneumonia :** It is caused by *Streptococcus pneumonia* or *Haemophilus influenza*. It infects alveoli of lungs and spread by coughs, sneezes, by sharing drinking glasses and eating utensils with an infected person and contact with used tissue or handkerchiefs.

Viral Diseases

- Rhinoviruses causes one of the most infectious disease called **common cold.** Rhinovirus is spread from one person to another by hand to hand contact or from one person sneezing close by another person.

Protozoan Diseases

Malaria : It is caused by *Plasmodium* species & spread through female *Anopheles* mosquito. Primary host are female mosquito of genus *Anopheles* and humans acts as intermediate host.

- Malaria result in anaemia, toxaemia and splenomegaly (enlarged spleen).
- *Plasmodium* enters the human body as sporozoites (**infectious form**) through the bite of infected female *Anopheles* mosquito. *Plasmodium* sporozoites enters the bloodstream and travel to liver where they divide repeatedly & other attack the red blood cells resulting in their rupture.

Amoebic Dysentery or Amoebiasis

- It is caused by *Entamoeba histolytica*. It is a protozoan parasite in the large intestine of human.

Helminthic Diseases

Filariasis

- Filariasis is caused by *Wuchereria bancrofti*.

Fungal Diseases

- Fungi causes diseases and these are known as **mycosis**.
- *Microsporum*, *Trichophyton* and *Epidermo-phyton* are responsible for ringworms, which is characterized by appearance of dry scaly lesions of the skin, nails and scalps.

Sexually Transmitted Diseases

- Sexually transmitted diseases (STDs) are a group of communicable diseases that are transmitted mainly by sexual contact. STDs are caused by a wide range of bacterial, viral, protozoal and fungal agents.

STDs	Pathogen
Syphilis	*Treponema pallidum* (bacterium)
Gonorrhoea	*Neisseria gonorrhoeae* (bacterium)
Vaginitis	*Candida albicans* (fungus)
AIDS	Human immunodeficiency virus (virus)

Diabetes mellitus

- It is caused by the deficiency of insulin hormone and is characterized by excessive concentration of sugar in the blood and urine. **Diabetes insipidus**, on the other hand, is characterized by excessive urination, urine being sugar-free and is caused by the deficiency of ADH.

Cancer

- **Cancer** is not inheritable.
- The non-regulated growth of the cells that accompanies cellular transformation produces **tumours or neoplasms**, each tumour being the product of proliferation of a single abnormal cell.
- Tumours are of two types – **benign** and **malignant**.
- **Benign tumour** cells is a large localized mass of abnormal tissue enclosed in connective tissue which does not spread to distant sites.
- **Malignant tumour** cells are cancer cells that spread to and take up residence in neighbouring tissues - a condition called **metastasis**.
- Agents that cause cancers are called **carcinogens**. UV radiations, smoking, mustard gas, soot, viruses, coal tar, aflatoxins and industrial pollutants are known to be carcinogenic.
- **Cancer can be detected by**
  - biopsy and histopathological studies of the tissue.
  - blood and bone marrow tests for increased cell counts as in Leukaemia.
  - use of techniques like radiography, magnetic resonance imaging (MRI) and computed tomography (CT) for cancer of internal organs.

Treatment of Cancer

- Therapy used in the treatment of cancer are surgery, radiotherapy, chemotherapy, immuno-therapy, hormonal therapy, etc.

AIDS

- **AIDS** is caused by Human Immunodeficiency Virus (HIV) which is retrovirus.

Life Cycle of HIV

- The virus after getting into the body of a person, enters the macrophages.
- The person becomes easily infected by bacteria like mycobacterium, viruses and even parasites like *Toxoplasma*.
- The person is unable to protect himself/herself against any infection.
- AIDS is diagnosed by **ELISA** (Enzyme Linked Immunosorbent Assay).

Prevention of AIDS

- World Health Organisation (WHO) has started a number of programmes to prevent spreading HIV infection; some such steps include :
  - ensuring use of disposable needles and syringes.
  - checking blood for HIV.
  - free distributions of condoms and advocating safe sex.
  - controlling drug abuse.
  - promoting regular check-up for HIV in susceptible populations, etc.
- Treatment with anti-retroviral drugs is only partially effective; they can only prolong the life of the patient and cannot prevent death.

Immunity

- The term **immunity** refers to the specific resistance exhibited by the host towards infections by micro-organisms (pathogens) and their products.

Innate or Natural Immunity

- **Innate immunity** is developed in an individual without having the disease or immunization, *e.g.*, recreation of sweat glands contain certain chemical substances which prevent the entry of micro-organisms.
- It is present from birth.
- It is the general defence of body including the following four mechanism —
  (i) *Phagocytosis* of invaders by leucocytes and macrophages (called *cellular barrier*).
  (ii) Resistance of skin to invading micro-organisms (called *physical barrier*).
  (iii) Destruction of micro-organisms swallowed with food by the HCl of gastric juice & by digestive enzymes and tear from eye (called *physiological barriers*).
  (iv) Virus infected cells secrete proteins (called interferons) which protect non-infected cells from further viral infection (*cytokine barriers*)

Acquired Immunity

- It is a third line defence and developed by an animal in response to a disease caused by infections of microbes.
- The resistance against infectious disease that an individual acquires during life is known as **acquired immunity.**

Antibody Mediated Immunity

- B cells produce specialized proteins called antibodies (immunoglobulin) which are glycoproteins.

Classification of Antibodies :

(a) **Ig A** – Protects from inhaled or ingested pathogens.
(b) **Ig D** – Present on lymphocyte surface as receptors, activation of B cells.
(c) **Ig E** – Mediator in allergic response.

(d) **Ig G** – Stimulation of phagocytes and complement system, passive immunity to foetus.

(e) **Ig M** – Activation of B cells.

Immunization

- Inoculation of vaccines to prevent diseases is called **immunization**.
- **Vaccines** are preparations of living or killed micro-organisms or their products. Vaccines are of two types – live vaccines and killed vaccines.
- **Genetic vaccines** involve one or more genes from diseases carrying agent (pathogen) and splicing these gene into plasmids (closed rings of DNA). These rings are then delivered into small groups of cell, often by infection into muscle cells or by propulsion into *via* so called '**gene gun**'.

Allergy and Autoimmunity

- Allergy is an important side effect of immunity.
- Autoimmune disease result when the immune system attack and destroys 'self' cells and molecules. Eg., rheumatoid arthritis.

Drugs and Alcohol Abuse

Major groups of psychotrophic drugs, their examples and effects

Types of drug	Examples	Effects
1. Sedatives and transquilizers (depressants)	Benzodiazephines (*e.g.* Valium), Barbiturates	(i) Depress brain activity (ii) Produce feelings of calmness, relaxation, and drowsiness
2. Opiate narcotics	Opium, Morphine, Heroin, Penthidine, Methadone	(i) Suppress brain function (ii) Relieve intense pain (iii) Causes loss of weight, sterility and lack of interest in work.
3. Stimulants	Caffeine (very mild), Cocaine, Amphetamines	(i) Stimulates the nervous system (ii) Make a person more wakeful (iii) Increase alertness and activity (iv) Produce excitement
4. Hallucinogens	LSD, Marijuana, Charas, Bhang, Hashish	(i) Alter thoughts, feelings and perceptions.

EXERCISE

1. Vaccines are
   (a) treated bacteria or viruses or one of their proteins
   (b) MHC (major histocompatibility complex) proteins
   (c) curative medicines
   (d) monoclonal antibodies
2. Which of the following is a sexually transmitted disease ?
   (a) Q fever (b) Leprosy
   (c) Whooping cough (d) Gonorrhoea
3. Which of the following is a pair of viral diseases?
   (a) Common cold, AIDS (b) Dysentery, common cold
   (c) Typhoid, tuberculosis (d) Ringworm, AIDS
4. Which of the following is most infectious disease?
   (a) Hepatitis - B (b) AIDS
   (c) Amoebiosis (d) Malaria
5. The formation of antibodies within our body is called
   (a) active immuntiy (b) passive immunity
   (c) innate immunity (d) acquired immunity
6. 'Malaria' a common disease world wide is caused by a
   (a) bacterium (b) virion
   (c) protozoa (d) fungi
7. Which of the following diseases is due to an allergic reaction?
   (a) Goitre (b) Skin cancer
   (c) Hay fever (d) Enteric fever
8. Which immunoglobin (Ig) is produced in primary immune response?
   (a) IgA (b) IgE
   (c) IgG (d) IgM
9. Expand ELISA
   (a) Enzyme Linked Immuno - Sorbent Assay
   (b) Enzyme Linked Ion Sorbent Assay
   (c) Enzyme Linked Inductive Assay
   (d) None of the above
10. Which one of the following is an Indian medicinal plant ?
    (a) *Saccharum officinarum*
    (b) *Rauwolfia serpentina*
    (c) *Oryza sativa*
    (d) *Solanum melongena*
11. AIDS is caused by HIV that principally infects
    (a) all lymphocytes (b) activator B cells
    (c) cytotoxic T cells (d) T_4 lymphocytes
12. Widal test is used for the diagnosis of
    (a) malaria (b) pneumonia
    (c) tuberculosis (d) typhoid
13. Who invented vaccine for small pox ?
    (a) Robert Koch (b) Robert Hooke
    (c) Edward Jener (d) Louis Pasteur
14. Which of the following diseases is also known as infantile paralysis?
    (a) Lock jaw (b) Rabies
    (c) Polio (d) Chicken pox
15. Which of the following is not a communicable disease ?
    (a) Typhoid (b) Malaria
    (c) AIDS (d) Goitre

16. Against which of the following does *interferon* act ?
(a) Bacteria (b) Virus
(c) Fungi (d) Snake venom

17. Which of the following disease is a hormonal disorder ?
(a) Anaemia (b) Cholera
(c) Diabetes (d) Goitre

18. AIDS day is
(a) June 1 (b) May 1
(c) December 1 (d) December 20

19. Which one of the following pairs of disease can spread through blood transfusion?
(a) Cholera and hepatitis
(b) Hepatitis and AIDS
(c) Diabetes mellitus and malaria
(d) Hay fever and AIDS

20. Which of the following diseases is caused by Protozoa ?
(a) Chicken pox (b) Measles
(c) Filariasis (d) Sleeping sickness

21. Cancer of blood is called
(a) Leukemia (b) Lymphoma
(c) Sarcoma (d) Hybridoma

22. DPT vaccine is given for
(a) Tetanus, polio, plague
(b) Diptheria, whooping cough and leprosy
(c) Diptheria, pneumonia, tetanus
(d) Diptheria, whooping cough, tetanus

23. Which is an autoimmune disease?
(a) Cancer (b) Asthma
(c) *Erythroblastosis foetalis* (d) *Rheumatoid arthritis*

24. The jaundice is a physiological liver disease. It is caused by a
(a) Bacterium (b) Virus
(c) Protozoan (d) Helminth

25. A certain patient is suspected to be suffering from Acquired Immuno Deficiency Syndrome. Which diagnostic technique will you recommend for its detection?
(a) ELISA (b) MRI
(c) Ultra sound (d) Widal test

26. Tobacco smoke contains carbon monoxide which
(a) reduces the oxygen-carrying capacity of blood
(b) Causes gastric ulcers
(c) Raises blood pressure
(d) is carcinogenic

27. In persons addicted to alcohol, the liver gets damaged because it
(a) has to detoxify the alcohol
(b) stores excess of glycogen
(c) is over stimulated to secrete more bile
(d) accumulates excess of fats

28. Community health aims at
(a) better health and family planning
(b) better hygiene and clean environment
(c) removing communicable diseases
(d) All of the above

29. Tuberculosis is caused by
(a) Bacterium (b) Virus
(c) Protozoan (d) Malnutrition

30. 'Plague' is transmitted by
(a) House fly (b) Tse-tse fly
(c) Rat flea (d) Mosquito

31. 'Black death' is related with
(a) Plague (b) Cancer
(c) Tuberculosis (d) Measles

32. Cholera, leprosy and diptheria are
(a) Bacteria diseases (b) Viral diseases
(c) Fungal diseases (d) Functional diseases

33. The group of diseases spread by houseflies is
(a) Malaria, Cholera, Scabies
(b) Rabies, Rickets, Diarrhoea
(c) Typhoid, Dysentery, Tuberculosis
(d) Ringworm, Scurvy, Vomiting

34. Which of the following is a communicable disease?
(a) Leucoderma (white patches on the skin)
(b) Diabetes mellitus
(c) Beri-beri
(d) Dysentery

35. Which scientist is credited with the development of medical vaccinations?
(a) Robert Koch (b) Charles Darwin
(c) Edward Jenner (d) William Harvey

ANSWER KEY

1	(a)	**6**	(c)	**11**	(d)	**16**	(b)	**21**	(a)	**26**	(a)	**31**	(a)
2	(d)	**7**	(c)	**12**	(d)	**17**	(c)	**22**	(d)	**27**	(c)	**32**	(a)
3	(a)	**8**	(d)	**13**	(c)	**18**	(c)	**23**	(c)	**28**	(d)	**33**	(c)
4	(a)	**9**	(a)	**14**	(c)	**19**	(b)	**24**	(a)	**29**	(a)	**34**	(a)
5	(a)	**10**	(b)	**15**	(d)	**20**	(d)	**25**	(a)	**30**	(c)	**35**	(c)

HINTS AND SOLUTIONS

1. (a) Vaccine contains dead, attenuated form or antigen of a pathogen which can be injected to provide immunity towards that pathogen. Monoclonal antibodies are homogenous immunological reagents of defined specificity, so that these can be utilized for diagnosis and screening with certainty.
2. (d) A common sexually transmitted disease most often affecting the genitourinary tract and occasionally, the pharynx, conjuctiva, or rectum.
4. (a) We know that HBV causes serum hepatitis. It is most frequently transmitted by blood or by blood contaminated instruments.
7. (c) Hay fever is due to some fungal spores sensitivity, which is an allergic disease with symptoms of bronchial asthma and skin rashes and also with increase in eosinophil (white cells) of blood.
10. (b) *Rauwolfia serpentina* belong to family Apocynaceae, its roots yield a chemical useful for high blood pressure.
11. (d) AIDS virus infects T_4 lymphocytes (also called Helper cells). Cytotoxic T cells called T_8 lymphocytes.
12. (d) Widal test is used for the diagnosis of typhoid. It is an agglutination test for the presence of antibodies against the *Salmonella* organisms, which cause typhoid fever.
13. (c) Edward Jenner is known as father of Immunology.
14. (c) Polio results in paralysis of limbs in infants.
15. (d) Goitre is caused due to deficiency of Iodine.
16. (b) The host cell invaded by a virus produces an antiviral protein called interferon which prevents the viral multiplication.
17. (c) Diabetes is caused due to increased glucose level in blood when insulin is not produced by pancreas in required amount.
20. (d) Sleeping sickness is caused by *Trypanosoma*.
25. (a) ELISA is an fundamental tool of clinical immunology and is used as an initial screen for HIV detection.
35. (c) Edward Jenner was the first person to vaccinate people against disease.

CHAPTER

8 Ecology and Environment Awareness

- The idea about ecology was first started by **Reiter**.
- The term ecology was given and defined by **Haeckel** as **Ecology** is the study of the interactions between the organism and their environment.
- **Population :** The collection of individuals of a given species is called population.
- **Community :** The interacting groups of populations of various species constitute a community.
- **Ecosystem :** A biological community and the physical environment associated with its constitute ecosystem.
- **Biome :** A major ecological community or complex of communities that extends over a large geographical area.
- **Species** is a group of organisms that resembles each other more than they resemble to any other organism, and that can breed among themselves and produces fertile offspring.
- **Habitat :** It is a specific place or locality where an organism lives.
- **Ecotone :** It is the marginal vegetation present in between two well established habitat.
- **Environment :** It is the sum total of physical and biotic conditions influencing the behaviour of the organism.
- **Atmosphere :** The multilayered gaseous envelope. It is divided into 5 distinct layers troposphere, stratosphere, mesosphere, ionosphere & exosphere.

Water Resource : It is the major component of the **hydrosphere** and covers about $3/4^{th}$ of the earth's surface.

- Out of this 97% is sea water which cannot be used directly. Only 3% is fresh water.
- Out of 3% about 77% is stored in ice caps, about 22.5% is ground water. Only about 0.5% is present in river & lakes which is available for direct use.
- Aquatic animals which can tolerate only a narrow range of salinity are called **stenohaline**.
- Aquatic organisms having wide range of salt tolerance are called **euryhaline**.

Soil : Soil is a mixture of inorganic mineral particles derived from weathering of rock and organic matter consisting of humus.

- **On the basis of the size of particles, soil is of following types :**
  (i) Clay - upto .062 mm (ii) Silt - .002 to .02 mm
  (iii) Fine sand - .02 to .2 mm (iv) Coarse sand - .2 to 2 mm
  (v) Fine gravel - 2 to 5 mm (vi) Coarse gravel - 5 and more
- **Population :** It is the total number of individual of a particular species inhabiting a particular area at a particular time.
- **Demography :** Study of population.

Population Characteristics

(1) Population density : It is number of individuals per unit area of environment.

(2) Natality : This is addition of individuals in a population due to birth.

(3) Mortality : It is the rate of death of individuals in a given population.

(4) Population Dispersion

(i) **Emigration** - One way outward movement.
(ii) **Immigration** - One way inward movement.
(iii) **Migration** : It is a cyclical movement with respect to and weather that during life history of an animal at definite intervals, and always includes a return trip from where it began.

(5) Age Structure : The proportion of individuals of various age group in a population forms the age structure.
Pre reproductive > Reproductive > Post reproductive $\rightarrow$ Expanding population
Pre reproductive = Reproductive > Post reproductive $\rightarrow$ Stable population
Pre reproductive < Reproductive < Post reproductive $\rightarrow$ Decline population.

(6) Biotic Potential : The inherent maximum capacity of an organism to reproduce or increase in number is termed as biotic potential. Nature keeps a check on it.

- **Carrying Capacity :** The maximum population size that can be supported by the environment is called carrying capacity.
- **Population growth :** Current population – Initial population + Birth + Immigration – Death – Emigration.

There are two main type of population growth forms

(1) J - Shaped : The population values when plotted against time gives a J - shaped growth curve, and at the peak of the population, growth ceases abruptly due to environmental resistance.

(2) Sigmoid or S-Shaped form : It shows an initial gradual increase in the population size and then it accelerates and finally slows to a nearly constant level.

Biological Interactions

Amensalism : It is a relationship in which one species is harmed whereas the other is unaffected.

Competition : It is best defined as a process in which the fitness of one species is significantly lower in the presence of another species.

Parasitism : Parasitism is a relationship between two species in which one benefits on the host (harm) of the other. It is always an one side relationship for the parasite which is always benefitted from the host.

Commensalism : The interaction in which one species benefits and the other is neither harmed nor benefited is known as **commensalism**.

Mutualism : Mutualism interaction is a positive reciprocal relationship between two different species. *Anabaena* (a nitrogen fixing blue green alga) is associated with water fern *Azolla*.

Predation : Predation is an interaction between members in which one population adversely affects the other by direct attack (capture, kill and eat) but is nevertheless dependent on other. The former is called **predators** & the latter is called **prey**

Structure of Ecosystem

A. Abiotic Components
- (a) Climatic conditions - Soil, temp, light, water.
- (b) Inorganic substances - Nitrogen, sulphur, phosphorus
- (c) Organic substances - Carbohydrate, protein, lipid.

B. Biotic Components
- (a) **Producers :** The organism which produce their own food. Herbs, shrubs, tree, Phytoplanktons, etc.
- (b) **Consumers :** They are the phagocytic heterotrophs which depend for their nutrition on the organic manufactured by producers, the green plants. They are of following 3 types :
- (i) Herbivores (Primary Consumers) - These animals feed directly on living plants or plant remains.
- (ii) Carnivore order - 1 (Secondary Consumers) - These carnivores feed on herbivores, *e.g.* frog, fish.
- (iii) Carnivore order - 2 (Tertiary Consumers) - These are carnivores feeding on other carnivores. (Eagle feeding on snake)
- (c) **Decomposers :** They bring about the decomposition of dead organic matter of producers as well as consumers. They help in returning the mineral elements to the abiotic phase and help in continuing biogeochemical cycle, *e.g.* - bacteria, fungi.

Productivity : The rate of production *i.e.* the amount of organic matter accumulated in any unit time. It is of following types :

(A) Primary Productivity : The rate at which radiant energy is stored by producers.
- (i) Gross Primary Productivity - It refers to the total rate of photosynthesis including the organic matter used up in respiration.
- (ii) Net Primary Productivity - It is the rate of storage of organic matter in plant tissue in excess of the respiratory utilization.

(B) Secondary Productivity : It is the rate of energy storage at consumer's level - herbivores, carnivores & decomposers.

(C) Net Productivity : It is the rate of storage of organic matter not used by heterotrophs or consumers, *i.e.* equivalent to net primary production minus consumption by the heterotrophs during unit period (year).

Energy Flow

Food Chains : The pattern of eating & being eaten forms a linear chain called food chain, which can always be traced back to the producers. Each step of food chain is known as trophic level. (Plants - 1^{st} trophic level)

Producers → Herbivores → Small fish → Large fish

Plants → Grasshopper → Lizard → Hawk

Ecological Pyramids : Concept of ecological pyramid was given by **Elton**.

- There occurs a regular pattern of change in the properties (like number, energy and biomass) of the organisms across different trophic level. It is the graphical representation of food chain.

Types of Ecological Pyramid

1. Pyramid of Number - upright or inverted
2. Pyramid of Biomass - upright or inverted
3. Pyramid of energy - Always upright

Lindeman's ten percent law : The food chain efficiency is only 10% *i.e.* the organism at a particular trophic level consumes 90% of the total energy which it receives from the preceeding trophic level and passes only the 10% remaining energy to the next level.

Ecological Succession

- It includes a series of changes that a biotic community undergoes in maturation towards a stable or climax condition.

Types of Succession

(1) Primary succession : If an area is colonized by organisms for the first time, the succession is called primary succession. Eg. - Newly exposed rock ; modified desert.

(2) Secondary succession : If succession starts on the area previously colonized, but has been cleared off by some environmental force (fire, flood, lightening), it is called secondary succession. Eg. - forest devastated by fire.

(3) Hydrarch : Succession which begins in water bodies like ponds.

(4) Xerarch : Successions initiated on bare rocks, sand dunes, rocky slopes etc. where there is extreme scarcity of water, are termed as xerarch.

Biodiversity

The sum total of all the species including plants, animals and micro-organisms on the earth.

The 3 richest region of biodiversity in India are :

(a) Western Ghats (b) North East (c) Kashmir.

Levels of Biodiversity

(1) Genetic Diversity : It refers to variations of genes within species.

(2) Species Diversity : It refers to variety of species per unit area.

(3) Community and ecosystem diversity : It has three perspectives
- (a) **Alpha diversity :** Diversity of organisms sharing the same community (intra community diversity).
- (b) **Beta diversity :** Diversity among the members of different communities. (inter community diversity).

(c) **Gamma diversity :** Diversity over the total landscape or geographical area.

- Biodiversity increases, as we move from high to low lattitude as (*i.e.*, from poles to equator).

Causes of Loss of Biodiversity

(i) **Natural extinction:** Some species disappear and are replaced by other species when environmental conditions change.

(ii) **Mass extinction:** Disappearance of large number of species because of some catastrophe.

(iii) **Anthropogenic extinction :** Disappearance or extinction of species due to human activity.

Conservation of Biodiversity

- There are 2 basic methods of biodiversity conservation:

(i) *In situ* (on site)

(ii) *Ex situ* (off site)

***In situ* conservation**

- Example of protected areas are National Park, wild life sancturies and biosphere reserve.

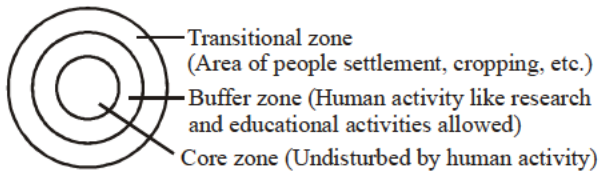
***Ex situ* conservation**

- *Ex situ* conservation includes botanical gardens, zoos, pollen seed, seedling, tissue culture and DNA banks.
- **Cryopreservation** is an *in vitro* conservation technique by which vegetatively propagated crops like potato are preserved in liquid nitrogen at a temperature of –196°C.
- **IUCN** and **WWF** are leading International Organisations concerned with biodiversity conservation.

Sanctuaries and National Parks : A sanctuary or a National park may be defined as an area declared by state, for the purpose of protecting, propagating or developing wild life therein, or it's natural environment for their scientific, educational & recreational value.

Biosphere Reserves : Launched in 1975 as a part of UNESCO's "Man & Biosphere" programme. They are special category of protected area wherein people are an integral component of the system.

- **It consists of 3 zones**



Pollution :

It is an undersirable change in physical, chemical or biological characteristics of environment which adversely affects the biological species including Man.

Waste products are of 2 categories

(1) **Biodegradable waste :** These are such waste substances which are acted upon by microorganisms and broken into simpler components. E.g. - Most of the organic waste.

(2) **Non - biodegradable waste :** These are such waste substances which are not acted upon by micro-organisms and remain in the same form for a long period of time. E.g. - Polythene, glass, DDT, etc.

Air Pollution

Imporrtant Air Pollutants and their Impact

(1) **SO_2, H_2S :** Lichens are most sensitive to SO_2. Eye irritation, destroys bronchial cilia. Causes acid rain thus decreasing the pH of soil.

(2) **Carbon Monoxide :** Reduces O_2 carrying capacity of blood by forming carboxy haemoglobin.

(3) **Nitrogen oxides :** Collapse of leaves. Nitrogen oxides reacts with hydrocarbons like methane, ethane, toluene, etc. to form peroxyacetyl nitrate or PAN ($C_2H_3O_5N$).

Photochemical smog : The mixture of PAN with ozone and various organic radicals.

(4) **Ozone :** $NO_2 \rightarrow NO + O$, $O_2 + O \rightarrow O_3$.

- Causes premature senescence in plants.
- Damage pulmonary organ in animals.

(5) **Cadmium**

- Causes cancer of liver and lungs.
- itai - itai (ouch ouch) disease (painful joints)

Water Pollution

- The term water pollution refers to any type of aquatic contamination between the following 2 extremes -
- A highly enriched, over productive biotic community, such as river or lake with nutrients from sewage or fertilizer (**cultural eutrophication**) or,
- A body of water poisoned by toxic chemicals which eliminate living organisms or even exclude all forms of life.

Causes of Water Pollution

(1) **Sewage**

(2) **Industrial waste**

(3) **Agrochemicals**

- **Methaemoglobinuria** or **Blue baby syndrome :** The surface run off water from agricultural fields contain high percentage of nitrates. When it enters the body of foetus, it reacts with the haemoglobin and forms methaemoglobin which has a highly reduced oxygen carrying capacity.
- Excess of fluoride - causes skeletal fluorosis (teeth and skeletal deformity)
- Arsenic - Black foot disease
- Mercury - Minimata disease (numbness of limbs, lips and tongue)

(4) **Thermal pollution or Calefaction :**

- The source is the heat from thermal & nuclear power plants.
- Gives thermal shocks which affect the aquatic life.

Biological Magnification (Amplification) : It is the increase in the effect of any non degradable chemical as it passes on in the food chain. E.g. - Polychlorinated biophenyl, DDT.

Biological (Biochemical) Oxygen Demand (BOD) : It is the measure of oxygen required by aerobic decomposers for biochemical degradation of organic materials (biodegradable) in water. This demand of oxygen is directly proportional to increasing input of organic wastes in water.

Noise Pollution

- Noise is an undesired sound. Sound pollution starts from 80 decibel.
- A constant exposure to noise level of 80 db causes : Mental irritation, Hypertension, Temporary deafness.

Organic farming

- Integrated approach, a cyclical, zero waste procedure, where waste products from one process are cycled in as nutrients for other processes. This allows maximum utilization of resource and increases efficiency of production.

Radioactive wastes

- This waste is generated as a result of generation of electricity from nuclear energy in nuclear reactors. Radiation emitted out by waste is lethal at high doses and cause mutation and genetic disorder at high doses which can be transmitted generation after generation.

Greenhouse Effect and Global Warming

- Greenhouse gases such as CO_2, CH_4, N_2O and CFC's present in atmosphere radiate part of radiowave radiations emitted by earth back to the earth. This downflux is called **greenhouse flux** which keeps the earth warm and phenomenon is called greenhouse effect.

Effect of Greenhouse Effect

- Temperature of earth has increased by 0.6°C in last 3 decades. This increase in temperature is leading to deleterious change in environment and resulting in climatic changes (**El Nino Effect**), leading to increased melting of polar ice caps as well as of other places like Himalayas snow caps.
- **CO_2 fertilization effect** – Increase in the growth rate of plants in response to elevated concentrations of CO_2 is known as carbondioxide fertilisation effect. **Kyotoprotocol** (1997) was signed to reduce the emission of green house gases. Under the protocol, industrialized countries as a whole will cut their overall CO_2 emission by at least 5.2% below 1990 level.

Global Warming

- The mean annual global temperature is 14°C. Any significant rise in this temperature is regarded as global warming. Major green house gases are CO_2, Methane, Chlorofluorocarbons (refrigerators, sprays), Nitrous oxide (NO_2).

Ozone Depletion

- Dobson unit is the unit for measurement of O_3 level in stratosphere.
  - 1 DV = 0.1 mm of compressed O_3 at NTP.
  - Normal O_3 level should be greater than 400 DV.

Major O_3 depleting substances

- Chlorofluorocarbon (C_1 component destroys O_3), Chloroform, CCl_4, Methane, N_2O (Nitrous oxide).
  - O_3 layer protects life from harmful U.V. radiations.
  - 3 forms of U.V. radiations :

  (a) U.V. C - 100 nm to 280 nm
  - Completely absorbed by O_3.

  (b) U.V. B - 280 nm to 315 nm
  - O_3 layer transforms it into infrared.
  - Thinning of O_3 layer leads to more penetration of U.V. B.

  Harmful impact of U.V. B :

  * Cataract * Skin Cancer (Melanoma)

  (c) U.V. A - 315 nm to 400 nm.
  - Reaches the surface of earth
  - harmless.
- **Montreal protocol** (1987) → Stop use of ozone depleting substances.
- **London protocol** (1990)
- **Chernobyl tragedy** - Radioactive pollution - Russia.

EXERCISE

1. The term 'Ecology' was coined by
   (a) Haeckel (b) Odum
   (c) Warming (d) Dudgeon
2. The age of pyramid with broad base indicates
   (a) high percentage of young individuals
   (b) low percentage of young individuals
   (c) high percentage of old individuals
   (d) low percentage of old individuals
3. Desert regions are characterized by ___ centimeters of rainfall per year.
   (a) less than 5 (b) less than 15
   (c) less than 25 (d) over 50
4. Resemblance of one organism to another for protection and hiding is
   (a) Mimicry (b) Predation
   (c) Adaptation (d) Camouflage
5. Which is not a part of atmosphere ?
   (a) Light (b) Temperature
   (c) Edaphic factor (d) Precipitation
6. Human population growth _____.
   (a) has an S-shaped curve
   (b) is currently in a logistic phase
   (c) is currently exponential
   (d) has reached carrying capacity
7. The term 'precipitation' includes
   (a) Rain
   (b) Hails
   (c) Snow
   (d) All forms of water that fall to the ground
8. Interactions in which the consumer lives within the host and does slow damage to the host are referred to as
   (a) commensalism (b) parasitism
   (c) mutualism (d) competition
9. An assocation between two individuals or population where both the benefitted and where neither can survive without the other is
   (a) Commensalism (b) Amensalism
   (c) Proto-cooperation (d) Mutualism
10. Which most often limits the primary productivity of the ecosystem ?
    (a) Solar radiation/light (b) Oxygen
    (c) Consumers (d) Nitrogen
11. Which of the following is the most stable ecosystem?
    (a) Mountain (b) Desert
    (c) Forest (d) Ocean
12. Energy flow in an ecosystem is
    (a) unidirectional (b) bidirectional
    (c) multidirectional (d) All of these
13. Which one is nature's cleaner ?
    (a) Consumers
    (b) Producers
    (c) Decomposers and scavengers
    (d) Symbionts
14. Who is referred to as the farmer's friend ?
    (a) Ant (b) Sparrow
    (c) Earthworm (d) Rabbit
15. How much portion of the PAR is captured by the plants?
    (a) 5 – 10% (b) 7 – 10%
    (c) 8 – 10% (d) 2 – 10%
16. The animals which occupy the same trophic level are
    (a) Lion & Bees
    (b) Deer & Bees
    (c) Snakes & Earthworm
    (d) Crow & Cow
17. In simple ecosystem with grass, deer and tiger in food chain, how much amount of food available to the tiger if the grass production is one tonne ?
    (a) 100 kg (b) 10 kg
    (c) 1 kg (d) 100 gm
18. In a food chain herbivores/deer are
    (a) Primary producers (b) Primary consumers
    (c) Secondary consumers (d) Decomposers
19. 10% law of flow of energy in ecosystem was proposed by
    (a) Lindeman (b) Carl Mobius
    (c) Tansley (d) Darwin
20. More than 70% of world's freshwater is contained in
    (a) polar ice
    (b) glaciers and mountains
    (c) antarctica
    (d) greenland
21. Which one of the following animals may occupy more than one trophic levels in the same ecosystem at the same time?
    (a) Sparrow (b) Lion
    (c) Goat (d) Frog
22. Which one of the following is not a gaseous biogeochemical cycle in ecosystem ?
    (a) Sulphur cycle (b) Phosphorus cycle
    (c) Nitrogen cycle (d) Carbon cycle
23. Which of the following animal has become almost extinct in India ?
    (a) Wolf (b) Rhinoceros
    (c) Hippopotamus (d) Cheetah
24. Diversity of habitat over the total landscape is called
    (a) β diversity (b) γ diveristy (gamma)
    (c) landscape diversity (d) ecosystem diversity
25. Habitat loss and fragmentation, over exploitation, alien species invasion and co-extinction are causes for
    (a) Population explosion (b) Migration
    (c) Biodiversity loss (d) Pollution
26. Which Biosphere reserve known as "Valley of Flower" ?
    (a) Nilgiri (b) Sunderbans
    (c) Uttarakhand (d) Nokrek
27. Plant genes of endangered species are stored in
    (a) gene library (b) gene bank
    (c) herbarium (d) None of these
28. Which National park is the new home of the Indian one-horned rhinoceros ?
    (a) Dudhwa (b) Jim Corbett
    (c) Kanha (d) Bandhavgarh
29. '*Project Tiger*' in India was started in
    (a) 1970 (b) 1972
    (c) 1981 (d) 1985

30. Which one of the following is an example of *Ex-situ* conservation?
(a) Wildlife sanctuary (b) Seed bank
(c) Sacred groves (d) National park

31. Which one of the following areas in India, is a hot spot of0 biodiversity ?
(a) Eastern Ghats (b) Gangetic Plain
(c) Sunderbans (d) Western Ghats

32. Noise pollution is created if noise is in excess to –
(a) 70-75 dB (b) 50-60 dB
(c) 80-99 dB (d) 40-65 dB

33. Which of the following is most harmful pollutant ?
(a) NO_2 (b) CO_2
(c) SO_2 (d) CO

34. Volcano is _____ source of pollution.
(a) artificial (b) natural
(c) Both (a) and (b) (d) man-made

35. Ozone layer is formed in which zone of atmosphere
(a) Mesosphere (b) Stratosphere
(c) Troposphere (d) Ionosphere

36. Today the concentration of green house gases is very high because of
(a) use of refrigerator
(b) increased combustion of oils and coal
(b) deforestation
(d) All of the above

37. Green house gases include
(a) CO_2, CFC, CH_4 and NO_2
(b) CO_2, O_2, N_2, NO_2 and NH_3
(c) CH_4, N_2, CO_2 and NH_3
(d) CFC, CO_2, NH_3 and N_2

38. Acid rain is caused due to increase in concentration of (in atmosphere)
(a) SO_2 and NO_2 (b) CO and CO_2
(c) CO and SO_3 (d) O_3 and dust

39. Deforestation causes
(a) soil erosion
(b) loss of biodiversity
(c) disturbance in hydrological cycle
(d) All of the above

40. Which constituent of the atmosphere is likely to change if the forest cover is removed ?
(a) O_2 level is increased
(b) CO_2 level is increased
(c) O_2 level is significantly increases
(d) CO_2 level is significantly decreased

ANSWER KEY

1	(a)	**11**	(d)	**21**	(a)	**31**	(d)
2	(a)	**12**	(a)	**22**	(b)	**32**	(c)
3	(c)	**13**	(c)	**23**	(d)	**33**	(c)
4	(a)	**14**	(c)	**24**	(b)	**34**	(b)
5	(c)	**15**	(d)	**25**	(c)	**35**	(b)
6	(c)	**16**	(d)	**26**	(a)	**36**	(d)
7	(d)	**17**	(b)	**27**	(b)	**37**	(a)
8	(b)	**18**	(b)	**28**	(a)	**38**	(a)
9	(d)	**19**	(a)	**29**	(b)	**39**	(d)
10	(a)	**20**	(a)	**30**	(b)	**40**	(b)

HINTS AND SOLUTIONS

3. (c) Deserts have less than 25 centimeters of rainfall per year.

5. (c) Because edaphic factors affects through soil and rest are the climatic factors.

6. (c) The exponential growth model virtually describes the population explosion of humans.

8. (b) This is the classic definition of a parasitic interaction.

11. (d) 2/3 parts of each is ocean here, various types of food chains form food webs. This ecosystem is most stable due to buffering action of water.

19. (a) Lindeman proposed the 10% law of flow of energy in ecosystem. According to this law only 10% energy passed from one trophic level to other in a food chain.

20. (a) Three fourth surface of earth is covered by oceans which contain 97.5% of total water. It is marine water with about 3.5% salt content only 2.5% is fresh water which occurs on land. Most of this water (1.97%) occurs as frozen ice caps and glaciers, 0.5% fresh water occurs as ground water. Rivers and lakes contain 0.02%, soil 0.01% while atmosphere possesses 0.001% of water as vapours.

21. (a) It feeds upon grains hence called primary consumer and can also feed on insects hence called secondary consumer at the same time in the same ecosystem.

22. (b) Phosphorus is mostly used as phosphate. Its reservoir pool is phosphate rocks while cycling pool is soil for terrestrial ecosystems and water for aquatic ecosystems.

27. (b) Plant genes of endangered species are stored in gene bank which is a collection of cloned DNA fragments representing the entire material of an organism.

30. (b) Ex-situ conservation is the conservation of selected organism in places outside their natural homes. They include off site collection and gene banks.
In situ conservation, on the other hand, is the conservation of endangered species in their natural habitat. Biosphere reserves, National parks, Wildlife sanctuaries and sacred groves all are examples of *In situ* conservation.

31. (d) Hotspots are the geographical area where biodiversity is maximum. Two hot spots in India are Western Ghats and North eastern himlayan region.

38. (a) The main precursors of acid rain are SO_2 and NO_2 in atmosphere which form H_2SO_4 (Sulphuric acid) and HNO_3 (nitric acid) with H_2O and these come down with rain. Such rains are called acid rains.