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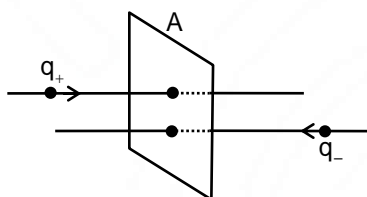
CHAPTER
01

CURRENT ELECTRICITY

1. Electric Current

Definition : The time rate of flow of charge through any cross-section is called electric current.

Consider a small area A held perpendicular to the direction of flow of charges as shown in figure. Let, Positive charges q_+ are flowing from left to right and negative charge q_- are flowing from right to left across the area. The net amount of charge flowing through the area in the interval t from left to right $q = |q_+| + |q_-|$



Here, the quotient i , is defined as the current across the area in the direction left to right.

$$\text{Current } i = \frac{\text{Charge}}{\text{Time}} = \frac{dq}{dt},$$

$$\text{if flow is uniform } i = \frac{q}{t}$$

S.I. Unit : Ampere (A)

1 ampere = 1 coulomb/second

Dimension : ($M^0 L^0 T^0 A^1$)

If n electrons pass through any cross section in

$$\text{every } t \text{ seconds then } i = \frac{Q}{t} = \frac{ne}{t}$$

where $e = 1.6 \times 10^{-19}$ coulomb.

1.1 Average & Instantaneous Current

1. Average current

If ΔQ charge flows through any cross section of conductor in the interval t to $t + \Delta t$, then average current in that interval is defined as

$$\text{the ratio of } \Delta Q \text{ to } \Delta t; I_{av} = \frac{\Delta Q}{\Delta t} = \frac{Q_2 - Q_1}{t_2 - t_1}$$

2. Instantaneous current

If the limit of Δt is tending to zero, then the current is defined to be instantaneous current at time t .

$$I = \lim_{\Delta t \rightarrow 0} \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt}$$

KEY POINTS

Instantaneous current through a cross-section

$$I = \frac{dQ}{dt}$$

Charge passed through the cross section in the interval t to $t + dt$

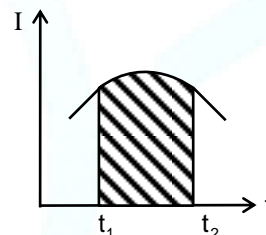
$$dQ = Idt$$

Total charge in the interval t_1 to t_2

$$Q = \int_{t_1}^{t_2} Idt = \text{Area below } I \text{ versus } t \text{ graph in the}$$

interval t_1 to t_2 as shown in figure.

Average current in the interval t_1 to t_2



$$I_{av} = \frac{\Delta Q}{\Delta t} = \frac{\int_{t_1}^{t_2} Idt}{\int_{t_1}^{t_2} dt} = \frac{\text{Area below } I \text{ versus } t \text{ graph}}{\text{Time - interval}}$$

1.2 1 Ampere

If 1 coulomb of charge flows per second then 1 ampere of current is said to be flowing.

1 ampere of current means the flow of 6.25×10^{18} electrons per second through any cross section of conductor

1.3 Direction of current flow

By convention, direction of current is taken as direction of motion of positively charged particles and opposite to the direction of negatively charged particles.

Order of currents in domestic appliances is 1A.

Order of current in our nerves is $1 \mu A$.

Order of current in lightening is 10^4 A.

Electric current is a scalar quality Although in



diagrams, we represent current in a wire by an arrow but the arrow simply indicate the direction of flow of positive charges in the wire.

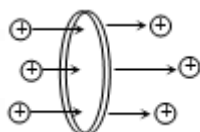
Current is a scalar quantity because it does not obey vector law of addition.

1.4 Current in different situation :

• Due to translatory motion of charge

In n particle each having a charge q , pass through a given area in time t then $i = \frac{nq}{t}$.

If n particles each having a charge q pass per second per unit area, the current associated with cross-sectional area A is $i = nqA$

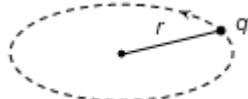


If there are n particle per unit volume each having a charge q and moving with velocity v , the current through, cross section A is $i = nqvA$

• Due to rotatory motion of charge

If a point charge q is moving in a circle of radius r with speed v (frequency ν , angular speed ω and time period T) then corresponding currents

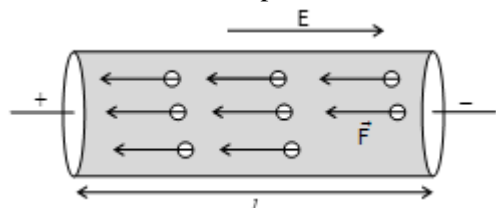
$$i = q\nu = \frac{q}{T} = \frac{qv}{2\pi r} = \frac{q\omega}{2\pi}$$



1.5 Flow of charge in conductors

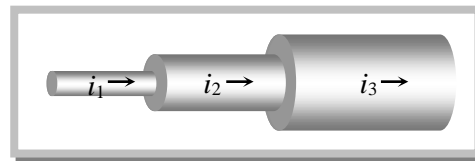
Net charge in a current carrying conductor is zero at any instant of time. In conductor the current is caused by free electron. The no. of electron (negative charge) and proton (positive charge) in a conductor is same. Hence the net charge in a current carrying conductor is zero.

- Value of the current is same throughout the conductor, irrespective of the cross section of conductor at different points.



- For a given conductor current does not change

with change in cross-sectional area. In the following figure $i_1 = i_2 = i_3$



- Electric field outside a current carrying conductor is zero, but it is non-zero inside the conductor.

KEY POINTS

- In solids, the charge carriers are free electrons.
- In liquids, the charge carriers are positive and negative ions.
- In gases, the charge carriers are positive ions and free electrons.
- In semiconductors, the charge carriers are holes and free electrons.
- The conventional direction of flow of current is opposite to the direction of flow of electrons.

Example 1:

If a charge of 1.6×10^{-19} coulomb flows per second through any cross section of any conductor, the current constituted will be :

- (1) 2.56×10^{-19} A (2) 6.25×10^{-19} A
(3) 1.6×10^{-19} A (4) 3.2×10^{-19} A

Solution:

From definition of current $i = \frac{q}{t}$

Here $q = 1.6 \times 10^{-19}$ C and $t = 1$ sec

$$\therefore i = \frac{1.6 \times 10^{-19}}{1} = 1.6 \times 10^{-19} \text{ ampere}$$

Example 2:

The no. of electrons flowing per second through any cross section of wire, if it carries a current of one ampere, will be :

- (1) 2.5×10^{18} (2) 6.25×10^{18}
(3) 12.5×10^{18} (4) 5×10^{18}

Solution:

$$I = \frac{q}{t} = \frac{ne}{t} \quad [\because q = ne, \text{ from quantization of charge}]$$

$$\Rightarrow n = \frac{I \times t}{e} = \frac{1 \times 1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$$



Example 3:

The no. of electron passing through a heater wire in one minute, if it carries a current of 8 ampere, will be:

- (1) 2×10^{20} (2) 2×10^{21}
(3) 3×10^{20} (4) 3×10^{21}

Solution:

$$n = \frac{It}{e} = \frac{8 \times 60}{1.6 \times 10^{-19}} = 3 \times 10^{21}$$

Example 4:

In hydrogen atom, the electron moves in an orbit of radius 5×10^{-11} m with a speed of 2.2×10^6 m/sec. the equivalent current will be :

- (1) 1.12 mA (2) 4.32 mA
(3) 3.32 mA (4) 7.12 mA

Solution:

Time taken by the electron in 1 revolution is

$$T = \frac{2\pi r}{v}; \text{ current } I = \frac{Q}{T} = \frac{Qv}{2\pi r}$$

where R is the radius of orbit and v is the speed.

$$I = \frac{2.2 \times 10^6 \times 1.6 \times 10^{-19}}{2 \times \left(\frac{22}{7}\right) \times (5 \times 10^{-11})} = 1.12 \text{ mA}$$

Example 5:

If charge flowing through a conductor is given by $q = 1.5 t^2 + t$. The current flow at $t = 2$ second will be—

- (1) 4A (2) 5A (3) 6A (4) 7A

Solution:

We know $i = \frac{dq}{dt}$

Here $q = 1.5 t^2 + t \therefore \frac{dq}{dt} = 3t + 1$

Now $I = \left(\frac{dq}{dt}\right)_{\text{at } t=2s} = 3 \times 2 + 1 = 7 \text{ Amp.}$

Example 6:

A conductor of non-uniform cross-sectional area, has cross-sectional area at three points as $A_1 = 2 \text{ cm}^2$, $A_2 = 4 \text{ cm}^2$ and $A_3 = 6 \text{ cm}^2$. If a current of 5 ampere is passed through A_1 . Value of current, when passed through A_2 and A_3 respectively as—

- (1) 10 A, 15 A (2) 20 A, 30 A
(3) 2.5 A, 1.66 A (4) 5A, 5A

Solution:

- (4) Current will remain same. (Independent of cross sectional area)

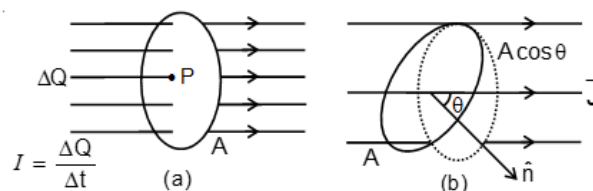
2. Current Density

Current density is defined as a vector having magnitude equal to current per unit area surrounding that point.

It is denoted by J i.e. $J = \frac{I}{A}$

I = Electric current and A = Area of cross section. Here, area A is normal to current I.

If the cross-sectional area is not normal to the current, but makes an angle θ with the normal to current, then



$$J = \frac{I}{A_{\text{normal}}} = \frac{I}{A \cos \theta}$$

$$\Rightarrow I = J A \cos \theta = \vec{J} \cdot \vec{A}$$

$$dI = \vec{J} \cdot d\vec{A} \Rightarrow I = \int \vec{J} \cdot d\vec{A}$$

Electric current is the flux of current density.

It is a vector quantity. It's direction is the direction of motion of the positive charges at that point.

Unit : ampere / meter² (A/m²)

Dimension : [M⁰L⁻²T⁰A]

Example 7:

An electron beam has an aperture 1.0 mm^2 . A total of 6.0×10^{16} electrons go through any perpendicular cross section per second. Find (a) the current and (b) the current density in the beam.

Solution:

- (a) The total charge crossing a perpendicular cross section in one second is

$$q = ne = 6.0 \times 10^{16} \times 1.6 \times 10^{-19} \text{ C} = 9.6 \times 10^{-3} \text{ C}$$

The current is

$$i = \frac{q}{t} = \frac{9.6 \times 10^{-3} \text{ C}}{1 \text{ s}} = 9.6 \times 10^{-3} \text{ A}$$



As the charge is negative the current is opposite to the direction of motion of the beam.

(b) The current density is

$$J = \frac{i}{A} = \frac{9.6 \times 10^{-3} \text{ A}}{1.0 \text{ mm}^2} = 9.6 \times 10^3 \text{ Am}^{-2}$$

3. Mechanism of Current Flow in Conductors

In atoms and molecules, negatively charged electrons and positively charged nuclei are bound to each other and thus are not free to move in electric field.

In some materials, the electrons will still be bound so when electric field is applied, they will not accelerate to develop current. These materials are generally called **insulators**.

In **bulk matter**, these molecules are so closely packed that electrons no longer are attached to individual nuclei. If an electric field is applied some of the electrons are practically free to move within the bulk material to develop currents in them. These materials are generally called **conductors** and these electrons are known as free electrons.

In the absence of electric field, the electrons move randomly and follow a zig-zag path. During their random motion they collide with fixed ions such that their speed before collision is equal to speed after collision but the direction of velocity after collision is completely random. Therefore, number of electrons in any direction will be equal to the number of electrons travelling in opposite direction, so there is no net electric current.

When electric field \vec{E} is applied, inside the conductor due to electric force the path of electron in general become curved (parabolic) instead of straight lines and electrons drift opposite to the field. So the electrons will be accelerated due to the field \vec{E} from end B to A. The motion constitute an electric current.

4. Factors Responsible for Current Flow

4.1 Thermal Speed (order of $v_T = 10^5 \text{ m/s}$)

Conductor contain a large number of free electrons, which are in continuous random motion. Due to random motion, the free electrons collide with positive metal ions with high frequency and undergo change in direction at each collision. So, the thermal velocities are randomly distributed in all possible directions are, individual thermal velocities of the free electrons at any given time. the total number of free electrons in the conductor = N

$$\text{average velocity } \vec{u}_{\text{avg.}} = \left[\frac{\vec{u}_1 + \vec{u}_2 + \dots + \vec{u}_N}{N} \right] = 0$$

4.2 Drift Velocity

Drift velocity is defined as the velocity with which the free electrons get drifted towards the positive terminal under the effect of the applied electric field.

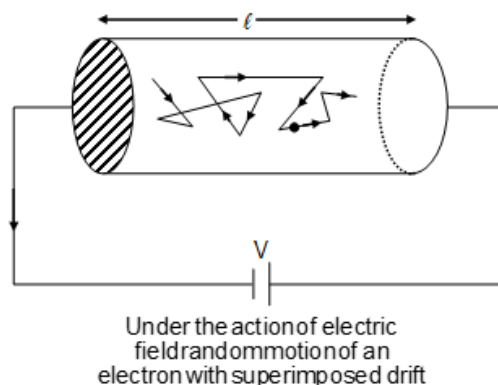
4.3 Relaxation Time

Average time elapsed between two successive collisions. It is of the order of 10^{-14} s . It is a temperature dependent characteristic of the material of the conductor. It decreases with increases in temperature.

4.4 Relation Between Drift Velocity & Relaxation Time

When the ends of a conductor are connected to a source of emf, an electric field E is established in the

conductor, such that $E = \frac{V}{\ell}$



where V = the potential difference across the



conductor and ℓ = the length of the conductor.

The electric field \vec{E} exerts an electrostatic force $-e\vec{E}$ on each electron in the conductor.

The acceleration of each electron $\vec{a} = \frac{-e\vec{E}}{m}$

m = mass of electron, e = charge of electron

so velocity of each electron $\vec{v} = \vec{u} + \vec{a}t$

So $\vec{v}_{av} = \vec{v}_d = \langle \vec{u} + \vec{a}t \rangle$

$\Rightarrow \vec{v}_d = \langle \vec{u} \rangle + \vec{a} \langle t \rangle$

since the average thermal velocity of free electrons is zero.

$$\vec{v}_d = \vec{a}\tau \Rightarrow \vec{v}_d = -\frac{e\vec{E}}{m}\tau$$

order of drift velocity is 10^{-4} m/s

4.5 Mean free path (λ)

The mean distance travelled by a conduction electron during relaxation time is known as mean free path λ . Mean free path of conduction electron is calculated as:

λ = Thermal velocity \times Relaxation time
(order of $\lambda = 10\text{\AA}$)

4.6 Relation between current density, conductivity and electric field

Let the number of free electrons per unit volume in a conductor = n

Total number of electrons in dx distance = $n(Adx)$

Total charge $\Delta Q = n(Adx)e$

Cross sectional area = A

$$\text{Current} = \frac{\Delta Q}{\Delta t} = nAe \frac{\Delta x}{\Delta t} \Rightarrow I = neAv_d$$

$$\text{Current density } J = \frac{I}{A} = nev_d$$

$$\Rightarrow J = ne \left(\frac{eE}{m} \right) \tau \quad \because v_d = \left(\frac{eE}{m} \right) \tau$$

$$\Rightarrow J = \left(\frac{ne^2\tau}{m} \right) E \quad \text{again, for ohmic conductor}$$

$$\vec{J} = \sigma \vec{E} \Rightarrow \sigma = \frac{ne^2\tau}{m} = \frac{1}{\rho}$$

Here, σ is conductivity & ρ is resistivity.

σ and ρ depends only on the material of the conductor and its temperature.

(i) Direction of current density \vec{J} is same as that of electric field \vec{E} .

(ii) If electric field is uniform (i.e. $\vec{E} = \text{constant}$) current density will be constant [as $\sigma = \text{constant}$]

(iii) If electric field is zero (as in electrostatics inside a conductor), current density and hence current will be zero.

4.7 Mobility (μ)

It is defined as the magnitude of the drift velocity per unit electric field

$$\mu = \frac{|\vec{v}_d|}{|E|}$$

Its SI unit is $\text{m}^2\text{V}^{-1}\text{s}^{-1}$ & Dimension is $[M^{-1}L^0T^2A^1]$

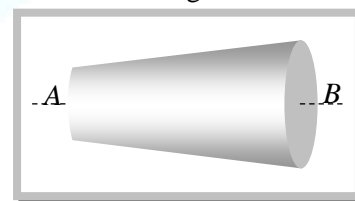
Its practical unit is $\text{cm}^2\text{V}^{-1}\text{s}^{-1}$

$$\text{We have } v_d = \frac{eE\tau}{m} \Rightarrow \mu = \frac{v_d}{E} = \frac{e\tau}{m}$$

Mobility of free electrons is independent of electric field and dimension of conductor.

Example 8:

A wire has a non-uniform cross-sectional area as shown in figure. A steady current i flows through it. Which one of the following statement is correct



- (1) The drift speed of electron is constant
- (2) The drift speed increases on moving from A to B
- (3) The drift speed decreases on moving from A to B
- (4) The drift speed varies randomly

Solution:

For a conductor of non-uniform cross-section

$$v_d \propto \frac{1}{\text{Area of cross-section}}$$

**Example 9:**

A copper wire of length 1m and radius 1mm is joined in series with an iron wire of length 2m and radius 3mm and a current is passed through the wire. The ratio of current densities in the copper and iron wire is

- (1) 18 : 1 (2) 9 : 1 (3) 6 : 1 (4) 2 : 3

Solution:

We know $J = \frac{i}{A}$ when $i = \text{constant}$ $J \propto \frac{1}{A}$

$$\Rightarrow \frac{J_c}{J_i} = \frac{A_i}{A_c} = \left(\frac{r_i}{r_c}\right)^2 = \left(\frac{3}{1}\right)^2 = \frac{9}{1}$$

Example 10:

The total momentum of electrons in a straight wire of length $\ell = 1000$ m carrying a current

$I = 70$ A, will be – (in Ns)

- (1) 0.40×10^{-6} (2) 0.20×10^{-6}
 (3) 0.80×10^{-6} (4) 0.16×10^{-6}

Solution:

We know $I = neAv_d$ where $v_d \rightarrow$ drift velocity
 $n \rightarrow$ no. density of electron.

Total no. of electron $N = nA\ell$

Total momentum (P) of electron = Nmv_d

$$\text{or } P = (nA\ell m) \times \frac{I}{neA} = \frac{I\ell m}{e}$$

$$\Rightarrow P = \frac{70 \times 1000 \times 9.3 \times 10^{-31}}{1.6 \times 10^{-19}} = 0.40 \mu \text{ Ns}$$

Example 11:

Find the resistivity of a metal carrying an electric field $E = 10$ V/m causing a current density $J = 3 \times 10^5$ A/m².

Solution:

$$\rho = \frac{E}{J} = \frac{10}{3 \times 10^5} = 3.33 \times 10^{-5} \text{ ohm-m}$$

Example 12:

An electric field $E = 5 \times 10^{-3}$ V/m sets a current $i = 1$ amp along a wire of radius = 10^{-3} m. Find τ . (no. density of $e^- = 3 \times 10^{28}/\text{m}^3$)

Solution:

$$\sigma = \frac{J}{E} = \frac{[1/\pi(10^{-3})^2]}{5 \times 10^{-3}} = 0.064 \times 10^9 (\Omega\text{-m})^{-1}$$

$$\begin{aligned} \text{Then } \tau &= \frac{m\sigma}{ne^2} = \frac{(9.1 \times 10^{-31})(0.064 \times 10^9)}{(3 \times 10^{28})(1.6 \times 10^{-19})^2} \\ &= 7.5 \times 10^{-14} \text{ s} \end{aligned}$$

Example 13:

What are the possible paths of free electrons inside a conductor ?

Solution:

In the absence of electric field inside conductor, Free electrons are unaccelerated, so their path between consecutive collisions is zig-zag.

In the presence of electric field inside conductor, free electrons are accelerated so their path is generally curved.

Example 14:

The number density of electrons in copper is $8.5 \times 10^{28} \text{ m}^{-3}$. Find the current flowing through a copper wire of length 0.2 m, area of cross section 1 mm^2 , when connected to a battery of 3V. Given that electron mobility = $4.5 \times 10^{-6} \text{ m}^2 \text{ V}^{-1} \text{ s}^{-1}$ and charge on electron = $1.6 \times 10^{-19} \text{ C}$.

Solution:

Here, $V = 3$ volt; $\ell = 0.2$ m; $A = 1 \text{ mm}^2 = 10^{-6} \text{ m}^2$; $n = 8.5 \times 10^{28} \text{ m}^{-3}$; $\mu = 4.5 \times 10^{-6} \text{ m}^2 \text{ V}^{-1} \text{ s}^{-1}$ and $e = 1.6 \times 10^{-19} \text{ C}$

The electric field set up across the conductor,

$$E = \frac{V}{\ell} = \frac{3}{0.2} = 15 \text{ Vm}^{-1}$$

Now, the current through the wire,

$$\begin{aligned} I &= n A \mu E e = 8.5 \times 10^{28} \times 10^{-6} \times 4.5 \times 10^{-6} \times 15 \\ &\times 1.6 \times 10^{-19} = 0.92 \text{ A} \end{aligned}$$

FUNDAMENTAL UNLOCKED- (FU#1) :

- Q.1** 10^6 positrons are flowing normally through an area in forward direction and same amount of electrons are flowing in backward direction in the interval of 10 ms. find the current through the area.



- Q.2** An electron moves in a circle of radius 10 cm with a constant speed of 4×10^6 m/s find the electric current at a point on the circle.
- Q.3** A current of 1.8 A flows through a wire of area of cross-section 0.5 mm^2 . Find the current density in the wire.
- Q.4** The diameter of a copper wire is 2mm. If a steady current of 6.25 A is caused by $8.5 \times 10^{28} / \text{m}^3$ electrons flowing through it. The drift velocity of conduction electrons will be –
- Q.5** Mobility of free electrons in a current carrying conductor is proportional to ?

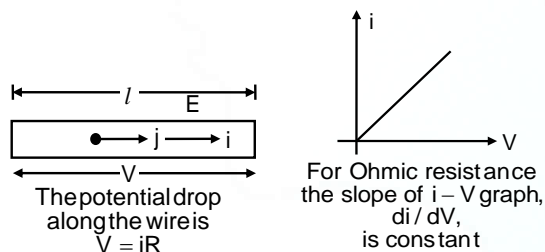
- (1) V_d (2) $\frac{1}{V_d}$ (3) J (4) ρ

5. Ohm's law

If the physical circumstances of the conductor (length, temp., mechanical strain etc.) remains constant, then the current flowing through the conductor is directly proportional to the potential difference across its two ends i.e., $i \propto V$

$$\Rightarrow V = iR \text{ or } \frac{V}{i} = R$$

When R is a proportionality constant, known as electric resistance.

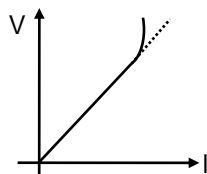


5.1 Limitations of Ohm's Law

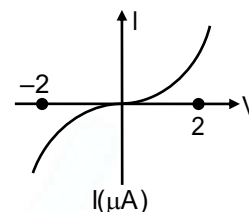
The proportionality of V and I does not hold for certain materials and devices used in electric circuits.

Following are few types of deviations.

- (i) V ceases to be proportional to I for a good conductor at high temperature or high current

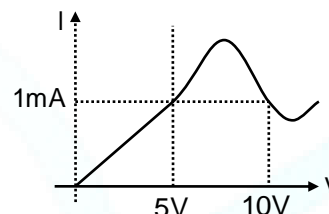


- (ii) Value of current is different for same potential difference on reversing the direction of V in semiconductors



Characteristic curve of diode

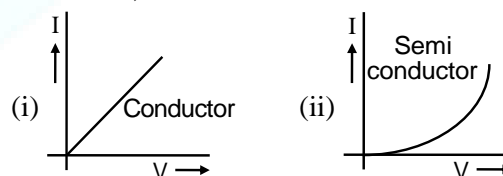
- (iii) Value of potential is different for same current



Variation of current v/s voltage for GaAs

KEY POINTS

- Unit of resistance R: ohm(Ω)
1 ohm = 1 volt / 1 ampere
- Dimension of resistance R: $[M^1 L^2 T^{-3} A^{-2}]$
- This is true for metallic conductors only which have free electrons
- The law is not applicable for ionized gases, transistors, semi-conductors etc.



Example 15:

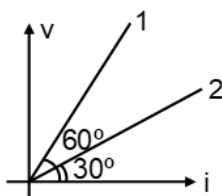
Find the ratio of the resistances of the conductors 1 and 2.

Solution:

$$R_1 = \left(\frac{V}{i} \right)_1 = \tan 60^\circ$$

$$R_2 = \left(\frac{V}{i} \right)_2 = \tan 30^\circ$$

$$\text{Hence, } \frac{R_1}{R_2} = \frac{\tan 60^\circ}{\tan 30^\circ} = \frac{\sqrt{3}}{1/\sqrt{3}} = 3$$

**Example 16:**

In a wire of length 4m and diameter 6mm, a current of 120 ampere is passed. The potential difference across the wire is found to be 80 volt. The resistance of wire will be –

- (1) 0.15 ohm (2) 0.25 ohm
(3) 0.667 ohm (4) none

Solution:

From the definition of resistance

$$R = \frac{V}{I} = \frac{80}{120} = 0.667 \Omega$$

6. Electrical Resistance

Definition : The property of substance by virtue of which it opposes the flow of current through it, is known as the resistance.

Cause of resistance of a conductor : It is due to the collisions of free electrons with the ions or atoms of the conductor while drifting towards the positive end of the conductor.

In short, the resistance is the property of conductor which produces hinderance to the current flow, causing the potential drop across the conductor.

6.1 Dependence of Resistance

Resistance of conductor does not depend upon the current i flowing through it and the potential difference (P.D.) along the conductor. However, it depends upon

(a) length i.e. $R \propto \ell$ (b) area i.e. $R \propto \frac{1}{A}$

(c) resistivity i.e. $R \propto \rho$

$$\text{Then } R = \rho \frac{\ell}{A}$$

where ρ = resistivity of the conductor

R is in Ohm(Ω)

- Unit of ρ is $\Omega\text{-m}$
- Dimension of ρ is $[M^1 L^3 T^{-3} A^{-2}]$

- Inverse of resistivity is called conductivity (σ) of the material $\sigma = \frac{1}{\rho}$ (unit : mho m^{-1})
- Inverse of resistance is called conductance (G) $G = \frac{1}{R}$ (unit : mho)
- Resistivity is also defined as the ratio of the intensity of the electric field E at any point within the conductor and the current density J at that point

$$\rho = \frac{E}{J} \quad \text{or} \quad J \propto E$$

KEY POINTS

- Resistivity is characteristic property of the material of the conductor. It does not depend upon length, area etc. of the conductor. Although it depends on temperature. It increases with increase in temperature.
- Value of resistivity is least for conductors and high for insulators.
- $\rho_{\text{alloy}} > \rho_{\text{semiconductor}} > \rho_{\text{conductor}}$

Effect of Stretching a Wire on Its Resistance

- If the length of wire is changed, then $\frac{R_1}{R_2} = \frac{\ell_1^2}{\ell_2^2}$
- If the radius of wire is changed, then $\frac{R_1}{R_2} = \frac{r_2^4}{r_1^4}$
- If the area of wire is changed, then $\frac{R_1}{R_2} = \frac{A_2^2}{A_1^2}$
- If $x\%$ change is brought in length of a wire, its resistance will change by $2x\%$. This is true for $x < 5\%$ only.
- If a conductor is stretched such that its radius is reduced to $1/n^{\text{th}}$ of its original values, then resistance will increase n^4 times similarly resistance will decrease n^4 times if radius is increased n times by contraction.
- Keeping volume of the conductor constant, its

$$\text{resistance } R = \rho \frac{L}{A} = \rho \frac{LA}{A^2} = \frac{\rho V}{A^2} = \frac{\rho m}{A^2 d}$$

Where m = mass and d = density of material



Example 17:

Resistance of a conductor of length ℓ and area of cross section A is R . If its length is doubled and area of cross section is halved then find its new resistance.

Solution:

Initial length = ℓ , Area = A

So, initial resistance $R = \rho \frac{\ell}{A}$

Final length $\ell' = 2\ell$, Area $A' = \frac{A}{2}$

New resistance $R' = \rho \frac{\ell'}{A'} = \rho \frac{2\ell}{\left(\frac{A}{2}\right)} = 4\rho \frac{\ell}{A} = 4R$

FUNDAMENTAL UNLOCKED- (FU#2) :

Q.1 A potential difference of 200 volt is maintained across a conductor of resistance 100 ohm. Calculate the number of electrons flowing through it in one second. Charge on electron, $e = 1.6 \times 10^{-19}$ C.

Q.2 In a wire of length 8m and diameter 3mm, a current of 10 ampere is passed. The potential difference across the wire is found to be 6 volt. The resistance of wire will be—

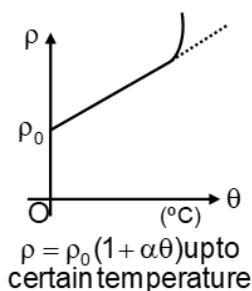
Q.3 Resistivity of a conductor of length ℓ and area of cross section A is ρ . If its length is doubled and area of cross section is halved, then its new resistivity will be

Q.4 A wire of resistance 5 ohm is drawn out so that its length is increased to twice its original length. Calculate its new resistance.

Q.5 A given piece of wire length ℓ , cross sectional area A and resistance R is stretched uniformly to a wire of length 2ℓ . What will be the new resistance.

7. Temperature Dependence of Resistance

If the temperature of a conductor increases, the atoms of the lattice vibrate with more amplitude and velocities. Furthermore, the conduction electron move with greater speeds.



Since $\sigma \propto \tau$ and \bar{v} increases with temperature and τ decreases. So, we can say that σ decreases or ρ increases with temperature.

- It is experimentally verified that the resistivity of a conductor varies linearly with temperature upto certain temperature. If ρ_0 = resistivity at 0°C , the resistivity at $\theta^\circ\text{C}$ is given as

$$\rho_\theta = \rho_0 (1 + \alpha\theta)$$

where α = temperature coefficient of resistivity given as

$$\alpha = \frac{\rho_\theta - \rho_0}{\rho_0 \theta} \text{ and its unit is } \text{K}^{-1} \text{ or } ^\circ\text{C}^{-1}.$$

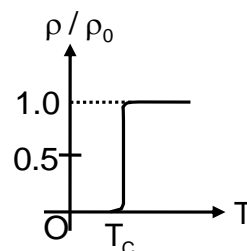
In differential form, $\alpha = \frac{d\rho}{\rho d\theta}$

Then, resistance R_θ at any temperature θ can be given as $R_\theta = R_0(1 + \alpha\theta)$ where R_0 = resistance at 0°C and α = average temperature coefficient of resistance.

- The alloys have very small value of α . Hence, their resistance does not change appreciably with increase or decrease in temperature. Therefore, the alloys can be used for making resistances of constant value.

7.1 Superconductivity

At a very low temperature, the resistivity of a metal is considerably lesser than that at room temperature. Some metal lose their resistances completely at temperature near 0 K (absolute zero). This property of a conductor is called super conductivity and the material is called “super-conductor”. The temperature at which a material becomes superconductor is called critical temperature T_C .





- A superconducting ring can retain electric currents of hundreds of amperes for a year without any external source.

Example 18:

The resistance of a wire at 20°C is 20 Ω and at 500°C is 60Ω. At which temperature resistance will be 25Ω

- (1) 50°C (2) 60°C (3) 70°C (4) 80°C

Solution:

By using

$$\frac{R_1}{R_2} = \frac{(1 + \alpha t_1)}{(1 + \alpha t_2)} \Rightarrow \frac{20}{60} = \frac{1 + 20\alpha}{1 + 500\alpha} \Rightarrow \alpha = \frac{1}{220}$$

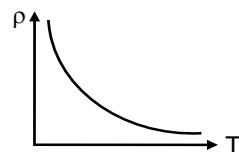
Again by using the same formula for 20Ω and 25Ω

$$\Rightarrow \frac{20}{25} = \frac{\left(1 + \frac{1}{220} \times 20\right)}{\left(1 + \frac{1}{220} \times t\right)} \Rightarrow t = 80^\circ\text{C}$$

KEY POINTS

- $R_2 = R_1 [1 + \alpha (t_2 - t_1)]$. This formula gives an approximate value.
- Resistance of the conductor decreases linearly with decrease in temperature and becomes zero at a specific temperature. This temperature is called critical or transition temperature, at this temperature conductor becomes a superconductor.
- There is no loss of energy in a circuit formed by superconductors. Current passed in loop formed by superconductor will continue flowing for infinite time if there is no resistance in the loop.
- Resistivity of a material is found to depend on the temperature. In conductors
resistivity $\rho = \frac{m}{ne^2\tau}$, where $\rho \propto \frac{1}{n}$ and $\rho \propto \frac{1}{\tau}$.
- When the temperature of conductor increases, average speed of free electrons increases. As a result collision frequency increases or relaxation time decreases. In metals n is not dependent on temperature to any appreciable extent and ρ increases with rise in temperature.
- For semiconductors, α is negative as their resistivity decreases with rise in temperature (n

increases with rise in temperature)



Temperature dependence of resistivity ρ of a semiconductor is shown in above figure.

- Metals :** For metals their temperature coefficient of resistance $\alpha > 0$. So resistance increases with temperature.
Physical explanation : Collision frequency of free electrons with the immobile positive ions increases
- Solid non-metals :** For these $\alpha = 0$. So resistance is independence of temperature.
Physical explanation : Complete absence of free electron.
- Semi-conductors :** For semi-conductor $\alpha < 0$ i.e. resistance decreases with temperature rise.
Physical explanation : Covalent bonds breaks, liberating more free electron and conduction increases.
- Electrolyte :** For electrolyte $\alpha < 0$ i.e. resistance decreases with temperature rise.
Physical explanation : The degree of ionisation increases and solution becomes less viscous.
- Ionised gases :** For ionised gases $\alpha < 0$ i.e. resistance decreases with temperature rise.
Physical explanation : Degree of ionisation increases.
- Alloys :** For alloys α has a small positive values. So with rise in temperature resistance of alloys is almost constant. Further alloy resistances are slightly higher than the pure metals resistance.
Alloys are used to made standard resistances, wires of resistance box, potentiometer wire, meter bridge wire etc.
Commonly used alloys are : Constantan, mangnin, Nichrome etc.
- Super conductors :** At low temperature, the resistance of certain substances becomes exactly zero. (e.g. Hg below 4.2 K or Pb below 7.2 K).



8. Combination of Resistors

8.1 Series Combination

The combination of resistors will be termed as series, if same amount of current is flowing through the resistors.

$$V_1 = IR_1, \quad V_2 = IR_2, \quad V_3 = IR_3$$

Sum of the voltages across resistances is equal to the voltage applied across the circuit i.e.

$$V = V_1 + V_2 + V_3 \Rightarrow V = IR_1 + IR_2 + IR_3$$

$$\frac{V}{I} = R_1 + R_2 + R_3 = R$$

Where, R = equivalent resistance

In series combination, the potential drop across the circuit is divided in the ratio of resistance

$$\text{i.e. } V_1 : V_2 : V_3 = R_1 : R_2 : R_3 \text{ \& } V_1 + V_2 + V_3 = V$$

$$\text{so } V_1 = \frac{R_1}{R_1 + R_2 + R_3} V; \quad V_2 = \frac{R_2}{R_1 + R_2 + R_3} V$$

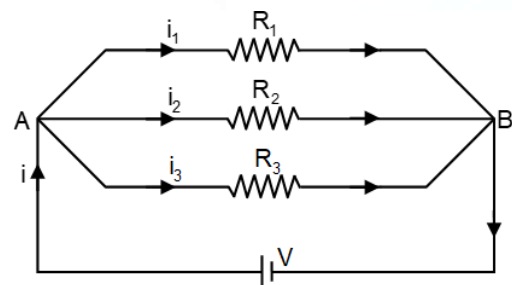
$$\text{\& } V_3 = \frac{R_3}{R_1 + R_2 + R_3} V$$

8.2 Parallel Combination

“Resistors will be parallel if the potential drop across them is same”

Current in each resistance is inversely proportional to the value of resistance i.e.

$$i_1 = \frac{V}{R_1}, \quad i_2 = \frac{V}{R_2}, \quad i_3 = \frac{V}{R_3}$$



Current flowing in the circuit is sum of the currents in individual resistances i.e.

$$i = i_1 + i_2 + i_3 \Rightarrow i = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{i}{V} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \Rightarrow \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\left(\because \frac{i}{V} = \frac{1}{R} \right)$$

where R = equivalent resistance

KEY POINTS

- (i) There is same drop of potential across each resistance in parallel combination.
- (ii) The equivalent resistance of parallel combination is lower than the value of lowest resistance in the combination.
If n identical resistances (i.e. each R) are connected
 - (i) in series, their equivalent resistance will be $R_s = nR$
 - (ii) in parallel, their equivalent resistance will be $R_p = R/n$
- (iii) $\frac{R_s}{R_p} = n^2$

Example 19:

Two resistances 12Ω and 4Ω are supplied to you. Find the maximum and minimum resistance that can be achieved by using them.

Solution:

$$R_1 = 12\Omega, \quad R_2 = 4\Omega$$

Maximum resistance is obtained, when they are used in series

$$R_s = R_1 + R_2 = (12 + 4)\Omega = 16\Omega$$

Minimum resistance is obtained when they are in parallel

$$R_p = \left(\frac{1}{R_1} + \frac{1}{R_2} \right)^{-1} = \left(\frac{1}{12} + \frac{1}{4} \right)^{-1} = \frac{48}{16} = 3\Omega$$

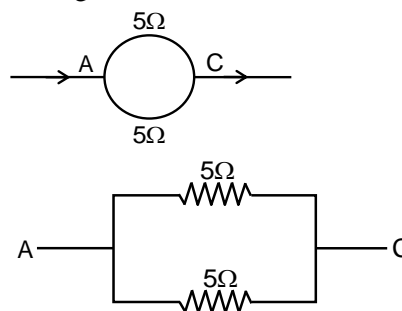
Example 20:

A wire of resistance 10Ω is bent to form a complete circle. It's resistance between two diametrically opposite points will be (in Ω)

- (1) 3.5 (2) 5 (3) 2.5 (4) 1.5

Solution:

The configuration is similar to

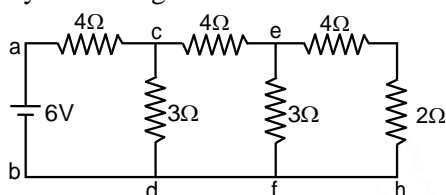


$$\text{Hence, equivalent resistance} = \frac{5 \times 5}{5 + 5} \Omega = 2.5\Omega$$



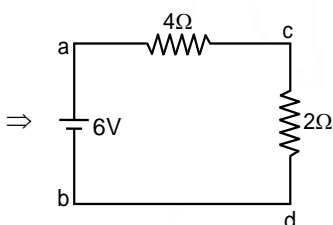
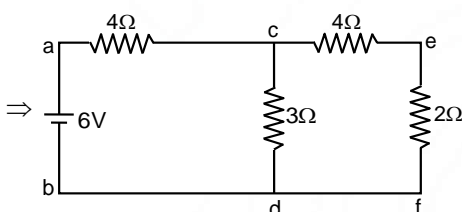
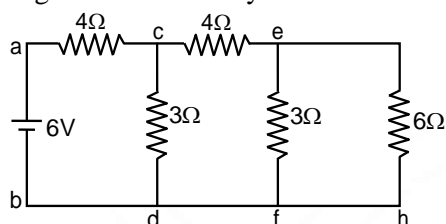
Example 21:

Find the equivalent resistance and current supplied by the battery in the diagram shown –



Solution:

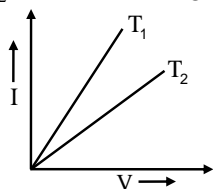
Solving the circuit one by one as follows.



Hence current supplied by the battery = $\frac{6V}{6\Omega} = 1 \text{ A}$

FUNDAMENTAL UNLOCKED- (FU#3) :

Q.1 The current voltage graph for a given metallic wire at two different temperatures T_1 and T_2 are shown in fig. Which is true –



- (1) $T_1 = T_2$ (2) $T_1 > T_2$
(3) $T_1 < T_2$ (4) None

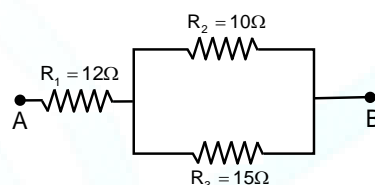
Q.2 An electric cable contains a single copper wire of radius 9 mm. It's resistance is 5Ω . This cable is replaced by six insulated copper wires, each of radius 3 mm. The resultant resistance of cable will be
(1) 7.5Ω (2) 45Ω (3) 90Ω (4) 270Ω

Q.3 Four resistances 10Ω , 5Ω , 7Ω and 3Ω are connected so that they form the sides of a rectangle AB, BC, CD and DA respectively. Another resistance of 10Ω is connected across the diagonal AC. The equivalent resistance between A & B is

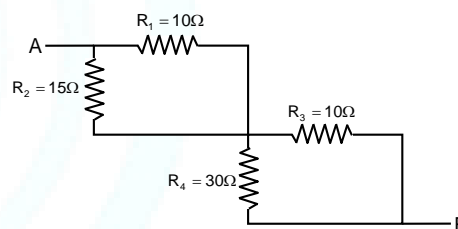
- (1) 2Ω (2) 5Ω
(3) 7Ω (4) 10Ω

Q.4 Resistance R , $2R$, $4R$, $8R$ ∞ are connected in parallel. What will be their equivalent resistance ?

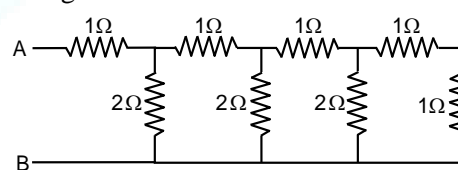
Q.5 Find the resistance across AB.



Q.6 Find the resistance across AB.



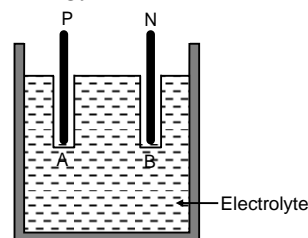
Q.7 What will be the resultant resistance between the points A and B in the following diagram ?



9. Cell : EMF, Internal Resistance & Terminal Voltage

9.1 Cell & Battery

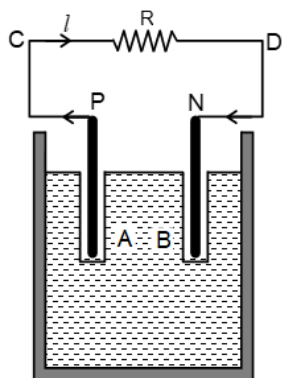
The device which converts chemical energy into electrical energy is known as electric cell.



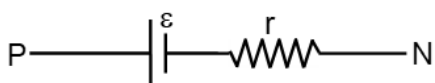
- A cell neither creates nor destroys charge but maintains the flow of charge present at various parts of the circuit by supplying energy needed for their organised motion.
- Cell is a source of constant emf but not constant current.
- Mainly cells are of two types :
(i) Primary cell : Cannot be recharged
(ii) Secondary cell : Can be recharged
- The direction of flow of current inside the cell is from negative to positive electrode while outside the cell is from positive to negative electrode.
- A cell is said to be ideal, if it has zero internal resistance.
- An electrolytic cell consists of two electrodes, called anode (P) and cathode (N) immersed in an electrolyte solution. Electrodes exchange charges with the electrolyte.

Battery can be considered as combination of multiple cells

When there is no current, the electrolyte is at same potential throughout, so the potential difference between P and N is known as electromotive force (emf) of the cell and denoted by ε . emf is a potential difference not a force. When a resistance R is connected across the cell as shown in figure, a current I flows from C to D. A steady current flows from P to N through the resistance R and flows from N to P through the electrolyte. the electrolyte through which current passes has a finite resistance r known as internal resistance of the cell.



A cell can be represented as



9.2 Parameter of Cell:

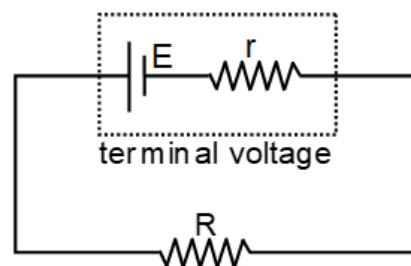
(a) Electro Motive Force (EMF)

The energy given by the cell in the flow of unit charge in the whole circuit (including the cell) is called the EMF of the cell. The potential difference across the terminals of a cell when it is not giving any current is called EMF of the cell. $E = \frac{W}{Q}$

• emf depends on:	• emf does not depend on:
(i) nature of electrolyte	(i) area of plates
(ii) metal of electrodes	(ii) distance between the electrodes
	(iii) quantity of electrolyte
	(iv) size of cell

(b) Terminal Voltage (V)

- When current is drawn through the cell or current is supplied to cell then, the potential difference across its terminals is called terminal voltage.



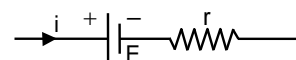
When i current is drawn from cell, then terminal voltage is less than its emf E .

$$V = E - i r$$

Where V = terminal voltage, r = internal resistance of battery

- When current is supplied to the cell, the terminal voltage is greater than the emf E i.e.

$$V = E + i r$$



- Units of both emf and terminal voltage are volt.



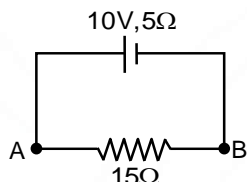
(c) Internal Resistance (r)

The resistance offered by the cell to the flow of current through it is called internal resistance of the cell.

- Distance between two electrodes $\uparrow r \uparrow$
- Area dipped in electrolyte $\uparrow r \downarrow$
- Concentration of electrolyte $\uparrow r \uparrow$
- Temperature $\uparrow r \downarrow$

Example 22:

A cell of emf 10 V and internal resistance 5Ω is connected across a resistance 15Ω . Find potential difference across AB.



Solution:

Above circuit can be redrawn as Current I through R is from A to B.

Network is simple series network.

Total resistance = $R + r = (15 + 5)\Omega = 20\Omega$

$$\text{Current } I = \frac{\varepsilon}{R + r} = \frac{10V}{20\Omega} = 0.5 \text{ A}$$

Potential difference across AB

$$V_A - V_B = IR = (0.5 \text{ A}) \times 15\Omega = 7.5 \text{ V}$$

Example 23:

What is the relationship between potential difference across the terminals of a cell and emf of the cell?

Solution:

When the cell is discharging then potential difference across its terminals is less than emf i.e. $V = \varepsilon - Ir$.

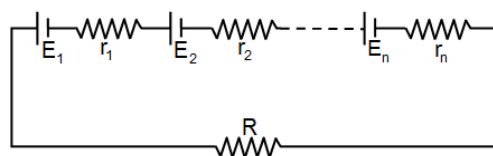
When the cell is being charged by passing current I through it, potential difference across its terminals is more than emf i.e. $V = \varepsilon + Ir$.

9.3 Combination of Cell:

(a) Series Combination

When the cells are connected in series the total e.m.f. of the series combination is equal to the sum of the e.m.f.'s of the individual cells and internal resistance of the cell also come in series.

Equivalent internal resistance



$$r = r_1 + r_2 + r_3 + \dots$$

$$\text{Equivalent emf } E = E_1 + E_2 + E_3 + \dots$$

$$\text{Current } I = \frac{E_{\text{net}}}{r_{\text{net}} + R}$$

$$\text{If all } n \text{ cells are identical then } I = \frac{nE}{nr + R}$$

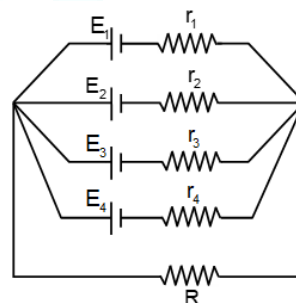
$$\bullet \text{ If } nr \gg R, I = \frac{E}{r}$$

$$\bullet \text{ If } nr \ll R, I = \frac{nE}{R}$$

(b) Parallel Combination

When the cells are connected in parallel, the cells can be replaced with a single cell of emf E_{net} & internal resistance r_{net} .

Internal resistance is



$$\frac{1}{r_{\text{net}}} = \frac{1}{r_1} + \frac{1}{r_2} + \dots$$

$$\text{and } E_{\text{net}} = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2} + \dots}{\frac{1}{r_1} + \frac{1}{r_2} + \dots}$$

If m identical cell connected in parallel then total

$$\text{internal resistance of this combination } r_{\text{net}} = \frac{r}{m}$$

Total e.m.f. of this combination $E_T = E$

Current in the circuit

$$I = \frac{E_T}{R + \frac{r}{m}} = \frac{E}{R + \frac{r}{m}} = \frac{mE}{mR + r}$$

$$\text{If } r \ll mR; I = \frac{E}{R}$$

$$\text{If } r \gg mR; I = \frac{mE}{r}$$



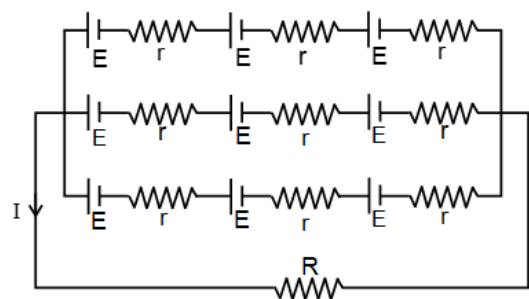
(c) **Mixed Combination**

Total number of identical cells in this circuit is nm . If n cells are connected in series and there is m such branches in the circuit.

The internal resistance of the cells connected in a row $= nr$

Total internal resistance of the circuit $r_{\text{net}} = \frac{nr}{m}$

(\because There are such m rows)



Total e.m.f. of the circuit = total e.m.f. of the cells connected in a row i.e. E_T or $E_{\text{net}} = nE$

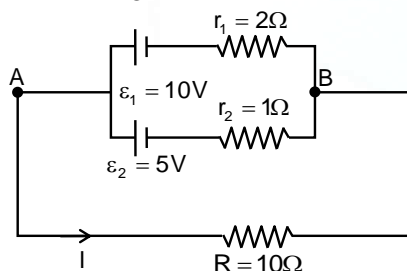
$$I = \frac{E_{\text{net}}}{R + r_{\text{net}}} = \frac{nE}{R + \frac{nr}{m}}$$

Current in the circuit is maximum when external resistance in the circuit is equal to the total internal

resistance of the cells $R = \frac{nr}{m}$

Example 24:

Find the current I through the 10Ω resistance in the network shown in figure.



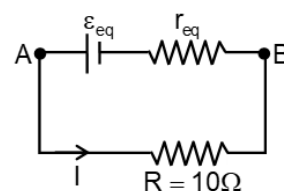
Solution:

Across A and B two cells are used in parallel so above circuit can be redrawn as

$$\epsilon_{\text{eq}} = \frac{\epsilon_1 r_2 + \epsilon_2 r_1}{r_1 + r_2} = \frac{10 \times 1 + 5 \times 2}{1 + 2} = \frac{20}{3} \text{ V}$$

$$r_{\text{eq}} = \frac{r_1 r_2}{r_1 + r_2} = \frac{1 \times 2}{1 + 2} = \frac{2}{3} \Omega$$

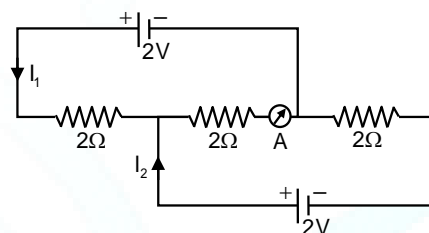
current through R



$$I = \frac{\epsilon_{\text{eq}}}{R + r_{\text{eq}}} = \frac{\frac{20}{3}}{10 + \frac{2}{3}} = \frac{20}{32} \text{ A} = \frac{5}{8} \text{ A}$$

Example 25:

The reading in the ammeter is –



- (1) 1 A (2) 2 A (3) 0.67 A (4) 1.5 A

Solution:

The circuit can be redrawn as

so the current flowing through the load will be (as based on parallel combination of cells)

$$I = \frac{E_r}{R + \frac{r}{m}} = \frac{E}{R + \frac{r}{m}} = \frac{2}{2 + \frac{2}{2}} = 0.67 \text{ Amp}$$

10. Kirchhoff's Rule

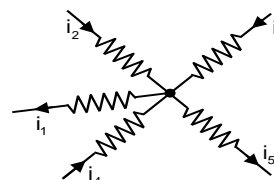
Kirchhoff in 1842 gave two laws for solving complicated electrical circuits. These laws are as follows–

10.1 First Law

In an electrical circuit, the algebraic sum of the current meeting at any junction in the circuit is zero.

OR

Sum of the currents entering the junction is equal to sum of the currents leaving the junction



$$\Rightarrow \Sigma i = 0$$

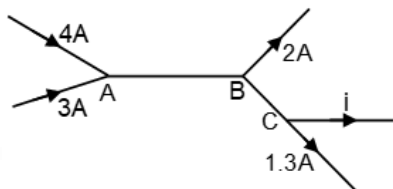
$$i_1 - i_2 - i_3 - i_4 + i_5 = 0 \text{ or } i_1 + i_5 = i_2 + i_3 + i_4$$



This law is based on law of conservation of charge. In other words, when a steady current flows in a circuit then there is neither accumulation of charge at point in the circuit nor any charge is removed from there.

Example 26:

The value of current i in the following circuit is.



- (1) 2.7 A (2) 3.7 A
(3) 3 A (4) 4 A

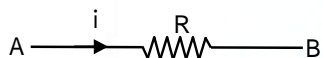
Solution:

$$i = ((4 + 3) - 2 - 1.3) = 3.7 \text{ A}$$

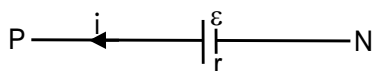
10.2 Second Law

In a 'closed' mesh of a circuit the algebraic sum of the products of the current and the resistance in each part of the mesh is equal to the algebraic sum of the e.m.f.'s in that mesh. i.e. $\sum iR = \sum E$
This law is based on 'law of conservation of energy'.

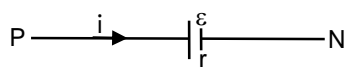
10.3 Sign Conventions



If the current is flowing through the resistance R from A to B , then potential difference across AB is $V_A - V_B = iR$ (i is determined to be positive).
Similarly potential difference across BA is, $V_B - V_A = -iR$ (i is determined to be negative).



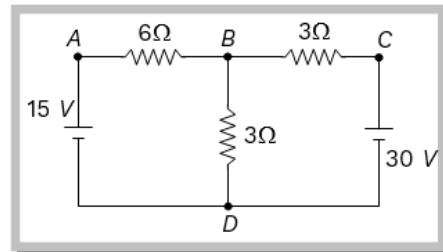
then, potential difference across the cell
 $V = V_P - V_N = \varepsilon - ir$



If the current is flowing from P to N
then $V = V_P - V_N = \varepsilon + ir$

Example 27:

In the circuit shown in figure, find the current through the branch BD



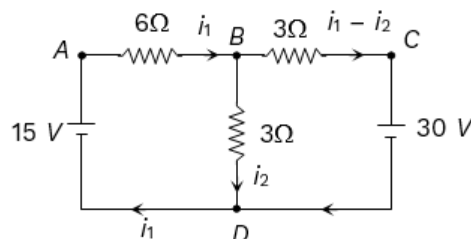
- (1) 5 A (2) 0 A (3) 3 A (4) 4 A

Solution:

The current in the circuit are assumed as shown in the fig.

Applying VL along the loop $ABDA$, we get

$$-6i_1 - 3i_2 + 15 = 0 \text{ or } 2i_1 + i_2 = 5 \quad \dots\dots (i)$$



Applying KVL along the loop $BCDB$, we get

$$-3(i_1 - i_2) - 30 + 3i_2 = 0 \text{ or } -i_1 + 2i_2 = 10 \quad (ii)$$

Solving equation (i) and (ii) for i_2 , we get $i_2 = 5 \text{ A}$

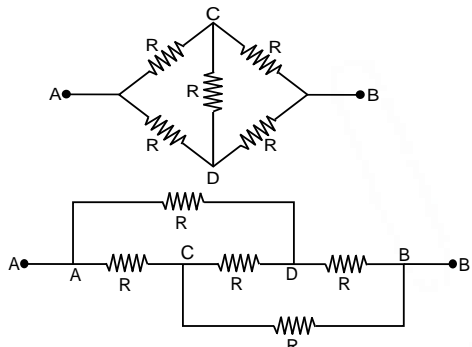
11. Wheat Stone Bridge

- The configuration in the adjacent figure is called wheat stone bridge.
- If $i_g = 0$ i.e. current in galvanometer is zero, then bridge is said to be balanced.
- For $i_g = 0$ (i) $V_D = V_B$ (ii) $\frac{P}{Q} = \frac{R}{S}$
- Equivalent resistance in balanced condition = $\frac{(P + Q)(R + S)}{P + Q + R + S}$
- If $\frac{P}{Q} < \frac{R}{S}$ then $V_B > V_D$ and current will flow from B to D .
- If $\frac{P}{Q} > \frac{R}{S}$, then $V_B < V_D$ and current will flow from D to B .
- Meter bridge and post office box work on this principle.



Example 28:

In the following figures, the resistance between A and B will respectively be –



- (1) $R/2$, R (2) $2R$, R (3) R , R (4) $3R$, R

Solution:

This is a balanced bridge ($P/Q = R/S$)

For this bridge, we can ignore the resistor between b and d.

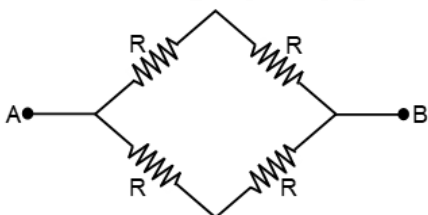


Fig (iii)

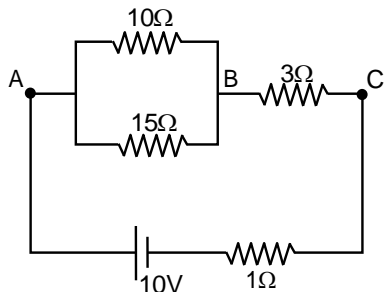
Hence both the above fig can be put as fig (iii).

Equivalent resistance in balanced condition

$$= R_{AB} = \frac{2R \times 2R}{2R + 2R} = R$$

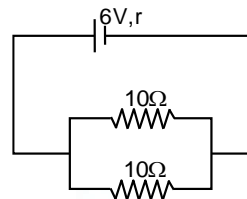
FUNDAMENTAL UNLOCKED- (FU#4) :

Q.1 In the network shown in the above figure, find the current through 3Ω and 10Ω resistances.



Q.2 A battery of emf 6 volts and internal resistance 0.4Ω is being charged. The potential difference between terminal of the battery is 7 V, then what is the current supplied to the battery?

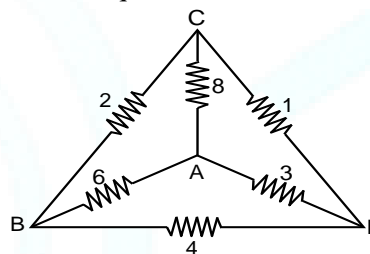
Q.3 Calculate the value of r if potential drop across 10Ω resistance is 4V.



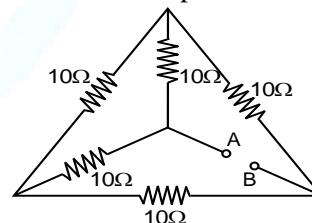
Q.4 Kirchhoff's first and second laws respectively show the conservation of

- (1) Charge and energy
- (2) Energy and charge
- (3) Mass and charge
- (4) Charge and mass

Q.5 Calculate equivalent resistance across AC



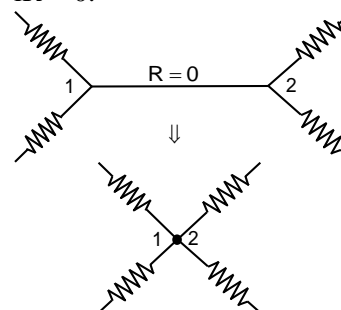
Q.6 In the adjoining network of resistors, each is of resistance 10 ohm, the equivalent resistance between points A and B is –



12. Shorting / Equipotential Points

Equipotential Points

In a current carrying electrical network, two points are said to be equipotential if they are at same potential. Between the points 1 and 2, if $\Delta V = iR = 0$.





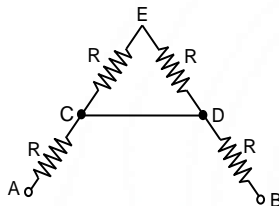
$$\Delta V = 0$$

$$V_1 = V_2 \text{ (equipotential)}$$

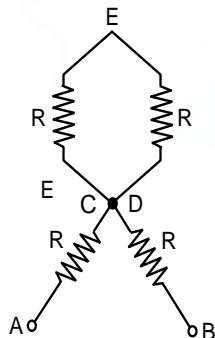
Then we have two cases, if $R = 0$, $\Delta V = 0$ ($i \neq 0$) and if $i = 0$ (R is finite) $\Delta V = 0$. The first case tells that when we connect any two points by an ideal conductor, the potential difference between them becomes zero. It is called “short circuiting”. The second case tells that, if we connect any two points by a non-zero resistor and find no current along the resistor, we can call these points equipotential. After finding equipotential points join them to a single point to simplify the given circuit.

Example 29:

Find R_{AB} .

**Solution:**

Since C and D are connected with a zero resistor they are equipotential. Then superimpose C and D to obtain the simplified circuit as shown. Since no current flows in the branches CE and ED, hence $R_{AB} = R + R = 2R$

**13. Electric Symmetry**

If the branches ab and ac have same resistances, and same current, same potential will be dropped along them. hence the branches ab and ac are electrically symmetrical. In this case, the points b and c are equipotential points. Then you can join these points

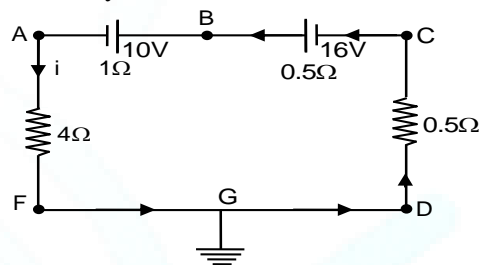
14. Earthing of a Circuit Point

If any Node/junction of the circuit is earthed, the potential of that node/junction becomes zero. i.e. the same node/junction becomes the reference potential.

Example 30:

From the fig. determine

- potential at A
- potential at C
- reading of the voltmeter connected across the 10V battery

**Solution:**

The current in circuit is (consider loop (CBAFGDC))

$$I = \frac{E_2 - E_1}{r_1 + r_2 + R_1 + R_2} = \frac{16 - 10}{1 + 0.5 + 4 + 0.5} = 1A$$

- $V_A - V_F = IR = 4$ volt

Because $V_F = 0$ (grounded), therefore $V_A = 4$ volt

- $V_D - V_C = 1 \times 0.5 = 0.5$ volt

$\therefore V_D = 0$ (grounded).

So $V_C = -0.5$ volt

- The 10V battery is being charged therefore

$$V = E + Ir = 10 + 1 \times 1 = 11 \text{ volt}$$

15. Electrical Energy & Power**15.1 Electric Energy**

When a potential difference is applied across a wire, current starts flowing in it. The free electrons collide with the positive ions of the metal and lose energy. Thus, energy taken from the battery is dissipated. The battery constantly provides energy to continue the motion of electrons and hence electric current in the circuit. Thus, energy taken from the battery gets transferred into heat. This energy is called electrical energy. This effect is also called ‘Heating Effect of Current’.

If, R = Resistance of wire

I = Current in wire



V = Potential difference across wire.

Flow of charge in 'dt' time = Idt .

Energy dissipated $dW = Vdq = VI dt$,

$$\therefore V = IR,$$

$$\therefore dW = VI dt = I^2 R dt = \frac{V^2}{R} dt = Vdq \text{ (joule)}$$

This energy is equal to work done by battery or heat produced in the wire.

Joule can be converted into calorie by using

$$1 \text{ calorie} = 4.2 \text{ Joules}$$

15.2 Electrical Power

The rate of loss of energy in an electrical circuit is called electrical power. It is denoted by 'P'

$$P = \frac{dW}{dt} = I^2 R = IV = \frac{V^2}{R}$$

units of power = joule/sec, watt, horse power

$$1 \text{ watt} = 1 \text{ joule/sec}, 1 \text{ HP} = 746 \text{ watt}$$

unit of electrical energy = watt second, kilowatt hour

$$1 \text{ kilowatt hour (kwh)} = 36 \times 10^5 \text{ Joule}$$

15.3 Power Loss in Transmission Lines

Consider a device of resistance R to be operated at voltage V and current through is I , then power of devices $P = VI$. If resistance of connecting wires from power station to the device, then

$$P_c = I^2 R_c = \frac{P^2 R_c}{V^2}$$

Therefore, to drive a device of power P , the power wasted in the connecting wires

$$P_c \propto \frac{1}{V^2} \propto R_c$$

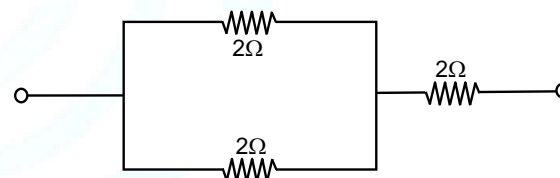
As the distance of power station is very large, R_c is considerable. So to decrease P_c , these wires carry current at enormous values of V and this is the reason for high voltage danger signs on transmission lines. These voltages are lowered to a value suitable for use by a device known as transformer.

KEY POINTS

- **Fuse Wire** : Fuse wire is used in a circuit to control the maximum current flowing in a circuit. It is a thin wire having high resistance and is made up of a material with low melting point. Current capacity $I \propto r^{3/2}$, $I \propto \ell^0$
- House wiring circuits are in parallel therefore the voltage across each bulb is constant. The power of the bulb is given by the formula : $P = V^2/R$. For constant voltage $P \propto (1/R)$ therefore, the great the resistance, the smaller is the power.
- If we take two bulbs of 60W and 100W, then the resistance of 60W bulb will be more than the resistance of 100 W bulb.
The filament of 60W bulb is thinner than the filament of 100 watt bulb.

Example 31:

Three resistances each of 2 ohm is joined as shown in the figure and each one can have maximum power of 18 watt (otherwise it will melt). The maximum power the whole circuit can take is:



- (1) 27 W (2) 9 W (3) 81 W (4) 18 W

Solution:

Electric power expended in a wire of resistance R is $P = i^2 R$

\therefore maximum current in any wire of the circuit $i =$

$$\sqrt{\left(\frac{P}{R}\right)} = \sqrt{\left(\frac{18}{2}\right)} = 3A$$

This circuit has two 2Ω wires in parallel and a third 2Ω wire in series with this parallel combination.

Hence the equivalent resistance of the whole circuit

$$\text{is } R' = \frac{2\Omega \times 2\Omega}{2\Omega + 2\Omega} + 2\Omega = 3\Omega.$$

\therefore maximum power expended in the whole circuit

$$\text{is } P_{\max} = i^2 R' = (3)^2 \times 3 = 27 \text{ watt}$$

**Example 32:**

A current of 5.0 A flows through an electric press of resistance 11Ω . Calculate the energy consumed by the press in 5 minutes.

Solution:

Here $I = 5.0 \text{ A}$; $R = 11 \Omega$;

$t = 5 \text{ min} = 5 \times 60 = 300 \text{ s}$

Electric energy consumed in 5 min

$$= I^2 R t = (5.0)^2 \times 11 \times 300 = 8.25 \times 10^4 \text{ J}$$

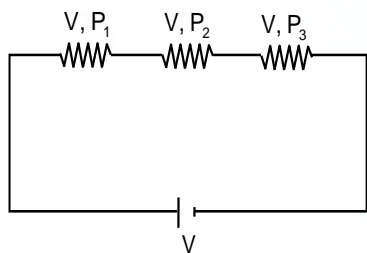
16. Connection of Electrical Appliances**16.1 Rating**

If 220V and 40W is written on an electrical instrument then this is called it's standard Ratings. It means that if 220V is applied across this instrument then 40W of power will be generated. Thus the resistance will be given by

$$R = \frac{V^2}{P} = \frac{(220)^2}{40} = 1210 \Omega$$

16.2 Series Combination

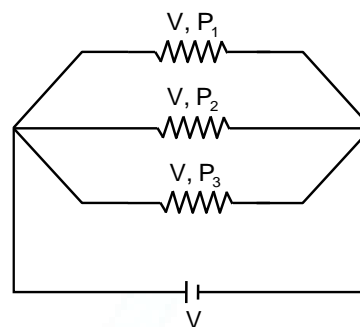
- If total power dissipated is P, then $\frac{1}{P} = \frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3} \dots (1)$



- In this combination, the bulb with least power will glow most and bulb with highest power will glow least or we can say that bulb with highest R will glow brightest and bulb with least R will glow least.

16.3 Parallel Combination

- Net power dissipation $P = P_1 + P_2 + P_3 \dots (2)$
- Bulb with least power will glow least or the bulb in which maximum current is flowing will glow brightest and vice-versa.

**Note:**

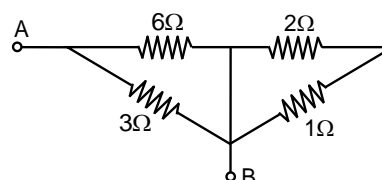
- These formulae eq. (1) & (2) are applicable only if the voltage ratings of all the instruments are equal along with the power source. If voltage ratings are different then circuit is solved by considering equivalent resistances of the instruments as follows.
- Replace the instrument by it's equivalent resistance. If standard rating is (V&P) then its resistance is $R = V^2/P$
- Find the currents and voltages in different branches using Kirchhoff's first and second laws.
- If rating of a bulb is changed from (V_1, P_1) to (V_2, P_2) then $\frac{V_1^2}{P_1} = \frac{V_2^2}{P_2} = R$ or $P_2 = \frac{V_2^2}{V_1^2} P_1$

KEY POINTS

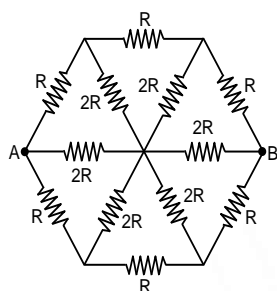
- Two identical heater coils gives total heat H_s when connected in series and H_p when connected in parallel than $H_p/H_s = 4$ [In this, it is assumed that supply voltage is same]
- If a heater boils m kg water in time T_1 and another heater boils the same water in time T_2 , then both connected in series will boil the same water in time $T_s = T_1 + T_2$ and if in parallel $T_p = T_1 T_2 / (T_1 + T_2)$
- Instruments based on heating effect of current, works on both A.C. and D.C. Equal value of A.C. (RMS) and D.C. produces, equal heating effect. That's why brightness of bulb is same whether it is operated by A.C. or same value D.C.

FUNDAMENTAL UNLOCKED- (FU#5) :

Q.1 Calculate equivalent Resistance across AB



Q.2 Find R_{AB} .

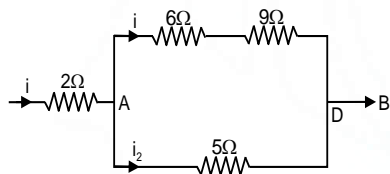


Q.3 A lamp of 100 W works at 220 volt. What is its resistance and current capacity ?

Q.4 A 220 volt 100 watt bulb is connected to a 110 volt source. The power consumed by the bulb will be

- (1) 25 W (2) 20 W
(3) 484 W (4) 120 W

Q.5 If heat generated in 5 ohm resistor due to current flowing in it is 45 J/s then find the rate of heat generated in 2 ohm resistor and potential different across 6 ohm resistor.



- (1) 32 J/s, 6V (2) 16 J/s, 3V
(3) 8 J/s, 1V (4) 64 J/s, 12V

Q.6 A 60 W –200 V bulb and 100 W – 220 V bulb are connected in parallel to mains supply. Which bulb will draw more current ?

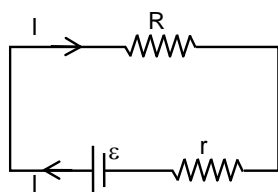
17. Power Distribution by Cell

(i) When a load resistance 'R' is connected with a battery of EMF ' ϵ ' & internal resistance 'r'. then

(a) Current through the load $I = \frac{\epsilon}{R + r}$

Power delivered at the load

$$P = I^2 R = \frac{\epsilon^2 R}{(R + r)^2}$$



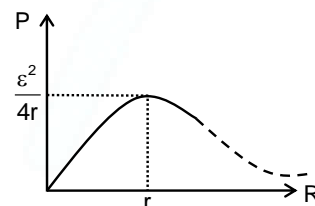
Power delivered at load is maximum, when

$$\frac{dP}{dR} = 0$$

Solving above equation $R = r$

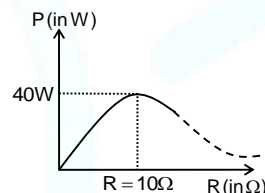
$$P_{\max} = \frac{\epsilon^2 r}{(r + r)^2} = \frac{\epsilon^2}{4r} = \frac{\epsilon^2}{4R}$$

(b) P versus R graph will be



Example 33:

The power delivered across a variable load varies with load resistor as shown. Find out its emf & internal resistance



Solution:

For maximum power delivery

$$r = R = 10\Omega$$

$$P_{\max} = 40W = \frac{\epsilon^2}{4r} \Rightarrow \epsilon = 40V$$

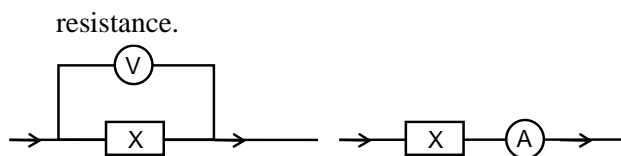
Measuring Devices

18. Current & Voltage Measurement

In D.C. circuits, we talked about emf, voltage, current and resistance. We measure the unknown

resistance by using Ohm's law as $R = \frac{V}{I}$. The

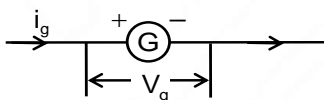
voltage across any circuit element can be measured by "voltmeter" and current along any branch can be measured by "ammeter". The emf of a cell can be measured by "potentiometer". Generally, we measure the voltage and current in a circuit element X by connecting the voltmeter and ammeter in two possible ways. The basic instrument that can be used for measuring both voltage and current is called "galvanometer". A galvanometer can be used as an ammeter and voltmeter by attaching it with a suitable



18.1 Galvanometer

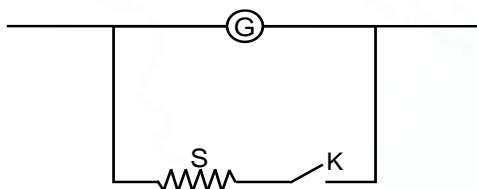
This device measures the current by means of magnetic force which will be discussed in next chapter. The maximum current that can flow through the galvanometer is current i_g and the corresponding voltage drop across the galvanometer is V_g .

Then $\frac{V_g}{i_g} = \text{Galvanometric resistance} = G$.



(A) Shunt:

The small resistance connected in parallel to galvanometer coil, in order to control current flowing through the galvanometer is known as shunt.



(B) Merits of Shunt:

- To protect the galvanometer coil from burning
- It can be used to convert any galvanometer into ammeter of desired range.

(C) **Demerits of Shunt:** Shunt resistance decreases the sensitivity of galvanometer.

18.2 Ammeter

- Ammeter is a shunted galvanometer which is used to measure current in a circuit.
- It is always connected in series so that the entire current passes through it.
- In principle, the current in the circuit must not change when a current measuring device like ammeter is introduced in the circuit therefore,

AN IDEAL AMMETER MUST HAVE ZERO RESISTANCE.

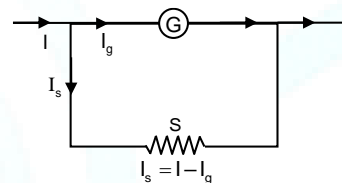
- However in practice, a moving coil meter has some resistance. Due to this the current in circuit is modified (reduced) when a moving coil ammeter is connected in circuit.

18.3 Voltmeter

Voltmeter is a device used to measure p.d. across two points in an electrical circuit. It is connected in parallel to these points. i.e. in parallel to the circuit.

18.4 Conversion of Galvanometer into Ammeter

- A galvanometer can be converted into an ammeter of a given range by connecting low resistance in parallel to its coil.



- From fig. $I_g G = (I - I_g) S$ or $S = \frac{I_g G}{I - I_g}$
- Higher is the range of I of ammeter, lower is the value of S required for conversion of galvanometer into ammeter.

The effective resistance of the ammeter is

$$R_A = \frac{GS}{G + S}$$

For an IDEAL AMMETER, $R_A = 0$

Example 34:

If only one hundredth part of total current flowing in the circuit is to be passed through a galvanometer of resistance $G\Omega$, Then the value of shunt resistance required will be-

- (1) $G/10$ (2) $G/100$ (3) $G/99$ (4) $G/999$

Solution:

$$S = \frac{G}{n-1} = \frac{G}{100-1} = \frac{G}{99} \Omega$$

Example 35:

A galvanometer has a coil of resistance of 60Ω and shows a full-scale deflection for $50 \mu A$ current. To convert this galvanometer into an ammeter of range 10 mA , required shunt resistance will be-

- (1) 0.30Ω (2) 0.20Ω (3) 0.6Ω (4) 0.40Ω



Solution:

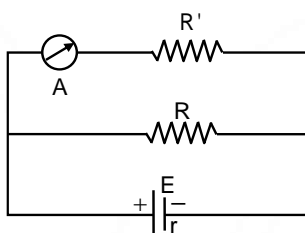
Given $I_g = 50 \mu A = 50 \times 10^{-6} A$

$$I = 10 \text{ mA} = 10 \times 10^{-3} A, G = 60 \Omega \quad \text{thus } S = \frac{I_g G}{I - I_g}$$

$$= \frac{50 \times 10^{-6} \times 60}{10 \times 10^{-3} - 50 \times 10^{-6}} = 0.30 \Omega$$

Example 36:

In the circuit shown below, if the value of R is increased then what will be the effect on the reading of ammeter if the internal resistance of cell is not negligible-



- (1) The reading of A will decrease
- (2) The reading of A will increase
- (3) The reading of A will remain unchanged
- (4) The reading of A will become zero.

Solution:

Current in the ammeter

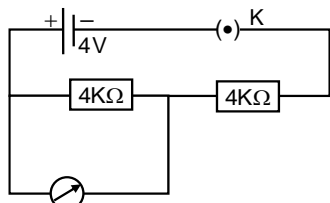
$$I = \frac{R}{R + R'} \left[\frac{E}{r + \frac{RR'}{R + R'}} \right] \quad I = \frac{E}{R' + r \left[1 + \frac{R'}{R} \right]}$$

On increasing the value of R , the denominator will decrease and consequently the value of I will increase.

Both R & R' are connected in parallel. If R increases then current in R' increases

Example 37:

In the circuit shown below fig. if the resistance of voltmeter is $4K\Omega$, then the error in the reading of voltmeter will be-

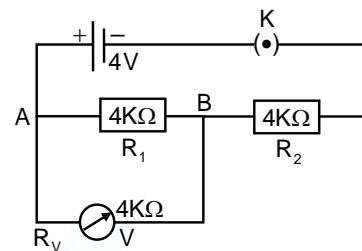


- (1) 50%
- (2) 68%
- (3) 17%
- (4) 33.3%

Solution:

The potential difference between A and B in the absence of voltmeter = 2 Volt.

Current flowing in the circuit



$$I = \frac{E}{R_2 + \frac{R_1 R_V}{R_1 + R_V}} \quad I = \frac{4}{4 + \frac{4 \times 4}{4 + 4}} = \frac{2}{3} A$$

\Rightarrow Potential difference measured by voltmeter

$$V'_{AB} = IR' = \frac{2}{3} \times 2 = \frac{4}{3} V$$

\Rightarrow Error in the reading of voltmeter

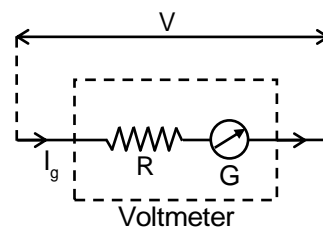
$$= V_{AB} - V'_{AB} = 2 - \frac{4}{3} = \frac{2}{3} V$$

$$\Rightarrow \% \text{ error} = \frac{V_f - V_i}{V_i} \times 100 = \frac{\frac{4}{3} - 2}{2} \times 100 = -33.3 \%$$

18.5 Conversion of Galvanometer into Voltmeter:

- A galvanometer is converted into a voltmeter by connecting a high resistance R in series with the galvanometer.
- From fig.

$$I_g (R + G) = V \text{ or } R = \frac{V}{I_g} - G$$



- Higher is the range of V of the voltmeter, higher is the value of R required for conversion of galvanometer into voltmeter.
- The effective resistance of the voltmeter is $R_V = R + G$
For an IDEAL VOLTMETER, $R_V = \infty$.

Example 38:

A voltmeter, an ammeter and a resistance are connected in series to an accumulator. There is a deflection in the voltmeter but the deflection in ammeter is negligible. Why?

Solution:

The voltmeter being in series, the resistance of the circuit becomes very high and so the current very low. This current on passing through the coil of the voltmeter produces some deflection, but in ammeter most of its part goes through the shunt of the ammeter and so the current going in the coil of the ammeter is too small to produce any deflection.

19. Meter Bridge

It is an instrument based on the balanced Wheatstone bridge to measure the unknown resistance X . It is fitted between the tapping points B and C and a known resistance R is fitted between the tapping points A and B . The slider D is moved along the meter bridge wire AC till i_g will be zero at any point D , (say).

Then, $\frac{R_{AD}}{R_{DC}} = \frac{\ell_1}{\ell_2}$, where ℓ_1 and ℓ_2 are the lengths of

the resistance R_{AD} and R_{DC} measured by the scale. If $\ell_1 + \ell_2 = 1$ m, $\ell_1 = y$, we have $\ell_2 = (1 - y)$. After

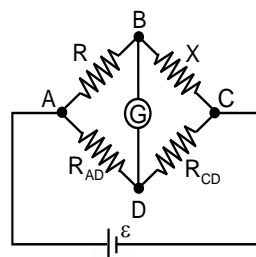
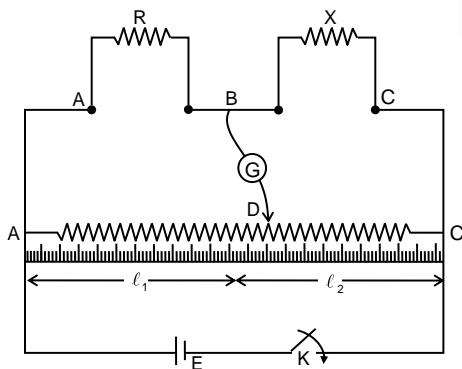
finding the value of $\frac{\ell_1}{\ell_2}$, equate it with the ratio R/X

to obtain the unknown resistance.

$$\frac{R}{x} = \frac{y}{(1-y)}$$

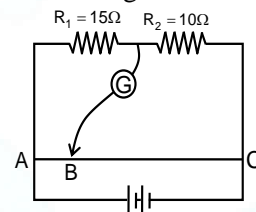
if y in cm

$$\frac{R}{x} = \frac{y}{100-y}$$



Example 39:

In the meter bridge shown in figure. find the length AB for null deflection in galvanometer.



Solution:

Let $AB = \ell$ cm then $BC = (100 - \ell)$ cm

At zero deflection of galvanometer, $\frac{R_1}{R_2} = \frac{R_{AB}}{R_{BC}} =$

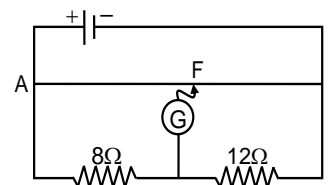
$$\frac{\ell}{100 - \ell}$$

$$\Rightarrow \frac{15}{10} = \frac{\ell}{100 - \ell} \Rightarrow \frac{3}{2} = \frac{\ell}{100 - \ell}$$

$$\Rightarrow 5\ell = 300 \Rightarrow \ell = 60 \text{ cm}$$

Example 40:

Let the meter bridge wire AB shown in figure is 40 cm long. When the sliding contact (jockey) is pressed at F , the galvanometer shows zero (null) deflection. The balancing length AF is-



(1) 8 cm

(2) 16 cm

(3) 24 cm

(4) 40 cm

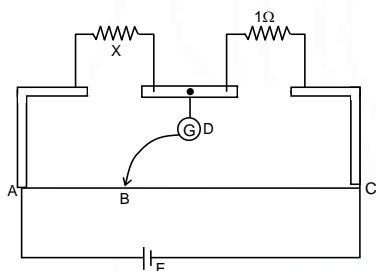
Solution:

For balancing point to be at F ,

$$\frac{\text{length } AF}{\text{length } FB} = \frac{8}{12} \quad \text{or} \quad \frac{\ell}{40 - \ell} = \frac{8}{12} \quad \text{or} \quad \ell = 16 \text{ cm}$$

FUNDAMENTAL UNLOCKED- (FU#6) :

- Q.1** The shunt required for 10% of main current to be sent through the moving coil galvanometer of resistance 99Ω will be-
 (1) 0.9Ω (2) 11Ω
 (3) 90Ω (4) 9.9Ω
- Q.2** What value of shunt is required to measure a current of 10.1 amp by using a galvanometer of rating $\frac{1}{10}$ amp, 6Ω ?
- Q.3** A galvanometer having 30 divisions has a current sensitivity of $20\mu\text{A/divisions}$. It has a resistance of 25Ω . To convert it into an ammeter measuring upto 1A and voltmeter reading upto 1 volt, the resistances required will be respectively-
- Q.4** In the meter bridge, the balancing length AB = 20 cm. The unknown resistance X is equal to



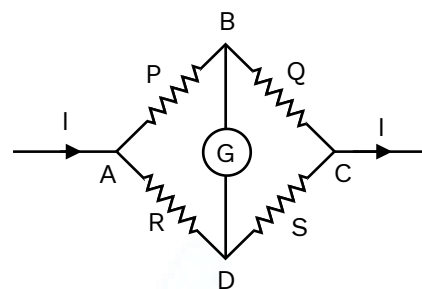
- Q.5** An unknown resistance R_1 is connected in series with 10Ω . When the combination is connected to left gap of a meter bridge and R_2 is connected to right gap, balance point from left end is at 50 cm. When the 10Ω is removed the balance point shifts to 40 cm. The value of R_1 is

20. Experiments

20.1 The resistivity of the material of a given wire using a meter bridge.

Meter bridge : The resistance of a metal wire depends on its length, area of cross-section and resistivity of the metal. The formula is

$$R = \rho \frac{\ell}{A}$$

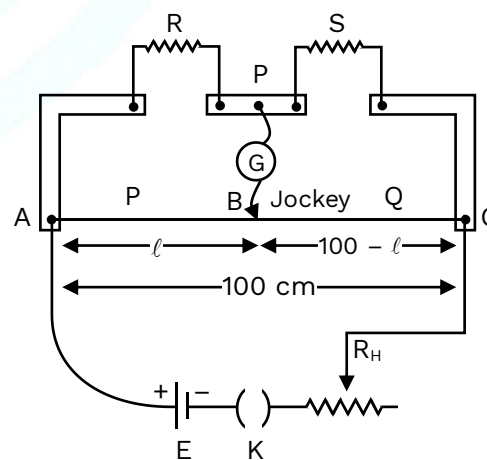


Here, ρ is the resistivity. Its unit is $\Omega\text{-m}$ (ohm-meter). To measure its resistivity, we use a meter bridge. The working of a meter bridge is based on balanced Wheatstone bridge principle.

The circuit shown is called Wheatstone bridge.

When $\frac{P}{Q} = \frac{R}{S}$, there is no flow of current in the branch BD. i.e., galvanometer shows zero deflection.

Arrangement : The arrangement consists of a 100 cm long wire connected between A and C. It is tapped at point B by a sliding contact called jockey. R is a known resistance. S is the resistance wire whose resistivity is to be determined. A cell and a variable resistance R_H are connected to supply current in the circuit.



Procedure : Following steps are used in the experiment.

1. Plug the key and slide the jockey on wire AC to locate point B where the galvanometer does not show deflection. Note down the length ℓ .
2. Compute the resistance S using the formula



$$\frac{P}{Q} = \frac{R}{S}$$

Here,

$$P = \rho_{\text{wire}} \times \frac{\ell}{A}$$

$$Q = \rho_{\text{wire}} \times \frac{100 - \ell}{A}$$

$$\therefore S = R \left(\frac{100 - \ell}{\ell} \right)$$

3. Compute the value of S by determining different values of length ℓ . This can be done by using different values of R .
4. Calculate the percentage error in measurement of S .
5. Compute the resistivity by measuring length and area of cross-section of resistance wire S using the formula $\rho = S \frac{A}{\ell}$.

FUNDAMENTAL UNLOCKED- (FU#7) :

1. The resistance of the conductor of unit length and unit area of cross-section is called
 - (1) Conductance
 - (2) Capacitance
 - (3) Specific resistance
 - (4) Conductivity
2. A meter bridge works on the principle of
 - (1) Balanced Wheatstone bridge
 - (2) Kirchhoff's voltage law
 - (3) Kirchhoff's current law
 - (4) Principle of superposition
3. Choose the correct statement regarding meter-bridge
 - (1) A meter bridge works on the principle of null-deflection.
 - (2) The meter bridge usually consists of a wire of length 1 m and of uniform cross-sectional area.
 - (3) The meter bridge is used for the precise measurement of low resistance
 - (4) All of these
4. in a meter bridge, there are two unknown resistances R_1 and R_2 . The ratio of R_1 and R_2 , if the galvanometer shows a null deflection at 30 cm from one end.
 - (1) 2 : 7
 - (2) 5 : 4
 - (3) 3 : 7
 - (4) 2 : 9
5. A resistance wire connected in the left gap of the meter bridge balances a 12Ω resistance in the right gap. This happens at a point where the bridge wire is divided in the ratio 2 : 1. Assuming length of wire to be 1 m, Calculate the approximate length of 1Ω resistance wire
 - (1) 2.1 cm
 - (2) 4.2 cm
 - (3) 6.1 cm
 - (4) 5.9 cm
6. In an experiment to find the resistivity of material using meter bridge, the null point was found to be at 60 cm as shown. The value of resistance Q is

 - (1) 2 Ω
 - (2) 4 Ω
 - (3) 5 Ω
 - (4) 6 Ω
7. In an experiment to find the resistivity of material using meter bridge, the resistance of wire is 16Ω . The resistivity of material of wire of length 1 m and radius 1 mm is
 - (1) $16\pi \times 10^{-7} \Omega\text{m}$
 - (2) $16\pi \times 10^{-6} \Omega\text{m}$
 - (3) $4\pi \times 10^{-7} \Omega\text{m}$
 - (4) $4\pi \times 10^{-6} \Omega\text{m}$
8. The best material used for making connecting wires among given options is
 - (1) Tungsten
 - (2) Iron
 - (3) Nichrome
 - (4) Copper
9. The wire of meter-bridge needs to have
 - (1) High specific heat and low temperature coefficient of resistance
 - (2) Low specific heat and low temperature coefficient of resistance
 - (3) Low specific heat and high temperature coefficient of resistance
 - (4) High specific heat and high temperature coefficient of resistance



10. The device used to measure small electric current in a circuit

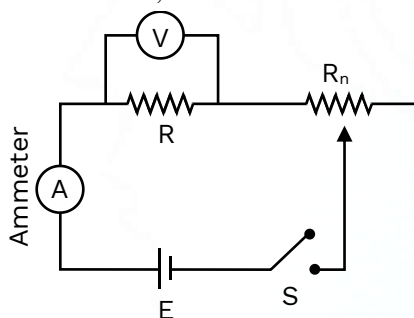
- (1) Meter bridge (2) Voltmeter
(3) Galvanometer (4) Resistance

20.2 The resistance of a given wire using Ohm's law.

According to ohm's law, the current flowing through a metallic conductor is directly proportional to the potential difference across the ends of the conductor provided the physical conditions like temperature and mechanical strain etc are kept constant.

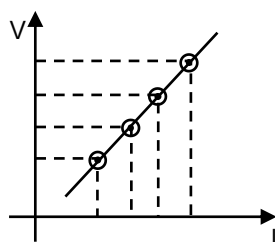
$V = IR$, where R is a constant called resistance

Arrangement : The figure shows the arrangement used to measure resistance of a wire. It consists of a cell of emf E , connected to a fixed resistance R and a variable resistance R_H . An ammeter is connected in the circuit to measure current/and a voltmeter is connected across the fixed resistance R to measure potential difference V ,



Procedure : Following steps are to be followed.

1. Close the switch S and note down the readings of voltmeter and ammeter.
2. Repeat the above process for different values of variable resistance R_H .
3. Plot a graph between V and I by taking V along y-axis and I along x-axis.
4. Slope or gradient of this graph is constant. This shows that $V \propto I$



FUNDAMENTAL UNLOCKED- (FU#5) :

Q.1 The Ohm's law for a metallic conductor can be represented by

- (1) $\frac{\text{Potential Difference}}{\text{Current}} = \text{Resistance}$
(2) $\text{Current} = \text{Resistance} \times \text{Potential difference}$
(3) $\text{Current} = \frac{\text{Resistance}}{\text{Potential difference}}$
(4) Both (2) and (3)

Q.2 According to Ohm's law current flowing through a conductor is directly proportional to the potential difference across its ends provided that

- (1) Temperature of the conductor remains constant
(2) Dimensions of conductor remains constant
(3) Temperature and physical conditions keep changing
(4) Both (1) and (2)

Q.3 Choose the correct statement among the following

- (1) Resistance of a material is independent of current passing through it.
(2) Resistance of a material is its tendency to oppose passage of free electrons
(3) Every material generally has resistance
(4) All of these

Q.4 The resistance of a conductor increases with increase in

- (1) Current (2) Potential difference
(3) Temperature (4) Both (1) and (2)

Q.5 The resistance of a wire depends on

- (1) Length of the wire
(2) Area of cross-section of the conductor
(3) Nature of material and temperature across conductor
(4) All of these

Q.6 An electrical instrument that is used for controlling the current by varying the resistance is

- (1) Voltmeter (2) Ammeter
(3) Galvanometer (4) Rheostat



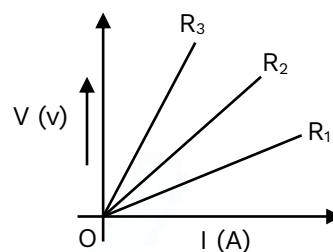
Q.7 Ammeter and voltmeter readings were recorded as 0.5 A and 1 V during the experiment to determine the resistance of a given wire using Ohm's law. The correct value of the resistance is

- (1) $1\ \Omega$ (2) $10.5\ \Omega$
(3) $2\ \Omega$ (4) $4.5\ \Omega$

Q.8 To measure potential difference across an element in a circuit

- (1) Voltmeter is connected in parallel to the element
(2) Voltmeter is connected in series to the element
(3) Ammeter is connected in parallel to the element
(4) Ammeter is connected in series to the element

Q.9 For the given V-I graphs it can be concluded that



- (1) $R_1 > R_2 > R_3$ (2) $R_1 < R_2 > R_3$
(3) $R_1 = R_2 = R_3$ (4) $R_3 > R_2 > R_1$

Q.10 The shape of V vs I graph for a ohmic conductor is

- (1) Parabola
(2) Straight line
(3) Hyperbola
(4) None of these




ANSWER KEY
FUNDAMENTAL UNLOCKED- (FU#1) :

- | | | |
|------------------------------|-------------------------------|-------------------------|
| 1. 3.2×10^{-11} amp | 2. 1.01×10^{-12} amp | 3. 3.6 A/mm^2 |
| 4. 0.15 mm/s | 5. (1) | |

FUNDAMENTAL UNLOCKED- (FU#2) :

- | | |
|----------------------------|---------------------|
| 1. 1.25×10^{19} | 2. $R = 0.6 \Omega$ |
| 3. ρ remains the same | 4. 20Ω |
| 5. $R' = 4R$ | |

FUNDAMENTAL UNLOCKED- (FU#3) :

- | | |
|------------------------|---|
| 1. (3) | 2. (1) |
| 3. (2) | 4. $R_{eq} = R/2$ |
| 5. $R_{AB} = 18\Omega$ | 6. $R_{AB} = 13.5 \Omega$ 7. $R_{AB} = 2\Omega$ |

FUNDAMENTAL UNLOCKED- (FU#4) :

- | | |
|--|------------------------|
| 1. $I_{10a} = \frac{3}{5} \text{ A}; I_{3a} = 1 \text{ A}$ | 2. $I = 2.5 \text{ A}$ |
| 3. $r = 2.5 \Omega$ | 4. (1) |
| 5. $R_{eq} = 2\Omega$ | 6. $R_{eq} = 10\Omega$ |

FUNDAMENTAL UNLOCKED- (FU#5) :

- | | |
|---|----------------------|
| 1. $R_{eq} = 2\Omega$ | 2. $\frac{28}{27} R$ |
| 3. $R = 484 \Omega, I = 0.45 \text{ A}$ | |
| 4. (1) | 5. (1) |
| 6. 100 W, 220 V will draw more current | |

FUNDAMENTAL UNLOCKED- (FU#6) :

- | | | |
|-----------------------------|----------------------|---|
| 1. $S = 11\Omega$ | 2. $S = 0.06 \Omega$ | 3. $S = 0.015 \Omega, R = 1641.67 \Omega$ |
| 4. $x = \frac{1}{4} \Omega$ | 5. $R_1 = 20\Omega$ | |

FUNDAMENTAL UNLOCKED- (FU#7) :

- | | | | |
|--------|---------|--------|--------|
| 1. (3) | 2. (1) | 3. (4) | 4. (3) |
| 5. (2) | 6. (2) | 7. (2) | 8. (4) |
| 9. (1) | 10. (3) | | |

FUNDAMENTAL UNLOCKED- (FU#8) :

- | | | | |
|--------|---------|--------|--------|
| 1. (1) | 2. (4) | 3. (4) | 4. (3) |
| 5. (4) | 6. (4) | 7. (3) | 8. (1) |
| 9. (4) | 10. (2) | | |





EXERCISE - I

Electric Current, Average Current, Types of Current, Instantaneous & Average Current

1. A current of 5 A exist on a 10 ohm resistance for 4 min. How much charge pass through any cross-section of the resistor in this time?
(1) 12 coulombs (2) 120 coulombs
(3) 1200 coulombs (4) 12000 coulombs
2. A charge of 2×10^{-2} C moves at 30 revolution per second in a circle of diameter 0.80 m. The current linked with the circuit will be:
(1) 0.1 A (2) 0.2 A (3) 0.4 A (4) 0.6 A
3. The current in a conductor varies with time t is $I = 2t + 3t^2$ where I is in ampere and t in seconds. Electric charge flowing through a section of conductor during $t = 2$ sec to $t = 3$ sec. is:
(1) 10 C (2) 24 C (3) 33 C (4) 44 C

Current Density, Drift Velocity, Free Charge Density, Mean Relaxation Time, Mean Free Path

4. The drift velocity of electrons in a conducting wire is of the order of 1 mm/s, yet the bulb glows very quickly after the switch is put on because:
(1) The random speed of electrons is very high, of the order of 10^5 m/s
(2) The electrons transfer their energy very quickly through collisions
(3) Electric field is set up in the wire very quickly, producing a current through each cross section, almost instantaneously
(4) All of above
5. A steady current is passing through a linear conductor of non-uniform cross-section. The net quantity of charge crossing any cross-section per second is:
(1) independent of area of cross-section
(2) directly proportional to the length of conductor
(3) directly proportional to the area of cross-section
(4) inversely proportional to the lengths of conductor

6. A current (I) flows through a uniform wire of diameter (d) when the mean drift velocity is v . The same current will flow through a wire of diameter $d/2$ made of the same material then the mean drift velocity of the electron is -
(1) $v/4$ (2) $v/2$ (3) $4v$ (4) $2v$
7. A wire of non-uniform cross-section is carrying a steady current along the wire:
(1) current and current density are constant
(2) only current is constant
(3) only current density is constant
(4) neither current nor current density is constant
8. A cross-sectional area of a copper wire is 3×10^{-6} m². The current of 4.2 amp is flowing through it. The current density in amp/m² through the wire is -
(1) 1.4×10^3 (2) 1.4×10^4
(3) 1.4×10^5 (4) 1.4×10^6

Ohm's Law, Resistance, Conductance, Mobility

9. The current in a copper wire is increased by increasing the potential difference between its end. Which one of the following statements regarding n , the number of charge carriers per unit volume in the wire and v the drift velocity of the charge carriers is correct:
(1) n is unaltered but v is decreased
(2) n is unaltered but v is increased
(3) n is increased but v is decreased
(4) n is increased but v is unaltered
10. A potential difference V exists between the ends of a metal wire of length ℓ . The drift velocity will be doubled if -
(1) V is doubled
(2) ℓ is doubled
(3) The diameter of the wire is doubled
(4) The temperature of the wire is doubled



11. There is a current of 1.344 amp in a copper wire whose area of cross-section normal to the length of the wire is 1mm^2 . If the number of free electrons per cm^3 is 8.4×10^{22} , then the drift velocity would be:

(1) 1.0 mm per sec (2) 1.0 metre per sec
(3) 0.1 mm per sec (4) 0.01 mm per sec

12. When the resistance of copper wire is $0.1\ \Omega$ and the radius is 1 mm, then the length of the wire is (specific resistance of copper is $3.14 \times 10^{-8}\ \text{ohm} \times \text{m}$):

(1) 10 cm (2) 10 m (3) 100 m (4) 100cm

13. When a potential difference (V) is applied across a conductor, the thermal speed of electrons is -

(1) zero (2) proportional to \sqrt{T}
(3) proportional to T (4) proportional to V

14. Specific resistance of a wire depends on the

(1) length of the wire
(2) area of cross-section of the wire
(3) resistance of the wire
(4) material of the wire

15. The resistance of wire is $20\ \Omega$. The wire is stretched to three times its length. Then the resistance will now be -

(1) $6.67\ \Omega$ (2) $60\ \Omega$
(3) $120\ \Omega$ (4) $180\ \Omega$

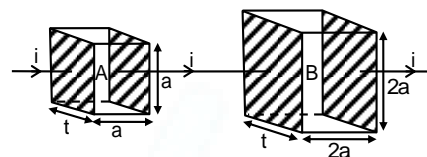
16. The dimensions of a manganin block are $1\text{ cm} \times 1\text{ cm} \times 100\text{ cm}$. The electrical resistivity of manganin is $4.4 \times 10^{-7}\ \text{ohm-meter}$. The resistance between the opposite rectangular faces is -

(1) $4.4 \times 10^{-7}\ \text{ohm}$ (2) $4.4 \times 10^{-3}\ \text{ohm}$
(3) $4.4 \times 10^{-5}\ \text{ohm}$ (4) $4.4 \times 10^{-1}\ \text{ohm}$

17. When the resistance wire is passed through a die the cross-section area decreases by 1%, the change in resistance of the wire is -

(1) 1% decrease (2) 1% increase
(3) 2% decrease (4) 2% increase

18. In the following diagram two parallelepiped A and B are of the same thickness. The arm of B is double that of A. Compare these resistances and find out the value of R_A/R_B is:



(1) 1 (2) 2 (3) $\frac{1}{2}\pi$ (4) 4

19. The resistance of a semi-conductors:

(1) increases with increase of temperature
(2) decreases with increase of temperature
(3) does not change with change of temperature
(4) first decreases and then increases with increase of temperature

20. Ohm's law is valid when the temperature of the conductor is:

(1) constant (2) very high
(3) very low (4) varying

21. A certain piece of copper is to be moulded into a wire of minimum resistance. Its length and diameter should be respectively:

(1) ℓ, d (2) $2\ell, d$ (3) $\ell/2, 2d$ (4) $2\ell, d/2$

22. A wire has a resistance of $10\ \Omega$. A second wire of the same material is having length double and radius of cross-section half that of the wire. The resistance of the second wire is:

(1) $20\ \Omega$ (2) $40\ \Omega$ (3) $80\ \Omega$ (4) $10\ \Omega$

23. A cylindrical copper rod is reformed to twice its original length with no change in volume. The resistance between its ends before the change was (R). Now its resistance:

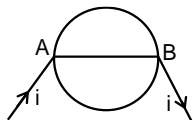
(1) 8R (2) 6R (3) 4R (4) 2R

24. Length of a hollow tube is 5m, it's outer diameter is 10 cm and thickness of it's wall is 5 mm. If resistivity of the material of the tube is $1.7 \times 10^{-8}\ \Omega \times \text{m}$ then resistance of tube will be:

(1) $5.6 \times 10^{-5}\ \Omega$ (2) $2 \times 10^{-5}\ \Omega$
(3) $4 \times 10^{-5}\ \Omega$ (4) None of these



25. A wire of resistance $0.5\Omega \text{ m}^{-1}$ is bent into a circle of radius 1m. The same wire is connected across a diameter AB as shown in fig. The equivalent resistance is:



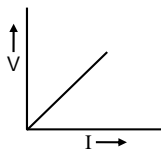
- (1) $\pi \Omega$ (2) $\frac{\pi}{\pi + 2} \Omega$
 (3) $\frac{\pi}{\pi + 4} \Omega$ (4) $(\pi + 1) \Omega$

26. Read the following statements carefully:
 Y : The resistivity of semiconductor decreases with increases of temperature.
 Z : In a conducting solid, the rate of collisions between free electrons and ions increases with increase of temperature.
 Select the correct statement (s) from the following:

- (1) Y is true but Z is false
 (2) Y is false but Z is true
 (3) Both Y and Z are true
 (4) Y is true and Z is the correct reason for Y

27. A wire is cut into 4 pieces, which are put together side by side to obtain one conductor. If the original resistance of the wire was R. The resistance of the bundle will be:
 (1) $R/4$ (2) $R/8$ (3) $R/16$ (4) $R/32$

28. The current -voltage variation for a wire of copper of length (L) and area (A) is shown in fig. The slope of the line will be:



- (1) less if experiment is done at a higher temperature
 (2) more if a wire of silver of same dimensions is used
 (3) will be doubled if the lengths of the wire is doubled
 (4) will be halved if the length is doubled

29. When there is an electric current through a conducting wire along its length, then an electric field must exist:

- (1) outside the wire but normal to it
 (2) outside the wire but parallel to it
 (3) inside the wire but parallel to it
 (4) inside the wire but normal to it

30. Consider two conducting wires of same length and material, one wire is solid with radius r. The other is a hollow tube of outer radius 2r while inner radius r. The ratio of resistance of the two wires will be:

- (1) 1 : 1 (2) 2 : 1 (3) 3 : 1 (4) 4 : 1

31. A steady current is passing through a linear conductor of non-uniform cross-section. The current density in the conductor is:

- (1) independent of area of cross-section
 (2) directly proportional to area of cross-section
 (3) inversely proportional to area of cross-section
 (4) inversely proportional to the square root of area of cross-section

32. The sides of a rectangular block are 2cm, 3cm and 4 cm. The ratio of maximum to minimum resistance between its parallel faces is -

- (1) 4 (2) 3 (3) 2 (4) 1

33. When a piece of aluminium wire of finite length is drawn through a series of dies to reduce its diameter to half its original value, its resistance will become-

- (1) two times (2) four times
 (3) eight times (4) sixteen times

Resistivity, Temperature Dependence of Resistivity, Concept of Super Conductors

34. The resistance of some substances become zero at very low temperature, then these substances are called -

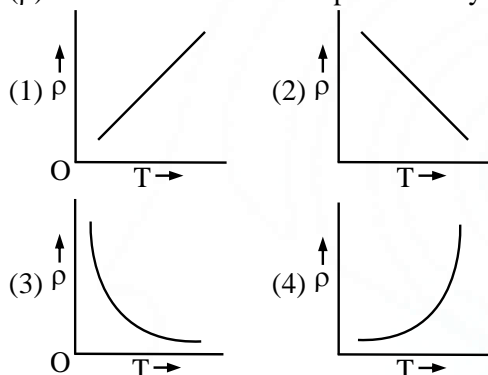
- (1) good conductors
 (2) super conductors
 (3) bad conductors
 (4) semi conductors



35. If the temperature of iron and silicon wires is increased from 30°C to 50°C , the correct statement is –
- (1) resistance of both wires increase
 - (2) resistance of both wires decrease
 - (3) resistance of iron wire increases and the resistance of silicon wire decreases
 - (4) resistance of iron wire decreases and the resistance of silicon wire increases

36. When the temperature of a metallic conductor is increased, its resistance –
- (1) always decreases
 - (2) always increases
 - (3) may increase or decrease
 - (4) remains the same

37. The temperature (T) dependence of resistivity (ρ) of a semiconductor is represented by –



38. A carbon and an aluminium wire connected in series. If the combination has resistance of 30 ohm at 0°C , what is the resistance of carbon and aluminium wire at 0°C so that the resistance of the combination does not change with temperature:

$$[\alpha_c = -0.5 \times 10^{-3} (\text{C}^{\circ})^{-1} \text{ and } \alpha_{Al} = 4 \times 10^{-3} (\text{C}^{\circ})^{-1}]$$

- (1) $\frac{10}{3} \Omega, \frac{80}{3} \Omega$
- (2) $\frac{80}{3} \Omega, \frac{10}{3} \Omega$
- (3) $10 \Omega, 80 \Omega$
- (4) $80 \Omega, 10 \Omega$

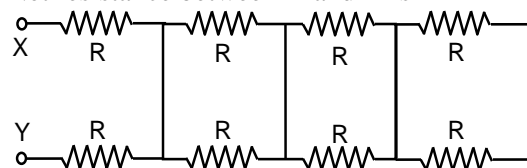
39. A potential difference of 200 V is applied to a coil at a temperature of 15°C and the current is 10A. What will be the mean temperature of the coil when the current has fallen to 5A, the applied voltage being the same as before –

$$\left(\text{Given } \alpha = \frac{1}{234} \text{ C}^{-1} \text{ at } 0^{\circ}\text{C}\right)$$

- (1) 254°
- (2) 256°
- (3) 258°
- (4) 264°

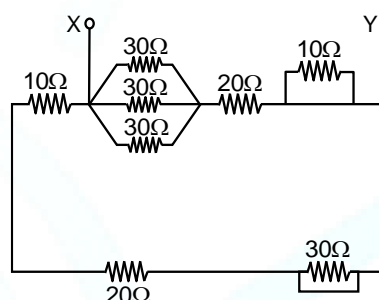
Combination of Resistors

40. Net resistance between X and Y is –



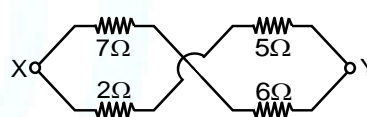
- (1) R
- (2) $2R$
- (3) $\frac{R}{2}$
- (4) $4R$

41. Net resistance between X and Y is –



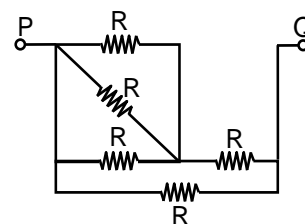
- (1) 5Ω
- (2) 10Ω
- (3) 15Ω
- (4) 60Ω

42. Net resistance between X and Y is –



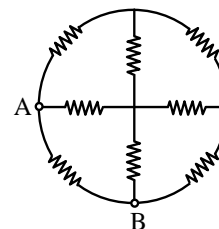
- (1) 4Ω
- (2) 4.55Ω
- (3) 2Ω
- (4) 20Ω

43. The equivalent resistance between the terminal point P and Q is 4Ω in the given circuit, then find out the resistance of R in ohms:



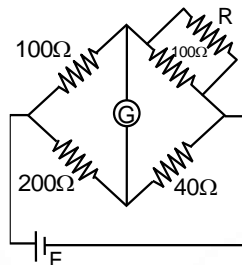
- (1) 7
- (2) 4
- (3) 2
- (4) 5

44. Eight resistances each of resistance 5Ω are connected in the circuit as shown in figure. The equivalent resistance between A and B is



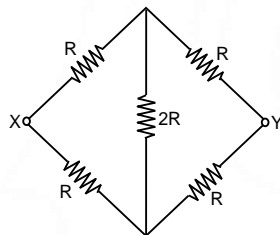
- (1) $\frac{8}{3} \Omega$ (2) $\frac{16}{3} \Omega$
 (3) $\frac{15}{7} \Omega$ (4) $\frac{19}{2} \Omega$

45. For following diagram, the galvanometer shows zero deflection, then the value of R is:



- (1) 52 Ω (2) 50 Ω
 (3) 100 Ω (4) 25 Ω

46. For following circuit, the value of total resistance between X and Y in ohm is -

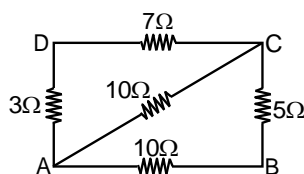


- (1) R (2) 4 R (3) 5 R (4) 6 R

47. The equivalent resistance in series combination is-

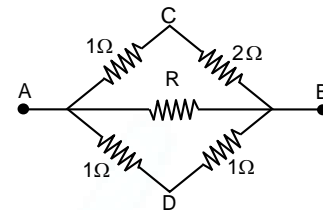
- (1) smaller than the largest resistance
 (2) larger than the largest resistance
 (3) smaller than the smallest resistance
 (4) larger than the smallest resistance

48. Five resistance are connected as shown in the adjoining figure. The equivalent resistance between A and B is:



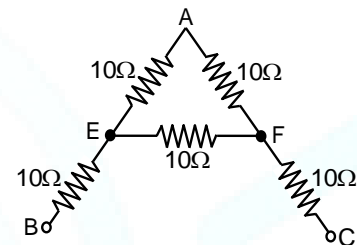
- (1) 35 Ω (2) 5 Ω (3) 15/4 Ω (4) 25 Ω

49. The equivalent resistance between points (A) and (B) in the adjoining fig. is one ohm. What is the value of middle resistance -



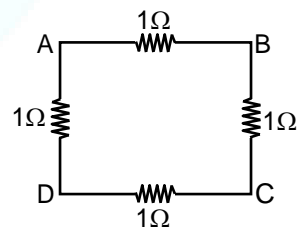
- (1) 9 Ω (2) 1 Ω (3) 6 Ω (4) 3 Ω

50. The effective resistance (in Ω) between (B) and (C) is



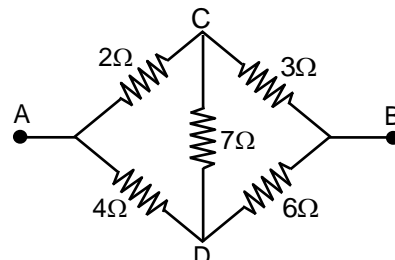
- (1) 60 (2) 40 (3) 80/3 (4) 160/9

51. Four identical resistances are joined as shown in fig. The equivalent resistance between points A and B is R_1 . The equivalent resistance between points A and C is R_2 then ratio of R_1/R_2 is -



- (1) 1 : 1 (2) 4 : 3 (3) 3 : 4 (4) 1 : 2

52. Five resistances are connected as shown in fig. The effective resistance between the points A and B is -



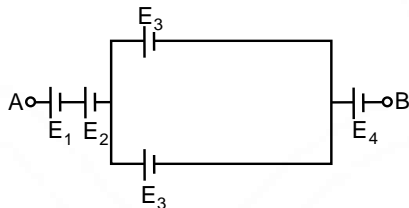
- (1) 10/3 Ω (2) 20/3 Ω (3) 15 Ω (4) 6 Ω



53. Twelve wires of equal resistance (R) are connected to form a cube. The effective resistance between two diagonal ends will be:
 (1) $5/6 R$ (2) $6/5 R$ (3) $3R$ (4) $12 R$

Introduction of Cells, EMF, Internal Resistance, Terminal P.D., Grouping of Cells

54. In the following circuit the resultant emf between AB is -



- (1) $E_1 + E_2 + E_3 + E_4$
 (2) $E_1 + E_2 + 2E_3 + E_4$
 (3) $E_1 + E_2 + (E_3/2) + E_4$
 (4) $E_1 + E_2 + (E_3/4) + E_4$
55. A cell of e.m.f (E) and internal resistance (r) is connected in series with an external resistance (nr) then the ratio of the terminal p.d. to E.M.F is-
 (1) $1/n$ (2) $1/(n+1)$
 (3) $n/(n+1)$ (4) $(n+1)/n$
56. The terminal potential difference of a cell, when cell is short circuited is-
 (1) E (2) $E/2$ (3) zero (4) $E/3$
57. Five dry cell each of e.m.f $1.5V$ are connected in parallel. The e.m.f of the combination is-
 (1) $7.5 V$ (2) $0.3 V$ (3) $3V$ (4) $1.5 V$
58. The internal resistance of cell is 0.1Ω and its emf is $2V$. When a current of $2A$ is being drawn from it, the potential difference across its terminals will be -
 (1) more than $2V$ (2) $2V$
 (3) $1.8V$ (4) none of these
59. A dry cell has an e.m.f of $1.5V$ and internal resistance 0.5Ω . If the cell sends a current of $1A$ through an external resistance, the p.d. of the cell will be -
 (1) $1.5V$ (2) $1V$ (3) $0.5V$ (4) $0V$

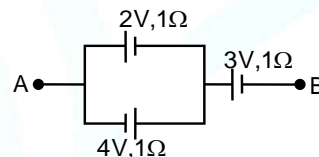
60. Five cells each of e.m.f (E) and internal resistance (r) are connected in series. If one cell is connected wrongly, then the equivalent e.m.f and internal resistance of the combination is -

- (1) $5E$ and $5r$ (2) $3E$ and $3r$
 (3) $3E$ and $5r$ (4) $5E$ and $4r$

61. A cell of e.m.f (E) volt and internal resistance (r) ohms is connected to an external resistance of (r) ohms. The potential difference across the terminals of the cell will be

- (1) E volt (2) $E/2$ Volt
 (3) $E/4$ volt (4) $2E$ volt

62. The potential difference between points A and B is -



- (1) $2 V$ (2) $6 V$ (3) $4 V$ (4) $3 V$

63. The number of dry cells, each of e.m.f. 1.5 volt and internal resistance 0.5Ω that must be joined in series with a resistance of 20 ohm so as to send a current of 0.6 ampere through the circuit is -

- (1) 2 (2) 8 (3) 10 (4) 12

64. Two batteries of different e.m.f. and internal resistance are connected in series with each other and with an external load resistor. The current is 3.0 amp . When the polarity of one battery is reversed, the current becomes 1.0 amp . The ratio of the e.m.f. of the two batteries is -

- (1) 2.5 (2) 2.0 (3) 1.5 (4) 1.0

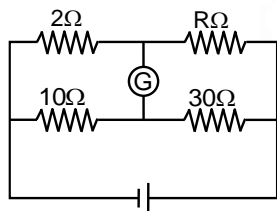
65. When a cell is connected to 1 ohm resistance, 1 ampere current flows through the circuit. When 3 ohm resistance is used then 0.5 amp current flows, then internal resistance of the cell is:

- (1) 1Ω (2) 1.5Ω (3) 2Ω (4) 2.5Ω



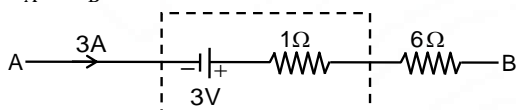
Kirchhoff's Law, (KVL & KCL), Wheat Stone Bridge

66. In the adjoining fig. there is no deflection in the galvanometer. Then R is equal to -



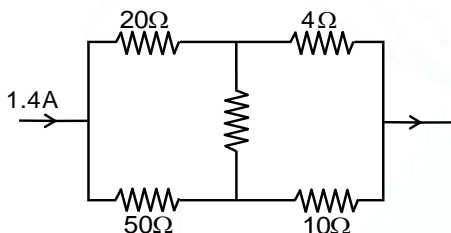
- (1) 2Ω (2) 30Ω (3) 6Ω (4) $(2/3)\Omega$

67. Fig represents a part of a closed circuit. The potential difference between (A) and (B) i.e. $V_A - V_B$ is -



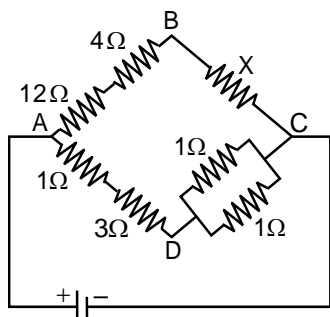
- (1) 24 V (2) 0 V
(3) 6 V (4) 18 V

68. In the following figure the current through 4 ohm resistor is -



- (1) 1.4 A (2) 0.4 A
(3) 1.0 A (4) 0.7 A

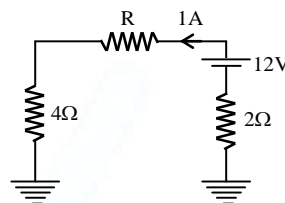
69. In the arrangement of resistances shown in the circuit, the potential difference between points B and D will be zero, when the unknown resistance X is:



- (1) 4Ω (2) 3Ω (3) 2Ω (4) 1Ω

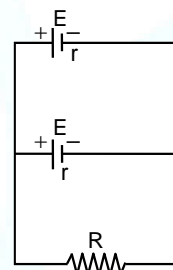
Electrical Energy, Power Distribution for Series Parallel Combination, Maximum Power

70. In the circuit shown in figure the value of R is-



- (1) 8Ω (2) 6Ω
(3) 10Ω (4) 12Ω

71. Two cells of same emf E and internal resistance r are connected in parallel with a resistance of R. To get maximum power in the external circuit, the value of R is:



- (1) $R = \frac{r}{2}$ (2) $R = r$
(3) $R = 2r$ (4) $R = 4r$

72. Two bulbs, one of 50 watt and another of 25 watt are connected in series to the mains, the ratio of the current through them is:

- (1) 2 : 1
(2) 1 : 2
(3) 1 : 1
(4) can't be determined without the p.d. of the main supply

73. Constant voltage is applied between the two ends of a uniform metallic wire. The heat developed is doubled if:

- (1) both the length and radius of the wire are halved
(2) both the length and radius of the wire are doubled
(3) the radius of wire is doubled
(4) the length of the wire is doubled

74. Two electric bulbs rated P_1 watt V volt and P_2 watt V volt are connected in parallel across V volt mains then the total power is:

(1) $P_1 + P_2$ (2) $\sqrt{P_1 P_2}$
 (3) $\frac{P_1 P_2}{(P_1 + P_2)}$ (4) $\frac{(P_1 + P_2)}{P_1 P_2}$

75. Lamps used for the house lightening are connected in:

- (1) series (2) parallel
 (3) mixed grouping (4) arbitrary manner

76. Two electric bulbs whose resistances are in the ratio of 1 : 2 are connected in parallel to a constant voltage source. The power dissipated in them have the ratio:

- (1) 1 : 2 (2) 1 : 1 (3) 2 : 1 (4) 1 : 4

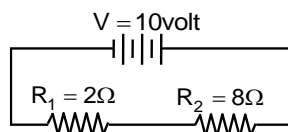
77. An electric bulb is rated 220 volt and 100 watt. The resistance of the filament of the electric bulb is:

- (1) 2.2Ω (2) $2.2 \times 10^4 \Omega$
 (3) 484Ω (4) 100Ω

78. Three electric bulbs 40W, 60W and 100W are designed to work on a 220V mains. Which bulb will glow most brightly if they are connected in series across 220V mains:

- (1) 100W bulb
 (2) 60W bulb
 (3) 40 W bulb
 (4) all bulbs will glow equally brightly

79. In fig the ratio of power dissipated in resistors R_1 and R_2 is



- (1) 1 : 4 (2) 4 : 1
 (3) 1 : 2 (4) 2 : 1

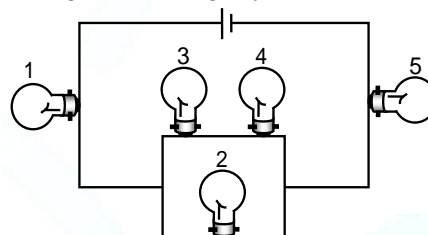
80. A house is served by a 220V supply line. In a circuit protected by a fuse marked 9A. The maximum number of 60W lamps in parallel that can be turned on is:

- (1) 44 (2) 20 (3) 22 (4) 33

81. Two bulbs 25 watt, 220 volt and 100 watt, 220 volt are connected in series across a 440 volt line:

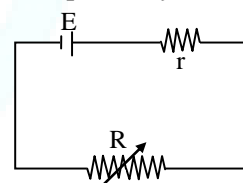
- (1) only 100 watt bulb will fuse
 (2) only 25 watt bulb will fuse
 (3) both bulbs will fuse
 (4) none of the bulb will fuse

82. All bulbs in figure below are identical, which bulb light most brightly -



- (1) 1 only (2) 2 only
 (3) 3 and 4 only (4) 1 and 5

83. In the figure shown, a cell of emf E and internal resistance r is connected to a variable resistor R . The (i) current in the circuit and (ii) heat produced in the resistor R will be maximum, respectively for:



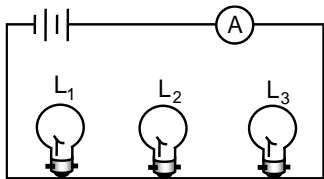
- (1) (i) $R = r$, (ii) $R = 0$
 (2) (i) $R = 0$, (ii) $R = r$
 (3) (i) $R = r$, (ii) $R = r$
 (4) (i) $R = 0$, (ii) $R = 0$

84. Two bulbs of 500 watt and 200 watt are manufactured to operate on 220 volt line. The ratio of heat produced in 500 watt and 200 watt, in two cases, when first they are joined in series and secondly in parallel, will be -

- (1) $\frac{5}{2}, \frac{2}{5}$ (2) $\frac{5}{2}, \frac{5}{2}$
 (3) $\frac{2}{5}, \frac{5}{2}$ (4) $\frac{2}{5}, \frac{2}{5}$



85. In the circuit below, ammeter (A) reads 0.5A. Bulbs L_1 and L_2 are brightly lit, but L_3 is not lit. What is the reason for L_3 not being lit ?



- (1) The ammeter is faulty
 (2) The filament of L_3 is broken
 (3) The resistance of L_3 is much lower than that of L_1 and L_2
 (4) There is a break in the connecting wire between L_2 and L_3
86. How much electrical energy in kilo-watt hour is consumed in operating ten 50 watt bulbs for 10 hours per day in a month of 30 days ?
 (1) 1500 (2) 15000
 (3) 15 (4) 150
87. Two bulbs 100 W, 250 V and 200 W, 250 V are connected in parallel across a 500 V line. Then -
 (1) 100 W bulb will fused
 (2) 200 W bulb will fused
 (3) Both bulbs will be fused
 (4) No bulb will fused
88. A uniform wire connected across a supply produces heat H per second. If the wire is cut into n equal parts and all the parts are connected in parallel across the same supply, the heat produced per second will be:
 (1) $\frac{H}{n}$ (2) nH
 (3) n^2H (4) $\frac{H}{n^2}$
89. Two electric bulbs 40 W, 200 V and 100 W, 200 V are connected in series. Then the maximum voltage that can be applied across the combination, without fusing either bulb is:
 (1) 280V (2) 400V
 (3) 3000V (4) 200V

90. The resistance of 3Ω and 6Ω are joined in series and connected across a battery of emf 10 V and internal resistance 1Ω . The power dissipated by battery is:
 (1) 3 W (2) 8 W (3) 9 W (4) 10 W
91. A 24 V battery of internal resistance 4Ω is connected to a variable resistor. The rate of heat production in the resistor is maximum when the current in the circuit is:
 (1) 2 A (2) 3 A (3) 4 A (4) 6 A

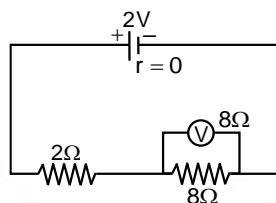
Meter Bridge, Ammeter, Voltmeter

92. A galvanometer having a coil resistance of 60Ω shows full scale deflection when a current of 1.0 A passes through it. It can be converted into an ammeter to read currents upto 5.0 A by :
 (1) putting in parallel a resistance of 240Ω
 (2) putting in series a resistance of 15Ω
 (3) putting in series a resistance of 240Ω
 (4) putting in parallel a resistance of 15Ω
93. A milli voltmeter of 25 milli volt range is to be converted into an ammeter of 25 ampere range. The value (in ohm) of necessary shunt will be:
 (1) 0.001 (2) 0.01 (3) 1 (4) 0.05
94. A galvanometer can be changed into ammeter by connecting:
 (1) high resistance in parallel
 (2) high resistance in series
 (3) low resistance in parallel
 (4) low resistance in series
95. A galvanometer of 50 ohm resistance has 25 divisions. A current of 4×10^{-4} ampere gives a deflection of one division. To convert this galvanometer into a voltmeter having a range of 25 volts, it should be connected with a resistance of:
 (1) 2500Ω as shunt
 (2) 2450Ω as shunt
 (3) 2550Ω in series
 (4) 2450Ω in series



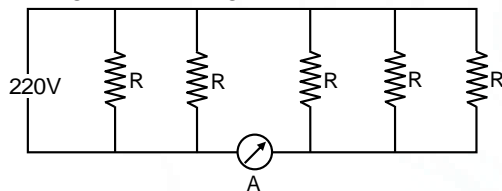
96. In Wheat stone's bridge $P = 9 \text{ ohm}$, $Q = 11 \text{ ohms}$, $R = 4 \text{ ohm}$ and $S = 6 \text{ ohms}$. How much resistance must be put in parallel to the resistance (S) to balance the bridge
- (1) 24 ohms (2) $(44/9) \text{ ohm}$
 (3) 26.4 ohms (4) 18.7 ohms

97. In the circuit shown in fig, the reading of voltmeter is -



- (1) 1.33 V (2) 0.8 V
 (3) 2.0 V (4) 1.6 V

98. Five identical lamps each resistance $R = 1100\Omega$ are connected to 220V as shown in fig. The reading of ideal ammeter (A) is -

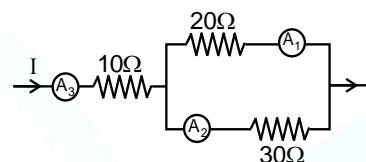


- (1) $1/5 \text{ A}$ (2) $2/5 \text{ A}$
 (3) $3/5 \text{ A}$ (4) 1 A

99. In meter bridge the balancing length from left and when standard resistance of 1Ω is in right gap is found to be 20 cm. The value of unknown resistance is:

- (1) 0.25Ω
 (2) 0.4Ω
 (3) 0.5Ω
 (4) 4Ω

100. If the reading of ammeter A_1 , in figure is 2.4 A, what will the ammeter A_2 and A_3 read? (Neglecting the resistances of ammeters)



- (1) 1.6 A, 2.3 A
 (2) 1.6 A, 4.0 A
 (3) 4.0 A, 1.6 A
 (4) 2.3 A, 1.6 A



EXERCISE – II

1. On interchanging the resistances, the balance point of a metre bridge shifts to the left by 10 cm. The resistance of their series combination is 1 k Ω . How much was the resistance of the left slot before interchanging the resistances?

(1) 990 Ω (2) 505 Ω
(3) 550 Ω (4) 910 Ω

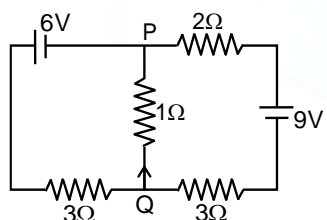
2. A galvanometer having a coil resistance of 100 Ω gives a full-scale deflection, when a current of 1 mA is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of 10 A, is:

(1) 0.01 Ω (2) 2 Ω
(3) 0.1 Ω (4) 3 Ω

3. When 5 V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is $2.5 \times 10^{-4} \text{ ms}^{-1}$. If the electron density in the wire is $8 \times 10^{28} \text{ m}^{-3}$, the resistivity of the material is close to:

(1) $1.6 \times 10^{-8} \Omega \text{ m}$ (2) $1.6 \times 10^{-7} \Omega \text{ m}$
(3) $1.6 \times 10^{-6} \Omega \text{ m}$ (4) $1.6 \times 10^{-5} \Omega \text{ m}$

4. In the circuit shown, the current in the 1 Ω resistor is:



(1) 1.3 A, from P to Q
(2) 0 A
(3) 0.13 A, from Q to P
(4) 0.13 A, from P to Q

5. In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of the electric mains is 220 V. The minimum capacity of the main fuse of the building will be:

(1) 8 A (2) 10 A (3) 12 A (4) 14 A

6. Two electric bulbs of 25 W – 220 V and 100 W – 220 V are connected in series with 440 V source. Which bulb will be fused?

(1) Both (2) 100 W
(3) 25 W (4) None of these

7. Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then errors in the value of resistance of the wire is:

(1) 6% (2) Zero (3) 1% (4) 3%

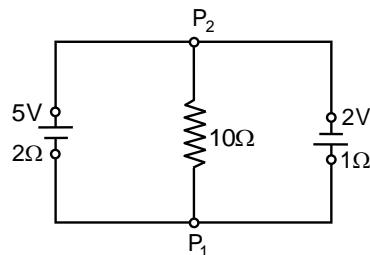
8. If a wire is stretched to make it 0.1% longer, its resistance will:

(1) 0.05% increase (2) 0.2% increase
(3) 0.2% decrease (4) 0.05% decrease

9. Two conductors have the same resistance at 0°C but their temperature coefficients of resistance are α_1 and α_2 . The respective temperature coefficients of their series and parallel combinations are nearly:

(1) $\frac{\alpha_1 + \alpha_2}{2}$, $\alpha_1 + \alpha_2$ (2) $\alpha_1 + \alpha_2$, $\frac{\alpha_1 + \alpha_2}{2}$
(3) $\alpha_1 + \alpha_2$, $\frac{\alpha_1 \times \alpha_2}{\alpha_1 + \alpha_2}$ (4) $\frac{\alpha_1 + \alpha_2}{2}$, $\frac{\alpha_1 + \alpha_2}{2}$

10. A 5 V battery with internal resistance 2 Ω and a 2 V battery with internal resistance 1 Ω are connected to a 10 Ω resistor as shown in the figure. The current in 10 Ω resistor is



(1) 0.27 A, from P₂ to P₁
(2) 0.03 A, from P₁ to P₂
(3) 0.03 A, from P₂ to P₁
(4) 0.27 A, from P₁ to P₂



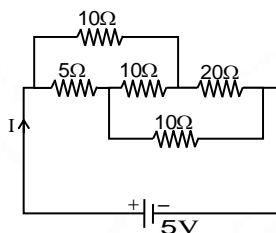
11. The resistance of a wire is 5 ohm at 50°C and 6 ohm at 100°C . The resistance of the wire at 0°C will be

(1) $2\ \Omega$ (2) $1\ \Omega$ (3) $4\ \Omega$ (4) $3\ \Omega$

12. A material B has twice the specific resistance of A. A circular wire made of B has twice the diameter of a wire made of A. Then for the two wires to have the same resistance, the ratio l_B/l_A of their respective lengths must be

(1) $1/2$ (2) $1/4$ (3) 2 (4) 1

13. The current I drawn from the 5 volt source will be



(1) 0.5 A (2) 0.67 A (3) 0.17 A (4) 0.33 A

14. The resistance of a bulb filament is $100\ \Omega$ at a temperature of 100°C . If its temperature coefficient of resistance be 0.005 per $^{\circ}\text{C}$, its resistance will become $200\ \Omega$ at a temperature of

(1) 400°C (2) 500°C (3) 200°C (4) 300°C

15. An electric bulb is rated 220 V – 100 W. The power consumed by it when operated on 110 V will be

(1) 40 W (2) 25 W (3) 50 W (4) 75 W

16. A moving coil galvanometer has 150 equal divisions. Its current sensitivity is 10 divisions per milliampere and voltage sensitivity is 2 divisions per millivolt. In order that each division reads 1 volt, the resistance in ohms needed to be connected in series with the coil will be

(1) 10^5 (2) 10^3 (3) 9995 (4) 99995

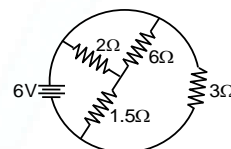
17. Two sources of equal emf are connected to an external resistance R . The internal resistances of the two sources are R_1 and R_2 ($R_2 > R_1$). If the potential difference across the source having internal resistance R_2 is zero, then

(1) $R = R_2 - R_1$
 (2) $R = R_2 \times (R_1 + R_2) / (R_2 - R_1)$
 (3) $R = R_1 R_2 / (R_2 - R_1)$
 (4) $R = R_1 R_2 / (R_1 + R_2)$

18. A heater coil is cut into two equal parts and only one part is now used in the heater. The heat generated will now be

(1) four time (2) doubled
 (3) half (4) one-fourth

19. The total current supplied to the circuit by the battery is

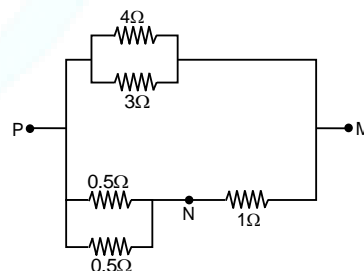


(1) 1 A (2) 6 A (3) 4 A (4) 2 A

20. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii of the wires are in the ratio of $4/3$ and $2/3$, then the ratio of the currents passing through the wires will be

(1) 3 (2) 2 (3) $8/9$ (4) $1/3$

21. In the circuit shown, the current through the $4\ \Omega$ resistor is 1 A when the points P and M are connected to a DC voltage source. The potential difference between the points M and N is :



(1) 1.5 V (2) 1.0 V
 (3) 0.5 V (4) 3.2 V

22. Choose the correct statement:

A. EMF of a cell is the potential difference between the positive and negative electrodes in an open circuit i.e., when no current is flowing in the circuit.
 B. The resistance offered by the electrolyte through which the current is flowing is called as internal resistance.



C. The internal resistance of dry cells is much higher than the common electrolyte cells.

D. The internal resistance of dry cells is much lesser than the common electrolyte cells.

- (1) A, B (2) A, B & D
(3) A, B & C (4) B, C

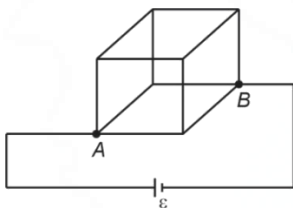
23. Consider the following statements and select incorrect statement(s).

Statement-A: The equivalent emf of a parallel combination of n cell is just the sum of their individual emf.

Statement-B: The equivalent internal resistance of a series combination of n cells is just the sum of their internal resistances.

- (1) Only state. A (2) Only state. B
(3) Both A & B (4) Neither A nor B

24. 12 identical wires, each of resistance 'R' are arranged in form of a cube and a battery of emf ε is connected across A, B as shown in the figure. What is the current drawn from the battery?



- (1) $\frac{4\varepsilon}{3R}$ (2) $\frac{5\varepsilon}{3R}$
(3) $\frac{3\varepsilon}{4R}$ (4) $\frac{5\varepsilon}{4R}$

25. Match the following by choosing correct options

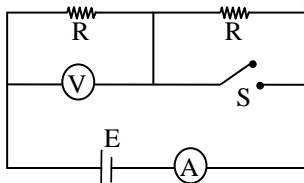
	Column-I		Column-II
a.		(i)	Resistivity ρ of copper as a function of temperature
b.		(ii)	Resistivity ρ of nichrome as a function of temperature
c.		(iii)	Resistivity of semiconductor as a function of temperature

- (1) a(iii), b(ii), c(i)
(2) a(ii), b(iii), c(i)
(3) a(i), b(iii), c(ii)
(4) a(iii), b(i), c(ii)



EXERCISE – III

1. In the circuit shown battery, ammeter and voltmeter are ideal and the switch S is initially closed as shown. When switch S is opened, match the parameter of column I with the effects in column II:



Column I		Column II	
A.	Equivalent resistance across the battery	P.	Remains same
B.	Power dissipated by left resistance R	Q.	Increases
C.	Voltmeter reading	R.	Decreases
D.	Ammeter reading	S.	Becomes zero

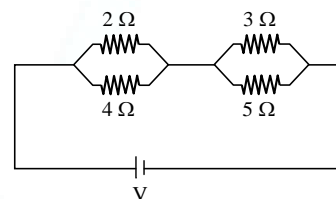
- (1) $A \rightarrow R$; $B \rightarrow Q$; $C \rightarrow S$; $D \rightarrow P$
 (2) $A \rightarrow Q$; $B \rightarrow R$; $C \rightarrow R$; $D \rightarrow S$
 (3) $A \rightarrow Q$; $B \rightarrow R$; $C \rightarrow R$; $D \rightarrow R$
 (4) $A \rightarrow R$; $B \rightarrow R$; $C \rightarrow Q$; $D \rightarrow Q$

2. In the circuits drawn in column I of the following table, all the bulbs are identical. Match the entries of column I with the entries of column II:

Column I		Column II	
A.		P.	Current drawn from the battery is maximum
B.		Q.	Current drawn from the battery is the least
C.		R.	Bulbs will lit the brightest
D.		S.	Bulbs will lit with brightness lying between maximum & minimum value

- (1) $A \rightarrow P$; $B \rightarrow R$; $C \rightarrow P$; $D \rightarrow S$
 (2) $A \rightarrow Q$; $B \rightarrow R$; $C \rightarrow P$; S ; $D \rightarrow S$
 (3) $A \rightarrow S$; $B \rightarrow R$; $C \rightarrow Q$; $D \rightarrow P$
 (4) $A \rightarrow P$; $B \rightarrow R$; $C \rightarrow Q$; $D \rightarrow P$

3. From the circuit shown in figure match the entries of column-I with entries in column II.



Column-I		Column-II	
a.	Minimum current will flow through	p.	2Ω
b.	Maximum current will flow through	q.	4Ω
c.	Maximum power will be generated across	r.	3Ω
d.	Minimum power will be generated across	s.	5Ω

- (1) $a \rightarrow q$, $b \rightarrow p$, $c \rightarrow r$, $d \rightarrow q$
 (2) $a \rightarrow p$, $b \rightarrow p$, $c \rightarrow r$, $d \rightarrow q$
 (3) $a \rightarrow p$, $b \rightarrow q$, $c \rightarrow r$, $d \rightarrow s$
 (4) $a \rightarrow s$, $b \rightarrow p$, $c \rightarrow r$, $d \rightarrow q$

Passage – (Q.4 to Q.6)

A set of experiments in the physics lab is designed to develop understanding of simple electrical circuit principles for direct current circuits. The student is given a variety of batteries, resistors, and DC meters ; and it directed to wire series and parallel combinations of resistors and batteries making measurements of the currents and voltage drops using the ammeters and voltmeters. The student calculator expected current and voltage values using ohm's law and kirchhoff's circuit rules and then checks the results with the meters.

4. A student connects a 6 volt battery and a 12 V battery in series and then connects this combination across a 10Ω resistor. What is the current in the resistor?
 (1) 0.8 A (2) 0.9 A (3) 1.8 A (4) 3.6 A



5. Resistors of $4\ \Omega$ and $8\ \Omega$ are connected in series. A battery of 6 V is connected across the series combination. How much power (in watts) is consumed in 8Ω resistor ?

(1) 0.67 W (2) 2 W
(3) 12 W (4) 24 W

6. A 6 V battery is connected across a 2Ω resistor. What is the heat energy dissipated in the resistor in 5 minutes?

(1) 430 J (2) 560 J
(3) 4300 J (4) 5400 J

Passage – (Q.7 to Q.10)

A potential difference is applied across a copper wire of radius 0.5 mm . It results in a uniform electric field 1.5 V/m along the length of wire. Consequently there is current in the wire. Temperature of the wire is 60°C . Assuming that each copper atom contributes one free electron and given that

Density of copper = 8.9 gm/cm^3

Resistivity of copper at 20°C

= $1.7 \times 10^{-8}\ \Omega\text{-m}$

Temperature coefficient of resistivity ' α ' at 20°C = $3.9 \times 10^{-3}/^\circ\text{C}$

Atomic mass of copper = 63.5

7. Resistivity of the material of wire under experimental conditions is -

(1) $4.52 \times 10^{-7}\ \Omega\text{-m}$ (2) $1.96 \times 10^{-8}\ \Omega\text{-m}$
(3) $2.75 \times 10^{-7}\ \Omega\text{-m}$ (4) $1.36 \times 10^{-6}\ \Omega\text{-m}$

8. Current density in the wire is -

(1) $7.65 \times 10^7\text{ A/m}^2$ (2) $9.45 \times 10^8\text{ A/m}^2$
(3) $11.25 \times 10^9\text{ A/m}^2$ (4) 526.5 A/m^2

9. Drift speed of electrons is -

(1) $2.1 \times 10^{-2}\text{ m/s}$ (2) $4.6 \times 10^{-4}\text{ m/s}$
(3) $8.2 \times 10^{-4}\text{ m/s}$ (4) $5.7 \times 10^{-3}\text{ m/s}$

10. Potential difference that needs to be applied between the ends of a 3m long wire to produce the given electric field is

(1) 1.5 V (2) 3 V (3) 4.5 V (4) 6 V

For Questions (11 to 14)

Read the **Assertion (A)** and **Reason (R)** carefully and mark the correct options.

(A) If both (A) and (R) are true, and (R) is the correct explanation of (A).

(B) If both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) If (A) is true but (R) is false.

(D) If (A) is false but (R) is true.

11. **Assertion:** When an external resistor of resistance R (connected across a cell of internal resistance r) is varied. Power consumed by resistance R is maximum when $R = r$

Reason: Power consumed by a resistor of constant resistance R is maximum when current through it is maximum

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

12. **Assertion:** Material used in the construction of a standard resistance is constantan or manganin.

Reason: Its temperature coefficient of resistance is very small.

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

13. **Assertion:** Fuse wire of any electronic equipment must have high resistance and low melting point.

Reason: Fuse is used for small current flow only.

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

14. **Assertion:** The average thermal velocity of the electrons in the conductor is zero.

Reason: Direction of motion of electrons are randomly oriented.

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





EXERCISE – IV (PREVIOUS YEAR QUESTIONS)

1. A wire of resistance $4\ \Omega$ is stretched to twice its original length. The resistance of stretched wire would be: [NEET_2013]

(1) $4\ \Omega$ (2) $8\ \Omega$ (3) $16\ \Omega$ (4) $2\ \Omega$

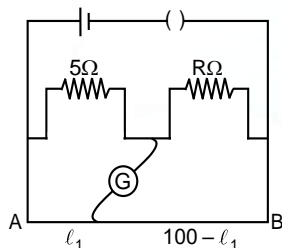
2. The internal resistance of a $2.1\ \text{V}$ cell which gives a current of $0.2\ \text{A}$ through a resistance of $10\ \Omega$ is: [NEET_2013]

(1) $0.5\ \Omega$ (2) $0.8\ \Omega$
(3) $1.0\ \Omega$ (4) $0.2\ \Omega$

3. The resistances of the four arms P, Q, R and S in a Wheatstone's bridge are $10\ \text{ohm}$, $30\ \text{ohm}$, $30\ \text{ohm}$ and $90\ \text{ohm}$, respectively. The e.m.f. and internal resistance of the cell are $7\ \text{Volt}$ and $5\ \text{ohm}$ respectively. If the galvanometer resistance is $50\ \text{ohm}$, the current drawn from the cell will be: [NEET_2013]

(1) $0.2\ \text{A}$ (2) $0.1\ \text{A}$
(3) $2.0\ \text{A}$ (4) $1.0\ \text{A}$

4. The resistance in the two arms of the meter bridge are $5\ \Omega$ and $R\ \Omega$, respectively. When the resistance R is shunted with an equal resistance, the new balance point is at $1.6\ \ell_1$. The resistance 'R' is: [AIPMT_2014]



(1) $10\ \Omega$ (2) $15\ \Omega$
(3) $20\ \Omega$ (4) $25\ \Omega$

5. In an ammeter 0.2% of main current passes through the galvanometer. If resistance of galvanometer is G , the resistance of ammeter will be: [AIPMT_2014]

(1) $\frac{1}{499} G$ (2) $\frac{499}{500} G$
(3) $\frac{1}{500} G$ (4) $\frac{500}{499} G$

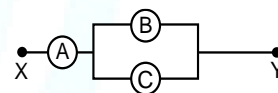
6. A circuit contains an ammeter, a battery of $30\ \text{V}$ and a resistance $40.8\ \text{ohm}$ all connected in series. If the ammeter has a coil of resistance $480\ \text{ohm}$ and a shunt of $20\ \text{ohm}$, the reading in the ammeter will be: [Re-AIPMT_2015]

(1) $1\ \text{A}$ (2) $0.5\ \text{A}$
(3) $0.25\ \text{A}$ (4) $2\ \text{A}$

7. The charge flowing through a resistance R varies with time t as $Q = at - bt^2$, where a and b are positive constants. The total heat produced in R is: [NEET_I_2016]

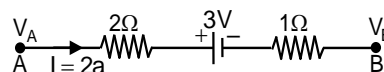
(1) $\frac{a^3 R}{6b}$ (2) $\frac{a^3 R}{3b}$ (3) $\frac{a^3 R}{2b}$ (4) $\frac{a^3 R}{b}$

8. A, B and C are voltmeters of resistance R , $1.5 R$ and $3 R$ respectively as shown in the figure. When some potential difference is applied between X and Y, the voltmeter readings are V_A , V_B and V_C respectively. Then: AIPMT_2015]



(1) $V_A \neq V_B = V_C$ (2) $V_A = V_B \neq V_C$
(3) $V_A \neq V_B \neq V_C$ (4) $V_A = V_B = V_C$

9. The potential difference ($V_A - V_B$) between the points A and B in the given figure is: [NEET_II_2016]



(1) $+6\ \text{V}$ (2) $+9\ \text{V}$
(3) $-3\ \text{V}$ (4) $+3\ \text{V}$

10. A filament bulb ($500\ \text{W}$, $100\ \text{V}$) is to be used in a $230\ \text{V}$ main supply. When a resistance R is connected in series, it works perfectly and the bulb consumes $500\ \text{W}$. The value of R is: [NEET_II_2016]

(1) $26\ \Omega$ (2) $13\ \Omega$
(3) $230\ \Omega$ (4) $46\ \Omega$



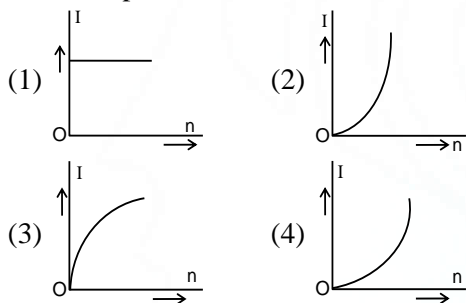
11. The resistance of a wire is 'R' ohm. If it is melted and stretched to 'n' times its original length, its new resistance will be: [NEET_2017]

(1) nR (2) $\frac{R}{n}$ (3) n^2R (4) $\frac{R}{n^2}$

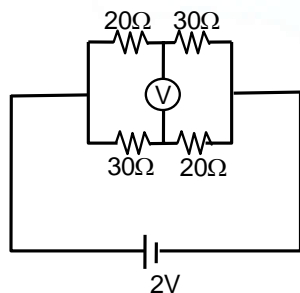
12. A set of 'n' equal resistors, of value 'R' each, are connected in series to a battery of emf E and internal resistance 'R'. The current drawn is I. Now, the 'n' resistors are connected in parallel to the same battery. Then the current drawn from battery becomes 10 I. The value of 'n' is [NEET_2018]

(1) 10 (2) 11 (3) 20 (4) 9

13. A battery consists of a variable number 'n' of identical cells (having internal resistance 'r' each) which are connected in series. The terminals of the battery are short-circuited and the current I is measured. Which of the graphs shows the correct relationship between I and 'n'? [NEET_2018]

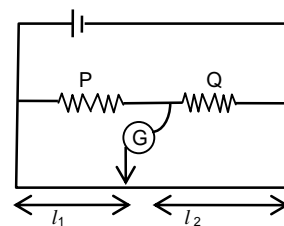


14. The reading of an ideal voltmeter in the circuit shown is: [NEET_2019(Odisha)]



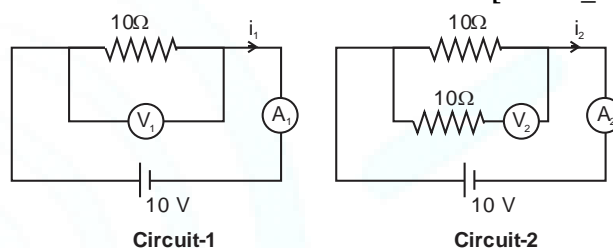
(1) 0.6 V (2) 0 V (3) 0.5 V (4) 0.4 V

15. The metre bridge shown is in balance position with $\frac{P}{Q} = \frac{l_1}{l_2}$. If we now interchange the positions of galvanometer and cell, will the bridge work? If yes, what will be balanced condition? [NEET_2019(Odisha)]



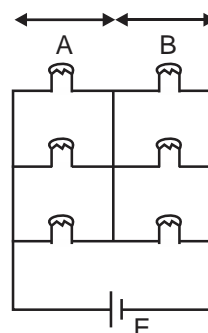
(1) yes, $\frac{P}{Q} = \frac{l_2 - l_1}{l_2 + l_1}$ (2) no, no null point
(3) yes, $\frac{P}{Q} = \frac{l_2}{l_1}$ (4) yes, $\frac{P}{Q} = \frac{l_1}{l_2}$

16. In the circuits shown below, the readings of the voltmeters and the ammeters will be: [NEET_2019]



(1) $V_1 = V_2$ and $i_1 = i_2$
(2) $V_2 > V_1$ and $i_1 > i_2$
(3) $V_2 > V_1$ and $i_1 = i_2$
(4) $V_1 = V_2$ and $i_1 > i_2$

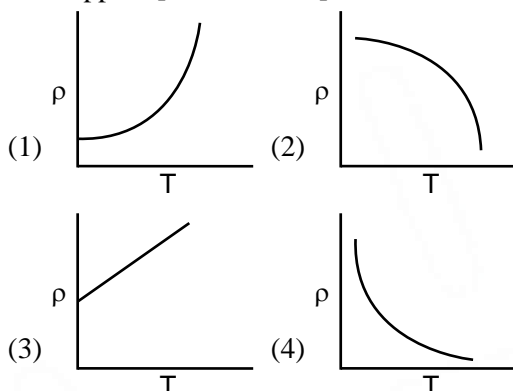
17. Six similar bulbs are connected as shown in the figure with a DC source of emf E, and zero internal resistance.



The ratio of power consumption by the bulbs when (i) all are glowing and (ii) in the situation when two from section A and one from section B are glowing will be [NEET_2019]

(1) 1 : 2 (2) 2 : 1
(3) 4 : 9 (4) 9 : 4

18. Which of the following graph represents the variation of resistivity (ρ) with temperature (T) For copper? [NEET_2020]



19. A charged particle having drift velocity of $7.5 \times 10^{-4} \text{ ms}^{-1}$ in an electric field of $3 \times 10^{-10} \text{ Vm}^{-1}$ has a mobility in $\text{m}^2 \text{ V}^{-1} \text{ s}^{-1}$ of: [NEET_2020]

- (1) 2.5×10^{-6} (2) 2.25×10^{-15}
(3) 2.25×10^{15} (4) 2.5×10^6

20. The solids which have the negative temperature coefficient of resistance are:

[NEET_2020]

- (1) semiconductors only
(2) insulators and semiconductors
(3) metals
(4) insulators only

21. A resistance wire connected in the left gap of a metre bridge balances a 10Ω resistance in the right gap at a point which divides the bridge wire in the ratio 3 : 2. If the length of the resistance wire is 1.5 m, then the length of 1Ω of the resistance wire is : [NEET_2020]

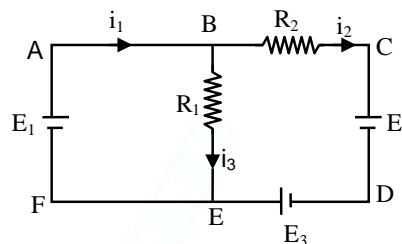
- (1) $1.5 \times 10^{-1} \text{ m}$ (2) $1.5 \times 10^{-2} \text{ m}$
(3) $1.0 \times 10^{-2} \text{ m}$ (4) $1.0 \times 10^{-1} \text{ m}$

22. Two solid conductors are made up of same material, have same length and same resistance. One of them has a circular cross section of area A_1 and the other one has a square cross section of area A_2 . The ratio A_1/A_2 is:

[NEET_2020(Covid)]

- (1) 1.5 (2) 1 (3) 0.8 (4) 2

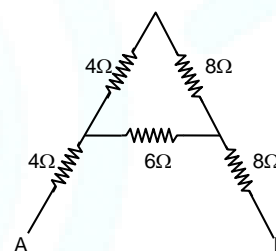
23. For the circuit given below, the Kirchhoff's loop rule for the loop BCDEB is given by the equation [NEET_2020(Covid)]



- (1) $-i_2 R_2 + E_2 - E_3 + i_3 R_1 = 0$
(2) $i_2 R_2 + E_2 - E_3 - i_3 R_1 = 0$
(3) $i_2 R_2 + E_2 + E_3 + i_3 R_1 = 0$
(4) $-i_2 R_2 + E_2 + E_3 + i_3 R_1 = 0$

24. The equivalent resistance between A and B for the mesh shown in the figure is:

[NEET_2020(Covid)]



- (1) 7.2Ω (2) 16Ω (3) 30Ω (4) 4.8Ω

25. **Column-I** gives certain physical terms associated with flow of current through a metallic conductor. **Column-II** gives some mathematical relations involving electrical quantities. Match **Column-I** and **Column-II** with appropriate relations. [NEET_2021]

Column-I		Column-II	
(A)	Drift Velocity	(P)	$\frac{m}{ne^2 \rho}$
(B)	Electrical Resistivity	(Q)	nev_d
(C)	Relaxation Period	(R)	$\frac{eE}{m} \tau$
(D)	Current Density	(S)	$\frac{E}{J}$

- (1) (A)-(R), (B)-(S), (C)-(P), (D)-(Q)
(2) (A)-(R), (B)-(S), (C)-(Q), (D)-(P)
(3) (A)-(R), (B)-(P), (C)-(S), (D)-(Q)
(4) (A)-(R), (B)-(Q), (C)-(S), (D)-(P)



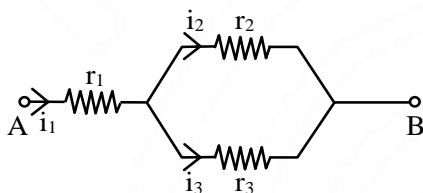
26. The effective resistance of a parallel connection that consists of four wires of equal length, equal area of cross-section and same material is 0.25Ω . What will be the effective resistance if they are connected in series?

[NEET_2021]

- (1) 0.25Ω (2) 0.5Ω
(3) 1Ω (4) 4Ω

27. Three resistors having resistances r_1 , r_2 and r_3 are connected as shown in the given circuit. The ratio $\frac{i_3}{i_1}$ of currents in terms of resistances used in the circuit is:

[NEET_2021]



- (1) $\frac{r_1}{r_2 + r_3}$ (2) $\frac{r_2}{r_2 + r_3}$
(3) $\frac{r_1}{r_1 + r_2}$ (4) $\frac{r_2}{r_1 + r_3}$

28. As the temperature increases, the electrical resistance:
- [NEET_2022]
- (1) increases for both conductors and semiconductors
(2) decreases for both conductors and semiconductors
(3) increases for conductors but decreases for semiconductors
(4) decreases for conductors but increases for semiconductors

29. A copper wire of length 10 m and radius $(10^{-2} / \sqrt{\pi})$ m has electrical resistance of 10Ω . The current density in the wire for an electric field strength of 10 (V/m) is:

[NEET_2022]

- (1) 10^4 A/m^2 (2) 10^6 A/m^2
(3) 10^{-5} A/m^2 (4) 10^5 A/m^2

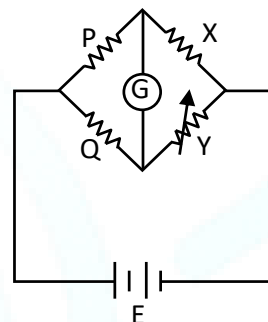
30. Two resistors of resistance, 100Ω and 200Ω are connected in parallel in an electrical circuit. The ratio of the thermal energy developed in 100Ω to that in 200Ω in a given time is:

[NEET_2022]

- (1) 1 : 2 (2) 2 : 1 (3) 1 : 4 (4) 4 : 1

31. A wheat stone bridge is used to determine the value of unknown resistance X by adjusting the variable resistance Y as shown in the figure. For the most precise measurement of X, the resistances P and Q:

[NEET_2022]



- (1) should be approximately equal to $2X$
(2) should be approximately equal and are small
(3) should be very large and unequal
(4) do not play any significant role

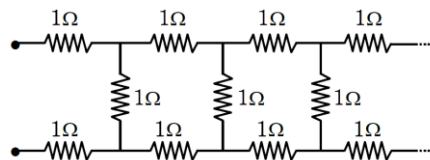
32. A cell of emf 4 V and internal resistance 0.5Ω is connected to a 7.5Ω external resistance. The terminal potential difference of the cell is –

[NEET_2022]

- (1) 3.75 V (2) 4.25 V
(3) 4 V (4) 0.375 V

33. The equivalent resistance of the infinite network given below is :

[NEET_2022]



- (1) 2Ω
(2) $(1 + \sqrt{2}) \Omega$
(3) $(1 + \sqrt{3}) \Omega$
(4) $(1 + \sqrt{5}) \Omega$



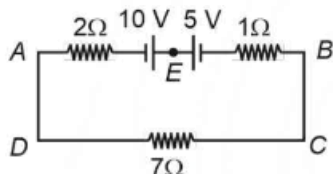
34. The resistance of platinum wire at 0°C is 2Ω and 6.8Ω at 80°C . The temperature coefficient of resistance of the wire is: [NEET_2023]

(1) $3 \times 10^{-2} ^\circ\text{C}^{-1}$ (2) $3 \times 10^{-1} ^\circ\text{C}^{-1}$
(3) $3 \times 10^{-4} ^\circ\text{C}^{-1}$ (4) $3 \times 10^{-3} ^\circ\text{C}^{-1}$

35. 10 resistors, each of resistance R are connected in series to a battery of emf E and negligible internal resistance. Then those are connected in parallel to the same battery, the current is increased n times. The value of n is: [NEET_2023]

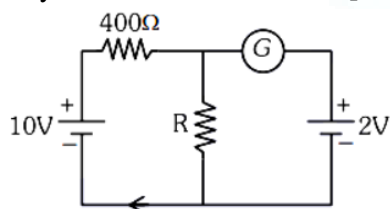
(1) 1 (2) 1000
(3) 10 (4) 100

36. The magnitude and direction of the current in the following circuit is: [NEET_2023]



(1) $\frac{5}{2}$ A from A to B through E
(2) 1.5 A from B to A through E
(3) 0.2 A from B to A through E
(4) 0.5 A from A to B through E

37. If the galvanometer G does not show any deflection in the circuit shown, the value of R is given by: [NEET_2023]

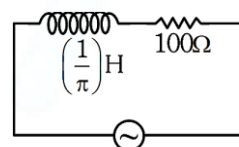


(1) 200Ω (2) 50Ω
(3) 100Ω (4) 400Ω

38. On the basis of electrical conductivity, which one of the following material has the smallest resistivity? [NEET_2023(Manipur)]

(1) Germanium (2) Silver
(3) Glass (4) Silicon

39. An ac source is connected in the given circuit. The value of ϕ will be: [NEET_2023(Manipur)]



$$V = 220 \sin(100\pi t + \phi) \text{ volt}$$

(1) 60° (2) 90° (3) 30° (4) 45°

40. A certain wire A has resistance 81Ω . The resistance of another wire B of same material and equal length but of diameter thrice the diameter of A will be: [NEET_2023(Manipur)]

(1) 81Ω (2) 9Ω
(3) 729Ω (4) 243Ω

41. A copper wire of radius 1 mm contains 10^{22} free electrons per cubic metre. The drift velocity for free electrons when 10 A current flows through the wire will be (Given, charge on electron = 1.6×10^{-19} C): [NEET_2023(Manipur)]

(1) $\frac{6.25 \times 10^4}{\pi} \text{ ms}^{-1}$ (2) $\frac{6.25}{\pi} \times 10^3 \text{ ms}^{-1}$
(3) $\frac{6.25}{\pi} \text{ ms}^{-1}$ (4) $\frac{6.25 \times 10^5}{\pi} \text{ ms}^{-1}$

42. The emf of a cell having internal resistance 1Ω is balanced against a length of 330 cm on a potentiometer wire. When an external resistance of 2Ω is connected across the cell, the balancing length will be: [NEET_2023(Manipur)]

(1) 220 cm (2) 330 cm
(3) 115 cm (4) 332 cm



ANSWER KEY

EXERCISE – I

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	4	2	3	1	3	2	4	2	1	3	2	2	4	4
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	4	1	2	1	3	3	3	1	3	3	3	3	3	3
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	3	1	4	2	3	2	3	2	4	2	3	2	1	1	4
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	2	3	3	3	1	1	1	3	3	4	3	2	3
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	2	1	3	2	1	3	4	3	3	2	1	3	2	1	2
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	3	3	3	1	4	2	4	2	3	3	4	3	3	1	4
Que.	91	92	93	94	95	96	97	98	99	100					
Ans.	2	4	1	3	4	3	1	3	1	2					

EXERCISE – II

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

EXERCISE – III

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ans.	3	2	1	3	2	4	2	1	4	3	2	1	3	1

EXERCISE – IV (PREVIOUS YEAR QUESTIONS)

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	1	1	2	3	2	1	4	2	1	3	1	1	4	4
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	4	1	4	2	4	2	2	2	1	4	2	3	4	2
Que.	31	32	33	34	35	36	37	38	39	40	41	42			
Ans.	2	1	2	1	4	4	3	2	4	2	2	1			



CHEMICAL BONDING

Introduction

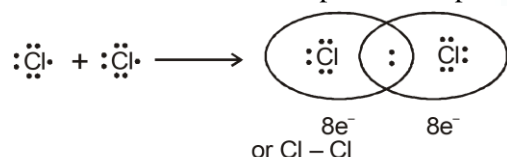
The attractive force which holds various constituents such as atoms, ions etc., together in different chemical species is called a chemical bond.

Octet rule :

"Tendency of atoms to have eight electrons in their outermost shell is known as Lewis octet rule". To achieve inert gas configuration atoms lose, gain or share electrons.

- It has been observed that atoms of noble gases have little or no tendency to combine with each other or with atoms of other elements.
- It means that these atoms must have a stable electronic configuration.
- These elements (noble gases) have 8 electrons ($ns^2 np^6$) except helium which has 2 electrons ($1s^2$) in their outer most shell.
- It is therefore concluded that $ns^2 np^6$ configuration in the outer energy level constitutes a structure of maximum stability or minimum energy.

The **Octet rule** can be understood by considering the formation of the chlorine molecule, Cl_2 . The Cl atom with electronic configuration, $[Ne]^{10} 3s^2 3p^5$, is one electron short of the argon configuration. The formation of the Cl_2 molecule can be understood in terms of the sharing of a pair of electrons between the two chlorine atoms, each chlorine atom contributing one electron to the shared pair. In the process both



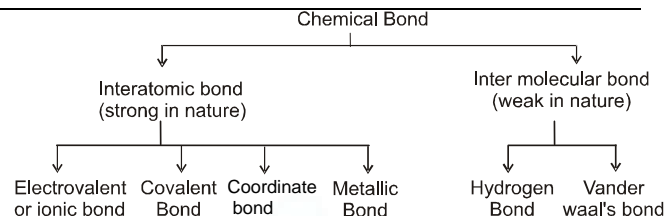
Covalent bond between two Cl atoms

Figure

chlorine atoms attain the outer shell octet of the nearest noble gas (i.e., argon). The dots represent electrons. Such structures are referred to as Lewis dot structures.

Classification of Chemical Bonds

On the basis of electronic valency theory and structure, chemical bonds can be classified as follows.



Electrovalent Or Ionic Bond

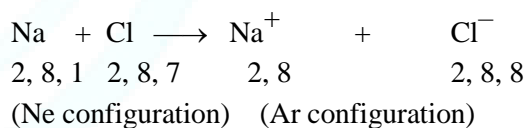
The chemical bond formed between two or more atoms as a result of complete transfer of one or more electrons from one atom to another is called ionic or electrovalent bond.

Electrovalent bond is not possible between similar atoms. This type of bonding requires two atoms of different nature. One atom should have the tendency to loose electrons i.e. electropositive in nature and the other atom should have the tendency to accept electrons i.e. electronegative in nature.

Electropositive atom looses electrons (group IA to IIIA)

Electronegative atom gains electron (group IVA to VII A)

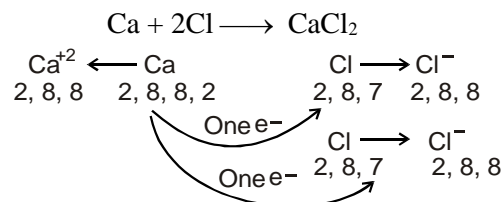
Example : IA and VII A group elements form strong ionic compound.



More the distance between two elements in the periodic table more will be the ionic character of the bond.

Total number of electrons lost or gained is called electrovalence.

Example :



Factors favoring formation of Ionic bonds:

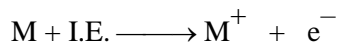
Formation of ionic bond depends upon three factors :

(A) Ionisation energy (IE) :

Amount of energy required to remove an electron from the outermost orbit of an isolated gaseous atom

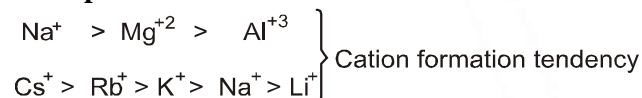


to form positive ion or cation is called ionization energy [energy is absorbed so it is an endothermic process]



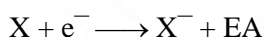
Less Ionisation energy \Rightarrow Greater tendency to form cation.

Example :

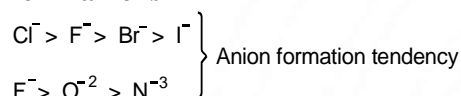


(B) Electron affinity :

Amount of energy released when an electron is added to an isolated gaseous atom to form negative ion or anion is called electron affinity [energy is released so it is an exothermic process]



High electron affinity \Rightarrow Greater tendency to form anions



Lattice Enthalpy

The Lattice Enthalpy of an ionic solid is defined as the energy required to completely separate one mole of a solid ionic compound into gaseous constituent ions. For example,

Factors affecting L.E.

(i) Lattice energy (L.E.) $\propto \frac{1}{r}$
 $r = r_+ + r_- = \text{interionic distance}$

(ii) L.E. $\propto Z_+ Z_-$
 $Z_+ \Rightarrow$ charge on cation in terms electronic charge
 $Z_- \Rightarrow$ charge on anion in terms electronic charge

(iii) Charge density of cation \uparrow L.E. \uparrow

- (a) $NaCl > KCl$
- (b) $NaCl < MgO$
- (c) $NaCl < MgCl_2$
- (d) $Al_2O_3 > MgO > Na_2O$

Characteristics of ionic compounds :

(i) Physical state

- (a) Electrovalent compounds are generally crystalline, hard & brittle in nature.
- (b) These compounds are generally made from ions which are arranged in a regular way as a lattice structure.
- (c) Thus electrovalent compounds exist as three dimensional solid aggregates.

(d) Normally each ion is surrounded by a number of oppositely charged ions and this number is called co-ordination number

(ii) Boiling point and melting point :

High boiling point and melting points are due to strong electrostatic force of attraction.

(iii) Electrical conductivity :

It depends on ionic mobility. In solid state there are no free ions so they are bad conductors of electricity. In fused state or aqueous solution free ions are present so they are good conductors of electricity (Conductivity order) Solid state $<$ Fused state $<$ Aqueous solution

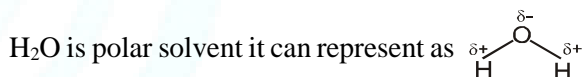
(iv) Ionic reactions:

- Ionic compounds show ionic reactions & covalent compounds show molecular reactions.

Ionic reactions are fast reactions.

(v) Solubility – Ionic compounds are soluble in polar solvent like H_2O , HF etc.

To explain solubility of ionic compound consider an example of $NaCl$ in water.



Solvation or Hydration :

Whenever any compound generally ionic or polar covalent is dissolved in a polar solvent or in water then, different ions of the compound will get separated and will get surrounded by polar solvent molecules. This process is known as solvation or hydration. Energy released in this process is known as solvation energy or hydration energy

The ionic compound will be soluble only if solvation energy (H.E.) is more than the lattice energy

Applications of Hydration energy:

- (a) Size of the hydrated ions: Greater the hydration of the ion greater will be its hydrated radii
 $Li^+(aq) > Na^+(aq)$
- (b) Mobility of the ion: more is the hydration smaller will be the mobility of the ions $\propto \frac{1}{\text{Hydrated radii}}$
 $Li^+(aq) < Na^+(aq) < K^+(aq) < Rb^+(aq) < Cs^+(aq)$.
- (c) Electrical conductance : is related to mobility so follows the same order



Covalent Character in Ionic Compounds (Fajan's Rule) :

When anion and cation approach each other, the valence shell of anion is pulled towards cation nucleus and thus shape of anion is deformed. This phenomenon of deformation of anion by a cation is known as polarisation and the ability of cation to polarize a near by anion is called as polarizing power of cation.

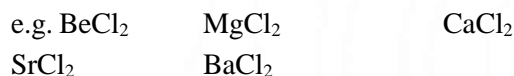


Fajan's pointed out that greater is the polarization of anion in a molecule, more is covalent character in it.

More distortion of anion, more will be polarisation then covalent character increases.

Fajan's gives some rules which govern the covalent character in the ionic compounds, which are as follows:

(i) **Size of cation : Size of cation \propto 1/polarisation.**

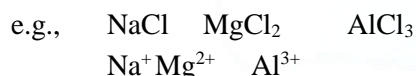


Size of cation increases Polarisation decreases
 Covalent character decreases

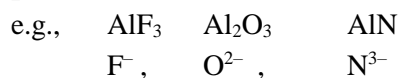
(ii) **Size of anion : Size of anion \propto polarisation**



(iii) **Charge on cation : Charge on cation \propto polarisation.**

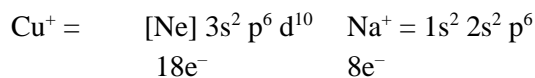


(iv) **Charge on anion : Charge on anion \propto polarisation.**



(v) **Pseudo inert gas configuration of cation:**

Cation having pseudo inert gas configuration has more polarizing power than the cation that has inert gas configuration. Thus NaCl having inert gas configuration will be more ionic whereas CuCl having pseudo inert gas configuration will be more covalent in nature.



Pseudo inert gas configuration

Inert gas configuration

(poor shielding of d-electrons)

(more shielding of s and p electrons)

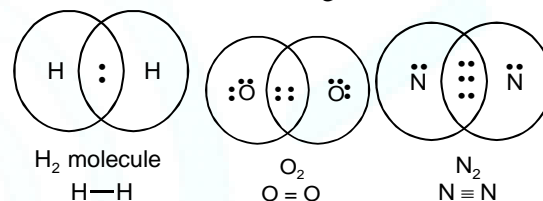
Covalent Bond

- A chemical bond formed by sharing of electrons between two elements is called as covalent bond.

$\text{A}-\text{A}$ (Single bond) : When 2 electrons are shared between the two combining elements.

$\text{A}=\text{A}$ (Double bond) : When 4 electrons are shared between the two combining elements.

$\text{A}\equiv\text{A}$ (Triple bond) : When 6 electrons are shared between the two combining elements.



Lewis Dot Structures :

- The total number of electrons are obtained by adding the valence electrons of combining atoms.
- For Anions, we need to add one electron for each negative charge.
- For cations, we need to subtract one electron for each positive charge.
- After then the central atom is decided.

To decide, Central atom, following steps are followed :

In general the **least electronegative atom** occupies the central position in the molecule/ion.

Characteristics of covalent compounds :

(i) **Physical state :**

- Under normal temperature and pressure, they exist as gases or liquids of low boiling points.
- This is due to the fact that very weak forces of attraction (Vander waal's forces) exist between the molecules due to which molecules are far from each other.
- If their molecular masses are high they exist as soft solids ex. Sulphur, phosphorus and iodine



(ii) Crystal structures :

Various types of structures that are present in a covalent compound are as follows.

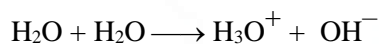
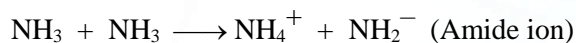
(a) Covalent solid – In this type of structure every atom is bonded to four other atoms by single covalent bonds resulting in the formation of a giant structure e.g. SiC, AlN and diamond these crystals are very hard and possess high melting point.

(b) Molecular solids : They are formed when one atom combines with another by a covalent bond and then the molecule combines with another similar molecule with the help of Vander waal's force of attraction or hydrogen bond

Example : CH₄(Solid), dry ice, ice

(iii) Electrical conductivity :

- In general covalent substances are bad conductors of electricity. Since they do not contain charged particles or free electrons.
- Substances which have polar character like HCl in a solution, can conduct electricity.
- Graphite can conduct electricity since electrons can pass from one layer to other.
- Some show conductivity due to self ionisation. example Liq NH₃



(iv) Chemical reactions :

Covalent substances give molecular reactions. Reaction rate is usually low because it involves two steps (i) breaking of covalent bonds of the reactants (ii) establishing new bonds. While in ionic reactions there is only regrouping of ions.

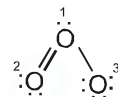
(vi) Solubility :

- Non polar compounds are soluble in non polar solvents.
- Polar compounds are soluble in polar solvents

Formal Charge :

Formal charge (F.C.)
On an atom in a Lewis
structure =

$$\left[\begin{array}{l} \text{Total number of valence} \\ \text{electron in the free atom} \end{array} \right] - \left[\begin{array}{l} \text{Total number of non bonding} \\ \text{(lone pair) electrons} \end{array} \right] - \left(\frac{1}{2} \right) \left[\begin{array}{l} \text{Total number of} \\ \text{bonding (shared)} \\ \text{electrons} \end{array} \right]$$



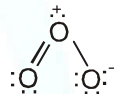
The atoms have been numbered as 1. 2 and 3. The formal charge on :

$$\text{The central O atom marked 1} = 6 - 2 - \frac{1}{2} (6) = +1$$

$$\text{The terminal O atom marked 2} = 6 - 4 - \frac{1}{2} (4) = 0$$

$$\text{The terminal O atom marked 3} = 6 - 6 - \frac{1}{2} (2) = -1$$

Hence, we represent O₃ along with the formal charges as follows :



Limitations of the Octet Rule :

1. The incomplete octet of the central atom

In some compounds, the number of electrons surrounding the central atom is less than eight.

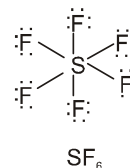
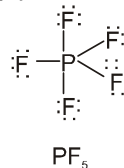
Examples are LiCl, BeH₂ and BCl₃. BeF₂, BF₃, AlCl₃

2. Odd-electron molecules

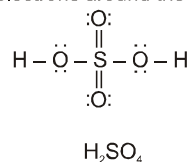
In molecules with an odd number of electrons. e.g. NO, ClO₂, ClO₃

3. The expanded octet, Super octet or Hypervalent molecules

In a number of compounds of these elements there are more than eight valence electrons around the central atom. This is termed as the expanded octet. Obviously, the octet rule does not apply in such cases.



10 electrons around the P atom 12 electrons around the S atom



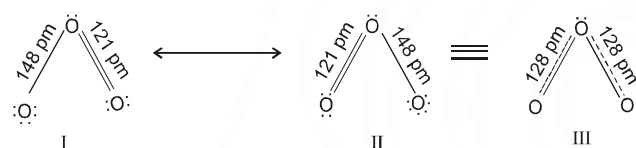
12 electrons around the S atom



- It is clear that octet rule is based upon the chemical inertness of noble gases. However, some noble gases (for example xenon and krypton) also combine with oxygen and fluorine to form a number of compounds like XeF_2 , KrF_2 , XeOF_2 etc.,
- This theory does not account for the shape of molecules.
- It does not explain the relative stability of the molecules being totally silent about the energy of a molecule

Resonance :

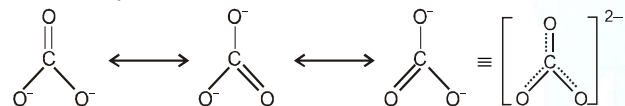
It is often observed that a single Lewis structure is inadequate for the representation of a molecule in conformity with its experimentally determined parameters. For example, the ozone, O_3 molecule can be equally represented by the structures I and II shown below :



Resonance in the O_3 molecule

Structures I and II represent the two canonical forms.

According to the concept of resonance, whenever a single Lewis structure cannot describe a molecule accurately, a number of structures with similar energy, positions of nuclei, bonding and non-bonding pairs of electrons are taken as the canonical structures of the hybrid which describes the molecule accurately.



Valence bond theory was introduced by Heitler and London (1927) and developed further by Pauling and others. A discussion of the valence bond theory is based on the knowledge of atomic orbitals, electronic configurations of elements, the overlap criteria of atomic orbitals, the hybridization of atomic orbitals and the principles of variation and superposition. Consider two hydrogen atoms A and B approaching each other having nuclei N_A and N_B and electrons present in them are represented by e_A and e_B . When

the two atoms are at large distance from each other, there is no interaction between them. As these two atoms approach each other, new attractive and repulsive forces begin to operate.

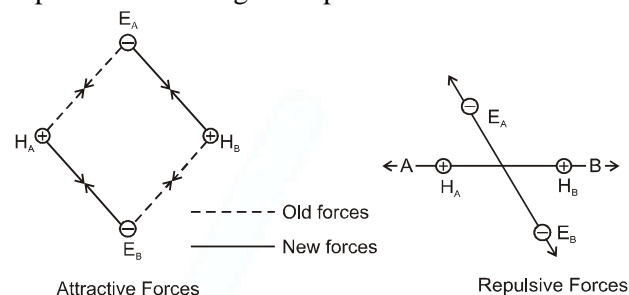


Fig- Forces of attraction and repulsion during the formation of H_2 molecule.

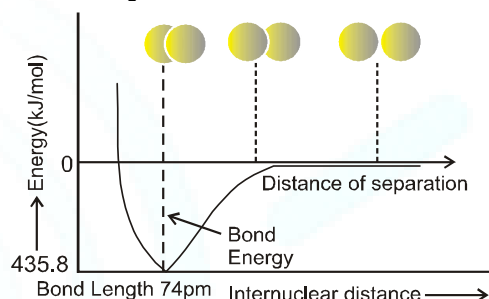


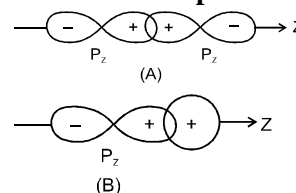
Fig. The potential energy curve for the formation of H_2 molecule as a function of internuclear distance of the H atoms. The minimum in the curve corresponds to the most stable state of H_2 .

Orbital Overlap Concept

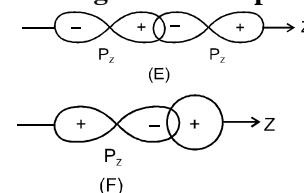
In the formation of hydrogen molecule, there is a minimum energy state when two hydrogen atoms are so near that their atomic orbitals undergo partial interpenetration. This partial merging of atomic orbitals is called overlapping of atomic orbitals which results in the pairing of electrons. The extent of overlap decides the strength of a covalent bond. In general, greater the overlap the stronger is the bond formed between two atoms. Therefore, according to orbital overlap concept, the formation of a covalent bond between two atoms results by pairing of electrons present in the valence shell having opposite spins.

Overlapping of Atomic Orbitals

Positive overlap



Negative overlap



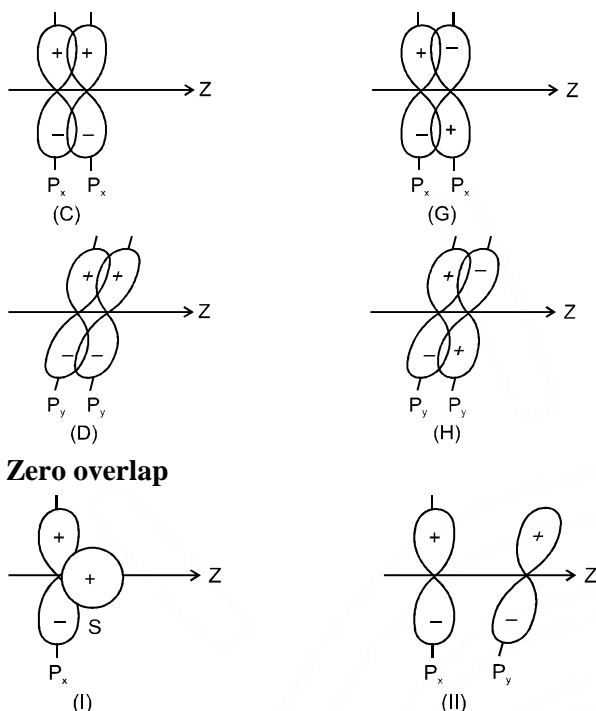


Figure : Positive, negative and zero overlaps of s and p atomic orbitals

Types of Overlapping and Nature of Covalent Bonds :

The covalent bond may be classified into two types depending upon the types of overlapping :

(i) Sigma (σ) bond, and (ii) pi (π) bond

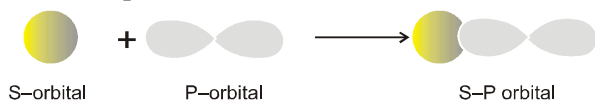
(i) Sigma (σ) bond :

This type of covalent bond is formed by the end to end (head-on) overlap of bonding orbitals along the internuclear axis. This is called as head on overlap or axial overlap. This can be formed by any one of the following types of combinations of atomic orbitals.

- s-s overlapping : In this case, there is overlap of two half filled s-orbitals along the internuclear axis as shown below :



- s-p overlapping: This type of overlap occurs between half filled s-orbitals of one atom and half filled p-orbitals of another atom.

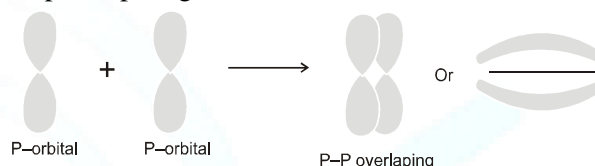


- p-p overlapping : This type of overlap takes place between half filled p-orbitals of the two approaching atoms.



(ii) pi(π) bond :

In the formation of π bond the atomic orbitals overlap in such a way that their axes remain parallel to each other and perpendicular to the internuclear axis. The orbitals formed due to sidewise overlapping consists of two saucer type charged clouds above and below the plane of the participating atoms.



Strength of Sigma and pi Bonds :

Basically the strength of a bond depends upon the extent of overlapping- In case of sigma bond, the overlapping of orbitals takes place to a larger extent. Hence, it is stronger as compared to the pi bond where the extent of overlapping occurs to a smaller extent. Further, it is important to note that pi bond . between two atoms is formed in addition to a sigma bond. It is always present in the molecules containing multiple bond (double or triple bonds)

Hybridisation

- Hypothetical concept Introduced by Pauling and Slater.
- Atomic orbitals combine to form new set of equivalent orbitals known as hybrid orbitals.
- This phenomenon is known as hybridization.
- Process of Intermixing of the atomic orbitals of equal or slightly different energies in the formation of new set of orbitals of equivalent energies and shape is known as hybridization.

Salient features of hybridisation : The main features of hybridisation are as under :

1. The number of hybrid orbitals is equal to the number of the atomic orbitals that get hybridised.
2. The hybridised orbitals are always equivalent in energy and shape.





- The hybrid orbitals are more effective in forming stable bonds than the pure atomic orbitals.
- These hybrid orbitals are directed in space in some preferred direction to have minimum repulsion between electron pairs and thus a stable arrangement is obtained. Therefore, the type of hybridisation indicates the geometry of the molecules.

Determination of Hybridisation state

Method (I) : Number of hybrid orbital = number of σ bond + number of lone pair [surrounding the central atom]

Method (II) : To predict hybridization following formulae may be used:

$$\text{No. of hybrid orbital} = \frac{1}{2}[\text{Ve}^- + \text{SA} \pm \text{C}]$$

[Ve⁻ = Total number of valence e⁻ in the central atom,

SA = total number of monovalent atoms; C = charge]

Example: $\text{NH}_4^+ \frac{1}{2}[5 + 4 - 1] = 4 \text{ sp}^3$ hybridization.

$$\text{SF}_4 \frac{1}{2}[6 + 4] = 5 \text{ sp}^3\text{d hybridization.}$$

$$\text{SO}_4^{2-} \frac{1}{2}[6 + 2] = 4 \text{ sp}^3 \text{ hybridization.}$$

('O' is divalent so add only charge on anion)

$$\text{NO}_3^- \frac{1}{2}[5 + 1] = 3 \text{ sp}^2 \text{ hybridization}$$

If such type of e⁻ pairs are-

Two - sp hybridization

Three - sp² hybridization

Four - sp³ hybridization

Five - sp³d hybridization

Six - sp³d² hybridization

Seven - sp³d³ hybridization

S.No.	Formula	Total pair of e ⁻		Hybridization	Geometry/Shape	Example
		bp	Lp			
1.	AB ₂	2	0	sp	Linear	BeCl ₂ , CO ₂
2.	AB ₃	3	0	Sp ²	Trigonal Planar	BCl ₃ , BF ₃
3.	AB ₄	4	0	Sp ³	Tetrahedral	CH ₄ , CCl ₄
4.	AB ₅	5	0	Sp ³ d	Trigonal bipyramidal	PCl ₅
5.	AB ₆	6	0	Sp ³ d ²	Octahedral (Square bipyramidal)	SF ₆
6.	AB ₇	7	0	Sp ³ d ³	Pentagonal bipyramidal	IF ₇

Position of lone pair & multiple bond

(i) sp/sp²/sp³ = Any where

(ii) sp³d = equatorial

(iii) sp³d² = axial (defined first)

(iv) $\text{sp}^3\text{d}^3 \begin{cases} \text{Lone pair} = 1 \text{ then equatorial} \\ \text{Lone pair} = 2 \text{ then axial} \end{cases}$

(v) $\left. \begin{matrix} \text{sp}^3\text{d hybridization Axial bond length} > \text{equatorial bond length} \\ \text{sp}^3\text{d}^2 \text{ hybridization Axial bond length} < \text{equatorial bond length} \end{matrix} \right\} \text{Terminal atom same}$

Valence shell electron pair repulsion (VSEPR) theory :

- The shape of a molecule depends upon the number of valence shell electron pairs [bonded or nonbonded) around the central atom.
- Pairs of electrons in the valence shell repel one another since their electron clouds are negatively charged.

(iii) These pairs of electrons tend to occupy such positions in space that minimise repulsion and thus maximise distance between them.

(iv) The valence shell is taken as a sphere with the electron pairs localising on the spherical surface at maximum distance from one another.

(v) A multiple bond is treated as if it is a single electron pair and the two or three electron pairs of a multiple bond are treated as a single super pair.

(vi) Where two or more resonance structures can represent a molecule, the VSEPR model is applicable to any such structure.

The repulsive interaction of electron pairs decreases in the order :

lone pair (lp) - lone pair (lp) > lone pair (lp) - bond pair (bp) > bond pair (bp) - bond pair (bp)





Shape (molecular geometry) of Some Simple Molecules / ions with central atom/ion having no Lone Pairs of Electrons (E).

Number of electron pairs	Arrangement of electron pairs	Molecular geometry	Example
2	<p style="text-align: center;">Linear</p>	$B - A - B$ Linear	$BeCl_2, HgCl_2$
3	<p style="text-align: center;">Trigonal planar</p>	<p style="text-align: center;">Trigonal planar</p>	BF_3
4	<p style="text-align: center;">Tetrahedral</p>	<p style="text-align: center;">Tetrahedral</p>	CH_4, NH_4^+
5	<p style="text-align: center;">Trigonal bipyramidal</p>	<p style="text-align: center;">Trigonal bipyramidal</p>	PCl_5
6	<p style="text-align: center;">Octahedral</p>	<p style="text-align: center;">Octahedral</p>	SF_6

Shape (molecular geometry) of Some Simple Molecules/Ions with central atom / ions having One or More Lone Pairs of Electrons (E).

Molecule type	No. of bonding pairs	No. of lone pairs	Arrangement of electron pairs	Shape	Examples
AB_2E	2	1		Bent	SO_2, O_3
AB_3E	3	1		Trigonal pyramidal	NH_3
AB_2E_2	2	2		Bent	H_2O
AB_4E	4	1		See saw	SF_4



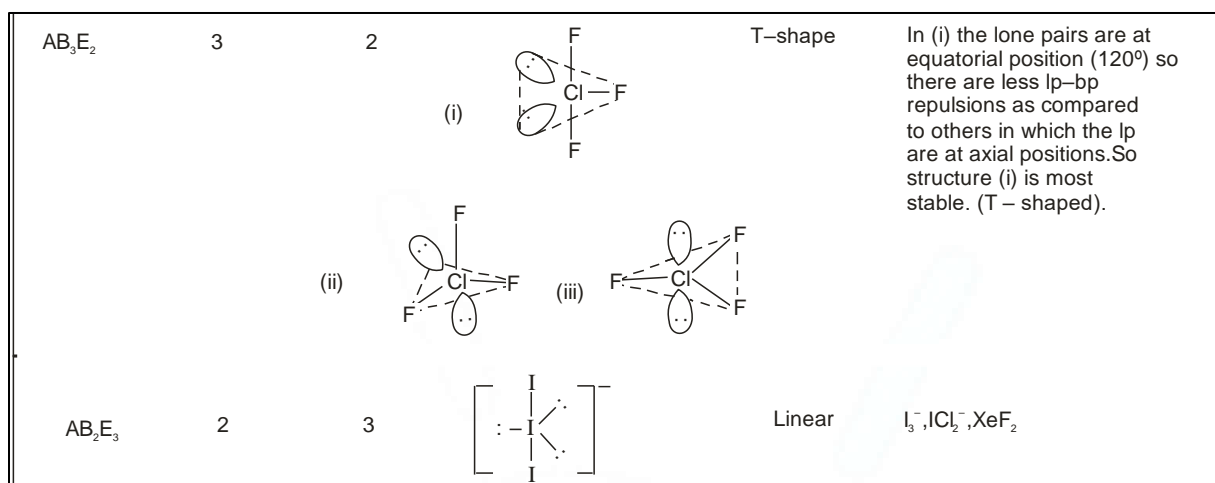


AB_3E_2	3	2		T-shape	ClF_3
AB_2E_3	2	3		Linear	I_3^- , ICl_2^- , XeF_2
AB_5E	5	1		Square pyramidal	BrF_5
AB_4E_2	4	2		Square planar	XeF_4

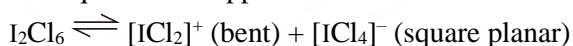
Shapes of Molecules containing Bond Pair and Lone Pair

Molecule type	No. of bonding pairs	No. of lone pairs	Shape	Reason for the shape acquired
AB_2E	4	1	 Bent	It is found to be bent or v-shaped. The reason being the lone pair-bond pair repulsion is much more as compared to the bond pair-bond pair repulsion. So the angle is reduced to 119.5° from 120° .
AB_3E	3	1	 Trigonal pyramidal	It is found to be trigonal pyramidal due to the repulsion between lp-bp (which is more than bp-bp repulsion) the angle between bond pairs is reduced to 107° to 109.5° .
AB_2E_2	2	2	 Bent	The shape is distorted tetrahedral or angular. The reason is lp-lp repulsion is more than lp-bp repulsion. Thus, the angle is reduced to 104.5° from 109.5° .
AB_5E	4	1	(i) (ii) See-saw (More stable)	In (i) the lp is present at axial position so there are three lp-bp repulsion at 90° . In (ii) the lp is in an equatorial position, and there are two lp-bp repulsions. Hence, arrangement (ii) is more stable. The shape shown in (ii) is called as a distorted tetrahedron, a folded square or a see-saw.





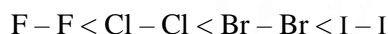
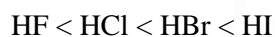
Note : The liquid has an appreciable electrical conductance due to self ionization.



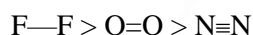
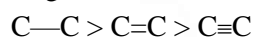
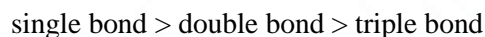
Bond Length And Bond Angle Comparison:

Bond Length

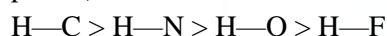
- (i) Size of atom (see along the group) \propto bond length



- (ii) Multiplicity of bond (nearly same period element)

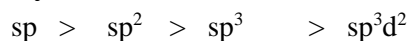


- (iii) Electronegativity difference (See along the period)

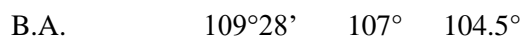
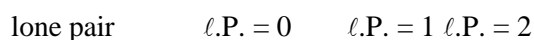
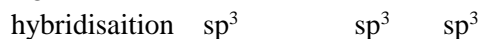
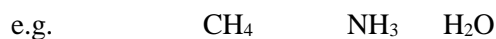


Bond Angle:

1. Hybridisation :



2. **Number of lone pair :** If hybridisation of the central atom is same but number of lone pair is different then more is the number of lone pair less is the bond angle.



3. **Size or electronegativity of central atom :** When hybridisation is same and no. of lone pair is same but central atom is different then see the

electronegativity of central atom. More is the electronegativity more is the bond angle.

e.g.	NH_3	PH_3	AsH_3	SbH_3
hybridisation	sp^3	no	no	no
lone pair	$\ell.P. = 1$	$\ell.P. = 1$	$\ell.P. = 1$	$\ell.P. = 1$
B.A.	107°	93°	92°	91°

4. Size or electronegativity of terminal atom :

Hybridisation same, lone pair same, central atom same but terminal atom is different then greater is the size of the terminal atom greater will be the bond angle. Only in case of fluorine the electronegativity factor is considered, due to greater electronegativity of the fluorine atom the bond angle for it comes out to be smallest (due to smaller bond bond pair repulsions)

e.g.	PF_3	PCl_3	PBr_3	PI_3
hybridisation	sp^3	sp^3	sp^3	sp^3
lone pair	$\ell.P. = 1$	$\ell.P. = 1$	$\ell.P. = 1$	$\ell.P. = 1$
B.A.	98°	100°	101°	102°

Molecular Orbital Theory (MOT) :

The molecular orbital theory was developed by F. Hund and R.S. Mulliken in 1932. The salient features are:

- Just as electrons of any atom are present in various atomic orbitals, electrons of the molecule are present in various molecular orbitals.
- Molecular orbitals are formed by the combination of atomic orbitals of comparable energies and proper symmetry.
- An electron in an atomic orbital is influenced by

one nucleus, while in a molecular orbital it is influenced by two or more nuclei depending upon the number of the atoms in the molecule. **Thus an atomic orbital is monocentric while a molecular orbital is polycentric.**

- (iv) The number of molecular orbitals formed is equal to the number of combining atomic orbitals. When two atomic orbitals combine, two molecular orbitals called **bonding molecular orbital** and **anti-bonding molecular orbital** are formed.
- (v) The bonding molecular orbital has lower energy and hence greater stability than the corresponding antibonding molecular orbital.
- (vi) Just as the electron probability distribution around a nucleus in an atom is given by an atomic orbital, the electron probability distribution around a group of nuclei in a molecule is given by molecular orbital.
- (vii) The molecular orbitals like the atomic orbitals are filled in accordance with the **Aufbau principle** obeying the **Pauli Exclusion principle** and the **Hund's Rule of Maximum Multiplicity**. But the filling order of these molecular orbitals is always **experimentally decided**, there is no rule like $(n + 1)$ rule in case of atomic orbitals.

Formation of Molecular Orbitals : Linear Combination of Atomic Orbitals(LCAO)

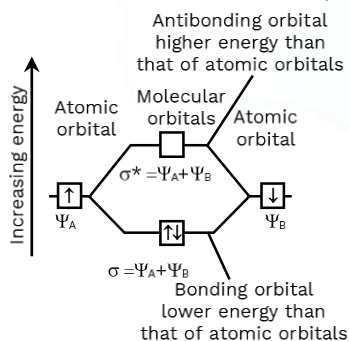


Fig.: Formation of bonding (σ) and antibonding (σ^*) molecular orbitals by the linear combination of atomic orbitals Ψ_A and Ψ_B centered on two atoms A and B respectively.

The linear combination of atomic orbitals to form molecular orbitals takes place only if the following conditions are satisfied :

1. The combining atomic orbitals must have the

same or nearly the same energy.

2. The combining atomic orbitals must have the same symmetry about the molecular axis.
3. The combining atomic orbitals must overlap to the maximum extent.

Energy Level Diagram For Molecular Orbitals :

The energy levels of molecular orbitals have been determined experimentally from spectroscopic data for homonuclear diatomic molecules of second row elements of the periodic table. The increasing order of energies of various molecular orbitals for O_2 and F_2 is given below :

$$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < (\pi 2p_x = \pi 2p_y) < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$$

The increasing order of energies of various molecular orbitals for Be_2 , B_2 , C_2 , N_2 etc., is :

$$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < (\pi 2p_x = \pi 2p_y) < \sigma 2p_z < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$$

The important characteristic feature of this order is that the **energy of $\sigma 2p_z$ molecular orbital is higher than that of $\pi 2p_x$ and $\pi 2p_y$ molecular orbitals.**

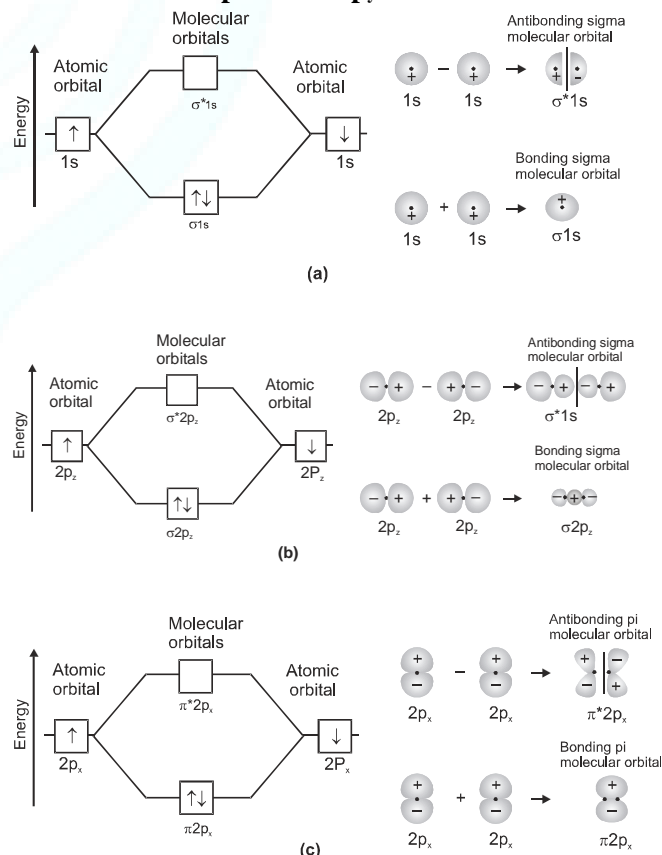


Fig. Bonding and antibonding molecular orbitals

formed through combinations of (a) 1s atomic orbitals;

(b) $2p_z$ atomic orbitals and (c) $2p_x$ atomic orbitals.

Electronic configuration and molecular behaviour:

Bond order

Bond order (b.o.) is defined as one half the difference between the number of electrons present in the bonding and the antibonding orbitals i.e., Bond order (b.o.) = $\frac{1}{2} (N_b - N_a)$

A positive bond order (i.e., $N_b > N_a$) means a stable molecule while a negative (i.e., $N_b < N_a$) or zero (i.e., $N_b = N_a$) bond order means an unstable molecule.

Nature of the bond

Integral bond order values of 1, 2 or 3 correspond to single, double or triple bonds respectively.

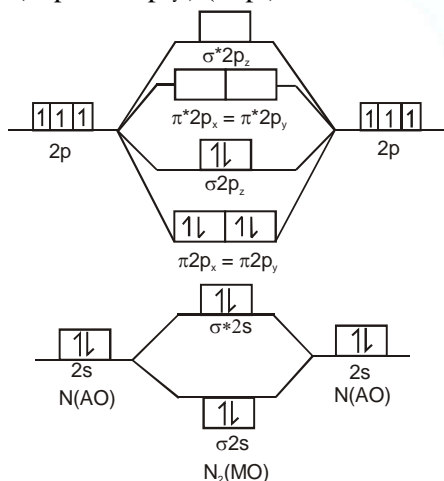
Bond-length

The bond order between two atoms in a molecule may be taken as an approximate measure of the bond length. The bond length decreases as bond order increases.

Magnetic nature

If all the molecular orbitals in a molecule are doubly occupied, the substance is diamagnetic (repelled by magnetic field) e.g., N_2 molecule. However if one or more molecular orbitals are singly occupied it is paramagnetic (attracted by magnetic field), e.g., O_2 molecule.

Nitrogen molecule (N_2) : $(\sigma 1s)^2 (\sigma^* 1s)^2 (\sigma 2s)^2 (\sigma^* 2s)^2 (\pi 2p_x = \pi 2p_y)^2 (\sigma 2p_z)^2$



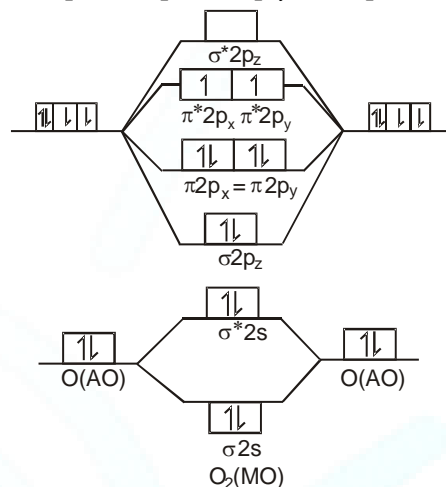
M.O. Energy level diagram for N_2 molecule

N_2 has a triple bond according to both the Lewis and

the molecular orbital models.

The bond order of N_2 is $\frac{1}{2}(10 - 4) = 3$. It contains one sigma and two π bonds.

Oxygen molecule (O_2) : $O_2 : (\sigma 1s)^2 (\sigma^* 1s)^2 (\sigma 2s)^2 (\sigma^* 2s)^2 (\sigma 2p_z)^2 (\pi 2p_x = \pi 2p_y)^2 (\pi^* 2p_x^1 = \pi^* 2p_y^1)$



M.O. Energy level diagram for O_2 molecule

Polarity of Bonds :

In reality no bond or a compound is either completely covalent or ionic. Even in case of covalent bond between two hydrogen atoms, there is some ionic character.

When a covalent bond is formed between two similar atoms, for example in H_2 , O_2 , Cl_2 , N_2 or F_2 the shared pair of electrons is equally attracted by the atoms. As a result electron pair is situated exactly between the two identical nuclei. The bond so formed is called nonpolar covalent bond. Contrary to this in case of a heteronuclear molecule like HF, the shared electron pair between the two atoms gets displaced more towards fluorine since the electronegativity of fluorine is far greater than that of hydrogen. The resultant covalent bond is a polar covalent bond.

As a result of polarisation, the molecule possesses the **dipole moment** which can be defined as the product of magnitude of the partial charge (δ^+ or δ^-) developed on any of the covalently bonded atoms and the distance between two atoms.

Dipole moment (μ) = Magnitude of charge (q) \times distance of separation (d)

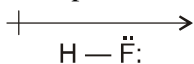
Dipole moment is usually expressed in Debye units (D). The conversion factors are

- $1 \text{ D} = 3.33564 \times 10^{-30} \text{ Cm}$, where C is coulomb

and m is meter.

- 1 Debye = 1×10^{-18} e.s.u. cm.

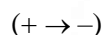
Further dipole moment is a vector quantity and is depicted by a small arrow with tail on the positive centre and head pointing towards the negative centre. For example the dipole moment of HF may be represented as



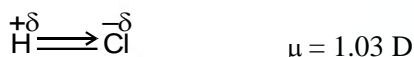
The shift in electron density is represented by crossed arrow (\longleftrightarrow) above the Lewis structure to indicate the direction of the shift.

(A) Diatomic molecules :

- Dipole moment is a vector quantity i.e., it has magnitude as well as direction. It is often represented by an arrow with its tail at the positive centre and head pointing towards the negative end

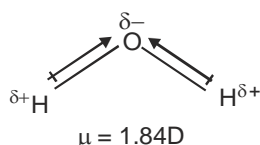


- As a polar diatomic molecule possesses only one polar bond, the dipole moment of that molecule is equal to the dipole moment of the polar bond e.g. in case of HCl, the molecular dipole moment is equal to the dipole moment of H-Cl bond i.e. 1.03 D. Thus,



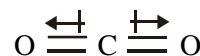
(B) Polyatomic molecules :

- As a polyatomic molecule has more than one polar bond, the dipole moment is equal to the resultant dipole moment of all the individual bonds.
- For example dipole moment of H_2O is 1.84 D which is equal to the resultant dipole moment of two O-H bonds.

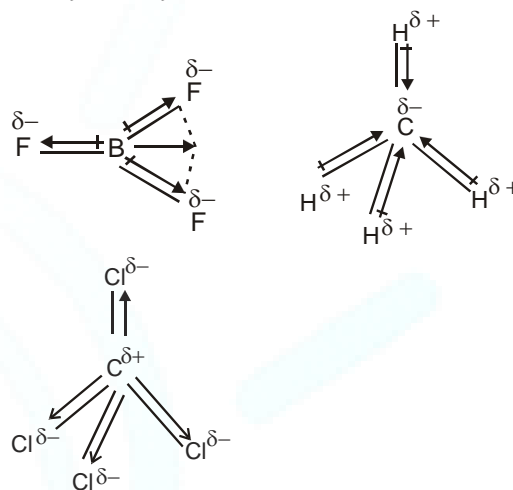


- Think about CO_2 molecule though C=O bond is polar due to electronegativity difference but the resultant dipole moment of molecule is zero as the individual dipole moments are of equal moment and opposite sign. This shows

that CO_2 is a linear molecule.



- Again in case of symmetrical molecules such as BF_3 , CH_4 and CCl_4 the molecular dipole moment is found to be zero. This is due to the fact that individual dipole moments cancel out on account of symmetry of the molecule.



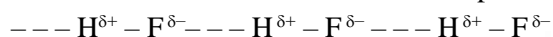
Some important points about dipole moment :

Type of Molecule	Example	Dipole Moment, $\mu(\text{D})$	Geometry
Molecule (AB)	HF	1.78	linear
	HCl	1.07	linear
	HBr	0.79	linear
	HI	0.39	linear
	H_2	0	linear
Molecule (AB ₂)	H_2O	1.85	bent
	H_2S	0.95	bent
	CO_2	0	linear
Molecule (AB ₃)	NH_3	1.47	trigonal-pyramidal
	NF_3	0.23	trigonal-pyramidal
	BF_3	0	trigonal-planar
Molecule (AB ₄)	CH_4	0	tetrahedral
	CHCl_3	1.04	tetrahedral
	CCl_4	0	tetrahedral

Hydrogen Bond :



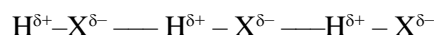
Nitrogen, oxygen and fluorine are the highly electronegative elements. When they are attached to a hydrogen atom to form covalent bond, the electrons of the covalent bond are shifted towards the more electronegative atom. This partially positively charged hydrogen atom forms a bond with the other more electronegative atom. This bond is known as hydrogen bond and is weaker than the covalent bond. For example, in hf molecule, the hydrogen bond exists between hydrogen atom of one molecule and fluorine atom of another molecule as depicted below:



Here, hydrogen bond acts as a bridge between atoms which holds one atom by covalent bond and the other by hydrogen bond. Hydrogen bond is represented by a dotted line (---) while a solid line represents the covalent bond. Thus, hydrogen bond can be defined as the attractive force which binds hydrogen atom of one molecule with the electronegative atom (F, O or N) of another molecule.

Cause of Formation of Hydrogen Bond:

When hydrogen is bonded to strongly Electronegative element 'x', the electron pair Shared between the two atoms moves far away From hydrogen atom. As a result the hydrogen Atom becomes highly electropositive with Respect to the other atom 'x'. Since there is Displacement of electrons towards x, the Hydrogen acquires fractional positive charge (δ^+) while 'x' attain fractional negative charge (δ^-). This results in the formation of a polar molecule having electrostatic force of attraction which can be represented as :



The magnitude of H-bonding depends on the physical state of the compound. it is maximum in the solid state and minimum in the gaseous state. thus, the hydrogen bonds have strong influence on the structure and properties of the compounds.

Types of H-Bonds

There are two types of H-bonds

- (i) Intermolecular hydrogen bond
- (ii) Intramolecular hydrogen bond

(1) Intermolecular Hydrogen Bond :

it is formed between two different molecules of the same or different compounds. For example, hbond in case of hf molecule, alcohol or water molecules, etc.

(2) Intramolecular Hydrogen Bond :

it is formed when hydrogen atom is in between the two highly electronegative (F, O, N) atoms present within the same molecule. For example, in *o*-nitrophenol the hydrogen is in between the two oxygen atoms.

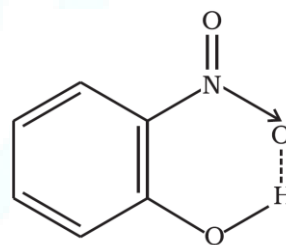


Fig. : Intramolecular hydrogen bonding in *o*-nitrophenol molecule




EXERCISE-1
Valency

- Which of the species follows octet rule:
(1) IBr_5 (2) CCl_4 (3) SF_4 (4) PCl_5
- Which of the following compound exist—
(1) OF_6 (2) NH_5 (3) NH_3 (4) CCl_6^{2-}
- Which one of the following element will never obey octet rule:
(1) Na (2) F (3) S (4) H
- In which of the following molecule sulphur is in 2nd excited state:
(1) SF_2 (2) SF_4 (3) SF_6 (4) All
- Which is not an exception to octet rule ?
(1) BF_3 (2) SnCl_4 (3) BeI_2 (4) ClO_2
- Which of the following pair has electron deficient compounds:
(1) $\text{BCl}_3, \text{AlCl}_3$ (2) $\text{CH}_4, \text{CCl}_4$
(3) $\text{SF}_2, \text{Cl}_2\text{O}$ (4) PCl_3, ICl
- Valency expresses generally:
(1) Total e^- in an atom
(2) Atomicity of an element
(3) Oxidation number of an element
(4) Combining capacity of an element
- Which element do not have valency equal to its group number:
(1) Sodium (2) Aluminium
(3) Oxygen (4) Carbon
- The oxide which is an odd electron molecule is:
(1) ClO_2 (2) N_2O (3) N_2O_4 (4) Cl_2O_6
- Which of the following does not act as lewis acid?
(1) BF_3 (2) SnCl_4 (3) CCl_4 (4) SF_4
- Boron compounds behave as Lewis acids because of their:
(1) Acidic nature
(2) Covalent nature
(3) Electron deficient character
(4) Ionising property
- Which of the following is not correctly matched?
(1) ClF_3 excited state I of Cl
(2) XeO_2F_2 excited state II of Xe
(3) BeCl_2 excited state I of Be
(4) SF_6 excited state II of S

VBT and Overlapping

- In a triple bond there is sharing of:—
(1) 3-electrons (2) 4-electrons
(3) Several electrons (4) 6-electrons
- The triple bond is made up of:—
(1) Three sigma bonds
(2) Three π -bonds
(3) One sigma and two π -bonds
(4) Two sigma and one π -bond
- The strength of bonds by 2s - 2s, 2p - 2p and 2p - 2s overlapping has the order:-
(1) $s - s > p - p > s - p$
(2) $s - s > p - s > p - p$
(3) $p - p > s - p > s - s$
(4) $p - p > s - s > p - s$
- Which of the following configuration shows second excitation state of Iodine:-
(1)

↑↓	↑↓	↑	↑	↑				
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(2)

↑↓	↑	↑	↑	↑	↑			
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(3)

↑↓	↑	↑	↑	↑	↑			
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(4)

↑	↑	↑	↑	↑	↑	↑		
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- Variable covalency is exhibited by:-
(1) P and S (2) N and O
(3) N and P (4) F and Cl
- A sigma bond is formed by the overlapping of:—
(1) s-s orbital only
(2) s and p orbitals only
(3) s-s, s-p or p-p orbitals along internuclear axis
(4) p-p orbital along the sides
- Which overlapping is involved in HCl molecule:—
(1) s-s overlap (2) p-p overlap
(3) s-d overlap (4) s-p overlap
- Which of the following bonds will have directional character
(1) Ionic bond
(2) Metallic bond
(3) Covalent bond
(4) Both covalent & metallic





21. Which is not characteristic of π -bond:-
 (1) π - bond is formed when a sigma bond is already formed
 (2) π - bond are formed from hybrid orbitals
 (3) π - bond may be formed by the overlapping of p-orbitals
 (4) π -bond results from lateral overlap of atomic orbitals
22. Weakest bond is formed by the orbital overlapping of:-
 (1) p – p side wise (2) s – p
 (3) s – s (4) p – p co-axial
23. Mostly overlapping of two hybrid orbitals can lead to the formation of:
 (1) Ionic bond (2) π -bond
 (3) σ -bond (4) (2) and (3) both
24. Which of the following statements is not correct?
 (1) Double bonds is shorter than a single bond
 (2) σ – bond is weaker than a π bond
 (3) Double bond is stronger than a single bond
 (4) Covalent bond is directional in nature
25. In H_2 molecule type of overlapping present between H–H bond:-
 (1) s – p (2) s – s (3) p – p (4) sp^2 – s
26. Covalent bond is formed by
 (1) Combination of ions
 (2) Combination of half filled orbitals
 (3) Exchange of electrons by atom
 (4) None of above
27. Generally the type of bond formed between two non metals would be
 (1) Covalent (2) Ionic
 (3) Co-ordinate (4) All the above
28. Which compound of xenon is not possible
 (1) XeF_2 (2) XeF_4 (3) XeF_5 (4) XeF_6
29. Which of the following statements regarding covalent bond is not true?
 (1) The electrons are shared between atoms
 (2) The bond is non-directional
 (3) The strength of the bond depends upon the extent of overlapping
 (4) The bond formed may or may not be polar
30. Linear combination of two hybridized orbitals belonging to two atoms and each having one electron leads to a:
 (1) Sigma bond
 (2) Double bond
 (3) Co-ordinate covalent bond
 (4) pi bond
31. CO_2 is a gas, while SiO_2 is a solid but both are-
 (1) Covalent containing π -bond
 (2) Molecules having $p\pi - d\pi$ bonding
 (3) Acidic
 (4) Discrete molecules
32. Which of the following element does not form diatomic molecule.
 (1) Iodine (2) Oxygen
 (3) Phosphorus (4) Nitrogen
33. Which trihalide ion is unknown due to absence of vacant d-orbital?
 (1) F_3^- (2) Br_3^- (3) I_3^- (4) Cl_3^-
34. Which of the following compound does not exist?
 (1) PF_3 (2) PCl_5 (3) PBr_5 (4) PI_5
35. The correct order of decreasing bond energy is:
 (1) $O - O > S - S > Se - Se$
 (2) $C - C > Si - Si > Ge - Ge$
 (3) $F - F > O - O > N - N$
 (4) $F - F > Cl - Cl > Br - Br$
36. Correct order of extent of overlapping is:
 (1) $1s-1s < 2s-2s < 2s-2p$
 (2) $2p-2p$ (axial) $< 2p-2p$ (colateral)
 (3) $1s-1s > 2p-2p$ (axial) $> 2s-2p > 2s-2s$
 (4) $1s-1s > 2s-2p > 2s-2s > 2p-2p$ (axial)

Hybridisation, VSEPR theory and Geometry

37. In the protonation of H_2O , change occurs in
 (1) Hybridisation state of oxygen
 (2) Shape of molecule
 (3) Hybridisation and shape both
 (4) None
38. The d- orbitals involved in sp^3d hybridisation is:-
 (1) $d_{x^2-y^2}$ (2) d_{z^2} (3) d_{xy} (4) d_{xz}





39. A sp^3 hybrid orbital contains:-
 (1) $\frac{3}{4}$ s-character (2) $\frac{1}{4}$ p-character
 (3) $\frac{3}{4}$ p-character (4) $\frac{1}{2}$ s-character
40. Among the following species identify the isostructural pairs:-
 NF_3 , NO_3^- , BF_3 , H_3O^+ , HN_3
 (1) $[NF_3, NO_3^-]$ and $[BF_3, H_3O^+]$
 (2) $[NF_3, HN_3]$ and $[NO_3^-, BF_3]$
 (3) $[NF_3, H_3O^+]$ and $[NO_3^-, BF_3]$
 (4) $[NF_3, H_3O^+]$ and $[HN_3, BF_3]$
41. Which of the set of species have same hybridisation state but different shapes:-
 (1) NO_2^+ , NO_2 , NO_2^-
 (2) ClO_4^- , SF_4 , XeF_4
 (3) NH_4^+ , H_3O^+ , OF_2
 (4) SO_4^{2-} , PO_4^{3-} , ClO_4^-
42. Which of the following elements can not exhibit sp^3d hybridisation state:-
 (a) C (b) P (c) Cl (d) B
 (1) a, c (2) a, d (3) b, c (4) b, d
43. Which of the following species are expected to be planar:-
 (a) NH_3 (b) NH_3^{2+}
 (c) NH_2^- (d) PCl_3
 (1) b and c (2) c and d
 (3) b and d (4) a and d
44. In which following set of compound/ion has linear geometry:-
 (1) CH_4 , NH_4^+ , BH_4^+ (2) CO_3^{2-} , NO_3^- , BF_3
 (3) NO_2^+ , CO_2 , XeF_2 (4) $BeCl_2$, BCl_3 , CH_4
45. Hybridisation in $XeOF_2$, XeO_2F_2 is sp^3d . But shape will be respectively:-
 (1) T, 'V' shape
 (2) T shape, See-Saw
 (3) Both have T shape
 (4) T shape, irregular octahedral
46. The shape of IF_4^+ will be:-
 (1) Square planar
 (2) Tetrahedral
 (3) Pentagonal bipyramidal
 (4) Distorted tetrahedral
47. In which of following compound, has four bond pair and one lone pair:-
 (1) NH_4^+ (2) ICl_4^- (3) SF_4 (4) XeF_4
48. Hybridisation state of I in ICl_2^+ is
 (1) dsp^2 (2) sp (3) sp^3 (4) sp^2
49. A σ bonded molecule MX_3 is T-shaped. The number of non-bonding pairs of electrons is
 (1) 0
 (2) 2
 (3) 1
 (4) Can be predicted only if atomic number of M is known.
50. The Ideal geometry of XeO_2F_2 should be:-
 (1) Plane triangular
 (2) Trigonal bipyramidal
 (3) Square planar
 (4) Tetrahedral
51. The hybrid states of central atom in $NH_4^+ BF_3$ and CCl_4 are respectively:-
 (1) sp^2 , sp^3 , sp^2 (2) sp^3 , sp^2 , sp^3
 (3) sp^3 , sp^3 , sp^3 (4) sp , sp^2 , sp^3
52. Amongst CO_3^{2-} , AsO_3^{3-} , XeO_3 , ClO_3^- , BO_3^{3-} and SO_3^{2-} the non-planar species are:-
 (1) XeO_3 , ClO_3^- , SO_3^{2-} , AsO_3^{3-}
 (2) AsO_3^{3-} , XeO_3 , CO_3^{2-}
 (3) BO_3^{3-} , CO_3^{2-} , SO_3^{2-}
 (4) AsO_3^{3-} , BO_3^{3-} , CO_3^{2-}
53. The type of hybrid orbitals used by chlorine atom in ClO^- , ClO_2^- , ClO_3^- and ClO_4^- is/are:-
 (1) sp , sp^2 , sp^3 and sp^3d
 (2) sp and sp^3
 (3) Only sp^3
 (4) Only sp
54. Descending order of electronegativity of sp^3 , sp^2 & sp hybridised orbitals
 (1) sp^2 , sp , sp^3 (2) sp^3 , sp^2 , sp
 (3) sp , sp^2 , sp^3 (4) sp , sp^3 , sp^2





55. The central atom of which of the following molecule is different from other three
(1) H_2O (2) SO_2 (3) Cl_2O (4) OF_2
56. Hybridization involves
(1) Addition of an electron pair
(2) Mixing up of atomic orbitals
(3) Removal of an electron pair
(4) Separation of orbitals
57. Which is having maximum % of s character
(1) $\text{C}-\text{C}$ (2) $\text{C}=\text{C}$ (3) $\text{C}\equiv\text{C}$ (4) None
58. The structure and hybridization of SiH_4 is:
(1) bent, sp
(2) trigonal, sp^2
(3) octahedral, sp^3d
(4) tetrahedral, sp^3
59. The AsF_5 molecule is trigonal bipyramidal. The hybrid orbitals used by the As atoms for bonding are:
(1) $\text{d}_{x^2-y^2}, \text{d}_{z^2}, \text{s}, \text{p}_x, \text{p}_y$ (2) $\text{d}_{xy}, \text{s}, \text{p}_x, \text{p}_y, \text{p}_z$
(3) $\text{s}, \text{p}_x, \text{p}_y, \text{p}_z, \text{d}_{z^2}$ (4) $\text{d}_{x^2-y^2}, \text{s}, \text{p}_x, \text{p}_y$
60. Among the following, compound has the central atom with sp^3 hybridisation:
(1) H_2CO_3 (2) SiF_4 (3) BF_3 (4) XeF_2
61. Which of the following molecule has regular geometry –
(1) H_2O (2) PF_3 (3) SF_6 (4) XeF_6
62. In sulphate ion the oxidation state of sulphur is +6 and hybridization state of sulphur is:
(1) sp^2 (2) sp^3d^2 (3) dsp^3 (4) sp^3
63. The hybridization states of the central atoms of the ions I_3^- , ICl_4^- and ICl_2^- are respectively:
(1) sp^2 , dsp^2 , sp^3
(2) sp^3d , sp^3d^2 and sp^3d
(3) sp^3d , sp^3d , dsp^2
(4) sp , sp , dsp^2
64. Molecular shapes of SF_4 , CF_4 and XeF_4 are:-
(1) The same, with 2, 0 and 1 lone pairs of electrons
(2) The same, with 1, 1, and 1 lone pairs of electrons
(3) Different, with 0, 1 and 2 lone pairs of electrons respectively
(4) Different, with 1, 0 and 2 lone pairs of electrons respectively.

65. Select the correct matching:

List-I List-II

A: XeF ₄	1.	Pyramidal	
B: XeF ₆	2.	T-shape	
C: XeO ₃	3.	Distorted octahedral	
D: XeOF ₂	4.	Square planar	
A	B	C	D
(1) 4	3	1	2
(2) 1	2	3	4
(3) 2	1	3	4
(4) 4	1	3	2

66. Which one of the following is a correct pair with respect to molecular formula of xenon compound and hybridization state of xenon in it:

- (1) XeF_4 , sp^3 (2) XeF_2 , sp
(3) XeF_2 , sp^3d (4) XeF_4 , sp^2

67. The xenon compounds that are iso-structural with IBr_2^- and BrO_3^- respectively are:

- (1) Linear XeF_2 and pyramidal XeO_3
(2) Bent XeF_2 and pyramidal XeO_3
(3) Bent XeF_2 and planar XeO_3
(4) Linear XeF_2 and tetrahedral XeO_3

68. VSEPR theory does not state:

- (1) the order of repulsion between different pair of electrons is $lp-lp > lp-bp > bp-bp$ (lp = lone pair electrons, bp = bond pair of electrons)
(2) as the number of lone pair of electrons on central atom increase, the deviation in BA from normal BA (Bond-Angle) also increase
(3) the number of lone pair on O in H_2O is 1 while on N in NH_3 is 2.
(4) the structure of Xenon-fluorides and Xenon-oxyfluorides could be explained on the basis of VSEPR theory.

Bond Angle

69. When the hybridization state of carbon atom changes from sp^3 , sp^2 and sp , the angle between the hybridized orbitals.
(1) decrease considerably
(2) increase progressively
(3) decrease gradually
(4) all of these





70. Which order of decreasing bond angle is correct:-

- (1) $\text{CCl}_4 > \text{BF}_3 > \text{NO}_2^+$ (2) $\text{NH}_3 > \text{NCl}_3 > \text{NBr}_3$
 (3) $\text{Br}_2\text{O} > \text{Cl}_2\text{O} > \text{OF}_2$ (4) $\text{PCl}_3 > \text{PBr}_3 > \text{PI}_3$

71. By the hybridization of one s & one p orbitals it will be obtained

- (1) Two orbitals mutually at 90° angle
 (2) two orbitals mutually at 180° angle
 (3) Two orbitals mutually at 120° angle
 (4) Two orbitals mutually at 150° angle

72. In compounds X, all the bond angles are exactly $109^\circ 28'$, X is:

- (1) Chloromethane
 (2) Carbon tetrachloride
 (3) Iodoform
 (4) Chloroform

73. Among the following orbital/bonds, the angle is minimum between:

- (1) sp^3 bonds
 (2) p_x and p_y orbitals
 (3) H–O–H bond in water
 (4) sp bonds

74. There is no effect of lone pair on bond angle in:

- (1) XeF_2 , ICl_4^- (2) BF_3 , OF_2
 (3) IF_5 , NH_3 (4) I_3^- , I_3^+

75. Which part(s) has same bond angles?

- (a) BF_3 , BCl_3 (b) PO_4^{3-} , SO_4^{2-}
 (c) BF_3 , PF_3 (d) NO_2^+ , N_2O

Correct option are:

- (1) a, b, d (2) b, d (3) b, c, d (4) a, d

76. $\angle \text{F}-\text{As}-\text{F}$ Bond angle in AsF_2Cl_3 molecules is:

- (1) 90° and 180° (2) 120°
 (3) 90° (4) 180°

Dipole Moment

77. Which statement is correct:-

- (1) All the compounds having polar bonds, have dipole moment
 (2) SO_2 is non-polar
 (3) H_2O molecule is non polar, having polar bonds
 (4) CH_4 is non polar molecule having polar bonds

78. BeF_2 has zero dipole moment where as H_2O has a dipole moment because:-

- (1) Water is linear
 (2) H_2O is bent
 (3) F is more electronegative than O
 (4) Hydrogen bonding is present in H_2O

79. Which of the following species are symmetrical:-

- (a) XeF_4 (b) XeF_6
 (c) SO_2 (d) NH_4^+
 (1) a and b (2) b and c
 (3) c and d (4) a and d

80. Which of the following molecule have zero dipole moment:-

- (1) BF_3 (2) CH_2Cl_2
 (3) NF_3 (4) SO_2

81. The dipole moment of NH_3 is:-

- (1) Less than dipole moment of NCl_3
 (2) Higher than dipole moment of NCl_3
 (3) Equal to the dipole moment of NCl_3
 (4) None of these

82. Which of the following species are polar:

- (a) C_6H_6 (b) XeF_2
 (c) SO_2 (d) SF_4
 (e) SF_6
 (1) (b) and (d) (2) (a), (b) and (e)
 (3) (a) and (e) (4) (c) and (d)

83. Which set of molecules is polar:-

- (1) XeF_4 , IF_7 , SO_3 (2) PCl_5 , C_6H_6 , SF_6
 (3) SnCl_2 , SO_2 , NO_2 (4) CO_2 , CS_2 , C_2H_6

84. Which of the following molecule has polar character ?

- (1) CO_2 (2) CH_4 (3) PF_5 (4) NH_3

85. Which of the following has symmetrical structure:

- (1) PCl_3 (2) CH_2Cl_2 (3) CHCl_3 (4) CCl_4

86. Species having zero dipole moment:-

- (1) XeF_4
 (2) 1,2,4 trichloro benzene
 (3) SF_4
 (4) CH_2Cl_2





87. PCl_5 is non polar because:-
 (1) P – Cl bond is non-polar
 (2) Its dipole moment is zero
 (3) P – Cl bond is polar
 (4) P & Cl have equal electronegativity
88. Dipole moment of CO_2 is zero which implies that:
 (1) Carbon and oxygen have equal electronegativities
 (2) Carbon has no polar bond
 (3) CO_2 is a linear molecule
 (4) Carbon has bond moments of zero value
89. Which contains both polar and non-polar bonds?
 (1) NH_4Cl (2) HCN
 (3) H_2O_2 (4) CH_4
90. The correct order of dipole moment is:
 (1) $\text{CH}_4 < \text{NF}_3 < \text{NH}_3 < \text{H}_2\text{O}$
 (2) $\text{NF}_3 < \text{CH}_4 < \text{NH}_3 < \text{H}_2\text{O}$
 (3) $\text{NH}_3 < \text{NF}_3 < \text{CH}_4 < \text{H}_2\text{O}$
 (4) $\text{H}_2\text{O} < \text{NH}_3 < \text{NF}_3 < \text{CH}_4$

Coordinate Bond

91. Which of the following contains Co-ordinate and covalent bonds:
 (a) N_2H_5^+ (b) H_3O^+ (c) HCl (d) H_2O
 (1) a & d (2) a & b
 (3) c & d (4) Only a
92. In Co-ordinate bond, the acceptor atoms must essentially contain in its valence shell an orbital:
 (1) With paired electron
 (2) With single electron
 (3) With no electron
 (4) With three electron
93. Dative bond is present in:
 (1) SO_3 (2) NH_3
 (3) K_2CO_3 (4) BF_3
94. Number of co-ordinate bond present in sulphuric acid are:
 (1) 1 (2) 2 (3) 3 (4) 4
95. The number of co-ordinate bonds presents in SO_3 molecule are:
 (1) 1 (2) 2 (3) 3 (4) 4

96. The compound containing co-ordinate bond is:
 (1) H_2SO_4 (2) O_3
 (3) SO_3 (4) All of these

Molecular Orbital Theory

97. The ion that is isoelectronic with CO and having same bond order is:-
 (1) CN^- (2) O_2^+ (3) O_2^- (4) N_2^+
98. Which of the following is paramagnetic:-
 (1) O_2^- (2) CN^- (3) CO (4) NO^+
99. Which has the bond order in fraction:-
 (1) O_2 (2) HeH^+ (3) CO (4) CN
100. Bond order in C_2^+ is:-
 (1) $\frac{1}{2}$ (2) $\frac{2}{3}$
 (3) $\frac{3}{2}$ (4) 1
101. In the following which of the two are paramagnetic
 (a) N_2 (b) CO (c) B_2 (d) NO_2
 Correct answer is:-
 (1) a and c (2) b and c
 (3) c and d (4) b and d
102. Increasing order of bond length in NO , NO^+ and NO^- is:-
 (1) $\text{NO} > \text{NO}^- > \text{NO}^+$ (2) $\text{NO}^+ < \text{NO} < \text{NO}^-$
 (3) $\text{NO} < \text{NO}^+ < \text{NO}^-$ (4) $\text{NO} < \text{NO}^+ = \text{NO}^-$
103. Bond order of Li_2 is:-
 (1) 0 (2) 1 (3) 2 (4) 3
104. In which of the following set, the value of bond order will be 2.5:-
 (1) O_2^+ , NO , NO^{+2} , CN
 (2) CN , NO^{+2} , CN^- , F_2
 (3) O_2^+ , NO^{+2} , O_2^{+2} , CN^-
 (4) O_2^{-2} , O_2^- , O_2^+O_2
105. Which of the following ion is diamagnetic:-
 (1) O_2^{-1} (2) O_2^{-2} (3) O_2 (4) O_2^{+1}
106. When two atomic orbitals combines, it forms:-
 (1) One molecular orbital
 (2) Two molecular orbital
 (3) Two bonding molecular orbitals
 (4) Two anti bonding molecular orbitals

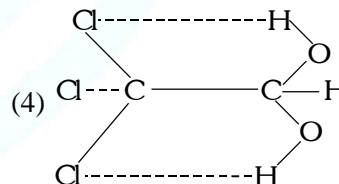
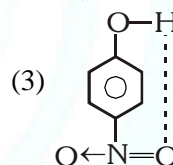
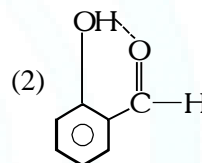
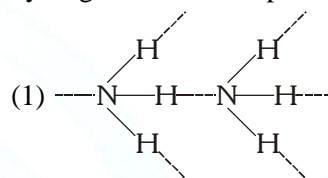


107. The paramagnetic property of oxygen is well explained by:-
 (1) Molecular orbital theory
 (2) Resonance theory
 (3) Valence bond theory
 (4) VSEPR theory
108. Which of the following has fractional bond order?
 (1) O_2^{2+} (2) O_2^{2-} (3) F_2^{2-} (4) H_2^-
109. The bond order of CO molecule on the basis of molecular orbital theory is
 (1) Zero (2) 2 (3) 3 (4) 1
110. The diamagnetic molecule is
 (1) Super oxide ion
 (2) Oxygen molecule
 (3) Carbon molecule
 (4) Unipositive ion of nitrogen molecule
111. Which of the following group of molecules have $2\frac{1}{2}$ bond order:-
 (1) N_2^{-2} , O_2^{-2} , CO (2) N_2^+ , O_2^+ , NO
 (3) C_2^{-2} , B_2 , O_2 (4) CN^- , NO^+ , O_2^{+2}
112. The molecule having one unpaired electron is
 (1) NO (2) CO (3) CN^- (4) O_2
113. The no. of antibonding electron pair in O_2^- is
 (1) 4 (2) 3 (3) 8 (4) 10
114. Maximum bond energy will be shown by the species
 (1) O_2^+ (2) O_2 (3) O_2^- (4) O_2^{-2}
115. Which of the following species will have the minimum bond energy
 (1) N_2 (2) N_2^- (3) N_2^+ (4) N_2^{-2}
116. Which of the following ion do not have bond order of 2.5 ?
 (1) O_2^- (2) O_2^+ (3) N_2^+ (4) N_2^-
117. In which of the following pairs of molecules/ions, both the species are not likely to exist?
 (1) H_2^{2+} , He_2 (2) H_2^{-2} , He_2^{2+}
 (3) H_2^+ , He_2^{2+} (4) H_2^- , He_2^{-2}
118. Which of the following species is paramagnetic with one unpaired electron?
 (1) BaO_2 (2) CaC_2 (3) O_2 (4) KO_2

119. Stability of the species Li_2 , Li_2^+ and Li_2^- increases in the order is:
 (1) $Li_2^- < Li_2 < Li_2^+$ (2) $Li_2 < Li_2^+ < Li_2^-$
 (3) $Li_2^- < Li_2^+ < Li_2$ (4) $Li_2 < Li_2^- < Li_2^+$

Hydrogen Bond

120. Intermolecular hydrogen bonds are not present in:-
 (1) CH_3CH_2OH (2) CH_3COOH
 (3) $C_2H_5NH_2$ (4) CH_3OCH_3
121. In which of the following molecule, the shown hydrogen bond is not possible:-



122. Correct order of volatility is:-
 (1) $HF > HCl > HBr > HI$
 (2) $HCl > HBr > HI > HF$
 (3) $HI > HBr > HCl > HF$
 (4) $HBr < HCl < HI < HF$
123. Glycerol is more viscous than glycol the reason is:-
 (1) Higher molecular wt.
 (2) More covalent
 (3) More extent of hydrogen bonding
 (4) Complex structure
124. Maximum number of H-bonding is shown by
 (1) H_2O (2) H_2Se
 (3) H_2S (4) HF



- 125.** Intermolecular H-bond:-
(1) Decreases Volatility
(2) Increases boiling point
(3) Increases viscosity
(4) All of these
- 126.** The incorrect order of decreasing boiling points is
(1) $\text{NH}_3 > \text{AsH}_3 > \text{PH}_3$
(2) $\text{H}_2\text{O} > \text{H}_2\text{Se} > \text{H}_2\text{S}$
(3) $\text{Br}_2 > \text{Cl}_2 > \text{F}_2$
(4) $\text{CH}_4 > \text{GeH}_4 > \text{SiH}_4$
- 127.** The crystal lattice of ice is mostly formed by:-
(1) Ionic forces
(2) Covalent bonds
(3) Inter molecular H-bonds
(4) Covalent as well as H-bonds
- 128.** Acetic acid exists as dimer in benzene due to:-
(1) Condensation reaction
(2) Hydrogen bonding
(3) Presence of carboxyl group
(4) None of the above
- 129.** Which of the following does not form a hydrogen bond with water
(1) $(\text{CH}_3)_2\text{CO}$ (2) CH_3CN
(3) CH_3OH (4) C_2H_6
- 130.** Maximum no. of hydrogen bonds formed by a water molecule in ice is
(1) 4 (2) 3 (3) 2 (4) 1
- 131.** In which of the following compounds intramolecular hydrogen bond is present
(1) Ethyl alcohol
(2) water
(3) Salicylaldehyde
(4) Hydrogen sulphide
- 132.** Hydrogen bonding is formed in compounds containing hydrogen and:
(1) Highly electro-negative atoms
(2) Highly electro-positive atoms
(3) Metal atoms with d-orbitals occupied
(4) Metalloids
- 133.** Which of the following hydrides has the lowest b.p.
(1) H_2O (2) H_2S (3) H_2Se (4) H_2Te
- 134.** The intermolecular force in hydrogen fluoride is due to:
(1) Dipole-induced dipole interactions
(2) Dipole-dipole interactions
(3) Hydrogen bond
(4) Dispersion interaction
- 135.** Strongest hydrogen bond is shown by:
(1) Water
(2) Ammonia
(3) Hydrogen fluoride
(4) Hydrogen sulphide
- 136.** NH_3 has abnormally high boiling point because it has:
(1) Alkaline nature
(2) Distorted shape
(3) sp^3 - Hybridisation
(4) Hydrogen bonding
- 137.** Which of the following is soluble in water?
(1) CS_2 (2) $\text{C}_2\text{H}_5\text{OH}$
(3) CCl_4 (4) CHCl_3
- 138.** KF combines with HF to form KHF_2 . The compound contains the species:
(1) K^+ , F^- and H^+ (2) K^+ , F^- and HF
(3) K^+ and $[\text{HF}_2]^-$ (4) $[\text{KHF}]^+$ and F_2
- 139.** Which of the following compounds show intramolecular hydrogen bonding:
(A) o - nitrophenol
(B) p - nitrophenol
(C) phenol
(D) salicylaldehyde
(1) A & B (2) A & C
(3) A & D (4) B & C
- 140.** The boiling point of a compound is raised by:
(1) intermolecular hydrogen bonding
(2) High volatility
(3) intramolecular hydrogen bonding
(4) non-polarity
- Vander Waals Forces**
- 141.** In a molecule of water following bonds are present-
(1) Two hydrogen bond
(2) Two ionic bond
(3) One covalent and one ionic bond
(4) Two covalent bond





- 142.** In dry ice the bond present between two molecules is
 (1) Ionic bond (2) Covalent bond
 (3) Hydrogen bond (4) Vander Waal
- 143.** Which is the weakest among the following types of bonds?
 (1) Debye force
 (2) Metallic bond
 (3) Dipole-dipole bond
 (4) Hydrogen bond
- 144.** Covalent molecules are usually held in a crystal structure by:
 (1) Dipole-dipole attraction
 (2) Electrostatic attraction
 (3) Hydrogen bond
 (4) Van-der waal's attraction
- 145.** In solid argon the atoms are held together:
 (1) by ionic bonds
 (2) by hydrogen bonds
 (3) by vander Waals forces
 (4) by hydrophobic bonds
- 146.** Which substance has the strongest London dispersion forces?
 (1) SiH_4 (2) CH_4 (3) SnH_4 (4) GeH_4
- 147.** Which force is least sensitive for distance?
 (1) Ion-dipole attraction
 (2) Dipole-induced dipole
 (3) Ion-induced dipole
 (4) Dispersion force

General Ionic Bond

- 148.** An atom with atomic number 20 is most likely to combine chemically with the atom whose atomic number is:
 (1) 11 (2) 16 (3) 18 (4) 10
- 149.** Conditions for ionic bond formation is/are:
 (a) Small cation, large anion
 (b) Low IP of cation, high electron affinity of anion
 (c) Large cation, small anion and less charge
 (d) Less lattice energy
 Correct answer is:
 (1) a, d (2) b, c and d
 (3) b and c (4) a, b

- 150.** Electrovalent compounds do not show stereoisomerism. The reason is:
 (1) Presence of ions
 (2) Strong electro static force of attraction
 (3) Brittleness
 (4) Non - directional nature of ionic bond
- 151.** The electronic configuration of metal 'M' is $1s^2 2s^1$ and of the non metal 'X' is $1s^2 2s^2 2p^3$. When these two elements combines, the formula of the compound will be:
 (1) MX_3 (2) M_3X (3) M_2X_3 (4) M_3X_2
- 152.** This is not the characteristics of ionic compound:
 (1) Brittle nature
 (2) Solubility in polar solvent
 (3) Directional bond
 (4) Conduction of electricity in fused state
- 153.** The bond in which two atoms are bonded by coulombic attraction force is called:
 (1) Hydrogen bond
 (2) Covalent bond
 (3) Ionic bond
 (4) Co-ordinate bond
- 154.** The electronic configuration of metal M is $1s^2 2s^2 2p^6 3s^1$. The formula of its oxide will be:
 (1) MO (2) M_2O (3) M_2O_3 (4) MO_2
- 155.** Consider two elements with atomic no. 37 and 53, the bond between their atoms would be:
 (1) Covalent (2) Ionic
 (3) Co-ordinate (4) Metallic
- 156.** Which of the following pairs will form the most stable ionic bond ?
 (1) Na and Cl (2) Mg and F
 (3) Li and F (4) Na and F
- 157.** The compound which contains both ionic and covalent bonds is:
 (1) CH_4 (2) HNO_3 (3) KNO_3 (4) KCl

Solubility

- 158.** Which one is the correct statement with reference to solubility of MgSO_4 in water:
 (1) Hydration energy of MgSO_4 is higher in comparison to its lattice energy
 (2) Ionic potential of Mg^{2+} is very low
 (3) SO_4^{2-} ion mainly contributes towards hydration energy
 (4) Size of Mg^{2+} and SO_4^{2-} are similar





- 159.** KCl easily dissolves in water because:
- (1) It is a salt of K
 - (2) It reacts with water
 - (3) It hydrolysed with water
 - (4) Its ions are easily solvated
- 160.** Capacity of solvent to neutralise charge on ionic compound is called:-
- (1) Solvation energy
 - (2) Dielectric constant
 - (3) Dipole moment
 - (4) Solubility
- 161.** The force responsible for dissolution of ionic compound in water is:
- (1) Dipole – dipole forces
 - (2) Ion – dipole force
 - (3) Ion – ion force
 - (4) Hydrogen bond
- 162.** The hydration of ionic compounds involves:
- (1) Evolution of heat
 - (2) Weakening of attractive forces
 - (3) Dissociation into ions
 - (4) All
- 163.** The hydration energy of Mg^{+2} is greater than the hydration energy of:
- (1) Al^{+3}
 - (2) Mg^{+3}
 - (3) Na^{+}
 - (4) Be^{+2}
- 164.** LiCl is soluble in organic solvent while NaCl is not because:
- (1) Lattice energy of NaCl is less than that of LiCl
 - (2) Ionisation potential of Li is more than that of Na
 - (3) Li^{+} has more hydration energy than Na^{+} ion
 - (4) LiCl is more covalent compound than that NaCl
- 165.** Which of the compound is least soluble in water?
- (1) AgF
 - (2) AgCl
 - (3) AgBr
 - (4) AgI
- 166.** Lithium chloride is highly soluble in:
- (1) C_6H_6
 - (2) H_2O
 - (3) D_2O
 - (4) All

- 167.** Ionic conductances of hydrated M^{+} ions are in the order:
- (1) $Li^{+}(aq) > Na^{+}(aq) > K^{+}(aq) > Rb^{+}(aq) > Cs^{+}(aq)$
 - (2) $Li^{+}(aq) > Na^{+}(aq) < K^{+}(aq) < Rb^{+}(aq) < Cs^{+}(aq)$
 - (3) $Li^{+}(aq) > Na^{+}(aq) > K^{+}(aq) > Rb^{+}(aq) < Cs^{+}(aq)$
 - (4) $Li^{+}(aq) < Na^{+}(aq) < K^{+}(aq) < Rb^{+}(aq) < Cs^{+}(aq)$

Melting Point and Boiling Point

- 168.** Which of the following has the lowest melting point
- (1) SrF_2
 - (2) BeF_2
 - (3) BaF_2
 - (4) MgF_2
- 169.** Which of the following substance will have highest b.p. ?
- (1) He
 - (2) CsF
 - (3) NH_3
 - (4) $CHCl_3$
- 170.** As compared to covalent compounds electrovalent compounds generally possess
- (1) High m.p. and high b.p.
 - (2) Low m.p. and low b.p.
 - (3) Low m.p. and high b.p.
 - (4) high m.p. and low b.p.
- 171.** Which of the following halides has the highest melting point ?
- (1) NaCl
 - (2) KCl
 - (3) NaBr
 - (4) NaF
- 172.** Which of the following molecule having lowest melting point.
- (1) NaCl
 - (2) RbCl
 - (3) CsCl
 - (4) LiCl

Lattice Energy

- 173.** Which of the following is not a correct statement about an ionic compound:
- (1) Higher the lattice energy, higher is melting point
 - (2) Higher the dipole moment of solvent, more the solubility
 - (3) Higher the lattice energy, more the solubility
 - (4) More difference in electronegativity, more is the ionic nature





- 174.** Born Haber cycle is mainly used to determine
- (1) Lattice energy
 - (2) Electron affinity
 - (3) Ionisation energy
 - (4) Electronegativity
- 175.** Pick out the wrong statement:-
- (1) LiF has less solubility in water than LiI
 - (2) Lattice energy of MgO is greater than Na₂O
 - (3) LiH is more stable than KH
 - (4) KO₂ is diamagnetic and colourless
- 176.** Among the following which compounds will show the highest lattice energy ?
- (1) KF
 - (2) NaF
 - (3) CsF
 - (4) RbF
- 177.** The lattice energy of the lithium is in the following order:
- (1) LiF > LiCl > LiBr > LiI
 - (2) LiCl > LiF > LiBr > LiI
 - (3) LiBr > LiCl > LiF > LiI
 - (4) LiI > LiBr > LiCl > LiF
- 178.** Which of the following compound has highest Lattice energy?
- (1) AlF₃
 - (2) Na₂S
 - (3) Al₂O₃
 - (4) CaF₂
- 179.** The correct expected order of decreasing lattice energy is:
- (1) CaO > MgBr₂ > CsI
 - (2) MgBr₂ > CaO > CsI
 - (3) CsI > MgBr₂ > CaO
 - (4) CsI > CaO > MgBr₂

Fajan's Rule

- 180.** The pair of elements which on combination are most likely to form an ionic compound is:
- (1) Na and Ca
 - (2) K and O
 - (3) O and Cl
 - (4) Al and I
- 181.** Out of the following the compound with maximum ionic nature are:
- (1) Metal oxide
 - (2) Metal fluoride
 - (3) Metal phosphide
 - (4) Metal sulphide
- 182.** The most covalent halide is:
- (1) AlF₃
 - (2) AlCl₃
 - (3) AlBr₃
 - (4) AlI₃
- 183.** Ionic potential (ϕ) of electropositive element will be highest in which of the following compound:
- (1) CsCl
 - (2) MgCl₂
 - (3) AlF₃
 - (4) SF₆

- 184.** AlCl₃ is covalent, while AlF₃ is ionic. This is justified by:
- (1) Molecular orbital theory
 - (2) Valency bond theory
 - (3) Fajan rule
 - (4) Lattice energy
- 185.** Correct order of covalent character of alkaline earth metal chloride in:
- (1) BeCl₂ < MgCl₂ < CaCl₂ < SrCl₂
 - (2) BeCl₂ < CaCl₂ < SrCl₂ < MgCl₂
 - (3) BeCl₂ > MgCl₂ > CaCl₂ > SrCl₂
 - (4) SrCl₂ > BeCl₂ > CaCl₂ > MgCl₂
- 186.** Which pair in the following has maximum and minimum ionic character respectively?
- (1) LiCl, RbCl
 - (2) RbCl, BeCl₂
 - (3) BeCl₂, RbCl
 - (4) AgCl, RbCl
- 187.** CCl₄ is more covalent than LiCl because:
- (1) There is more polarization of Cl in CCl₄
 - (2) There is more polarization of Cl in LiCl
 - (3) CCl₄ has more weight
 - (4) None of above
- 188.** Among LiCl, BeCl₂, BCl₃ and CCl₄, the covalent bond character follows the order:
- (1) LiCl < BeCl₂ > BCl₃ > CCl₄
 - (2) LiCl > BeCl₂ < BCl₃ < CCl₄
 - (3) LiCl < BeCl₂ < BCl₃ < CCl₄
 - (4) LiCl > BeCl₂ > BCl₃ > CCl₄
- 189.** The correct order of decreasing polarisable ions is:
- (1) Cl⁻, Br⁻, I⁻, F⁻
 - (2) F⁻, I⁻, Br⁻, Cl⁻
 - (3) F⁻, I⁻, Br⁻, Cl⁻
 - (4) I⁻, Br⁻, Cl⁻, F⁻
- 190.** On the basis of concept of ionic potential (ϕ), the tendency to form covalent bond in a group:
- (1) increases
 - (2) decreases
 - (3) remains unchanged
 - (4) shows erratic/irregular change
- 191.** According to Fajan's rules necessary condition to form covalent bond is:
- (1) small cation and large anion
 - (2) small cation and small anion
 - (3) large cation and large anion
 - (4) large cation and small anion





- 192.** Which of the following order is incorrect?
 (1) Ionic character = $\text{MCl} < \text{MCl}_2 < \text{MCl}_3$
 (2) Polarizability = $\text{F}^- < \text{Cl}^- < \text{Br}^- < \text{I}^-$
 (3) Polarising power = $\text{Na}^+ < \text{Ca}^{+2} < \text{Mg}^{+2} < \text{Al}^{+3}$
 (4) Covalent character = $\text{LiF} < \text{LiCl} < \text{LiBr} < \text{LiI}$
- 193.** According to Fajan's rules, electrovalent-bond formation is favoured by:
 (1) low positive charge, and small size of cations and large size of anions
 (2) low positive charge, and large size of cations and small size of anions
 (3) high negative charge, and large size of cations and large size of anions
 (4) high positive charge, and small size of cations and small size of anions

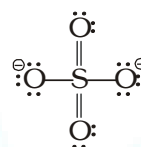
Thermal Decomposition / Heating Effect

- 194.** The most stable carbonate is:
 (1) Li_2CO_3
 (2) BeCO_3
 (3) CaCO_3
 (4) BaCO_3
- 195.** Which of the following does not give an oxide on heating:
 (1) MgCO_3 (2) Li_2CO_3
 (3) ZnCO_3 (4) K_2CO_3
- 196.** Which decomposes on heating ?
 (1) NaOH (2) KOH
 (3) LiOH (4) RbOH
- 197.** Which of the following forms metal oxide on heating?
 (1) Na_2CO_3
 (2) Li_2CO_3
 (3) K_2SO_4
 (4) NaHCO_3
- 198.** Increasing order of stability of:
 I. K_2CO_3 II. MgCO_3 III. Na_2CO_3
 (1) $\text{I} < \text{II} < \text{III}$
 (2) $\text{II} < \text{III} < \text{I}$
 (3) $\text{II} < \text{I} < \text{III}$
 (4) $\text{I} < \text{III} < \text{II}$

- 199.** Which of the following carbonate will not decompose on heating ?
 (1) BaCO_3 (2) ZnCO_3
 (3) Na_2CO_3 (4) Li_2CO_3
- 200.** Alkaline earth metal nitrates on heating decompose to give:
 (1) $\text{M}(\text{NO}_2)$ and O_2 only
 (2) MO , N_2 and O_2
 (3) MO , NO_2 and O_2
 (4) MO and NO_2 only

Resonance and Formal Charge

- 201.** One of the resonating structure of SO_4^{2-} is



Which set of average formal charge on oxygen and bond order is correct

- (1) -0.5 and 1.5 (2) -1.5 and 3
 (3) -2 and 3 (4) -1.5 and 1.5
- 202.** The correct order of the O—O bond length in O_2 , H_2O_2 and O_3 is:—
 (1) $\text{O}_3 > \text{H}_2\text{O}_2 > \text{O}_2$ (2) $\text{O}_2 > \text{H}_2\text{O}_2 > \text{O}_3$
 (3) $\text{O}_2 > \text{O}_3 > \text{H}_2\text{O}_2$ (4) $\text{H}_2\text{O}_2 > \text{O}_3 > \text{O}_2$
- 203.** Higher is the bond order, greater is -
 (1) Bond dissociation energy
 (2) Covalent character
 (3) Bond length
 (4) Paramagnetism
- 204.** The species having no $p\pi$ - $p\pi$ bond but has bond order equal to that of O_2 :
 (1) ClO_3^- (2) PO_4^{3-}
 (3) SO_4^{2-} (4) XeO_3
- 205.** Bond order and average formal charge of perchlorate ion are:
 (1) 1.75 and -0.25 (2) 1.75 and -0.33
 (3) 1.66 and -0.33 (4) 1.50 and -0.50




EXERCISE-II

- Pick out the incorrect statement:-
 - sp^3d hybridisation involves $d_{x^2-y^2}$ orbital
 - Generally Hybridised orbital form σ -bond when overlaps with other orbitals.
 - SF_2 molecule is more polar than CS_2
 - o-nitrophenol is more volatile than p-nitrophenol.
- The nature of π -bond in perchlorate (ClO_4^-) ion is:-
 - $O_{(d\pi)} - Cl_{(p\pi)}$
 - $O_{(p\pi)} - Cl_{(p\pi)}$
 - $O_{(p\pi)} - Cl_{(d\pi)}$
 - $O_{(d\pi)} - Cl_{(d\pi)}$
- In which of the following compounds ionic & covalent bonds are present
 - KCl
 - SO_2
 - NaOH
 - CH_4
- Which compound has the weakest bond
 - Diamond
 - Neon(solid)
 - KCl
 - water (ice)
- In a regular octahedral molecule of SF_6 the number of F-S-F bonds at 180° is
 - Six
 - Two
 - Four
 - Three
- Select the correct statement(s):
 - Bond angle H-N-H in NH_3 is less than H-O-H bond angle in water
 - IN PCl_5 molecules, axial and equatorial bonds are of equal length
 - H_2S is having high boiling point than H_2O
 - N_2 has higher bond order than N_2^+ .
- Nitrogen does not form NF_5 because
 - Nitrogen is member of V group
 - It contains no empty d-orbital
 - The bond energy of $N \equiv N$ is very high
 - Inert pair effect exists in the molecule
- The boiling point of ICl is nearly $40^\circ C$ higher than that of Br_2 although the two substances have the same relative molecular mass. This is because:-
 - ICl is ionic compound
 - I-Cl bond is stronger than Br - Br bond
 - ICl is polar covalent molecule while Br_2 is non polar
 - IP of Iodine is less than that of Br.
- The correct order of bond length is
 - $C - C < C = C < C \equiv C$
 - $C \equiv C < C = C < C - C$
 - $C = C < C \equiv C < C - C$
 - $C = C < C - C < C \equiv C$
- Which of the following set is not correct:-
 - SO_3 , O_3 , NH_4^+ all have coordinate bonds
 - H_2O , NO_2 , ClO_2^- , all are 'V' shape molecules
 - I_3^- , ICl_2^- , NO_2^+ ; all are linear molecules
 - SF_4 , SiF_4 , XeF_4 are tetrahedral in shape
- Nitrogen forms N_2 but phosphorus do not forms P_2 , but it exists as P_4 the reason for this is:
 - Triple bond is present between phosphorus atom
 - $p\pi-p\pi$ bonding is weak
 - $p\pi-p\pi$ bonding is strong
 - Multiple bond is formed easily
- The F-F bond is weak because:
 - The repulsion between the nonbonding pairs of electrons of two fluorine atom is large
 - The ionization energy of the fluorine atom is very low
 - The length of the F-F bond much larger than the bond lengths in other halogen molecules
 - The F-F bond distance is small and hence the internuclear repulsion between the two F atoms is very low
- Incorrect code regarding shape is:-
 - Linear: N_3^- , $BeCl_2$, ICl_2^-
 - Pyramidal: CH_3^- , NH_3 , XeO_3
 - Trigonal planar: CH_3^+ , $\dot{C}H_3$, CH_3^{\ominus}
 - Tetrahedral: SiH_4 , XeO_4 , PCl_4^+
- If molecule MX_3 has zero dipole moment then orbitals used by M (atomic number < 21) for sigma bond formation are:
 - pure p
 - sp
 - sp^2
 - sp^3





15. If equatorial plane in PCl_5 molecule is the X-Y plane, the orbital hybridizing to produce axial bonds:

- (1) p_z, d_{z^2} (2) $d_{x^2-y^2}, d_{xy}$
(3) p_y, p_x (4) d_{z^2}, d_{xz}

16. Which of the following molecules is having $2p\pi-3p\pi$ bond as well as $2p\pi-3d\pi$ bond?

- (1) SO_3 (2) NO_3^- (3) SO_4^{2-} (4) PO_4^{3-}

17. What is the hybridisation on the central atom of SiO_2 ?

- (1) sp (2) sp^2 (3) sp^3 (4) sp^3d

18. In which of the following change, adjacent bond angle increases?

- (1) $\text{BeF}_2 + 2\text{F}^- \longrightarrow \text{BeF}_4^{2-}$
(2) $\text{SiF}_4 + 2\text{F}^- \longrightarrow \text{SiF}_6^{2-}$
(3) $\text{BF}_3 + \text{F}^- \longrightarrow \text{BF}_4^-$
(4) $\text{NH}_3 + \text{H}^+ \longrightarrow \text{NH}_4^+$

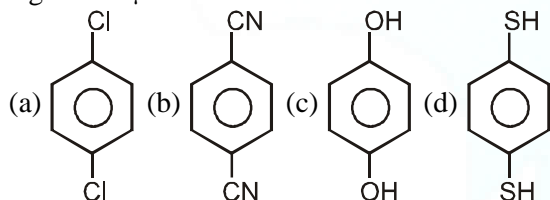
19. Which of the following is correct order of dipole moment:-

- (1) $\text{HF} > \text{NH}_3 > \text{PH}_3$
(2) $\text{CH}_4 > \text{NH}_3 > \text{H}_2\text{O}$
(3) $\text{CH}_3\text{Cl} < \text{CH}_2\text{Cl}_2 < \text{CHCl}_3$
(4) $\text{BF}_3 > \text{BeF}_2 > \text{F}_2$

20. An example of a polar covalent molecule is

- (1) S_8 (2) $\text{H}-\text{O}-\text{H}$
(3) Na^+Cl^- (4) $\text{F}-\text{F}$

21. For which of the following molecule significant $\mu \neq 0$?



- (1) Only (c) (2) (c) and (d)
(3) Only (a) (4) (a) and (b)

22. Arrange the following compound in order of increasing dipole moment:

- (I) 1, 3, 5-Trichloro benzene
(II) 1, 2, 4-Trichloro benzene
(III) 1, 2, 3, 4-Tetrachloro benzene
(IV) P-dichloro benzene

- (1) $\text{I} = \text{IV} < \text{II} < \text{III}$ (2) $\text{IV} < \text{I} < \text{II} < \text{III}$
(3) $\text{IV} > \text{I} < \text{III} < \text{II}$ (4) $\text{IV} < \text{II} < \text{I} < \text{III}$

23. Which species do not exists:

- (1) AlF_6^{3-} (2) BF_4^- (3) BeF_4^{2-} (4) CCl_6^{2-}

24. No. of σ and π bonds in $\text{C}_2(\text{CN})_4$ are respectively:

- (1) 9 σ , 9 π (2) 8 σ , 7 π
(3) 1 σ , 1 π (4) 9 σ , 8 π

25. The pair of compounds which can form a co-ordinate bond is:

- (1) $(\text{C}_2\text{H}_5)_3\text{B}$ and $(\text{CH}_3)_3\text{N}$
(2) HCl and HBr
(3) BF_3 and NH_3
(4) (1) & (3) both

26. In the neutralization process of NH_3 and AlCl_3 the compound formed will have the bonding:

- (1) Ionic (2) Covalent
(3) Co-ordinate (4) Hydrogen

27. Which of the following has no co-ordinate bond ?

- (1) PH_3 (2) $\text{P}_2\text{H}_6^{2+}$ (3) P_2H_5^+ (4) PH_4^+

28. Formula of a metal oxide is MO , formula of its phosphate will be:

- (1) $\text{M}_3(\text{PO}_4)_2$ (2) MPO_4
(3) $\text{M}_2(\text{PO}_4)_2$ (4) $\text{M}_2(\text{PO}_4)_3$

29. A metal M readily forms its sulphate MSO_4 , which is water soluble. It forms an insoluble hydroxide $\text{M}(\text{OH})_2$ which is soluble in NaOH solution, then M is:

- (1) Mg (2) Ca (3) Be (4) Ba

30. Which of the following exists?

- (1) KHSr_2 (2) KHCl_2 (3) KHF_2 (4) KHI_2

31. Maximum covalent character will be shown by the compound is:

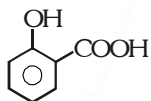
- (1) SiCl_4 (2) AlCl_3 (3) MgCl_2 (4) NaCl

32. Which of the following is not correct for IIA metals?

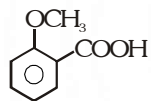
- (1) Thermal stability of carbonate, sulphate increases on moving down the group
(2) Solubility of sulphates increases down the group
(3) Solubility of Hydroxides increases on moving down the group
(4) Bicarbonate do not exist in solid state.

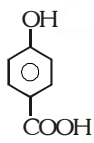




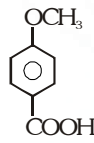
33. The hydrogen bond is strongest in:-
 (1) $\text{O}-\text{H} \cdots \text{S}$ (2) $\text{S}-\text{H} \cdots \text{O}$
 (3) $\text{F}-\text{H} \cdots \text{F}$ (4) $\text{O}-\text{H} \cdots \text{O}$
34. H_2O boils at higher temperature than H_2S , because it is capable of forming:-
 (1) Ionic bonds
 (2) Covalent bonds
 (3) Hydrogen bonds
 (4) Metallic bonds
35. The correct order of volatility is:-
 (1) $\text{NH}_3 < \text{H}_2\text{O}$
 (2) p-nitro phenol < o-nitro phenol
 (3) $\text{CH}_3\text{OH} > \text{CH}_3-\text{O}-\text{CH}_3$
 (4) $\text{HF} > \text{HCl}$
36. H-bond is not present in
 (1) Glycerol (2) Water
 (3) H_2S (4) HF
37. Which of the following has strongest intra molecular hydrogen bonding:-
- 

(1)



(2)
- 

(3)



(4)
38. Increasing strength of H-bonding ($\text{X} \cdots \text{H}-\text{X}$) in S, O, F, Cl, N is:-
 (1) Cl, S, N, O, F (2) N, Cl, S, O, F
 (3) S, Cl, N, O, F (4) S, N, Cl, O, F
39. The boiling point of p-nitrophenol is higher than that of o-nitrophenol because:
 (1) NO_2 group at p-position behaves in a different way from that at o-position
 (2) Intramolecular hydrogen bonding exists in p-nitrophenol
 (3) There is intermolecular hydrogen bonding in p-nitrophenol
 (4) p-nitrophenol has a higher molecular weight than o-nitrophenol
40. In which molecule the Vander Waals force (dispersion force) is likely to be the most important in determining the m.pt. and b.p.
 (1) Br_2 (2) CO (3) H_2S (4) HCl

41. Which of the following is incorrectly matched?
 (1) $\text{KCl} + \text{H}_2\text{O} =$ dipole-dipole attraction.
 (2) $\text{CH}_3-\text{C}(\text{O})-\text{CH}_3 + \text{CH}_3-\text{C}\equiv\text{N}$ Keesom attraction
 (3) $\text{Xe} + \text{H}_2\text{O} =$ Debye attraction
 (4) $\text{CF}_4 + \text{CF}_4 =$ London force
42. Which among the following attraction is strongest?
 (1) $\text{HF} \cdots \text{H}_2\text{O}$ (2) $\text{Na}^+ \cdots \text{HCl}$
 (3) $\text{H}_2\text{O} \cdots \text{Cl}_2$ (4) $\text{Cl}-\text{Cl} \cdots \text{Cl}-\text{Cl}$
43. Which of the following molecules have unpaired electron:-
 (1) H_2 (2) H_3O^+
 (3) H_2O (4) HeH
44. Of the following species which has the highest bond order and shortest bond length:
 $\text{NO}, \text{NO}^+, \text{NO}^{2+}, \text{NO}^-$
 (1) NO only
 (2) Bond order of NO is highest and bond length of NO^{2+} is shortest
 (3) NO^+ only
 (4) NO^{2+} only
45. The energy of σ_{2s} orbital is greater, than σ_{1s}^* orbital because
 (1) σ_{2s} orbital is bigger than σ_{1s}^* orbital
 (2) σ_{2s} orbital is a bonding orbital where as σ_{1s}^* is an antibonding orbital
 (3) σ_{2s} orbital has a greater value of n than σ_{1s}^* orbital
 (4) None
46. N_2 and O_2 are converted into monocations, N_2^+ and O_2^+ respectively. Which of the following is wrong ?
 (1) In N_2^+ , N-N bond weakens
 (2) In O_2^+ , the O-O bond order increases
 (3) In O_2^+ , paramagnetism decreases
 (4) N_2^+ becomes diamagnetic
47. In a homonuclear molecule which of the following set of orbitals are degenerate?
 (1) σ_{2s} and σ_{1s} (2) π_{2px} and π_{2py}
 (3) π_{2px} and σ_{2pz} (4) σ_{2pz} and π_{2px}^*





48. Which of the following LCAO represent formation of bonding molecular orbital?
- (1) $\begin{array}{c} \oplus \\ 1s \end{array} - \begin{array}{c} \oplus \\ 1s \end{array}$ (2) $\begin{array}{c} \oplus \\ 2p_z \end{array} + \begin{array}{c} \oplus \\ 2p_z \end{array}$
- (3) $\begin{array}{c} \oplus \\ 2p_x \end{array} - \begin{array}{c} \oplus \\ 2p_x \end{array}$ (4) $\begin{array}{c} \oplus \\ 2s \end{array} + \begin{array}{c} \oplus \\ 2p_z \end{array}$
49. Which of the following is not the correct statement regarding C_2 molecule?
- (1) It has total 12 electrons, out of which $8e^-$ occupy bonding orbital and $4e^-$ anti bonding orbitals
 (2) C_2 molecules has been found to exist in vapour phase
 (3) C_2 molecule contains double bonds and both are π -bonds
 (4) C_2 Molecule is paramagnetic
50. Which of the following is paramagnetic?
- (1) NO_2 (2) N_2O
 (3) N_2O_3 (4) N_2O_5
51. The ONO angle is maximum in:
- (1) NO_3^- (2) NO_2^- (3) NO_2 (4) NO_2^+
52. Among the following molecules:
 (i) XeO_3 (ii) $XeOF_4$ (iii) XeF_6
 Those having same number of lone pairs on Xe are:
- (1) (i) and (ii) only (2) (i) and (iii) only
 (3) (ii) and (iii) only (4) (i), (ii) and (iii)
53. In solid ice oxygen atom is surrounded:
- (1) Tetrahedrally by 4 hydrogen atoms
 (2) Octahedrally by 2 oxygen and 4 hydrogen atoms
 (3) Tetrahedrally 2 hydrogen and 2 oxygen atoms
 (4) Octahedrally by 6 hydrogen atoms
54. Decreasing order of bond angle is:
- (1) $BeCl_2 > NO_2 > SO_2$
 (2) $BeCl_2 > SO_2 > NO_2$
 (3) $SO_2 > BeCl_2 > NO_2$
 (4) $SO_2 > NO_2 > BeCl_2$
55. Total number of Antibonding electrons present in O_2 will be:
- (1) 6 (2) 8 (3) 4 (4) 2
56. Which molecule has the largest dipole moment?
- (1) HF (2) HI (3) HBr (4) HCl
57. SF_4 & XeF_2 shape respectively are:
- (1) Linear and distorted tetrahedral
 (2) See-saw and linear
 (3) T-shape and trigonal bipyramidal
 (4) Tetrahedral and linear
58. Minimum lone pair on central atom will be present in:
- (1) XeO_3 (2) XeF_4 (3) ClF_3 (4) $HOCl$
59. Which of the following has paramagnetic character in gaseous state:
- (1) S^{2-} (2) S_2 (3) S_8 (4) S_6
60. Select the incorrect statement:
- (1) Excitation of electron is not essential for hybridisation.
 (2) Only half filled atomic orbital can participate in hybridisation.
 (3) Bond energy of hybrid orbitals are more than unhybrid atomic orbital
 (4) Without hybridisation geometry of molecule is uncertain.
61. Which of the following has tetrahedral structure?
- (1) XeF_4 (2) H_3PO_4 (3) SF_4 (4) ClF_3
62. Which of the following is correct?
- (1) N_2O is a coloured gas
 (2) CO is an acidic oxide
 (3) CO_2 is not absorbed in $CsOH$
 (4) N_2O is a neutral oxide
63. Which of the following molecule has more than one lone pair on central atom.
- (1) SO_2 (2) XeF_2 (3) PCl_5 (4) IF_7
64. Which molecule pair do not have identical structure:
- (1) I_3^- , BeF_2 (2) $HClO$, SO_2
 (3) BF_3 , ICl_3 (4) BrF_4^- , XeF_4
65. Which contain at least one e^- in $\sigma 2p$ bonding MO:
- (1) O_2 (2) B_2 (3) C_2 (4) Li_2





- | | |
|--|---|
| <p>66. In which of the following shape is same but hybridization is different:</p> <p>(1) ICl_2^-, XeF_2 (2) SO_2, NO_2^+
 (3) SO_2, NH_2^- (4) CO_2, SO_2</p> <p>67. Which pair of diatomic species have same bond order?</p> <p>(1) B_2^-, C_2 (2) O_2^{2-}, F_2^-
 (3) N_2^+, O_2^- (4) B_2^{2-}, C_2</p> | <p>68. ClF_2^-, ClF_4^- find out number of lone pair and geometry.</p> <p>(1) 3 – Linear, 2 – Square planar
 (2) 3 – Square planar, 2 – Linear
 (3) 0 – Linear, 3 – Square planar
 (4) 2 – Linear, 2 – Square planar</p> <p>69. Which have correct order of dipole moment:</p> <p>(1) $\text{SO}_2 > \text{H}_2\text{O}$ (2) $\text{NF}_3 > \text{NH}_3$
 (3) $\text{BF}_3 < \text{NH}_3$ (4) $\text{SO}_2 < \text{SO}_3$</p> |
|--|---|





EXERCISE-III (PREVIOUS YEAR QUESTION)

- Nitrogen form N_2 and phosphorous form P_2 , but it convert into P_4 , at a instant the reason is
[AIPMT 2001]
(1) Triple bond present between phosphorous atom
(2) $p_\pi - p_\pi$ bonding is weak
(3) $p_\pi - p_\pi$ bonding is strong
(4) Multiple bond form easily
- Which of the following has $p_\pi - d_\pi$ bonding:
[AIPMT 2002]
(1) NO_3^- (2) SO_3^{2-} (3) BO_3^{3-} (4) CO_3^{2-}
- Which of the following statements is not correct for sigma and pi bond formed between two carbon atoms?
[AIPMT 2003]
(1) Free rotation of atoms about a sigma-bond is allowed but not in case of a pi-bond
(2) Sigma-bond determines the direction between carbon atoms but a pi-bond has no primary effect in this regard
(3) Sigma-bond is stronger than a pi-bond
(4) Bond energies of sigma- and pi- bonds are of the order of 264 kJ/mol and 347 kJ/mol. respectively
- Which of the following are arranged in the decreasing order of dipole moment.
[AIPMT 2003]
(1) CH_3Cl , CH_3Br , CH_3F
(2) CH_3Cl , CH_3F , CH_3Br
(3) CH_3Br , CH_3Cl , CH_3F
(4) CH_3Br , CH_3F , CH_3Cl
- H_2O is polar, whereas BeF_2 is not because:
[AIPMT 2004]
(1) H_2O is angular and BeF_2 is linear
(2) The electronegativity of F is greater than that of O
(3) H_2O involves hydrogen bonding whereas BeF_2 is a discrete molecule
(4) H_2O is linear and BeF_2 is angular
- Among the following pair which of the two species are not isostructural:
[AIPMT 2004]
(1) PF_6^- and SF_6 (2) SiF_4 and SF_4
(3) IO_3^- and XeO_3 (4) BH_4^- and NH_4^+
- In a regular octahedral molecule, MX_6 the number of $X - M - X$ bonds at 180° is:
[AIPMT 2004]
(1) Four (2) Three
(3) Two (4) Six
- Which one of the following oxides is expected to exhibit paramagnetic behaviour:
[AIPMT 2005]
(1) CO_2 (2) ClO_2
(3) SO_2 (4) SiO_2
- Which of the following molecules has trigonal planer geometry:
[AIPMT 2005]
(1) NH_3 (2) BF_3
(3) PCl_3 (4) IF_3
- Which of the following would have a permanent dipole moment:
[AIPMT 2005]
(1) BF_3 (2) SF_4 (3) SiF_4 (4) XeF_4
- The correct sequence of increasing covalent character is represented by:
[AIPMT 2005]
(1) $BeCl_2 < NaCl < LiCl$
(2) $NaCl < LiCl < BeCl_2$
(3) $BeCl_2 < LiCl < NaCl$
(4) $LiCl < NaCl < BeCl_2$
- The surface tension of which of the following liquid is maximum:
[AIPMT 2005]
(1) H_2O (2) C_6H_6
(3) CH_3OH (4) C_2H_5OH
- The number of unpaired electrons in a paramagnetic diatomic molecule of an element with atomic number 16 is:
[AIPMT 2006]
(1) 1 (2) 2 (3) 3 (4) 4
- Which of the following is **not** a correct statement?
[AIPMT 2006]
(1) Multiple bonds are always shorter than corresponding single bonds
(2) The electron-deficient molecules can act as Lewis acids
(3) The canonical structures have no real existence
(4) Every AB_5 molecule does in fact have square pyramid structure.





15. Which of the following species has a linear shape? [AIPMT 2006]
 (1) O_3 (2) NO_2^- (3) SO_2 (4) NO_2^+
16. Which of the following is not isostructural with $SiCl_4$? [AIPMT 2006]
 (1) NH_4^+ (2) $SiCl_4$
 (3) SO_4^{2-} (4) PO_4^{3-}
17. The electronegativity difference between N and F is greater than that between N and H yet the dipole moment of NH_3 (1.5 D) is larger than that of NF_3 (0.2 D). This is because: [AIPMT 2006]
 (1) in NH_3 the atomic dipole and bond dipole are in the opposite directions whereas in NF_3 these are in the same direction
 (2) in NH_3 as well as in NF_3 the atomic dipole and bond dipole are in the same direction
 (3) in NH_3 the atomic dipole and bond dipole are in the same direction whereas in NF_3 these are in opposite directions
 (4) in NH_3 as well as NF_3 the atomic dipole and bond dipole are in opposite directions
18. In which of the following molecules are all the bonds **not** equal? [AIPMT 2006]
 (1) NF_3 (2) ClF_3 (3) BF_3 (4) AlF_3
19. The correct order of increasing thermal stability of K_2CO_3 , $MgCO_3$, $CaCO_3$ and $BeCO_3$ is: [AIPMT 2007]
 (1) $BeCO_3 < MgCO_3 < CaCO_3 < K_2CO_3$
 (2) $MgCO_3 < BeCO_3 < CaCO_3 < K_2CO_3$
 (3) $K_2CO_3 < MgCO_3 < CaCO_3 < BeCO_3$
 (4) $BeCO_3 < MgCO_3 < K_2CO_3 < CaCO_3$
20. In which of the following pairs the two species are iso-structural: [AIPMT 2007]
 (1) SO_3^{2-} and NO_3^- (2) BF_3 and NF_3
 (3) BrO_3^- and XeO_3 (4) SF_4 and XeF_4
21. The correct order of C–O bond length among CO, CO_3^{2-} , CO_2 is: [AIPMT 2007]
 (1) $CO < CO_3^{2-} < CO_2$ (2) $CO_3^{2-} < CO_2 < CO$
 (3) $CO < CO_2 < CO_3^{2-}$ (4) $CO_2 < CO < CO_3^{2-}$
22. Four diatomic species are listed below in different sequences. Which of these presents the correct order of their increasing bond order? [AIPMT 2008]
 (1) $C_2^{2-} < He_2^+ < NO < O_2^-$ (2) $He_2^+ < O_2^- < NO < C_2^{2-}$
 (3) $O_2^- < NO < C_2^{2-} < He_2^+$ (4) $NO < C_2^{2-} < O_2^- < He_2^+$
23. The angular shape of ozone molecule (O_3) consists of: [AIPMT 2008]
 (1) 1 sigma and 1 pi bonds
 (2) 2 sigma and 1 pi bonds
 (3) 1 sigma and 2 pi bonds
 (4) 2 sigma and 2 pi bonds
24. The correct order of increasing bond angles in the following triatomic species is: [AIPMT 2008]
 (1) $NO_2^+ < NO_2 < NO_2^-$ (2) $NO_2^+ < NO_2^- < NO_2$
 (3) $NO_2^+ < NO_2^- < NO_2$ (4) $NO_2^- < NO_2 < NO_2^+$
25. According to MO theory which of the following lists ranks the nitrogen species in terms of increasing bond order? [AIPMT 2009]
 (1) $N_2^- < N_2^{2-} < N_2$ (2) $N_2^- < N_2 < N_2^{2-}$
 (3) $N_2^{2-} < N_2^- < N_2$ (4) $N_2 < N_2^{2-} < N_2^-$
26. In the case of alkali metals, the covalent character decreases in the order: [AIPMT 2009]
 (1) $MI > MBr > MCl > MF$
 (2) $MCl > MI > MBr > MF$
 (3) $MF > MCl > MBr > MI$
 (4) $MF > MCl > MI > MBr$
27. What is the dominant intermolecular force or bond that must be overcome in converting liquid CH_3OH to a gas? [AIPMT 2009]
 (1) London or dispersion force
 (2) Hydrogen bonding
 (3) Dipole-dipole interaction
 (4) Covalent bonds
28. Some of the properties of the two species, NO_3^- and H_3O^+ are described below. Which one of them is correct:- [AIPMT 2010]





- (1) Isostructural with same hybridization for the central atom.
 (2) Isostructural with different hybridization for the central atom.
 (3) Similar in hybridization for the central atom with different structures.
 (4) Dissimilar in hybridization for the central atom with different structures.

29. In which of the following molecules the central atom does not have sp^3 hybridization:-

[AIPMT 2010]

- (1) SF_4 (2) BF_4^- (3) NH_4^+ (4) CH_4

30. Which one of the following species does not exist under normal conditions?

[AIPMT 2010]

- (1) Li_2 (2) Be_2^+ (3) Be_2 (4) B_2

31. Which of the following alkaline earth metal sulphates has hydration enthalpy higher than the lattice enthalpy?

[AIPMT 2010]

- (1) $SrSO_4$ (2) $CaSO_4$
 (3) $BeSO_4$ (4) $BaSO_4$

32. In which one of the following species the central atom has the type of hybridisation which is not the same as that present in the other three ?

[AIPMT 2010]

- (1) PCl_5 (2) SF_4
 (3) I_3^- (4) $SbCl_5^{2-}$

33. Which one of the following molecular hydrides acts as a Lewis acid?

[AIPMT 2010]

- (1) CH_4 (2) NH_3 (3) H_2O (4) B_2H_6

34. Properties of the alkaline earth metals that increases with their atomic number:

[AIPMT 2010]

- (1) Electronegativity
 (2) Solubility of their hydroxides in water
 (3) Solubility of their sulphates in water
 (4) Ionization energy

35. In which of the following pairs of molecules/ions, the central atoms have sp^2 hybridization :

[AIPMT-2010]

- (1) BF_3 and NH_2^- (2) NO_2^- and NH_3
 (3) BF_3 and NO_2^- (4) NH_2^- and H_2O

36. Which of the following has the minimum bond length?

[AIPMT Pre.-2011]

- (1) O_2^+ (2) O_2^- (3) O_2^{2-} (4) O_2

37. Which of the two ions from the list given below that have the geometry that is explained by the same hybridization of orbitals,

NO_2^- , NO_3^- , NH_2^- , NH_4^+ , SCN^- ?

[AIPMT Pre.-2011]

- (1) NO_2^- and NO_3^- (2) NO_2^+ and NO_3^-
 (3) SCN^- and NO_2^- (4) NO_2^- and NH_2^-

38. Considering the state of hybridization of carbon atoms, find out the molecule among the following which is linear:

[AIPMT Pre-2011]

- (1) $CH_3-CH=CH-CH_3$
 (2) $CH_3-C \equiv C-CH_3$
 (3) $CH_2=CH-CH_2C \equiv CH$
 (4) $CH_3-CH_2-CH_2-CH_3$

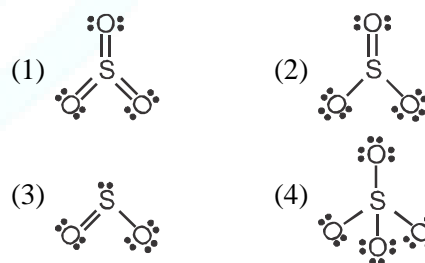
39. Which of the following compounds has the lowest melting point:

[AIPMT Pre-2011]

- (1) $CaCl_2$ (2) $CaBr_2$ (3) CaI_2 (4) CaF_2

40. Which of the following structures is the most preferred and hence is of lowest energy for SO_3 ?

[AIPMT Pre-2011]



41. Which one of the following pairs is isostructural (i.e. having the same shape and hybridization):

[AIPMT Pre-2012]

- (1) NF_3 and BF_3 (2) BF_4^- and NH_4^+
 (3) BCl_3 and $BrCl_3$ (4) NH_3 and NO_3^-

42. Which of the following species contains three bond pairs and one lone pair around the central atom?

[AIPMT Pre.- 2012]

- (1) NH_2^- (2) PCl_3
 (3) H_2O (4) BF_3





43. The pair of species with the same bond order is: [AIPMT Pre.- 2012]
 (1) NO, CO (2) N₂, O₂
 (3) O₂²⁻, B₂ (4) O₂⁺, NO⁺
44. Bond order of 1.5 is shown by: [AIPMT Pre.- 2012]
 (1) O₂²⁻ (2) O₂ (3) O₂⁺ (4) O₂⁻
45. During change of O₂ to O₂⁻ ion, the electron adds on which one of the following orbitals? [AIPMT Mains -2012]
 (1) σ* orbital (2) σ orbital
 (3) π* orbital (4) π orbital
46. Four diatomic species are listed below in different sequences. Which of these presents the correct order of their increasing bond order? [AIPMT Mains 2012]
 (1) C₂²⁻ < He₂⁺ < NO < O₂⁻
 (2) He₂⁺ < O₂⁻ < NO < C₂²⁻
 (3) O₂⁻ < NO < C₂²⁻ < He₂⁺
 (4) NO < C₂²⁻ < O₂⁻ < He₂⁺
47. Which of the following is electron-deficient? [NEET-UG 2013]
 (1) PH₃ (2) (CH₃)₂
 (3) (SiH₃)₂ (4) (BH₃)₂
48. Which one of the following molecules contains no π bond? [NEET-UG 2013]
 (1) NO₂ (2) CO₂ (3) H₂O (4) SO₂
49. XeF₂ is isostructural with: [NEET-UG 2013]
 (1) BaCl₂ (2) TeF₂ (3) ICl₂⁻ (4) SbCl₃
50. Dipole induced dipole interactions are present in which of the following pairs: [NEET-UG 2013]
 (1) SiF₄ and He atoms
 (2) H₂O and alcohol
 (3) Cl₂ and CCl₄
 (4) HCl and He atoms
51. Which of the following is a polar molecule? [NEET-UG 2013]
 (1) XeF₄ (2) BF₃ (3) SF₄ (4) SiF₄
52. Which of these is least likely to act as a Lewis base? [NEET-UG 2013]
 (1) PF₃ (2) CO (3) F⁻ (4) BF₃
53. Which of the following is paramagnetic? [NEET-UG 2013]
 (1) NO⁺ (2) CO (3) O₂⁻ (4) CN⁻
54. Identify the correct order of solubility in aqueous medium: [NEET-UG 2013]
 (1) Na₂S > ZnS > CuS
 (2) CuS > ZnS > Na₂S
 (3) ZnS > Na₂S > CuS
 (4) Na₂S < CuS > ZnS
55. Which of the following molecules has the maximum dipole moment? [AIPMT 2014]
 (1) CO₂ (2) CH₄ (3) NH₃ (4) NF₃
56. Which one of the following species has plane triangular shape? [AIPMT 2014]
 (1) N₃⁻ (2) NO₃⁻ (3) NO₂⁻ (4) CO₂
57. Which of the following pairs of ions are isoelectronic and isostructural? [AIPMT 2015]
 (1) ClO₃⁻, CO₃²⁻ (2) SO₃²⁻, NO₃⁻
 (3) ClO₃⁻, SO₃²⁻ (4) CO₃²⁻, SO₃²⁻
58. Which of the following options represents the correct bond order? [AIPMT 2015]
 (1) O₂⁻ < O₂ < O₂⁺ (2) O₂⁻ > O₂ < O₂⁺
 (3) O₂⁻ < O₂ > O₂⁺ (4) O₂⁻ > O₂ > O₂⁺
59. Solubility of the alkaline earth's metal sulphates in water decreases in the sequence: [AIPMT 2015]
 (1) Ca > Sr > Ba > Mg
 (2) Sr > Ca > Mg > Ba
 (3) Ba > Mg > Sr > Ca
 (4) Mg > Ca > Sr > Ba
60. Maximum bond angle at nitrogen is present in which of the following? [AIPMT 2015]
 (1) NO₂⁻ (2) NO₂⁺ (3) NO₃⁻ (4) NO₂
61. The variation of the boiling points of the hydrogen halides is in the order HF > HI > HBr > HCl. What explains the higher boiling point of hydrogen fluoride? [Re-AIPMT-2015]





- (1) The bond energy of HF molecules is greater than in other hydrogen halides
- (2) The effect of nuclear shielding is much reduced in fluorine which polarizes the HF molecule
- (3) The electronegativity of fluorine is much higher than for other elements in the group.
- (4) There is strong hydrogen bonding between HF molecules

62. On heating which of the following releases CO_2 most easily: [RE-AIPMT 2015]

- (1) MgCO_3 (2) CaCO_3
- (3) K_2CO_3 (4) Na_2CO_3

63. Decreasing order of stability of O_2 , O_2^- , O_2^+ and O_2^{2-} is: [RE-AIPMT 2015]

- (1) $\text{O}_2 > \text{O}_2^+ > \text{O}_2^{2-} > \text{O}_2^-$
- (2) $\text{O}_2^- > \text{O}_2^{2-} > \text{O}_2^+ > \text{O}_2$
- (3) $\text{O}_2^+ > \text{O}_2 > \text{O}_2^- > \text{O}_2^{2-}$
- (4) $\text{O}_2^{2-} > \text{O}_2^- > \text{O}_2 > \text{O}_2^+$

64. In which of the following pairs, both the species are not isostructural? [RE-AIPMT 2015]

- (1) NH_3 , PH_3
- (2) XeF_4 , XeO_4
- (3) SiCl_4 , PCl_4^+
- (4) Diamond, silicon carbide

65. Consider the molecules CH_4 , NH_3 and H_2O . Which of the given statements is false? [NEET-I 2016]

- (1) The H-C-H bond angle in CH_4 , the H-N-H bond angle in NH_3 , and the H-O-H bond angle in H_2O are all greater than 90°
- (2) The H-O-H bond angle in H_2O is larger than the H-C-H bond angle in CH_4 .
- (3) The H-O-H bond angle in H_2O is smaller than the H-N-H bond angle in NH_3 .
- (4) The H-C-H bond angle in CH_4 is larger than the H-N-H bond angle in NH_3 .

66. Predict the correct order among the following: [NEET-I 2016]

- (1) lone pair - lone pair > lone pair - bond pair > bond pair - bond pair
- (2) lone pair - lone pair > bond pair - bond pair > lone pair - bond pair
- (3) bond pair - bond pair > lone pair - bond pair > lone pair - lone pair
- (4) lone pair - bond pair > bond pair - bond pair > lone pair - lone pair

67. Which one of the following orders is correct for the bond dissociation enthalpy of halogen molecules? [NEET-I 2016]

- (1) $\text{I}_2 > \text{Br}_2 > \text{Cl}_2 > \text{F}_2$
- (2) $\text{Cl}_2 > \text{Br}_2 > \text{F}_2 > \text{I}_2$
- (3) $\text{Br}_2 > \text{I}_2 > \text{F}_2 > \text{Cl}_2$
- (4) $\text{F}_2 < \text{Cl}_2 > \text{Br}_2 > \text{I}_2$

68. Match the compounds given in column I with the hybridisation and shape given in column II and mark the correct option. [NEET-I 2016]

Column -I	Column -II
(a) XeF_6	(i) Distorted Octahedral
(b) XeO_3	(ii) Square planar
(c) XeOF_4	(iii) Pyramidal
(d) XeF_4	(iv) Square Pyramidal

(a)	(b)	(c)	(d)
(1) (i)	(iii)	(iv)	(ii)
(2) (i)	(ii)	(iv)	(iii)
(3) (iv)	(iii)	(i)	(ii)
(4) (iv)	(i)	(ii)	(iii)

69. The hybridization of atomic orbitals of nitrogen in NO_2^+ , NO_3^- and NH_4^+ respectively are [NEET-II-2016]

- (1) sp, sp^2 and sp^3
- (2) sp^2 , sp and sp^3
- (3) sp, sp^3 and sp^2
- (4) sp^2 , sp^3 and sp

70. The correct geometry and hybridization for XeF_4 are: [NEET-II 2016]

- (1) Planar triangle, sp^3d^3
- (2) square planar, sp^3d^2
- (3) octahedral, sp^3d^2
- (4) trigonal bipyramidal, sp^3d





71. Among the following which one is a wrong statement? [NEET-II 2016]

- (1) SeF_4 and CH_4 have same shape
- (2) I_3^+ has bent geometry
- (3) PH_5 and BiCl_5 do not exist
- (4) $p\pi$ - $d\pi$ bond is present in SO_2

72. Which of the following fluoro-compounds is most likely to behave as a Lewis base? [NEET-II 2016]

- (1) CF_4 (2) SiF_4 (3) BF_3 (4) PF_3

73. Ionic mobility of which of the following alkali metal ions is lowest when aqueous solution of their salts are put in electric field? [NEET 2017]

- (1) K (2) Rb (3) Li (4) Na

74. The species, having bond angles of 120° is: [NEET 2017]

- (1) PH_3 (2) ClF_3 (3) NCl_3 (4) BCl_3

75. Which of the following pairs of compounds is isoelectronic and isostructural? [NEET 2017]

- (1) BeCl_2 , XeF_2 (2) TeI_2 , XeF_2
- (3) IBr_2^- , XeF_2 (4) IF_3 , XeF_2

76. Match the interhalogen compounds of column-I with the geometry in column II and assign the correct code: [NEET 2017]

Column-I

Column-II

- | | |
|--------------------|-----------------------------|
| (a) XX' | (i) T-shape |
| (b) XX'_3 | (ii) Pentagonal bipyramidal |
| (c) XX'_5 | (iii) Linear |
| (d) XX'_7 | (iv) square -pyramidal |
| | (v) Tetrahedral |

Code:

- | (a) | (b) | (c) | (d) |
|-----------|-------|-------|------|
| (1) (iii) | (iv) | (i) | (ii) |
| (2) (iii) | (i) | (iv) | (ii) |
| (3) (v) | (iv) | (iii) | (ii) |
| (4) (iv) | (iii) | (ii) | (i) |

77. Which one of the following pairs of species have the same bond order? [NEET 2017]

- (1) CO, NO (2) O_2 , NO^+
- (3) CN^- , CO (4) N_2 , O_2^-

78. Among CaH_2 , BeH_2 , BaH_2 , the order of ionic character is [NEET 2018]

- (1) $\text{BeH}_2 < \text{CaH}_2 < \text{BaH}_2$
- (2) $\text{CaH}_2 < \text{BeH}_2 < \text{BaH}_2$
- (3) $\text{BeH}_2 < \text{BaH}_2 < \text{CaH}_2$
- (4) $\text{BaH}_2 < \text{BeH}_2 < \text{CaH}_2$

79. Magnesium reacts with element (X) to form an ionic compound. If the ground state electronic configuration of (X) is $1s^2 2s^2 2p^3$, the simplest formula for this compound is [NEET 2018]

- (1) Mg_2X_3 (2) MgX_2 (3) Mg_2X (4) Mg_3X_2

80. Which one of the following elements is unable to form MF_6^{3-} ion? [NEET 2018]

- (1) Ga (2) Al (3) B (4) In

81. Consider the following species:

CN^+ , CN^- , NO and CN

Which one of these will have the highest bond order? [NEET 2018]

- (1) NO (2) CN^- (3) CN^+ (4) CN

82. In the structure of ClF_3 , the number of lone pairs of electrons on central atom 'Cl' is: [NEET 2018]

- (1) One (2) Two (3) Four (4) Three

83. Which of the following diatomic molecular species has only π bonds according to Molecular Orbital Theory? [NEET 2019]

- (1) O_2 (2) N_2 (3) C_2 (4) Be

84. Which of the following species is not stable? [NEET 2019]

- (1) $[\text{SiF}_6]^{2-}$ (2) $[\text{GeCl}_6]^{2-}$
- (3) $[\text{Sn}(\text{OH})_6]^{2-}$ (4) $[\text{SiCl}_6]^{2-}$

85. Identify the incorrect statement related to PCl_5 from the following: [NEET 2019]

- (1) Three equatorial P-Cl bonds make an angle of 120° with each other
- (2) Two axial P-Cl bonds make an angle of 180° with each other
- (3) Axial P-Cl bonds are longer than equatorial P-Cl bonds
- (4) PCl_5 molecule is non-reactive

86. Match the Xenon compounds in Column-I with its structure in Column-II and assign the correct code: [NEET 2019]

Column - I

Column - II

- | | |
|---------------------|----------------------------|
| (a) XeF_4 | (i) Pyramidal |
| (b) XeF_6 | (ii) square planar |
| (c) XeOF_4 | (iii) distorted octahedral |
| (d) XeO_3 | (iv) square pyramidal |





Code:

	(a)	(b)	(c)	(d)
(1)	(i)	(ii)	(iii)	(iv)
(2)	(ii)	(iii)	(iv)	(i)
(3)	(ii)	(iii)	(i)	(iv)
(4)	(iii)	(iv)	(i)	(ii)

87. Which is the correct thermal stability order for H_2E ($E=O, S, Se, Te$ and Po)? [NEET 2019]

- (1) $H_2S < H_2O < H_2Se < H_2Te < H_2Po$
- (2) $H_2O < H_2S < H_2Se < H_2Te < H_2Po$
- (3) $H_2Po < H_2Te < H_2Se < H_2S < H_2O$
- (4) $H_2Se < H_2Te < H_2Po < H_2O < H_2S$

88. Which of the following is paramagnetic?

[NEET 2019(ODISHA)]

- (1) N_2
- (2) H_2
- (3) Li_2
- (4) O_2

89. Which of the following is the correct order of dipole moment? [NEET 2019(ODISHA)]

- (1) $NH_3 < BF_3 < NF_3 < H_2O$
- (2) $BF_3 < NF_3 < NH_3 < H_2O$
- (3) $BF_3 < NH_3 < NF_3 < H_2O$
- (4) $H_2O < NF_3 < NH_3 < BF_3$

90. The number of hydrogen bonded water molecule(s) associated with $CuSO_4 \cdot 5H_2O$ is:

[NEET 2019(ODISHA)]

- (1) 3
- (2) 1
- (3) 2
- (4) 5

91. Identify a molecule which does not exist

[NEET-2020]

- (1) O_2
- (2) He_2
- (3) Li_2
- (4) C_2

92. Which of the following set of molecules will have zero dipole moment? [NEET-2020]

- (1) Boron trifluoride, beryllium difluoride, carbon dioxide, 1,4-dichlorobenzene
- (2) Ammonia, beryllium difluoride, water, 1,4-dichlorobenzene
- (3) Boron trifluoride, hydrogen fluoride, carbon dioxide, 1,3-dichlorobenzene
- (4) Nitrogen trifluoride, beryllium difluoride, water, 1,3-dichlorobenzene

93. Among the compounds shown below which one revealed a linear structure?

[NEET II-2020]

- (1) NO_2
- (2) $HOCl$
- (3) O_3
- (4) N_2O

94. Match the compounds of Xe in column I with the molecular structure in column II.

[NEET II-2020]

Column-I Column-II

- | | | |
|--------------|-------|------------------|
| (a) XeF_2 | (i) | Square planar |
| (b) XeF_4 | (ii) | Linear |
| (c) XeO_3 | (iii) | Square pyramidal |
| (d) $XeOF_4$ | (iv) | Pyramidal |

(1) (a)-(ii) (b)-(i) (c)-(iii) (d)-(iv)

(2) (a)-(ii) (b)-(iv) (c)-(iii) (d)-(i)

(3) (a)-(ii) (b)-(iii) (c)-(i) (d)-(iv)

(4) (a)-(ii) (b)-(i) (c)-(iv) (d)-(iii)

95. BF_3 is planar and electron deficient compound. Hybridization and number of electrons around the central atom, respectively are

[NEET-2021]

- | | |
|------------------|------------------|
| (1) sp^3 and 4 | (2) sp^3 and 6 |
| (3) sp^2 and 6 | (4) sp^2 and 8 |

96. Match List-I with List-II [NEET-2021]

List-I

List-II

- | | |
|-------------|---------------------------|
| (a) PCl_5 | (i) Square pyramidal |
| (b) SF_6 | (ii) Trigonal planar |
| (c) BrF_5 | (iii) octahedral |
| (d) BF_3 | (iv) Trigonal bipyramidal |

Choose the correct answer from the options given below.

(1) (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)

(2) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)

(3) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

(4) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

97. The correct sequence of bond enthalpy of 'C-X' bond is [NEET-2021]

- (1) $CH_3-F < CH_3-Cl < CH_3-Br < CH_3-I$
- (2) $CH_3-F > CH_3-Cl > CH_3-Br > CH_3-I$
- (3) $CH_3-F < CH_3-Cl < CH_3-Br < CH_3-I$
- (4) $CH_3-Cl < CH_3-F < CH_3-Br < CH_3-I$

98. which of the following molecules in non-polar in nature? [NEET-2021]

- (1) $POCl_3$
- (2) CH_2O
- (3) $SbCl_5$
- (4) NO_2

99. Given below are two statements:

Statement I:

The boiling points of the following hydrides of group 16 elements increases in the order $H_2O < H_2S < H_2Se < H_2Te$

Statement II:

The boiling points of these hydrides increase with increase in molar mass.

In the light of the above statements, choose the most appropriate answer from the options given below: [NEET-2022]





- (1) Both **Statement I** and **Statement II** are correct
- (2) Both **Statement I** and **Statement II** are incorrect
- (3) **Statement I** is correct but **Statement II** is incorrect
- (4) **Statement I** is incorrect but **Statement II** is correct

100. Amongst the following which one will have maximum 'lone pair-lone pair' electron repulsions? **[NEET-2022]**

- (1) ClF_3 (2) IF_5 (3) SF_4 (4) XeF_2

101. Which amongst the following is incorrect statement? **[NEET-2022]**

- (1) The bond orders of O_2^+ , O_2 , O_2^- and O_2^{2-} are 2.5, 2, 1.5 and 1, respectively.
- (2) C_2 molecule has four electrons in its two degenerate π molecular orbitals.
- (3) H_2^+ ion has one electron.
- (4) O_2^+ ion is diamagnetic.





ANSWER KEY

EXERCISE-I

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	3	4	3	2	1	4	3	1	3	3	2	4	3	3
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	1	3	4	3	2	1	3	2	2	2	1	3	2	1
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	3	3	1	4	2	3	2	2	3	3	3	2	1	3	2
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	3	3	2	2	2	1	3	3	2	2	3	4	3	2
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	3	4	2	4	1	3	1	3	2	3	2	2	2	1	1
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	4	4	2	4	1	2	4	3	4	4	1	2	3	3	1
Que.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Ans.	2	3	1	2	2	4	1	1	4	3	3	2	2	1	2
Que.	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	2	1	4	3	3	2	1	2	1	4	1	1	4	3	4
Que.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Ans.	3	2	3	1	4	4	4	2	4	1	3	1	2	3	3
Que.	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
Ans.	4	2	3	3	1	4	4	1	4	3	3	1	2	3	4
Que.	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
Ans.	2	3	3	2	2	2	3	1	4	2	2	4	3	4	4
Que.	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans.	1	4	2	2	1	4	4	3	1	4	2	1	3	1	2
Que.	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
Ans.	2	4	4	3	3	2	1	3	4	2	1	1	2	4	4
Que.	196	197	198	199	200	201	202	203	204	205					
Ans.	3	2	2	3	3	1	4	1	4	1					

EXERCISE-II

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	3	3	2	4	4	2	3	2	4	2	1	3	3	1
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	3	4	1	2	2	1	4	1	4	3	1	1	3	3
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	1	2	3	3	2	3	1	3	3	1	1	2	4	3	3
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	2	3	4	1	4	4	1	1	1	1	2	1	2	2
Que.	61	62	63	64	65	66	67	68	69						
Ans.	2	4	2	3	1	3	4	1	3						




EXERCISE-III

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	2	4	2	1	2	2	2	2	2	2	1	2	4	4
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	2	3	2	1	3	3	2	2	4	3	1	2	4	1	3
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	3	4	4	2	3	1	1	2	3	1	2	2	3	4	3
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	4	3	3	4	3	4	3	1	3	2	3	1	4	2
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	4	1	3	2	2	1	2	1	1	2	1	4	3	4	3
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	2	3	1	4	3	2	2	3	4	4	2	3	4	2	2
Que.	91	92	93	94	95	96	97	98	99	100	101				
Ans.	2	1	4	4	3	1	2	3	2	4	4				





ORGANISM, POPULATION AND COMMUNITY

Introduction

- The term ecology was coined and described by **E.Haeckel**. The term ecology was first authentically used by **Reiter**.
- Father of ecology – **Reiter**
- Father of Indian Ecology
– **Prof. Ram Deo Mishra**
- The study of interaction or inter-relationship of organism with their environment is called ecology.

Organism \rightleftharpoons Environment

- Organism and environment are always interdependent, inter related or mutually reactive.
- Branches of Ecology:** It is based on organisation level –

1. Autoecology or Species Ecology:

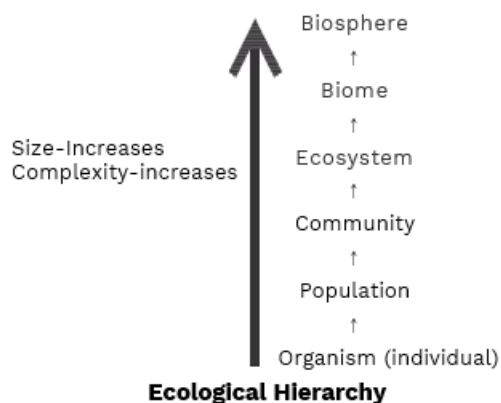
Study of the relation of a species with its environment is known as autoecology

2. Synecology or Biocoenology or Community Ecology:

Study of the relation of the group of different species with their environment. Ex. community, ecosystem, biome ecology.

Aims & Scope of Ecology

- The main aim of ecology is to study the interrelationship between organisms. i.e., Plants, animals and environment.
- Studies like pollution, soil conservation, soil erosion, proper use of land, afforestation, control on deforestation, regulation of overgrazing, flood control, maintenance of soil fertility etc., are also done in the ecology.



Some Ecological Terminology

- Organism:** Basic unit of study of ecology.
- Species:** Similar organisms having the **potential** to interbreed and **producing fertile offspring**.
- Population:** Group of individuals of species inhabiting a given area at a given time.
- Community:** Assemblage of different populations in an area, interacting with each other.
- Ecosystem:** Biological communities integrated with its physical (abiotic) environment through the **exchange of energy** and **recycling of nutrients**.
- Land Scape:** A unit of land with natural boundary having a **mosaic of patches**, which represents different ecosystems.
- Biome:** Large regional unit or ecosystem characterised by major vegetation type (flora) and associated fauna in a specific **climatic zone**.
- Biosphere:** All the earth's terrestrial biomes and aquatic systems constitute biosphere. It includes lower atmosphere the land and the oceans, rivers and lakes, where living beings are found.

Organisms and its Environment

- Ecology at the organismic level is actually physiological ecology which study that how different organisms are adapted to their environment in terms of their survival and reproduction.
- An organism is the smallest unit of ecological hierarchy and basic unit of ecological study.
- It may be small, large, unicellular or multicellular.
- It has defined life span and organized life cycle (birth to death)

Population

A group of individuals (members) of same species living at one place (specific geographical area) constitute a population.



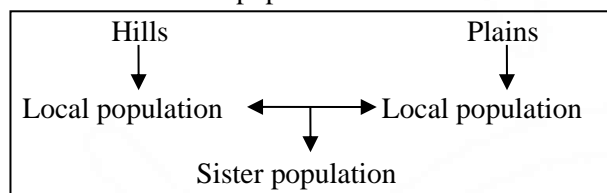


(A) Local Population or Demes (Sub Groups of Population):

Population of organism inhabiting a particular area. **eg.** Homo sapiens inhabiting hills, plains.

(B) Sister Population:

Different population of same species of organisms which are found in different places are known as sister population.



(C) Metapopulation:

A set of local population which are interconnected by dispersing individuals.

1. Endemic Species of Endemism

A species which is found only in a particular area is known as endemic species.

e.g. Metasequoia is found only in valley of China, Kangaroo in Australia

2. Keystone Species: The species having much greater influence on community characteristics, relative to their low abundance or biomass are called **Keystone species**.

- Keystone species regulate relative abundance of other species.
 - Removal of keystone species affects **species diversity** and **relative abundance** of other species in community. For example, in **tropical forest** different species of **Fig** are Keystone species as they produce large quantity of fruits. During food scarcity, these fruits are eaten by monkeys, birds, bats and other vertebrates. So by protecting Fig trees, these animals dependent on them are also conserved.
 - Very few species works as keystone species.
 - Tiger in forest, Kangaroo rat in desert are keystone species.
- 3. Link Species or Critical Link Species:** The species which establish essential link with other species to help in vital activities.
- **Mycorrhizal fungi** in soil are **critical link species** as they establish essential link in

absorption of nutrients (**Phosphate**) from soil provide to host plants.

- Some critical link species provide food for network species.
- **Pollinator species** like **ants, bee, birds** which helps in pollination and seed dispersal.
- Tropical rain forests are rich in critical link species, due to high degree of animal dependent pollination and dispersal due to high species diversity.

Community/Biological Community

Community/Biotic Community

- Biotic community is the organization of populations of different species which are interdependent and interact with each other in a habitat.
- Large number of biotic communities are found in nature due to-
- Existence of diverse habitat with characteristic environmental conditions.
- Co-occurrence of different species whose tolerance range overlap with environmental conditions obtained in that habitat.
- When similar conditions are repeated at another location the same biotic community established there.
- Each biotic community posses ecological characteristics which differentiate it from another community.

Characteristics of Biotic Community:

(A) Species Composition/Community Diversity:

The kinds of species (Plants and Animals) present in a community represents it's species composition.

- Species composition are different in different biotic communities, even in same community in different season like plant species.
- More the productive habitat more the diversity of species in a community. For example, **coral reef** and **tropical rain forest** show **high species diversity** while desert community show low species diversity.





- The species diversity includes the total number of species present in community and the relative abundance of these species.
- More is the diversity, higher is the stability of a community.

(B) Species Dominance / Dominance: - The highest number of organisms of a species present in a community (in terms of number and biomass) is called **dominant species**.

- Communities are generally named after their dominant species. For example, forest community with dominance of pine trees is called **Pine forest**; **grassland community** represents dominance of grasses.
- Communities are also named after important environmental factors like **desert community** with dry conditions, **marine community** due to saline conditions of ocean.

(C) Physiognomy and Stratification:

- **Physiognomy** is **external appearance** or **look** of a community.
- A community is first noticed by its Physiognomy.
- The '**look**' or external appearance is the total effect created by the **combination of vertical structure and architecture of dominant species of vegetation**. For example, high physiognomy of a forest differ from low physiognomy of a grassland.
- **Stratification:** It represent the vertical layering of vegetation or different layers occupies by different species.
- The vertical stratification provides physical structure to the plant community, in which many life forms of plants and animals live in.

For Example:

(i) Stratification in Forest Ecosystem:

Upper most - Forest Canopy Formed By Large Trees.

- then - Understory tree layer (shrubs)
- then - Under shrub layer
- then - herb layer
- then - Forest floor (lower most).

(ii) Stratification in Lake

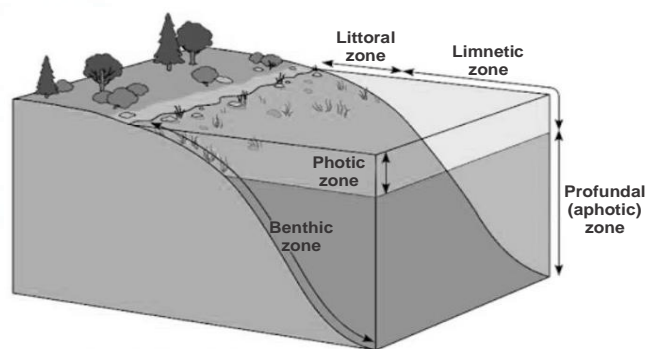
In deep lake, zonation or stratification may be according to the need of **light**. Lake is differentiated into different zones.

A. Littoral Zone: This zone is found at bank of lake with very shallow water or marshy bank is present. Rooted vegetation is found in this zone.

B. Limnetic Zone: This is the zone of lake water, where light reaches in sufficient amount to entire surface area. It means this is not too deep. In this region phytoplanktons, different types of floating plants, suspended and submerged plants are present.

C. Profundal Zone: It is very deep area of the lake where light does not reach. Only **heterotrophs** are present in this zone.

Benthic Zone: It is mud covered bottom of water body. Sediment characteristics determine the type of organisms in this region. Decomposers like bacteria and fungi are found in this zone. Some molluscs are also found.



- **Significance of Stratification:** Vertical stratification leads to increase in number of species and leads to efficient use of resources of a habitat by different types of plants.
- In aquatic ecosystems, the stratification from surface to bottom is determined by **light penetration, temperature profile and oxygen profile**.

Ecological Succession & Population Interactions
Succession

- The successive replacement of communities in an area over a period of time is known as succession.
- Both biotic and abiotic components are involved in successional changes.
- Succession is a community-controlled phenomenon, which results due to action and co-action of living organisms.
- Physical environment also determines the nature, direction, rate and optimal limit of change during succession.
- During succession changes occurs in both plant and animal communities.





Type of Succession:

- Primary Succession** - Occurs in the barren area where there was no previously any type of living matter, e.g. volcanic lava, estuarine soil, mud bank, igneous rock, sand dunes, Rocks, Newly created pond.
It occurs at **slow pace** and may takes more than 1000 years.
- Secondary Succession:** This type of succession occur where vegetation was present previously but vegetation was destroyed due to natural or artificial causes i.e. fire, flood, sudden changes in climate, land slide, glaciation, earthquake etc.
This succession is comparatively more rapid, required 50-100 years for grass land and 100-200 years for forest. It occurs in **fast pace**.

Terms, Features and Causes of Succession

Term of Community in Succession:

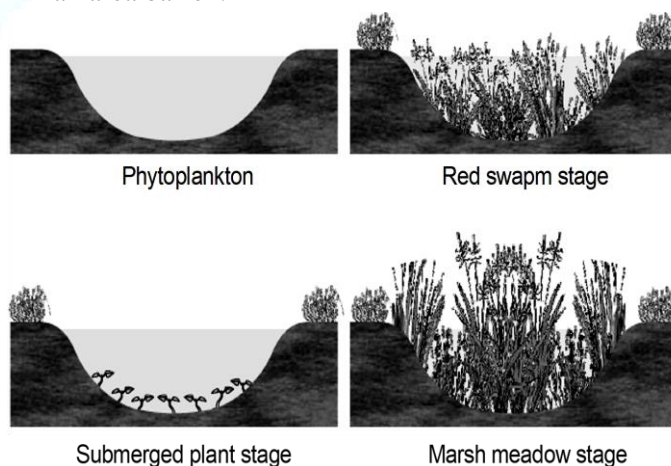
- Pioneer Community:** The first community to inhabit an area is called Pioneer community.
- Climax Community:** The last and stable community in an area is called climax community. This is most stable. Usually mesophytes are present in climax community.
- Seral Communities or Seral Stage:** In succession, communities or stages which comes in between pioneer community and climax are called transitional or seral communities.
- Sere:** The entire series of communities in a succession process is called sere
The name of sere depends on where the succession occurs or takes place.
 - Succession in fresh water → **Hydrosere**
 - Succession in salty water → **Halosere**
 - Succession in acidic water → **Oxalosere**
 - Succession in dry region → **Xerosere**
 - Succession on rocks → **Lithosere**
 - Succession on sand → **Psamosere**
 - Succession in moistened region → **Mesosere**
 - Succession of microbes on decomposed matters → **Serula**

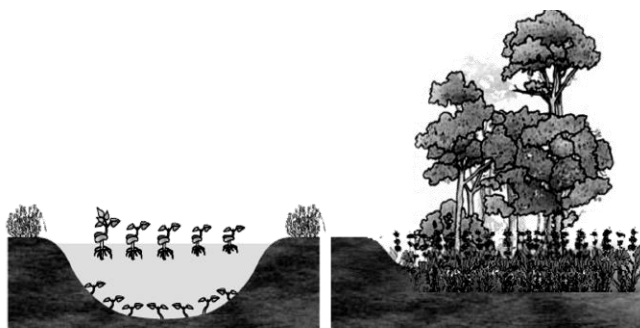
Ecological Succession Shows Certain Characteristics:

- Gradual replacement → Form short lived to long lived plant.
- Continuous change occur in communities towards a state of stability or climax.
- Increases species-diversity, biomass, niche specialization, humus content.
- Future seral communities can be predicted as it is a directional process.
- succession and evolution would have been parallel process.
- Description of ecological succession usually focuses on changes in vegetation. However, these vegetational changes in turn affect food and shelter for various types of animals. Thus, as succession proceeds, the numbers and types of animals and decomposers also change.

Causes of Succession:

- Biotic Factors:** The action of each seral community (interaction with it's environment) makes the area less favourable for itself and more favourable for next seral community in the succession.
- Physiographic Factors:** These include climatic and other physical factors like soil erosion, landslide, volcanic lava. These all factors makes an area barren.





Submerged free floating plant stage

Scrub stage



Forest

Pioneer community	Seral communities						Climax community
1 Phytoplankton stage	2 Rotted submerged stage	3 Floating stage	4 Reed-swamp stage	5 Sedge-meadow stage	6 Woodland stage	7 Forest stage	
Blue-green algae, Green algae, Diatoms, Bacteria etc.	Hydrilla Vallisneria Utricularia	<i>Nelumbo</i> <i>Nymphaea</i> <i>Trapa</i> <i>Azolla</i> <i>Lemna</i> <i>Wolffia</i> <i>Pistia</i> <i>Salvinia</i>	<i>Scirpus</i> <i>Typha</i> <i>Sagittaria</i>	<i>Carex</i> <i>Juncus</i> <i>Cyperus</i>	<i>Salix</i> <i>Populus</i> <i>Alnus</i>	<i>Quercus</i>	

General trend of succession →

Xerarch or Xerosere:

- The ecological succession taking place in a dry area is called as xerarch. The stages through which it occurs on a bare rock constitute the **lithosere** or on a sand-dune constitute the **psamosere**. Here we will discuss only the lithosere. **Lichens are pioneer in Lithosere.**

Lithosere

- Crustose Lichens Stage** – It is pioneer community, tolerates desiccation, produces organic acid which causes weathering of rocks, so first minerals are released for own use.
- Foliose Lichens Stage** – Large lichens with leafy thalli
- Moss Stage**
- Herb Stage** – Annual hardy grasses
- Shrub Stage**
- Forest Stage**

Note: All succession whether taking place in water or on land, proceeds to a similar climax community – the mesic.

Ecological Succession Shows Certain Characteristics:

Change in Characteristics of Community During Succession:

Community Structure Seral Stage Climax

- | | | |
|--------------------------|--------|---------|
| • Size of Individual | Small | Large |
| • Community organisation | Simple | Complex |
| • Community diversity | Low | High |

Community Functions Seral Stage

Climax

- | | | |
|--|----------------|--------------|
| • Food chain & Food web | Simple | Complex |
| • Efficiency & energy use | Low | High |
| • Nutrient conservation (nutrient cycling & Storage) | Low | High |
| • Heterotrophs | Few | Many |
| • Ecological Niche | Few | Many |
| • Competition & Predation | Low | High |
| • Net community Productivity | High | Low |
| • r & k - selection | 'r'-strategist | k-strategist |

Species Interactions/Population Interactions

Ecological Interactions / Interspecific Interactions:

- (1) Positive or Beneficial Interaction:** Member of one or both the interacting species are benefitted but neither is harmed.





(2) **Negative Interaction:** One or both interacting species are harmed.

(1) **Positive or Beneficial Interactions:**

(a) **Mutualism (+/+) or Symbiosis:**

Positive interspecific integration in which members of two different species completely depend on each other for growth and survival, **physical contact** is present in between both the interacting species. It is obligatory relationship. Both are benefited.

e.g.

1. Termites and Flagellates (Trichonympha)
2. Lichens
3. Mycorrhizal association - **Boletus** in roots of pinus.
4. Yucca plant and Pronuba insects –
5. **Fig Tree and Wasp Species:**

In many species of fig trees, there is a tight one to one relationship with the pollinator species of wasp. It means that a given fig species can be pollinated only by its partner wasp species and no other species. The female wasp uses the fruit not only as an **oviposition (egg-laying)** site but uses the developing seeds with in the fruit for nourishing its larvae. The wasp pollinates the fig inflorescence while searching for suitable egg-laying sites. In return for the favour of pollination the fig offers the wasp some of its developing seeds, as food for the developing wasp larvae.

6. **Bees and Orchid Flower:**

Orchids show diversity of floral patterns, which have evolved to attract the right pollinator insect (bees and bumblebees) and ensure guaranteed pollination by it.

The Mediterranean orchid **Ophrys** employs ‘sexual deceit’ to get pollination done by a species of bee. One petal of its flower resemblance to the female of the bee in size, colour and markings. The male bee is attracted to what it perceives as a female, **pseudo copulates** with the flower and during that process is dusted with pollen from the flower, it transfers pollen to it and thus, pollinates the flower.

Note: Species showing symbiotic relations show the property of co evolution and co extinction.

(b) **Commensalism (+ / 0):**

Association between members of two species in which **one is benefitted** while **other is almost unaffected**.

- **Lianas:** are woody climbers. Their roots are present in soil but their stem use other plants or object for support to get better light. They are found in dense forest. No nutritional relationship. Lianas are the speciality of tropical rain forest.

e.g. **Bauhinia, Tinospora**

- **Epiphytes:** Small plants grow on other plants in tropical rain forest. They utilise only the space of host plant for light and humidity.

e.g. Orchids, Hanging mosses

- **Epizones:** Those animals which depend on plants or other animals.

Sucker fish (Echeneis) - Shark

Pilot fish - Shark

E. coli bacteria - Man (intestine)

Clown fish - Sea anemone

Barnacles - Whale

Cattle egret birds - Cattle

(c) **Proto-Cooperation (+/+):**

Association in which **both organisms are benefitted but can live separately**. It is a facultative or optional or occasional association also called as **non-obligatory relationship**.

e.g.

- Hermit crab - Sea anemone
- Tick bird (Red-billed or yellow billed) - Rhinoceros
- Crocodile - Bird

Note:

Scavenging: Association in which one partner called scavenger or saprobiont, eats the dead bodies of other animals, which have naturally or killed by another animal.

e.g. Jackal, Vulture, Ant, Crow

- **Helotism:** Association in between two organism, when one behaves as a master and another as slave. e.g. Lichen

(2) **Negative Interaction (Antagonism)/Detrimental:**

- Two type of negative interaction:
(A) **Exploitation** (B) **Amensalism**
(C) **Competition**

(A) **Exploitation:** One species harms the other by making its direct or indirect use for **support, shelter** or food. It is of three types:

(a) **Parasitism** (b) **Predation**





(a) **Parasitism (+ / -):** This association involves individuals of two species of different size in which **smaller (Parasite) is benefitted** and **larger (host) is harmed**. The parasite gets nourishment and shelter from host but does **not kill** the host.

- Parasites may reduce the survival, growth and reproduction of the host and reduce its population density. They might render the host more vulnerable to predation by making it physically weak.
- Parasites and hosts tend to co-evolve that is, if the host evolves special mechanisms for rejecting or resisting the parasite, the parasite has to evolve mechanisms to counteract and neutralise them, in order to be successful with the same host species.
- Endoparasite evolution: Loss of unnecessary sense organs, presence of adhesive organs or suckers to cling on the host, loss of digestive system and high reproductive capacity.

Examples:

(a) Ectoparasites – Leech, Lice, Ticks, Copepods on fishes.

(b) Endoparasites – Human liver fluke, Ascaris.

- Hyper parasitism → A parasite living on another parasite
e.g. Bacteriophages on bacteria.
- Brood parasitism → Parasitism in which the parasitic bird (cuckoo) lays its eggs in the nest of its host (crow) and lets the host incubate them, this relation is known as brood parasitism.
- Hollo parasite → Parasite which are totally dependent upon the host for their requirement
e.g. Rafflesia, (Total root parasite)
Cuscuta (Total stem parasite)-a parasitic plant that is commonly found growing on hedge plants, has lost its chlorophyll and leaves in the course of evolution. It derives its nutrition from the host plant which it parasitizes.
- Hemiparasite → Parasite which partially depend on the host

e.g. $\left. \begin{array}{l} \text{Viscum} \quad - \text{on oak} \\ \text{Loranthus} - \text{on mango} \end{array} \right\}$

both are partial stem parasite

Note:

- Arceuthobium is the smallest parasitic angiosperm.
- Female Anopheles mosquito is not considered as parasite.

(b) **Predation (+ / -):** A free living organism which **catches** and **kills** another species for food.

- All the herbivores are predators.

Significance of Predators

- Predators acting as conduits for energy transfer across trophic levels, predators play other important roles.
- They **keep prey populations under control** in the absence of predators, prey species could achieve very high population densities and cause ecosystem instability. When certain exotic species are introduced into a geographical area, they become invasive and start spreading fast because the invaded land does not have its natural predators.
- The **prickly pear cactus** introduced into **Australia** in the early 1920's caused havoc by spreading rapidly into millions of hectares of rangeland. Finally, the invasive cactus was brought under control only after a **cactus feeding predator (a moth *Cactoblastiscactorum*)** from its natural habitat was introduced into the country.
- Biological control methods** adopted in agricultural. **Pest control** are based on the ability of the predator to regulate prey population.
- Predators also help in **maintaining species diversity in community**, by reducing the intensity of competition among competing prey species. In the rocky intertidal communities of the **American Pacific Coast** the **starfish Pisaster** is an important predator. In a field experiment, when all the starfish were removed from an enclosed intertidal area, more than 10 species of invertebrates became extinct within a year because of interspecific competition.
- If a predator is too efficient and overexploits its prey, then the prey might become extinct and following it, the predator will also become extinct due to lack of food. This is reason why **predators in nature are 'prudent'**. **Camouflage**:
- In some animals, the capacity to blend with surroundings or camouflage is a common adaptation. Some on their bodies, which make it





difficult to distinguish them from shadows and branches, or from their surrounding.

- Prey species have evolved various defences to lessen the impact of predation. Some species of **insects and frogs** are **cryptically-coloured** (camouflaged) to avoid being detected easily by the predator. Some are poisonous and therefore avoided by the predators. The Monarch butterfly is highly distasteful to its predator birds because of a special chemical present in its body. The butterfly acquires this chemical during its caterpillar stage by feeding on poisonous weed. (Asclepius)
- For **plants, herbivores are predators**. About 25% of all insects are **phytophagous** (feeding on plant parts and plant sap) are predators. Plants have specific adaptations or morphological and chemical defence against herbivores.
- Thorns - in *Acacia*, Cactus.
- Many plants produce and store chemicals that can make herbivore sick or inhibit feeding or disrupt digestion, reproduction or even kill.
- The weed *Calotropis* growing in abandoned fields, produces highly poisonous cardiac glycosides and that is why you never see any cattle or goats browsing on this plant.
- A wide variety of chemical substances that we extract from plants on a commercial scale (nicotine, caffeine, quinine, strychnine, opium, etc....) are produced by them actually as defences against grazers and browsers.

(B) Amensalism (– / 0):

Amensal = (–) Inhibitor = (0)

- In this interaction one species is inhibited by toxic secretion of another species. Inhibitor is neither benefitted nor harmed.

Type of Amensalism:

(i) Antibiosis (ii) Allelopathy

- (C) **Competition** (–, –) → Interaction in which the fitness of one species is significantly lowered in the presence of another species. According to Darwin the struggle for existence and survival of the fittest in nature, shown that interspecific competition is a potent force in organic evolution.

- Competition is best defined as a **process in which the fitness of one species** (measured in terms of its 'r' the intrinsic rate of increase) **is significantly lowered in the presence of another species**.
- **Totally unrelated species could also compete for the same resource**. For instance, in some **shallow South America lakes** visiting **flamingoes** and **resident fishes** compete for their **common food, the zooplankton** in the lake.
- It is generally believed that competition occurs when closely related species compete for the same resources that are limiting, but this is not entirely true.
- **Resources need not be limiting for competition** to occur; in **interference competition**, the feeding efficiency of one species might be reduced due to the interfering and inhibitory presence of the other species, even if resources (Food and Space) are abundant.
- It is relatively easy to demonstrate in laboratory experiments, as **Guase** and other experimental ecologists did, **when resources are limited the competitively superior species will eventually eliminate the other species**, but evidence for such **competitive exclusion** occurring in nature is not always conclusive.
- **Gause's Law**: No two species can occupy the same niche indefinitely in a habitat.
- Strong and persuasive circumstantial evidence does exist, however in some cases. The **Abingdon tortoise in Galapagos Island** became extinct within a decade **after goats were introduced** on the island, apparently due to the greater browsing efficiency of the goats. This is called '**competitive exclusion**'.
- **Guase's 'Competitive Exclusion Principle'** states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually. This may be true **if resources are limiting** but not otherwise. More recent studies do not support such gross generalisation about competition.
- While they do not rule out the occurrence of interspecific competition in nature, they point out





that species facing competition might evolve mechanisms that promote co-existence rather than exclusion.

- One such mechanism is '**resource partitioning**'. If two species compete for the same resource, they could avoid competition by choosing, for instance, different times for feeding or different foraging patterns.
- MacArthur showed that five closely related species of warbler living on the same tree were able to compete and co-exist due to behavioural difference in their foraging activities.
- A species whose distribution is restricted to a small geographical area because of the presence of a competitively superior species, is found to expand its distributional range dramatically when the competing species is experimentally removed. It is called **competitive release**. One such example is Connell's elegant field experiments showed that on the **rocky sea coasts of Scotland**, the larger and **competitively superior barnacle *Barlanus*** dominates the intertidal area, and excludes the **smaller barnacle *Chathamalus*** from that zone.
- When superior barnacle *Balanus* was experimentally removed from the area then *Chathamalus* increased its distribution.

Note: In general, herbivores and plants appear to be more adversely affected by competition than carnivores.

Population Interactions

Species A	Species B	Name of Interaction
+	+	Mutualism
-	-	Competition
+	-	Predation
+	-	Parasitism
+	0	Commensalism
-	0	Amensalism

Both the species benefit in **mutualism** and both lose in **competition** in their interactions with each other. In both **parasitism** and **predation** only one species benefits (parasite and predator, respectively) and the interaction

SPECIAL POINT

- **Climate/Weather:** Short term properties of the atmosphere (Temperature, Pressure, Humidity, Rainfall, Sun-shine, Cloud cover and Wind) at a given place and time is **weather** and **average**

weather of an area is climate. Weather change in hours, day, week while climate is a long term property.

- **Microclimate:** Climatic conditions that present at a local scale or in area of limited size.
- It is an immediate climate (real climate) of an organism which is different from the average climate of region. **eg.** Forest floor, burrow and surface of desert.
- **Habitat:** Place where an organism live on or place occupied by an entire biological community.
- **Microhabitat:** Subdivision of habitat.
- **Ecological Niche:** Word given by **Grinnel**. The range of conditions that an organism can tolerate, the resource it utilize and it's functional role in ecological system. It is a occupational address or functional status of a species in an ecosystem. Each species has a distinct niche and no two species can occupy same niche in a habitat.
- **Ecotone:** The transition zone in between two communities is called ecotone or **tension zone**. It has greater number of species and density or it is a transition zone between two communities where one type of community is modified into another type of community is known as ecotone.

Ex.: Sea shore, Estuary.

- **Edge effect:** Species which occur most abundantly and spend their time in ecotone are called edge species. The tendency to increase variety and density of some organism at the community border is known as edge effect.

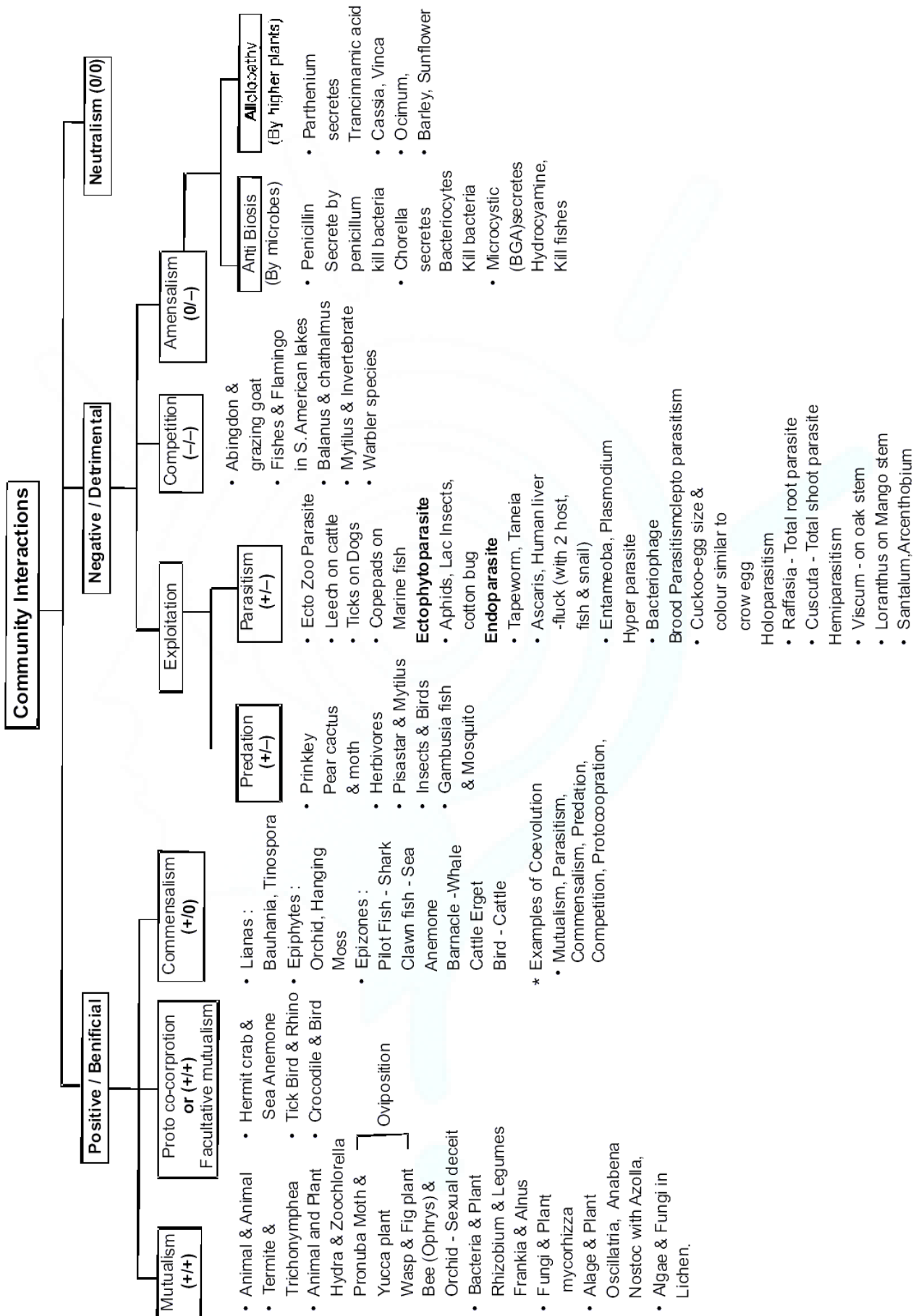
Ex.: Species diversity is high in estuary.

- **Biotic potential (Reproductive potential or potential ability):** The term biotic potential was first used by **Chapmann**.

Under most **favourable** environmental conditions the **maximum reproductive capacity** of an species is known as biotic potential.

- **Vitality:** Capacity of normal growth metabolism and reproduction for survival of a organism or species. It depends upon weight of plant, stem height, root length, leaf number etc.







Population (Demography)

- A **group of individuals** (members) of **same species** living at a defined geographical area at a given time constitute a population.
- Sister population – Different population of same kind of organisms having high genetic similarity, which are found in different places are known as sister population.
- Meta population – A set of local population which are interconnected by dispersing individuals.

Characteristics of Population

(i) Natalty:

- The increase in number of individuals in a population under given environmental conditions is called Natalty.
- Birth, Hatching, Germination, Vegetative propagation cause increase in number of individuals of population.
- The increase in number of individuals in unit area and time is called **Natalty** or **Birth rate**.

(ii) Mortality:

- The loss of individuals due to death in a population under given environmental conditions is called mortality.
- Death of number of individuals of a population over a unit time is called **Mortality**.
- Population have many features different from a individual. Like individuals have birth and death, while population has **birth rate (Natalty)** and **death rate (Mortality)**.

Affected by environment

- Abiotic : Light, Temp., Water, Soil, Space, Nutrients
- Biotic : Food, Predator, Pathogen, Parasite, Competitor

- In a population these rates are called as **per capita birth** and **death**. It can be calculated as for example In a pond 20 lotus plants in last year, 8 new plants are added means current population is 28.

So birth rate of population is $\frac{8}{20} = 0.4$

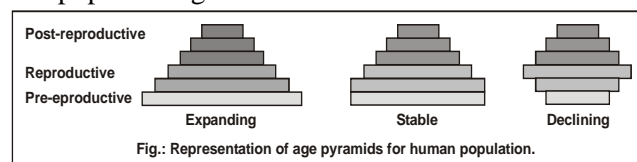
- If out of 20 lotus plants 4 are died then death rate of populations is $\frac{4}{20} = 0.2$

(iii) Sex Ratio:

- An individual is either male or female, but a population has **sex ratio**. i.e., ratio of male and female like 60% of population are female and 40% are male.
- Can be determined in species having sexual dimorphism.
- For humans sex ratio - number of females per 1000 males (according to census 2011 in India sex ratio is 940 female per 1000 males).

(iv) Age Pyramid:

- A population at any given time is composed of individuals of different ages.
- If the age distribution (percent individuals of a given age or age group) is plotted for the population. the resulting structure is called **Age pyramid**.
- For human population, the age pyramid generally show age distribution of males and females in a combined diagram.
- Age pyramid reflects the **growth status** of the population. i.e.,
(A) Growing (B) Stable (C) Declining
- Various age groups in a population determine it's reproductive status. In a population three age groups i.e., **Reproductive**, **Reproductive** and **Post reproductive** are considered as **ecological ages**.
- Different species have different duration of ecological ages.
- **Cohart**: Individuals of same ecological age.
- Distribution of age groups influence the population growth.



(v) Population Density or Population Size:

- The size of the population is represented by population density.
- Population density- Total number of individuals present per unit area or volume at a given time. For example 50 tree of a species grown per hectare.

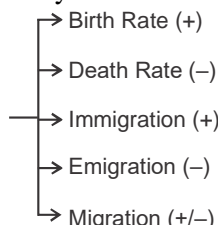
Affected by environment

- Abiotic : Light, Temp., Water, Soil, Space, Nutrients
- Biotic : Food, Predator, Pathogen, Parasite, Competitor





- Population density is also affected by



Immigration: Increase in population due to entry of individuals into habitat from elsewhere during given period of time.

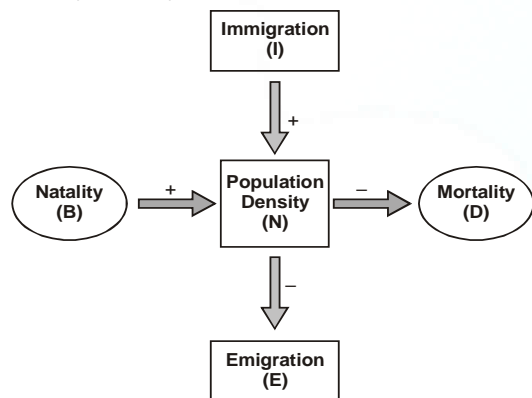
Emigration: The number of individuals of population who left the habitat and gone elsewhere during given time period.

Migration: The large scale movement of animals from one environment to another.



- Plant density is calculated by study of predetermined size. **Sample quadrat** method.
- Census or Counting of **human population done every ten year** in India.
- Wild animals counted by - **Pug mark, faecal pellet analysis, water point, camera trap, GPS** methods.
- Bacterial population counted by - **Serial dilution** method.
- Greater density of plants in rainy season than in dry season.
- Population size is determined by available resources like nutrients, water etc. at a given time.
- So if 'N' is population density at time 't' then at time t + 1. It's density is:

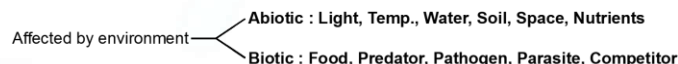
$$N_{t+1} = N_t + [(B + I) - (D + E)]$$



Biotic Potential and Environmental Resistance

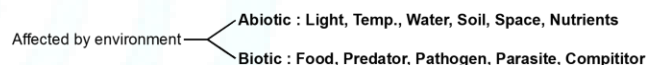
- Biotic Potential:** The inherent maximum capacity of an organism to reproduce or increase in number.
- Biotic Potential** (symbol 'r') can be realised only when environmental conditions are most favourable. So that natality rate is maximum and mortality rate is minimum. In this condition population size increase at maximum rate.

- Environmental Resistance:** The environmental control on population size, on it's biotic potential.
- Nature keeps a check on expression of biotic potential. With increase in population size, the environmental resistance (against population) increase.
- Environmental resistance represents the **limiting effect of abiotic** (water, space) and **biotic factors** (**food, competition**). Which do not allow organisms to attain their biotic potential and keep the population size at much lower level.



Population Growth Forms

- Population have characteristics patterns of growth with time known as **population growth form**.
- The growth or size of a population of a species is not a static parameter, but it keep changing time to time, due to change in biotic (Food availability, predation pressure) factors and abiotic factors (water, nutrients, space, weather).



- The population growth forms (**Characteristic pattern of growth in unit time**) is of two types.

(i) J-shaped or Exponential or Geometric Growth Form:

- In the case of **J-shaped growth** form, the population grows exponentially, and after attaining the peak value, the population may abruptly crash. The exponential growth cannot be sustained infinitely because not only environment is ever changing, food and space are also limited.
- For example, many insect populations show explosive increase in numbers during the rainy season, followed by their disappearance at the end of the season. The J-shaped growth form is represented by the following exponential equation:

$$\frac{dN}{dt} = rN$$

- Where, **dN/dt** is the rate of change in population size,
- 'r' is the intrinsic rate of increase, and
- 't' time period
- 'N' is the **population size**.



- For Norway rate 'r' is 0.015 for flour beetle it is 0.12.
In India in 1981 'r' value for human population was 0.0205 s

(ii) **S-shaped or Sigmoid or Logistic or Verhulst-Pearl Logistic Growth Form**

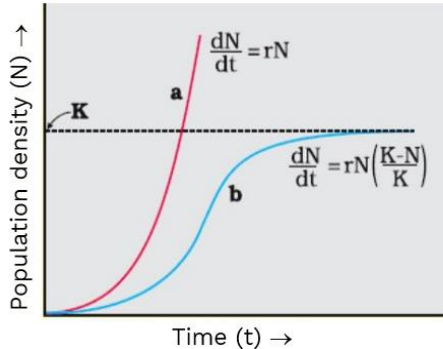


Figure : Population growth curve
a when responses are not limiting the growth plot is exponential,
b when responses are limiting the growth, plot is logistic,
k is carrying capacity

- S-shaped or sigmoid growth form** shows an initial gradual increase in population size, followed by an exponential increase and then population size is saturated or it becomes almost constant. This slow-down following the exponential phase, occurs due to increasing environmental resistance. In such cases, plotting of the rate of increase of population over time gives an **S-shaped** or **sigmoid curve**.
- Generally, the population size stabilises with time, with minor fluctuations around this upper limit. The maximum number of individuals of a population that can be sustained indefinitely in a given habitat, represents its **carrying capacity (K)**. The S-shaped sigmoid growth form is represented by the following equation, which includes an expression for environmental resistance:

$$\frac{dN}{dt} = rN \left(\frac{K - N}{K} \right) = rN \left(1 - \frac{N}{K} \right)$$

- Where, dN/dt , r and N are the same as in the equation for J-shaped growth form, and $(K - N)/K$ or $(1 - N/K)$ stands for environmental resistance.

Life History Variations:

- Populations evolve to maximise their reproductive fitness, also called Darwinian

fitness (high r value), in the habitat in which they live.

- Under a particular set of selection pressures, organisms evolve towards the most efficient reproductive strategy.
- Some organisms breed only once in their lifetime (Pacific salmon fish, bamboo) while others breed many times during their lifetime (most birds and mammals).
- Some produce a large number of small-sized offspring (Oysters, pelagic fishes) while others produce a small number of large-sized offspring (birds, mammals).
- Ecologists suggest that life history traits of organisms have evolved in relation to the constraints imposed by the abiotic and biotic components of the habitat in which they live.

	r-strategists	k-strategists
	Density independent More impact of environmental changes	Density dependent Less impact of environmental changes
1.	Small sized organisms	Large sized organisms
2.	Energy used to produce a offspring is low.	Energy used to produce a offspring is high
3.	Produce large number of, small sized offspring Ex. Oyster, Pelagic fishes	Produce few offspring, of large size Ex. Birds and Mammals
4.	Short life span	Long life span
5.	Early maturity E.g. Weeds, Insects, Bacteria, Diatoms. * Small rodents (Rat, Mice)	Late maturity with prolonged parental care
6.	Some of them may reproduce only one in life time Ex. Pacific Salmon fish, Bamboo	Reproduce more than once in life time Ex. Birds, Mammals - Human, Whale, Arctic tern, Tiger, Elephant, Rhino ect.



EXERCISE - I

Organism, Population, Community, Ecological Succession Population Interactions

1. Ecology takes into account:
 - (1) Environmental factors only
 - (2) Plant adaptations only
 - (3) Effect of plants on environment
 - (4) Relationships between organisms and their environment
2. Autecology means the study of:
 - (1) Effect of temperature on vegetation
 - (2) Effect of soil on vegetation
 - (3) Ecology of individual organism
 - (4) Effect of precipitation on vegetation
3. Synecology is the study of:
 - (1) Environment
 - (2) Plant community
 - (3) Individual
 - (4) None
4. The transitional zone between two different communities is called:
 - (1) Niche
 - (2) Ecotone
 - (3) Eked
 - (4) Ecotype
5. Humus rich soil layer is:
 - (1) A₀₀
 - (2) A₀
 - (3) A₁
 - (4) A₂
6. Biotic factors are:
 - (1) All the living organisms which influence other organisms
 - (2) Factors of atmosphere which affect life
 - (3) Chemical factors of soil which affect life
 - (4) Physical factors of soil which affect life
7. Vegetation of Sundarbans is:
 - (1) Desert type
 - (2) Temperate evergreen
 - (3) Mangrove type
 - (4) Monsoon type
8. *Vallisneria* and *Hydrilla* are example of:
 - (1) Floating and anchored
 - (2) Suspended hydrophyte
 - (3) Submerged hydrophyte
 - (4) A free floating hydrophyte

9. Endemic plants:
 - (1) Cosmopolitan
 - (2) Occur in a particular area
 - (3) Occur at high altitudes
 - (4) Occur on north pole
10. Father of Indian ecology is:
 - (1) Prof. R Mishra
 - (2) G.S. Puri
 - (3) S.C. Pandey
 - (4) Prof. N. Dudgeon
11. Species ecology is:
 - (1) Autecology
 - (2) Synecology
 - (3) Palaeo ecology
 - (4) Forest ecology
12. The term Autecology refers to study of:
 - (1) Plant community
 - (2) Individual organism
 - (3) Environment
 - (4) Soil form
13. In commensalism:
 - (1) Both partners are harmed
 - (2) Both partners are benefited
 - (3) None of the partners benefited
 - (4) One partner is benefited, other is unaffected
14. Mutualism means:
 - (1) Living apart with benefit to one and harm to another partner
 - (2) Living together with benefit to both partners
 - (3) Living together with benefit to one partner
 - (4) Living together without harm
15. When one organism inhibits another organism without a significant gain (OR) Antagonism between two organism through gases or allochemicals is called ?
 - (1) Parasitism
 - (2) Mutualism
 - (3) Amensalism
 - (4) Commensalism
16. The relationship between the alga *Microcystis* and the surrounding fauna corresponds to:
 - (1) Exploitation
 - (2) Parasitism
 - (3) Amensalism
 - (4) Predation





17. A component produced by one organism which inhibit the growth of another organism is:
 (1) Antiallergic (2) Anticoagulant
 (3) Antibiotic (4) Antiseptic
18. *Mycorrhizae* is a symbiotic association between:
 (1) Fungi and roots of higher plants
 (2) Algae and roots of gymnosperms
 (3) Algae and bryophytes
 (4) Algae and fungi
19. Carrot grass/ congress grass (*Parthenium*) exhibit allelopathy by virtue of the production of:
 (1) Alkaloids and glycosides
 (2) Absciscic acid
 (3) Protocaterchuic acid
 (4) Hydrocynic acid and transcinnamic acid
20. Mark the hyperparasite:
 (1) Bacteriophage (2) Bird
 (3) Tapeworm (4) Man
21. Zone of transition, presenting a situation of special ecological interest between two types of communities is called as:
 (1) Eked (2) Ecotype
 (3) Ecotone (4) None of these
22. The relationship between a climber and the host corresponds to:
 (1) Mutualism
 (2) Parasitism
 (3) Neutralism
 (4) Commensalism
23. The protoco-operation is also called as:
 (1) Facultative predation
 (2) Facultative parasitism
 (3) Non-obligatory mutualism
 (4) Non-commensalism
24. Secondary succession occurs on:
 (1) Burnt lands (2) Humus rich soil
 (3) Cut woodlands (4) All of these
25. In any lithosere the pioneer community is:
 (1) Blue green algae (2) Crustose lichen
 (3) Foliose lichens (4) Mosses
26. In a hydrosere, the submerged stage is followed by:
 (1) Sedges (2) Reed-swamps
 (3) Floating plants (4) Phytoplanktons
27. Which of the biomes exhibit distinct stratification into stories ?
 (1) Temperate biome
 (2) Chapparal biome
 (3) Tundra biome
 (4) Tropical rainforest biome
28. A total parasite is nutritionally:
 (1) A photoautotroph
 (2) A chemoautotroph
 (3) A photoheterotroph
 (4) A chemoheterotrophs
29. Which of the following does not show commensalism ?
 (1) Epiphytes growing on a tree
 (2) Rhizobium in Soyabean
 (3) Small fish surviving on the excretes of large fish
 (4) E.coli residing in the intestine of human
30. Which of the following ecological relationship between pairs of organism is different from the other pairs ?
 (1) Fish - Algae (2) Cow - Grass
 (3) Fungus - Wheat (4) Giraffe - Shrub
31. Which of the following statement is correct ?
 (1) Two species within given community can have exactly the same niche.
 (2) Two species within given community cannot have exactly the same niche
 (3) Two species can live permanently together
 (4) Both (2) & (3)
32. Crow also incubates the eggs of:
 (1) Pigeon (2) Dove
 (3) Koel (4) Weaver bird
33. Inhabitation of growth of plants by release of certain chemicals by higher plants is called:
 (1) Antibiosis (2) Allelopathy
 (3) Predation (4) None of these





34. Biotic potential refers to:
 - (1) Increase of population under optimum conditions
 - (2) Increase of population under given conditions
 - (3) Increase of population under natural conditions
 - (4) Increase of population under stress conditions
35. Bee dance is a mode of:
 - (1) Mating
 - (2) Grouping
 - (3) reproduction
 - (4) Communications
36. Which of the following interaction is not a positive interaction ?
 - (1) Flower and pollinator
 - (2) Plant & herbivore
 - (3) Legume plant and N_2 fixing organism
 - (4) Lichen
37. Which of the following is not an example of predation ?
 - (1) Browsing by goats
 - (2) Killing of deer by lion
 - (3) Killing of small fish by shark
 - (4) Ticks on dogs
38. Among the following a partial parasite is:
 - (1) Bacteria
 - (2) Fungi
 - (3) *Viscum*
 - (4) *Cuscuta*
39. Which of the following counter acts biotic potential ?
 - (1) Limitation of food supply
 - (2) Predation
 - (3) Competition
 - (4) All of the above
40. Which of the following is least likely to be true for ecological succession ?
 - (1) The species composition of the community change regularly
 - (2) The total number of species rises initially than stabilises
 - (3) The total non-living material is increases
 - (4) Total biomass is declined after initial stage
41. An area was cleared for road. Road was not constructed and the land was left to overgrow. The process by which the vegetation re-established is called:
 - (1) Primary succession
 - (2) Secondary succession
 - (3) Tertiary succession
 - (4) Regenerative succession
42. External appearance of community is known as:
 - (1) Stratification
 - (2) Physiogamy
 - (3) Physiognomy
 - (4) Diversity
43. Which is not a character of climax community ?
 - (1) Large size
 - (2) Mesophytic
 - (3) Simple food chain
 - (4) Complex organisation
44. When the vegetation of any region reaches at climatic climax it is mostly ?
 - (1) Lithophytic
 - (2) Xerophytic
 - (3) Mesophytic
 - (4) Hydrophytic
45. The sequence: crustose lichen → foliage lichen → masses → shrubs → dicot plant represent:
 - (1) Phylogenetic trend
 - (2) Food pyramid
 - (3) Ecological succession trend
 - (4) Genetic drift
46. If the vegetation of a place is burnt the first one to appear will be:
 - (1) Mosses
 - (2) Lichens
 - (3) Liverwort
 - (4) Ferns
47. Name the term used to describe a single dominant species that dictate community structure:
 - (1) Pioneer species
 - (2) Exogenous species
 - (3) Dominant species
 - (4) Edge species
48. In succession complexities in structure:
 - (1) Increase
 - (2) Decrease
 - (3) Remain constant
 - (4) Initially increase than decrease





49. Which of the following is the keystone species in tropical rain forest ?
 (1) Fig (2) Pinus
 (3) Cycas (4) Fungi
50. Climax community is:
 (1) 1st community
 (2) Unstable community
 (3) Intermediate community
 (4) Last community
51. Primary succession on rocks starts with:
 (1) Herbs (2) Animals
 (3) Lichen (4) Trees
52. The direction of succession:
 (1) Predictable
 (2) Unpredictable
 (3) Haphazard
 (4) Always changing
53. The pioneer in a hydrosere:
 (1) Diatoms (2) Sedges
 (3) Wolffia (4) Lemna
54. No. of species is more at ecotone, this phenomenon is known as:
 (1) Ecotone effect
 (2) Edge effect
 (3) Diversity effect
 (4) All of the above
55. Species which are present at ecotone is known as:
 (1) Ecotone species
 (2) Keystone species
 (3) Link species
 (4) Edge species
56. Pioneer community in xerosere is:
 (1) Foliose lichen
 (2) Moss
 (3) Crustose lichen
 (4) Fern
57. In the process of succession:
 (1) Ecological niche become more specialised
 (2) Diversity decreased
 (3) Complexity decreased
 (4) All of the above
58. The successive developmental stage in succession is known as:
 (1) Pioneer (2) Climax
 (3) Sere (4) All of the above
59. In a population unrestricted reproductive capacity is called as:
 (1) Biotic potential (2) Fertility
 (3) Carrying capacity (4) Birth rate
60. What is true for individuals of same species ?
 (1) Live in same niche
 (2) Live in same habitat
 (3) Interbreeding
 (4) Live in different habitat
61. Which of the following is predator ?
 (1) Cow (2) Bird (3) Insect (4) All
62. The community which starts succession at a place is termed:
 (1) Climax community
 (2) Seral community
 (3) Pioneer community
 (4) Primary community
63. In plant succession last community is called:
 (1) Ecotone
 (2) Climax community
 (3) Seral community
 (4) Ecosystem
64. Stable plant community formed during succession is called:
 (1) Sere community
 (2) Climax community
 (3) Dominant community
 (4) Ecotone
65. Succession in a water body leads to formation of:
 (1) Mesophytic vegetation
 (2) Xerophytic vegetation
 (3) Halophytic vegetation
 (4) Epiphytic vegetation
66. Which of the following is the smallest parasite ?
 (1) Lemna (2) Arceuthobium
 (3) Spirodella (4) Wolffia





67. Temperate evergreen forests in India found in:
 (1) Himalaya (2) W. Bengal
 (3) Andman (4) Rajasthan
68. Find the odd one out:
 (1) Lianas in tropical rain forest
 (2) E. coli in large intestine of man
 (3) Pilot fish Remora and shark
 (4) Rafflesia on roots of forest tree
69. One of the following is hemi-parasite:
 (1) Viscum (2) Cuscuta
 (3) Rafflesia (4) Monotropa
70. The species which are present in large number and have large size are called:
 (1) Ecological equivalent
 (2) Ecological dominants
 (3) Link species
 (4) Key stone species

Demography

71. Complete the following equation by putting one of the following option respectively. For constant size population: Birth + = Death +
 (1) Emigration, immigration,
 (2) Immigration, emigration
 (3) Emigration, population density
 (4) Immigration, population density
72. Which of the following set of value would result in a population with a growth rate of zero?
 b = birth d = death
 i = immigration e = emigration
 (1) b = 1000 d = 500 i = 750 e = 1000
 (2) b = 1000 d = 500 i = 1000 e = 1000
 (3) b = 1000 d = 500 i = 1500 e = 1000
 (4) b = 1000 d = 500 i = 500 e = 1000
73. The population of a place tends to increase when:
 (1) Predation increases
 (2) Emigration occur
 (3) Immigration occur
 (4) Reproductivity decrease

74. Which of the following are characteristic feature of population?
 (1) Birth rate (2) Death rate
 (3) Sex ratio (4) All of the above
75. The carrying capacity of a population mean:
 (1) The rate at which the density of individual increase over time
 (2) The maximum number of individual which can be supported in a given environment
 (3) The proportion of individual which are most responsible for population growth
 (4) The minimum number of individual necessary to avoid extinction
76. The most important factor regulating seasonal migration is:
 (1) Change in air temperature
 (2) Change in day length
 (3) Increased parasite pressure
 (4) Increased predator pressure
77. The actual rate of growth of population is the difference between the:
 (1) Number of adult and number of new born
 (2) Size last year minus death rate
 (3) Number of breeding and non-breeding individual
 (4) Birth rate & Death rate
78. Which equation shows logistic growth?
 (1) $dN/dt = rN \left(\frac{K - N}{K} \right)$
 (2) $dN/dt = rN$
 (3) $dN/dt = rN(1 + N/K)$
 (4) $N_t = N_0 e^{rt}$
79. The number of individual in reproductive age is more than pre-reproductive phase in:
 (1) Declining population
 (2) Stable population
 (3) Expanding population
 (4) None
80. Which equation shows exponential growth?
 (1) $dN/dt = -rN$
 (2) $dN/dt = rN$
 (3) $dN/dt = rN \left(\frac{K - N}{K} \right)$
 (4) $dN/dt = rN \left(\frac{K + N}{K} \right)$



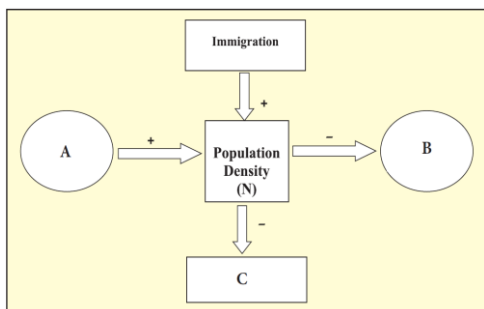


- 81.** J-shaped curve is formed in:
 (1) Logistic growth
 (2) Exponential growth
 (3) Limited growth
 (4) 2 & 3 Both
- 82.** S-shaped growth curve is obtained in:
 (1) Logistic growth
 (2) Exponential growth
 (3) Limited growth
 (4) 1 & 2 Both
- 83.** Proportion of young individual is highest in:
 (1) Declining population
 (2) Stable population
 (3) 1 & 2 Both
 (4) Expanding population
- 84.** When a population reaches up to carrying capacity of environment than ?
 (1) Mortality rate = Birth rate
 (2) Mortality rate > Birth rate
 (3) Mortality rate < Birth rate
 (4) None of the above
- 85.** An Urn shaped population age pyramid represents:
 (1) Growing population
 (2) Static population
 (3) Declining population
 (4) Threatened population
- 86.** Ability of an environment to support a population is called its:
 (1) Biotic potential
 (2) Purifying capacity
 (3) Carrying capacity
 (4) Environmental resistance
- 87.** The equation for J-shaped population growth curve:
 (1) $\frac{dN}{dt} = rN$
 (2) $\frac{dN}{dt} = rN \left(\frac{K - N}{K} \right)$
 (3) $N_t = N_0 + B + I - D - E$
 (4) $D = \frac{N}{S}$
- 88.** In the equation for S-shaped population growth $\frac{dN}{dt} = rN \left(\frac{K - N}{K} \right)$, r represents:
 (1) Carrying capacity
 (2) Environmental resistance
 (3) Intrinsic growth rate
 (4) Population size
- 89.** Which is not true for J-shaped growth curve?
 (1) Exponential phase is prolonged
 (2) Population never grows beyond carrying capacity
 (3) Population crash occurs
 (4) Population seldom reaches equilibrium
- 90.** The exponential increase in insect populations during rains is finally controlled by:
 (1) Environmental stress
 (2) Reproductive potential
 (3) Growth rate
 (4) Carrying capacity
- 91.** Which statement is not related to S-shaped populations curve ?
 (1) Environmental resistance suddenly becomes effective
 (2) Exponential phase is followed by decline phase
 (3) Mass mortality and population crash occurs
 (4) Both (1) & (3)
- 92.** July 11 is observed as:
 (1) World population Day
 (2) No Tobacco Day
 (3) World Environment Day
 (4) World Health Day
- 93.** The age pyramid with broad base indicates:-
 (1) High percentage of young individuals
 (2) Low percentage of young individuals
 (3) High percentage of old individuals
 (4) Low percentage of old individuals
- 94.** In a decline population of a country
 (1) Number of pre-reproductive is more than reproductive.
 (2) Number of pre-reproductive is less than reproductive
 (3) Number of pre-reproductive is equal to reproductive
 (4) Reproductive are less than post reproductive.





95. In the diagram given below, which of the following option correctly represents A, B and C.



- (1) A = Death rate, B = Birth rate, C = Emigration
 (2) A = Birth rate, B = Death rate, C = Emigration
 (3) A = Emigration, B = Death rate, C = Birth rate
 (4) A = Death rate, B = Emigration, C = Birth rate
96. Which of the following equation is/are correct for the population density (N) at time $t + 1$?
 N = density at time 't'
 B = Natality
 D = Mortality
 I = Immigration
 E = Emigration
 (A) $N = N + [(B + I) - (D + E)]$
 (B) $N = N + [(B - D) + (I - E)]$
 (C) $N = N + [(B + I) + (D + E)]$
 (D) $N = N - [(B - D) + (I - E)]$
 (1) Only A
 (2) Only A and B
 (3) Only C
 (4) A, B, C and D
97. In a population there are higher number of reproductive individuals, moderate number of reproductive individuals are present. This type of population represents: -
 (1) Population of developed countries

- (2) Population of developing country
 (3) Stable growth
 (4) Declining population

98. In a new habitat which is just being colonised which will play significant role in population growth:-

- (1) Birth rate (2) Emigration
 (3) Migration (4) Immigration

99. In a population birth rate is 0.15 and death rate is 0.08 during a unit time period. What is the value of (intrinsic rate of natural increase) for given population ?

- (1) 0.23 (2) 0.07 (3) 0.05 (4) 0.25

100. A population has more young individuals, compared to older individuals. What would be the status of the population after some years:

- (1) It will decline
 (2) It will stabilize
 (3) It will past decline and then stabilize
 (4) It will increase

101. In a month of January Siberian cranes migrate from Russia to India for breeding, a survey was done

- Till December total population of Siberian cranes = 1200
- Birth rate = 400
- Mortality rate = 200
- Number of cranes immigrated = 600
- Number of cranes emigrated = 300

Calculate the total population

- (1) 1500 (2) 1000 (3) 2000 (4) 1700

102. If a population of 50 Paramecium present in a pool increase to 150 after an hour, what would be the growth rate of population?

- (1) 50 per hour (2) 200 per hour
 (3) 5 per hour (4) 100 per hour




EXERCISE – II

1. Autecology includes the study of:
 - (1) An organism
 - (2) A population
 - (3) A Species
 - (4) All of the above
2. Phytoplanktons are mainly found in:
 - (1) Littoral zone (2) Limnetic zone
 - (3) Profundal zone (4) Benthic zone
3. Velamen tissue is found in:
 - (1) Mesophytes (2) Epiphytes
 - (3) Hydrophytes (4) Xerophytes
4. The term synecology may relate to study of:
 - (1) Plant community
 - (2) Individual organism
 - (3) Environment
 - (4) Soil form
5. Autecology refers to:
 - (1) Plant ecology
 - (2) Animal ecology
 - (3) Ecological study of individual species
 - (4) Ecological study of group of species, which is grown together
6. More than 70% of world's fresh water is contained in:
 - (1) Antarctica
 - (2) Polar ice
 - (3) Glaciers and Mountains
 - (4) Greenland
7. Basic unit of ecological study is:
 - (1) Organism (2) Species
 - (3) Population (4) Ecosystem
8. The different organisms inhabiting a common environment belongs to the same:
 - (1) Species (2) Genus
 - (3) Population (4) Community
9. 'Edge effect' refers to:
 - (1) Occurrence of ecophenes and ecotypes in a community
 - (2) Low diversity of organisms in ecotone
 - (3) High diversity of organisms in ecotone
 - (4) Defence of territories by organisms
10. Which one of the following is a matching pair of certain organism(s) and the kind of association?
 - (1) Shark and sucker fish-commensalism
 - (2) Algae and fungi in lichens-mutualism
 - (3) Orchids growing on trees-parasitism
 - (4) Cuscuta (dodder) growing on other flowering plants-epiphytism
11. The plant having the largest flower is:
 - (1) Total stem parasite
 - (2) Epiphyte
 - (3) Total root parasite
 - (4) Partial stem parasite
12. What will happen if the number of organism increased at a place ?
 - (1) Inter species competition
 - (2) Intra species competition
 - (3) Both
 - (4) None
13. What is a keystone species ?
 - (1) A common species that has plenty of biomass, yet has fairly low impact on the community's organization
 - (2) A rare species that has minimal impact on the biomass and on other species in the community
 - (3) A dominant species that constitutes a large proportion of the biomass and which effects many other species
 - (4) A species which makes up only a small proportion of the total biomass of a community, yet has a huge impact on the community's organization and survival
14. Lichens are well known combination of an algae and a fungus where fungus has:
 - (1) An epiphytic relationship with the alga
 - (2) A parasitic relationship with the alga
 - (3) A symbiotic relationship with the alga
 - (4) A saprophytic relationship with the alga

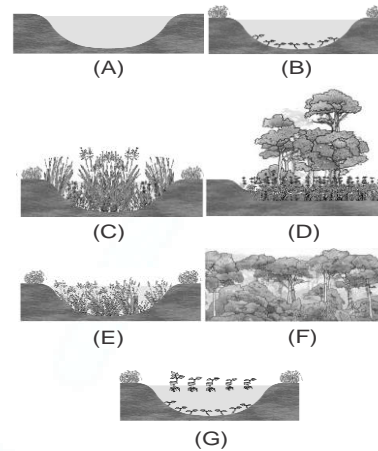




15. Select **incorrect** statement about predators:
- (1) Predators are prudent in nature
 - (2) Predators are responsible for their prey species extinction.
 - (3) Predators maintains species diversity of their prey species.
 - (4) Predators regulates relative abundance of their prey species.

16. Key stone species of community:
- (A) Regulate species diversity of community
 - (B) Regulates relative abundance of species in community
 - (C) Connects the two individuals of different species
 - (D) Are always predators
- (1) A, B, C, D (2) A, B
- (3) C, D (4) A, B, D

17. Arrange the following diagram in their correct order of successional events:



- (1) A→B→C→D→E→F→G
- (2) A→C→D→B→E→F→G
- (3) A→B→G→E→C→D→F
- (4) A→D→E→F→G→C→B




EXERCISE – III (PREVIOUS YEAR QUESTIONS)
[AIPMT-2005]

1. Which of the following is not **true** for a species ?
- (1) Members of a species can interbreed
 - (2) Gene flow does not occur between the populations of a species
 - (3) Each species is reproductively isolated from every other species
 - (4) Variations occur among members of a species

[AIPMT-2006]

2. Niche overlap indicates:
- (1) Sharing of one or more resources between the two species
 - (2) Mutualism between two species
 - (3) Active cooperation between two species
 - (4) Two different parasites on the same host

[AIPMT-2007]

3. A high density of elephant population in an area can result in:
- (1) Predation on one another
 - (2) Mutualism
 - (3) Intra specific competition
 - (4) Inter specific competition

[AIPMT-2008]

4. The table below gives the populations (in thousands) of ten species (A – J) in four areas (a – d) consisting of the number of habitats given within brackets against each. Study the table and answer the question which follows -

Area and Number of habitats	Species and their populations (in thousands) in the areas									
	A	B	C	D	E	F	G	H	I	J
a (11)	2	1.2	0.52	6	-	3.1	1.1	9	-	10.3
b (11)	10	-	0.62	-	1.5	3	-	8.2	1.1	11.2
c (13)	11	0.9	0.48	2.4	1.4	4.2	0.8	8.4	2.2	4.1
d (12)	3	10.2	11.1	4.8	0.4	3.3	0.8	7.3	11.3	2.1

Which area out of a to d shows maximum species diversity ?

- (1) d
- (2) a
- (3) b
- (4) c

[AIPMT-2009]

5. The correct sequence of plants in a hydrosere is:
- (1) Oak → Lantana → Volvox → Hydrilla → Hydrilla → Pistia → Scirpus
 - (2) Oak → Lantana → Scirpus → Pistia → Hydrilla → Volvox
 - (3) Volvox → Hydrilla → Pistia → Scirpus → Lantana → Oak
 - (4) Pistia → Volvox → Scirpus → Hydrilla → Oak → Lantana

[Pre-AIPMT-2010]

6. Which one of the following is one of the characteristics of a biological community?
- (1) Stratification
 - (2) Natality
 - (3) Mortality
 - (4) Sex-ratio

[Mains-AIPMT-2010]

7. Which one of the following is *most appropriately* defined ?
- (1) *Amensalism* is a relationship in which one species is benefited whereas the other is unaffected
 - (2) *Predator* is an organism that catches and kills other organism for food.
 - (3) *Parasite* is an organism which always lives inside the body of other organism and may kill it.
 - (4) *Host* is an organism which provides food to another organism.

[Mains-AIPMT-2011]

8. Both, hydrarch and xerarch successions lead to:
- (1) Excessive wet conditions
 - (2) Medium water conditions
 - (3) Xeric conditions
 - (4) Highly dry conditions

[AIIMS-2011]

9. Monarch butterfly escapes from predators by ?
- (1) Foul smell
 - (2) Bitter taste
 - (3) Colour combination
 - (4) Rough skin





[Pre-AIPMT-2011]

10. Which one of the following statements is correct for secondary succession ?
 (1) It is similar to primary succession except that it has a relatively fast pace.
 (2) It begins on a bare rock.
 (3) It occurs on deforested site
 (4) It follows primary succession
11. Which one of the following is categorised as a parasite in **true sense** ?
 (1) The cuckoo (koel) lays its eggs in crow's nest
 (2) The female anopheles bites and sucks blood from humans
 (3) Human foetus developing inside the uterus draws nourishment from the mother
 (4) Head louse living on the human scalp as well as laying eggs on human hair
12. Large Woody Vines are more commonly found in:
 (1) Alpine forests
 (2) Temperate forests
 (3) Mangroves
 (4) Tropical rainforests

[RPMT-2011]

13. Browsing by animals is an example of:
 (1) Parasitism (2) Predation
 (3) Commensalism (4) Ferns
14. Intermediate community between Pioneer and Climax communities is called:
 (1) Seral community
 (2) Biotic community
 (3) Temporary community
 (4) Ecosere

[Mains-AIPMT-2012]

15. The second stage of hydrosere is occupied by plants like:
 (1) Salix (2) Vallisneria
 (3) Azolla (4) Typha
16. *Cuscuta* is an example of:
 (1) Predation
 (2) Endoparasitism
 (3) Ectoparasitism
 (4) Brood parasitism

[NEET UG-2013]

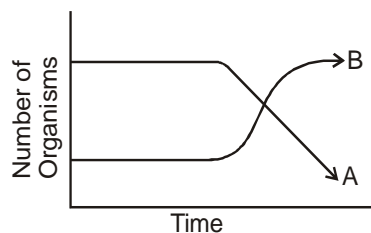
17. A sedentary sea anemone gets attached to the shell lining of hermit crab. The association is:
 (1) Amensalism (2) Ectoparasitism
 (3) Symbiosis (4) Commensalism

[AIIMS-2014]

18. Which of the following is an example of mutualism ?
 (1) Worm in intestine
 (2) Fig and wasp
 (3) Barnacle on whale
 (4) Sea anemone and clown fish

[AIPMT-2015]

19. Vertical distribution of different species occupying different levels in a biotic community is known as:
 (1) Stratification (2) Zonation
 (3) Pyramid (4) Divergence
20. Secondary Succession takes place on/in:
 (1) Degraded forest
 (2) Newly created pond
 (3) Newly cooled lava
 (4) Bare rock
21. The following graph depicts changes in two populations (A and B) of herbivores in a grassy field. A possible reason for these changes is that:



- (1) Population B competed more successfully for food than population A
 (2) Population A produced more offspring than population B
 (3) Population A consumed the members of population B
 (4) Both plant populations in this habitat decreased




[Re-AIPMT-2015]

22. An association of individuals of different species living in the same habitat and having functional interactions is:
- (1) Population (2) Ecological niche
(3) Biotic community (4) Ecosystem
23. In which of the following interactions both partners are adversely affected ?
- (1) Mutation (2) Competition
(3) Predation (4) Parasitism
24. During ecological succession:
- (1) The changes lead to a community that is in near equilibrium with the environment and is called pioneer community
(2) The gradual and predictable change in species composition occurs in a given area
(3) The establishment of a new biotic community is very fast in its primary phase
(4) The numbers and types of animals remain constant
25. The species confined to a particular region and not found elsewhere is termed as:
- (1) Rare (2) Keystone
(3) Alien (4) Endemic

[NEET-I 2016]

26. Which of the following is correct for r-selected species ?
- (1) Large number of offspring's, of small size
(2) Large number of offspring's, of large size
(3) Small number of offspring's, of small size
(4) Small number of offspring's, of large size
27. If '+' indicates beneficial interaction, '-' indicates harmful interaction and '0' indicates neutral interaction, then population showing '+' '-' interactions indicates:
- (1) Mutualism (2) Amensalism
(3) Symbiosis (4) Parasitism
28. Which of the following would appear as the pioneer organisms on bare rocks ?
- (1) Lichens (2) Liverworts
(3) Mosses (4) Green algae

[NEET-II 2016]

29. Gause's principle of competitive exclusion states that:
- (1) More abundant species will exclude the less abundant species through competition.
(2) Competition for the same resources excludes species having different food preferences.
(3) No two species can occupy the same niche indefinitely for the same limiting resources.
(4) Larger organisms exclude smaller ones through competition

[NEET-2017]

30. Presence of plants arranged into well defined vertical layers depending on their height can be seen best in:
- (1) Tropical Savanah
(2) Tropical Rain Forest
(3) Grassland
(4) Temperate Forest
31. Mycorrhizae are the example of:
- (1) Fungusitasis (2) Amensalism
(3) Antibiosis (4) Mutualism

[NEET-2018]

32. Niche is:
- (1) The functional role played by the organism where it lives
(2) All the biological factors in the organism environment
(3) The range of temperature that the organism needs to live
(4) The physical space where an organism live
33. Which one of the following population interactions is widely used in medical science for the production of antibiotics ?
- (1) Amensalism
(2) Commensalism
(3) Parasitism
(4) Mutualism
34. Which one of the following plants shows a very close relationship with a species of moth, where none of the two can complete its life cycle without the other ?
- (1) Viola (2) Hydrilla
(3) Banana (4) Yucca





35. Which of the following flowers only once in its life-time ?
 (1) Papaya (2) Bamboo species
 (3) Mango (4) Jackfruit

[NEET-2019]

36. Match **Column-I** with **Column-II**.

	Column-I		Column-II
(a)	Saprophyte	(i)	Symbiotic association of fungi with plant roots
(b)	Parasite	(ii)	Decomposition of dead organic materials
(c)	Lichens	(iii)	Living on living plants or animals
(d)	Mycorrhiza	(iv)	Symbiotic association of algae and fungi

Choose the **correct** answer form the options given below.

- | | | | |
|-----------|-------|-------|------|
| (a) | (b) | (c) | (d) |
| (1) (ii) | (i) | (iii) | (iv) |
| (2) (ii) | (iii) | (iv) | (i) |
| (3) (i) | (ii) | (ii) | (iv) |
| (4) (iii) | (ii) | (i) | (iv) |

[NEET (Odisha) -2019]

37. Carnivorous animals-lions and leopards, occupy the same niche but lions predate mostly larger animals and leopards take smaller ones. This mechanism of competition is referred to as:-
 (1) Character displacement
 (2) Altruism
 (3) Resource partitioning
 (4) Competitive exclusion
38. Western Ghats have a large number of plant and animal species that are not found anywhere else. Which of the following terms will you use to notify such species?
 (1) Endemic (2) Vulnerable
 (3) Threatened (4) Keystone
39. Between which among the following, the relationship is not an example of commensalism?
 (1) Orchid and the tree on which it grows
 (2) Cattle Egret and grazing cattle
 (3) Sea Anemone and Clown fish
 (4) Female wasp and fig species

[NEET-2010 (Covid-19)]

40. Match the items in Column-I with those in Column-II

Column I

Column II

- | | |
|-----------------------|------------------|
| (a) Herbivores-Plants | (i) Commensalism |
| (b) Mycorrhiza-Plants | (ii) Mutualism |
| (c) Sheep-Cattle | (iv) Predation |
| (d) Orchid-Tree | (v) Competition |

Select the correct option form following:

- (1) (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)
 (2) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)
 (3) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)
 (4) (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

[NEET-2021]

41. Inspite of interspecific competition in nature, which mechanism the competing species might have evolved for their survival ?
 (1) resource partitioning
 (2) Competitive release
 (3) Mutualism
 (4) Predation
42. Amensalism can be represented as:
 (1) Species A (-); Species B (0)
 (2) Species A (+); Species B (+)
 (3) Species A (-); Species B (-)
 (4) Species A (+); Species B (0)
43. The amount of nutrients, such as carbon, nitrogen, phosphorus and calcium present in the soil at any given time, is referred as:
 (1) Climax
 (2) Climax community
 (3) Standing state
 (4) Standing crop

[NEET-2022]

44. Which one of the following statements cannot be connected to Predation?
 (1) It helps in maintaining species diversity in community
 (2) It might lead to extinction of a species
 (3) Both the interacting species are negatively impacted
 (4) It is necessitated by nature to maintain the ecological balance





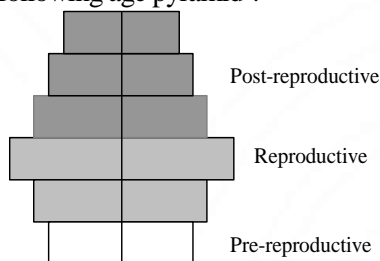
45. While explaining interspecific interaction of population, (+) sign is assigned for beneficial interaction, (−) sign is assigned for detrimental interaction and (0) for neutral interaction. Which of the following interactions can be assigned (+) for one species and (−) for another species involved in the interaction?

(1) Predation (2) Amensalism
(3) Commensalism (4) Competition

Demography

[Pre-AIPMT 2011]

46. What type of human population is represented by the following age pyramid?



(1) Expanding population
(2) Vanishing population
(3) Stable population
(4) Declining population

[Mains-AIPMT 2011]

47. The logistic population growth is expressed by the equation :

(1) $\frac{dN}{dt} = rN \left(\frac{N - K}{N} \right)$
(2) $\frac{dt}{dN} = Nr \left(\frac{N - K}{K} \right)$
(3) $\frac{dN}{dt} = rN \left(\frac{K - N}{K} \right)$
(4) $\frac{dN}{dt} = rN$

[NEET-2017]

48. Asymptote in a logistic growth curve is obtained when:

(1) The value of 'r' approaches zero
(2) $K = N$
(3) $K > N$
(4) $K < N$

[NEET-2018]

49. In a growing population of a country.
(1) Pre-reproductive individuals are less than the reproductive individuals.
(2) Pre-reproductive individuals are more than the reproductive individuals.
(3) Reproductive and pre-reproductive individuals are equal in number.
(4) Reproductive individuals are less than the post reproductive individuals.

50. Natality refers to:

(1) Number of individuals entering a habitat
(2) Death rate
(3) Number of individuals leaving the habitat
(4) Birth rate

[NEET-2020]

51. Which of the following is not an attribute of a population?

(1) Species interaction
(2) Sex ratio
(3) Natality
(4) Mortality

[NEET-2020(Covid-19)]

52. The impact of immigration on population density is:-

(1) Negative
(2) Both positive and negative
(3) Neutralized by natality
(4) Positive

[NEET-2021]

53. In the exponential growth equation $N_t = N_0 e^{rt}$, e represents:

(1) The base of number logarithms
(2) The base of exponential logarithms
(3) The base of natural logarithms
(4) The base of geometric logarithms





ANSWER KEY

EXERCISE – I

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	3	2	2	3	1	3	3	2	1	1	2	4	2	3
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	3	1	4	1	3	4	3	4	2	3	4	4	2	3
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	3	2	1	4	2	4	3	4	4	2	3	3	3	3
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	3	1	1	4	3	1	1	2	4	3	1	3	1	3
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	4	3	2	2	1	2	1	4	1	2	2	4	3	4	2
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	2	4	1	1	2	2	1	4	1	3	3	1	3	2	1
Que.	91	92	93	94	95	96	97	98	99	100	101	102			
Ans.	4	1	1	2	2	2	2	4	2	4	4	4			

EXERCISE – II

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	2	2	2	3	2	1	4	3	2	3	3	4	3	2
Que.	16	17													
Ans.	2	3													

EXERCISE – III

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	1	3	1	3	1	2	2	2	3	4	4	2	1	2
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	4	2	1	1	1	3	2	2	4	1	4	1	3	2
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	1	1	4	2	2	3	1	4	2	1	1	3	3	1
Que.	46	47	48	49	50	51	52	53							
Ans.	4	3	2	2	4	1	4	3							

