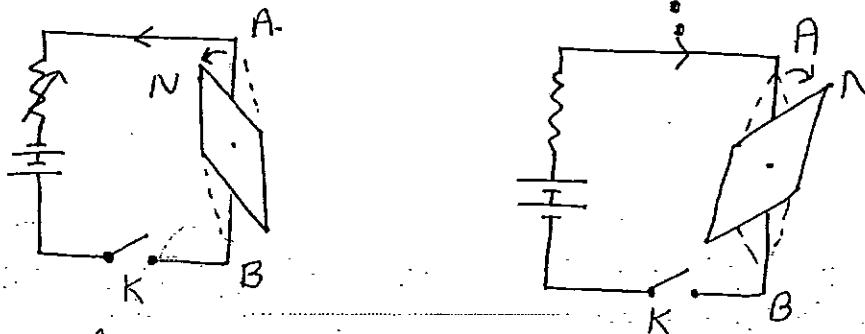


Magnetic effects of current

Oersted's experiment →



- (i) When sufficient current was allowed to pass through a wire AB placed along the axis of a magnetic needle kept directly below and close to the wire, the needle was found to deflect from its normal position.
- (ii) The deflection of the needle was found to be in the opposite direction on reversing the direction of the current by reversing the polarity of the battery.

Ampere's swimming rule → Imagine a man who swims along the conductor in the direction of current facing the needle such that current enters his feet then North of the needle will deflect towards his left hand.

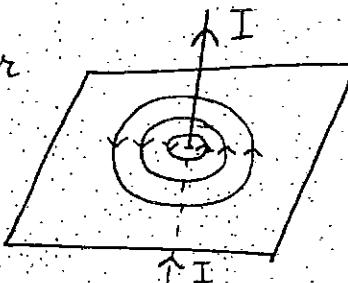
* This is also known as SNOW
i.e. current flows from South to North in a wire kept over the needle, North pole deflects towards West.

Magnetic field → The space or region around the current carrying conductor within which its influence can be felt by the magnetic needle is called the strength of magnetic field (B) of the current carrying conductor. It is also called magnetic field or magnetic induction.

Superposition Principle → Net magnetic field strength \vec{B} of many sources at a point is given by

$$\vec{B} = \vec{B}_1 + \vec{B}_2 + \vec{B}_3 + \dots$$

Magnetic field near the conductor is stronger & becomes weaker with distance



Magnetic field around a current carrying conductor

Direction of magnetic field → Direction of magnetic field is given by

Maxwell's cork screw rule or right hand thumb rule.

Lorentz force → When a charged particle having charge q moves in a region, where both electric field \vec{E} and magnetic field \vec{B} exist, it experiences a net force called Lorentz force (\vec{F}).

$$\begin{aligned}\vec{F} &= \vec{F}_e + \vec{F}_m \\ &= q\vec{E} + q(\vec{v} \times \vec{B})\end{aligned}$$

Here $\vec{F}_m = q(\vec{V} \times \vec{B})$ is magnetic force

$\vec{F}_m = 0$ when \vec{V} & \vec{B} are parallel or antiparallel i.e. $\theta = 0^\circ$ or 180°

$F_m = qVB$ when \vec{V} & \vec{B} are perpendicular to each other i.e. $\theta = 90^\circ$

Definition of magnetic field $\rightarrow \vec{F}_m = q(\vec{V} \times \vec{B})$

$$\text{or } F_m = qVB \sin\theta \text{ or } B = \frac{F_m}{qV \sin\theta}$$

Magnetic field at a point may be defined as the magnetic force experienced by a unit charge moving with unit velocity at right angle to the magnetic field.

Magnetic force on a current carrying conductor placed in uniform magnetic field \rightarrow

Let us consider a conductor of length l carrying a current (I) placed in a uniform magnetic field \vec{B} .

Let n = Number of free electrons per unit volume

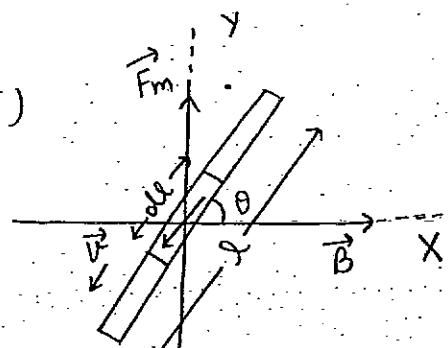
& A = Area of cross-section of conductor

Magnetic Lorentz force is given by

$$\vec{f}_m = -e(\vec{V} \times \vec{B}) \quad (\text{For electron})$$

No. of electrons in element = $nA dl$

$$\therefore d\vec{f}_m = -neA dl(\vec{V} \times \vec{B})$$



$$\text{Now } \vec{V} = \frac{d\vec{l}}{dt} \Rightarrow d\vec{F}_m = (nAdl)e \left(\frac{d\vec{l}}{dt} \times \vec{B} \right)$$

$$\text{Now } nAdl e = I$$

$$\Rightarrow d\vec{F}_m = nAdl \vec{F}_m = I(\vec{dl} \times \vec{B})$$

$$\text{Now } \vec{F}_m = \int d\vec{F}_m = I(\vec{l} \times \vec{B})$$

$$F_m = BIl \sin\theta$$

(i) If $\theta = 0^\circ$ or 180° , $F_m = 0$

(ii) If $\theta = 90^\circ$, $F_m = BIl$ (maximum)

Direction of Lorentz force is given by
Fleming's left hand rule.

Charged particle in electric field

Force on charge q

$$\text{is } \vec{F} = q\vec{E}$$

$$\& \vec{a} = \frac{\vec{F}}{m} \text{ or } \vec{a} = \frac{q\vec{E}}{m}$$

$$\text{Now } S_x = u_x t + \frac{1}{2} a_x t^2$$

$$a_x = 0, u_x = v$$

$$S_x = x = vt \text{ or } t = x/v$$

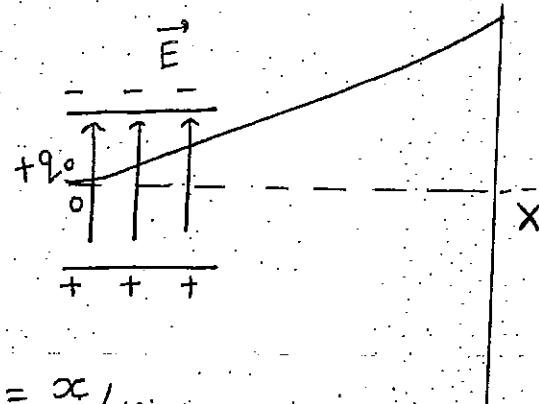
$$S_y = u_y t + \frac{1}{2} a_y t^2$$

$$a_y = \frac{qE}{m}, u_y = 0$$

$$\Rightarrow S_y = y = \frac{1}{2} \left(\frac{qE}{m} \right) t^2$$

$$y = \frac{1}{2} \left(\frac{qE}{m} \right) \frac{x^2}{v^2} \quad \left\{ K = \frac{qE}{2mv^2} \right\}$$

$$\text{or } y = Kx^2 \text{ (Parabolic)}$$



Charged particle moving in a uniform magnetic field

- Case I If motion of charged particle is parallel or antiparallel to the magnetic field, moving charged particle does not experience any force.
- Case II When charged particle moves at right angle to the magnetic field

Force acting on charge $+q$ is given by

$$\vec{F} = q(\vec{v} \times \vec{B})$$

$$\text{or } F = qvB \sin\theta$$

$$\text{If } \theta = 90^\circ, F = qvB$$

Now if force is perpendicular to the direction of motion of particle, the path of charged particle is circular.

This centripetal force is provided by magnetic Lorentz force, $F = qvB$

$$\text{Now } \frac{mv^2}{r} = qvB$$

$$\Rightarrow \text{Radius of circular path } r = \frac{mv}{qB}$$

$$\text{or } r = \frac{v}{(q/m)B}$$

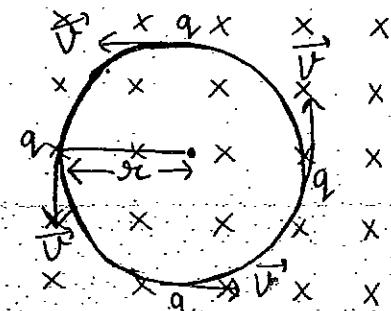
Time period of charged particle is given by $T = \frac{2\pi r}{v} = \frac{2\pi}{v} \times \frac{mv}{qB}$

$$\text{or } T = \frac{2\pi m}{qB}$$

Frequency of charged particle

$$f = \frac{1}{T} = \frac{qB}{2\pi m}$$

$$\& \omega = 2\pi f = \frac{qB}{m} = \text{angular (gyro) freq.}$$

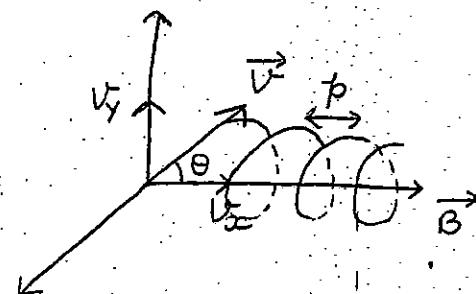


Case III

When the charged particle moves at an angle to the magnetic field (other than $0^\circ, 90^\circ$ & 180°)

$$v_x = v \cos \theta, v_y = v \sin \theta$$

centripetal force required to move the particle in a circle is provided by the magnetic Lorentz force.



$$\frac{m(v \sin \theta)^2}{r} = q(v \sin \theta) B \sin \theta = qVB \sin^2 \theta$$

$$\Rightarrow \text{radius } r = \frac{mv \sin \theta}{qB}$$

Time period of the particle

$$T = \frac{2\pi r}{v \sin \theta} = \frac{2\pi}{v \sin \theta} \times \frac{mv \sin \theta}{qB}$$

$$\text{or. } T = \frac{2\pi m}{qB}$$

$$\therefore \text{Frequency } \nu = \frac{1}{T} = \frac{qB}{2\pi m}$$

* Time period is independent of velocity of charged particle.

Pitch \rightarrow It is linear distance travelled by the charged particle in one rotation
It is called pitch of helix (helical path).

$$\text{pitch, } p = (v \cos \theta) \cdot T$$

$$= v \cos \theta \times \frac{2\pi m}{qB}$$

$$\text{or } p = \frac{2\pi m v \cos \theta}{qB}$$

* Frequency is independent of velocity of charged particle.

Cyclotron → It is a device used to accelerate positively charged particles to acquire enough energy to carry out nuclear disintegrations.

Principle → When a positively charged particle is made to move time & again in a high frequency electric field and using strong magnetic field, it gets accelerated & acquires sufficiently large energy.

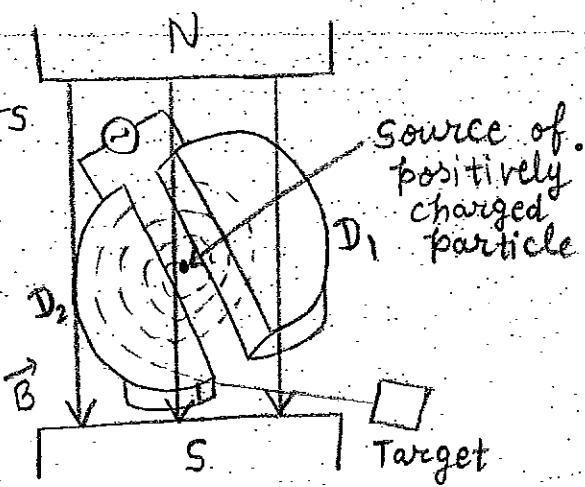
Construction → It consists of two hollow

D-shaped metallic chambers D_1 & D_2 called dees.

These dees are separated by a small gap where a source of positively charged particles is placed.

Dees are connected to high frequency oscillator, which provides high frequency electric field across the gap of dees. This arrangement is placed between two pole pieces of a strong electromagnet.

Working → If a positively charged particle is emitted from source, when dee D_2 is negatively charged and dee D_1 is positively charged, it will accelerate towards D_2 . As soon as it enters D_2 , it describes a semi-circle inside it. As soon as it enters the gap, polarities of dees get reversed so the proton gets accelerated towards D_1 & again describes a semi-circle due to magnetic field.



This process continues and every time the radius of circular path increases till the proton reaches the external boundary of the dee system. Then proton gets deflected towards the target.

Theory → Lorentz force acting on positively charged particle (e.g. proton) is given by

$$F = qvB = \frac{mv^2}{r}$$

$$\text{or } r = \frac{mv}{qB}$$

Now t = time to cover semicircle

$$\therefore t = \frac{\pi r}{v} = \frac{\pi}{v} \left(\frac{mv}{qB} \right) = \frac{\pi m}{qB}$$

If T is the time period then

$$\frac{T}{2} = t = \frac{\pi m}{qB}$$

$$\text{or } T = \frac{2\pi m}{qB}$$

$$\& \nu_c = \frac{1}{T} = \frac{qB}{2\pi m} \quad \text{or } \omega_c = \frac{qB}{m}$$

Energy gained, $E = \frac{1}{2} mv^2$, $v = \frac{qBr}{m}$

$$\text{or } E = \frac{1}{2} m \frac{q^2 B^2 r^2}{m^2} = \frac{q^2 B^2 r^2}{2m}$$

$$E_{\max} = \frac{q^2 B^2 r_{\max}^2}{2m}$$

uses of cyclotron → (i) In nuclear reactions

(ii) Radio active materials production for medical purposes (iii) To synthesise substances

Limitations of cyclotron

(i) It can not accelerate uncharged particles like neutrons.

- (ii) It can not accelerate electrons due to small mass.
- (iii) charged particle can be accelerated only upto a certain limit. When speed becomes comparable to speed of light, the mass of ion increases as $m = \frac{m_0}{\sqrt{1-v^2/c^2}}$

So the time taken also gets changed and it will be out of step with freq. of the oscillator and further acceleration will not be there.

* Resonance condition → When freq. of oscillating field matches with the frequency of oscillation of charged particle then this is known as resonance condition. That frequency is known as magnetic resonance frequency.

* Functions of electric & magnetic field in cyclotron

Electric field accelerates the charged particle in between the dees of cyclotron.
Magnetic field enables the charged particle to move in a circular path inside the dees to enter the gap between the dees for further acceleration due to electric field.

Since the charged particle moves in a circular path in the magnetic field, so its motion is accelerated. Thus, both electric and magnetic fields accelerate the charged particle in cyclotron.

Biot Savart's law \rightarrow It is used to determine the strength of the magnetic field at any point due to a current carrying conductor.

- Consider a small current element $d\vec{l}$ of a conductor carrying current I .

The strength of magnetic field $d\vec{B}$ due to this small current element $d\vec{l}$ at point P at distance r is given by

$$|d\vec{B}| \propto d\vec{l}$$

$$\propto I$$

$$\propto \sin\theta$$

$$\propto \frac{1}{r^2}$$

$$d\vec{B} \propto \frac{I d\vec{l} \sin\theta}{r^2} \quad \text{or} \quad d\vec{B} = \frac{\kappa I d\vec{l} \sin\theta}{r^2}$$

$$\text{Here } \kappa = \frac{\mu_0}{4\pi} \quad \mu_0 = 4\pi \times 10^{-7} \text{ T m/A}$$

$$\Rightarrow d\vec{B} = \frac{\mu_0}{4\pi} \frac{I d\vec{l} \sin\theta}{r^2}$$

$$\& \vec{d\vec{B}} = \frac{\mu_0}{4\pi} \frac{I (d\vec{l} \times \vec{r})}{r^3}$$

Read only

Magnetic field due to infinitely long straight wire carrying current

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I d\vec{l} \sin\phi}{r^2}$$

$$\sin\phi = \cos\theta = \frac{x}{r}, \quad r = \frac{x}{\cos\theta}$$

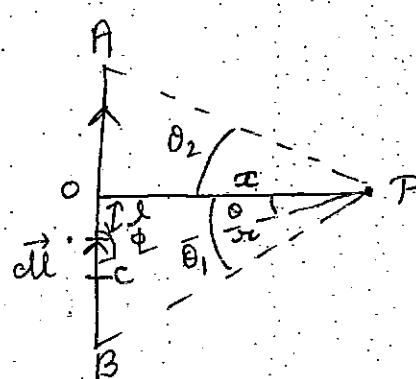
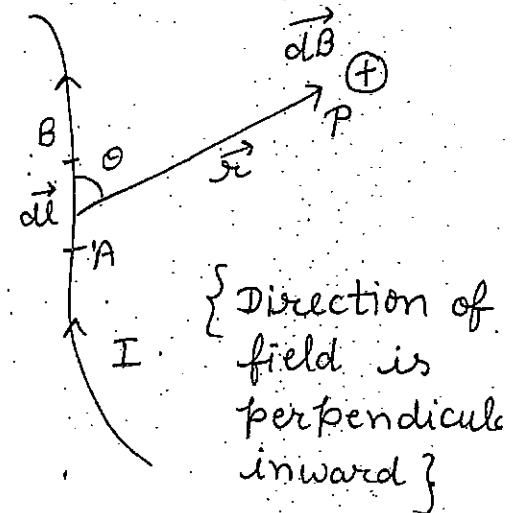
$$l = x + \tan\theta \quad d\vec{l} = x \sec^2\theta d\theta$$

$$\text{we get} \quad d\vec{B} = \frac{\mu_0}{4\pi} \frac{I \cos\theta d\theta}{x}$$

$$B = \int_{\theta_1}^{\theta_2} \frac{\mu_0}{4\pi} \frac{I \cos\theta d\theta}{x} = \frac{\mu_0}{4\pi x} [\sin\theta_1 + \sin\theta_2]$$

$$* \text{ For infinitely long wire } B = \frac{\mu_0}{4\pi} \left(\frac{2I}{x} \right)$$

$\therefore \theta_1 = \theta_2 = \pi/2$



Magnetic field on the axis of a circular loop carrying current

Let P be the point on the axis of a circular loop at the distance x from the centre of the loop.

According to Biot-Savart's law, magnetic field due to small current element XY at point P is given by

$$dB = \frac{\mu_0}{4\pi} \frac{I dl \sin\phi}{r^2}$$

$$\text{As } \sin\phi = 1 \quad (\because \theta = 90^\circ)$$

$$\Rightarrow dB = \frac{\mu_0}{4\pi} \frac{I dl}{r^2}$$

The direction of $d\vec{B}$ is perpendicular to the plane formed by dl and \vec{r} .

Resolving $d\vec{B}$ into two components, we get

(i) $dB_{\cos\theta}$ \perp to the axis of coil

(ii) $dB_{\sin\theta}$ along the axis of coil

Due to symmetry all $dB_{\cos\theta}$ components will cancel out in pairs and all $dB_{\sin\theta}$ components will add up to give the resultant.

$$B = \sum dB_{\sin\theta} = \int dB_{\sin\theta} = \int \frac{\mu_0}{4\pi} \frac{I dl \sin\theta}{r^2}$$

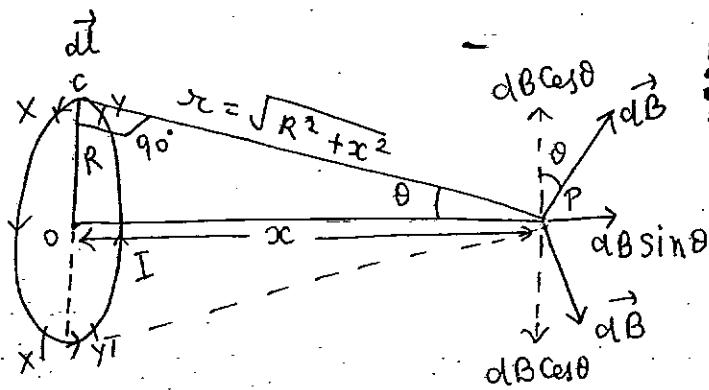
$$= \frac{\mu_0 I \sin\theta}{4\pi r^2} \int dl = \frac{\mu_0 I}{4\pi r^2} \sin\theta (2\pi R)$$

$$\text{Now } \sin\theta = R/r \quad (\text{from figure}) \quad \& \quad r = \sqrt{R^2 + x^2}$$

$$\Rightarrow B = \frac{\mu_0 I}{4\pi} \frac{2\pi (R^2)}{(R^2 + x^2)^{3/2}}$$

$$* \text{ If } x = 0 \text{ i.e. at centre of coil } B = \frac{\mu_0 I}{2R}$$

$$* \text{ If } x \gg R \text{ then } B = \frac{\mu_0}{4\pi} \left(\frac{2\pi I R^2}{x^3} \right)$$



Magnetic field at the centre of a current carrying loop → According to

1. Biot-Savart's law,

the magnetic field at point C due to current element AB is given by

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I d\vec{l} \times \hat{r}}{R^2}$$

As $d\vec{l}$ & \hat{r} are \perp to each other

$$\therefore d\vec{B} = \frac{\mu_0}{4\pi} \frac{I d\vec{l}}{R^2}$$

Magnetic field at C due to whole loop is given by

$$B = \frac{\mu_0 I}{4\pi R^2} \oint d\vec{l} = \frac{\mu_0 I}{4\pi R^2} (2\pi R)$$

$$\Rightarrow B = \frac{\mu_0 I}{2R} = \frac{\mu_0}{4\pi} \left(\frac{2\pi I}{R} \right)$$

For loop having N-turns

$$B = \frac{\mu_0 N I}{2R} = \frac{\mu_0}{4\pi} \left(\frac{2\pi N I}{R} \right)$$

Ampere's circuital law → It states that the line integral of magnetic field around any closed path in free space is equal to absolute permeability (μ_0) times the net current passing through any surface enclosed by the closed path.

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I$$

Acc to Biot-Savart's law

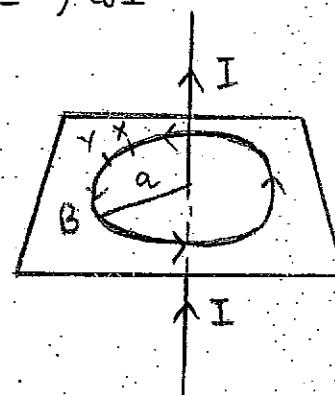
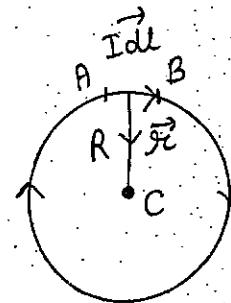
$$B = \frac{\mu_0}{4\pi} \left(\frac{2I}{a} \right)$$

Now $\vec{B} \cdot d\vec{l} = B d\vec{l}$ (as $\theta = 0^\circ$)

$$\oint \vec{B} \cdot d\vec{l} = \oint B d\vec{l} = \frac{\mu_0}{4\pi} \left(\frac{2I}{a} \right) \oint d\vec{l}$$

$$\oint \vec{B} \cdot d\vec{l} = \frac{\mu_0}{4\pi} \left(\frac{2I}{a} \right) (2\pi a) = \mu_0 I$$

which is Ampere-circuital law



Magnetic field due to current carrying circular wire of infinite length using Ampere's law

Let us consider a portion of a circular wire of infinite length. Let a be the radius of the wire and a steady current I be flowing through it. The flow of current gives rise to a magnetic field around it.

case I Magnetic field intensity at a point P_1 outside the wire

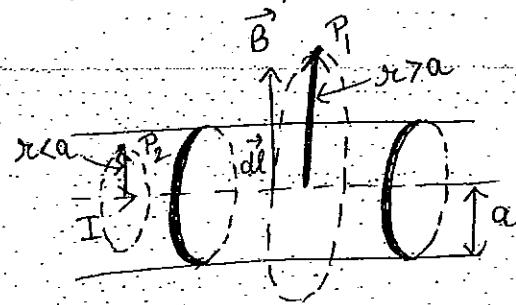
$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I$$

$$\text{or } \oint \vec{B} \cdot d\vec{l} = \oint B dl = \mu_0 I$$

[As \vec{B} & $d\vec{l}$ are parallel]

$$\text{or } B \oint dl = \mu_0 I \quad \text{or } B(2\pi r) = \mu_0 I$$

$$\text{or } B = \frac{\mu_0 I}{2\pi r} \Rightarrow B \propto \frac{1}{r}$$



case II Magnetic field intensity on the surface of wire i.e. $r = a$

$$\therefore B = \frac{\mu_0 I}{2\pi a}$$

Case III Magnetic field intensity at a point inside the wire

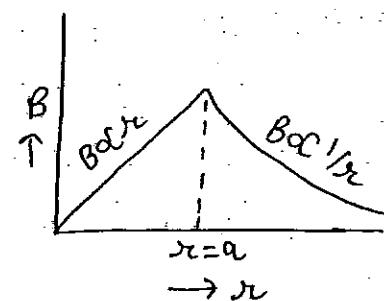
(a) If current flows only along the surface then $\oint \vec{B} \cdot d\vec{l} = 0$ or $B = 0$

(b) If current is uniformly distributed through the cross-section of wire

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I' \quad I' = \frac{I}{\pi a^2} \times \pi r^2$$

$$\Rightarrow \oint B dl = \frac{\mu_0 I r^2}{a^2} \quad (\because \oint dl = 2\pi r)$$

$$\text{& } B = \frac{\mu_0 I r}{2\pi a^2} \text{ or } B \propto r$$



Magnetic field due to a current carrying Solenoid

Solenoid is a cylindrical coil of many tightly wound turns of insulated wire whose diameter is very small as compared to its length.

Let us consider a long solenoid having n -turns per unit length of solenoid. Let current I be flowing through solenoid.

(a) Let P be the point well inside the solenoid

Consider a rectangular loop $ABCD$.

$$\text{Now } \oint \vec{B} \cdot d\vec{l} = \int \vec{B} \cdot d\vec{l} + \int \vec{B} \cdot d\vec{l} + \int \vec{B} \cdot d\vec{l} + \int \vec{B} \cdot d\vec{l}$$

$$\int \vec{B} \cdot d\vec{l} = \int_A^B \vec{B} \cdot d\vec{l} = 0 (\because \theta = 90^\circ)$$

Since CD is outside the solenoid

$$\text{so } \int_C^D \vec{B} \cdot d\vec{l} = 0$$

$$\therefore \oint \vec{B} \cdot d\vec{l} = \int_A^B \vec{B} \cdot d\vec{l} = \int_A^B B dl = Bl$$

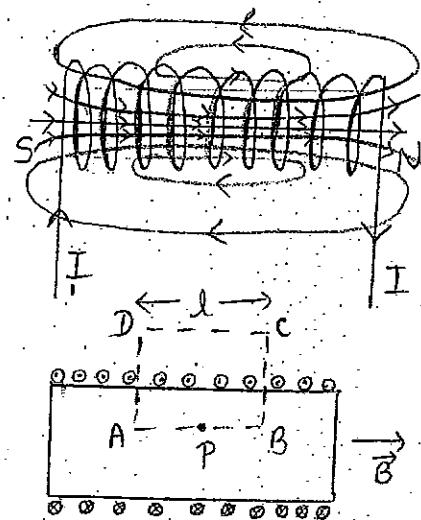
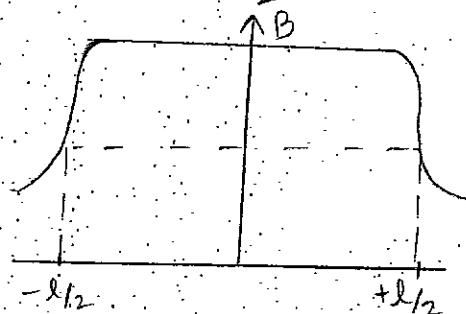
$$\text{Now } \oint \vec{B} \cdot d\vec{l} = Bl = \mu_0 I$$

$$\Rightarrow B = \frac{\mu_0 I}{l} \Rightarrow \mu_0 I n \text{ (For } n \text{ turns per unit length)}$$

$$\Rightarrow B = \mu_0 n I = \frac{\mu_0 N I}{l} \text{ (length)}$$

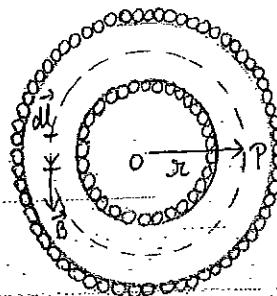
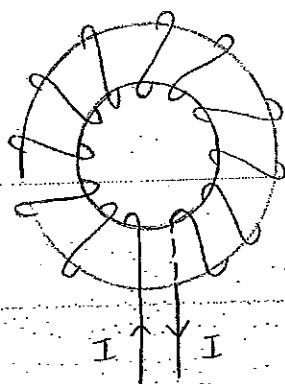
(b) Magnetic field at each end is

$$B_{\text{end}} = \frac{1}{2} \mu_0 n I$$



Magnetic field at a point due to a Toroid

A toroid is a hollow circular ring of finite thickness on which a large no. of turns of insulated wire are closely wound.



$$\oint \vec{B} \cdot d\vec{l} = B \oint dl = B \cdot 2\pi r$$

where r is distance of point P inside the toroid.

$$\text{Now } \oint \vec{B} \cdot d\vec{l} = B \cdot 2\pi r = \mu_0 I \times n l = \mu_0 N I (2\pi r)$$

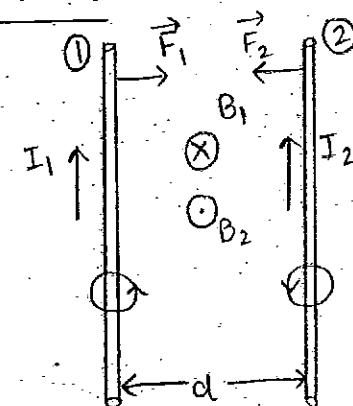
$$\Rightarrow B = \frac{\mu_0 N I}{2\pi r} \quad n = \frac{N}{2\pi r}$$

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

* For any point inside the empty space surrounded by toroid as well as outside the toroid, magnetic field B is zero.

Force between two infinitely long straight parallel current carrying conductors

Let us consider two infinitely long parallel conductors carrying currents I_1 & I_2 in the same direction. Let d be the distance between two conductors.



Magnetic field at any point on the conductor ② due to current I_1 in conductor ① is given by

$$B_1 = \frac{\mu_0}{4\pi} \left(\frac{2I_1}{d} \right) \quad (\perp \text{vertically downward})$$

$$\text{Now } F = BIL \Rightarrow F_2 = B_1 I_2 l$$

$$\text{Force per unit length } f_2 = \frac{F_2}{l} = B_1 I_2$$

$$\Rightarrow f_2 = \frac{\mu_0}{4\pi} \left(\frac{2I_1 I_2}{d} \right) \quad [\text{Towards } ①]$$

$$\text{Hence } f_1 = \frac{\mu_0}{4\pi} \left(\frac{2I_2 I_1}{d} \right) \quad [\text{Towards } ②]$$

Definition of Ampere → one ampere is that current which if maintained

in two infinitely long parallel conductors of negligible cross-sectional area separated by 1 metre in vacuum causes a force of $2 \times 10^{-7} N$ on each metre of other wire.

$$\left. \begin{array}{l} f = \frac{\mu_0}{4\pi} \left(\frac{2I_1 I_2}{d} \right) \quad \text{Put } I_1 = I_2 = 1 \text{ amp.} \\ \text{we get } f = 2 \times 10^{-7} N \quad \& d = 1 \text{ m} \end{array} \right\}$$

Torque on current carrying rectangular loop placed in uniform magnetic field

In the given diagram \vec{F}_1 & \vec{F}_2 constitute a torque whereas \vec{F}_3 & \vec{F}_4 cancel out each other.

$$F_1 = F_2 = BIL$$

$$\text{Torque } T = F_1 \times DN$$

$$= BIL \times b \sin \theta$$

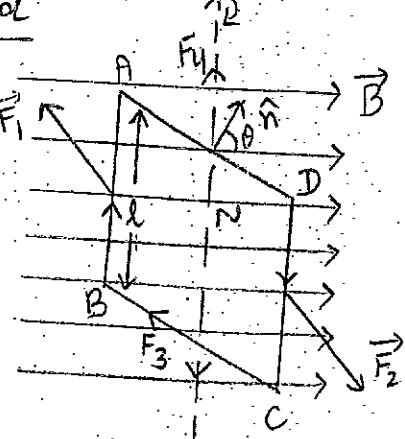
$$\Rightarrow T = BIA \sin \theta \quad (\because A = l \times b)$$

$$\vec{T} = I(\vec{A} \times \vec{B}) \quad [\vec{A} = \text{Area vector} = A\hat{n}]$$

$$\text{For } N \text{ turns, } |\vec{T}| = NBIAS \sin \theta$$

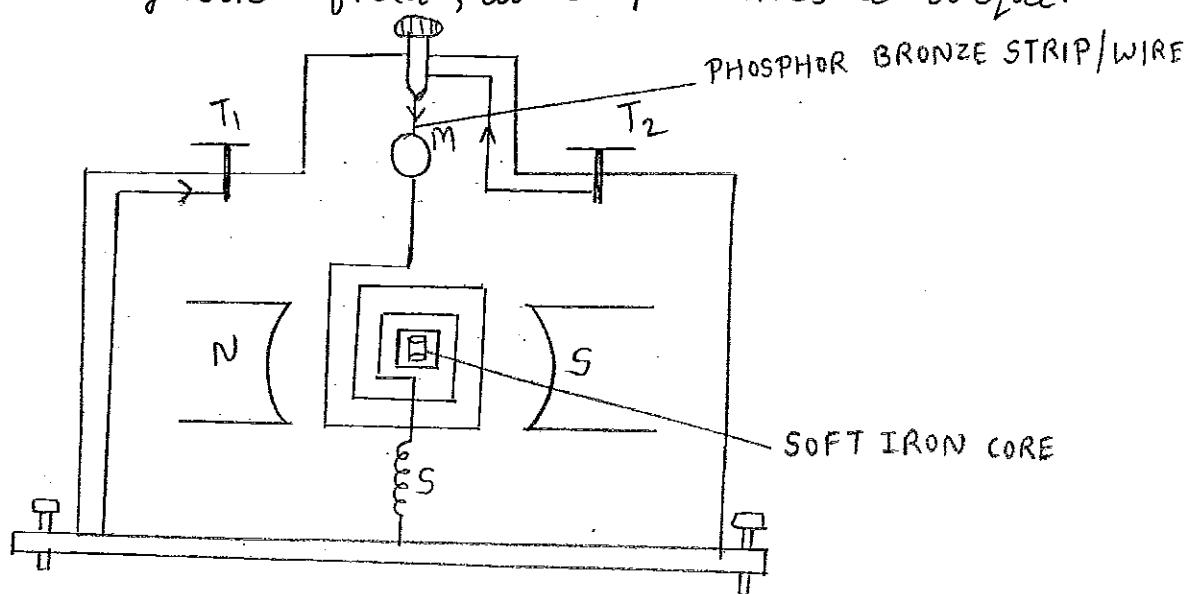
$$* T_{\max.} = NBIA \text{ if } \theta = 90^\circ \text{ i.e. } \hat{n} \text{ is } \perp \text{ to } \vec{B}$$

$$* T_{\min.} = 0 \quad \text{if } \theta = 0^\circ \text{ i.e. } \hat{n} \text{ is } \parallel \text{ to } \vec{B}$$



Moving Coil Galvanometer → It is a device used to detect small electric current flowing in the electric circuit

Principle → It is based on the fact that when a current carrying coil is placed in a uniform magnetic field, it experiences a torque.



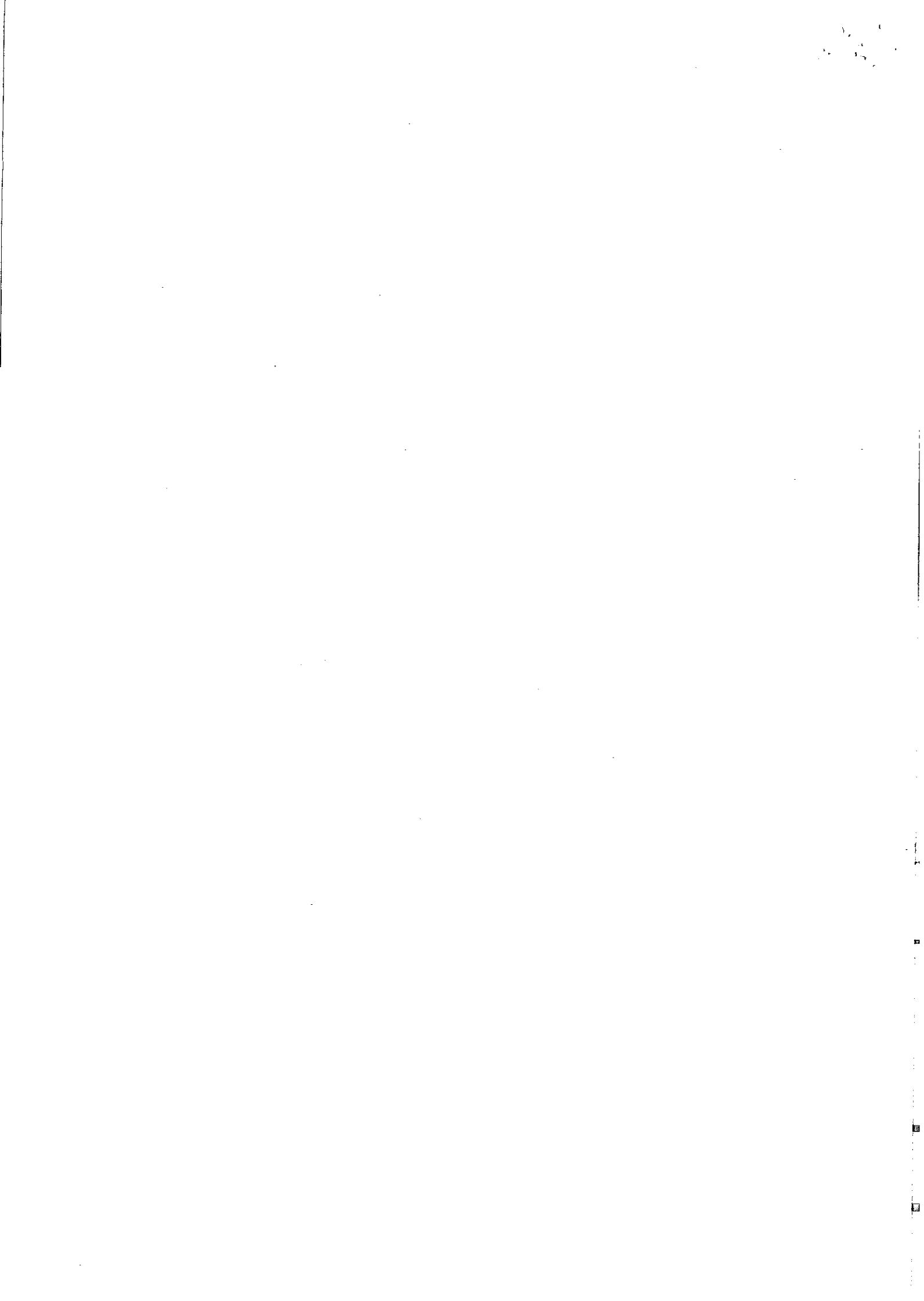
Construction → It consists of a coil wound on a frame (usually brass). The coil is suspended between two pole pieces of permanent magnet which are cylindrical in shape. The end of the coil is connected to a light spring which exerts a very small restoring (force) torque on the coil. A plane mirror is used to note the deflection of the coil. The whole system is enclosed in wooden case to avoid disturbance

Theory → We know that $T = NBIA \sin\theta$

$$\text{Now } \theta = 90^\circ \Rightarrow T = NBIA$$

This is known as deflecting torque

As coil gets deflected, the spring is twisted and a restoring force is developed in it.



Restoring torque for deflection ϕ is given by

$$\tau' = K\phi$$

For equilibrium of the coil,

Deflecting torque = Restoring torque

$$\Rightarrow NBI A = K\phi$$

$$I = \left(\frac{K}{NBA}\right)\phi = G_i\phi$$

Where $G_i = \frac{K}{NBA}$ is galvanometer constant

$$\Rightarrow I \propto \phi$$

use of Radial magnetic field in moving coil

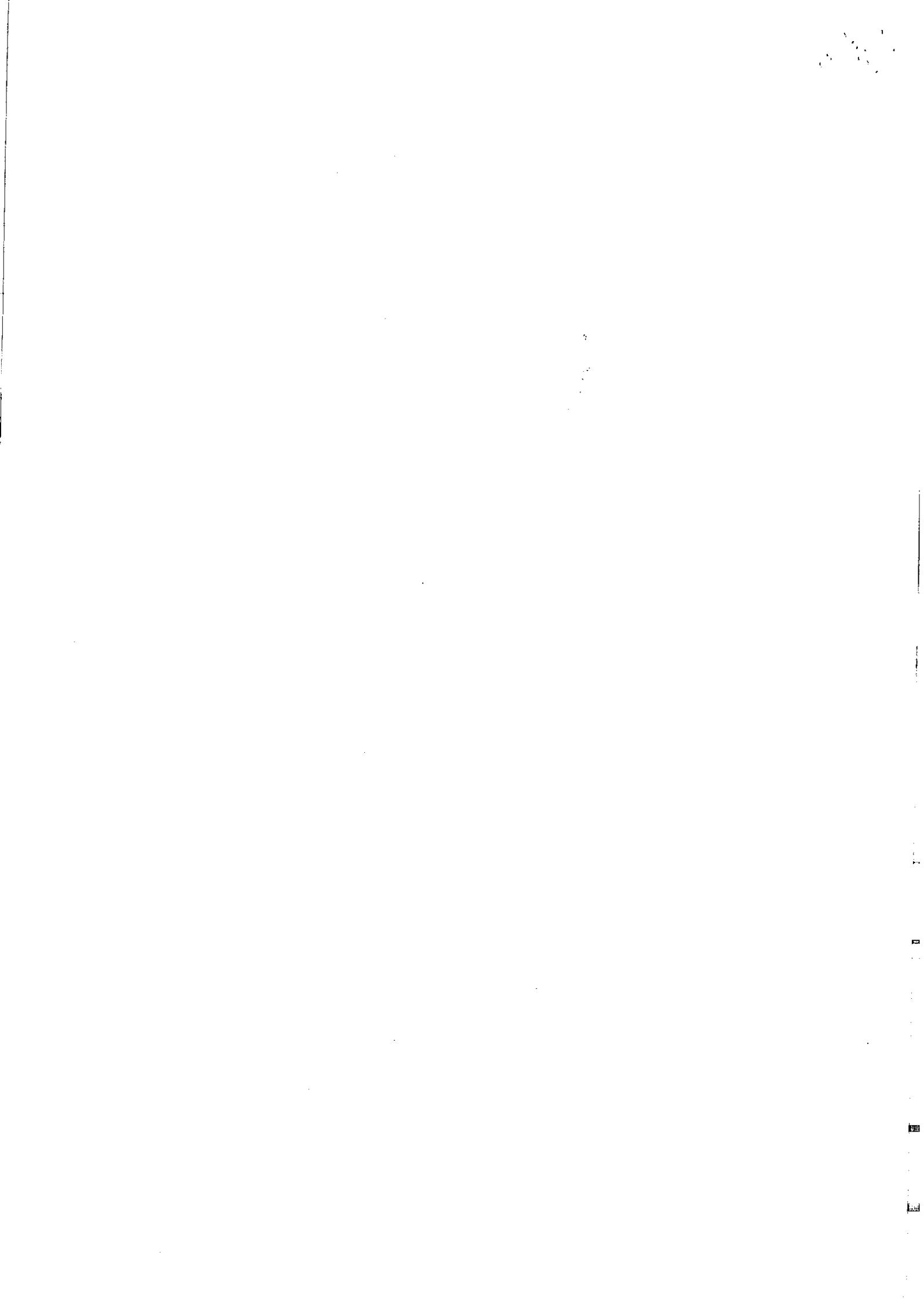
galvanometer → A radial magnetic field, produced by cylindrical poles of

permanent magnet of galvanometer is always parallel to the plane of the coil.

For radial magnetic field, the angle between the normal to the plane of the loop and the magnetic field is 90° . Therefore $\tau = NBI A$ or $\tau \propto I$ Thus deflection of the coil is proportional to the current flowing through it. Hence a linear scale is used to determine the deflection of the coil.

uses of galvanometer

- (i) It is used to detect electric current in a circuit.
- (ii) It can be converted into a voltmeter or an ammeter using suitable resistances.
- (iii) It is used as an ohmmeter.



Sensitivity of a Galvanometer

A galvanometer is said to be sensitive if a small current flowing through the coil of the galvanometer produces a large deflection in it.

(i) Current sensitivity

It is defined as the deflection produced in the galvanometer per unit current flowing through it.

$$\text{Current sensitivity} = \frac{\phi}{I} = \frac{NBA}{K}$$

Current sensitivity can be increased by

- (i) By increasing magnetic field B
- (ii) By increasing no. of turns N
- (iii) By increasing area of the coil
- (iv) By decreasing the value of force constant K
(e.g. by using phosphor bronze strip)

(ii) Voltage sensitivity

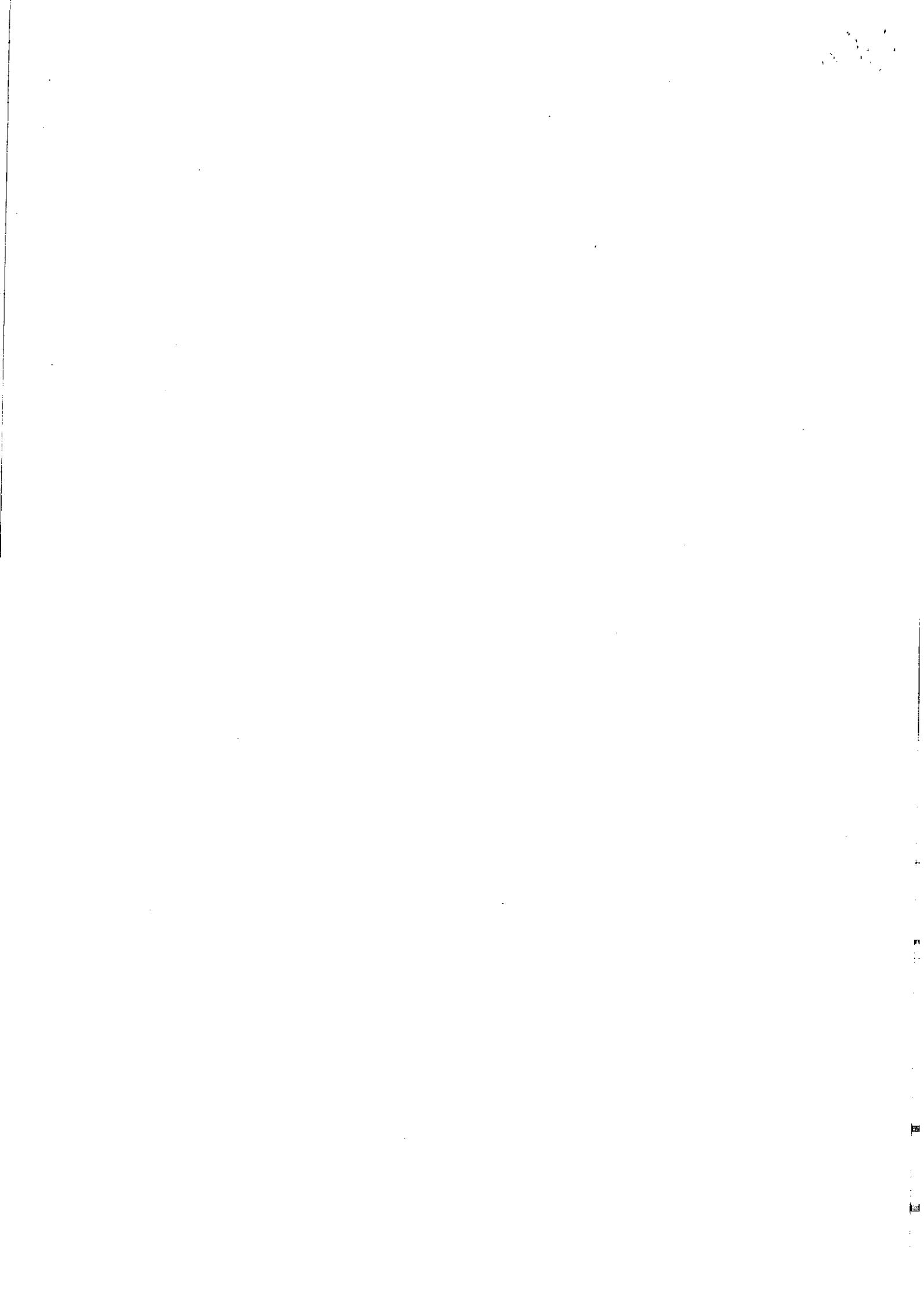
It is defined as the deflection produced in the galvanometer per unit voltage applied to it.

$$\text{Voltage sensitivity} = \frac{\phi}{V} = \frac{\phi}{IR} = \frac{NBA}{KR}$$

Voltage sensitivity can be increased by

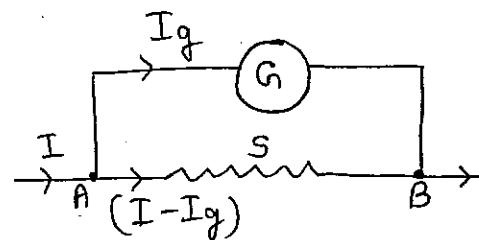
- (i) increasing B (ii) increasing A (iii) increasing N
- (iv) decreasing K (v) decreasing R

* Increase in current sensitivity may not result in increase in voltage sensitivity.



Conversion of galvanometer into an ammeter

A galvanometer can be converted into an ammeter by connecting a low resistance (shunt) parallel to the galvanometer.



$$I_g \times G = (I - I_g)S, \quad S = \left(\frac{I_g}{I - I_g} \right) G$$

Effective resistance of ammeter

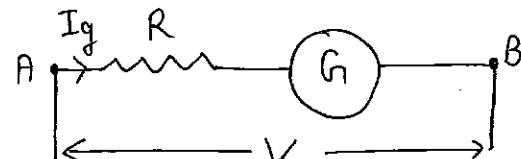
$$\frac{1}{R_{\text{eff}}} = \frac{1}{G} + \frac{1}{S} \quad R_{\text{eff}} = \frac{G S}{G + S}$$

Since $G \gg S \Rightarrow G + S \approx G$

& $R_{\text{eff}} \approx S$ (low resistance)

Conversion of galvanometer into a voltmeter

A galvanometer can be converted into a voltmeter by connecting a large resistance in series to the galvanometer.

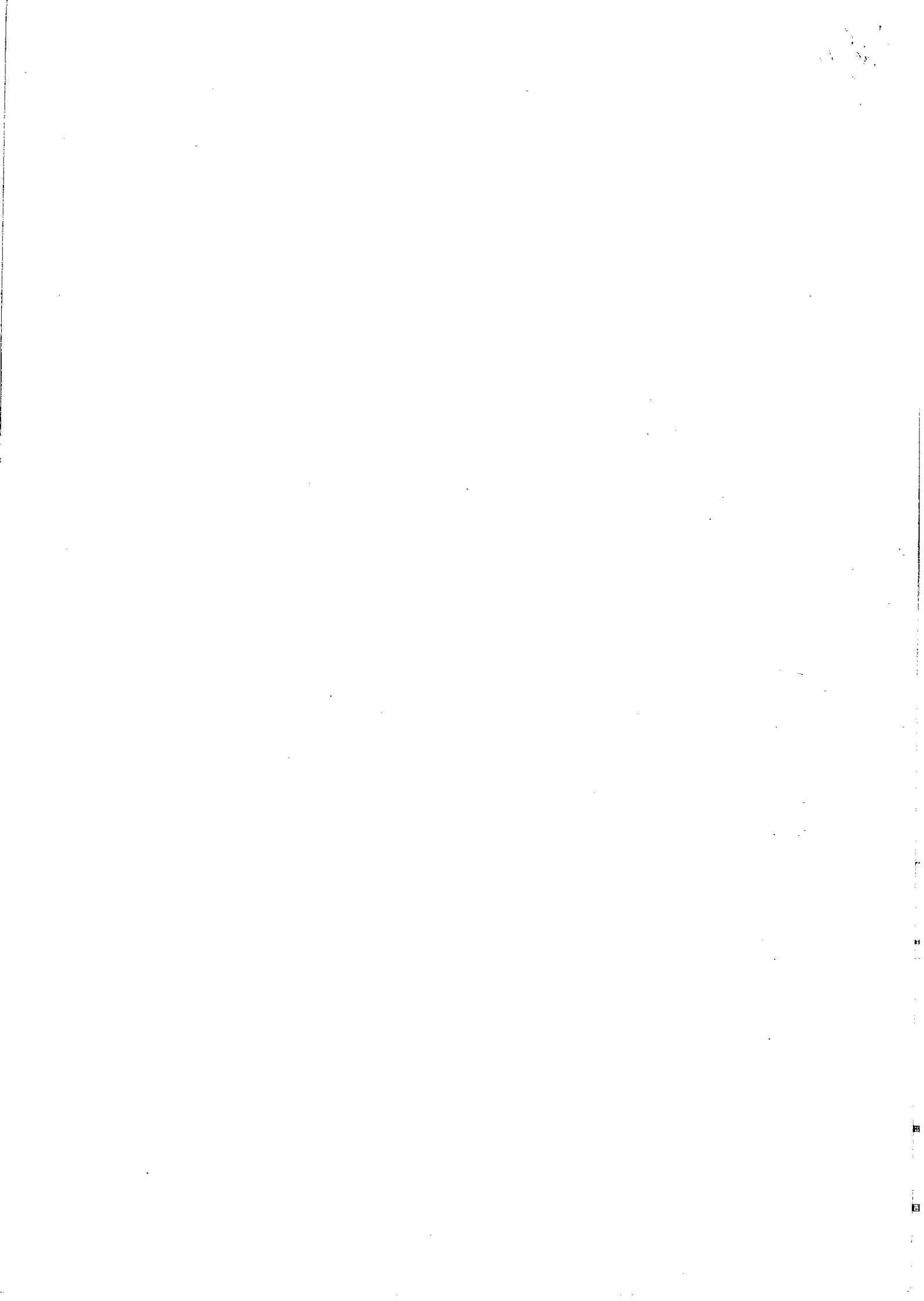


$$\begin{aligned} V &= I_g R + I_g G \\ &= I_g (R + G) \end{aligned}$$

$$\Rightarrow R + G = \frac{V}{I_g} \quad \text{or} \quad R = \frac{V}{I_g} - G$$

Effective resistance of voltmeter

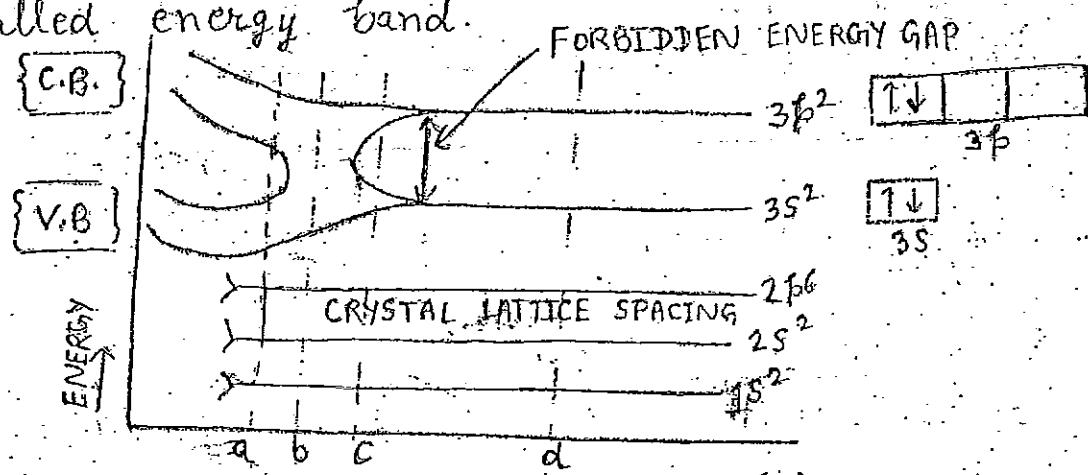
$$R_{\text{eff.}} = R + G \quad (\text{high resistance})$$



SOLIDS & SEMICONDUCTOR DEVICES

Electronic device \rightarrow Any device whose action is based on the controlled flow of electrons through it is called an electronic device. Electronic devices are of two types: (i) vacuum tubes
 (ii) solid-state electronic devices (semiconductor devices)

Energy bands in solids \rightarrow Electrons have well defined energy levels in an isolated atom. But due to interatomic interaction in a crystal, the electrons of the outer shells are forced to have energies different from those in the isolated atoms. Each energy level splits into a number of energy levels forming a continuous band called energy band.



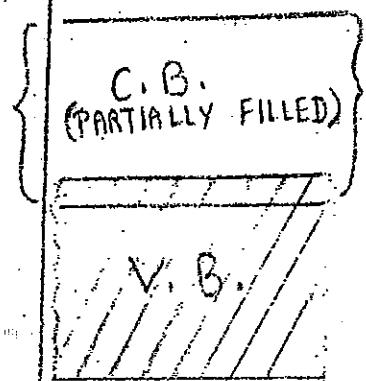
Consider a small single crystal of silicon. Suppose it has N atoms. Imagine that these atoms are being brought closer from infinity so as to form a crystal of lattice spacing ' a '.

In the graph (Interatomic spacing vs energy)

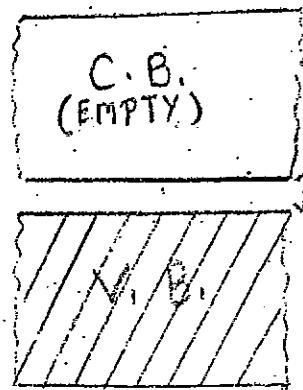
- ① When $r = d \gg a$, there is no interaction between neighbouring atoms. All the N -atoms have identical energy levels.
- ② When $r = c < d$ ($\& c \gg a$), the valence electrons of neighbouring atoms begin to interact. The energies of $3s$ and $3p$ levels of each atom get slightly changed. We now have N different energy levels of $3s$ -type and $3N$ different levels of $3p$ -type. The energy gap between $3s$ & $3p$ levels decreases. We have closely spaced energy levels called energy bands.
- ③ When $r = b > a$ ($\& b < c$), the energy gap between $3s$ & $3p$ levels completely disappears and the upper and lower energy bands merge with each other. We now have a set of continuously distributed $4N$ energy levels.
- ④ When $r = a$, the band of $2N$ filled energy levels gets separated from the band of $2N$ empty levels by an energy gap.
The highest energy band filled with valence electrons is called valence band. The lowest unfilled allowed energy band next to valence band is called conduction band.

Distinction between metals; insulators and semiconductors on the basis of band theory.

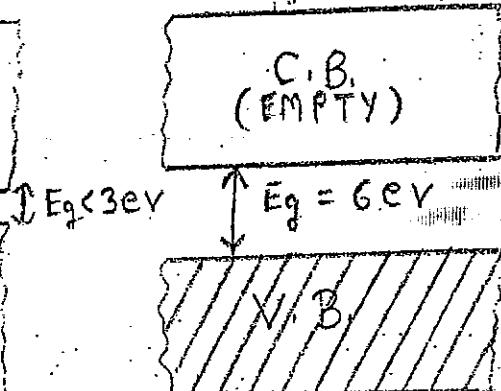
Metals



Semiconductors



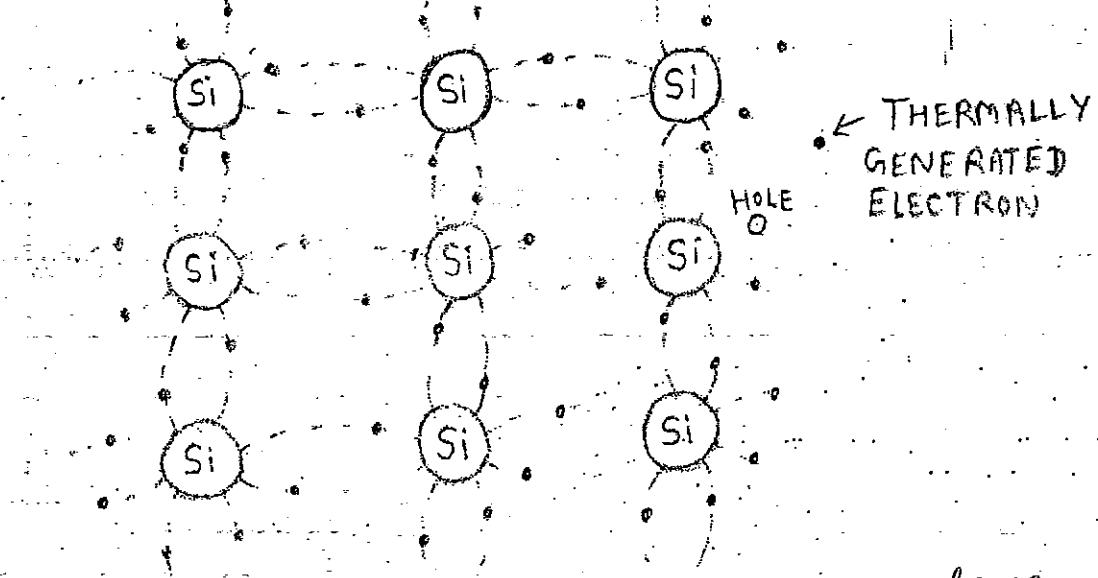
Insulators



Types of semiconductors

- Intrinsic semiconductors (Pure)
- Extrinsic semiconductors (Impure)

Valence bond model for Intrinsic semiconductors



At absolute zero, there is no free electron in crystal lattice. As the temperature increases, the thermal energy of valence electrons increases. An electron may break away from covalent bond and becomes free.

As each free electron creates one hole, so in an intrinsic semiconductor, number density of free electrons (n_e) is equal to the number density of holes (n_h) and each is equal to the intrinsic charge carrier concentration (n_i).

$$n_e = n_h = n_i$$

Doping → The process of deliberate addition of a desirable impurity to a pure semiconductor so as to increase its conductivity is called doping.

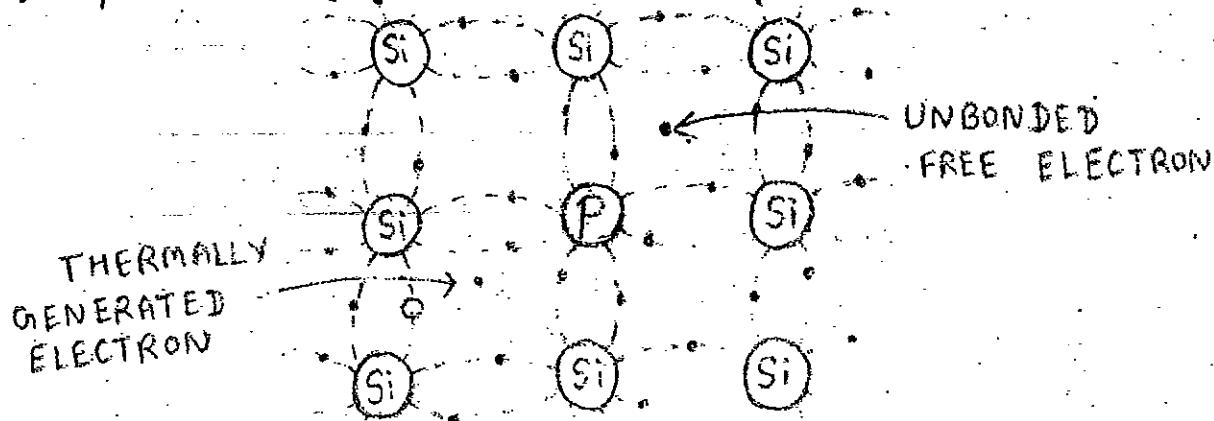
The impurity atoms added are called dopants and the semiconductors doped with the impurity atoms are called extrinsic semiconductors.

Valence Bond model of Extrinsic semiconductors

Extrinsic semiconductors are of two types:

- (i) N-type semiconductors
- (ii) P-type semiconductors

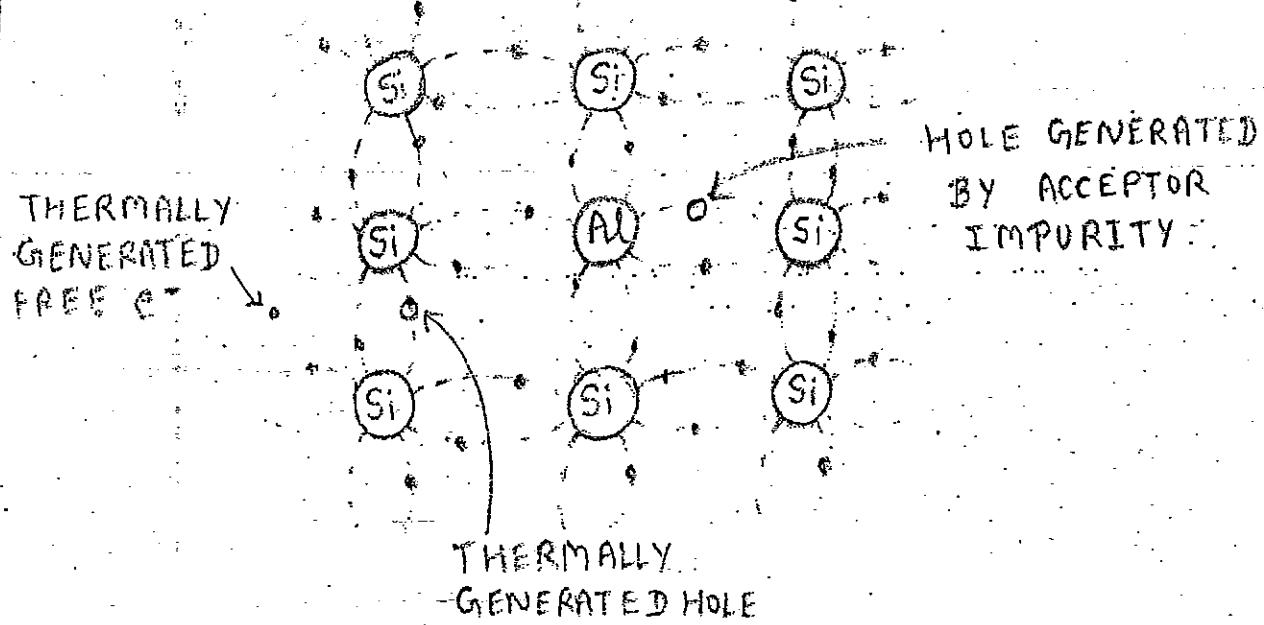
(i) N-type Semiconductors → This is obtained by doping tetravalent semiconductor Si (or Ge) with pentavalent impurities (such as As, P or Sb etc)



As each pentavalent impurity atom donates one extra electron for conduction, it gets converted into an ionised +ve core.

These semiconductors have free electrons contributed by donors and generated by the thermal process while the holes are only due to thermal generation. Hence electrons are the majority charge carriers and holes are the minority charge carriers.
i.e. $n_e \gg n_h$ $n_e \cdot n_h = n_i^2$

- (ii) P-type semiconductors → This is obtained by doping the tetravalent semiconductor Si (or Ge) with trivalent impurities (such as Al, In or Ga).



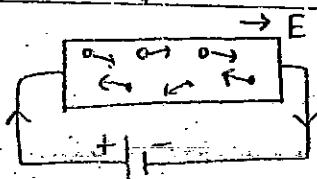
As each trivalent impurity atom accepts an electron or has a tendency to accept e⁻, it gets converted into an ionised -ve core.

These semiconductors have holes created by the acceptor atoms in addition to the thermally generated holes while the free electrons are only due to thermal generation. Hence holes are the majority charge carriers and electrons are the minority charge carriers.

$$\text{i.e. } n_h \gg n_e \quad n_e \cdot n_h = n_i^2$$

Mobility of a charge carrier → The drift velocity acquired by a charge carrier per unit electric field is electrical mobility. The mobility of an electron in the conduction band of a semiconductor is greater than the mobility of a hole in the valence band.

Electrical conductivity of extrinsic semiconductor.



Let us consider a block of semiconductor of length l and area of cross-section A and n_e, n_h are free electron or hole density. If potential diff V is applied across its ends then

$$\text{electric field } E = V/l \quad I = I_e + I_h$$

$$I_e = e n_e A v_e, \quad I_h = e n_h A v_h$$

$$\Rightarrow I = e A (n_e v_e + n_h v_h) = \frac{V}{R} \quad R = \rho l / A$$

$$\Rightarrow \frac{V}{\rho l} = e A (n_e v_e + n_h v_h) \quad [\because E = V/l]$$

$$\Rightarrow \frac{E}{\rho} = e (n_e v_e + n_h v_h) \quad \text{or} \quad \frac{1}{\rho} = e \left(\frac{n_e v_e}{E} + \frac{n_h v_h}{E} \right)$$

$$\Rightarrow \sigma = \frac{1}{\rho} = e (n_e \mu_e + n_h \mu_h) \quad \frac{v_e}{E} = \mu_e \quad (\text{mobility})$$

$$\text{or } \rho = \frac{1}{e (n_e \mu_e + n_h \mu_h)}$$

$$\& \frac{v_h}{E} = \mu_h$$

Effect of temperature on the conductivity of semiconductors → The conductivity of a semiconductor is given by

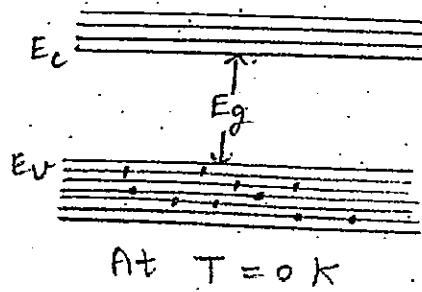
$$\sigma = e(n_e \mu_e + n_h \mu_h)$$

As the temperature increases, the mobilities μ_e and μ_h of electrons and holes decrease due to the increase in their collision frequency. But due to the small energy gap of semiconductors, more and more electrons from the valence band cross over to the conduction band. $[n \propto e^{-E_g/2kT}]$ The increase in carrier concentrations, n_e and n_h is so large that the decrease in the values of μ_e & μ_h has very less influence (negligible). Ultimately the overall effect is that the conductivity increases or the resistivity decreases with the increase of temperature.

Fermi Level → The highest energy level in the conduction band filled up with electrons at absolute zero is called Fermi level and the energy corresponding to the Fermi level is called Fermi energy.

Energy bands of Intrinsic and extrinsic semiconductors →

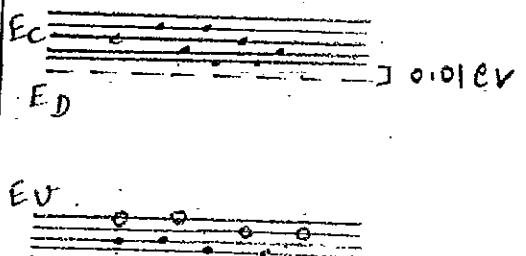
① Intrinsic semiconductor



② Extrinsic semiconductor

N-TYPE

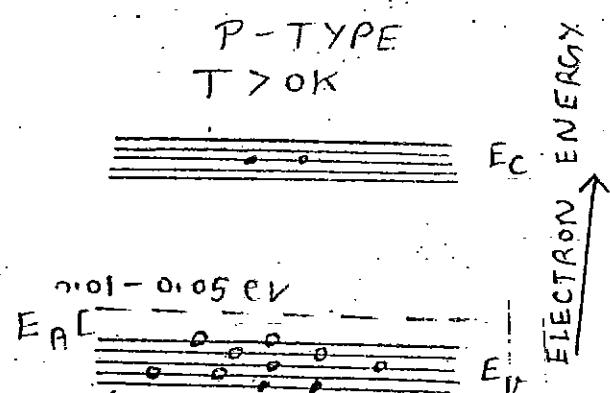
$T > 0\text{K}$



Donor level lies
just below the
conduction band

P-TYPE

$T > 0\text{K}$



Acceptor level lies
just above the valence
band

Difference between n-type and p-type

n-type semiconductors

- ① These are obtained by doping atoms of group V
- ② The donor impurity level lies just below the conduction band.
- ③ The electrons are the majority carriers and holes are minority carriers.

p-type semiconductors

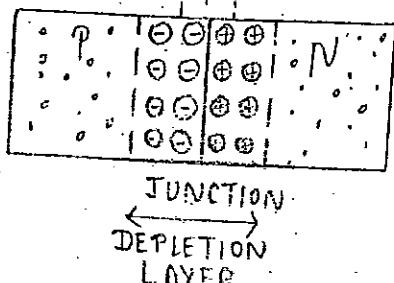
- These are obtained by doping atoms of group III
- The acceptor impurity level lies just above the valence band.
- The holes are the majority carriers and electrons are the minority charge carriers.

PN - Junction → A single piece of a semiconductor material with one portion doped with pentavalent impurity and the other portion doped with trivalent impurity behaves as a PN - Junction.

* [Refer to NCERT]

Formation of depletion layer in a P-N Junction

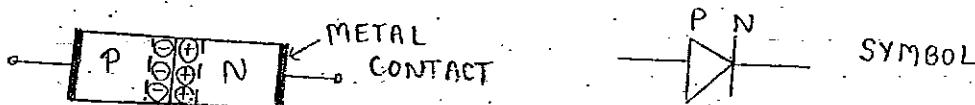
The region around the PN Junction having no mobile charge carriers is known as depletion layer or depletion region.



Junction Barrier or Potential Barrier

The potential difference due to negative immobile ions on P-side of the junction and positive immobile ions on the N-side of the junction is called potential barrier.

PN Junction diode

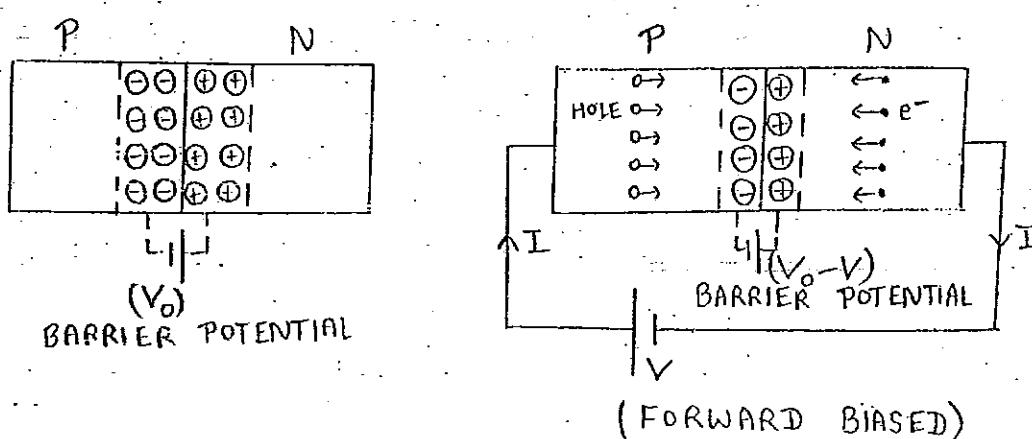


PN Junction diode under forward bias (external voltage)

When a positive terminal of a cell is connected to P-region and the negative terminal of the cell is connected to N-region of junction diode, then it is said to be forward biased.

When a forward potential difference of V volt is applied across the diode, this reduces the potential barrier V_0 . The effective barrier potential reduces to $(V_0 - V)$ and the thickness of the depletion layer also decreases. The junction resistance becomes very low. The holes in P-region and electrons in N-region (majority carriers) acquire sufficient energy to cross over the potential barrier across the junction.

The crossed over electrons in P-region and holes in N-region are minority carriers so this process is called minority carrier injection. Concentration of injected holes in N-side and that of injected electrons in P-side increases a lot near the junction than ends. Concentration gradient makes the injected holes and electrons diffuse to the ends of N-side and P-side respectively. The movement of holes and electrons constitute diffusion hole current (I_h) and diffusion electron current (I_e) respectively. i.e. $I = I_e + I_h$

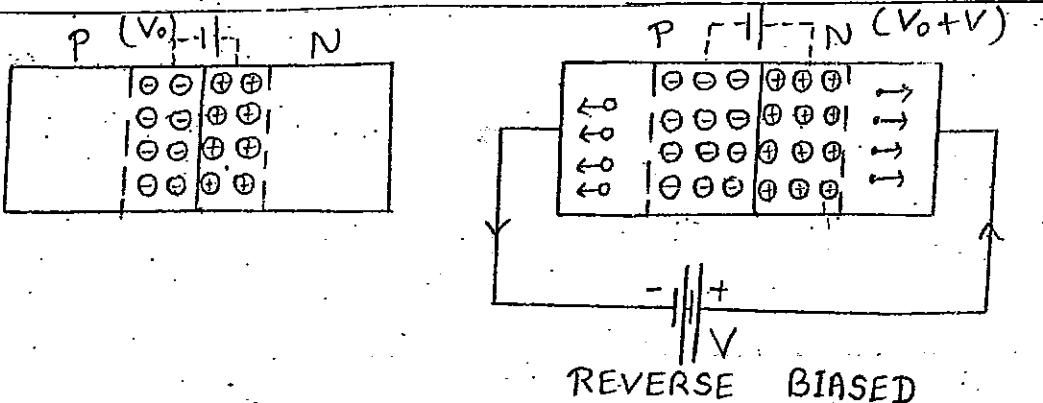


PN Junction diode under reverse bias

A PN - Junction is said to be reverse biased when the positive terminal of a cell is connected to the N - side and negative terminal is connected to the P - side of the PN - Junction diode.

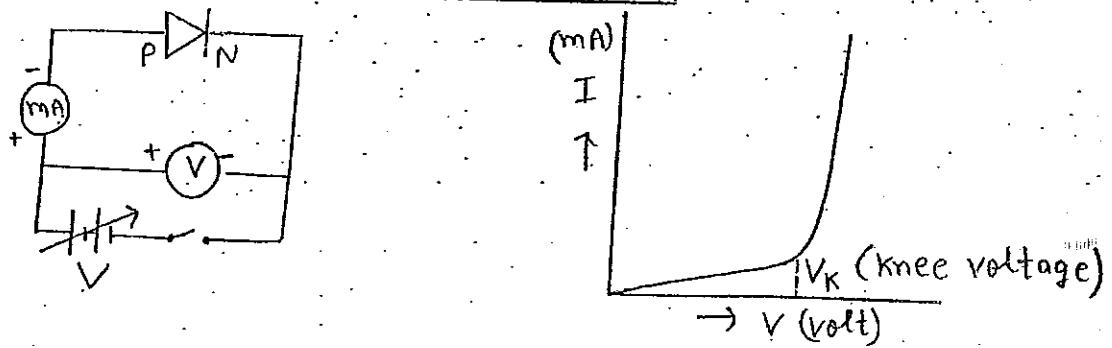
When a potential difference of V volt is applied across the diode in reverse mode, this adds up to the barrier potential V_0 . This increases the thickness of depletion layer. The junction resistance increases in reverse bias. The majority carriers in P - region and N - region respectively are attracted by the negative and positive terminal of the battery respectively, so both electrons and holes are drifted away from the junction.

There is a small saturation current due to sweep of minority carrier in P - region and N - region. If the reverse bias is increased to a high value, the covalent bonds near the junction break down and a large number of electron - hole pairs are generated. The reverse current increases to a very high value abruptly. This process is known as breakdown which can destroy the diode due to overheating.



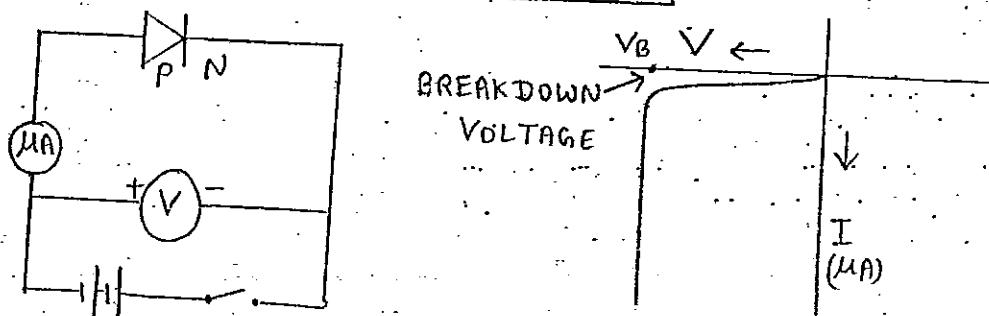
CHARACTERISTICS of PN-Junction diode

① Forward bias characteristic



The forward current increases slowly at first but as soon as the battery voltage increases (above V_K), forward current increases rapidly.

② Reverse bias characteristic



As the reverse voltage is increased to a certain value, called breakdown voltage, large amount of current is produced due to breakage of covalent bonds.

Static (D.C.) resistance of diode

$$\checkmark R_s = \frac{V}{I}$$

Dynamic (A.C) resistance of diode

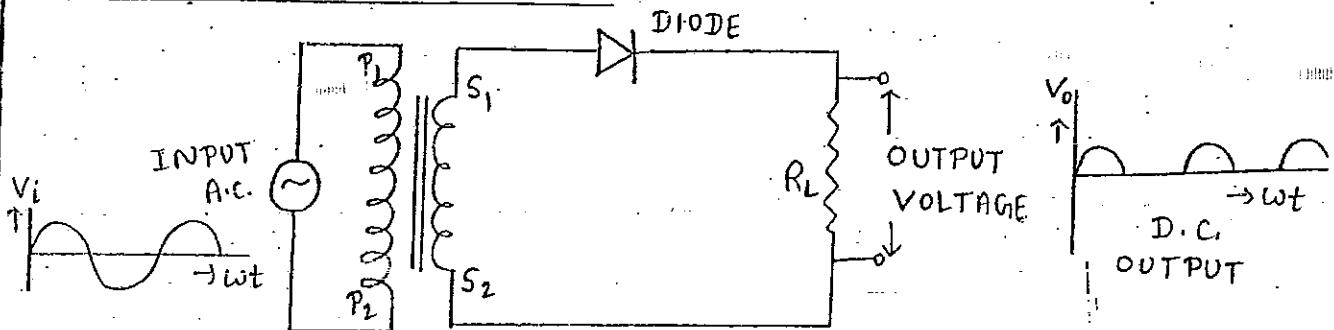
$$\checkmark r_d = \frac{\Delta V}{\Delta I}$$

* PN Junction diode is highly current sensitive.

PN Junction diode as rectifier \rightarrow A device

A.C. into D.C. is known as rectifier.

Half wave rectifier



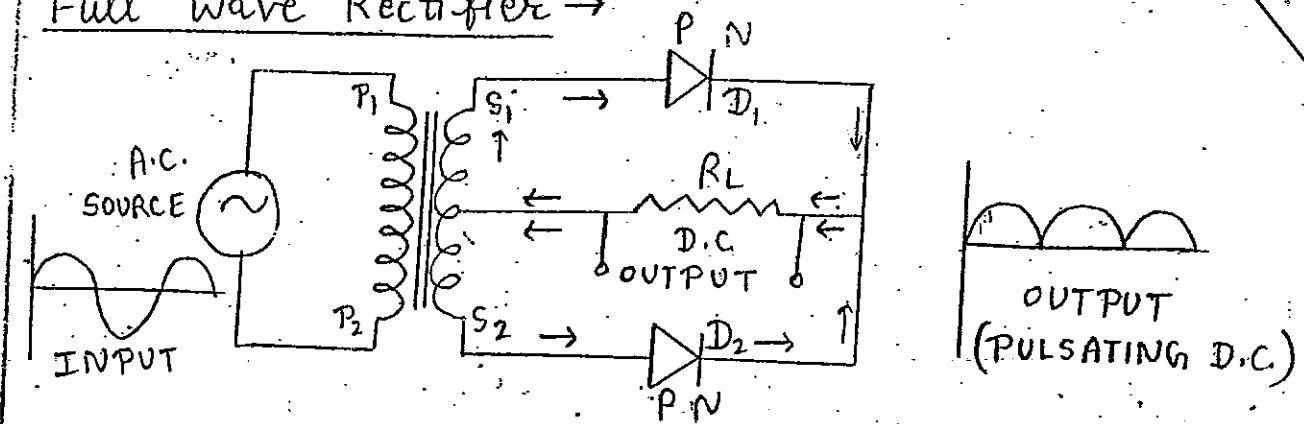
Working \rightarrow During +ve half cycle of input signal

let P_1 is -ve and P_2 is +ve and S_1 is +ve and S_2 is -ve corresponding to that.

Due to this, diode gets forward biased and we get output across R_L similar to input.

During -ve half cycle of input signal let P_1 is +ve and P_2 is -ve and S_1 is -ve and S_2 is +ve corresponding to that. Due to this, diode gets reverse biased and a current of few mA flows through the diode and output across R_L is negligible as diode is OFF.

Full Wave Rectifier



Working → During +ve half cycle of input A.C. signal let P_1 is -ve and P_2 is +ve. Due to that S_1 is +ve and S_2 is -ve, Thus the diode D_1 is forward biased and D_2 is reverse biased. Current due to D_1 flows in upper part of circuit as shown (in given direction).

During -ve half cycle of input A.C. signal diode D_1 is reverse biased and D_2 is forward biased. Current due to D_2 flows in the lower half of circuit as shown (in same direction through R_L as previous). Finally we get the output as shown.

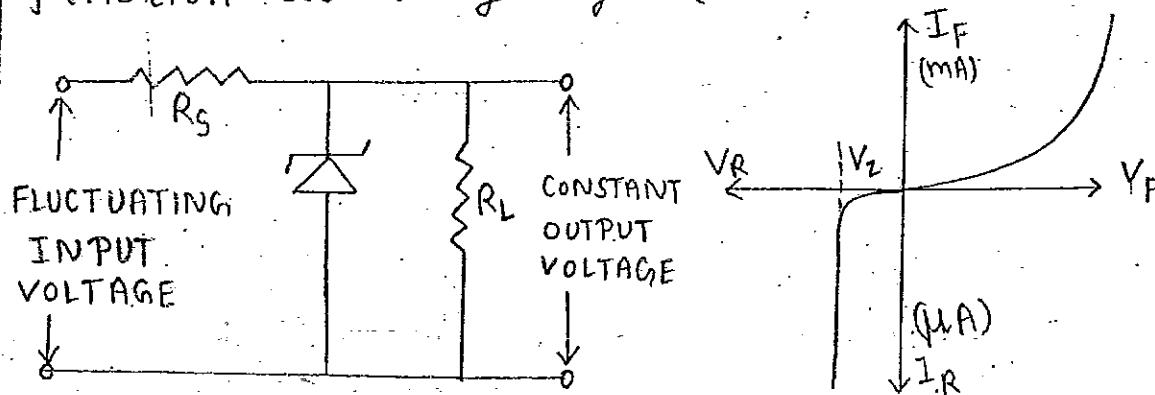
* This pulsating D.C in the output can be smoothed by passing through different types of filters.

* Ripple factor → It is defined as the ratio of r.m.s. value of A.C component to the D.C. value of output voltage. It is denoted by γ . For half wave rectifier, $\gamma = 1.21$ and for full wave rectifier, $\gamma = 0.48$.

Special purpose PN-Junction diodes

I Zener diode → A specially designed PN-Junction diode which works in the breakdown region without damaging itself is called a zener diode.

In this diode, P and N regions are heavily doped. Zener voltage V_Z depends on the concentration of doping. Its depletion layer is very thin. As $E = -\frac{dV}{dx}$ so even for small applied voltage, electric field across the junction is very high (MV order).

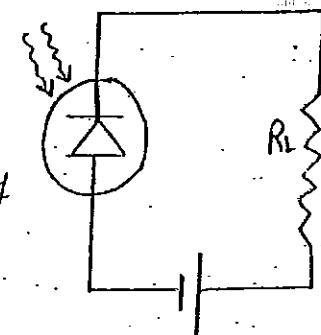


Zener diode as a voltage regulator

A zener diode can be used as voltage regulator. When the input voltage increases, resistance of zener diode decreases and hence the current through the diode increases to high value. As a result, large voltage drop occurs across resistance R_S . Hence voltage across R_L is constant. When input voltage decreases, voltage drop across R_S decreases and output voltage across R_L is maintained at constant value.

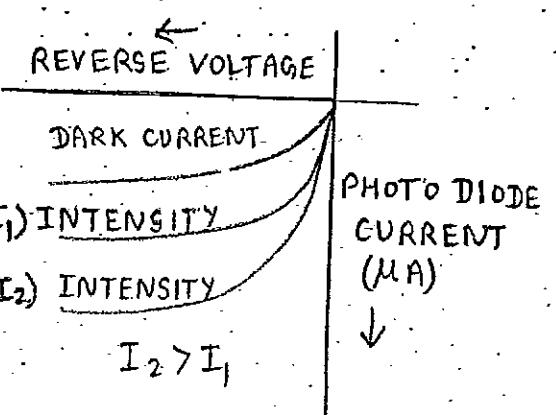
(II) Photo diode → A reverse biased special PN Junction diode having transparent window is known as photo diode and when it is illuminated with light, the reverse diode current varies linearly with light.

When photo diode is reverse biased then a constant current I_0 due to thermally generated minority carrier flows in the circuit. This current is also known as dark current.



When light of energy more than E_g falls on the photo diode, additional electron-hole pairs are formed proportional to the number of incident photons. These electrons-holes diffuse through the junction and hence current I_s flows in addition to I_0 . So total reverse current is given by $I = I_0 + I_s$

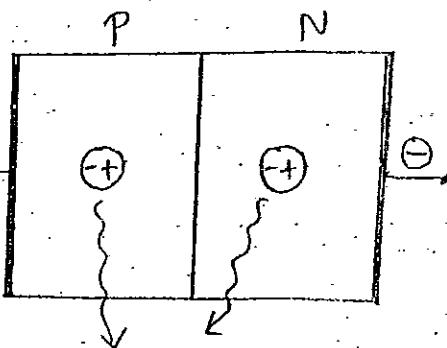
* During reverse bias the current is due to minority charge carriers. Light variations affect minority carrier based reverse current much more than forward current so photo-diode is used in reverse bias.



(2)

Light Emitting Diode (LED) → A specially designed heavily doped PN junction diode which emits spontaneous radiation when forward biased is known as light emitting diode (LED).

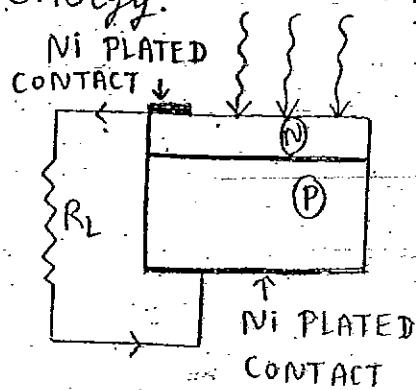
When a PN-Junction is forward biased in diode, the electrons injected to p-side of the junction diode falls from the conduction band to the valence band and recombine with the holes.



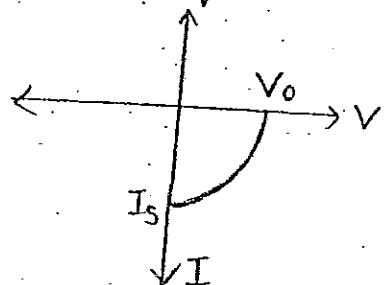
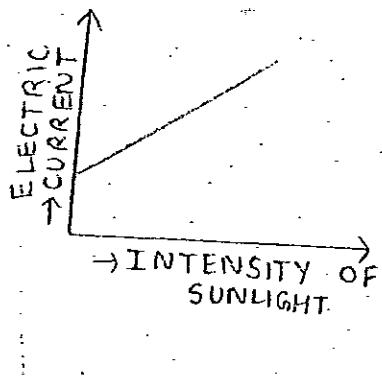
Hence energy is released in the process of recombination of electron-hole in the form of visible light. The wavelength of the emitted light is given by $\lambda = \frac{hc}{E_g}$. VI-characteristic of LED is same as PN-Junction diode except that its knee voltage is much higher. Its reverse breakdown voltage is very low (5 V).

IV) Solar cell → A PN-Junction diode which is specially designed so as to convert solar energy into electrical energy. SOLAR ENERGY

When solar energy falls on solar cells, electron-hole pairs are generated in both n-region and p-region of junction diode. Electrons from p-region diffuse through the junction to N-region



and holes from N-region diffuse through the junction to the P-region due to electric field of depletion layer. If PN-Junction diode is open circuited then holes and electrons will collect on the two sides of junction. When an external resistance is connected across the diode, electric current flows through the circuit.

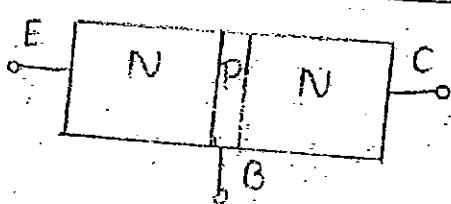


$V_o \rightarrow$ OPEN CIRCUIT VOLTAGE
 $I_s \rightarrow$ SHORT CIRCUIT CURRENT

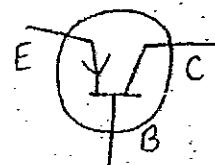
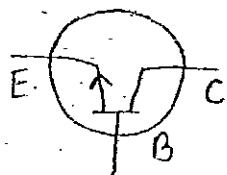
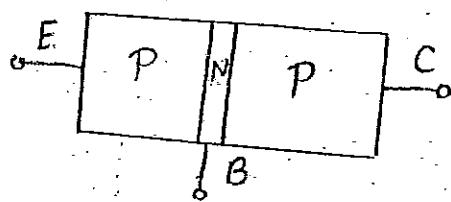
Junction Transistors

A transistor is a three terminal semiconductor device. A junction transistor consists of a thin layer of one type of extrinsic semiconductor sandwiched between two thick layers of other type of extrinsic semiconductor. It is of two types.

NPN transistor



PNP transistor



Action of transistors

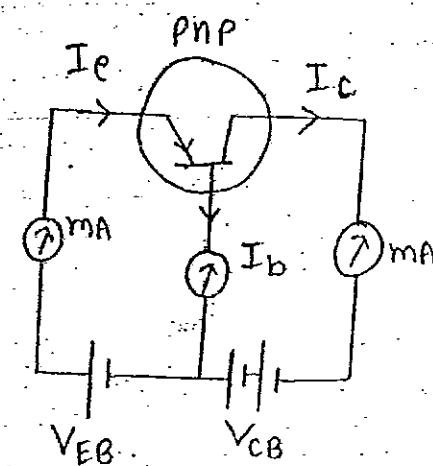
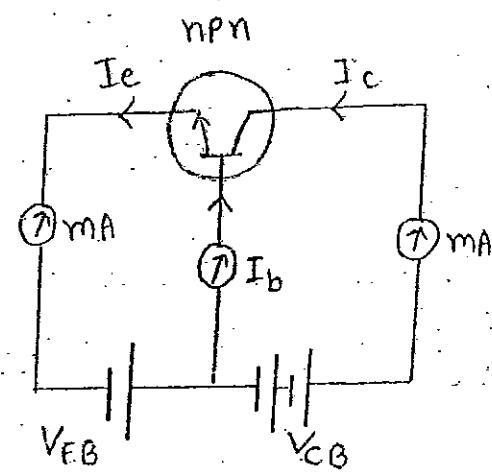
Action of n-p-n transistor

When emitter-base junction is forward biased, electrons in the emitter are repelled by the negative terminal of the cell towards base. The barrier potential of emitter-base junction decreases and electrons enter the base. About 5% of these electrons combine with the holes in the base region resulting in small base current (I_B). The remaining electrons (95%) enter the collector region because they are attracted towards the positive terminal of the battery. For each e^- entering the positive terminal of battery V_{CB} , an e^- from the negative terminal of the cell V_{CE} enters the emitter region.

Thus continuous flow of e^- from emitter to collector through the base begins.
 $I_C = I_B + I_C$ and $I_C \approx I_E$

Action of p-n-p transistor

When emitter-base junction is forward biased, holes in the emitter are repelled by the positive terminal of the cell towards the base.



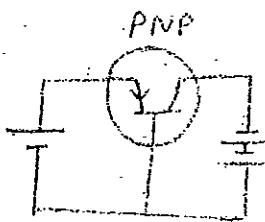
The barrier potential of emitter-base junction decreases and the holes enter the base (n-region). About 5% holes combine with the electrons of n-region resulting in small base current (I_B). The remaining holes (95%) enter the collector region because they are attracted towards the negative terminal of the battery. These holes constitute the collector current (I_C). The collector current is slightly less than the emitter current. As one hole reaches the collector, it is neutralized by an electron from the negative terminal of the battery. As soon as one electron and a hole get neutralized in the collector, a hole (created by breakage of covalent bond) in the emitter is pushed towards the collector by the positive terminal of battery V_{EB} . A continuous flow of holes from emitter to collector through the base begins. $I_e = I_b + I_c$ & $I_c \approx I_e$

* Base in the transistor is thin & lightly doped so that minimum number of majority carriers passing through the base get neutralized and large output will be available.

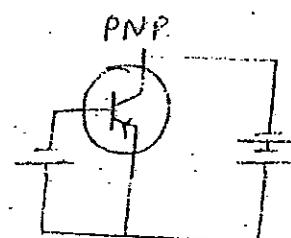
* In a transistor circuit, reverse bias is high as compared to forward bias so that it may exert a large attractive force on carriers to enter in collector region (i.e. least

Transistor circuit configurations & characteristics

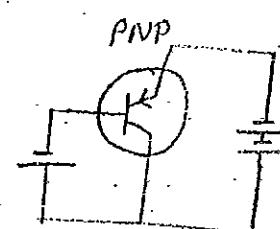
Common - base



Common-emitter

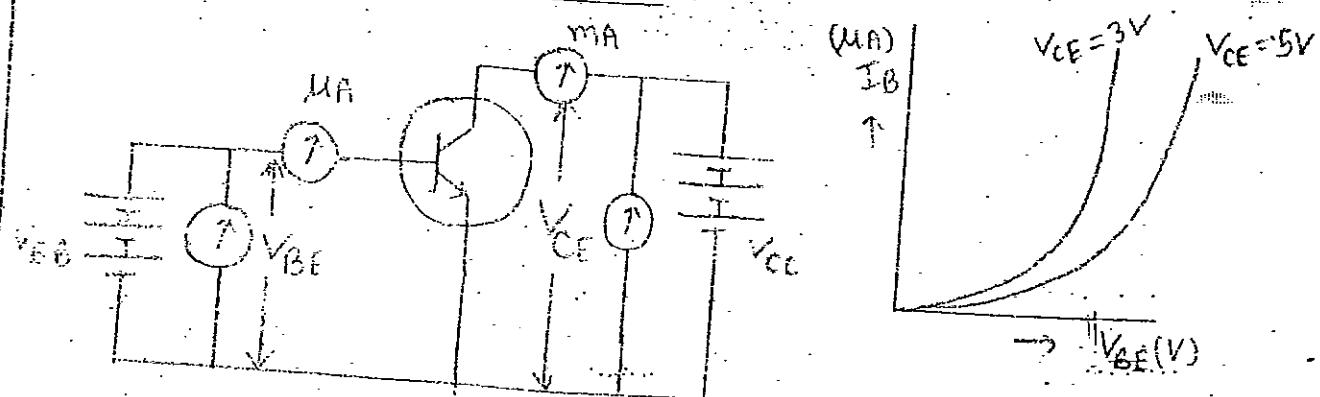


Common-collector



Common-emitter transistor characteristics

(i) Input characteristics



First keep the collector-emitter voltage (V_{CE}) constant & change V_{BE} in steps and note down the corresponding change in the values of V_{BE} vs I_B , plot the graph. The curve obtained is input characteristic.

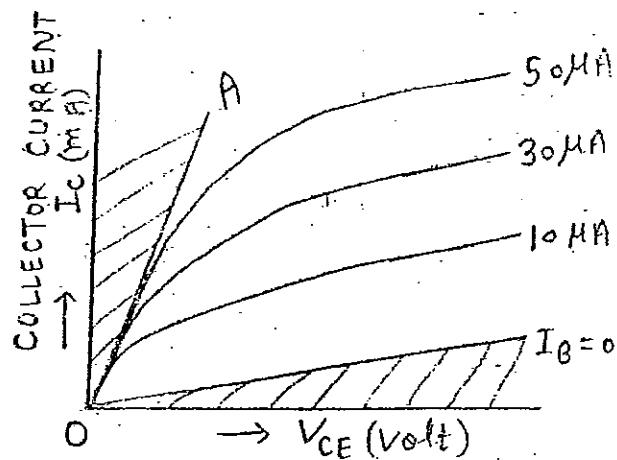
Input characteristics are similar to forward biased characteristics of a junction diode.

For a given value of V_{BE} , the base current decreases with increase of V_{CE} .

Input dynamic resistance $r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B} \right)_{V_{CE} \text{ constt}}$

output characteristics →

First keep the base current I_B constant and change V_{CE} in steps and note down the corresponding values of collector current I_c .



The graph of V_{CE} vs I_c gives output characteristic. When the voltage V_{CE} increases from 0 to about 0.5V , I_c increases rapidly. This value of V_{CE} is called knee voltage. Once V_{CE} exceeds V_{BE} , I_c varies slowly & linearly with V_{CE} for given value of I_B . Larger the value of I_B , larger is the value of I_c for a given value of V_{CE} .

Three regions of output characteristic

(i) Saturation region → when $V_{CE} < V_{BE}$, both the junctions are forward biased. I_c does not depend on input current I_B . Shaded region towards the left of line OA is called saturation region.

(ii) Cut-off region → The shaded region lying below the curve $I_B = 0$ is called cut-off region. In this region, both the junctions are reverse biased & $I_c = 0$.

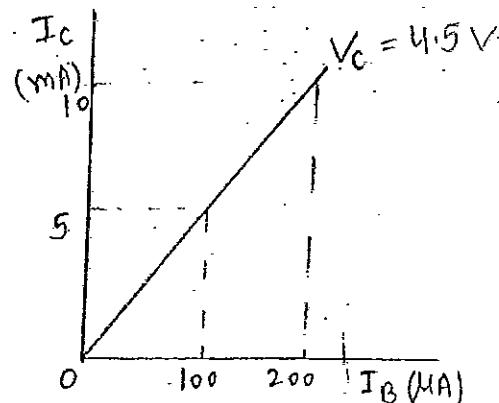
* In the shaded regions, the transistor acts as a smooth cut-off (OFF) & saturation (ON)

Active region → The non-shaded central region of output characteristic is called active region. In this region, the emitter-base junction is forward biased and collector-base junction is reverse biased. A transistor works as an audio amplifier in this region.

$$\text{output resistance, } r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C} \right)_{I_B \text{ constt.}}$$

Transfer characteristic

It is a graph showing the variation of collector current I_C with base current I_B at constant collector-emitter voltage.



Current amplification factor (β) → It is defined as the ratio of change in collector current to small change in base current at constant V_{CE} when the transistor is in active state.

$$\beta_{a.c} = \left(\frac{\Delta I_C}{\Delta I_B} \right)_{V_{CE} \text{ constt.}}$$

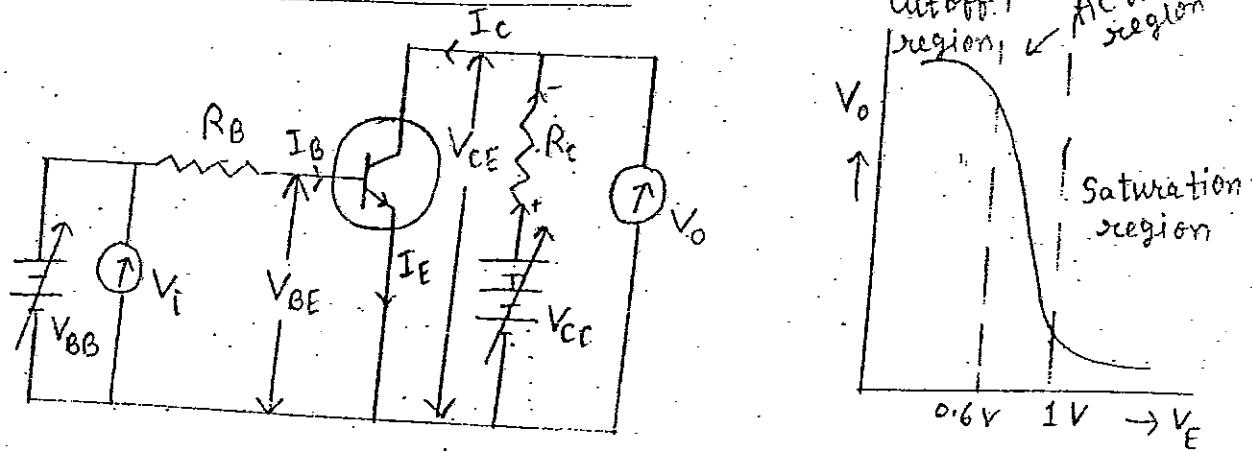
= Signal current gain

$$\& \beta_{d.c.} = \frac{I_C}{I_B}$$

Here values of $\beta_{a.c}$ and $\beta_{d.c.}$ are nearly equal.

* Read only

Transistor as a switch



Applying Kirchhoff's rule to the input & output circuits separately, we get

$$V_{BB} = I_B R_B + V_{BE} \text{ or } V_i = I_B R_B + V_{BE}$$

$$\& V_{CC} = I_C R_C + V_{CE} \text{ or } V_{CE} = V_o = V_{CC} - I_C R_C$$

Switching action of a transistor

When base input voltage V_{BB} is very low so that transistor is not forward biased then no current flows through R_C i.e. $I_C = 0$. Hence output voltage is V_{CC} . Here transistor is in OFF state & acts as open circuit.

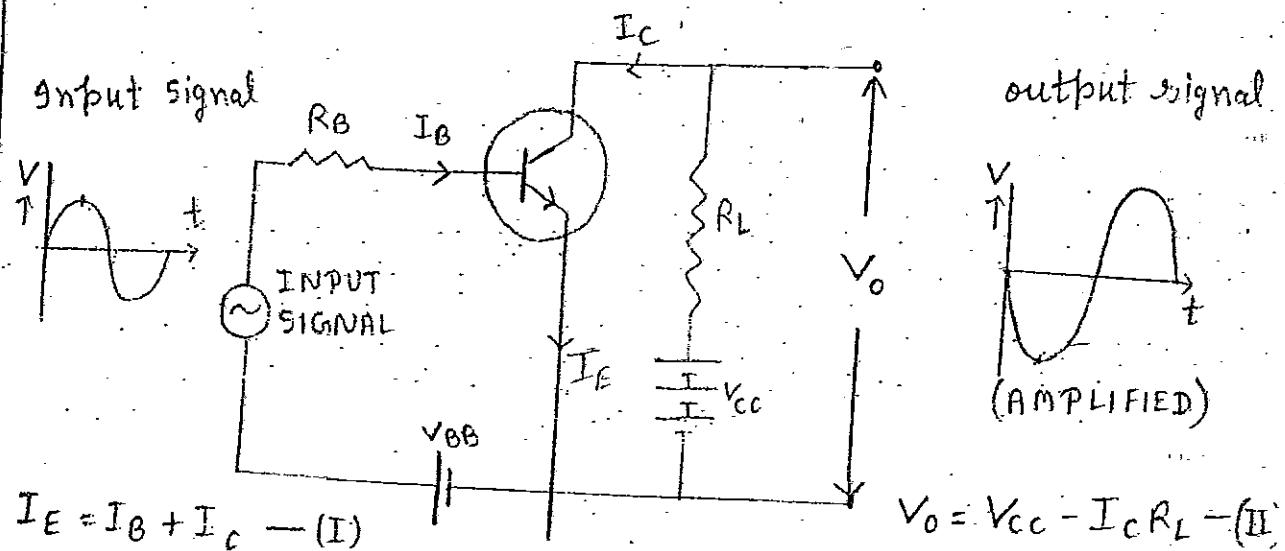
When base input voltage is made positive sufficiently, the transistor is forward biased. Now current I_C flows through R_C . Voltage drop across R_C is V_{CC} and $V_{CE} = 0$. Transistor is in saturation state and transistor acts as closed switch i.e. ON state.

* Transistor switching circuit is so designed that it never remains in active state.

Transistor as an amplifier (CE configuration)

A device which increases the amplitude of the input signal is called amplifier.

Amplifier circuit using n-p-n transistor



$$I_E = I_B + I_C \quad \text{(I)}$$

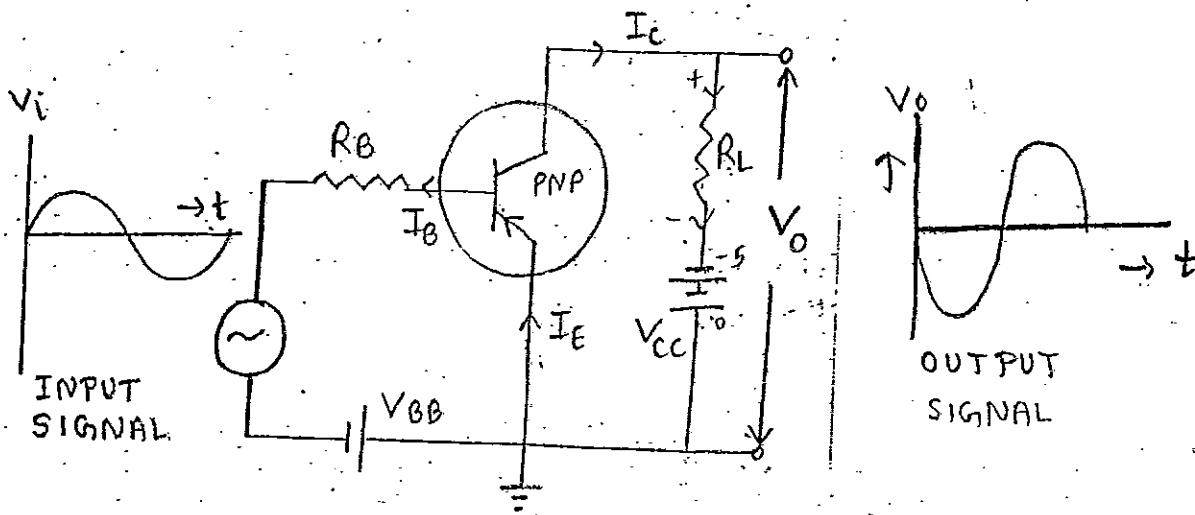
$$V_o = V_{cc} - I_C R_L \quad \text{(II)}$$

During positive half cycle of input signal, the forward bias of emitter-base junction increases. Due to increased forward bias, I_E increases & hence I_C also increases. Therefore voltage drop across R_L (i.e. $I_C R_L$) increases & hence V_o decreases according to eqn. II.

Similarly, during negative half cycle of input signal, the forward bias of emitter-base junction decreases. As a result of this, I_E decreases and hence I_C decreases. Therefore voltage drop across R_L (i.e. $I_C R_L$) decreases & hence V_o increases according to eqn. II.

Hence there is a phase difference of π between input & output signal.

Amplifier circuit using p-n-p transistor



$$I_E = I_B + I_C \quad \text{--- I}$$

$$V_o = V_{CC} - I_C R_L \quad \text{--- II}$$

During positive half cycle of input signal, the forward bias of emitter-base junction decreases. As a result of this, I_E and hence I_C decreases and according to eqn II V_o increases. Since collector is connected to the negative terminal of the battery so V_o becomes more negative.

During negative half cycle of input signal, the forward bias of emitter-base junction increases. As a result of this, I_E and hence I_C increases and according to eqn. II V_o decreases. Since collector is connected to the negative terminal of the battery so V_o becomes less negative.

In common-emitter amplifier, input & output signal are out of phase i.e. there is a phase difference of π between the input & output signals.

Transistor gains in C.E. amplifiers

Current gain (β)

$$\text{A.C current gain, } \beta_{\text{a.c.}} = \left(\frac{\Delta I_C}{\Delta I_B} \right)$$

$$\text{D.C current gain, } \beta = \frac{I_C}{I_B} \quad V_{CE} = \text{constt.}$$

Voltage gain (A_V)

$$A_V = \frac{\Delta V_o}{\Delta V_i}$$

$$V_o = V_{CC} - I_C R_L$$

$$V_i = V_{BE} + I_B R_B$$

$$|A_V| = \left(\frac{\Delta I_C}{\Delta I_B} \right) \left(\frac{R_L}{R_B} \right) = \beta_{\text{a.c.}} \times \text{resistance gain}$$

$$\text{Resistance gain} = \frac{R_o}{R_i} \approx \frac{R_L}{R_B}$$

Power gain

$$\text{Power gain} = \frac{\Delta P_o}{\Delta P_i}$$

$$P_o = V_o I_C = I_C^2 R_o$$

$$P_i = V_i I_B = I_B^2 R_i$$

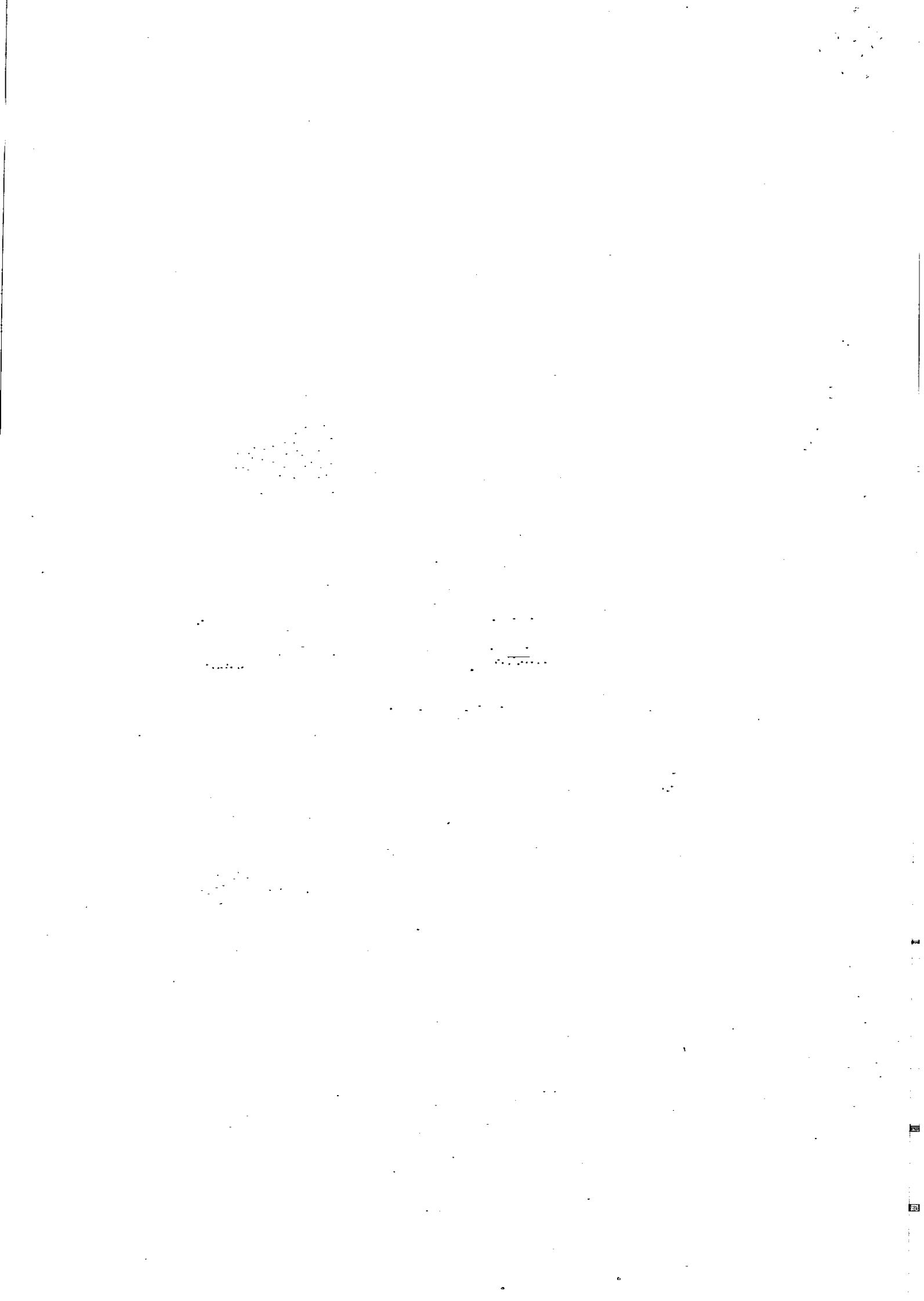
$$\Rightarrow \text{Power gain} = \frac{\Delta I_C^2 R_o}{\Delta I_B^2 R_i}$$

$$= \left(\frac{\Delta I_C}{\Delta I_B} \right)^2 \left(\frac{R_o}{R_i} \right) = \beta_{\text{a.c.}}^2 \times \text{resistance gain}$$

Transconductance

$$\text{or } g_m = \beta_{\text{a.c.}} / R_i$$

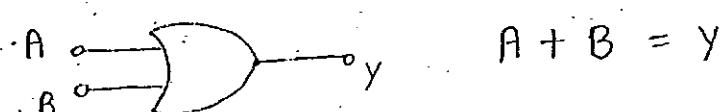
$$g_m = \left(\frac{\Delta I_C}{\Delta I_B} \right) \left(\frac{\Delta I_B}{\Delta V_B} \right) = \left(\frac{\Delta I_C}{\Delta V_B} \right)$$



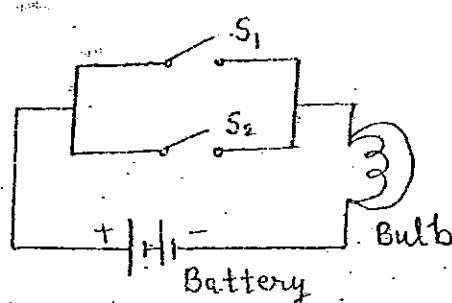
Logic gates → A gate is a digital circuit that is designed for performing a particular logical operation. As it works according to some logical relationship between input and output voltages, so it is generally known as a logic gate. There are three basic gates:

- ① OR gate
- ② AND gate
- ③ NOT gate

The 'OR' gate



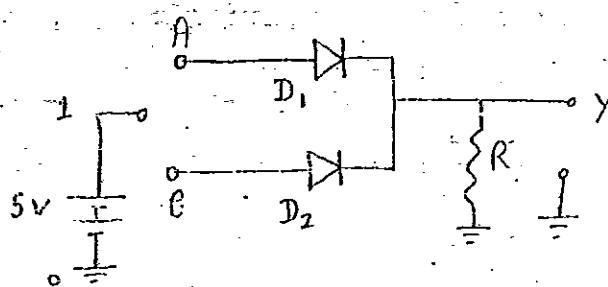
Analog circuit



Truth Table

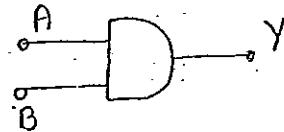
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Realisation of OR gate



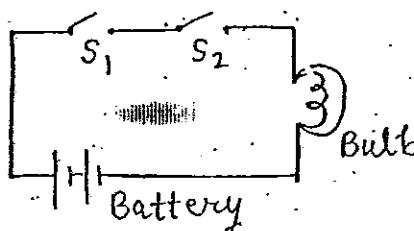
- (i) When $A=0$, $B=0$, both D_1 & D_2 will not conduct & output across R i.e. Y is zero.
- (ii) When $A=0$, $B=1$, D_1 will not conduct & D_2 will conduct and we get full voltage across R , $Y=1$.
- (iii) When $A=1$, $B=0$, D_1 will conduct & D_2 will not conduct & we get full voltage across R , $Y=1$.
- (iv) When $A=1$, $B=1$, both D_1 & D_2 will conduct & their anti-parallel & output is high $Y=1$.

The 'AND' gate



$$A \cdot B = Y$$

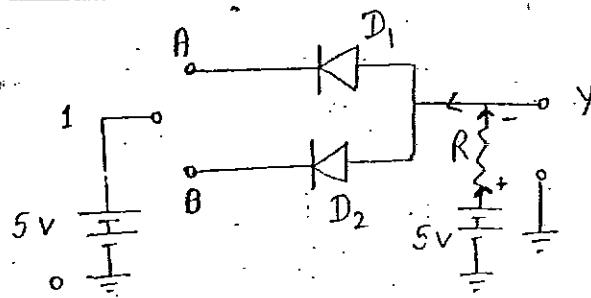
Analog circuit



Truth Table

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Realisation of AND gate



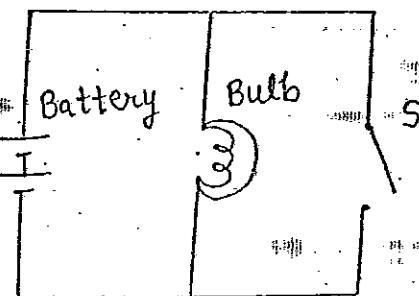
- (i) When $A=0$ & $B=0$, both D_1 & D_2 are forward biased and they conduct to give voltage drop across R and we get output $Y=0$
- (ii) When $A=0$ & $B=1$, diode D_1 will conduct & D_2 will not conduct. Due to D_1 , current flows through R & there is voltage drop across R & output $Y=0$
- (iii) When $A=1$ & $B=0$, diode D_2 will conduct & D_1 will not conduct. Due to D_2 , current flows & there is voltage drop across R . We get output $Y=0$
- (iv) When $A=1$ & $B=1$, both D_1 & D_2 will not conduct and we get output high & $Y=1$

The 'NOT' gate (or NOT circuit)



$$\bar{A} = Y$$

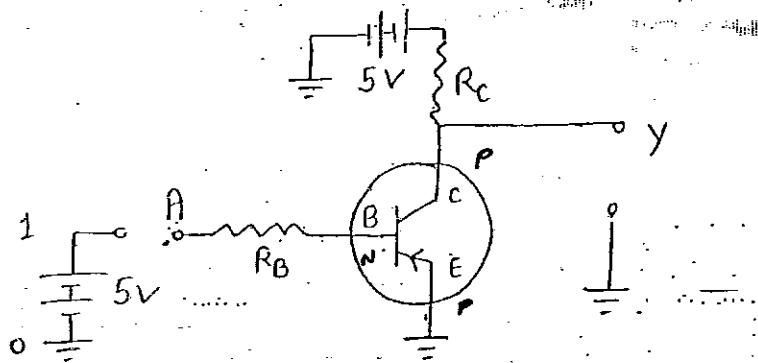
Analog circuit



Truth Table

A	Y
0	1
1	0

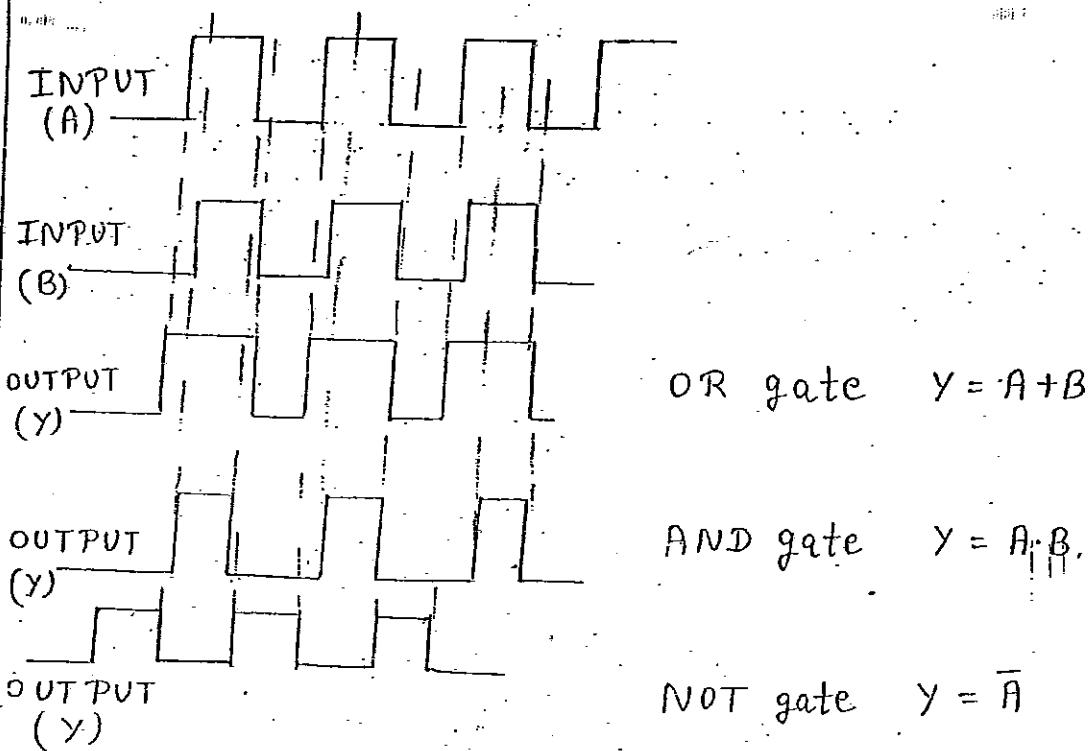
Realisation of NOT gate



- (i) When input $A=0$, emitter-base junction is not forward biased and the collector-base junction is reverse biased. Both I_B & I_C are zero and transistor is in cut off mode. There is no voltage drop across R_C and output $Y=1$.
- (ii) When input $A=1$, both emitter and collector are forward biased. A large collector current flows. The transistor is in saturation mode. The voltage drop across R_C is almost 5V. Hence output $Y=0$.

Sketch the output waveform obtained from
(i) an OR gate (ii) an AND gate (iii) a NOT gate
for the given square wave input 'A'.

* Square Wave Input (Digital input).



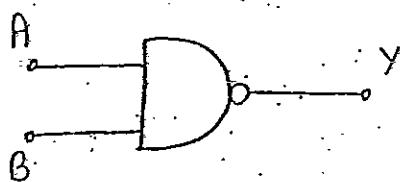
Key points

OR gate → output is high, when either A or B is high.

AND gate → output is high, when both A & B are high.

NOT gate → output is high, when input is low
and output is low, when input is high.

The 'NAND' gate

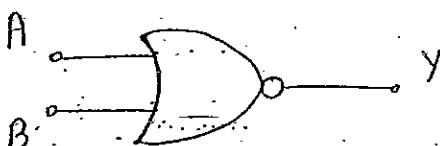


$$Y = \overline{A \cdot B}$$

Truth Table

A	B	$Y' = AB$	$Y = \overline{AB}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

The 'NOR' gate



$$Y = \overline{A + B}$$

Truth Table

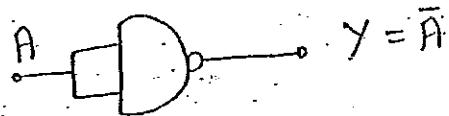
A	B	$Y' = A + B$	$Y = \overline{A + B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

- * NAND gate \rightarrow output will be high if anyone of inputs is low.
- * NOR gate \rightarrow output will be low if anyone of inputs is high.

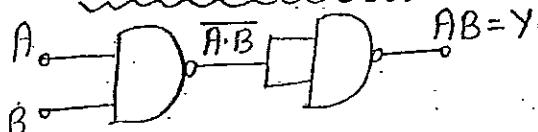
NAND & NOR gates as digital building blocks

NAND & NOR are called universal gates as all basic gates (OR, AND & NOT) can be obtained from these gates.

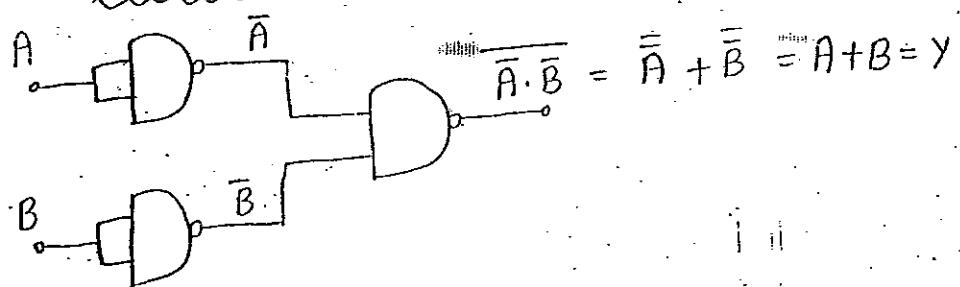
NAND \rightarrow NOT



NAND \rightarrow AND



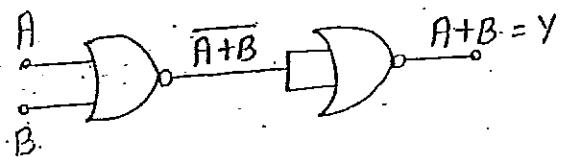
NAND \rightarrow OR



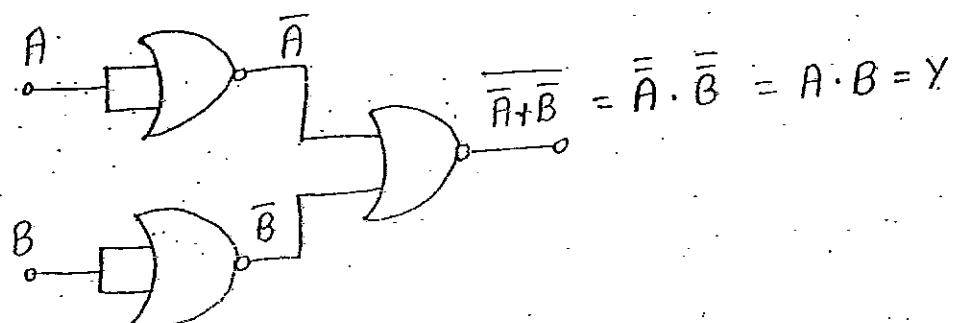
NOR \rightarrow NOT



NOR \rightarrow OR

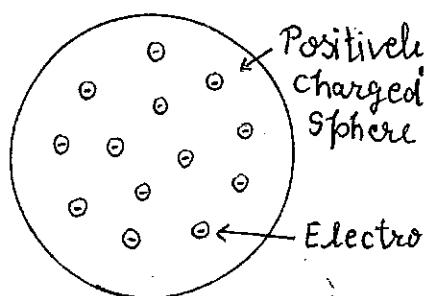


NOR \rightarrow AND

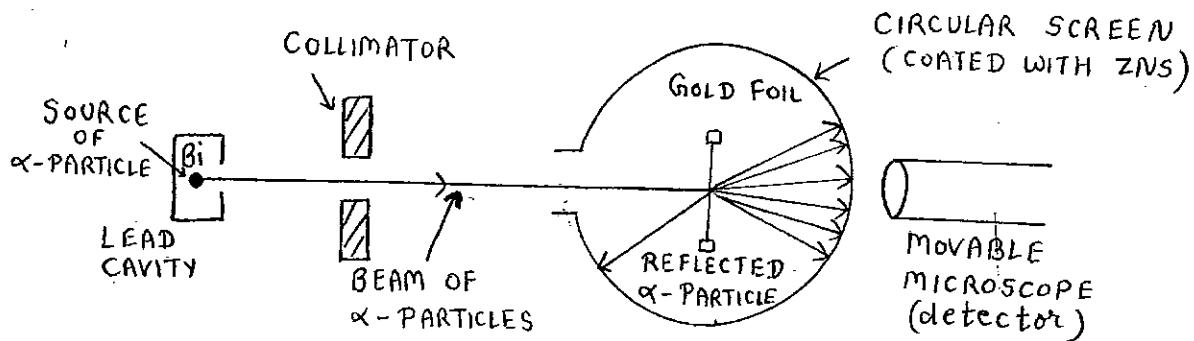


Atoms and Nuclei

Thomson model → An atom is a sphere of positive charges of uniform density of about 10^{-10}m diameter in which negative charges are embedded like plums in the pudding. This is also called 'Plum pudding model'.

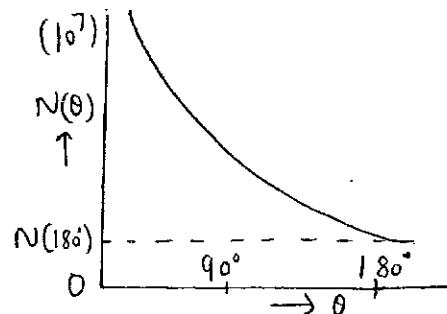


Alpha - Particle scattering experiment and Rutherford's Nuclear model of atom →



- Observations → (i) Most of the α -particles passed through the gold foil undeflected.
(ii) Some of the α -particles were deflected through small angles ($>1^\circ$)
(iii) A few α -particles were deflected through large angles ($>90^\circ$) & very few retraced their path.
(iv) The number of α -particles per unit area [$N(\theta)$] that reach the screen at a scattering angle θ were found to vary as

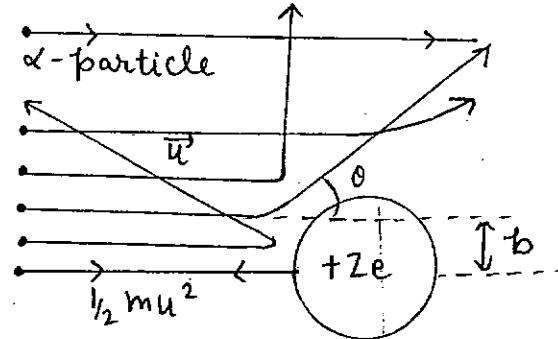
$$N(\theta) \propto \frac{1}{\sin^4(\theta/2)}$$



- Conclusions → (i) As most of the α -particles pass through the gold foil undeflected, so it indicates that most of the space in an atom is empty.
- (ii) The positive charges in an atom were concentrated in a very small region at the centre of the atom.
- (iii) Electrons being very light do not affect the α -particles.

Alpha-Particle Trajectory and Impact Parameter

The perpendicular distance of the velocity vector (\vec{u}) of the incident α -particle from the centre of the nucleus when α -particle is not deflected is known as Impact Parameter. (b).



The angle between the direction of approach of the alpha particle and the direction of moving away of α -particle is called scattering angle (θ)

$$b = \frac{2e^2 \cot \theta/2}{4\pi\epsilon_0 E} \quad \& \quad E = \frac{1}{2}mu^2$$

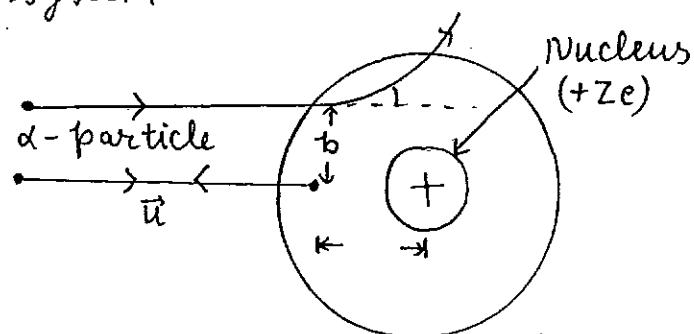
Distance of Closest Approach

K.E. of α -particle = P.E. of system

$$\frac{1}{2}mu^2 = \frac{1}{4\pi\epsilon_0} \frac{2Ze^2}{r_0}$$

$$\Rightarrow r_0 = \frac{2Ze^2}{4\pi\epsilon_0 (\frac{1}{2}mu^2)}$$

$$\Rightarrow r_0 = \frac{2Ze^2}{4\pi\epsilon_0 (K.E.)}$$



Drawbacks of Rutherford's model of Atom

- (i) It failed to fully explain the stability of the atom.
- (ii) It failed to explain the complex spectrum emitted by an atom.

Atomic Spectra → Atomic spectra deals with frequencies (or wavelengths) and intensities of electromagnetic radiations absorbed or emitted by atom.

Types of atomic spectra

- (i) Line emission spectrum → It is the series of lines of various wavelengths emitted by an atomic gas or vapour usually excited by passing an electric current through it.
Examples (i) The spectrum of mercury vapours has strong blue & strong green lines
(ii) Spectrum of sodium has strong yellow line ($\lambda = 590\text{nm}$) alongwith a closely spaced dim yellow line ($\lambda = 596\text{nm}$)
(iii) Spectrum of neon has intense red lines responsible for the red colour of neon bulb.
- (ii) Line Absorption spectrum → When white light passes through a gas or vapour, then the spectrum of transmitted light observed with a spectrometer shows some dark lines. This is known a absorption spectrum. This is similar to emission spectrum.

Bohr's atomic model

- (i) An electron revolves around the nucleus with a definite fixed energy in a fixed path known as stationary state (energy level).
- (ii) It states that electrons can revolve only in those energy levels, in which its angular momentum is an integral multiple of $\hbar/2\pi$.
- (iii) It states that electron can jump from higher energy level to lower energy level radiating energy in the form of a photon of frequency ν .

$$\hbar\nu = E_i - E_f$$

Bohr's theory of Hydrogen atom (Derivations)

Coulomb's force of attraction between the nucleus and the electron revolving in an orbit of radius r_n is given by

$$F_n = \frac{e^2}{4\pi\epsilon_0 r_n^2}$$

This provides centripetal force for electron

$$\Rightarrow \frac{mv_n^2}{r_n} = \frac{e^2}{4\pi\epsilon_0 r_n^2} \text{ or } mv_n^2 = \frac{e^2}{4\pi\epsilon_0 r_n}$$

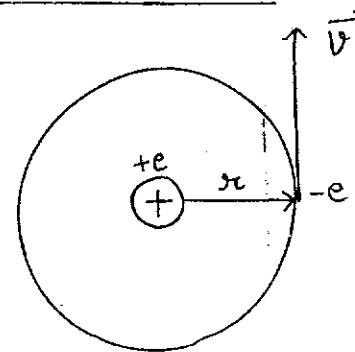
$$\text{Now } L_n = mv_n r_n = nh/2\pi$$

$$\Rightarrow v_n = \frac{nh}{2\pi mr_n}$$

$$\text{Radius of an orbit } m \left(\frac{nh}{2\pi mr_n} \right)^2 = \frac{e^2}{4\pi\epsilon_0 r_n}$$

$$\Rightarrow r_n = \frac{n^2 h^2 \epsilon_0}{\pi m e^2}$$

$$\Rightarrow r_n \propto n^2$$



Speed of an electron in an orbit

$$v_n = \frac{n\hbar}{2\pi m r_n} = \frac{n\hbar}{2\pi m} \left(\frac{\pi m c^2}{n^2 h^2 \epsilon_0} \right)$$

$$\Rightarrow v_n = \frac{e^2}{2\pi \epsilon_0 n}$$

$$\Rightarrow v_n \propto \frac{1}{n} \quad \square$$

Total energy of an electron in an orbit

$$E_n = K.E_n + P.E_n$$

$$K.E._n = \frac{1}{2} m v_n^2$$

$$= \frac{1}{2} \frac{e^2}{4\pi \epsilon_0 r_n}$$

$$P.E._n = -\frac{e^2}{4\pi \epsilon_0 r_n}$$

$$\Rightarrow E_n = \frac{e^2}{8\pi \epsilon_0 r_n} - \frac{e^2}{4\pi \epsilon_0 r_n}$$

$$= -\frac{e^2}{8\pi \epsilon_0 r_n}$$

$$\text{or } E_n = -\frac{m e^4}{8\pi^2 \epsilon_0^2 h^2 n^2}$$

After putting the values of constants for Hydrogen, we get

$$E_n = -\frac{13.6}{n^2} \text{ eV} \quad \square$$

Frequency (v_n) of an electron in nth orbit

$$v_n = \frac{v_n}{2\pi r_n}$$

$$v_n = \frac{e^2}{2\pi \epsilon_0 n} \quad \& \quad r_n = \frac{n^2 \hbar^2 \epsilon_0}{\pi m c^2}$$

$$\Rightarrow v_n = \frac{1}{2\pi} \times \frac{e^2}{2\pi \epsilon_0 n} \times \frac{\pi m c^2}{n^2 \hbar^2 \epsilon_0} = \frac{m c^4}{4 \pi^3 \epsilon_0^2 n^3}$$

$$\Rightarrow v_n \propto \frac{1}{n^3} \quad \square$$

Energy levels of hydrogen atom

$$E_n = -\frac{13.6}{n^2} \text{ eV}$$

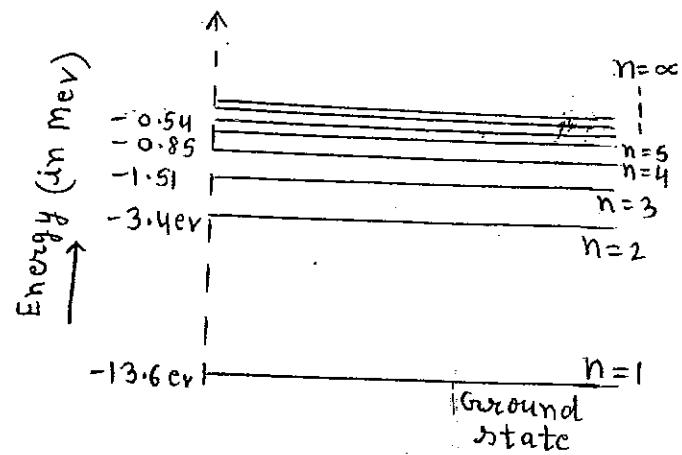
For $n=1$, $E_1 = -13.6 \text{ eV}$ (ground state)

$$\text{For } n=2, E_2 = -\frac{13.6}{2^2} = -3.4 \text{ eV}$$

$$\text{For } n=3, E_3 = -\frac{13.6}{3^2} = -1.51 \text{ eV}$$

$$\text{--- For } n=\infty, E_{\infty} = -\frac{13.6}{\infty} = 0$$

It is clear from the diagram that when principle quantum number (n) increases, the energy levels come closer & closer to each other.



The line spectra of Hydrogen atom

$$h\nu = E_{n_i} - E_{n_f}$$

$$\text{Now } E_n = \frac{-me^4}{8\pi^2\epsilon_0^2 n^2}$$

$$\Rightarrow h\nu = \frac{-me^4}{8\epsilon_0^2 n_i^2 h^2} - \left(\frac{-me^4}{8\epsilon_0^2 n_f^2 h^2} \right)$$

$$\Rightarrow \nu = \frac{me^4}{8\epsilon_0^2 ch^3} \left[\frac{1}{n_f^2} - \frac{1}{n_i^2} \right] = \frac{c}{\lambda}$$

$$\text{or } \frac{1}{\lambda} = \frac{me^4}{8\epsilon_0^2 ch^3} \left[\frac{1}{n_f^2} - \frac{1}{n_i^2} \right]$$

$$\text{or } \frac{1}{\lambda} = R \left[\frac{1}{n_f^2} - \frac{1}{n_i^2} \right] \quad \left\{ \begin{array}{l} R = \frac{me^4}{8\epsilon_0^2 ch^3} \\ = 1.097 \times 10^7 \text{ m}^{-1} \end{array} \right\}$$

$$\frac{1}{\lambda} = \bar{\nu} \text{ (wave number)} = R \left[\frac{1}{n_f^2} - \frac{1}{n_i^2} \right] \leq$$

Various spectral series (H-atom)

(i) Lyman series → The spectral lines emitted due to the transition of an electron from any outer orbit ($n_i = 2, 3, 4, \dots$) to the first orbit ($n_f = 1$) form a spectral series known as Lyman series.

$$\bar{\nu} = \frac{1}{\lambda} = R \left[\frac{1}{n_f^2} - \frac{1}{n_i^2} \right]$$

$$\Rightarrow \bar{\nu} = R \left[\frac{1}{1^2} - \frac{1}{n_i^2} \right] \quad n_i = 2, 3, 4, \dots$$

Longest wavelength ($\lambda_{L\max}$)

$$\frac{1}{\lambda_{L\max}} = R \left[\frac{1}{1^2} - \frac{1}{2^2} \right] = \frac{3R}{4}$$

$$\lambda_{L\max} = \frac{4}{3R} = 1.216 \times 10^{-7} \text{ m}$$

Shortest wavelength ($\lambda_{L\min}$)

$$\frac{1}{\lambda_{L\min}} = R \left[\frac{1}{1^2} - \frac{1}{\infty} \right] = R$$

$$\lambda_{L\min} = \frac{1}{R} = 0.911 \times 10^{-7} \text{ m}$$

This series lies in ultra-violet region

(ii) Balmer series → The spectral lines emitted due to the transition of an electron from any outer orbit ($n_i = 3, 4, 5, 6, \dots$) to the second orbit ($n_f = 2$) form a spectral series known as Balmer series.

$$\bar{\nu} = \frac{1}{\lambda} = R \left[\frac{1}{2^2} - \frac{1}{n_i^2} \right] \quad n_i = 3, 4, 5, \dots$$

Longest wavelength $\lambda_{B\max}$

$$\frac{1}{\lambda_{B\max}} = R \left[\frac{1}{2^2} - \frac{1}{3^2} \right] = \frac{5R}{36}$$

$$\lambda_{B\max} = \frac{36}{5R} = 6560 \text{ Å}$$

shortest wavelength ($\lambda_{B\text{ min.}}$)

$$\frac{1}{\lambda_{B\text{ min.}}} = R \left[\frac{1}{2^2} - \frac{1}{\infty} \right] = \frac{R}{4}$$

$$\lambda_{B\text{ min.}} = \frac{4}{R} = 3644 \text{ Å}$$

This series lies in the visible region.

(iii) Paschen series → The spectral lines emitted due to the transition of an electron from any outer orbit ($n_i = 4, 5, 6, \dots$) to the third orbit ($n_f = 3$) form a spectral series known as Paschen series.

$$\bar{\nu} = \frac{1}{\lambda} = R \left[\frac{1}{3^2} - \frac{1}{n_i^2} \right] \quad n_i = 4, 5, 6, \dots$$

longest wavelength ($\lambda_{Pa\text{ max.}}$)

$$\frac{1}{\lambda_{Pa\text{ max.}}} = R \left[\frac{1}{3^2} - \frac{1}{4^2} \right] = \frac{7R}{144}$$

$$\lambda_{Pa\text{ max.}} = \frac{144}{7R} = 18741 \text{ Å}$$

shortest wavelength ($\lambda_{Pa\text{ min.}}$)

$$\frac{1}{\lambda_{Pa\text{ min.}}} = R \left[\frac{1}{3^2} - \frac{1}{\infty} \right] = \frac{R}{9}$$

$$\lambda_{Pa\text{ min.}} = \frac{9}{R} = 8199 \text{ Å}$$

This series lies in the Infra-red region.

(iv) Brackett Series → The spectral lines emitted due to the transition of an electron from any outer orbit ($n_i = 5, 6, 7, \dots$) to the fourth orbit ($n_f = 4$) form a spectral series known as Brackett series.

$$\bar{\nu} = \frac{1}{\lambda} = R \left[\frac{1}{4^2} - \frac{1}{n_i^2} \right] \quad n_i = 5, 6, 7, \dots$$

Longest wavelength ($\lambda_{Br. max}$)

$$\frac{1}{\lambda_{Br. max}} = R \left[\frac{1}{4^2} - \frac{1}{5^2} \right] = \frac{9R}{400}$$

$$\text{or } \lambda_{Br. max} = \frac{400}{9R} = 40589 \text{ Å}$$

shortest wavelength ($\lambda_{Br. min.}$)

$$\frac{1}{\lambda_{Br. min.}} = R \left[\frac{1}{4^2} - \frac{1}{\infty} \right] = \frac{R}{16}$$

$$\text{or } \lambda_{Br. min.} = \frac{16}{R} = 14576 \text{ Å}$$

This series lies in Infra-red region.

(V) Pfund series → The spectral lines emitted due to the transition of an electron from any outer orbit ($n_i = 6, 7, 8, \dots$) to the fifth orbit ($n_f = 5$) form a spectral series known as Pfund series.

$$\bar{v} = \frac{1}{\lambda} = R \left[\frac{1}{5^2} - \frac{1}{n_i^2} \right] \quad n_i = 6, 7, 8, \dots$$

Longest wavelength ($\lambda_{Pf max}$)

$$\frac{1}{\lambda_{Pf max}} = R \left[\frac{1}{5^2} - \frac{1}{6^2} \right] = \frac{11R}{900}$$

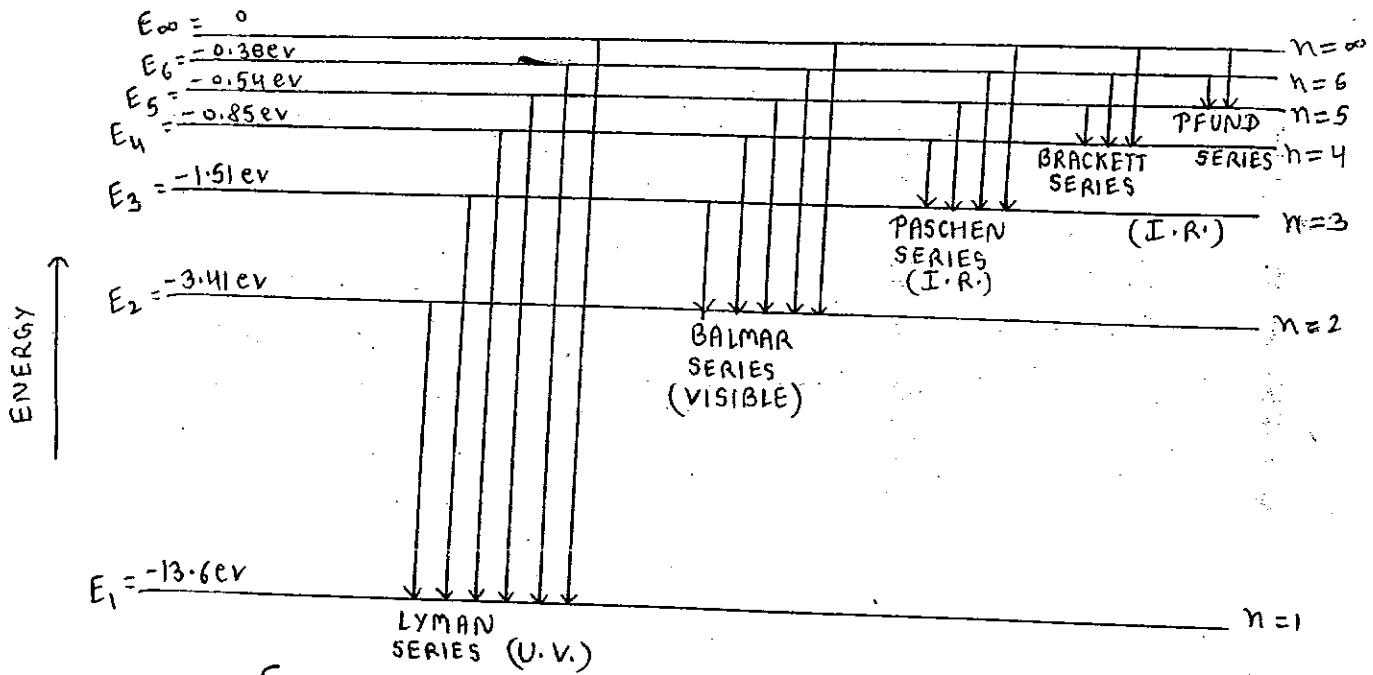
$$\text{or } \lambda_{Pf max.} = \frac{900}{11R} = 74536 \text{ Å}$$

shortest wavelength ($\lambda_{Pf min.}$)

$$\frac{1}{\lambda_{Pf min.}} = R \left[\frac{1}{5^2} - \frac{1}{\infty} \right] = \frac{R}{25}$$

$$\text{or } \lambda_{Pf min.} = \frac{25}{R} = 22775 \text{ Å}$$

This series lies in Infra-red region.



[Energy level diagram (H-atom)]

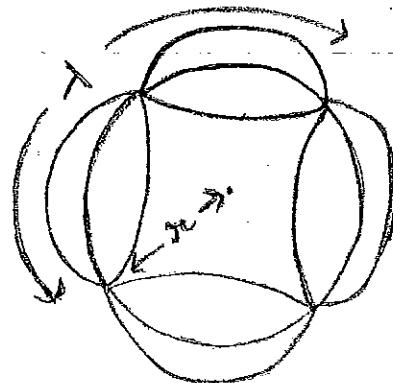
De-Broglie's explanation of Bohr's second postulate of quantization of Angular momentum →

Bohr could not explain as to why only certain energy levels were allowed for orbiting the e^- around the nucleus of atom. De-Broglie assumed that an electron orbit would be stable only if it contained an integral multiple of e^- wavelength. According to him

$$2\pi r = n\lambda, \lambda = \frac{h}{mv}$$

$$\Rightarrow 2\pi r = \frac{nh}{mv} \quad \text{or} \quad mv r = \frac{nh}{2\pi}$$

$$\Rightarrow L = n(\hbar/2\pi)$$



Drawbacks of Bohr's model

- It could not explain spectra of complex atoms.
- It could not explain fine structure of Balmer series spectral lines.
- It could not account for wave nature of electrons.
- It could not explain Zeeman and Stark effect.

Composition of a Nucleus

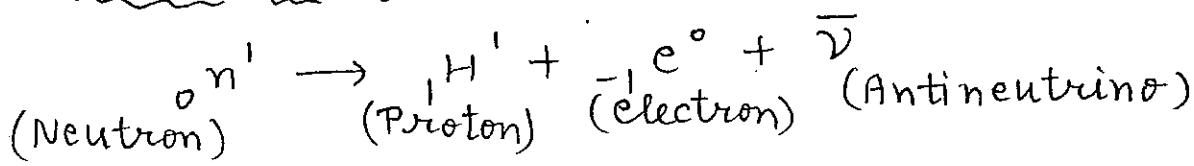
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The number of protons in a nucleus is known as atomic number (Z).

The sum of no. of protons (Z) and no. of neutrons (N) is called mass number (A).

$$A = z + N \quad \text{or} \quad N = A - z$$

Nucleus is represented by ${}_{Z}^{A}X$ or ${}_{Z}^{A}X$
Decay of free neutron



The half time of a free neutron is about 15 minutes.

Size of nucleus

$$\text{Volume } V = \frac{4}{3} \pi R^3 \propto A$$

$$\text{or } R \propto A^{1/3} \quad \text{or } R = R_0 A^{1/3}$$

R_0 is empirical constant $R_0 = 1.2$ fermi

Einstein's mass-energy equation

$$E = mc^2 \quad (\text{Acc to Einstein})$$

Rest mass energy is $m_0 c^2$

If T is K.E. of particle then

Total mass-energy, $E = m_0 c^2 + T$

$$\text{or } mc^2 = m_0 c^2 + T$$

$$\text{or } T = (m - m_0)c^2 = \Delta mc^2$$

$$\leq T = \Delta m c^2$$

Mass Defect → It is defined as the difference between the mass of constituent nucleons of a nucleus in the free state and the mass of the nucleus. It is denoted by Δm .

$$\Delta m = \{Z m_p + (A-Z) m_n\} - M$$

Nuclear Binding energy → The total energy required to disintegrate the nucleus into its constituent particles (i.e. nucleons) is called nuclear binding energy.

The energy equivalent to mass-defect is the binding energy of the nucleus.

$$E_b = \Delta m \cdot c^2 \text{ (Binding energy)}$$

$$\Delta m = \{Z m_p + (A-Z) m_n\} - M$$

$$\Rightarrow E_b = [\{Z m_p + (A-Z) m_n\} - M] \cdot c^2$$

$$\text{We can also write, } E_b = \Delta m \times 931 \text{ MeV}$$

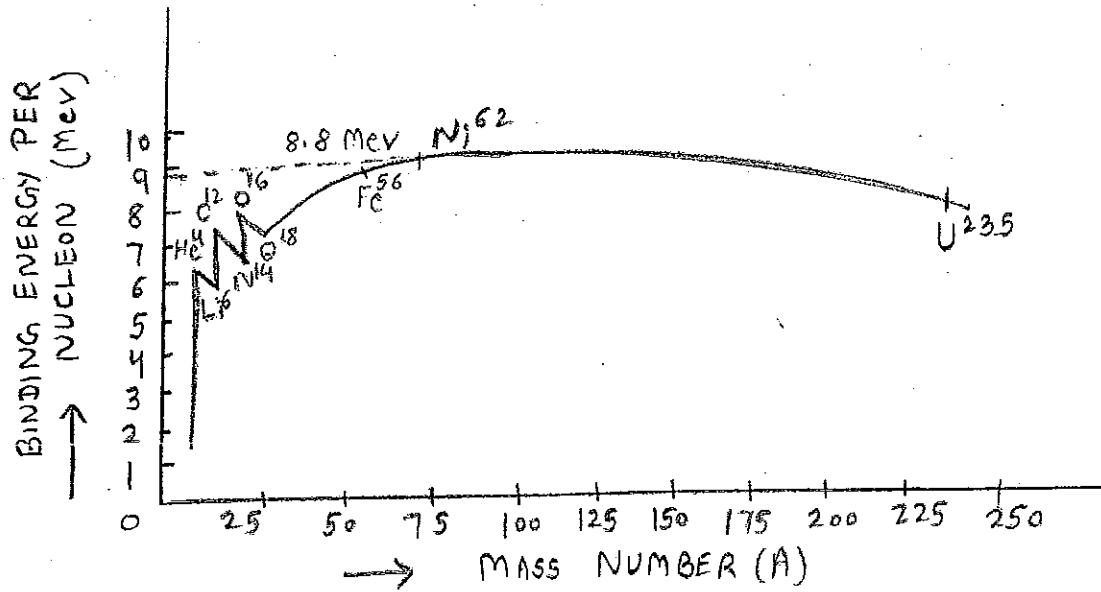
Nuclear Binding Energy Per Nucleon → The average energy required to release a nucleon from the nucleus is called binding energy per nucleon.

$$\text{Binding energy per nucleon} = \frac{\text{Binding Energy}}{\text{Mass Number}}$$

$$E_{bn} = \frac{\Delta m \times 931}{A} \text{ MeV}$$

B.E./Nucleon determines the stability of a nucleus.

B.E. per Nucleon curve



- (i) Average B.E. per nucleon for mass number less than 3 is very small.
- (ii) Some nuclei ${}_2^{He^4}$, ${}_4^{Be^8}$, ${}_6^{C^{12}}$, ${}_8^{O^{16}}$ and ${}_{10}^{Ne^{20}}$ have greater B.E. than their neighbouring nuclei.
- (iii) For ${}_{28}^{Ni^{62}}$, B.E. per nucleon is maximum (i.e. 8.8 Mev). Thus iron, Nickel etc are stable elements.
- (iv) For $A > 62$, B.E./nucleon decreases and for $A = 238$, it drops to 7.5 Mev.

Importance of the curve → (i) When a heavy nucleus splits up into lighter nuclei, the B.E. per nucleon of lighter nuclei is more than that of heavy nucleus. Thus energy is released. (Nuclear fission)
(ii) When two very light nuclei $A \leq 10$ combines to form a relatively heavy nucleus then energy is released (Nuclear fusion).

Packing Fraction \rightarrow It is defined as the mass difference per nucleon.

$$P_f = \frac{(M - A)}{A}$$

Here M is actual mass of nucleus.

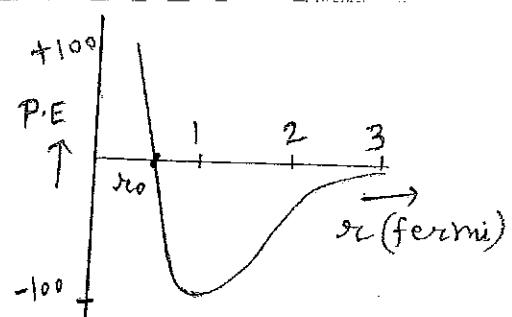
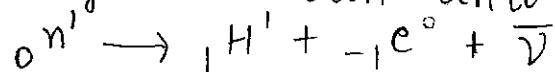
Packing fraction measures the stability of the nucleus.

Nuclear forces \rightarrow Nuclear forces are the strongest and short-range forces. Nuclear forces arise due to exchange of particles known as π -mesons between the nucleons. They are attractive forces. They are charge independent.

- * π -meson is a fundamental particle whose mass is 270 times the mass of electron.
There are three types of π -mesons $[\pi^+, \pi^-, \pi^0]$
- * For distance $r_0 < 0.8$ fermi, nuclear forces become repulsive.

Nuclear Instability

The presence of neutrons in a nucleus plays an important role in nuclear stability. A nucleus becomes stable when no. of neutrons is equal to no. of protons in it. Thus heavy nuclei become stable by converting a neutron into a proton.



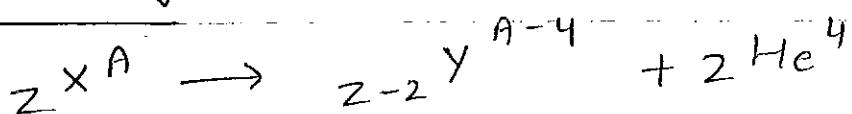
Radioactivity → The phenomenon of spontaneous emission of radiation by heavy unstable elements is called radio-activity.

Cause of radioactivity → Instability of heavy nuclei is the cause of radioactivity. Heavy nuclei have large number of protons. Electrostatic repulsion between protons make the heavy nucleus unstable.

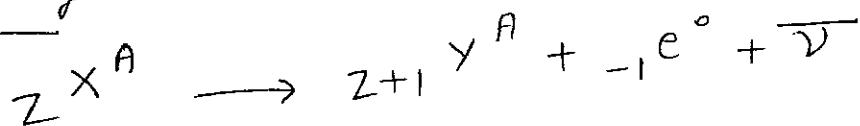
Heavy nuclei become stable by converting a neutron into a proton by emitting β -particle and antineutrino till the no. of neutrons is equal to no. of protons in the nucleus.

Becquerel rays → There are three types of rays emitted during radioactive decay ; α -rays, β -rays, γ -ray.

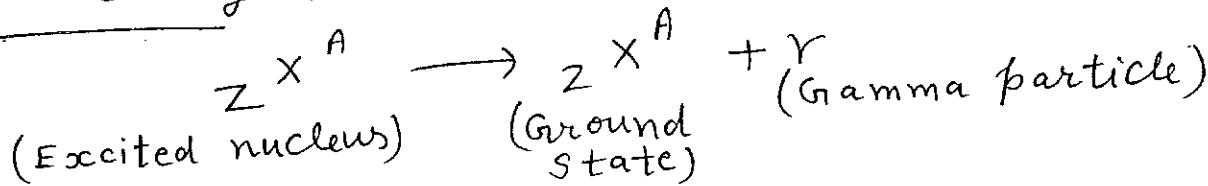
α - Decay →



β - Decay →



γ - Decay →



Properties of α , β & γ particles \rightarrow

- (1) α -particles \rightarrow (i) An α -particle is equivalent to helium nucleus (${}_{2}^{4}\text{He}^4$).
(ii) They have low penetrating power & high ionising power.
(iii) Their velocities ranges from $1.4 \times 10^7 \text{ m/s}$ to $2.2 \times 10^7 \text{ m/s}$.
(iv) They slightly affect the photographic plates.
(v) They can cause skin burns.
- (2) β -particles \rightarrow (i) A β -particle is compared to a fast moving electron ($-e^\circ$).
(ii) They have more penetrating power but less ($\frac{1}{100}$ th) ionising power than α -particle.
(iii) Their velocity can have value nearly equal to vel of light.
(iv) They affect the photographic plates.
(v) They are deflected by electric & magnetic fields.
- (3) γ -particles \rightarrow (i) They have no charge and their relative rest mass is zero.
(ii) They travel with speed of light in vacuum.
(iii) They have very high penetrating power & low ionising power ($\frac{1}{100}$ th of β -particles).
(iv) They affect the photographic plates.
(v) They are not deflected by electric & magnetic field.

Law of Radioactive decay → The rate of disintegration of a radioactive substance at an instant is directly proportional to the number of nuclei in the radioactive substance at that time.

Mathematical form → Let N_0 be the no. of atoms present in radioactive substance initially. When disintegration begins then after time t , no. of atoms remained N .

According to decay law

$$-\frac{dN}{dt} \propto N \quad [\lambda \text{ is disintegration constant}]$$

$$\text{or } R = -\frac{dN}{dt} = \lambda N$$

$$\text{or } \frac{dN}{N} = -\lambda dt$$

$$\Rightarrow \int \frac{dN}{N} = \int -\lambda dt$$

$$\Rightarrow \log_e N = -\lambda t + k$$

$$\text{at } t=0 \quad N = N_0$$

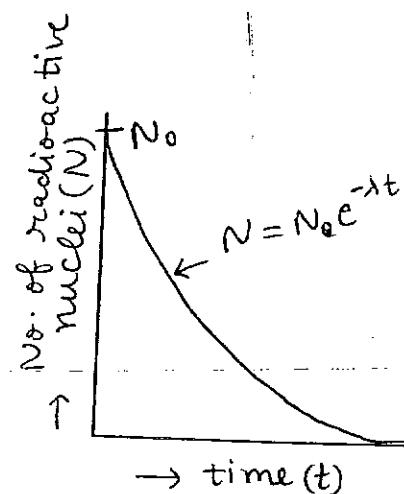
$$\Rightarrow \log_e N_0 = k$$

$$\Rightarrow \log_e N = -\lambda t + \log_e N_0$$

$$\Rightarrow \log_e \left(\frac{N}{N_0} \right) = -\lambda t \quad \left[\because \log N - \log N_0 = \log \frac{N}{N_0} \right]$$

$$\Rightarrow \frac{N}{N_0} = e^{-\lambda t}$$

$$\text{or } N = N_0 e^{-\lambda t}$$



Radioactive decay (disintegration) constant

Radioactive decay constant is the reciprocal of the time during which the number of atoms in the radioactive substance reduces to 36.8% of the original value of atoms in it.

$$N = N_0 e^{-\lambda t}$$

$$\text{At } t = \frac{1}{\lambda} \quad N = \frac{N_0}{e} = \frac{N_0}{2.718} = 0.368 N_0$$

$$\text{or } N = 36.8\% N_0$$

Half life of a radioactive substance

The time during which half of the atoms of the radioactive substance disintegrates is called half life of a radioactive substance.

$$N = N_0 e^{-\lambda t}$$

$$N = N_0 / 2 \quad \text{At } t = T_{1/2}$$

$$\Rightarrow \frac{N_0}{2} = N_0 e^{-\lambda T_{1/2}}$$

$$\Rightarrow e^{-\lambda T_{1/2}} = 2$$

$$\Rightarrow +\lambda T_{1/2} = \log_e 2 = 2.303 \log_{10} 2$$

$$\Rightarrow T_{1/2} = \frac{2.303 \times 0.3010}{\lambda} = \frac{0.6931}{\lambda}$$

$$\Rightarrow T_{1/2} \propto \frac{1}{\lambda}$$

Mean (Average) life of a Radioactive substance

It is given by the total sum of life time of all atoms divided by the total no. of atoms present.

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Mean life, $\tau = \frac{\text{Sum of lives of all atoms}}{\text{Total No. of atoms present}}$

$$\tau = \frac{T_{\text{total}}}{N_0}$$

We know that $N = N_0 e^{-\lambda t}$

$$\Rightarrow \frac{dN}{dt} = -\lambda N_0 e^{-\lambda t}$$

$$\Rightarrow dN = -\lambda N_0 e^{-\lambda t} dt$$

Total life of dN atoms $= \int_{N=N_0}^{N=0} t dN$

$$\begin{aligned} T_{\text{total}} &= \int_{N_0}^0 t (dN) \\ &= \lambda N_0 \int_0^\infty t e^{-\lambda t} dt \\ &= \lambda N_0 \left[\left(\frac{t e^{-\lambda t}}{-\lambda} \right)_0^\infty - \int_0^\infty \frac{e^{-\lambda t}}{-\lambda} dt \right] \\ &= -\frac{N_0}{\lambda} [e^{-\infty} - e^0] = \frac{N_0}{\lambda} \end{aligned}$$

$$\text{Now } \tau = \frac{N_0}{\lambda N_0} = \frac{1}{\lambda}$$

Relation between Half-life and mean life

$$T_{1/2} = \frac{0.693}{\lambda}, \quad \tau = \frac{1}{\lambda}$$

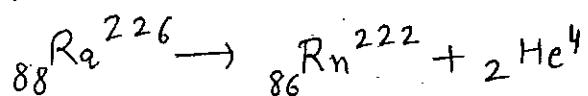
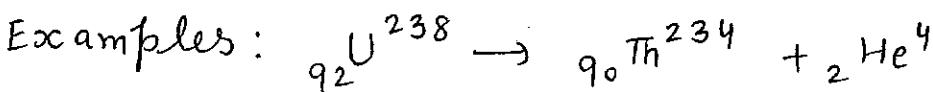
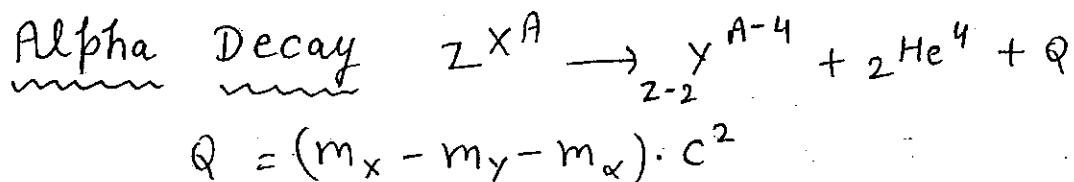
$$\tau = 1.44 T_{1/2}$$

Activity of a radioactive substance

The total decay rate of the substance is also known as the activity of a radioactive substance.

$$A = \lambda N$$

S.I. unit is 1 Bq.

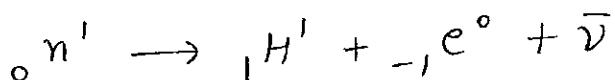
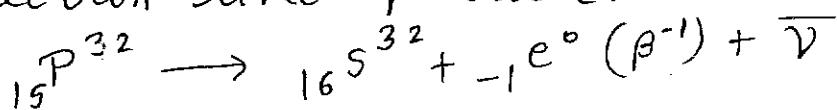


$$K.E. \text{ of } \alpha\text{-particle} = \left(\frac{A-4}{A}\right) Q$$

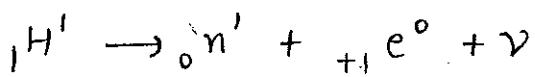
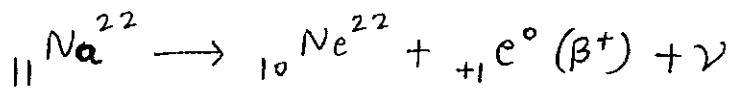
Escape of α -particle \rightarrow The motion of an α -particle in the neighbourhood of potential barrier is considered as a wave. It is found that there is a small but definite probability that the α -particle may tunnel through the potential barrier even if the kinetic energy of α -particle is less than the height of potential barrier. This effect is known as tunneling of the nucleus. (The potential barrier of nucleus is of the order of 26 Mev & no α -particle can have this much amount of energy.)

Beta Decay

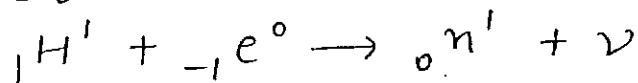
(i) β^- decay \rightarrow The neutron inside the nucleus is converted into a proton & an electron like particle.



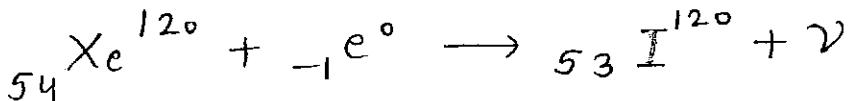
(ii) β^+ decay \rightarrow A proton is converted into a neutron and a positron (${}_+^1 e^0$) is emitted if a nucleus has more protons than neutrons.



(iii) Electron capture \rightarrow In this process, the nucleus absorbs one of the inner e^- revolving around it and hence a nuclear proton becomes a neutron and a neutrino (ν) is emitted.



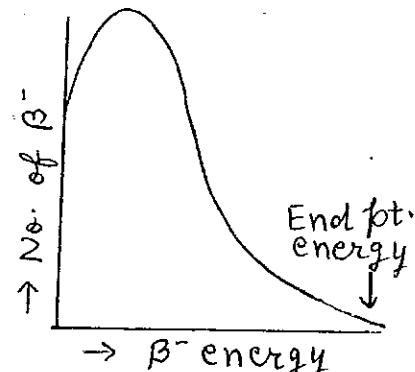
* In heavy elements, e^- capture is more frequent than positron emission.



gmp Energy carried by emitted β^- -particle

(i) only few β^- -particles carry maximum energy called end point energy.

(ii) The energy spectrum is continuous which indicates that the emitted β^- -particles have all possible energies from 0 to $(Q_B)_{\max}$.



① The energy calculations showed that the energy of a nucleus emitting β -particles decreases by an amount equal to the end point energy of continuous spectrum but most of the β -particles emitted have energies smaller than $(Q_\beta)_{\max}$.

② Another contradiction arises in respect of conservation of angular momentum. β -particle has spin $1/2$ so during β -particle emission, spin or angular momentum of nucleus must change by $1/2$ but it never occurs.

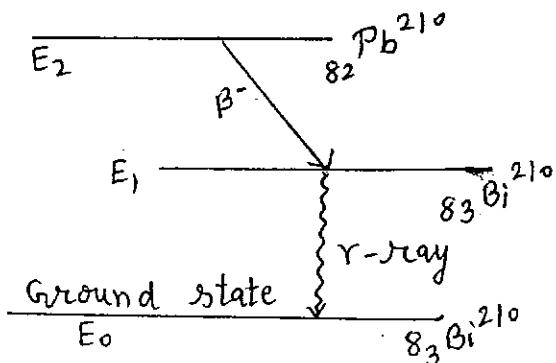
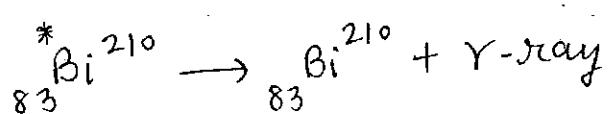
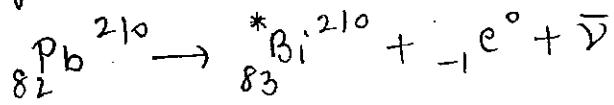
These two problems were resolved by Pauli.

Neutrino Hypothesis → He suggested that the emission of low energy β^-

particle by any nucleus is accompanied by an other neutral particle of zero rest mass and spin $1/2$ known as anti-neutrino ($\bar{\nu}$). This particle carries energy which solves the first part and due to spin $1/2$ it solves the problem of conservation of momentum.

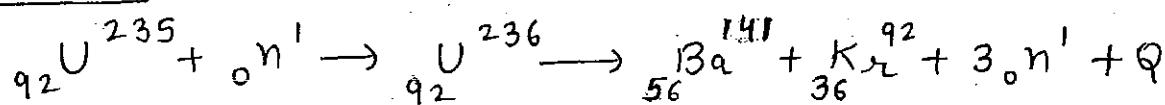
Gamma-Decay → The spontaneous process of emission of high energy photon

from a radioactive nucleus.

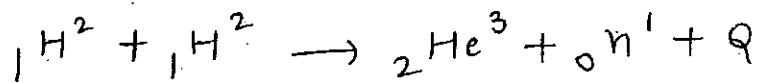


Nuclear Reactions (Read from NCERT)* for detail

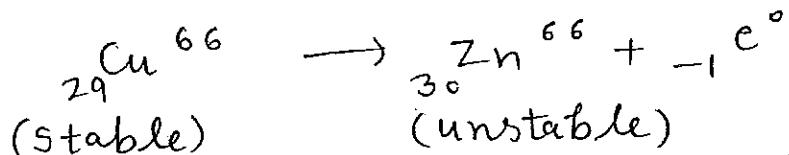
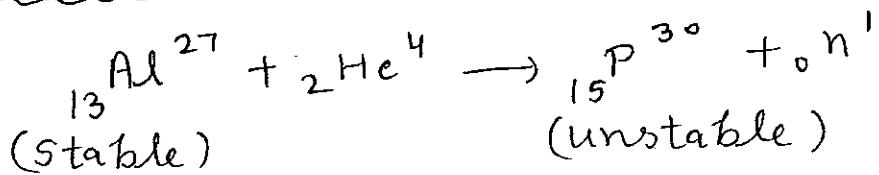
① Fission



② Fusion



Artificial Radioactivity



Applications of Radio-isotopes

- ① Tracer technique in field of fluid technology & medicine
 - ② In treatment of skin cancer
 - ③ To investigate flow of liquids in chemical plants.
 - ④ It can be used in carbon-dating.

8
7

3

ORGANIC CHEMISTRY

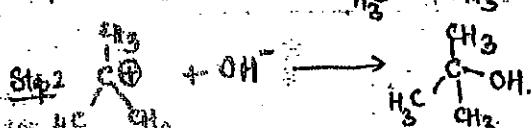
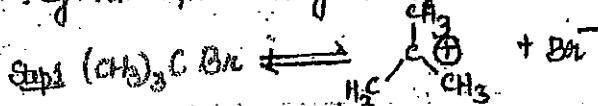
(MECHANISMS)

S_N1: Substitution nucleophilic unimolecular

- follows first order kinetics

- it is carried out in polar protic solvents

e.g. rxn b/w t-butylbromide and OH⁻



- occurs in 3° alkyl halides, due to formation of carbocation.

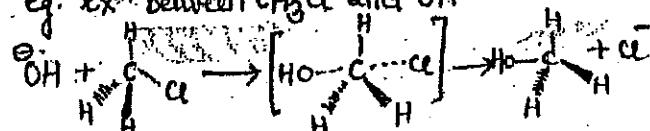
- results in formation of racemic mixture.

S_N2: Substitution nucleophilic bimolecular

- follows second order kinetics i.e.

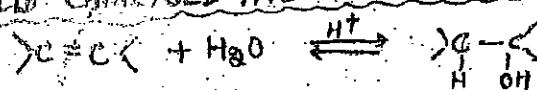
- rate depends upon conc. of both reactants

e.g. rxn between CH₃Cl and OH⁻

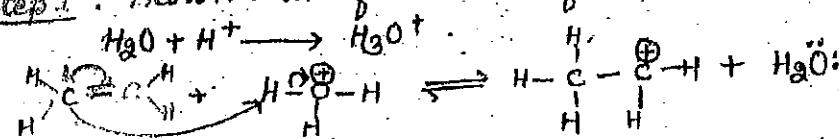


Transition state

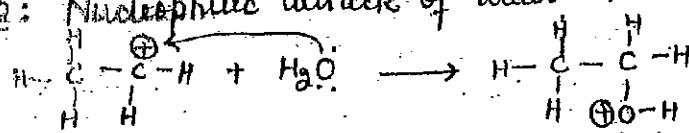
- occurs in 1° alkyl halides, due to less steric hindrance
- results in inversion of configuration

ACID CATALYSED HYDRATION OF ALKENESMechanism

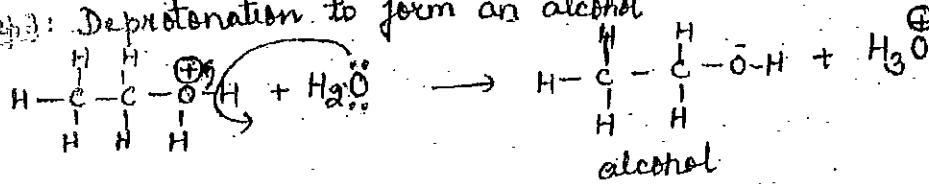
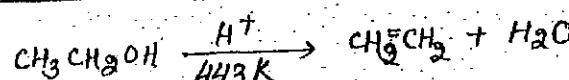
Step 1: Preparation of alkene to form carbocation by electrophilic attack of H₃O⁺



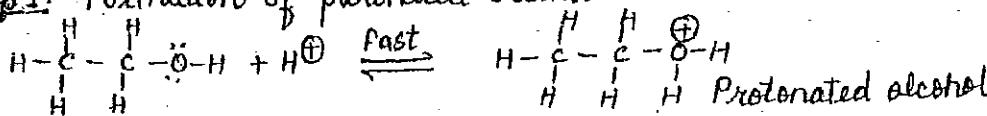
Step 2: Nucleophilic attack of water on carbocation



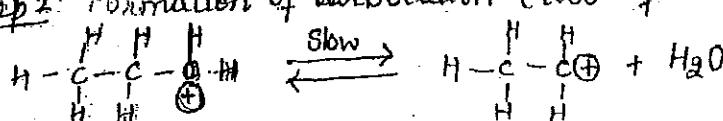
Step 3: Deprotonation to form an alcohol

DEHYDRATION OF ETHANOL

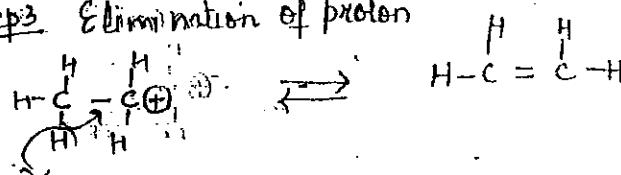
Step 1: Formation of protonated alcohol



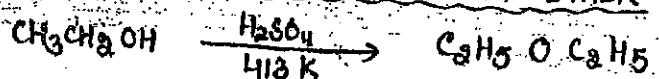
Step 2: Formation of carbocation (loss of water), slowest step.



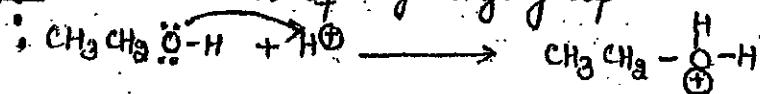
Step 3: Elimination of proton



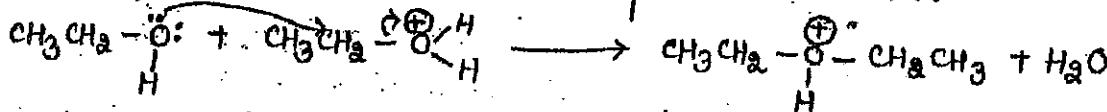
DEHYDRATION OF ALCOHOL TO FORM ETHER



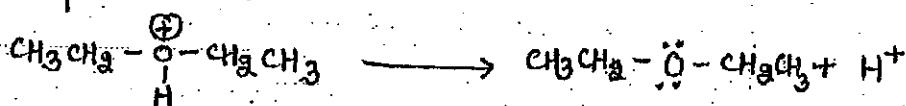
Step 1: Protonation of hydroxyl group



Step 2: Attack of alcohol molecule on a protonated alcohol

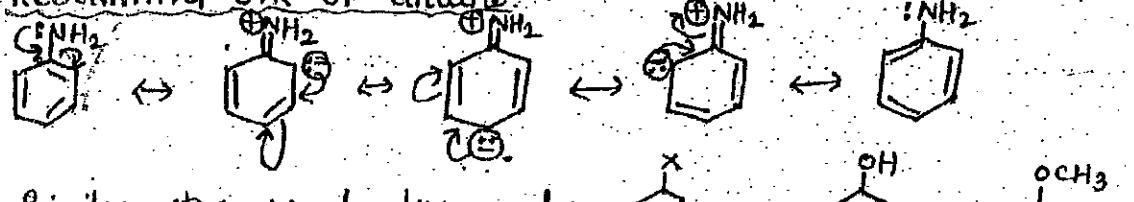


Step 3: Deprotonation



nation

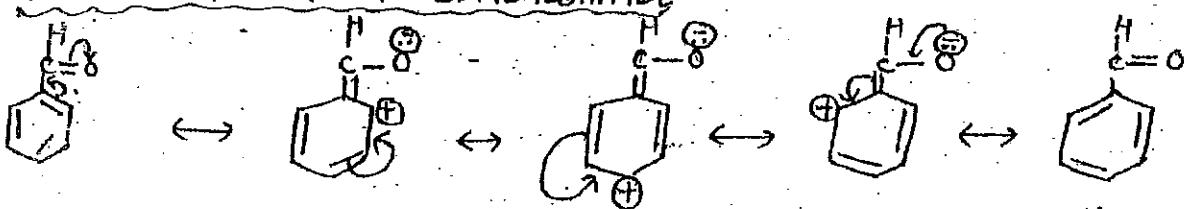
RESONATING STR. OF ANILINE



Similar str. can be drawn for $\text{C}_6\text{H}_5\text{O}^-$, $\text{C}_6\text{H}_5\text{OH}$, $\text{C}_6\text{H}_5\text{OCH}_3$ etc.
($\text{X} = \text{Cl}, \text{Br}$)

These are σ - & ρ -directing as electron density resides on ortho and para positions.

RESONATING STR. OF BENZALDHYDE



Similar str. can be drawn for $\text{C}_6\text{H}_5\text{COOH}$, $\text{C}_6\text{H}_5\text{CN}$, $\text{C}_6\text{H}_5\text{NO}_2$ etc.

These are meta directing as +ve charge resides on ortho and para positions.

AMITY INTERNATIONAL SCHOOL, NOIDA

Class XII

Subject : Chemistry

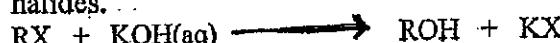
Chapter : 9-13

Organic Chemistry(Distinction Test)

(CBSE weightage: 2 marks)

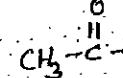
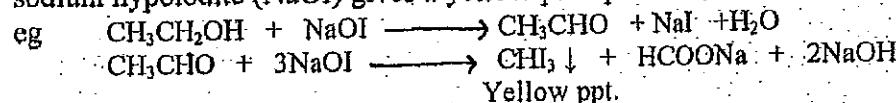
Some important reactions used in distinction tests:

1. Silver nitrate test: This test is used to distinguish between different alkyl halides.

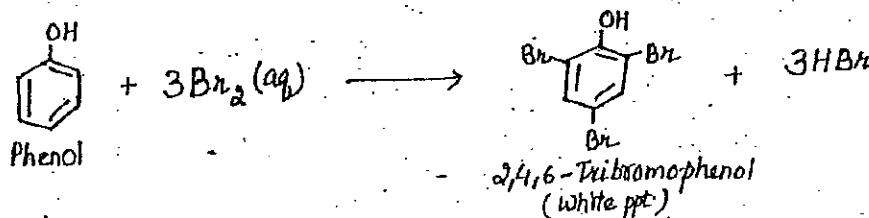
If X is Chlorine, $AgCl$ is formed which is white in colour.If X is Bromine, $AgBr$ is formed which is light yellow in colour.If X is Iodine, AgI is formed which is yellow in colour.

2. Lucas Test: This test is used to distinguish between primary, secondary and tertiary alcohols. Here alcohol is treated with the Lucas reagent (anhy. $ZnCl_2$ + conc. HCl). If the alcohol is tertiary turbidity appears simultaneously, for secondary alcohol turbidity appears in 5 minutes and for primary alcohol turbidity does not appear at room temperature.

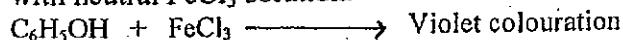
3. Iodoform Test: This test is characteristic to compounds containing CH_3CO- or $CH_3CH(OH)-$ group. The compounds containing these, when warmed with sodium hypoiodite ($NaOI$) gives a yellow precipitate of iodoform.



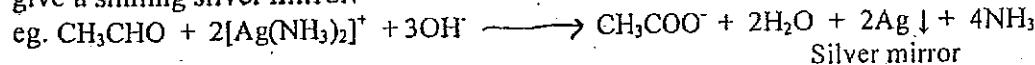
4. Bromine water test: This test is characteristic to phenol. Phenol decolourises Bromine water to give a white precipitate of 2,4,6-Tribromophenol.



5. $FeCl_3$ test: This test is characteristic to phenol. Phenol gives a violet colouration with neutral $FeCl_3$ solution.



6. Tollen's Reagent test: This test is characteristic to Aldehydes and is used to distinguish between aldehydes and ketones. Aldehydes reduce Tollen's reagent to give a shining silver mirror.

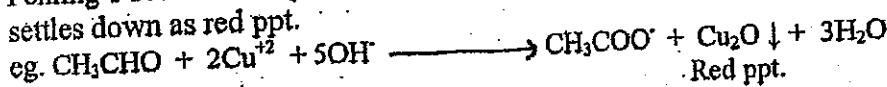


AMITY INTERNATIONAL SCHOOL, NOIDA
ORGANIC CHEMISTRY (DISTINCTION BETWEEN)

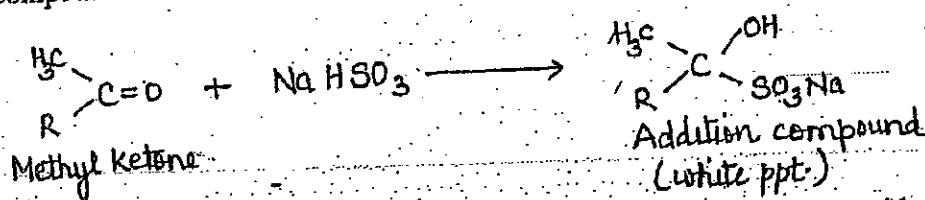
Distinguish between the following set of compounds using Chemical test:

1. Chloroethane, Bromoethane and iodoethane
2. Chlorobenzene and chlorocyclohexane
3. Methanol and Ethanol
4. Ethanol and Propanol
5. Ethanol and Propanone
6. Propanol and Propan-2-ol
7. Butanol and Butan-2-ol
8. Propanol and propanone
9. Propanol and t-butylalcohol
10. Ethanol and Benzylalcohol
11. Ethanol and Phenol
12. Phenol and Cyclohexanol
13. Phenol and Benzyl alcohol
14. Ethanol and Propanal
15. Acetaldehyde and Benzaldehyde
16. Propanal and Propanone
17. Propanal and Diethylether
18. Bezeldehyde and acetone
19. Pentanal and Diethylketone
20. Pentanone-2 and Pentanone-3
21. Acetophenone and Benzophenone
22. Benzaldehyde and Acetophenone
23. Benzoic acid and Phenol
24. Benzaldehyde and Benzoic acid
25. Ethyl/ Methyl amine and aniline
- 26. Benzamide and p-aminobenzoic acid
27. Benzylamine and aniline
28. Ethyl amine and Diethylamine
29. Methylamine and Dimethylamine
30. Aniline and N-methylaniline

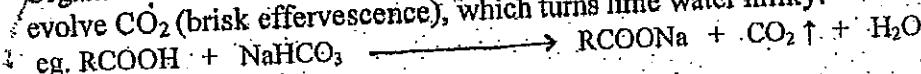
7. Fehling's Solution: This test is characteristic to Aldehydes and is used to distinguish between aldehydes and ketones. It can also be used as a distinguishing test between aliphatic and aromatic aldehydes. Aromatic Aldehydes do not reduce Fehling's solution. Aliphatic aldehydes reduce Fehling's solution to Cu_2O which settles down as red ppt.



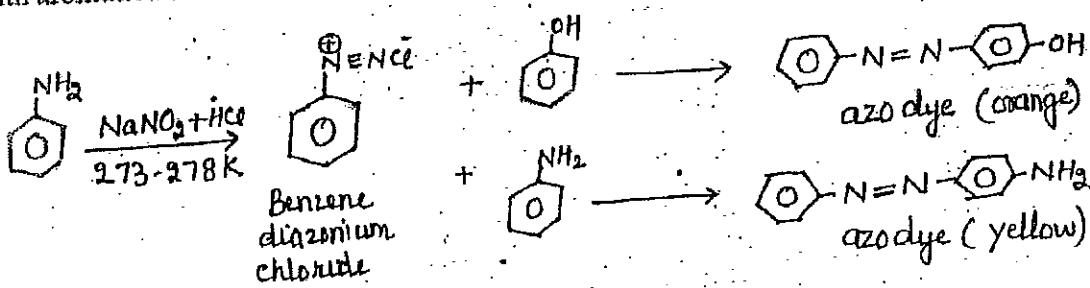
8. Sodium bisulphite test: This test is characteristic to methyl ketones. A methyl ketone when treated with a saturated solution of sodium bisulphite an addition compound is formed which settles down as white ppt.



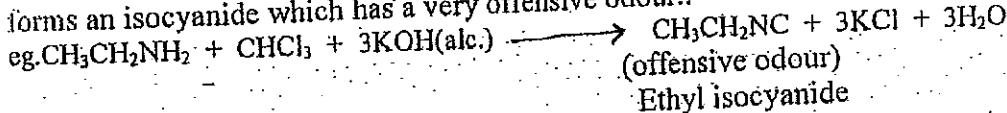
9. Sodium bicarbonate test: This test is characteristic to carboxylic acids. Organic acids being stronger than carbonic acid (H_2CO_3) decomposes NaHCO_3 to evolve CO_2 (brisk effervescence), which turns lime water milky.



10. Azo Dye test: This test is characteristic to aromatic primary amines. These on treatment with HNO_2 ($\text{NaNO}_2 + \text{dil. HCl}$) at 273-278K followed by treatment with aromatic alcohol or amine forms orange or yellow coloured azo dye.



11. Carbyl amine test: This test is characteristic to aliphatic or aromatic primary amines. These when heated with an alcoholic solution of KOH and CHCl_3 , forms an isocyanide which has a very offensive odour.

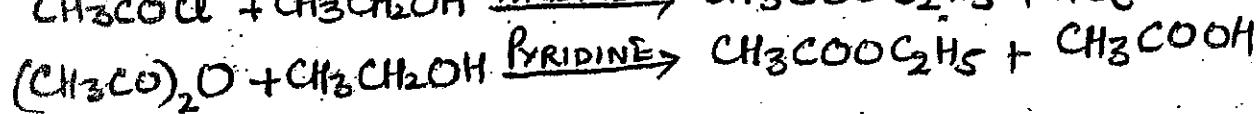
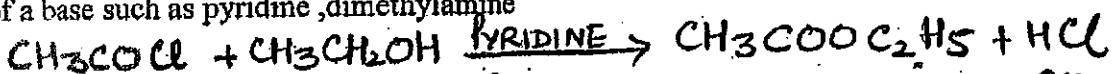


12. Hinsberg Test: This test is used to distinguish between primary, secondary and tertiary amines. Hinsberg reagent (Benzene sulphonyl chloride $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$) reacts with primary amine to form a salt soluble in alkali, with a secondary amine to form a salt insoluble in alkali and shows no reaction with a tertiary amine.

ORGANIC CHEMISTRY (NAME REACTIONS)

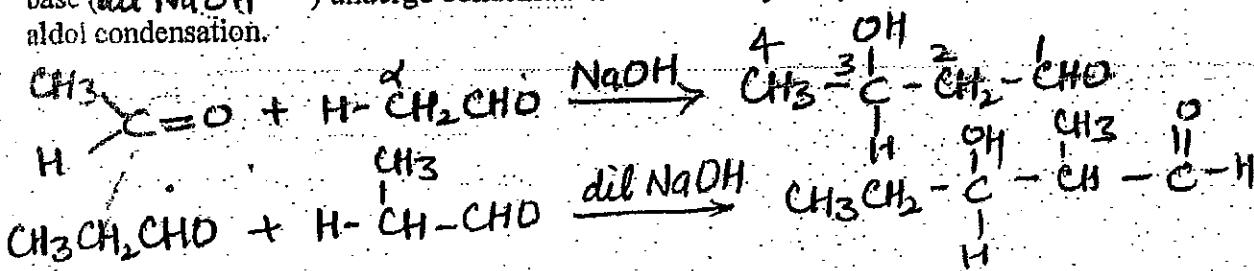
1. ACYLATION

The replacement of an active hydrogen of alcohols, phenols, or amines with an acyl group to form corresponding ester /amide is called acylation. This is carried in presence of a base such as pyridine, dimethylamine



2. ALDOOL CONDENSATION

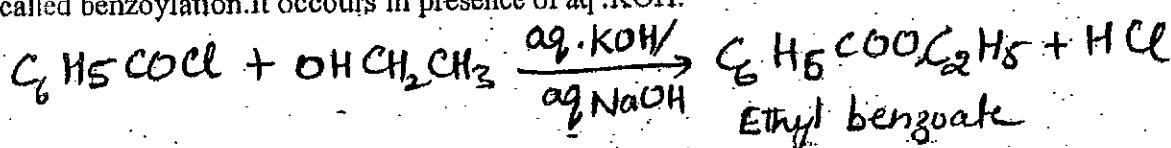
Two molecules of aldehyde or ketone containing α -hydrogen on treatment with a dilute base (dil NaOH) undergo condensation to form α -hydroxy ketones. This is called aldol condensation.



Aldehydes such as benzaldehyde which do not contain α -hydrogen do not undergo aldol condensation.

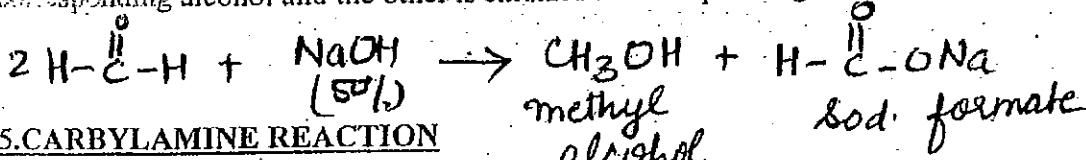
3. BENZOYLATION

The replacement of an active hydrogen of alcohols, phenols, or amines by benzyl group is called benzylation. It occurs in presence of aq. KOH.



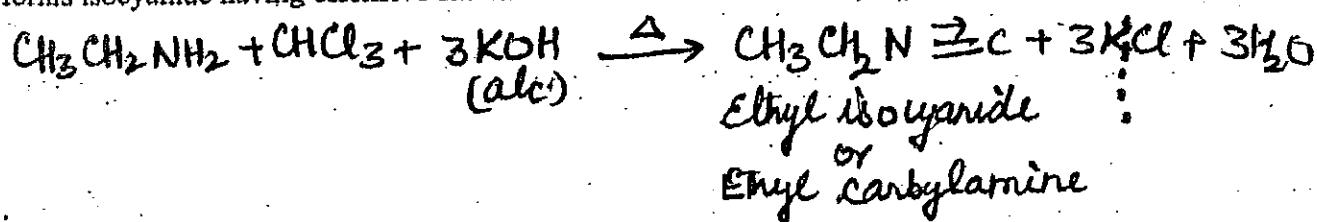
4. CANNIZARO REACTION

Aldehydes which do not contain an α -hydrogen atom, when treated with conc. Alkali undergo self oxidation and reduction. One molecule of aldehyde is reduced to corresponding alcohol and the other is oxidized to corresponding acid.



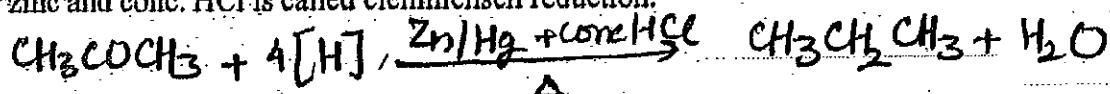
5. CARBYLAMINE REACTION

When a primary amine (aliphatic or aromatic) is warmed with chloroform and alc.KOH it forms isocyanide having offensive smell. This reaction is called carbylamine



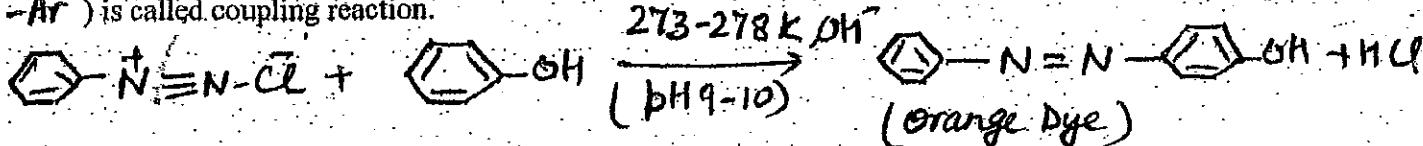
6.CLEMMENSEN REACTION

The reduction of aldehydes and ketons to corresponding hydrocarbons with amalgamated zinc and conc. HCl is called clemmensen reduction.



7.COUPLING REACTION

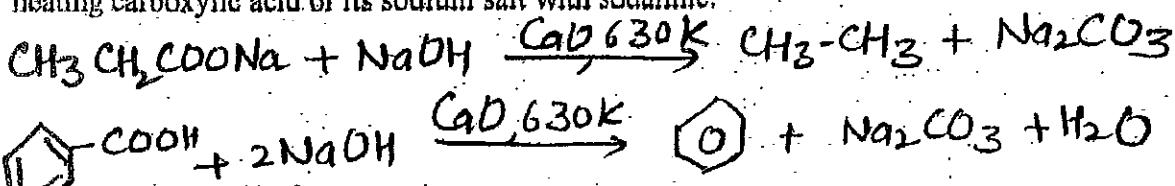
Reaction of diazonium salt with phenols and aromatic amines to form azo compounds ($\text{Ar}-\text{N}=\text{N}-\text{Ar}'$) is called coupling reaction.



(coupling generally occurs at the p- positon w.r.t. hydroxyl or amino group)

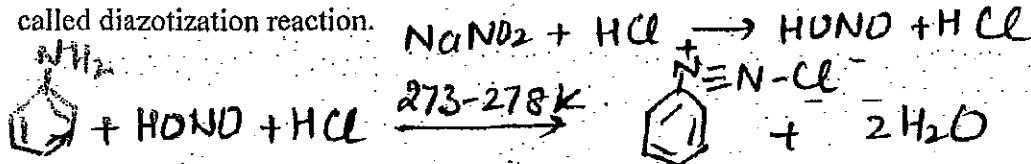
8.DECARBOXYLATION REACTION

The removal of CO_2 from a carboxylic acid is called decarboxylation. It is carried out by heating carboxylic acid or its sodium salt with sodalime.



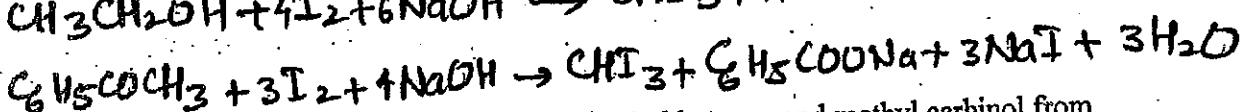
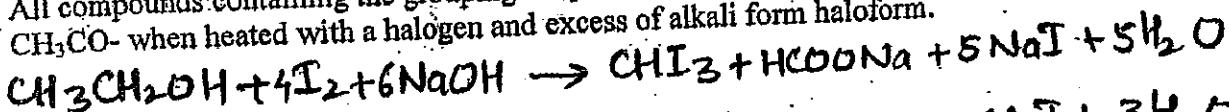
9.DIAZOTISATION REACTION

When a cold solution of primary aromatic amine in dilute mineral acid is heated with a cold solution of nitrous acid at 273-278K arene diazonium salt is formed. This reaction is called diazotization reaction.



10.HALOFORM REACTION

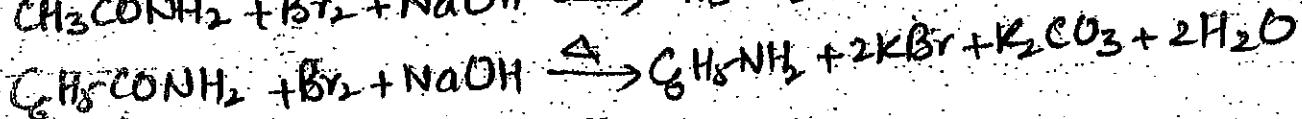
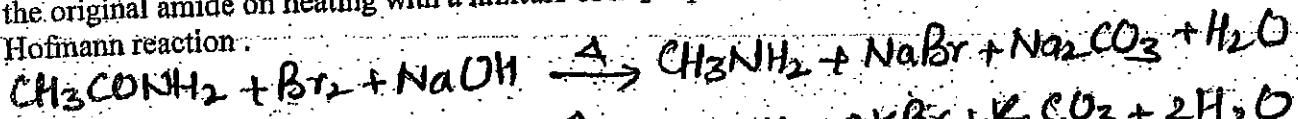
All compounds containing the grouping CH_3CHOH linked to either H or carbon or $\text{CH}_3\text{CO}-$ when heated with a halogen and excess of alkali form haloform.



(Iodoform reaction is used for distinction of methyl ketones and methyl carbinol from other ketones and aldehydes.)

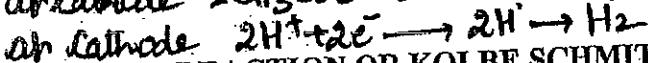
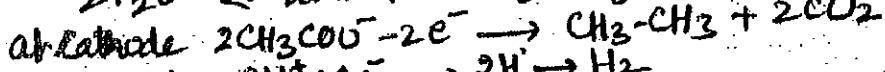
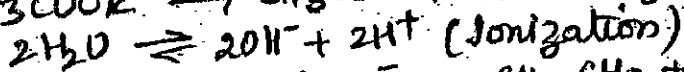
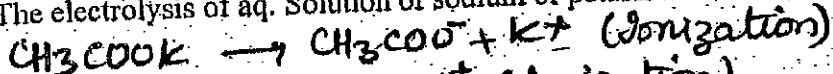
11. HOFMANN BROMAMIDE REACTION OR HOFMANN DEGRADATION OF AMIDES

The conversion of a primary amide to primary amine containing one carbon atom less than the original amide on heating with a mixture of Br_2 in presence of NaOH/KOH is called Hofmann reaction.



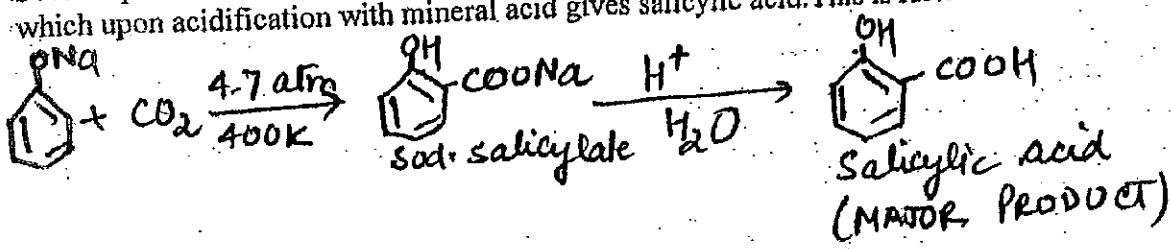
12. KOLBE ELECTROLYTIC REACTION

The electrolysis of aq. Solution of sodium or potassium salt of suitable acids.



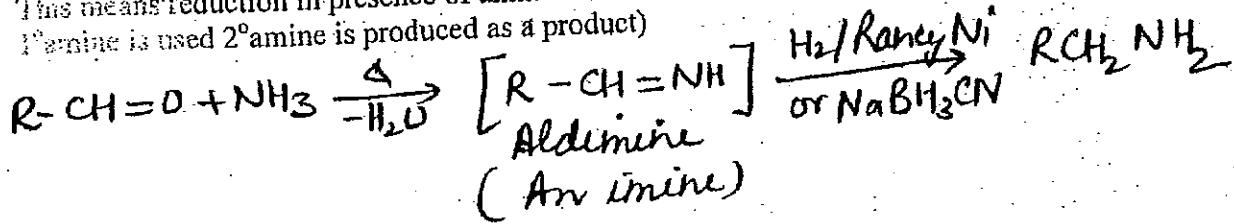
13. KOLBE REACTION OR KOLBE SCHMITT REACTION

Sodium phenoxide reacts with CO_2 pressure 4-7 atm at 400K to form sodium salicylate which upon acidification with mineral acid gives salicylic acid. This is Kolbe reaction.



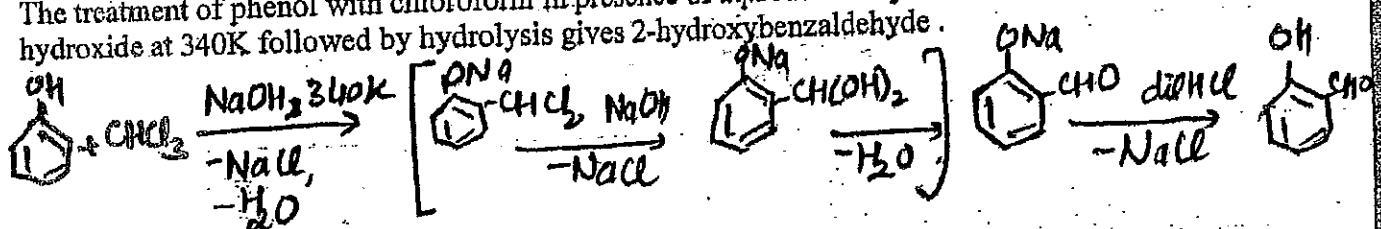
14. REDUCTIVE ANIMATION

This means reduction in presence of ammonia to form 1° amine. (if instead of ammonia 1° amine is used 2° amine is produced as a product)



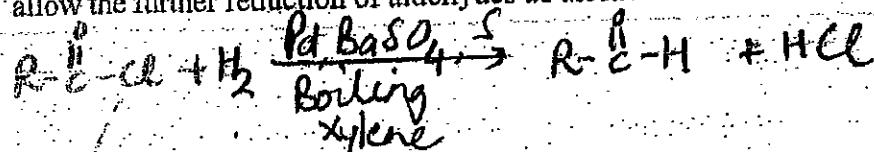
15. REIMER TIEMANN REACTION

The treatment of phenol with chloroform in presence of aq. sodium or potassium hydroxide at 340K followed by hydrolysis gives 2-hydroxybenzaldehyde.



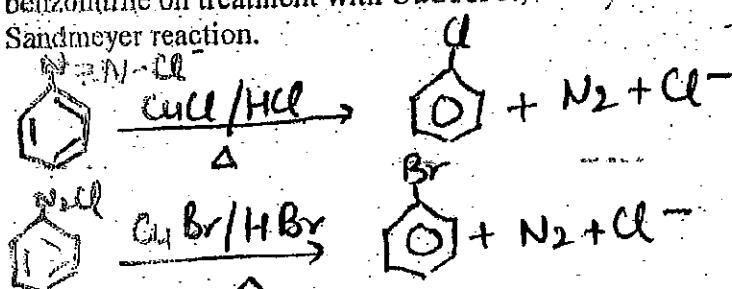
16. ROSEN MUND REDUCTION

Catalytic reduction of acid chlorides to corresponding aldehydes is called Rosenmund reaction. The function of BaSO_4 and sulfur is to poison the catalyst so that it does not allow the further reduction of aldehydes to alcohols.



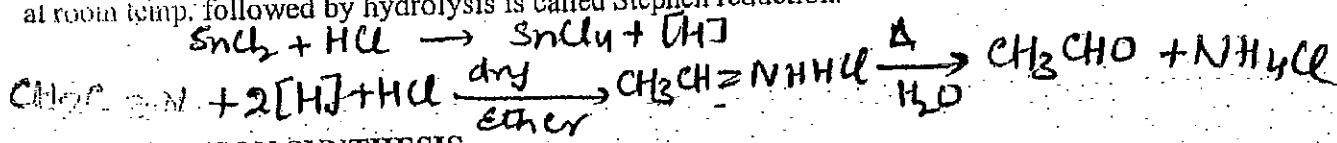
17. SANDMEYER REACTION

The conversion of benzene diazonium chloride to chlorobenzene, bromobenzene and benzonitrile on treatment with CuCl/HCl , CuBr/HBr or CuCN/KCN respectively is called Sandmeyer reaction.



18. STEPHEN REDUCTION

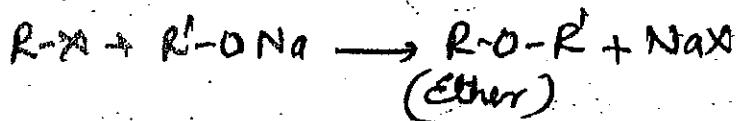
The partial reduction of alkyl or aryl cyanides to corresponding aldehydes with a suspension of anhydrous stannous chloride in dry ether saturated with hydrogen chloride at room temp. followed by hydrolysis is called Stephen reduction.



19. WILLIAMSON SYNTHESIS

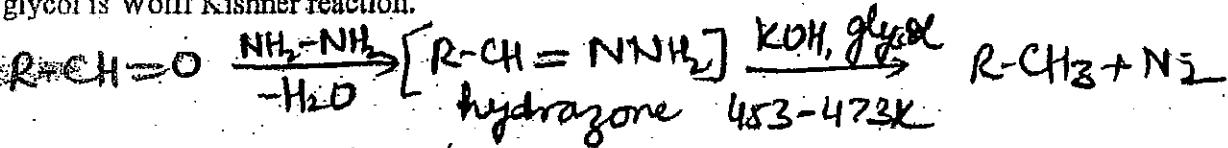
The reaction of alkyl halides with sodium alkoxides or sodium phenoxide to form ethers is called Williamson reaction.

This is one of the best methods to prepare both simple and mixed ether.



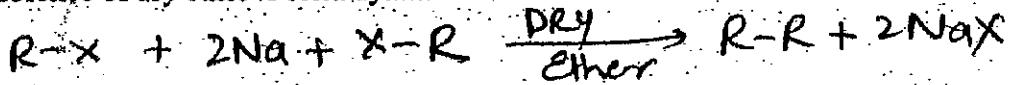
20. WOLFF-KISHNER REACTION

The reduction of aldehydes ketons to corresponding hydrocarbon by heating them with hydrazine and KOH or potassium *tert*-butoxide in a high boiling solvent such as ethylene glycol is Wolff Kishner reaction.



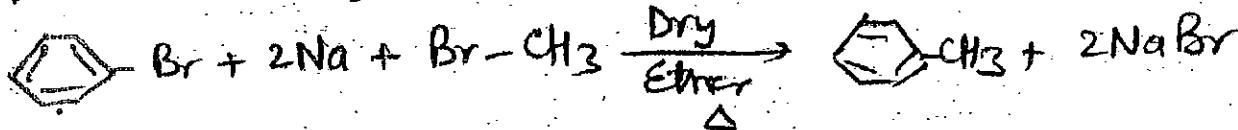
21. WURTZ REACTION

It involves the interaction of two molecules of an alkyl halide with metallic sodium in presence of dry ether to form symmetrical alkane.



22. WURTZ FITTIG REACION

The heating of a mixture of alkyl halide and aryl halide with metallic sodium in presence dry ether is called Wurtz fittig reaction.



AMITY INTERNATIONAL SCHOOL, NOIDA

Class XII (Chemistry)

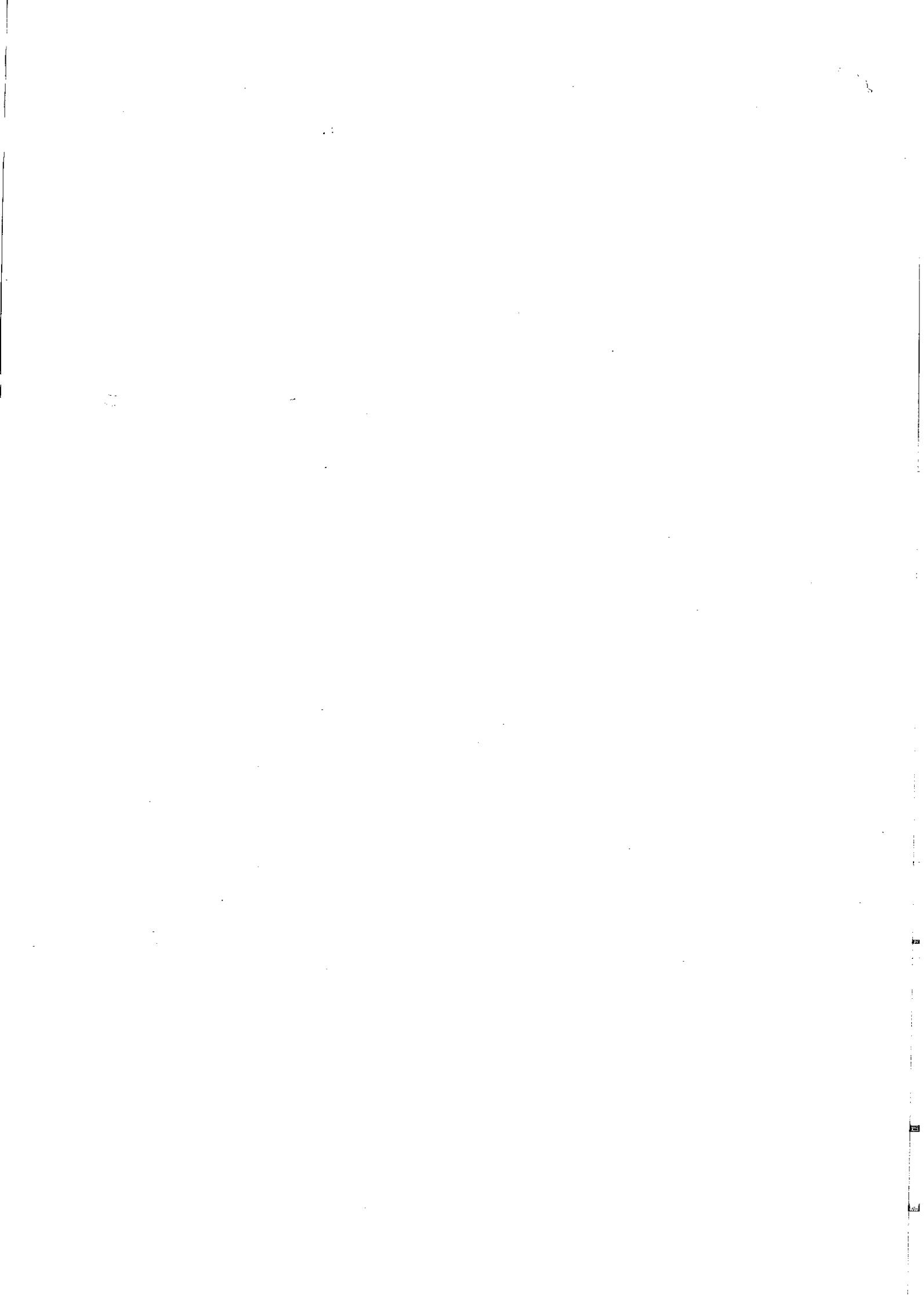
Unit: 1(SOLID STATE)

Level I Questions:

1. Name a compound which shows both Frenkel and Schottky defect. Ag_2S (1)
2. Metallic potassium crystallizes in bcc type of lattice. How many nearest neighbours does each potassium atom have? 8 (1)
3. Why does ZnO appear yellow on heating? $\text{ZnO} \xrightarrow{\Delta} \text{Zn}^{2+} + \frac{1}{2}\text{O}_2 + 2e^-$ (1)
4. Write one major point of difference between Ionic and Metallic Solids. (1)
5. Differentiate between the following: (3)
 - a. Stoichiometric /Intrinsic/Thermodynamic and Non-Stoichiometric defect
 - b. Frenkel and Schottky defect
 - c. n-type and p-type semiconductors

Level II Questions:

6. What happens when small amount of SrCl_2 or AgCl is added to molten NaCl ? $\xrightarrow{\text{impurity defect leading to vacancy}}$ (1) $\xrightarrow{\text{only impurity defect}}$
7. What is the difference between glass and silica though both contain SiO_4^{4-} unit? $\xrightarrow{\text{glass is amorphous}}$ $\xrightarrow{\text{silica is crystalline}}$
8. The electrical conductivity of a metal decreases with rise in temperature while that of semiconductor increases. Explain. $\xrightarrow{\text{vibration of kernels, obstruct the path of moving e-}}$ $\xrightarrow{\text{energy of e- increases, so e- can jump into the conduction band.}}$ (1)
9. Give reason for the following observations: (2)
 - a) Frenkel defect is not found in pure alkali metal halides. $\xrightarrow{\text{The large alkali metal ion cannot fit in the interstitial space}}$
 - b) Fe_3O_4 is ferrimagnetic at room temperature but becomes paramagnetic at 850K. $\xrightarrow{\text{Randomisation of spin}}$
10. Silver crystallizes in face centered cubic unit cell. Each side of the unit cell has an edge length of 400pm. Calculate the radius of the silver atom assuming that the atoms just touch each other on the diagonal across the face of the unit cell i.e each face atom is touching the four corner atoms.
Answer: 141.4pm $a = 400\text{ pm}$ $r = \frac{a}{2\sqrt{2}} = \frac{400\sqrt{2}}{4} = 141.4\text{ pm.}$ (2)
11. Analysis shows that a metal oxide has empirical formula $\text{M}_{0.96}\text{O}_{1.00}$. Calculate the percentage of M^{2+} and M^{3+} ions in the crystal. Let $\text{M}^{2+} = x$, $\text{M}^{3+} = (0.96-x)$ (2)
Answer: 91.67%, 8.33% $2x + 3(0.96-x) = 2$ $\% \text{ of } \text{M}^{2+} = \frac{0.88}{0.96} \times 100 = 91.67\%$
 $2x - 3x + 2.88 = 2$ $\% \text{ of } \text{M}^{3+} = 100 - 91.67\% = 8.33\%$
 $x = 0.88$
12. The density of lead is 11.15 g/cm^3 and the metal crystallises with fcc unit cell. Estimate the radius of lead atom. (At mass of lead = 207 g/mol) $f = \frac{Z \times M}{a^3 \times N_A}$ $a = 2\sqrt{2}r$ (3)
Answer: 175 pm $\therefore r = \sqrt[3]{\frac{4 \times 207}{(2\sqrt{2})^3 \times 11.15 \times 6.02 \times 10^{23}}}$
13. Calculate the density of silver which crystallizes in a face-centered cubic structure. The distance between the nearest silver atoms in the structure is 287pm. (Atomic mass of Silver = 107.87u)
Answer: 10.72 g/cm^3 $f = \frac{Z \times M}{a^3 \times N_A} = \frac{4 \times 108}{(\sqrt{2} \times 287 \times 10^{-10})^3 \times 6.022 \times 10^{-23}}$ (3)
 $a = 2\sqrt{2}r$
 $a = \sqrt{2} \times d$
 $= 10.72 \text{ g/cm}^3$



14. An element crystallizes in bcc structure. If the edge length of unit cell is $1.469 \times 10^{-10} \text{ m}$ and the density of crystal is 18 g/cm^3 , calculate

- a) radius of this element $r = \frac{\sqrt{3}}{4} a$
b) atomic mass of the element $M = \frac{a^3 \times N_A \times Z}{2}$

Answer: $6.36 \times 10^{-11} \text{ m}$, 18.42 u

(3)

15. Government of a state decided to convert all the ancient palaces of the state into museums and open it to the general public. Sahil went to see this palace turned museum with his friends, during the summer vacations. He observed that the glass of the window panes of the palace was yellow and also thicker at the bottom. He discussed the same with his teacher at school, after the vacations were over.

(4) VQB

- a) What type of solid is glass? Justify giving reason. amorphous solid. it has tendency to flow
b) What explanation do you think, the teacher must have given to him in order to explain him both the phenomenon i.e. thickening of glass and flowing of glass? colouring — tendency to flow — crystallization
c) According to you, what are the values associated with the decision of the government? preservation of national heritage

Level III Questions:

16. Iron changes from the body centered cubic lattice to the face centered cubic lattice at 1199K. How would the density of iron change during this transformation? increases (1) (HOTS)

17. Metallic cerium occurs as both hcp and fcc crystals. Would there be a difference in density of the two crystals? Justify. No change (1) (HOTS)

18. What are group 12-16 and group 13-15 compounds? Explain giving example and the advantage of their use. (2)

19. The melting points of some compounds are given below:

$$\begin{array}{ll} \text{Water} = 273 \text{ K}, & \text{Ethyl alcohol} = 155.7 \text{ K}, \\ \text{Diethyl ether} = 156.8 \text{ K}, & \text{Methane} = 90.5 \text{ K} \end{array}$$

Which of these will have the strongest intermolecular forces between them? Also suggest a reason for your answer. water, m.p.t is the parameter of extent of strong intermolecular forces.

20. Answer the following questions: (2)

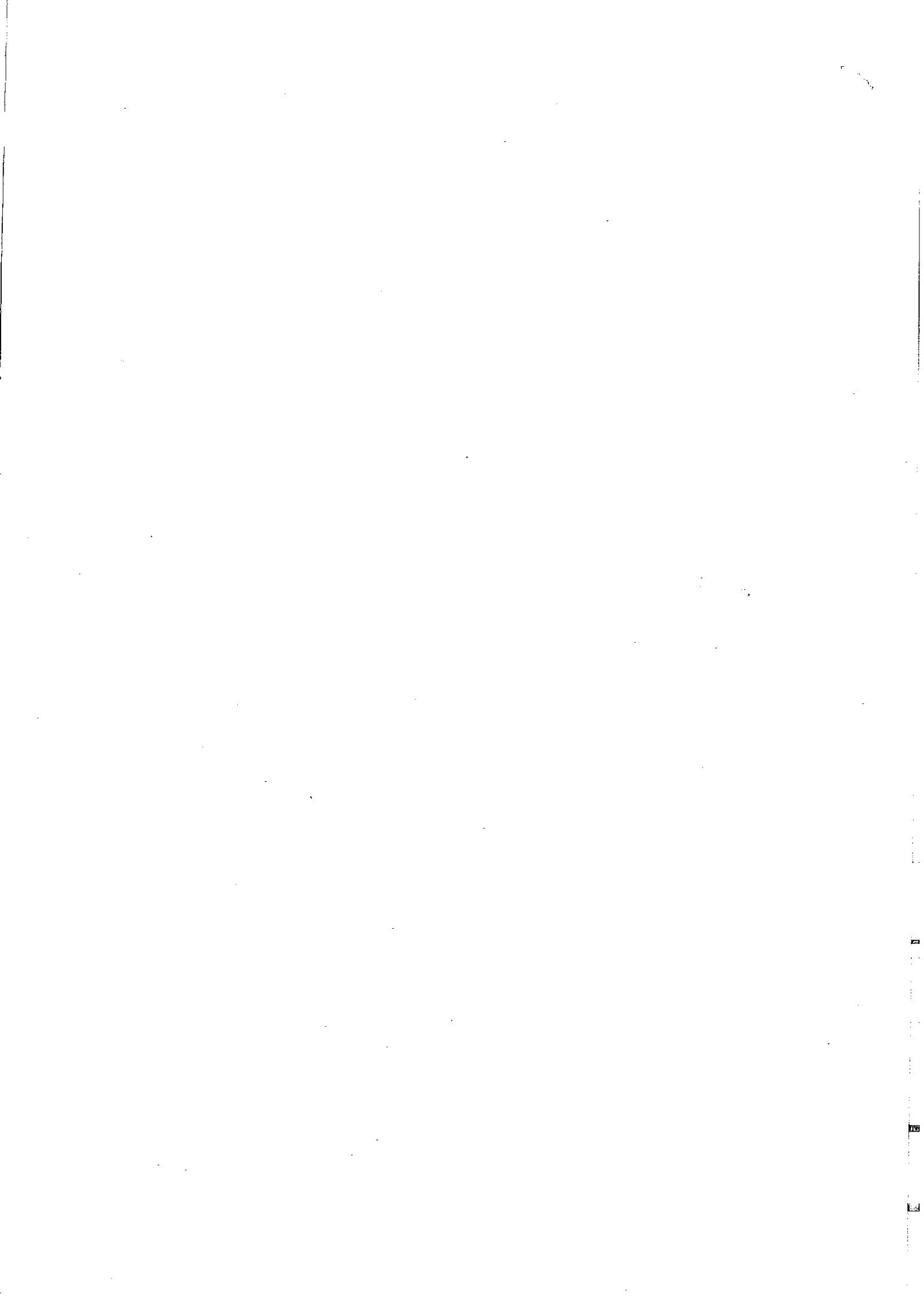
- a) A compound formed by elements A and B crystallizes in the cubic arrangement in which A atoms are at the corners of a cube and B atoms are at the face centers. What is the formula of the compound?

Answer: AB_3

- b) A solid is made up of two elements P and Q. Atoms Q are in CCP arrangement, while atoms P occupy all tetrahedral sites. What is the formula of the compound?

Answer: P_2Q

Jain
Famili



Amity International School- NOIDAClass XIISubject- Chemistry

(Session:2015-16)

UNIT 2 : SOLUTIONSLEVEL I

No, it is a liquid mixture of definite composition, which has const. b.p.

- Can we separate an azeotropic mixture by distillation? Justify your answer. (1)
- Two liquids A and B boil at 145°C and 190°C respectively. Which of them has higher vapour pressure at 80°C and why? A, lower b.p., more is the VP. (1)
- Addition of 0.65 g of a compound to 50 ml of benzene (density = 0.879 g/ml) lowers the freezing point from 5.51°C to 5.03°C . If K_f for benzene is 5.12 K Kg/mol, calculate molecular weight of the compound. (Ans = 156 g/mol) $T_f = 5.51 - 5.03 = 0.48$
 $M_w = \frac{50 \times 0.879}{0.48} = 43.8$ g
- When dried fruits and vegetables are placed in water for some time, they slowly swell in size, why? Does temperature increase accelerate the process? Explain. (2)
- Give reason for the following: \hookrightarrow Yes $\pi \propto T$ Fruit covering as SPM, osmosis takes place.
 - Helium is preferred over Nitrogen in liquid oxygen, during deep sea diving. Lower solubility, small size, can pass through cell walls
 - It is advised to add ethylene glycol to water in a car radiator while driving in a hill station. lowering of f.p.
 - At higher altitude, people suffer from a disease called anoxia. low P... less is the conc. of O_2 in blood.
- (a) What is meant by a 'colligative property'?
 (b) 1.22 g of benzoic acid is dissolved in (i) 100 g of acetone ($k_b = 1.7$) and (ii) 100 g of benzene ($k_b = 2.6$). The elevations in boiling is 0.17 and 0.13°C respectively.
 (i) What are molar masses of benzoic acid in two solvents? in acetone 122 g/mol, in benzene 214 g/m.
 (ii) What do you deduce out of it in terms of structure of benzoic acid? (5)
 dimerises in benzene.

LEVEL II

- For NH_4Cl , $\Delta H_{\text{sol}} > 0$. What is the effect of temperature on its solubility? increases (1)
- Will the elevation in boiling point be same if 0.1 mole of sodium chloride or 0.1 mole of sugar is dissolved in 1L of water? Reason out your answer. No, as NaCl dissociates while sugar does not (1)
- 50 ml of a liquid A is mixed with 50 ml of another liquid B. Final volume of the solution was found to be less than 100 ml. What information do we get from this data? Will the process (mixing) be exothermic or endothermic? -ve deviation, exo, more force of attraction bet' solute & solvent
- Account for the following:
 - NaCl is used to clear snow on the road. lowers the f.p
 - Osmotic pressure is the best colligative property for determining molar masses of macro molecules.
 - At 25°C , $p_A^0 > p_B^0$ but boiling point of liquid A is less than that of liquid B. (3)
- On the basis of the given observation in each case predict (a) whether $i=1, i<1$ or $i>1$

\hookrightarrow less heating required for V.P. = atm. press
 \therefore lower b.p.

(b) comment on the molecular state of the solute whether normal, association or dissociation.

- (i) ΔT_b : expected 0.82 K, observed 0.82 K $i = 1$ normal
- (ii) π : expected 1.8 bar, observed 2.1 bar $i > 1$ dissociation
- (iii) ΔT_f : expected 1.68 K, observed 1.42 K $i < 1$ association. (3)

12. How can you remove the hard CaCO_3 layer of the egg without damaging its semi permeable membrane? Can this egg be inserted into a bottle with a narrow neck without distorting its shape? Explain the process involved.

*dissolving it in dil. HCl, put egg in salt sol⁽³⁾ it shrinks
insert in bottle, fill the bottle with water, egg swells.*

LEVEL III

13. What is the expected value of van't Hoff factor for $\text{K}_3[\text{Fe}(\text{CN})_6]$ in dilute solution? (1) $i > 1$ due to dissociation

14. At the same temperature, Hydrogen is more soluble in water than Helium. Which of them will have a higher value of K_H and why? Higher K_H , lower is the solubility acc. to Henry's law

15. When outer shells of two eggs are removed, one of the eggs is placed in pure water and the other is placed in saturated solution of NaCl , what will be observed and why?

egg shrinks solvent from egg to NaCl soln. egg swells as solvent moves in the egg.

16. Sulphuric acid used in lead storage batteries is 38% by mass and has a density of 1.30 g/cm³. Calculate its molarity. (Ans = 5M) (2)

$$n = 38/98, \quad V = \frac{100}{1.3 \times 1000} \quad M = n/V$$

17. Phenol associates in benzene to a certain extent to form a dimer. A solution containing $w_2 = 2 \times 10^{-2}$ kg of phenol in 1 kg of benzene has its freezing point decreased by 0.69 K. = ΔT_f

Calculate degree of association of phenol (If K_f for benzene is 5.12 K kg/mol)

$$(Ans = 72\%) \quad \text{Mol. mass} = \frac{1000 \times \text{kg} \times w_2}{w_1 \times \Delta T} = 146.9 \text{ g/mol.} \quad i = \frac{94}{146.9} = 0.64 \quad (3) \quad \alpha = \frac{(1 - 0.64) \times 2}{2 - 1} = 72\%$$

18. A decimolar solution of $\text{K}_4[\text{Fe}(\text{CN})_6]$ is 50% dissociated at 300 K. Calculate osmotic pressure of solution. $C = \frac{1}{10}, \alpha = \frac{i-1}{m-1}$ or $0.5 = \frac{i-1}{5-1}$ (Ans = 7.38) $i = 3, \pi = iCRT$ (3) $= 3 \times \frac{1}{10} \times 0.082 \times 300 = 7.38$

19. (i) Why is freezing point depression considered a colligative property?

(ii) The cryoscopic constant of water is 1.86 K mol⁻¹ per kg solvent. Comment on this statement.

F.P. of H_2O is lowered by 1.86 K when 1 mol q non-volatile solute is dissolved in 1000 g

(iii) Calculate the amount of ice that will separate out on cooling solution containing 50g of ethylene glycol in 200g H_2O to -9.3°C. (K_f for water = 1.86 K kg mol⁻¹)

$$(Ans = 38.71\text{g}) \quad (5)$$

20. Aman's uncle was trading in food grains. He used to purchase 1000 bags of wheat before the rainy season & sell off the same after the rainy season. He was doing it for so many years.

He became rich & was living a luxurious life. Can you comment on-

19 (iii)

(a) The secret behind his exceptional earning.
(Hint- Mass of the grain increases due to osmosis)

$$w_1 = \frac{k_f \times 1000 \times w_2}{M_2 \times \Delta T_f} = \frac{1.86 \times 10^3 \times 50}{62 \times 9.3} = 161.29$$

(b) His involvement in such business.

(Hint- such a practice is devoid of value as he is using unfair means to grow his business) (VBQ)

$$(4) \text{ separates from} \\ 200\text{g of } \text{H}_2\text{O} \\ = 200 - 161.29 \\ = 38.71\text{g}$$

FORMULA:

Degree of dissociation

$$\alpha = \frac{i-1}{m-1}$$

Degree of association

$$\alpha = \frac{i-1}{n-1}$$

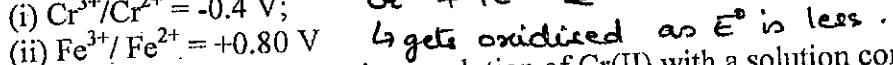
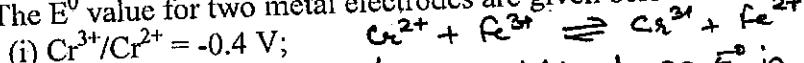
where $m \& n$ are no. of ions after dissociation & no. of molecules which are associated respectively.

Shabu

Chiragpal
14.7.15

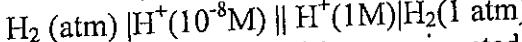
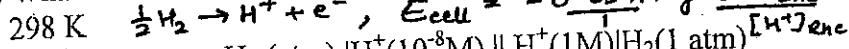
LEVEL I

- eg: oxidation
O₂ → O₂⁻
- What is the use of platinum foil in hydrogen electrode? adsorbs H₂. provides surface where e⁻ exchange takes place
 - What do you understand by the term over voltage? The extra voltage required for evolution of gas.
 - Rusting of iron becomes quicker in saline medium. Why? facilitates the movement of ions.
 - The E⁰ value for two metal electrodes are given below:



Comment on the result of treating a solution of Cr(II) with a solution containing Fe(III) ions.

- What is the maximum electric potential difference between two hydrogen half cells at 298 K?



- If the two half cells described in part (a) are connected so that charge is transferred for a long time interval, what will eventually happen to the hydrogen ion concentration in the two half cells.

(Ans: E_{cell} = 0.47V, [H⁺] will be same as equilibrium is attained) (3)

- Write the overall reaction of Mercury cell. Also mention one of its uses. Zn(Hg) + HgO(s) → ZnO(s) + Hg(l)
- Why does a Mercury cell give a constant voltage throughout its life? over all R_{xx} does not change in soln where conc can change

- State two advantages of H₂-O₂ fuel cell over ordinary cell.

- Silver is electrodeposited on a metallic vessel of total surface area 900 cm³ by passing a current of 0.5 A for two hours. Calculate the thickness of silver deposited.

(Given: Density of Ag=10.5g/cc, At.mass of Ag=108u) (Ans: 4.22 × 10⁻⁴ cm)

$$Q = It = 0.5 \times 2 \times 60 \times 60 = 3600 \text{ C}, \quad 96500 \text{ F required for } 108 \text{ g} \therefore \frac{108}{96500} \times 3600 = (5)$$

$$\text{LEVEL II } f = \frac{m}{V}, \quad 10.5 = \frac{108 \times 36}{96500 \times t}, \quad t =$$

dee. with respect to T

- What is the effect of temperature on the electrical conduction of metallic conductors and electrolytic conductors? → inc. (1)
- What is role of zinc chloride in a dry cell? ZnCl₂ combines with NH₃ to form [Zn(NH₃)₂Cl₂]. No NH₃ produced. (1)
- Why is it that sodium metal cannot be obtained by electrolysis of aqueous solution of its salt? Na reacts with water. (1)

- Explain the principle of (i) cathodic protection of iron against rusting.

(ii) The effect of dissolved CO₂ in natural water on rusting of iron. formation of HCO₃, generates H⁺

- A Daniel cell transfers 4825C of electric charge through an external circuit when the potential difference between the terminals is 1V given that E⁰_{cell} = 1.10V. Zn → Zn²⁺ + 2e⁻

(a) How many moles of zinc will be changed to Zn²⁺? 2 × 96500 = 1 mol of Zn; $\frac{4825}{2 \times 96500} = 0.05 \text{ mol Zn}$

(b) What is the quantity of electrical energy of Zn? ΔG = -nFE_{cell} = -2 × 96500 × 1V = -193 kJ/mol of Zn

(c) Compare the quantity of electrical energy transferred per mole of Zn in this case with maximum quantity of electrical energy that can be transferred by a Daniel cell. ΔG° = -2 × 1.10 × 96500 = -212.3 kJ/mol

(Ans: 0.05mol of Zn; -193kJ/mol, -212.3kJ/mol) (3)

- At 291K, molar conductivities at infinite dilution of NH₄Cl, NaOH and NaCl are 129.8, 217.4, 108.9 ohm⁻¹cm² respectively. If the molar conductivity of centinormal of NH₄OH is 9.33 ohm⁻¹cm². Suggest how this information may be used to calculate the degree of dissociation of NH₄OH in its above mentioned solution. (Ans: α = 3.9%)

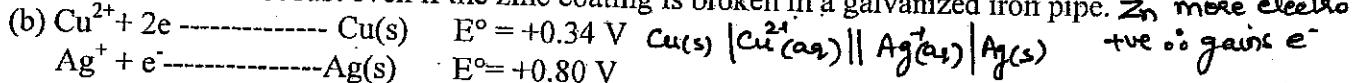
$$\lambda_{(\text{NH}_4\text{OH})} = \lambda_{\text{NH}_4\text{Cl}} + \lambda_{\text{NaOH}} - \lambda_{\text{NaCl}} = 129.8 + 217.4 - 108.9 = 238.3 \text{ ohm}^{-1}\text{cm}^2 \text{ mol}^{-1}, \quad \alpha = \frac{\lambda_c}{\lambda_{\text{NH}_4\text{OH}}} = \frac{9.33}{238.3} = 0.039$$

- The standard reduction potential values of 3 metallic cations X, Y, Z are 0.52, -3.03, -1.18 V respectively. What will be the order of reducing power of the corresponding metals. X < Z < Y increasing reducing power. (3)

14. (a) Account for the following :

i. An oxide film protects aluminium but cannot protect iron.

ii. Iron does not rust even if the zinc coating is broken in a galvanized iron pipe. Zn more electro-



i. Construct a galvanic cell using the above data.

ii. For what concentration of Ag^+ ions will the EMF of the cell be zero at 25°C, if the concentration of Cu^{2+} is 0.1 M ? (Ans. $= 5.18 \times 10^{-9}$) (5)

$$E_{cell} = E^\circ - \frac{0.059}{2} \log \frac{[Cu^{2+}]}{[Ag^+]^2}$$

$$\text{LEVEL III} \quad 0 = 0.46 - 0.0295 \log \frac{0.1}{(Ag^+)^2}$$

15. Electrolysis of KBr(aq) gives Br_2 at anode but KF(aq) does not give F_2 . Give reason for this disparity. H_2O is more easily oxidised as compared to F^- ion. (1) O_2 is released instead of F_2 .

16. Which solution will allow greater conductance of electricity, 1M NaCl at 293K or 1M NaCl at 323K? as ionic mobility inc with inc. in T. (1)

17. Electrolysis of aqueous solution of NaCl gives H_2 gas at cathode but electrolysis of molten NaCl yields Na metal. How is this difference in results explained? Molten NaCl $\xrightarrow{2} Na^+ + Cl^-$
 for aq. NaCl $Na^+ Cl^- H^+$ will reduce as it has higher E° $\therefore H_2$ released. $J+e \quad J-e$
 $H^+ OX^- Cl^-$ " oxidise because of other voltage $Na + Cl^-$

18. At 25°C, the conductivity of saturated solution of $AgCl$ is $2.68 \times 10^{-6} \Omega^{-1} cm^{-1}$ and that of water in which the solution is made is $0.86 \times 10^{-6} \Omega^{-1} cm^{-1}$. If the limiting molar conductivities of $AgNO_3$, HNO_3 and HCl are respectively 133, 421 and $426 \Omega^{-1} cm^2 mol^{-1}$. Calculate the solubility of $AgCl$ in water at a given temperature. (3)

(Ans: $K_{AgCl} = 1.82 \times 10^{-6} \Omega^{-1} cm^{-1}$, $\Lambda_m^0 (AgCl) = 138 \Omega^{-1} cm^2 mol^{-1}$, $s = 1.32 \times 10^{-5} \text{ mol/litre}$)

19. Iron and nickel are used to make an electrochemical cell by using a salt bridge to join a half cell containing 1.0 M solution of Fe^{2+} (aq) in which a strip of iron has been immersed to a second half-cell which contains 1.0M Ni^{2+} (aq) solution in which a strip of nickel has been immersed.

A voltmeter is connected between the two metal strips.

i. In which cell does reduction occur? Nickel half cell.

ii. Write the half-cell reactions involved. $Ni^{2+} + 2e^- \rightarrow Ni$

iii. In which directions are the electrons passing through the voltmeter? Fe to Ni

iv. What would be effect on the voltmeter reading if Fe^{2+} concentration were increased? decrease

v. What will be the voltmeter reading when the cell reaches equilibrium? zero

Given that the standard electrode potentials of Fe^{2+}/Fe and Ni^{2+}/Ni electrodes are -0.44 and -0.25 volt respectively (5)

20. It was 8 p. m. and Raj has to appear for his board exam the next morning. Suddenly the power went off. There was an announcement that the supply will be restored after 12 hours. What to do? Candles were not available either. "Mom, are there lemons in the house"? Yes dear, we have two lemons in the refrigerator answered the mother. That's fine. Raj made some assembly & light was seen in the house. Raj could prepare for his exam.

(a) Can you guess how Raj could manage to obtain power supply? Explain. (Hint-An electrochemical cell)

(b) What values are attached to Raj's initiative? (Hint-Where there is a will there is a way)

(VBQ - 4)

$$18. K_{AgCl} = \frac{\Lambda_m^0}{\Lambda_m^0 (AgCl)_{(sat)}} = \frac{1.82 \times 10^{-6}}{2.68 \times 10^{-6}}$$

$$= 2.68 \times 10^{-6} - 0.86 \times 10^{-6} = 1.86 \times 10^{-6} \Omega^{-1} cm^{-1}$$

$$\Lambda_m^0 AgCl = 133 + 426 - 421 = 138 \Omega^{-1} cm^2 mol^{-1} = \Lambda_m^0 AgNO_3 + \Lambda_m^0 HCl - \Lambda_m^0 HNO_3$$

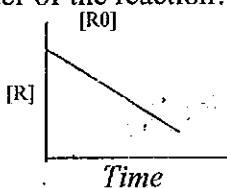
$$\text{Solubility} = \frac{10^{-6} \times 10^{-6}}{138} = \frac{1.82 \times 10^{-6} \times 10^{-6}}{138} = 1.32 \times 10^{-5} \text{ mol/L}$$

Shahrukh
of amrah
31/7/15

AMITY INTERNATIONAL SCHOOL, NOIDA
CLASS-XII, CHEMISTRY
UNIT-4 CHEMICAL KINETICS
SESSION-2015-16

Level -I

- The specific reaction rate of a reaction is $6.2 \times 10^{-3} \text{ L}^2 \text{ mol}^{-2} \text{ sec}^{-1}$. What is the order of the reaction? (1)
- Variation of concentration of a reactant with time for a given reaction is shown below. What is the order of the reaction? **zero order** (1)



3rd order

- The activation energy of a reaction is zero. If k_1 is its rate const. at temp. 300K, what would be the value of k_2 at 350K in terms of k_1 ? Show it mathematically. (2) $(\text{Ans- } k_2 = k_1)$
- The activation energy of a first order reaction is 30 kJ/mol at 298K. The activation energy for the same reaction in the presence of a catalyst is 20 kJ/mol at 298K. How many times the reaction rate has changed in the presence of a catalyst? (2) $\log k = \log A - \frac{30 \times 10^3}{2.303 RT}$, $\log k' = \log A - \frac{20 \times 10^3}{2.303 RT}$, $\log k' - \log k = \frac{-30 + 20 \times 10^3}{2.303 RT} \frac{1}{k} = -0.00175 \times 10^3$ $(\text{Ans- } 55.08)$
- For a certain chemical reaction: $A + 2B \rightarrow 2C + D$ The experimentally obtained information is tabulated below:

Experiment	[A] mol/L	[B] mol/L	Initial rate of formation of D (mol/L/min)
1	0.30	0.30	0.096
2	0.60	0.30	0.384
3	0.30	0.60	0.192
4	0.60	0.60	0.768

(i) What is the order of reaction w.r.t. both the reactants A and B. (*Ans -2&1*)

(ii) Write the rate law.

(iii) Calculate the value of rate constant k and write its unit. (*Ans - $K=3.56 \text{ mol}^{-2} \text{ L}^2 \text{ min}^{-1}$*)

Level II

- Under what conditions does the rate of reaction become equal to rate constant? (1)
 When rate is independent of the conc. of reactants.
 Or $[R] = \text{Unity}$.

7. Why is that instantaneous rate of reaction does not change when a part of the reacting solution is taken out. $\text{rate} \propto [\text{R}]$, change in $[\text{R}]$ is negligible. (1)
8. What does the low value of steric factor 'p' indicates? Improper orientation \rightarrow less eff. collision \rightarrow slow rate. (1)
9. Identify the possible value of molecularity from the following: - 0, 1, 1/3, 4. (1)
10. Why does equilibrium constant remain unchanged even on adding a catalyst? inc. the speed of forward reaction (1)
11. Differentiate between activation energy & threshold energy. (2)
12. Explain with the help of a graph how does the catalyst increase the rate of a reaction? (2)
13. In the Arrhenius equation for a certain reaction, the value of A and Ea are $4 \times 10^{13} \text{ s}^{-1}$ and 98.6 kJ/mol respectively. If the reaction is of first order; at what temperature will its half life period be 10 minutes?
- $$k = \frac{0.693}{10 \times 60}, \log k = \log A - \frac{E_a}{2.303RT} \quad (\text{Ans- } 311.34 \text{ K})$$
14. A first order reaction has a rate constant of 0.0051 min^{-1} . If we begin with 0.10 M conc. of the reactant, what concentration of the reactant will be left after 3 hours? (3) $k = \frac{2.303}{180} \log \frac{1}{A_f}$ (Ans -0.04M)
15. The following reaction was carried out in water: $\text{Cl}_2 + 2\text{I}^- \rightarrow 2\text{Cl}^- + \text{I}_2$
The initial conc. of I^- was 0.25 mol/L & the conc. after 10 mins was 0.23 mol/L. Calculate the rate of disappearance of I^- & appearance of I_2 . (3) (Ans-0.002 mol/L/min, 10^{-3} mol/L/min)
- $$\leftarrow -\frac{\Delta [\text{I}^-]}{\Delta t} \quad \leftarrow \frac{\Delta [\text{I}_2]}{\Delta t} = -\frac{1}{2} \frac{\Delta [\text{I}^-]}{\Delta t}$$

Level III

16. Why change in Gibbs energy is positive for photochemical reaction? A part of light energy absorbed by R & gets converted to free energy. (1)
17. Explain the following:- (3)
- One gram of pulverized wood burns faster than a one gram piece of wood. more surface area
 - An increase of 10 K in temperature rarely doubles the kinetic energy of particles but this increase in temperature may be enough to double the rate of reaction. Rate \uparrow with \uparrow in T as there is \uparrow in total no.
 - In some cases, it is found that a large number of colliding molecules have energy more than threshold energy, yet the reaction is slow. Why? due to improper orientation
18. Derive integrated rate equation for a zero order reaction and obtain a relation for its half-life. Give two examples of zero order reaction. What is the unit of rate constant for a zero order reaction? (2+2+1)
19. What is the effect of temperature on rate of a reaction? Explain the reason for this. How the activation energy of a reaction can be determined? Derive the desired relation from Arrhenius equation. (1+1+1+2)

VALUE BASED QUESTION (4 marks)

20. It was peak of summer and all the family members were back from their trip. All of them were feeling thirsty but no one was in a mood to go to kitchen and prepare some refreshing drink. Vinita the eldest among the siblings and a student of chemistry got up and prepared nimbupani with some powdered sugar. She took only few minutes to prepare the same.
- What according to you is the principle behind the short time taken by Vinita to prepare the nimbupani? more surface area of powdered sugar
 - Name two factors on which the rate of the reaction depends? conc. of Reactants, Temp.
 - What are the values shown by Vinita? concern for others, application of basic knowledge.

AMITY INTERNATIONAL SCHOOL, NOIDA

Class : XII

Subject :ChemistryUNIT : 5 (Surface Chemistry)**Level I Questions:**

- Which has higher enthalpy of adsorption: physisorption or chemisorption? (1)
- Why is finely divided substance more effective as an adsorbent? more surface area (1)
- Explain the cleansing action of soap. Why do soaps not work in hard water? Hard water contains Ca and Mg salts. In hard water, soap gets precipitated as scum. So they don't work in hard water. Page 137
- What do you mean by coagulation of colloidal solution? How can coagulation of lyophobic sols be carried out? The process of settling down of colloidal particles through induced aggregation by addition of suitable electrolyte. Methods: Electrophoresis, boiling, persistent dialysis
- What are characteristics of the following colloids? Give one example of each: (3)
 - Multimolecular colloids e.g. S₈, gold sol
 - Lyophobic sol e.g. Fe(OH)₃, As₂S₃ sol
 - Emulsions e.g. Milk

Level II Questions :

- What causes Brownian movement in colloidal solution? unbalanced forces / bombardment of particles by molecules of dispersion medium
- In case of chemisorption, why adsorption first increases and then decreases with temperature? (1) because of formation of chemical bonds.
- When does a fine gold sol appear red and purple? Fine gold sol is red as the particle size increases it appears purple.
- Adsorption of a gas on the surface of solid is generally accompanied by decrease in entropy; still it is a spontaneous process. Explain. Page 123, NCERT (2)
- Which of the following is most effective in coagulating ferric hydroxide sol and why? (2)

KCl, FeCl₃, Na₂SO₄, K₃[Fe(CN)₆] max → +ve charge will be most effective
- A colloidal solution of AgI is prepared by two different ways: in coagulation (Hardy Schulze Rule) (HOTS)(2)

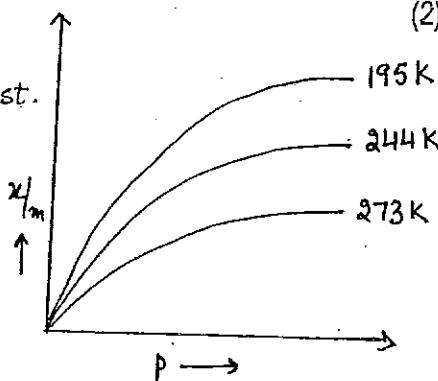
Test tube A: By adding KI to AgNO₃ solution. [Ag⁺]_(A) [KI]_(B) $\xrightarrow{\text{A}} \text{AgI}/\text{Ag}^+ + \text{ve charge}$

Test tube B: By adding AgNO₃ to KI solution. [Ag⁺]_(A) [KI]_(B) $\xrightarrow{\text{B}} \text{AgI}/\text{I}^- - \text{ve charge}$
- What is the charge of colloidal particles in the two test tubes? Give reason for the origin of charge. Selective absorption of common ion
- Consider the adsorption isotherm given on the side and interpret the variation in the extent of adsorption (x/m) when

- (a) (i) Temperature increases at constant pressure.
first increases and then becomes const.

- (ii) pressure increases at constant temperature
Finely divided Fe Molybdenum

- (b) Name the catalyst and the promoter used in Haber's process for the manufacture of ammonia.



13. Give reason for the following observations: (3)

- Sky appears blue in colour. Scattering of light by colloidal particles. Blue has max. scattering
- Colloidal medicines are more effective. Large surface area so easily assimilated
- Cottrell's smoke precipitator is fitted at the mouth of the chimney used in factories. for precipitation of colloidal particles of smoke.

14. Explain the following observations: (3)

- Rate of physical adsorption decreases with rise of temperature. as vander waal forces decreases with rise in temperature.
- Artificial rain is caused by spraying electrified sand on clouds. clouds are charged and on spraying electrified sand having opp. charge, ppt. (artificial rain) takes place.
- Bleeding from a fresh cut can be stopped by applying alum. Coagulation

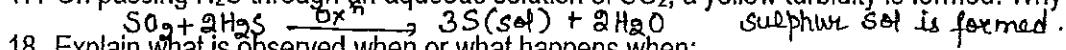
15. What happens when (3)

- An emulsion is subjected to centrifugation. demulsification i.e. emulsion separates into its constituent lig.
- FeCl₃ is added to excess of hot water. Colloidal sol of Fe(OH)₃ is formed.
- A freshly prepared Fe(OH)₃ is shaken with little amount of dilute solution of FeCl₃. Peptisation

Level III Questions :

16. Which will be adsorbed more readily on the surface of charcoal and why: NH₃ or CO₂? (1) H-bond

17. On passing H₂S through an aqueous solution of SO₂, a yellow turbidity is formed. Why? (2)(HOTS)



18. Explain what is observed when or what happens when: (3)

- Gelatin is added to gold sol. Gelatin is a protective colloid. So gold which is lyophobic sol starts behaving like a lyophilic sol.
- A mixture of milk and water is observed in transmitted and reflected light. It appears red in transmitted light & blue in reflected light.
- Colloid is subjected to persistent dialysis. Electrolyte is completely removed, colloid becomes unstable ∴ coagulation

19. Explain the following giving suitable reasons: (3)

- Delta's are formed when river meets the sea. Coagulation of colloidal clay particles by electrolyte of sea.
- Zeolites are called shape selective catalyst. The specific pore size of zeolites allow only selective molecules to be adsorbed in the pores.
- Silica gel bags are used for air tight packaging. As they adsorb moisture from the environment.

20. On the day of pleasant weather, Ram and Shyam went biking on the country side. Suddenly they felt a

chocking sensation. What they saw on their left side was a chimney vomiting thick black fumes of carbon. They remembered that they were taught in Chemistry, how these fumes can be controlled.

They thought of suggesting the same to the owner of the factory.

VBQ(4)

- What are the effects of untreated smoke on environment? Causes air pollution, respiratory diseases, acid rain etc.
- Name the device that can be used in the chimney of this factory. Cottrell's smoke precipitator.
- Explain the working of this device. It consist of charged electrodes. Electrophoresis of charged colloidal particles takes place followed by precipitation.
- What values do you associate with the prompt action taken by Ram and Shyam? So smoke is free of colloidal particles. Concern for Environment, scientific aptitude

Jain
Gangashri

AMITY INTERNATIONAL SCHOOL, NOIDA
CLASS-XII **SUB-CHEMISTRY**
WORKSHEET- General Principles and processes
of isolation of elements

Shallop

LEVEL-I

1. Name one mineral & one ore of Aluminium. (1) Mica, Bauxite
 2. Write the major point of difference between electrolytic reduction and reduction with carbon. (1)
It is based on difference in electrode potential of ore-metal and impurity.
Whereas in other method carbon is used as reducing agent to reduce metal oxides.
 3. Name the adsorbent which is used in column chromatography? (1) Al_2O_3
 - Mond's Zone Refining Van Arkel Process
 4. Name the method used for the refining of (i) Nickel (ii). Zirconium. (1)
 5. What is a flux? Name the substance which is formed when flux combines with gangue.
(1) *A substance which is added during metallurgical process to remove gangue.*
Slag is formed.
 6. Write the metal present in the following ores. (2)
 - (a) Dolomite Calcium
 - (b) Cinnabar Mercury
 - (c) Calamine Zinc
 - (d) Argentite Silver

LEVEL-II

7. Graphite is used as anode in electrolytic refining not diamond. Give reason. (1)
Graphite is a good conductor while diamond is not / Graphite has free e⁻. So better conductor

8. Why do blisters generally appear when molten copper is allowed to cool in Bessemer converter? (1) because of evolution of SO_2 gas

9. What is the thermodynamic consideration in the choice of a reducing agent in metallurgy? ΔG_f should be highly negative

10. What does a steep increase in slope of line on Ellingham diagram? (1) change of state (solid \rightarrow liquid)

11. Give reason for the following-(1+1)

 - (a) Graphite rods in Hall-Herault's process need to be changed frequently. because oxygen evolved during the process reacts to it to form CO_2
 - (b) Metals do not occur in the form of nitrates.
Nitrates are water soluble

12. Discuss the role of depressant in froth floatation process with the help of chemical equation.(1) It prevents one of the sulphide ore from going into froth.
eg NaCN is a depressant for mixture of ZnS and PbS

13. Give reason-(1+1)

- (a) Froth floatation method is used for the concentration of sulphide ore. As sulphide ores are wetted by oil
- (b) CaCO_3 is used for the extraction of Iron. It acts as flux to remove impurity of SiO_2
14. Describe the principle controlling each of the following processes and name one metal which can be refined by each method--(1+1+1)

- (a) Vapour phase refining eg Ni, Zr, Ti
- (b) Zone refining eg Si, Ge
- (c) Electrolytic refining eg Zn, Cu

15. Differentiate between--(1+1+1)

- (a) Calcination & Roasting
- (b) Distillation & Liquation
- (c) Pyrometallurgy & Hydrometallurgy

LEVEL- III

16. Copper and silver lie below in the electrochemical series and yet they are found in the combined state as sulphides in nature. Comment (1) due to high polarising power of copper and silver ions their sulphides are even more stable than metals.

17. Why is zinc not copper used for the recovery of metallic silver from its cyanide complex? (1) Zinc is highly electropositive while Cu is not

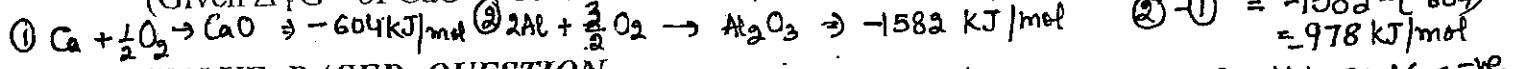
18. The extraction of Au by leaching with NaCN involves both Oxidation and reduction. Justify giving equations. (2)

$$\text{Au} + \text{NaCN} + \text{H}_2\text{O} \xrightarrow{\text{Ox^n of Au}} [\text{Au}(\text{CN})_2]^- + \text{NaOH}$$

$$[\text{Au}(\text{CN})_2]^- + \text{Zn} \longrightarrow [\text{Zn}(\text{CN})_4]^{2-} + \text{Au (pure)} \quad \text{Red^n of Ac}$$

19. A student suggested that calcium could be obtained by reducing dolomite ($\text{CaCO}_3 \cdot \text{Mg CO}_3$) with Aluminium powder. Was he correct in his approach? Suggest. (2)

(Given $\Delta_f G^\circ$ of $\text{CaO} = -604.0 \text{ kJ/mol}$ $\Delta_f G^\circ$ of $\text{Al}_2\text{O}_3(s) = -1582.0 \text{ kJ/mol}$)



VALUE BASED QUESTION

Rxn is feasible as $\Delta G = -ve$

20. Amit's father is an employee of SAIL. During his vacation he requested his father to take him to the plant to see the metallurgical process carried out there. He was anxiously waiting for the day. Amit visited the plant along with his father & his engineer friend to know more about metallurgical processes. The engineer friend explained Amit about the principle of extracting a metal from its ore.

- (a) What was the explanation given to Amit about Ore dressing? (1) *earthly impurities (gangue) from ore.*
- (b) What is the process known as? (1) *Concentration of ore*
- (c) Name the method of concentrating an ore where the ore is heavier than the gangue particles. (1) *Hydraulic washing*
- (d) What values are associated with it? (1) *Curiosity, scientific temperament.*

*Spiral path
6-10-15*

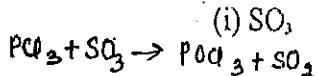
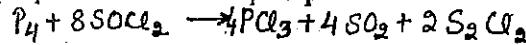
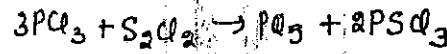
AMITY INTERNATIONAL SCHOOL, NOIDA
CLASS-XII SUB-CHEMISTRY
WORKSHEET- p-BLOCK ELEMENTS

Level I

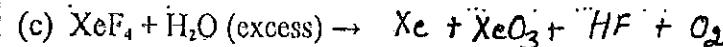
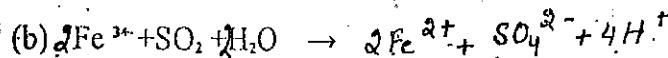
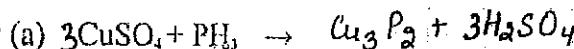
1. Name the oxoacid of phosphorous which contain one P-P linkage. $H_4P_2O_7$ Pyrophosphoric acid (1)
 2. NH_3 is a good complexing agent. Give reason. Lone pair on NH_3 (1)
 3. Write one major point of difference on the reactivity of white phosphorus and red phosphorus. White P is more reactive (2) because of
 4. What is Inert Pair effect? Explain the same with reference to group-15 elements. Reluctance of s-orbital to unpair and participate in bond formation (3)
 5. Which of the halogens (except At)
 - (a) Forms the weakest acid? F
 - (b) Has the minimum ionization enthalpy? Cl
 - (c) Has the maximum electron affinity? Cl
- $n^2 np^3$: OS : +3,+5
Down the gp +3 becomes more stable because of inert pair effect

Level II

6. Name the gas liberated when Ammonium Nitrate is strongly heated. N_2O (1)
7. H_2S acts as a reducing agent but SO_2 acts as an oxidizing as well as reducing agent. Why? In SO_2 , S is intermediate OS (1)
8. Out of $HClO$ and $HClO_4$ which has lower pKa value and why? It is stronger acid (1)
9. Iodine is more soluble in aq. KI than in water. Why? Iodine combines with KI to form soluble complex KI_3 as ClO_4^- is more resonance stabilized
10. When NaI is heated with conc H_2SO_4 , I_2 is produced but when $NaCl$ is heated with conc H_2SO_4 , HCl is produced: Why? In case of NaI , HI liberated, being a reducing agent reduces H_2SO_4 to SO_2 , and oxidising itself to liberate I_2 (2)
11. Draw the structure of peroxodisulphic acid. What is the basicity of the acid? What is the oxidation state of sulphur? $H_2S_2O_8$. Basicity = 2 O.S of S = +6 (2)
12. How is PCl_3 prepared from white phosphorous? How does it react with:-

(i) SO_2 (ii) S_2Cl_2 

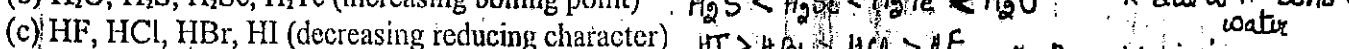
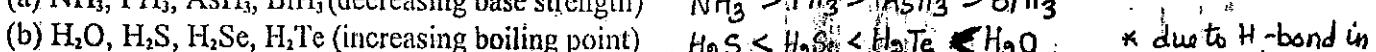
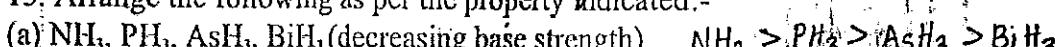
13. Complete the following equations:- (3)



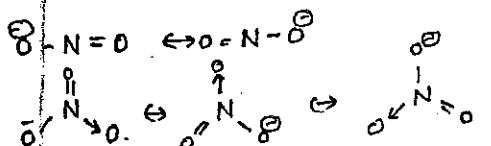
14. Give reason for the following: - (3)

- (a) CN^- ion is known but CP^- is not known. Inability of P to form pπ-pπ multiple bonds.
- (b) NF_3 is an exothermic compound but NCl_3 is an endothermic. Small size of F. So N-F bond is stronger
- (c) SF_6 is known but SH_6 is not known. F being electronegative can excite the central atom to highest O.S than N-Cl bond.

15. Arrange the following as per the property indicated: - (3)



Note $H_x \rightarrow H_2 + X_2$ (Reducing power of H_x depends on the ease with which it decomposes to give $H_2 + X_2$)



In NO_3^- , B.O of N=O bond is $3/2 = 1.5$

(one double and 1 single bond)

In NO_3^- Bond order is $\frac{4}{2} = 1.33$ (1 double and 2 single bonds)

NO_2 has shorter bond length

(Bond length)

Level III

16. Account for the following:-

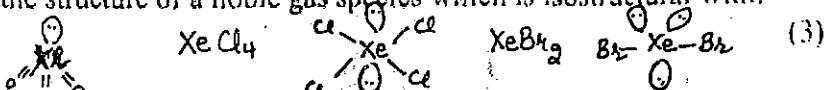
(2)

(a) The bond length of N-O in NO_3^- is less than that of NO_2^- .

(b) Oxides of nitrogen have open chain structure, while those of phosphorus have closed chain structures. N-N is unstable while P-P is stable, whereas N can form π - π multiple bonds.

17. Give the formulas and describe the structure of a noble gas species which is isostructural with:

17. Give the formulas and names of BrO_3 , ICl_4^- , and IBr_3^- . ~~K_2O_3~~

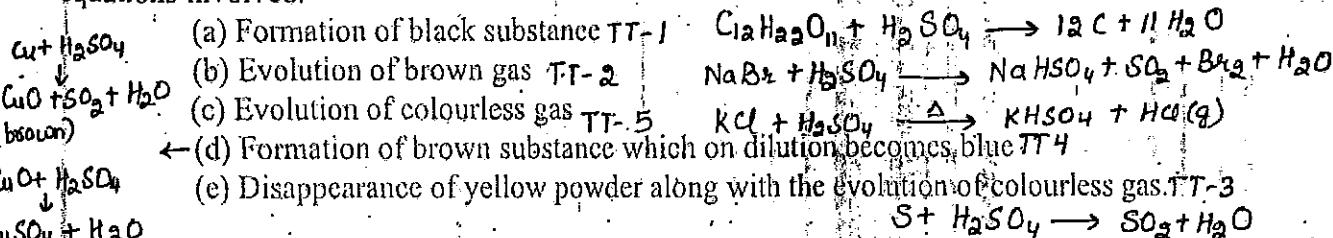


18. An element 'A' exists as a yellow solid in standard state. It forms a volatile hydride 'B' which is a foul smelling gas and is extensively used in qualitative analysis of salts. When treated with oxygen, 'B' forms an oxide 'C' which is colourless, pungent smelling gas. This gas when passed through acidified KMnO_4 solution decolourizes it. 'C' gets oxidized to another oxide 'D' in the presence of a Heterogeneous catalyst. Identify A, B, C, D and also give the chemical equation of reaction of 'C' with acidified KMnO_4 solution and for conversion of 'C' to 'D'. A $\xrightarrow{\text{H}_2}$ B $\xrightarrow{(O_2)}$ C $\xrightarrow{\text{V}_2\text{O}_5}$ D (5)

19. Conc. H_2SO_4 is added to following test tubes,

TT-1	TT-2	TT-3	TT-4	TT-5
Cane sugar	Sodium bromide	Sulphur powder	Copper turnings	Potassium chloride

Identify in which of the following test tubes, the following changes will take place & Write all equations involved.



(blue) VALUE BASED QUESTION

20. Anurag was enjoying his summer holidays in a sea beach at Mauritius along with his friends. He observed a deep sea diver carrying a gas cylinder at the back and ready to leave for his under-water journey. Out of curiosity Anurag asked him about the gas in the cylinder and its use? The diver explained about the mixture of gases in it.

- (a) What was the mixture of gases present in the cylinder? Oxygen, N_2 + H_2 (1)
 (b) What was the explanation given by the diver? Inert gases dilute the oxygen. (2)
 (c) What values are attached to this situation? At normal temp, the solubility of oxygen in

Scientific temperament of Anurag:

Excess of everything is harmful for the system.

- These gases receive the oxygen.
 - At very high P, the solubility of oxygen increases and hence oxygen poisoning occurs which can cause confusion, impairment of vision, etc.
 - He is insoluble and doesn't participate in any chemical reaction.

~~Chlorine gas~~ Vision, nausea et
8/11/01/5 So oxygen:
diluted in
cylinders by
adding water.

AMITY INTERNATIONAL SCHOOL, NOIDA

Class XII

Subject :Chemistry

Unit : 8

d- and f- BLOCK ELEMENT

Level I questions

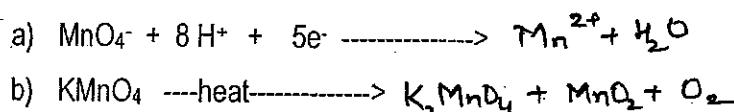
1. Name the lanthanoid which exhibits +4 oxidation state besides +3 oxidation state. (1) Cerium
2. Arrange the following in increasing order of basic character: MnO, MnO₂, Mn₂O₇. (1) Mn₂O₇ < MnO₂ < MnO
3. Name two properties of central metal ion which enables it to form stable complex entities. (1) high Z_{eff}, empty d
4. What is the composition of MISCH metal? Also mention its use. (2)
5. Describe with an example the oxidizing actions of permanganate ion in acidic and alkaline medium. Which acid and alkali are usually used? (3)

Level II questions

6. What is the effect of increasing pH on potassium chromate solution? $\text{CrO}_4^{2-} \xrightleftharpoons[\text{OH}^-]{\text{H}^+} \text{Cr}_2\text{O}_7^{2-}$ (1)
7. Which is more basic, La(OH)₃ or Lu(OH)₃ and why? Lanth. contraction La → Lu. (1)
8. Out of Cr²⁺ and Cr³⁺, which one is stable in aqueous solution and why? half filled t_{2g} (1)
9. Which of these is more paramagnetic: Co²⁺(d⁷) or Cu²⁺(d⁹)? Explain. more unpaired e⁻ (1)
10. HCl is not used to acidify permanganate solution in volumetric estimations of Fe²⁺ or C₂O₄²⁻. Explain. (1) Cl⁻ is oxidised to Cl₂
11. Give suitable explanation of the following: (2)
 - a) Zn, Cd and Hg have low melting point. fully filled d ∴ weak interelectronic interactions.
 - b) Sm²⁺, Eu²⁺ and Yb²⁺ ions in solution are good reducing agents but Ce⁴⁺ is a good oxidizing agent. as all are more stable in +3 O.S.
12. Assign reasons for the following: (2)
 - a) Copper (I) ion is not known in aqueous solution. disproportionation $\text{Cu}^+ \rightarrow \text{Cu}^{2+} + \text{Cu}$.
 - b) Transition metals and their compounds generally exhibit a paramagnetic behavior. unpaired e⁻, d-d transition
13. Give reasons why? (3)
 - a) Actinides in general exhibit a greater range of oxidation states than the lanthanides. 5f, 6d + 7s - similar energy.
 - b) Zinc salts are white while Cu²⁺ salts are coloured. (Zn=30, Cu=29) absence of unpaired e⁻ ∴ no d-d transition
 - c) A transition metal forms alloy with other transition metal easily. similar atomic radii
14. (i) Write balanced equations to represent what happens when (2+3)
 - (a) Acidified KMnO₄ solution is treated with oxalate ions in solution. $\text{C}_2\text{O}_4^{2-} + 2\text{MnO}_4^- + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 10\text{CO}_2$
 - (b) An iodide ion is treated with an acidified dichromate ion in solution. $\text{Cr}_2\text{O}_7^{2-} + 3\text{I}^- + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 3\text{I}_2 + 7\text{H}_2\text{O}$
- (ii) Give reasons for the following observations:
 - a) Cu(I) is diamagnetic while Cu(II) is paramagnetic. unpaired e⁻ in Cu(II)
 - b) V₂O₅ acts as a good oxidizing agent. exhibits its variable O.S., large surface area.
 - c) Transition elements form interstitial compounds. large interstitial space.

15. (i) Complete the following equations:

(2+3)



(ii) Give reasons for the following:

- Only transition metals form complex compounds with ligands such as CO. empty d orbital forms σ -bond with CO.
- Zirconium and Hafnium exhibit similarity in properties. Lanth. contraction.
- E° for $\text{Mn}^{3+}/\text{Mn}^{2+}$ couple is more positive than that of $\text{Fe}^{3+}/\text{Fe}^{2+}$. (At. No. of Mn = 25, Fe = 26)

as Mn is more stable in +2 (half filled) while Fe³⁺ is more stable.

Level III questions

16. The sum of first and second ionisation energies and those of third and fourth ionisation energies of nickel and platinum are:

$$\text{IE1} + \text{IE2}(\text{kJ/mol}) \quad \text{IE3} + \text{IE4}(\text{kJ/mol}) \quad (2)$$

Ni	2.49	8.8
Pt	2.66	6.7

Based on this information, write

- The most common oxidation state of Ni and why? +2 as $\text{IE}_1 + \text{IE}_2$ is low.
- Which of the two will form compounds in +4 oxidation state and why? Pt as $(\text{IE}_1 + \text{IE}_2 + \text{IE}_3 + \text{IE}_4)$ is low

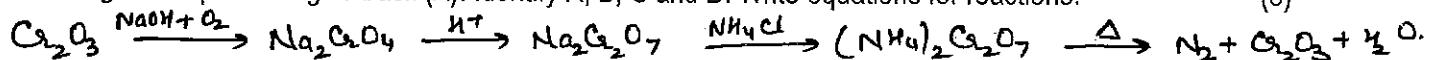
17. Mention direct consequences of the following factors on the chemical behaviour of the transition elements: (2)

- They have completely filled d-orbitals in the ground state or in one of the oxidized states of their atom. white salts diamagnetic
- They contribute more valence electrons per atom in the formation of metallic bonds.
very high enthalpy of atomisation.

18. Answer the following questions: (3)

- Out of Ag_2SO_4 , CuF_2 and MgF_2 , which is coloured and why? Cu^{2+} , unpaired e⁻, d-d transition.
- CrO_4^{2-} is a strong oxidising agent while MnO_4^- is not. Cr is in highest O.S., while Mn is not.
- Mn(II) shows maximum paramagnetic character amongst the divalent ions of the first transition series. Maxⁿ unpaired e⁻

19. A green compound (A) on fusion with alkali gives a yellow compound (B) which on acidification gave an orange coloured compound (C). 'C' on treatment with NH_4Cl gives an orange coloured product (D), which on heating decomposes to give back (A). Identify A, B, C and D. Write equations for reactions. (3)



20. Raj was travelling in a car with his driver. They were stopped by a policeman and the driver was asked to take the breath analyzer test for alcohol. He was asked to blow air into the device which contained a pink solution whose colour faded. (4)

- What is the pink coloured solution and why did it fade? Acidified KMnO_4 , colour fades because of Mn^{2+} of KMnO_4 with alcohol.
- Why are such tests conducted on drivers?
To check whether they are under the influence of alcohol
- What are the values involved in the action of the policeman?

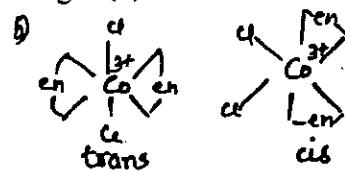
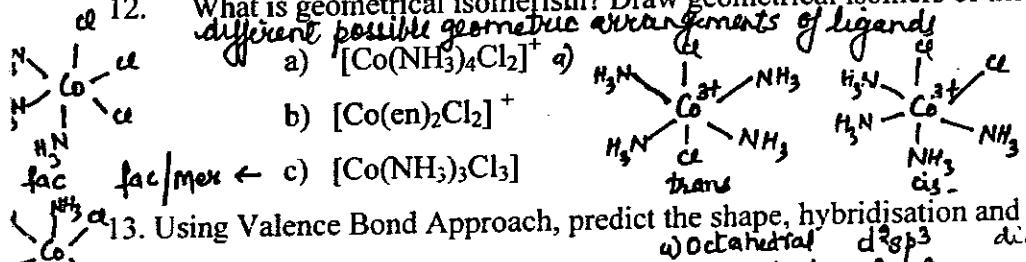


Aanjanee
Jyoti



11. Write the name, stereochemistry and magnetic behaviour of the following:
- | | stereochemistry | magnetic behaviour | |
|-------------------------|---|--------------------|---------|
| a) $K_4[Mn(CN)_6]$ | Potassium hexacyanomanganate (II) | d^2sp^3 | Para- |
| b) $[Co(NH_3)_5Cl]Cl_2$ | Pentaamminechloridocobalt (II) chloride | d^2sp^3 | Diamag. |
| c) $K_2[Ni(CN)_4]$ | Potassium tetracyanonickelate (II) | dsb^2 | Diam |

12. What is geometrical isomerism? Draw geometrical isomers of the following: (3)



13. Using Valence Bond Approach, predict the shape, hybridisation and magnetic character of the following:
- | | | |
|----------------|-----------|---------------|
| a) Octahedral | d^2sp^3 | diaximagnetic |
| b) octahedral | d^2sp^3 | paramagnetic |
| c) tetrahedral | sp^3 | paramagnetic |
- (a) $[Cr(CO)_6]$ (b) $[Fe(CN)_6]$ (c) $[CoCl_4]^-$

14. Explain the following: (3)

- (a) $[NiCl_4]^{2-}$ is paramagnetic while $[Ni(CO)_4]$ is diamagnetic although both are tetrahedral.
- (b) $[Ti(H_2O)_6]^{3+}$ is coloured while $[Sc(H_2O)_6]^{3+}$ is colourless. Ti^{3+} does not have unpaired e^- . So No d-d transition
- (c) $[Ni(CO)_4]$ possesses tetrahedral geometry, while $[Pt(NH_3)_2Cl_2]$ is square planar.

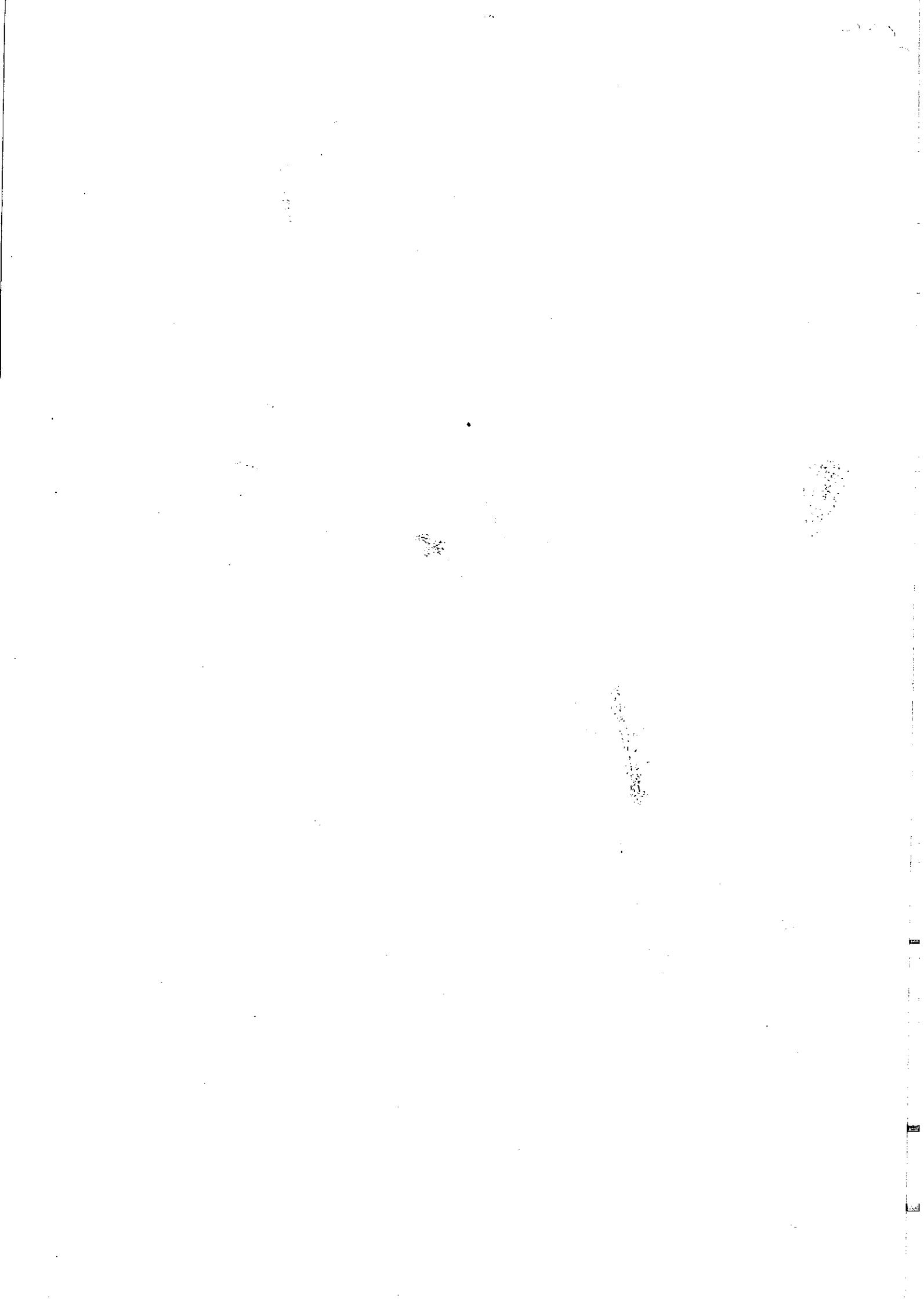
Cl is weak field ligand while CO is strong field ligand

15. $CoCl_3 \cdot 4NH_3$ precipitates silver chloride with 1 mole of $AgNO_3$ (aq) reacting in equimolar amounts, though it has three moles of chlorides per mole. Further the compound was exhibiting different colours when prepared at different times – sometimes green and sometimes violet.

- a. Predict the structure of the complex and give IUPAC name of the compound. $[Co(NH_3)_4Cl_2]Cl$
- b. Why does it exhibit different colours? *geometrical isomers*.
- c. What are the values that can be attached with the observations? (VBQ, 4)

Level III

16. Name the ligand used in treatment of lead poisoning and mention its denticity. (1) EDTA, 6
17. The hexaaqua manganese(II) ion contains five unpaired electrons, while the hexacyanido ion contains only one unpaired electron. Explain using CFST. H_2O is a weak field ligand so no pairing. CN^- is a strong field ligand, so pairing occurs.
18. The spin only magnetic moment of $[MnBr_4]^{2-}$ is 5.9BM. Predict the geometry of the complex ion? ($\eta = 5$, no pairing, sp^3 , tetrahedral) (2)
19. Give a chemical test to distinguish between $[Co(NH_3)_5Br]SO_4$ and $[Co(NH_3)_5SO_4]Br$. What kind of isomerism do they exhibit? *BaCl₂ test for SO₄²⁻* (2)
20. AgNO₃ test for Br⁻ (2)
- a) Write IUPAC name for
- (a) Linkage isomer of $[Co(NH_3)_5ONO]Cl_2$ $[Co(NH_3)_5NO_2]Cl_2$, Pentaamine nitro-N- cobalt (III) chloride
- (b) Coordination isomer of $[Co(NH_3)_6][Cr(CN)_6]$ $[Co(NH_3)_6][Co(CN)_6]$, Hexaamine chromium (III) hexa cyanocobaltate (III)
- (c) Ionisation isomer of $[Co(NH_3)_5Br]SO_4$ $[Co(NH_3)_5SO_4]Br$, Pentaamine sulphato cobalt (III) boronate.



AMITY INTERNATIONAL SCHOOL NOIDA
SUB-CHEMISTRY **UNIT-10-Haloalkanes & Haloarenes**

CLASS -XII

LEVEL I

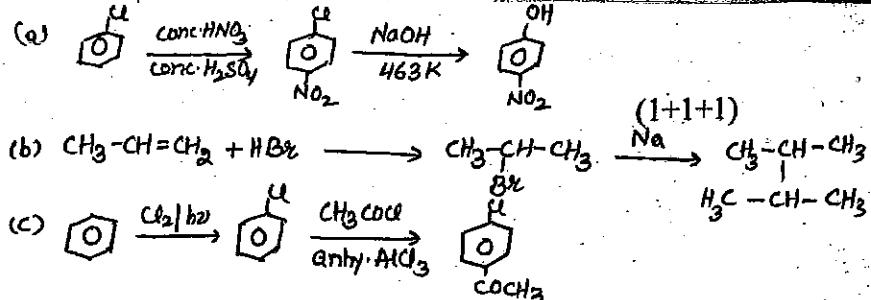
- Draw the structure of DDT and write its IUPAC name.
 - What is known as a racemic mixture? A mixture containing 50% dextro and 50% laevo isomer. (1)
 - Name the chlorine containing antibiotic which is used for treatment of typhoid fever and the anesthetic used during surgery. **Chloramphenicol / Halothane** (1)
 - Write the IUPAC name of the following:
- (a)
- 1-Chloro-2,4-dimethylbenzene
- (b)
- 2-Chloro-3,3-Dimethylbutane { 3-Chloro-2,2-dimethylbutane
5. Distinguish between - Retention and inversion of configuration by giving suitable example. (2)

LEVEL II

- A hydrocarbon C_5H_{12} gives only one monochlorinated product. Identify the hydrocarbon.
- Out of ethyl chloride & ethyl bromide which has a higher boiling point & why? **higher molar mass** (1)
- RCI is hydrolyzed to ROH slowly but the reaction is rapid if a catalytic amount of KI is added to reaction mixture. Why? $KI \rightarrow K^+ + I^-$, $I^- + RCl \rightarrow RI$, $RI + OH^- \rightarrow ROH$ (2)
 I^- is a powerful nucleophile and a better leaving group.
- During halogenation reactions why fluorination and iodination are generally not preferred? (2)
Fluorination is explosive due to low bond dissociation enthalpy of F_2 . Iodination is reversible and is to be carried out in presence of HIO_3 .
- Explain the following with the help of suitable examples- (1+1)
 - S_N1 reactions are favoured through solvation of halide ion with proton of protic solvent. **it helps in generation of carbocation**
 - S_N2 mechanism does not take place in tertiary halides. **because of steric hindrance**.
- Aryl halides are extremely less reactive towards nucleophilic substitution reaction than alkyl halides. Give reason. (i) Resonance (ii) sp^2 hybridised C (iii) Instability of phenyl carbocation (iv) Repulsion by the ring (2)
- Write chemical equations for the following when toluene is chlorinated: (1+1)
 - In presence of sunlight
 - In dark & in presence of Lewis acid
- Which one of the following undergoes dehydrohalogenation faster via S_N1 mechanism and why? (2)
 $CH_3CH_2CH_2Cl$ & $CH_3CHClCH_3$
 2° carbocation is more stable than 1° carbocation

14. Carry out the following conversions:

- (a) Chlorobenzene to p-Nitro phenol
- (b) Propene to 2, 3-Dimethylbutane
- (c) Benzene to 4-chloroacetophenone



15. Identify the name reaction in the following along with the catalyst used (if any): (1+1+1)

- (a) Chlorobenzene obtained from Benzenediazonium chloride Sandmeyer rxn"
- (b) Chloromethane is treated with Hg_2F_2 Swartz rxn"
- (c) Biphenyl obtained from bromobenzene. Fittig rxn", Na metal

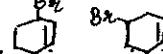
LEVEL-III

16. Suggest a chemical test to distinguish between the following pairs: (1+1)

- (a) Chlorobenzene and benzyl chloride Add $\text{KOH} + \text{AgNO}_3$, benzyl chloride will give white ppt.
- (b) Chloroform and carbon tetrachloride. Carbylamine test, add 1° amine + KOH , chloroform will give offensive smell of carbonyl amine

17. Give reasons for the following: (1+1)

(a) 3-Bromocyclohexene is more reactive than 4-Bromocyclohexene towards hydrolysis with aq. NaOH .

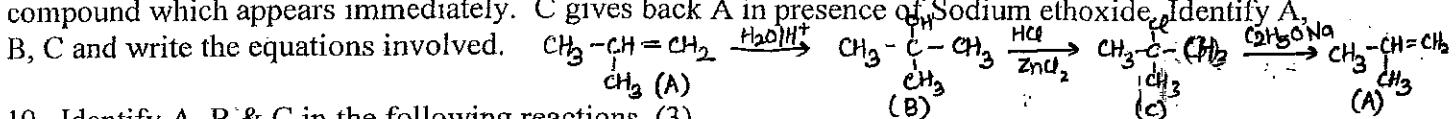


Forms allylic carbocation which is very stable.

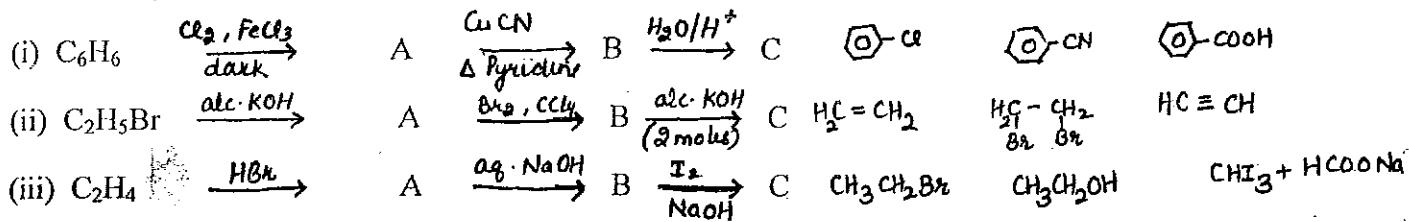
(b) Wurtz reaction is carried out in dry ether.

Na reacts explosively with water.

18. An organic compound A, having molecular formula C_4H_8 on treatment with H_2O in presence of dilute H_2SO_4 gives B. B on treatment with conc. HCl and anhydrous ZnCl_2 gives C, a turbid compound which appears immediately. C gives back A in presence of Sodium ethoxide. Identify A, B, C and write the equations involved.



19. Identify A, B & C in the following reactions. (3)



Value Based Question (4 marks)

20. A bottle containing some anesthesia was left on the window side of the operation theatre for a few days. The contents of the same bottle was used on one of his patients and found the patient having severe vomiting and stomach poisoning.

- (i) Identify the compound and write its IUPAC name. Chloroform, 1,1,1-trichloro methane
- (ii) Give relevant equation for the action of sunlight on it. $\text{CHCl}_3 + \text{O}_2 \xrightarrow{\text{h}\nu} \text{CO}_2 + \text{HCl}$
- (iii) What is the moral behind this incident? professional ethics.

Chirag
20/3/15

AMITY INTERNATIONAL SCHOOL , NOIDA

Class: XII

Subject: Chemistry

UNIT: 11 (Alcohols, Phenols and Ethers)

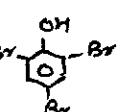
LEVEL I

1. Why is phenol much more acidic than alcohol? *Phenoxyde ion is resonance stabilised.* (1)
2. How is alcohol made unfit for drinking purposes? *by adding methanol / pyridine* (1)
3. Name a compound which can be used as both antiseptic and disinfectant both. (1) *Phenol*
4. Using Grignard reagent prepare the following alcohols: (2)
 - a) 3-Methylpentan-3-ol from Butan-2-one $\text{CH}_3-\overset{\text{C}}{\underset{\text{O}}{\text{||}}}-\text{CH}_2\text{CH}_3 + \text{C}_2\text{H}_5\text{MgBr} \xrightarrow{\text{H}_2\text{O}} \text{CH}_3-\overset{\text{C}}{\underset{\text{OH}}{\text{||}}}-\text{CH}_2\text{CH}_3$
 - b) 1-Phenylbutan-1-ol from Butanal $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} + \text{C}_6\text{H}_5\text{MgBr} \xrightarrow{\text{H}_2\text{O}} \text{CH}_3\text{CH}_2\text{CH}_2-\overset{\text{C}}{\underset{\text{OH}}{\text{||}}}-\text{C}_6\text{H}_5$
5. Name the reagents used in the following: (3)
 - a) Oxidation of 1-Cyclohexylmethan-1-ol to cyclohexanecarbaldehyde *PCC, PDC*
 - b) Butan-2-one to Butan-2-ol *LAH*
 - c) Dehydration of Butan-2-ol to But-2-ene *conc. H_2SO_4*

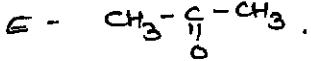
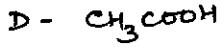
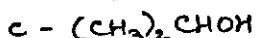
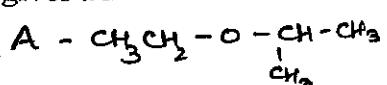
Level II Questions

6. Glycol has very high boiling point. Why? *extensive H-bonding* (1)
7. Why is acid catalysed dehydration of t-butanol faster than n-Butanol? *t-carbo cation is more stable* (1)
8. Two compounds A and B have molecular formula $\text{C}_2\text{H}_6\text{O}$. With HI, A gives alkyl iodide and H_2O while B gives alkyl iodide and alcohol. Identify A and B and write the reactions involved. $\text{A} \rightarrow \text{CH}_3\text{CH}_2\text{OH}$ $\text{B} \rightarrow \text{CH}_3\text{OCH}_3$ (2)
9. Which of the following gives fastest reaction with HBr (assuming that the reaction proceeds by $\text{S}_{\text{N}}\text{I}$ mechanism) and why? *Stability of t-carbocation* (2)

 $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3, \text{CH}_3\text{CH}_2\text{OH}, (\text{CH}_3)_3\text{C-OH}, \text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$
10. What happens when: (3)
 - a) Phenol reacts with benzene diazonium chloride. $\text{O}-\text{N}=\text{N}-\text{C}_6\text{H}_5-\text{OH}$ *orange azo dye*
 - b) Phenol is exposed to air / $\text{Na}_2\text{Cr}_2\text{O}_7$. $\text{O}-\text{C}_6\text{H}_5-\text{O}$ *Benzquinone*
 - c) Phenol is treated with aq. Br_2 . (Support your answers with chemical equations)


11. Give reasons for the following observations: (3)
 - a) Di tertiary butyl ether cannot be prepared by Williamson's synthesis. (HOTS) *steric hindrance*
 - b) Ethers possess dipole moment even though alkyl groups in the molecule are same. *non linear*
 - c) Di methyl ether is completely soluble in water but diethyl ether is slightly soluble. *larger hydrophobic part.*
12. An ether A($\text{C}_5\text{H}_{12}\text{O}$) on heating with conc. HI produced two alkyl halides which on hydrolysis form compounds B and C. Oxidation of B gives an acid D and oxidation of C gives a ketone E. Deduce the structures of A, B, C, D and E. (3)

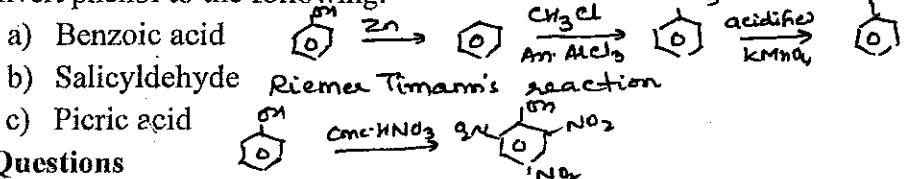
$\text{A} - \text{CH}_3\text{CH}_2-\text{O}-\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{ }}}-\text{CH}_3$	$\text{C} - (\text{CH}_3)_2\text{CHOH}$
$\text{B} - \text{CH}_3\text{CH}_2\text{OH}$	$\text{D} - \text{CH}_3\text{COOH}$
	$\text{E} - \text{CH}_3-\overset{\text{C}}{\underset{\text{O}}{\text{ }}}-\text{CH}_3$



13. Give chemical tests to distinguish between the following: (3)

- Cyclohexanol and phenol $\xrightarrow{\text{Br}_2 \text{ water}}$ Picric acid $\xrightarrow{\text{Azo dye}}$ Neutral
- Pentan-3-ol and 3-Methylpentan-3-ol Lucas test (immediate turbidity) $\xrightarrow{\text{FeCl}_3}$
- Methanol and Ethanol Iodoform

14. Convert phenol to the following: (3)

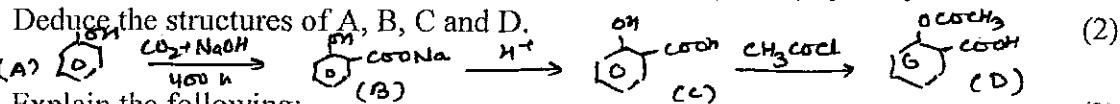


Level III Questions

15. Dehydration of alcohols to form alkenes is always carried out with conc. H_2SO_4 and not with conc. HCl or HNO_3 . Explain. (HOTS) HCl results in substitution HNO_3 causes oxidation. (1)

16. Sodium metal can be used for drying diethylether and benzene but not ethanol. Why? (1)
 \hookrightarrow reacts with ethanol (acidic nature) $\text{C}_2\text{H}_5\text{OH} + \text{Na} \rightarrow \text{C}_2\text{H}_5\text{ONa} + \text{H}_2$

17. An organic compound A with molecular formula $\text{C}_6\text{H}_6\text{O}$ gives colour with FeCl_3 solution. A on treatment with CO_2 and NaOH at 400K under pressure gives B which on acidification gives C. C reacts with acetyl chloride to give a popular pain killer D.



18. Explain the following: (3)

- The C-O-C bond angle in dimethyl ether is 111.7° . (HOTS) e^- cloud repulsion of 2 methyl
- Phenol is less polar than ethanol. In $\text{C}_2\text{H}_5\text{OH}$, O attached to more EN sp^2 C atoms
- Alcohols are less acidic than water. $\text{R}-\text{O}^\ominus$ destabilised due to $+\text{I}$ effect of R .

19. Arrange the following in increasing order of property mentioned: (HOTS) (3)

- n-Butyl alcohol, sec- Butyl alcohol, tert-Butyl alcohol (solubility in water) $\xrightarrow{\text{less surface area}} \text{alkyl more solubility}$
- Butan-1-ol, Butan-2-ol, 2- Methylpropan-2-ol (reactivity with sodium metal)
- Phenol, p- Chloro phenol, 2,4-Dichlorophenol, 2,4,6-Trichlorophenol (acidic -I effect character)

Value Based Question (4)

20. Sudhir heard a lot of noise and weeping in nearby jhuggis. He took courage and went to enquire what had happened. He found that some people had taken spurious alcohol containing methanol and were crying with pain. Some were complaining of loss of eyesight. He immediately hired an autoricksaw and packed it with the affected people and rushed to the hospital.

- Write the formula of alcohol used for drinking purposes and its IUPAC name.
 - How does methanol in drinking alcohol causes problem? It is poisonous, causes blindness as it is easily oxidised to HCHO
 - What treatment might the doctor have undertaken to save the patients?
 - What message would you give to the people who consumed spurious alcohol?
- b) Doctor might give intravenous infusions of diluted ethanol. Thus the enzyme that is responsible for oxid. of HCHO to acid is swapped allowing time for kidney to excrete methanol.
- c) A small benefit to pocket may cause serious injury to health. \therefore it at all required, alcohol must be purchased from authorised source.
- Avin
Farzeh*

Unit 12: Aldehydes, Ketones & Carboxylic Acids

LEVEL I:

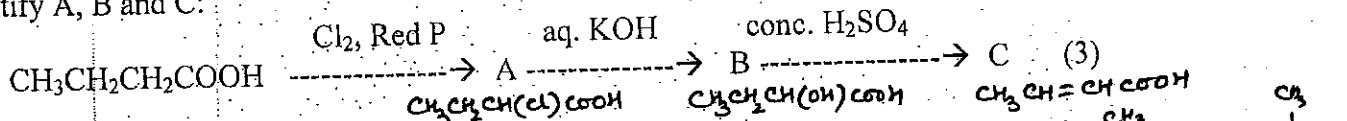
1. Arrange the following in increasing order of boiling points –
 propanone, propanal, propan-1-ol, propene, dimethylether
 ④ ③ ⑤ ① ②

2. How are formalin and trioxane related to methanal?

3. Give reasons:

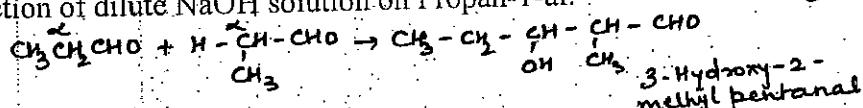
 - Most aromatic acids are solids while aliphatic acids like acetic acid is liquid.
 - Ketones are less reactive towards nucleophiles than aldehydes. (2)

4. Identify A, B and C: Cl_2 , $\text{Ba}(\text{OH})_2$, aq. KOH , conc. H_2SO_4



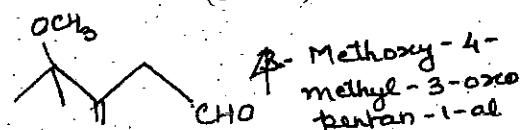
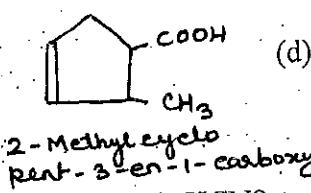
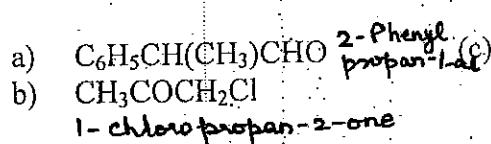
5. Write chemical equations for the following reactions:

- (a) Action of conc. NaOH solution on 2,2-Dimethyl-

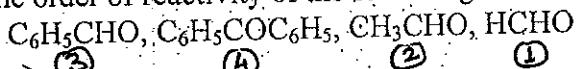


LEVEL II

- ### 6. Write IUPAC names:



7. What is the order of reactivity of the following towards HCN? (Decreasing order) (1)



8. Assign a suitable structure to $C_4H_8O_2$ that gives CHI_3 test and turbidity with Lucas reagent on heating. $CH_3 - C - CH_2 - CHOH$ (1)

- Heating. — The heat of the body is generated by the oxidation of food.

- 9 Give chemical tests to distinguish between

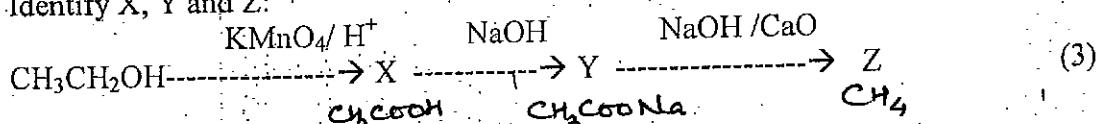
- a) Pentan-2-one and Pentan-3-one
 b) Benzaldehyde and Benzoic acid

- 1 cm³ test | NaHSO₃ test

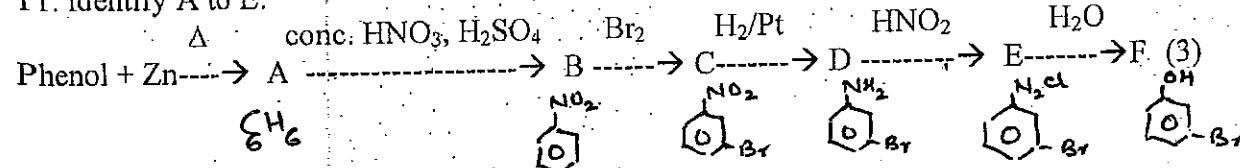
- NaHCO_3 test | Tollen's test

- (2)

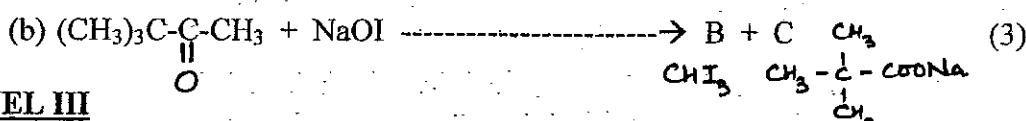
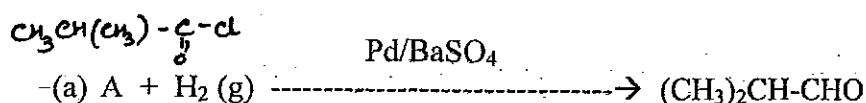
10. Identify X, Y and Z:



11. Identify A to E:



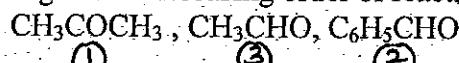
12. Complete the following reactions by identifying A, B and C.



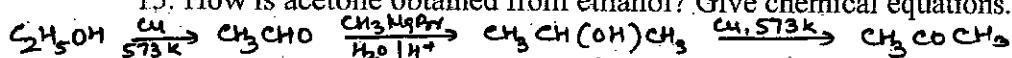
LEVEL III

13. Mention a chemical property in which formic acid differs from acetic acid. (1)
 Reduces Tollen's reagent ← ↳ gives HVZ reaction

14. Arrange the following in the increasing order of reactivity with C₆H₅MgBr (1)



15. How is acetone obtained from ethanol? Give chemical equations. (2)



16. Out of 2-Phenylpropane (cumene) and 2-Methyl-2-phenylpropane (t-butyl benzene), which can be oxidised to the carboxylic acid by KMnO₄/ KOH. Justify your answer. (2)

$(\text{C}_6\text{H}_5)_3\text{C}$ does not contain any benzylic H atom

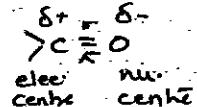
17. Give reasons:

- a) Formaldehyde gives Cannizaro reaction but acetaldehyde does not. No α H atom in HCHO
- b) Aldehydes have lower b. pts than corresponding alcohols & acids. → H bond
- c) Formic acid does not form anhydride on heating. $\text{HCOOH} \xrightarrow{\Delta} \text{H}_2\text{O} + \text{CO}$ (3)

18. Give reasons:

- a) Alpha H atoms in ethanal are acidic in nature. -I effect of $\overset{\delta}{\underset{\delta}{\text{C}}}$, resonance stabilisation of enol anion
- b) Chloro acetic acid is stronger than acetic acid. due to -I effect of Cl, decrease in e- density about disperses δ^- ve charge on chloroacetate ion.
- c) The reaction between aldehydes and weaker nucleophiles are carried out in weakly acidic medium. Inc. +ve charge on C $\text{>}=\text{O} + \text{H}^+ \rightleftharpoons [\text{>}=\text{O} \leftarrow \text{C}-\text{OH}]$
- d) Oxidation of alcohols to get aldehydes is done under controlled conditions.
- e) Benzaldehyde does not undergo aldol condensation. no α H atom (5)

19. a) Describe the structure of carbonyl group and indicate clearly the hybridised state of carbon, the sigma and pi-bonds present and the electrophilic and nucleophilic centres in it.



b) An organic compound 'A' with molecular formula C₅H₈O₂ is reduced to n-pentane on treatment with Zn-Hg/HCl. 'A' forms a dioxime with hydroxylamine and gives a positive iodoform test and Tollen's test. Identify the compound 'A' and write equations for the above reactions. (5)

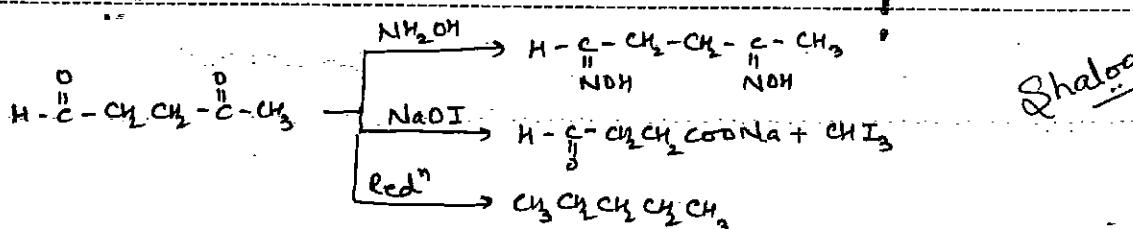
20. Kapil and Vinita were revising the chapter and found that these compounds find use in a number of eatables and perfumeries. The 'yagna' that is performed on religious events uses another aldehyde. Few of these compounds possess pleasant fragrances and are obtained from plants. Vanillin - Vanilla beans - food products, Cinnamaldehyde - cinnamon - flavouring agent

(a) Name any two carbonyl compounds that can be obtained from plants. Name the plant and one use of such compound.

(b) How do you benefit from the knowledge of this class of compounds?

(Hint: Use of plant source and avoid synthetic materials in food stuffs.) (VBQ - 4)

19 (b)



AMITY INTERNATIONAL SCHOOL, NOIDA
CLASS-XII **SUB-CHEMISTRY**

UNIT-13- ORGANIC COMPOUNDS CONTAINING NITROGEN

LEVEL-I

Benzene sulphonyl chloride:

- Benzene Sulphonate Esters

 - What is Hinsberg's reagent? Write its chemical formula.(1) 
 - Draw the zwitter ion of sulphanilic acid.(1)
 - Name an antihistamine drug which contains a tertiary amino group.(1)
 - What is diazotization? Write chemical reaction occurring in preparation of p-aminoazobenzene from aniline.(2)
 - Identify the name reaction and write a chemical equation for the same.(3)

(a) Aromatic amines cannot be prepared by this method. Gabriel Pthalimide synthesis

(b) Primary amines form isocyanides having extremely unpleasant smell. *Caryyl amine reaction*

(c) This reaction is widely used for descent of homologous series where an amide is converted to primary amine. Hofmann's bromamide reaction (degradation)

LEVEL-II

6. Mention the chief use of quaternary ammonium salts derived from long chain amines. (1)

7. Which one of the following- methylamine or methanol has a higher boiling point & why? (1)

8. Why do amines behave as nucleophiles? (1) due to lone pair on N
more polarity due to EN oxygen atom

9. Condensation of aniline and benzaldehyde gives compound A that is hydrogenated to give B.

Identify A and B. Write the equations involved. (2)

10. How can the following conversion be carried out:- (2)

(a) Ethanamine to methanamine $\text{C}_2\text{H}_5\text{NH}_2 \xrightarrow{\text{HNO}_2} \text{C}_2\text{H}_5\text{OH} \xrightarrow{\text{alk. KMnO}_4} \text{CH}_3\text{COOH} \xrightarrow{\text{NH}_3} \text{CH}_3\text{CONH}_2 \xrightarrow{\text{Br}_2/\text{NaOH}} \text{CH}_3\text{NH}_2$

(b) Aniline to benzyl alcohol. $\text{C}_6\text{H}_5\text{NH}_2 \xrightarrow{\text{HNO}_2} \text{C}_6\text{H}_5\text{N}_2\text{Cl} \xrightarrow{\text{H}_3\text{PO}_4} \text{C}_6\text{H}_5\text{Cl} \xrightarrow[\text{AlCl}_3]{\text{CH}_3\text{Cl}} \text{C}_6\text{H}_5\text{CH}_2\text{Cl} \xrightarrow[\text{KOH}]{\text{Cl}_2/\text{H}_2\text{O}} \text{C}_6\text{H}_5\text{CH}_2\text{OH}$

11. With the help of examples explain the difference between Gattermann Reaction from Sandmeyer Reaction. (2)

12. Suggest a chemical test to distinguish the following pair of organic compounds-(3)

(a) Methylamine and Dimethylamine Carbonyl amine / Hinsberg

(b) Aniline and cyclohexylamine Carbonyl amine / azo dye

(c) Benzenamine & benzyl amine Carbonyl amine

13. Assign reason for each of the following :- (3)

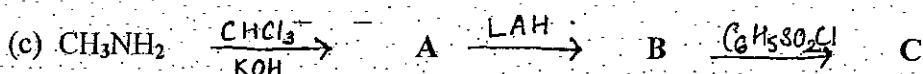
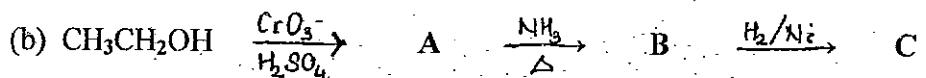
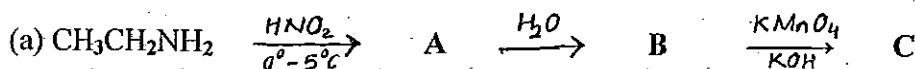
13. Assign reason for each of the following :- (3)

(a) Diazonium salt of aliphatic amines is not known.

(b) Aniline gets colour on standing in air for a long time.

(c) CH_3CONH_2 is a weaker base than $\text{CH}_3\text{CH}_2\text{NH}_2$

14. Complete the following- (3)



15. An organic compound on treatment with aqueous ammonia and on subsequent heating forms B which on heating with Br_2 and KOH forms a compound C of molecular formula $\text{C}_6\text{H}_7\text{N}$. Suggest the structure and IUPAC names of compounds A, B and C formed.(3)

LEVEL-III

16. Why is necessary to maintain the temperature between 273 K and 278 K during diazotization?(1)

17. Can tertiary amines undergo acetylation? Support your answer with a reason.(1)

18. The basicity order of methyl amines is – $(\text{CH}_3)_2\text{NH}_2 > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_3\text{NH}_2$ where as for ethyl amines it is $(\text{C}_2\text{H}_5)_2\text{NH}_2 > (\text{C}_2\text{H}_5)_3\text{NH}_2 > \text{C}_2\text{H}_5\text{NH}_2$. Justify your answer.(3)

19. A compound A of molecular formula $\text{C}_3\text{H}_7\text{O}_2\text{N}$ on reaction with Fe and conc. HCl gives a compound B of molecular formula $\text{C}_3\text{H}_9\text{N}$. Compound B on treatment with NaNO_2 and HCl gives another compound C of molecular formula $\text{C}_3\text{H}_8\text{O}$. The compound C gives effervescence with Sodium. On oxidation with acidic CrO_3 , the compound C gives a carboxylic acid. Identify A, B, C.

(3)

Value Based Question (4 marks)

20. During a football match in the school playground a child got badly injured. He was bleeding profusely due to a broken tooth. His friends gathered around him & with the help of teachers they took him to the school's medical room. The child was provided with first-aid and shifted to the nearby hospital for a dental surgery.

(a) Name the compound which is used as an anesthetic in dentistry. (1)

(b) What is the type of the functional group present in the compound? (1)

(c) What values are involved in this incidence? (2)

AMITY INTERNATIONAL SCHOOL , NOIDAClass XIISubject- ChemistryUNIT : 14 BIOMOLECULESLEVEL I:

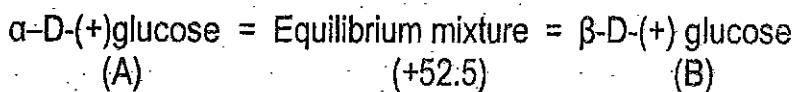
1. Which biomolecule gives purple colour with ninhydrin? Protein (1)
2. Which vitamin regulates the absorption of Ca & P in body? Vitamin D (1)
3. Why is cellulose not digested in human body? The corresponding cellulase enzyme is not found in humans. (1)
4. Define the term hyper vitaminosis and avitaminosis. Multiple deficiency
Excess intake of vitamin A + D caused by more than one vitamin (2)
5. Name the components of starch. How do they differ from each other structurally? (2)
6. (a) What type of linkage holds together the monomers of DNA? Phosphodiester linkage
 (b) Give an example of anomers. α -D (+) Glucose ; β -D (+) Glucose
 (c) Give the name and structural formula of simplest amino acid. Glycine (3)

$$\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$$

LEVEL II:

7. How many peptide bonds are present in tripeptide? two (1)
8. The base sequence on one strand in DNA molecule is CCAGTAATC, Write the base sequence in complementary strand. GGTCAATTG (1)
9. On prolonged heating with HI, glucose forms n-hexane what does this tell us about the structure of glucose? Six C-atoms are linearly arranged (1)
10. Explain the process involved when β -glucose is dissolved in water? (2)
Hydration, with equation.
11. Identify the type of protein in (a) Keratin (b) Insulin. Also specify which one of the two is soluble in water. Fibrous Globular (2)
↳ water soluble.
12. Why is hydrolysis of sucrose known as inversion of cane sugar? (2)

13. An optically active compound having molecular formula $C_6H_{12}O_6$ is found in two isomeric forms [A] and [B]. They show following equilibrium when dissolved in water:



- (a) What are such isomers called? Anomers
(b) Can they be called enantiomers. Justify. No, because they are not optical isomers
(c) Draw the cyclic structure of anomer [A]. (3)

LEVEL III:

14. Glucose doesn't give 2,4-DNP test. Give reason. $-\text{CHO}$ group is not free. (1)

15. What are the expected products of the hydrolysis of a nucleotide from RNA? (1)
Ribose sugar, nitrogenous base A, G, C, U, phosphate group

16. What are the characteristics features of an amino acid at isoelectric point? (2) zwitter ion, the cationic & anionic form will become equal & no migration of amino acid in electric field

17. Why is sucrose regarded as a non-reducing sugar although it consists of glucose and fructose and both of these are reducing in nature? $-\text{CHO}$ is not free & involved in glycoside linkage. (2)

* 18. Glycine exists as Zwitter ion but O & p-amino benzoic acids does not. Why? (2)

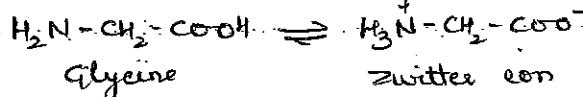
19. An optically active amino acid (A) can exist in three forms depending on the pH of the medium. If the molecular formula of (A) is $C_3H_7NO_2$, write:

- i) The ionic structure of (A) in aqueous medium. $\text{H}_3\text{N}^+ - \overset{\text{CH}_3}{\text{CH}} - \text{COO}^-$
ii) Which two functional groups does this ion have? $=\text{NH}_2$, $-\text{COOH}$
iii) What is specific name for such ions? zwitter ion (3)

20. Vitamins are required for growth and maintenance of our body. However, deficiency as well as excess of the same is harmful for the body.

- (a) What moral applications does this statement have in our life?
(b) Name the vitamin whose deficiency is responsible for (i) poor coagulation of blood
(ii) bleeding gums. (4)

* 18. lone pair of N is involved with the ring thereby decreases the acidic character of $-\text{COOH}$ & basic character of N so no zwitter ion is formed



Shahrukh
16.5.15

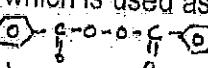
Gangrohi
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AMITY INTERNATIONAL SCHOOL, NOIDA

Class: XII (Chemistry)

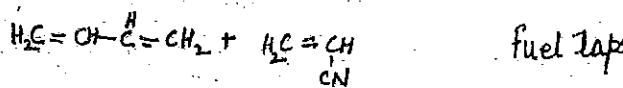
UNIT : 15(Polymers)

Level I Questions:

- What does '6, 6' indicate in the name of nylon-6,6? Two monomers with 6 C-atoms each.
- Name and draw the structure of the compound which is used as an initiator in polymerization of ethene. Benzoyl peroxide 
- Name the monomers of Nylon 2 Nylon 6. Caprolactam
- What are rubbers? Explain the two types of rubbers specifying the structural units involved in polymerization. Rubbers are polymers with elastic properties, weakest intermolecular force
- How are polymers classified on the basis of magnitude of forces between them? Explain giving examples. Elastomers, Fibres, Thermoplastic, Thermosetting

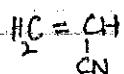
Level II Questions:

- What is the primary structural feature necessary for a molecule to make it useful in a condensation polymerization reaction? bifunctional / trifunctional monomer
- What are free radicals? Show the free radical mechanism of polymerization of isoprene to form polyisoprene. Rxn intermediates with free (non-bonded e⁻)
- Differentiate between the following pair of polymers based on the property mentioned against each.
 - Novolac and Bakelite (Structure) Novolac is linear polymer of phenol & formaldehyde, Bakelite is cross-linked polymer fibre → elastomer
 - BUNA-S and Terelene (intermolecular forces of attraction) (Strong forces) (Weak forces)
- Identify the type of polymerisation and name the polymer in the following:
 - $-\text{[CH}_2\text{-CH}(\text{C}_6\text{H}_5)]_n$ Addⁿ polymerisation, Polystyrene.
 - $-\text{[CO-(CH}_2)_4\text{CO-NH-(CH}_2)_6\text{-NH]}_n$ Condensation polymerisation, NYLON 6,6
- Name the following:
 - Polymer used in manufacture of laminated sheets Urea formaldehyde resin
 - Biomolecules having structural similarity with synthetic polyamides. Proteins
- Write the monomers of the following polymers and mention the type of polymer (Addition or Condensation) against each of them:
 - PVC Vinyl chloride Addⁿ
 - Teflon 1,1,2,2-Tetrafluoroethene Addⁿ
 - Glyptal Ethylene glycol + Phthalic acid Condensation
- Draw the structures of the monomer(s) of the following polymers and mention one use:
 - Melamine $\text{NH}_2\text{-C}_6\text{H}_4\text{-NH}_2$ unbreakable
 - BUNA - N N_2O + HCHO , non-stick cookware, crockery.





c) PAN



manufacture of fibres

(3)

13. Give one example each of:

- a) Addition homopolymer Polythene, PVC etc
- b) Condensation copolymer Nylon 6,6, Glyptal
- c) Cross linked polymer Bakelite, Melamine

(3)

14. Distinguish between the following giving at least one example:

- a) High density and low density polythene
- b) Chain growth and step growth polymerization
- c) Nylon -6 and Nylon-66

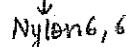
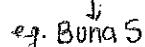
(3)

15. Jagdish and his family were having tough time in their house. It had been raining the whole night. The sever water was moving back in their toilets and their life was becoming miserable. His daughter asked "Why is the sever water coming back?" He explained that it was because of the polythene that blocks the main holes. He also suggested the use of alternate methods to prevent such situations. (VBQ, 4)

- a) Explain the logic behind his explanation. *Polythene is non-biodegradable, hence accumulates.*
- b) Suggest a polymer that can be suitably used. *Paper/ cloth bag*
- c) As a student, what do you suggest can be done at school level to discourage the use of polythene? *Awareness campaign*
- d) What value did Jagdish exhibit in the above passage? *Concern for environment*

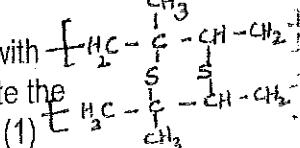
Level III Questions:

16. Can a copolymer be formed in both addition and condensation polymerization? Explain with example. Yes



(1)

17. A natural linear polymer of 2-methyl-1,3-butadiene becomes hard on treatment with sulphur between 373 to 415K and -S-S- bonds are formed between chains. Write the structure of the product of this treatment. (1)

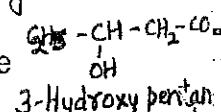
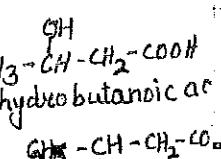


18. What is NYLON? Why does a drop of HCl make a hole in a nylon stocking? (2) *Hydrolysis of amide linkages*

It is a fibre having high tensile strength and strong intermolecular forces.

19. An aliphatic biodegradable polyester is used in packaging and orthopaedic devices.

Identify the polymer. Write its full form. Also write the structures and names of its monomers. PHBV, Poly β -hydroxybutyrate-co- β -hydroxy valerate (3) *2-hydrobutanoic acid*



20. Which of the following polymers soften on heating and harden on cooling? What are the polymers of this category collectively called? What are the structural similarities between such polymers?

Bakelite, Urea-formaldehyde resin, polythene, Polyvinyl chloride, Polystyrene

Thermoplastic

- They are linear or slightly branched polymer chains

- Intermolecular forces of attraction are intermediate between fibres and elastomers.

(3)



AMITY INTERNATIONAL SCHOOL, NOIDA

Class XII (CHEMISTRY)

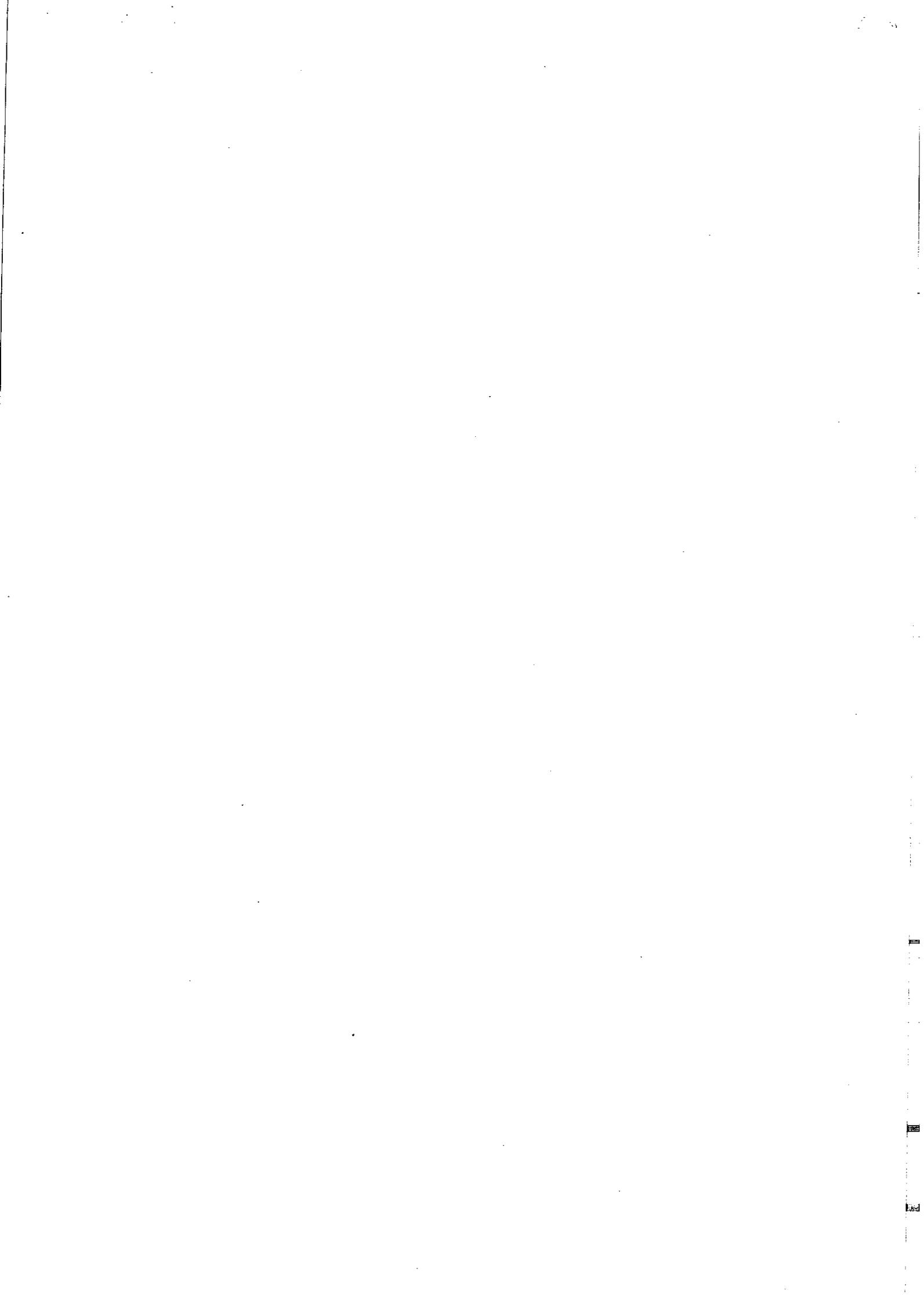
UNIT: 16 (Chemistry in Everyday Life)

Level I Questions

1. Name a commonly used food preservative used by food producers common salt (NaCl)
2. What is the major difference between Broad spectrum and narrow spectrum antibiotics?
Kill or inhibit a wide range of bacteria. Kills or inhibit a single microorganism e.g. Penicillin, Amoxycillin.
3. Define antioxidant using suitable example.
Chemicals that prevent oxⁿ of food. e.g. Na_2 , BHT or BHA (Butylated hydroxy anisole) (1)
4. What are receptors? Why do they show selectivity and how do they act as drug targets? (3)
(Page 442, NCERT)
5. Explain the various type of synthetic detergents with examples. Page 432 (3)
Cationic, Anionic, Non-ionic NCERT

Level II Questions

6. Why are metal hydroxides considered to be better alternative antacid than sodium bicarbonate? as they are insoluble and don't increase the pH above neutrality.
7. What do you understand by the term 'ANTAGONIST'?
Drugs that bind to the receptor site and inhibit the normal functioning (1)
8. Write the formula and IUPAC name of 'Aspirin'. Why should it not be taken empty stomach?
 2-Acetoxybenzoic acid It generates salicylic acid on hydrolysis which can be harmful
9. Explain the following giving one example: (2)
 - a) Tranquillizers Drugs which reduce anxiety and produce a feeling of well-being.
 - b) Antacid Substances which neutralise excess of acid in stomach
eg. Sodium hydrogen sulphate Equanil & Second
10. In order to wash clothes with water containing dissolved calcium hydrogen carbonate, which cleaning agent will you prefer and why: soaps or synthetic detergents? Give one advantage of soaps over synthetic detergents. Soaps form scum
Soaps are biodegradable.
11. Name the following: (3)
 - a) A neurotransmitter that plays a role in mood change. Noradrenaline
 - b) A drug used for relief of postoperative pain, cardiac pain etc. Morphine and its homologues.
 - c) An estrogen which forms a part of an oral contraceptive. Ethynodiol
12. Define and give one example of the following:
Ethylenestradiol
 - a) Antibiotics Drugs which kill or prevent the growth of bacteria e.g. Penicillin
 - b) Antipyretics Drugs which reduce body temp e.g. Paracetamol
 - c) Antihistamines Drugs which counteract the effect of histamines produced due to allergy e.g. Chlorphenamine



13. Mention one use of each of the following drugs: (3)(HOTS)

- Equanil controlling depression and hypertension
- Sucralose enhancing sweetness of food without adding calories
- Amoxycillin/ Ampicillin They are broad spectrum antibiotics used for sore throat, gonorrhoea, local infections etc.

14. Differentiate between the following: (3)

- Bacteriostatic and bacteriocidal antibiotics
- Antiseptic and disinfectant
- Competitive and non-competitive inhibition

15. Sonu's grand ma complained of burning sensation in her stomach/ food pipe. The doctor was not available at that time. For immediate relief he gave her a tablet of RANITIDINE. (4) VBA

- Is his action justifiable? Yes
- What type of drug is ranitidine? Antacid
- What alternate could have Sonu used incase there was no medicine available at home, as well as there was no possibility of getting the same from the market? Used bicarbonate
- What moral value is associated with Sonu's action? *Act wisely and in emergency, use first aid medicine (baking soda)*

Level III Questions

16. To which class of drugs do the following belong: (2)(HOTS)

- Sleeping pills Tranquillizers
- Streptomycin Antibiotic

17. Account for the following: (2)

- Certain chemicals are added to food. for preservation, enhancing food appeal and increasing their nutritive value.
- Detergents with highly branched hydrocarbon chain degrade slowly.

18. What is salvarsan? To which class of drugs does it belong and for what disease is it used? It is a drug used for treatment of syphilis - ANTIBIOTIC (2)

19. Pick out the odd one from the following on the basis of their medicinal properties: (2)

- Luminal, Seconal, Phenacetin Equanil others are tranquilisers
- Chloroxylenol, Phenol, Chloramphenicol Bithional others are antibiotic

20. Account for the following: (3)

- Diabetic patients are advised to take artificial sweeteners instead of natural sweeteners. Artificial sweeteners do not add calories to food.
- Antihistamines do not effect the secretion of acid in stomach. different receptors
- Aspirin helps in prevention of heart attack. Aspirin prevents platelet coagulation and has anti-blood-clotting action.

1

Design
1/3/14

10

COORDINATION CHEMISTRY :-

CONCEPTUAL QUESTIONS

1. Square planar complexes with CN=4 exhibit geometrical isomerism whereas tetrahedral complexes do not.

Ans:- the relative positions of the ligands attached to the central atom are same w.r.t each other.

2. $[\text{Fe}(\text{CN})_6]^{3-}$ is weakly paramagnetic while $[\text{Fe}(\text{CN})_6]^{4-}$ is diamagnetic.

Ans:- $[\text{Fe}(\text{CN})_6]^{3-} \rightarrow d^2sp^3$ hybd. & an octahedral complex with one unpaired e⁻ hence weakly paramagnetic.

$[\text{Fe}(\text{CN})_6]^{4-} \rightarrow d^2sp^3$ hybd., octahedral complex with no unpaired e⁻ hence diamagnetic.

3. Ni(CO)₄ has tetrahedral geometry whereas $[\text{Ni}(\text{CN})_4]^{2-}$ has square planar geometry.

Ans:- $\text{Ni}(\text{CO})_4 \rightarrow sp^3$ hybd. with no unpaired e⁻s due to strong field ligand CO.
This is diamagnetic.

$[\text{Ni}(\text{CN})_4]^{2-} \rightarrow dsp^2$ hybd. with no unpaired e⁻s due to strong field ligand CN.
This is diamagnetic.

HOTS
4. Some square planar complexes of Ni(II) are diamagnetic while some others are paramagnetic. Justify.

Ans:- Ni²⁺ :

II	II	II	I	I
----	----	----	---	---

3d	4s	4p
----	----	----

In some complexes, the two unpaired 3d- e⁻s pair up & the hybridisation is dsp² with no unpaired e⁻. The complex is diamagnetic.

In some other complexes, one unpaired 3d- e⁻ is excited to 4p. The hybridisation is dsp² with two unpaired e⁻, the complex is paramagnetic.

5. Why only transition metals are known to form π-complexes?

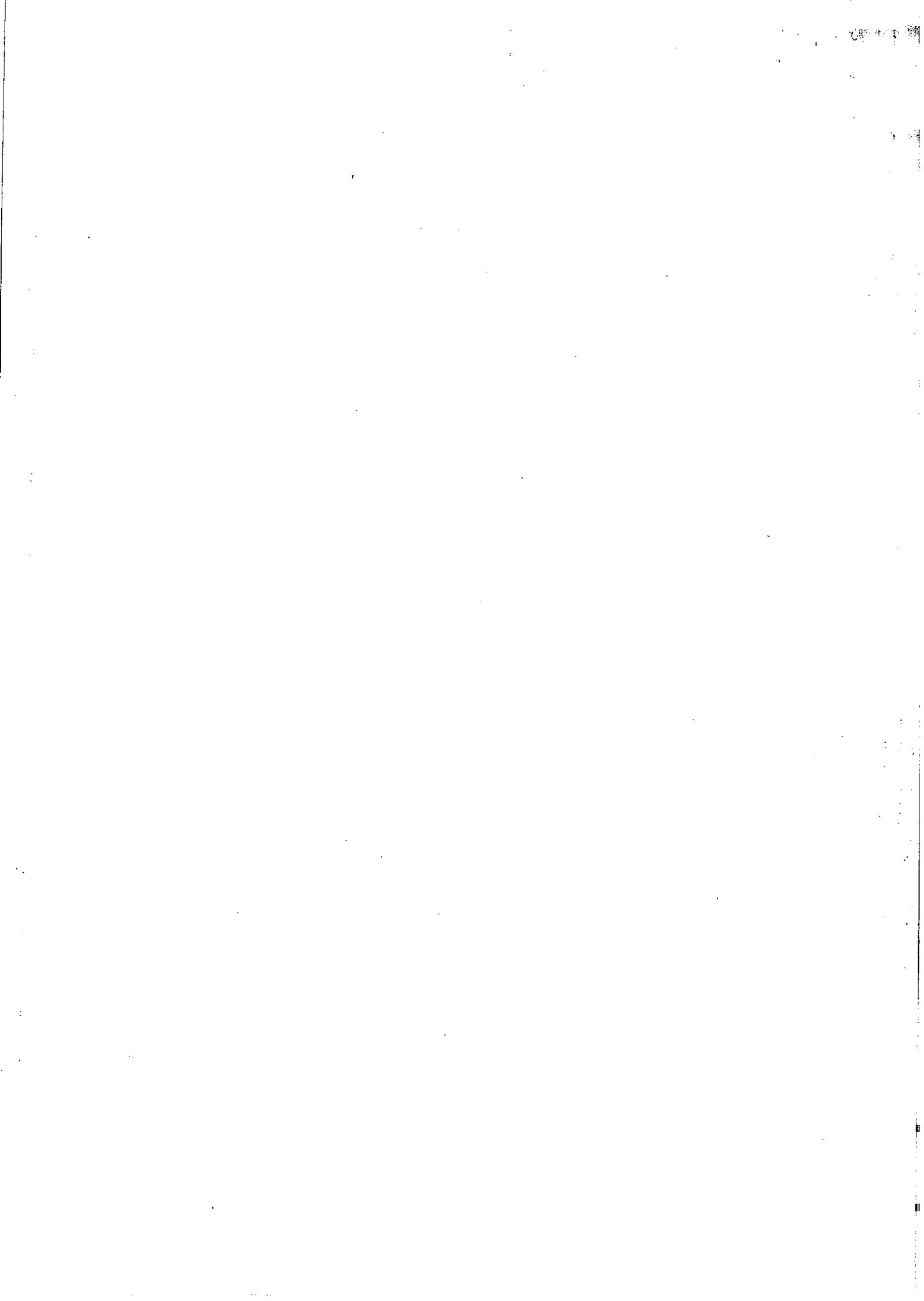
Ans:- Transition metals/tions have empty d-orbitals into which the e⁻ pairs can be

donated by the ligands containing π-e⁻s. (e⁻s in their π-molecular orbitals e.g C₆H₅- CH₂-CH₂ etc.)

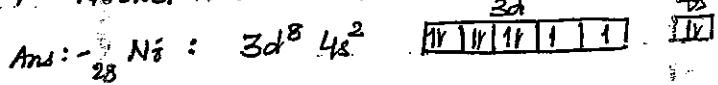
6. $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ is coloured while $[\text{Sc}(\text{H}_2\text{O})_6]^{3+}$ is colourless.

Ans:- $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$: Ti³⁺ has one e⁻ in the d-subshell (t_{2g}^1) which can absorb light in the visible region resulting into d-d transition ($t_{2g} \rightarrow e_g$) as a result the complex has a colour. In $[\text{Sc}(\text{H}_2\text{O})_6]^{3+}$, there is no d-electron, hence it is colourless.

①



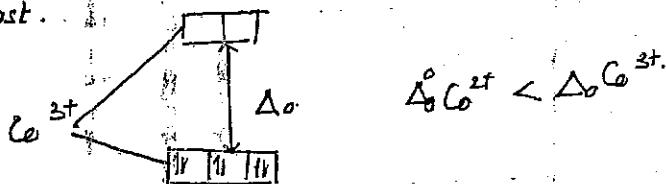
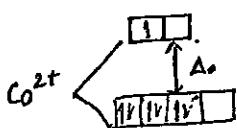
7. Nickel does not form low spin octahedral complex.

Ans:- Ni : $3d^8 4s^2$ 

For low spin complex es should pair up. This produces only one empty d-orbital, hence d^2sp^3 hybridisation is not possible to form octahedral complex.

8. Co^{2+} is easily oxidised to Co^{3+} in the presence of strong ligand.

Ans:- Co^{2+} has $3d^7$ configuration with three unpaired es. Water being a weak ligand does not pair up the es. In the presence of strong ligands & air, the two unpaired es in 3d pair up & the third unpaired e shifts to higher energy (eg) from where it can be easily lost.



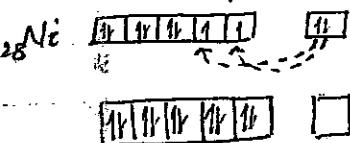
Highly stable with d^6 due to higher CFSE.

9. CO is a stronger ligand than NH_3 for many metals.

Ans:- Ligands such as CO, CN^- & NO^- have empty σ & π -orbitals which overlap with the filled d-orbitals (t_{2g}) of transition metals forming π -bonds (back-bonding). This π -interactions increase the value of Δ_o . Hence the ligands are termed as strong field ligands. NH_3 cannot form π -bonds by back-bonding.

10. $[Ni(CO)_4]$ is diamagnetic but $[NiCl_4]^{2-}$ is paramagnetic though both are tetrahedral.

Ans:- $[Ni(CO)_4] \rightarrow Ni^0 : 3d^8 4s^2$. In the presence of strong field ligand CO, the 4s es shift to 3d to pair up unpaired 3d es. There is no unpaired es left in the 3d-orbital, hence it is diamagnetic.

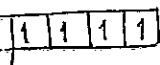


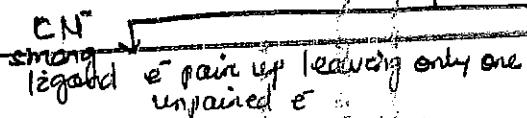
$[NiCl_4]^{2-} : Ni^{2+} : 3d^8 4s^0$

In the presence of a weak field ligand Cl⁻, the es in the 3d orbital do not pair up, hence it is paramagnetic.

11. $[Fe(H_2O)_6]^{3+}$ is strongly paramagnetic whereas $(Fe(CN)_6)^{3-}$ is weakly paramagnetic.

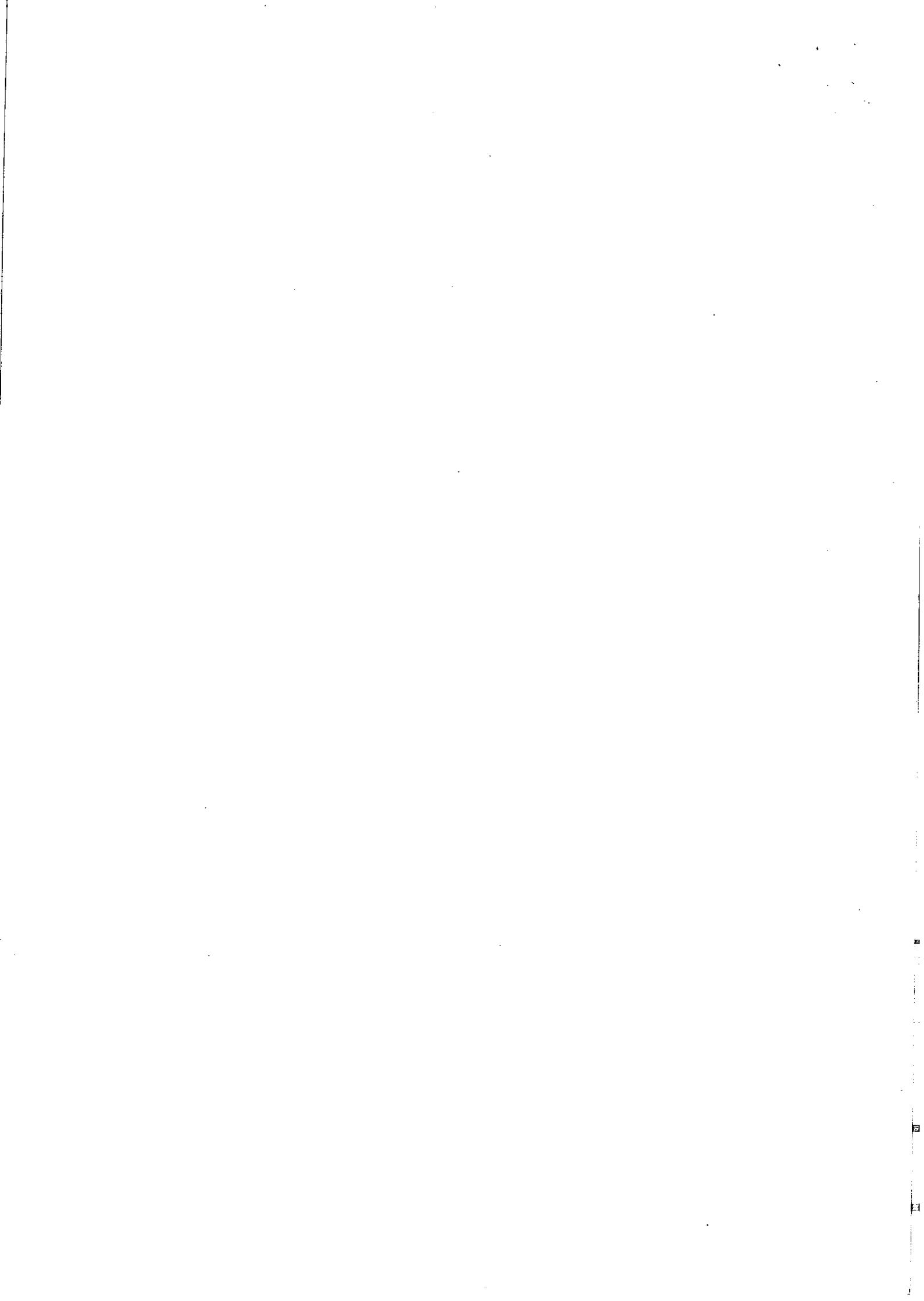
$^{26}Fe : 3d^6 4s^2$ 

$Fe^{3+} : 3d^5 4s^0$ 

CN^- 

H_2O is a weak ligand.

es do not pair up



$[\text{Fe}(\text{CN})_6]^{3+}$: d^2sp^3 hyb. \rightarrow inner d-complex
 \rightarrow one unpaired e^- \rightarrow weakly paramagnetic.

$[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$: sp^3d^2 hyb \rightarrow outer d-complex
 \rightarrow five unpaired e^-s \rightarrow strongly paramagnetic.

12. $[\text{Co}(\text{NH}_3)_6]^{3+}$ is an inner orbital complex whereas $[\text{Ni}(\text{NH}_3)_6]^{2+}$ is an outer orbital complex.

Ans:-

$[\text{Co}(\text{NH}_3)_6]^{3+}$: Co^{3+} $\boxed{\text{VVVII}}$, In presence of strong ligand NH_3 , the $3d-e^-s$ pair up leaving two d-orbitals empty. It forms d^2sp^3 hyb. As inner d-orbitals involved, hence called inner orbital complex.

$[\text{Ni}(\text{NH}_3)_6]^{2+}$: Ni^{2+} $\boxed{\text{VVVVI}}$, In presence of strong field ligand NH_3 , the $3d-e^-s$ should pair up, but it results only one empty d-orbital hence the hybridisation is sp^3d^2 instead of d^2sp^3 . As outer d-orbitals are involved, therefore it is called outer orbital complex.

13. Hexaaquamanganese(II) ion has five unpaired e^-s while hexacyano ion contains only one unpaired e^- . (Explain using CFIT)

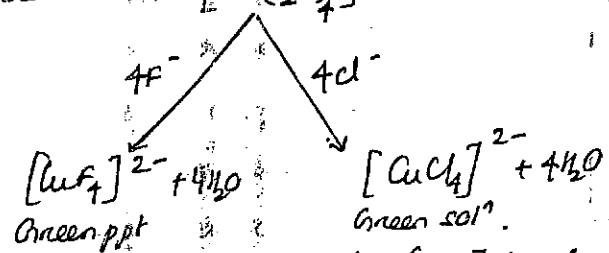
Ans:- Mn^{2+} has d^5 configuration $\rightarrow t_{2g}^3 e_g^2$

H_2O is a weak ligand so no pairing of e^-s take place, whereas in case of CN^- , due to its strong field the e^-s get paired up $t_{2g}^5 e_g^0$.

There is one unpaired e^- on the t_{2g} orbital.

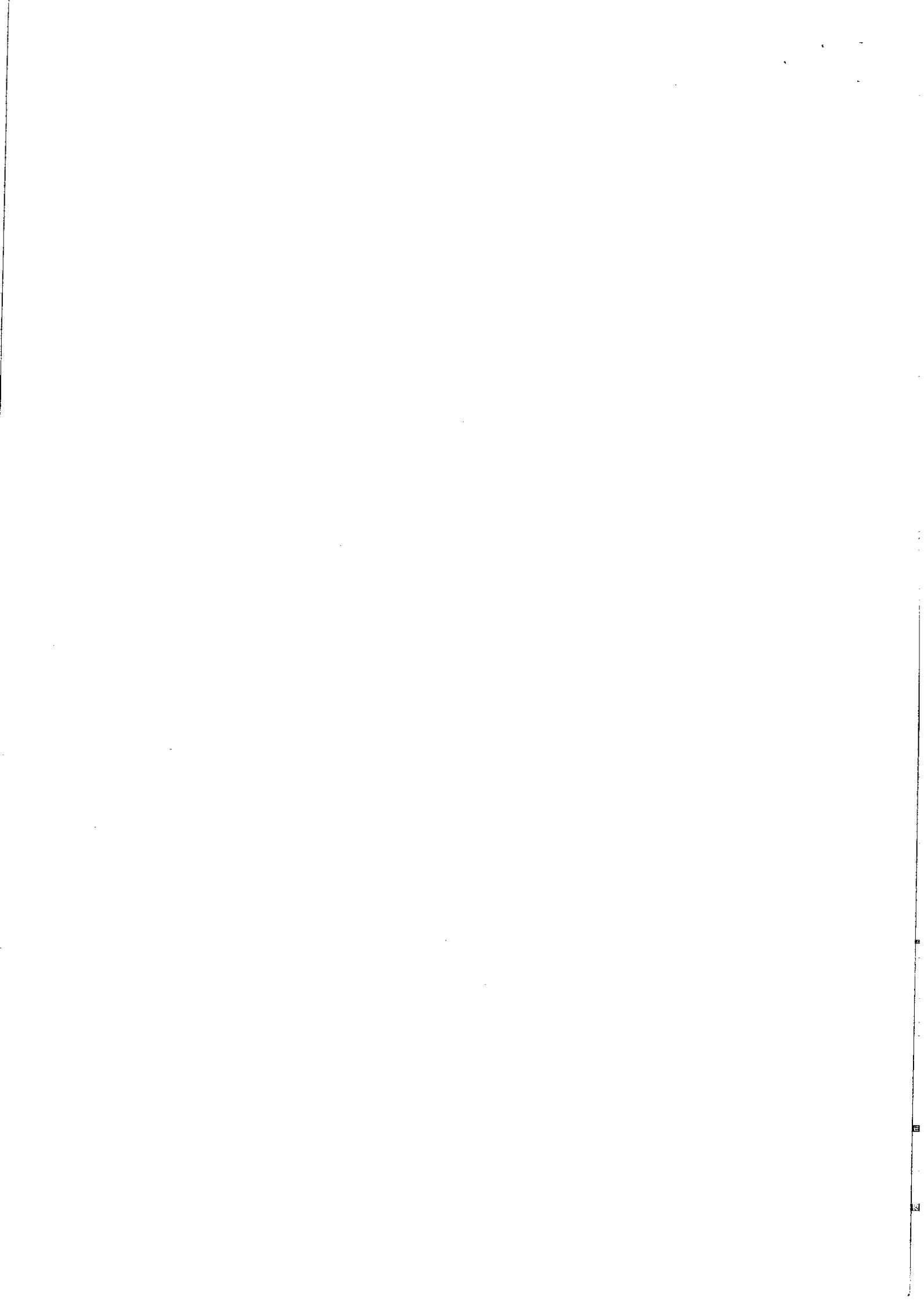
14. Ag. CuSO_4 gives a green ppt. with ag. KF and a bright green soln with ag. KCl .

Ans:- Ag. CuSO_4 has a blue colour due to $[\text{Cu}(\text{H}_2\text{O})_4]^{2+}$ ion as CuSO_4 soln exists as $\text{[CuSO}_4 \cdot [\text{Cu}(\text{H}_2\text{O})_4]\text{SO}_4]$.



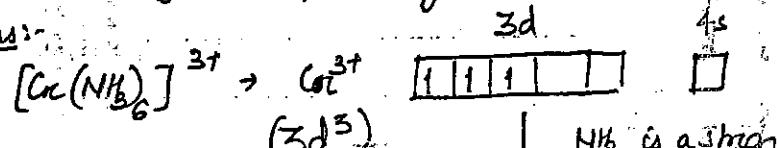
15. When excess of ag. KCN is added to CuSO_4 , $\text{K}_3[\text{Cu}(\text{CN})_4]$ is formed. When $\text{H}_2\text{S(g)}$ is passed through this solution, no ppt. of CuS is obtained.

Ans:- As CN^- is a strong field ligand, the complex ion is highly stable and does not ionise to give Cu^{2+} ions. Hence no ppt. observed with H_2S gas.



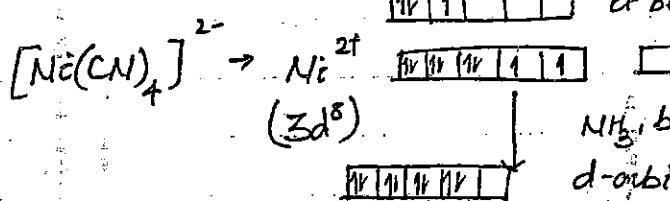
16. $[\text{Cr}(\text{NH}_3)_6]^{3+}$ is paramagnetic while $[\text{Ni}(\text{CN})_4]^{2-}$ is diamagnetic.

Ans:-



$(3d^3)$

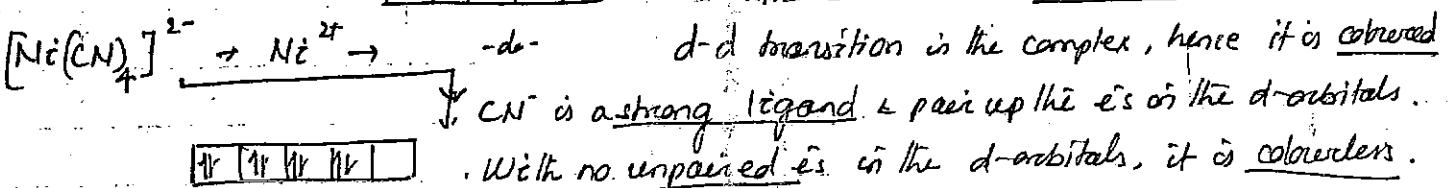
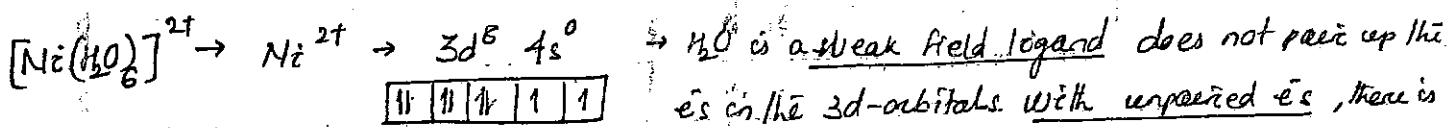
\downarrow NH_3 is a strong field ligand, hence pairing of e^- takes place. With one unpaired e^- in the d-orbital it becomes paramagnetic.



$(3d^8)$

NH_3 , being a strong ligand, pairs up the e^- s in the d-orbital, leaving no unpaired e^- s, hence the complex is diamagnetic.

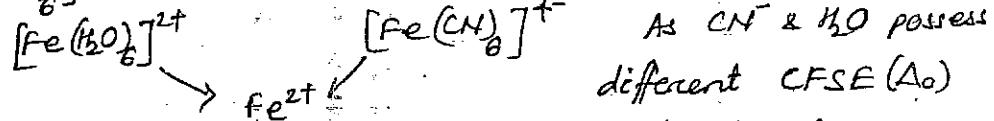
17. A solution of $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is green but a solution of $[\text{Ni}(\text{CN})_4]^{2-}$ is colourless.



H_2O is a weak field ligand does not pair up the e^- s in the 3d-orbitals with unpaired e^- s, there is d-d transition in the complex, hence it is coloured.

CN^- is a strong ligand & pair up the e^- s in the d-orbitals. With no unpaired e^- s in the d-orbitals, it is colourless.

18. $[\text{Fe}(\text{CN})_6]^{4-}$ and $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ are of different colours in dil. solutions.

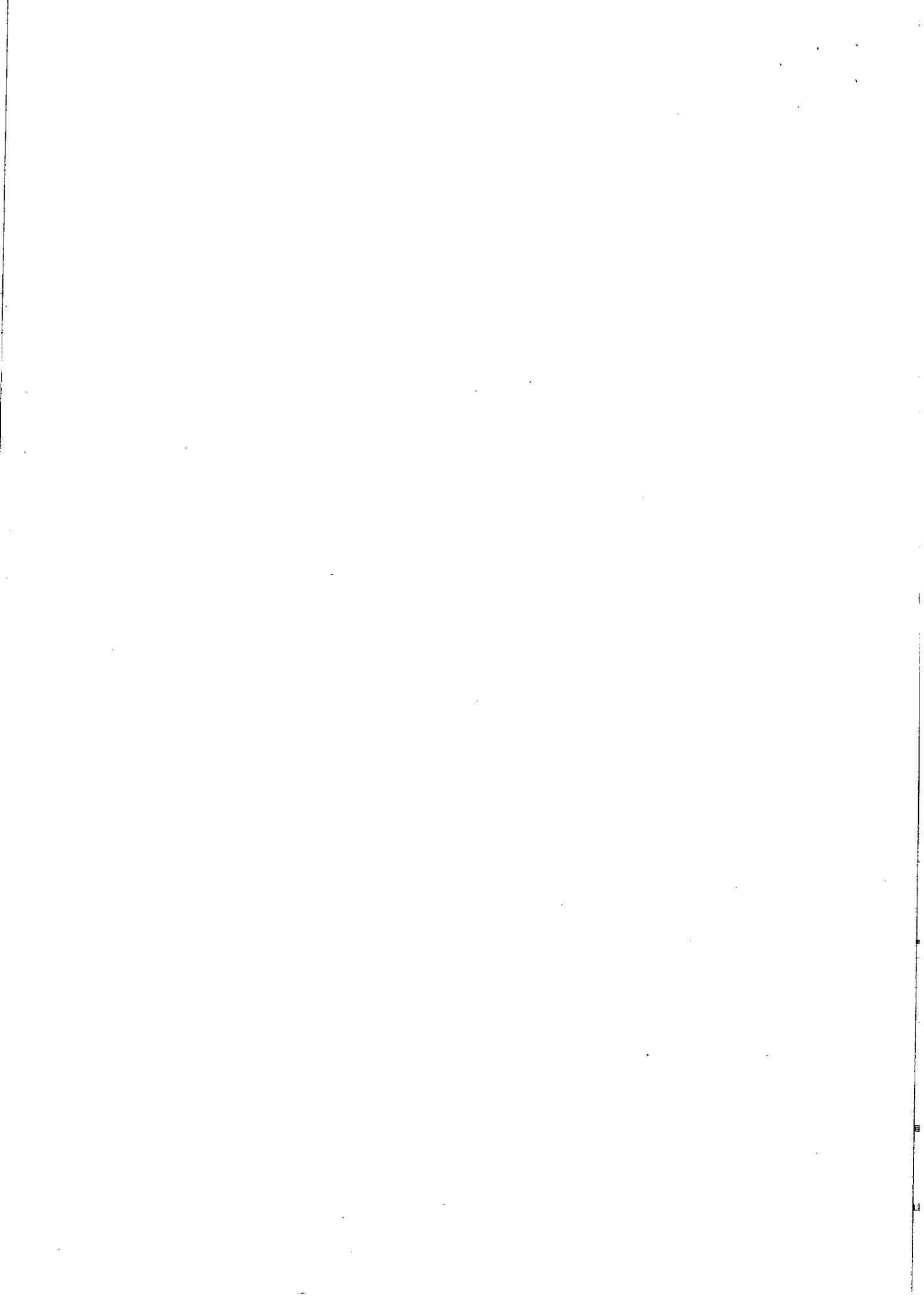


$\rightarrow \text{Fe}^{2+} \quad \begin{array}{|c|c|c|c|c|c|} \hline 3d & 1 & 1 & 1 & 1 & 1 \\ \hline \end{array} \quad \text{As they absorb different components of visible light for d-d transition}$

Hence, they show different colours.

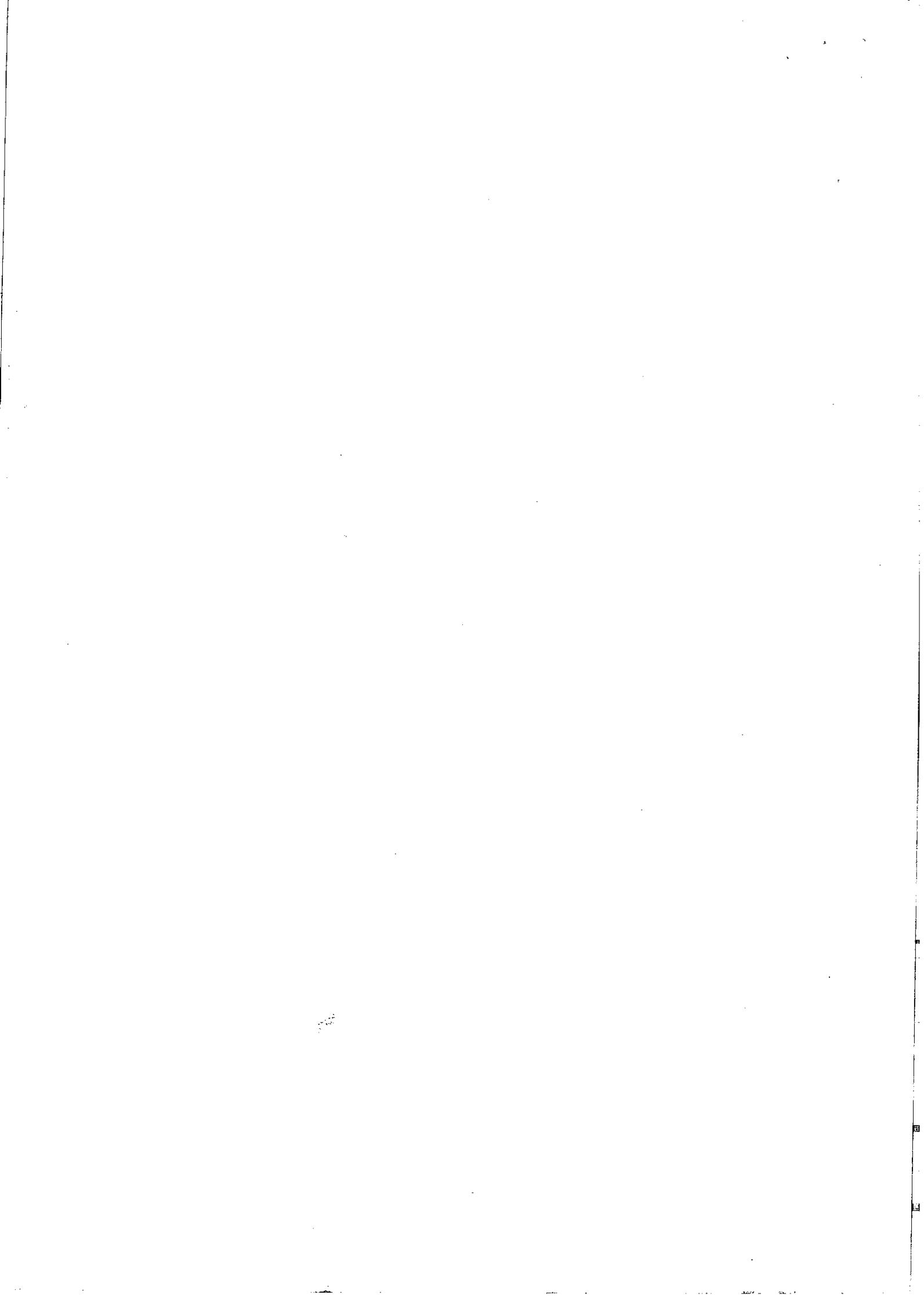
19. Complexes are preferred in the electrolytic bath for electroplating.

Ans:- As they dissociate slowly, hence give a smooth & even deposit.



IMP. APPLICATIONS OF CO-ORDINATION COMPOUNDS :-

S.NO.	NAME OF THE COMPOUND	APPLICATION
01.	EDTA	<ul style="list-style-type: none"> → treatment of Lead poisoning → for removing hardness of water → Analysis
02.	DMG - Dimethyl glyoxime	<ul style="list-style-type: none"> → test for Ni^{2+} → Analysis
03.	α -Nitroso- β -naphthol	→ Analysis
04.	Gold complex $[Au(CN)_2]^-$	<ul style="list-style-type: none"> → Extraction of Au by breaking the complex with Zinc.
05.	$Ni(CO)_4$	→ Extraction of Ni by Mond's Process.
06.	Chlorophyll (comp. of Mg)	→ Responsible for photosynthesis
07.	Haemoglobin (comp. of Fe)	→ Oxygen carrier in the blood.
08.	Vitamin - B_{12} (cyanocobalamin)	→ Anti pernicious anaemia factor.
09.	Carboxypeptidase	} - Enzymes .
10.	Carbonic anhydrase	
11.	Wilkinson Catalyst $(Ph_3P)_3RhCl$ (compound of Rhodium)	→ Catalyst for hydrogenation of ethene
12.	$[Ag(CN)_2]^-$, $[Au(CN)_2]^-$	→ Used for electroplating
13.	$[Ag(S_2O_3)_2]^{3-}$	→ Photography
14.	D-penicillamine Desferrioxamine-B	<ul style="list-style-type: none"> → form chelating complexes with Cu & Fe. → treatment of cancer.
15.	Cis - platin	



4/3/14

d & f BLOCK ELEMENTS :-

CONCEPTUAL QUESTIONS :-

- 1) Zn, Cd & Hg are generally not considered as transition metals.
Ans:- These elements in their most common oxidation state of +2 have completely filled d-orbitals.
- 2) Though copper, silver & gold have completely filled sets of d-orbitals yet they are considered as transition metals.
Ans:- These metals have incompletely filled d-orbitals in their common o.s.
- 3) Zn^{2+} salts are white while Ni^{2+} salts are blue?
Ans:- Zn^{2+} has a completely filled d-orbital ($3d^{10}$) while Ni^{2+} has incompletely filled d-orbitals ($3d^8$). As a result d-d transition is feasible in case of Ni^{2+} but not in case of Zn^{2+} .
- 4) K_2PtCl_6 is a well known compound whereas corresponding Ni compound is not known.
Ans:- Pt^{4+} is more stable than Ni^{4+} as $IE_1 + IE_2 + IE_3 + IE_4$ of Pt is less than that of Ni.
- 5) Most of the transition metals do not displace Hydrogen from dil. acids.
Ans:- Most of transition metals have -ve. and²⁺ potential. They have a tendency to get reduced.
- 6) Transition elements have high enthalpy of atomisation.
Ans:- As the transition metals contain large no. of unpaired e⁻s, they have strong interatomic attractions (metallic bonding). Hence more amount of heat is reqd. to break the metal lattice to get free atoms.
- 7) Transition metals have high enthalpy of hydration.
Ans:- Due to their small size & large nuclear charge, more amount of heat is released on hydration.
- 8) Transition elements show variable oxidation state.
Ans:- In the transition metals, the energies of (n-1)d-orbitals & ns-orbitals are very close. Hence e⁻s from both can participate in bonding.
- 9) The M.P & B.P of Zn, Cd & Hg are low.
Ans:- Metallic bonds present in these metals are weak as all the d-e⁻s are paired.
- 10) Transition elements have many irregularities in their electronic configurations
Ans:- In the transition metals, the (n-1)d subshell & ns subshell have very small difference in energy. The incoming e⁻ may enter into ns or (n-1)d subshell. Hence the irregularities are obscured in their Electronic Configuration.

$\rho = \rho_0 e^{-\frac{m}{kT}}$

11) The paramagnetic character in 3d-series increases upto Mn & then decreases.

Ans:- In the 3d-series as we move from ${}_{21}^{Sc}$ to ${}_{25}^{Mn}$, the number of unpaired e⁻s increases hence paramagnetic character increases. After Mn, pairing of e⁻s in the d-subshell starts and the no. of unpaired e⁻s decreases, hence paramagnetic character decreases.

12) Fe is a transition metal but Na is not.

Ans:- ${}_{26}^{Fe} = [Ar] 3d^6 4s^2 \rightarrow$ It has incompletely filled 3d subshell, hence it is a transition metal.

${}_{11}^{Na} = [Ne] 3s^1 \rightarrow$ It has ^{no} d-subshell. It belongs s-block.

13) E° for Mn^{3+}/Mn^{2+} couple is more than that for Fe^{3+}/Fe^{2+} .

Ans:- $Mn^{3+} \rightarrow Mn^{2+}$
 $d^5 \rightarrow$ exactly half-filled stable configuration.

$Fe^{3+} \rightarrow Fe^{2+}$. The process is feasible but less easily.

d^5 configuration which is stable

E° is the sum of ΔH_{IE} + ΔH_{HYD} + ΔH_{ATT} . Large third IE is reqd. to change Mn^{2+} to Mn^{3+} .

14) Scandium forms no coloured ions, yet it is regarded as transition element.

Ans:- ${}_{21}^{Sc} = [Ar] 3d^1 4s^2 \rightarrow$ has one unpaired e⁻ in the ground state, hence it is regarded as a transition metal. In its common O.S. +3 it has no unpaired e⁻ in the d-orbital hence it does not form coloured ions.

15) Chromium is a typical hard metal while mercury is a liquid.

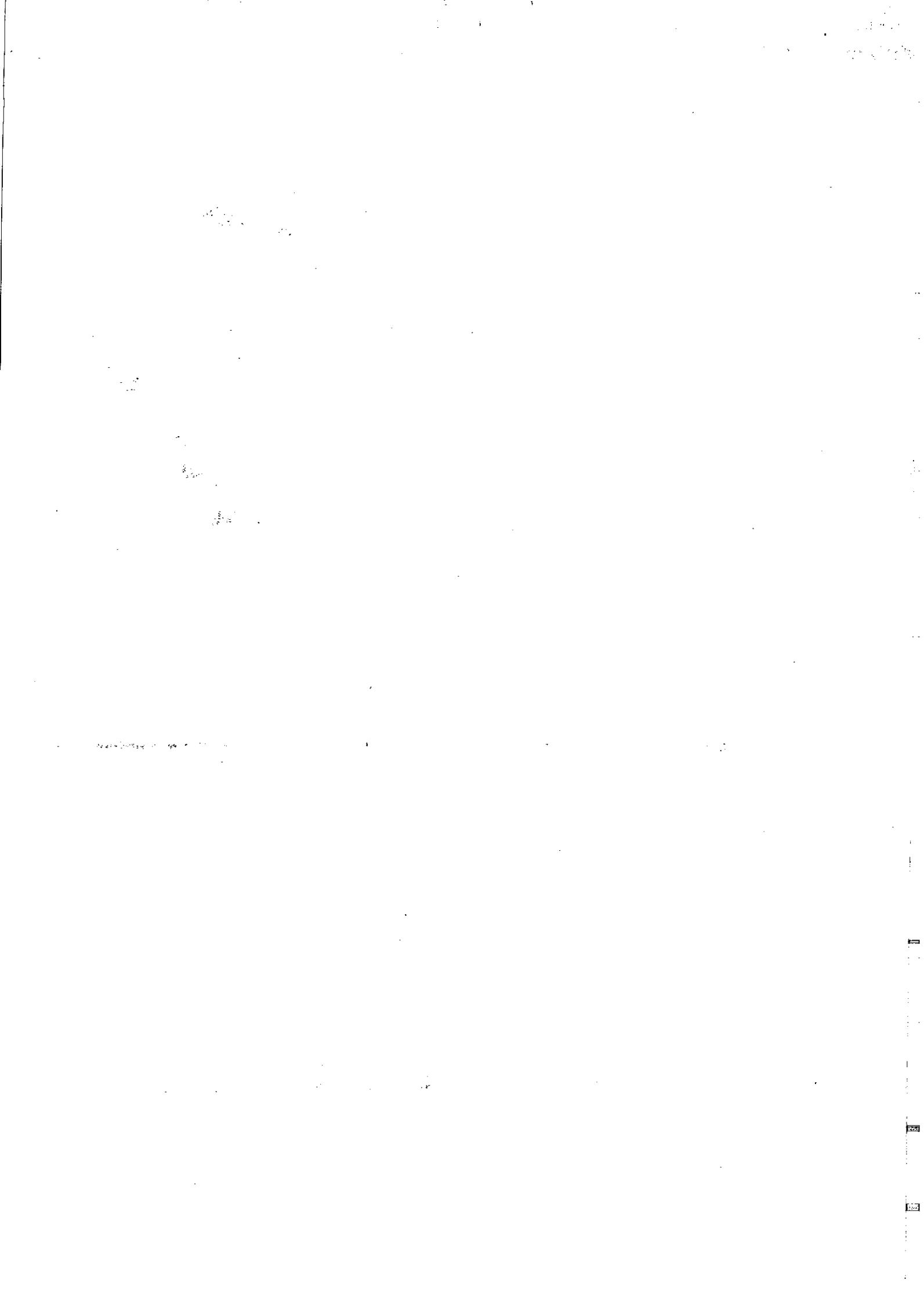
Ans:- ${}_{24}^{Cr} = [Ar] 3d^5 4s^1 \rightarrow$ has five unpaired d-e⁻s hence can form strong 1 metallic bonds. In case of Hg, it has a filled d¹⁰ configuration as a result ${}_{20}^{Hg} = [Kr] 4d^10 5s^2$ has a weak metallic bonding, hence liquid at room temp.

16) In the titration of Fe^{2+} ions with $KMnO_4$ in acidic medium, dil. H_2SO_4 is used instead of dil. HCl.

Ans:- $KMnO_4$ in presence of dil. H_2SO_4 acts as an oxidising agent to oxidise Fe^{2+} to Fe^{3+} but in presence of dil. HCl it poorly oxidises Cl⁻ to Cl_2 , hence not used.

17) $KMnO_4$ is used in cleaning surgical instruments in hospitals.

Ans:- $KMnO_4$ has a germicidal action.



18) $\text{Sm}^{2+}, \text{Eu}^{2+}, \text{Yb}^{2+}$ ions in solutions are good reducing agents but in aq. soln of Ce^{4+} it is a good oxidising agent & is a good oxidising agent.

Ans:- The most stable O.S. of Lanthanoids is +3 & of lanthanoids is +3.

$\text{Sm}^{2+}, \text{Eu}^{2+}, \text{Yb}^{2+} \rightarrow \text{Sm}^{3+}, \text{Eu}^{3+}, \text{Yb}^{3+}$ by losing one e^- it is oxidised hence act as good reducing agent.

$\text{Ce}^{4+} + e^- \rightarrow \text{Ce}^{3+}$, accepts one e^- is reduced, hence acts as good oxidising agent.

19) Of the Lanthanides, Ce forms Ce^{4+} .

Ans:- $\text{Ce}^{3+} \rightarrow \text{Ce}^{4+}$

$4f^1 5d^0 6s^0 \rightarrow (4f^0 5d^0 6s^0)$ more stable configuration

This is the only Lanthanide which exists in solution.

20) The +3 O.S. of $\text{La}^{(67)}$, $\text{Gd}^{(70)}$ & $\text{Lu}^{(71)}$ are more stable.

Ans:- $\text{La}^{3+} \rightarrow 4f^0$ empty

$\text{Gd}^{3+} \rightarrow 4f^7$ half-filled

$\text{Lu}^{3+} \rightarrow 4f^{14}$ complete filled subshells are more stable.

21) Ta & Hf have similar properties. ($\text{Nb} & \text{Ta}$)

Ans:- Due to Lanthanoid contraction, Ta & Hf have similar radii. Hence their properties are similar.

(defⁿ + L.C.)

22) La(OH)_3 is more basic than Lu(OH)_3 .

Ans:- Due to Lanthanoid contraction the size of the ions decreases from La^{3+} to Lu^{3+} as a result the covalent character of the hydroxides increases hence the basic strength decreases.

23) Second & Third transition series elements show similar sizes.

Ans:- Due to Lanthanoid contraction.

24) Separation of Lanthanoids difficult.

Ans:- Due to Lanthanoid contraction.

25) All Lanthanoids except La^{3+} & Lu^{3+} are paramagnetic in nature.

Ans:- due to the presence of unpaired e^- s.

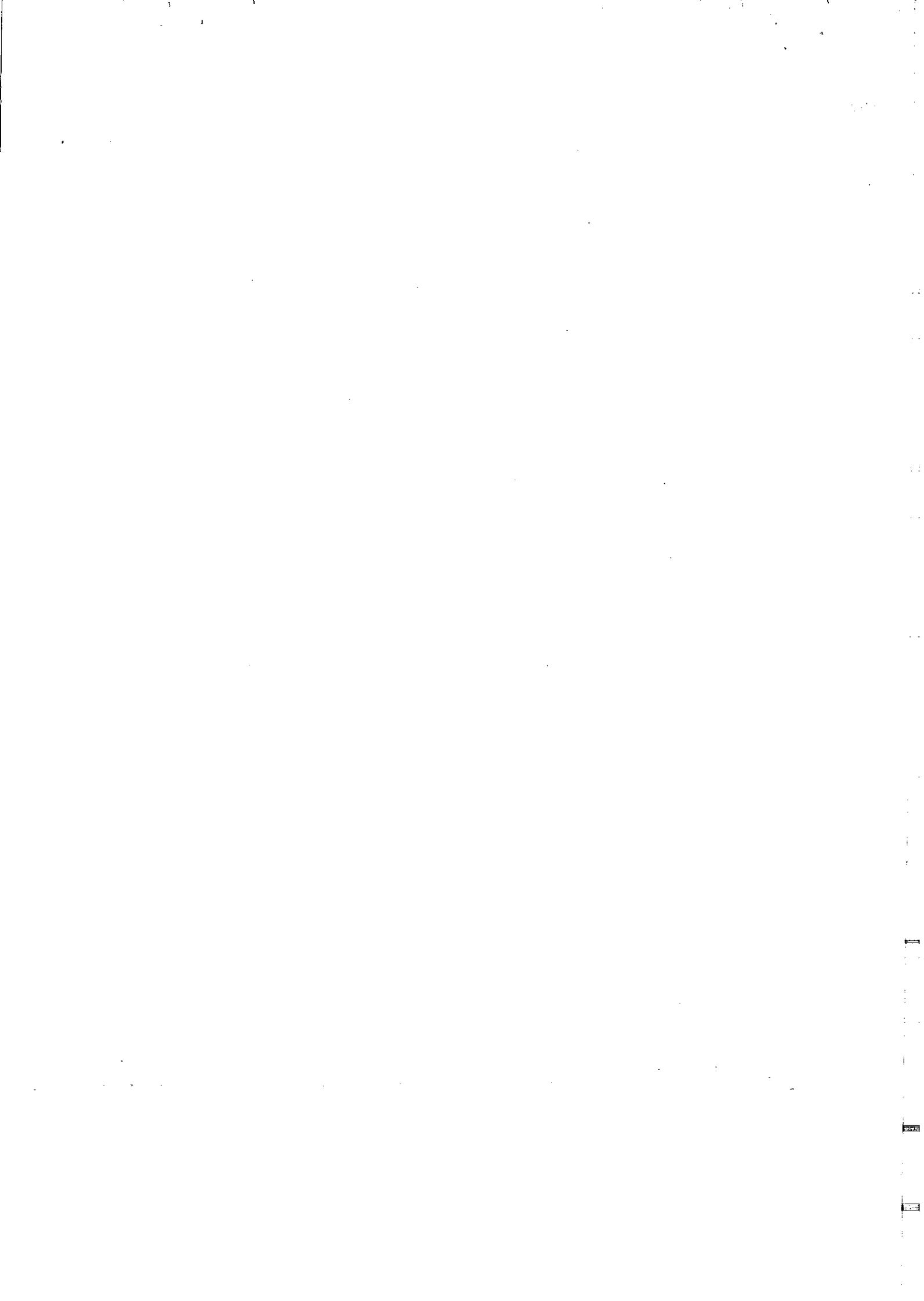
26) The second I.E. of $\text{Cr} & \text{Cu}$ are higher than those of the next elements.

Ans:- $24\text{Cr} + [18\text{Ar}] 3d^5 4s^1 \rightarrow$ Half-filled $\boxed{3d^5}$

$29\text{Cu} - [18\text{Ar}] 3d^{10} 4s^1 \rightarrow$ Fully filled orbitals are highly stable hence I_E is more.

$\boxed{3d^{10}}$

③



27) Transition metal fluorides are ionic in nature whereas as bromides & iodides are usually covalent compounds. Chlorides are intermediate.

Ans:- As electronegativity of halogens decreases in the order $F > Cl > Br > I$, the ionic character decreases as $M-F > M-Cl > M-Br > M-I$. Hence fluorides are ionic whereas chlorides & bromides are covalent.

28) In MnO_4^- , there is a covalency between Mn & Oxygen.

Ans:- In MnO_4^- , Mn is the highest O.S. +7. The transition metals form covalent bonds. Acc. to Fajans rule, higher the O.S., covalent character is more.

29) Transition metals & their compounds are good catalysts.

Ans:- Transition metals provide large surface area, show variable oxidation states & has partly filled d-orbitals hence act as good catalysts.

30) Actinoids exhibit a larger no. of oxidation states than lanthanoids.

Ans:- The energy gap between 5f, 6d & 7s subshell is very small, hence all the e⁻s present in these subshells can participate in bonding whereas in case of lanthanoids the energy gap between 4f & 5d subshell is large, hence all the e⁻s in these subshells cannot participate in bonding.

31) There is an increase in density of elements from Ti to Ce.

Ans:- As we move along the series the atomic size decreases but atomic mass increases hence the density of element decreases increases.

32) The highest Oxidation State of a metal is exhibited in its oxide or fluoride.

Ans:- Oxygen and fluorine are highly electronegative elements with small size, hence they bring out the highest O.S. in metals.

33) Transition elements generally form coloured compounds.

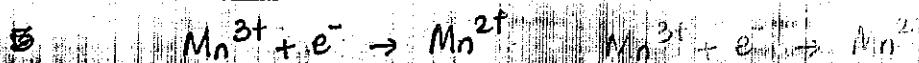
Ans:- They contain incompletely filled d-orbitals and unpaired e⁻s can undergo d-d transition by absorbing light from the visible region.

34) Cr^{2+} is reducing & Mn^{3+} is oxidising through 'half hole' d⁵ configuration.

Ans:- $Cr^{2+} \rightarrow Cr^{3+} + e^-$

d⁵ t_{2g}³ → half filled configuration hence more stable.



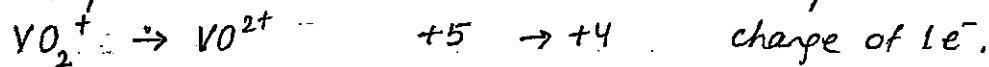
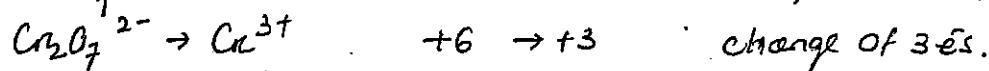
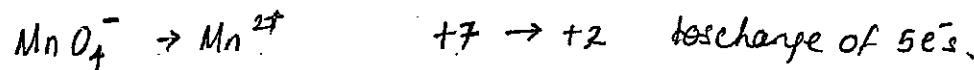


$d^4 + d^5$ half-filled configuration hence more stable.

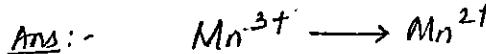
In order to attain a stable configuration Cr^{2+} acts as reducing agent & Mn^{3+} acts as oxidising agent.

38) The increasing oxidising power in the series $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$.

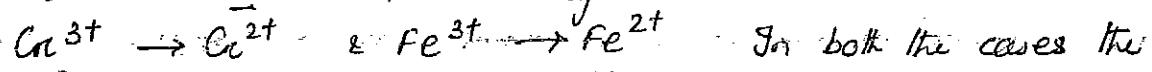
Ans:- This is due to the increasing stability of the species with lower O.s of the metal atom to which it is reduced.



39) E° values for Mn^{3+}/Mn^{2+} is much more positive than for Ca^{3+}/Ca or Fe^{3+}/Fe .



d^5 half-filled configuration hence more stable.



$d^3 \quad d^4 \quad d^5 \quad d^4$ configuration changes from
more stable to less stable hence not favourable if E° is less.

40) In the series of Se to In, the enthalpy of atomisation of In is the lowest.

Ans:- In has no unpaired e.s in its outermost shell hence the intermetallic bonding is weakest in In. Therefore enthalpy of atomisation is lowest.

