

Atom

Date _____

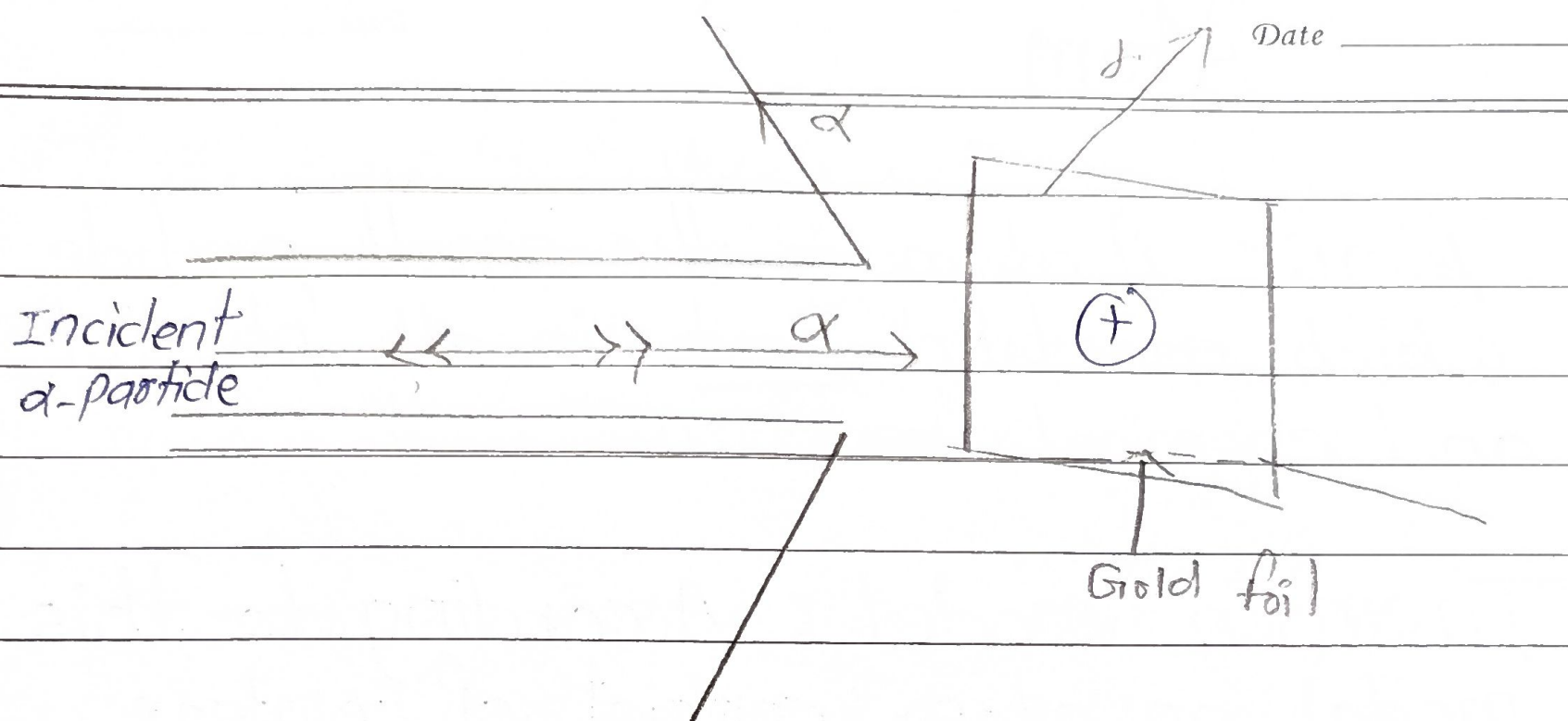
Atom: A atom is the small particle which can take part in all physical and chemical reaction.

Thomson model: According to this model an atom consist of Nucleas in which there are protons and neutrons and electron are embedded inside the nucleas like seeds in Watermelon.

But this theory was wrong because electrons are not embedded inside nucleus.

Rutherford α -particle scattering Experiment:

Rutherford perform an experiment with gold foil and he fall α -particle on gold foil.



observation :

- ↳ Most of the α -particle pass through gold foil without any deflection
- ↳ Some of the α -particle deviate through small angle.
- ↳ Only one α -particle out of 8000 retraces its path.

Conclusion :

There is some empty-space in both the gold foil

There is some charge present on nucleus.

There is a dense nucleus present at the centre because the α -particle which retraces its path moving along the central line.

Limitation :

According to Rutherford, the electrons are revolving around the nucleus with losing their energy but this was wrong because if it so they will finally fall in the nucleus.

Distance of closest approach :

When α -particles are projected towards nucleus, then a stage comes at which the α -particle retraces its path. That distance from the nucleus

to form where α -particles retraces its path is called distance of closest approach.

Note:

α -particle retraces its path when kinetic energy of α -particle gets converted into electric potential energy.

Kinetic energy = potential e.

$$\frac{1}{2} mv^2 = \frac{Ze \cdot 2e}{4\pi\epsilon_0 r_0}$$

$$r_0 = \frac{Ze \cdot 2e}{4\pi\epsilon_0 \times \frac{1}{2} mv^2}$$

$$\therefore V = \frac{W}{q}$$

$$W = Vq$$

$$W = \frac{kq_1 \times q_2}{r}$$

$$W = \frac{q \times q}{r} \text{ also,}$$

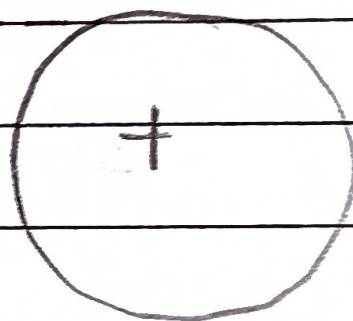
$$= \frac{Ze \cdot 2e}{4\pi\epsilon_0 \times E}$$

Impact parameter :-

It is defined as the perpendicular distance of initial velocity vector of α -particle from the central line of the nucleus.

Velocity vector
of α -particle

b
Central line



$$b = \frac{1}{4\pi\epsilon_0} \frac{Ze^2 \cot \frac{\theta}{2}}{\frac{1}{2}mv^2}$$

Electron orbits :

f_c = Centripetal force

f_e = electrostatic force.

$$F_c = F_e$$

$$\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

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

$$v^2 = \frac{1}{4\pi\epsilon_0} \frac{e^2 r}{r^2 m}$$

$$v^2 = \frac{1}{4\pi\epsilon_0} \frac{e^2}{r m}$$

$$v^2 = \frac{1}{4\pi\epsilon_0} \frac{e^2}{r m}$$

Total Energy of electron in orbital -

$$= K.E + P.E$$

$$\text{Kinetic } E = \frac{1}{2} m v^2$$

$$K.E = \frac{1}{2} m \times \frac{e^2}{4\pi\epsilon_0 m r}$$

$$K.E = \frac{e^2}{8\pi\epsilon_0 r}$$

$$\begin{aligned} \text{Potential } E &= V \cdot q \\ &= \frac{-e^2}{4\pi\epsilon_0 r} \end{aligned}$$

$$\text{Total energy} = \frac{e^2}{8\pi\epsilon_0 r} + \left(\frac{-e^2}{4\pi\epsilon_0 r} \right)$$

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

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

Bohr Model of Hydrogen atom:

Bohr combined classical and early quantum concepts and give theory in the form of 3 postulates

Postulates of Bohr Model:

1) According to Bohr, Every atom consist of a central core called nucleus, in which entire positive charge and almost entire mass of atom is concentrated. A suitable number of electron revolve around the nucleus in circular orbit.

2. According to Bohr, e^- can revolve in certain non-radiating orbit called stationary orbit for which the total angular momentum of revolving electron is integral multiple of $\left[\frac{h}{2\pi} \right]$

revolving e^- & angular momentum
$$= \frac{nh}{2\pi}$$

also, angular momentum = mvr

$$\therefore \left[\frac{nh}{2\pi} = mvr \right]$$

where n is positive integer or principle quantum number.

3) The emission or absorption of energy occur only when e^- jumps from one of its orbit to another orbit and it is given as -

$$E_2 - E_1 = h\nu$$

The energy of hydrogen atom in any shell can be given as,

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

for $n=1$

$$E = \frac{-13.6}{(1)^2} = -13.6 \text{ eV}$$

for $n=2$

$$E = \frac{-13.6}{2^2} = -3.4 \text{ eV}$$

$$h\nu = E_2 - E_1$$

$$h\nu = -3.4 - (-13.6 \text{ eV})$$

$$h\nu = -3.4 + 13.6 \text{ eV}$$

$$h\nu = 10.2 \text{ eV}$$

The line spectra of the Hydrogen atom:

Hydrogen spectrum consist of bright lines in a dark background is known as hydrogen emission spectrum.

Hydrogen spectrum in which we get dark lines on the bright background is known as absorption spectrum.

Formula of wave number of radiation.

$$\bar{\nu} = \frac{1}{\lambda} = R \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

where,

n_1 = final shell

n_2 = initial shell

R = Rydberg constant $= 1.097 \times 10^7 \text{ m}^{-1}$
 $= 10^{-7} \text{ or } \text{m}^{-1}$

For Lyman series :

When an electron jumps to first orbit from any outer orbit.

$$\bar{v} = \frac{1}{\lambda} = R \left[\frac{1}{(1)^2} - \frac{1}{n^2} \right] \quad n_1 = 1 \text{ and } n_2 = n (2, 3, \dots)$$

This series lies in UV region

for Balmer series :

When an electron jumps to second orbit from any outer orbit.

$$n_1 = 2 \quad \text{and} \quad n_2 = n (3, 4, 5, \dots)$$

This series lies in visible region

3) For Paschen series:

When an electron jumps to third orbit from any outer orbit

$$n_1 = 3 \quad n_2 = n \quad (4, 5, 6, \dots)$$

This series lie in the infrared region

4. For Brackett series: When an e^- jumps to fourth orbit from any outer orbit.

$$n_1 = 4 \quad n_2 = n \quad (5, 6, 7, \dots)$$

This series lies in the infrared region

5. Pfund series:

Solution should conduct electricity is ionic compound

M. Faraday state that when electricity pass through electrolyte solution charge shift at electrode (anode and cathode) after that charge strike on metals and recharge and glow.

Like and unlike charge

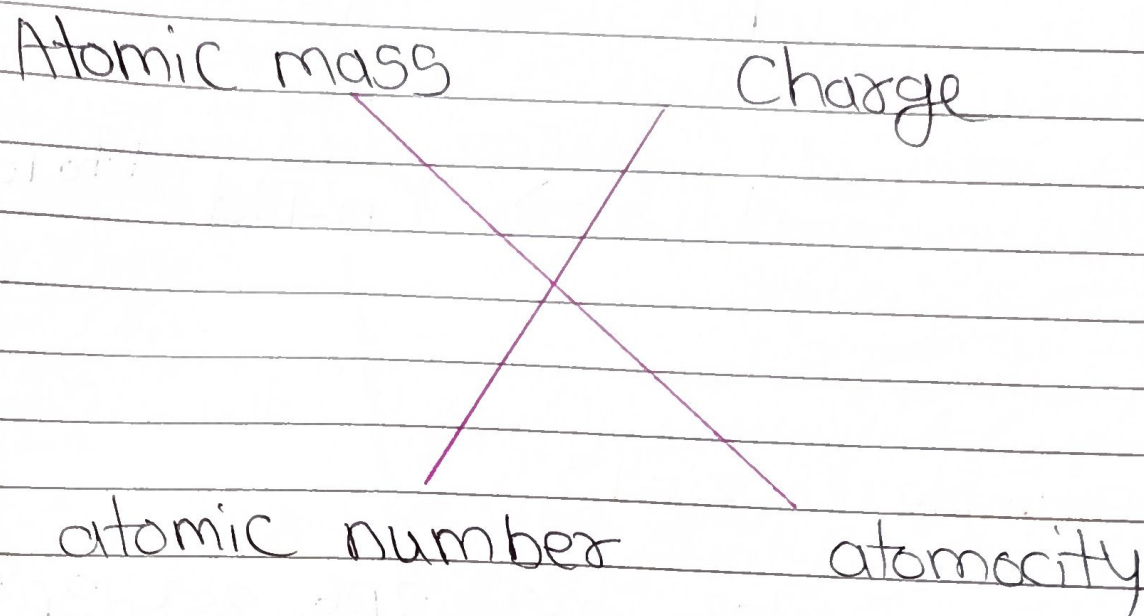
like charge

Same type of charge repel to each other is called like charge ($\oplus \oplus$)

unlike charge

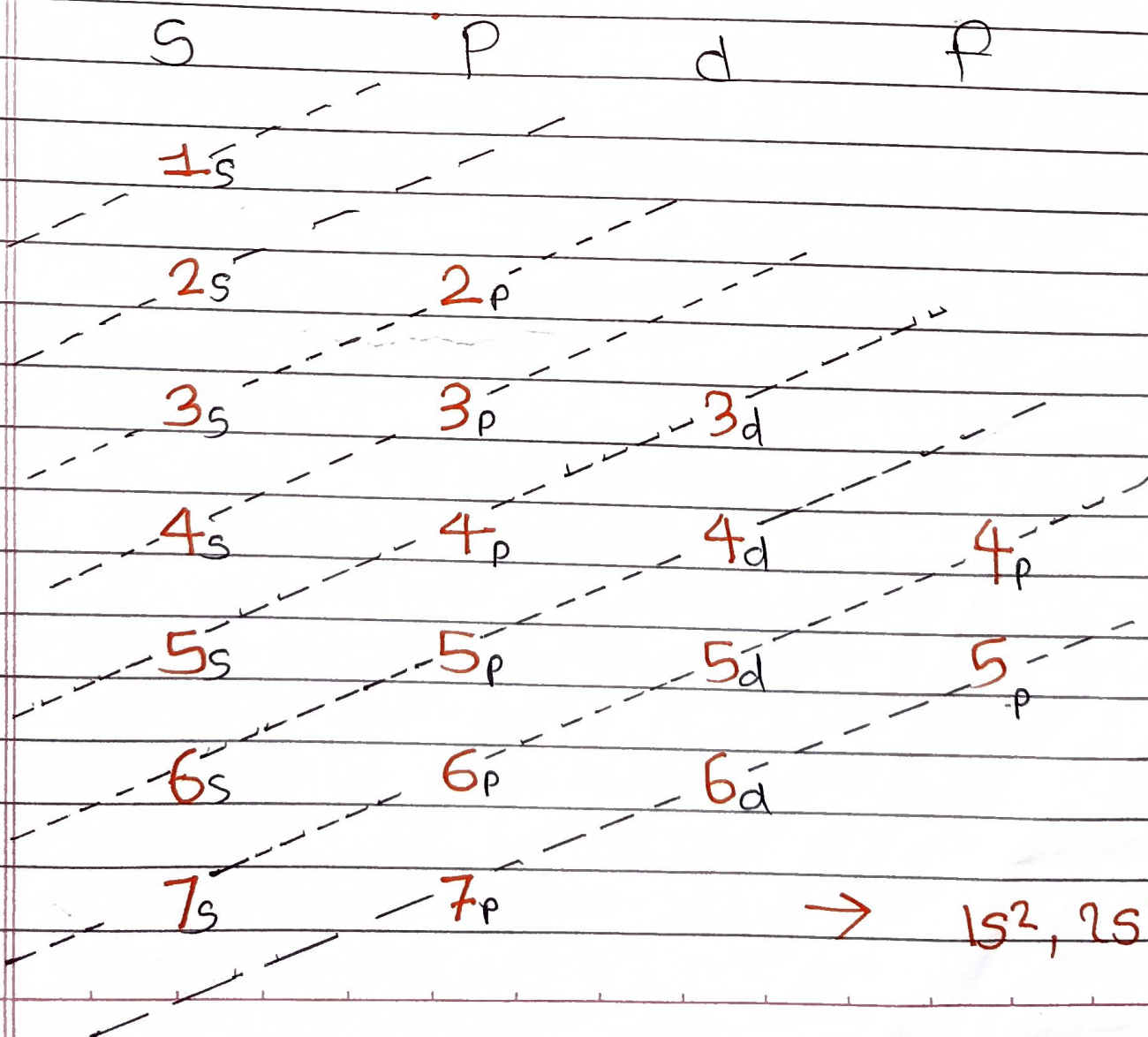
different types of charge attract each other is called unlike charge ($\oplus \ominus$)

Atomic mass and Molecular mass



★ Electronic Configuration

Aufbau Principle



Note: $s = 2$
 $p = 6$
 $d = 10$
 $f = 14$

→ $1s^2, 2s^2, 2p^6, 3s^2, \dots$

Note : $s \rightarrow ns^{1 \text{ to } 2}$

$p \rightarrow ns^2 \quad np^{1 \text{ to } 6}$

$d \rightarrow (n-1)d^{1 \text{ to } 10} \quad ns^{1 \text{ to } 2}$

Example $Z = 13$

$1s^2, 2s^2, 2p^6, 3s^2, 3p^3$

$n = 3$ period

$P = \text{block}$

group = 13

Isotop and Isobar

Isotop

- 1) Same element
- 2) Same atomic number
- 3) different law
- 4) ${}^1_1\text{H}$ ${}^2_1\text{H}$ ${}^3_1\text{H}$

Isobar

- 1) different element
- 2) different atomic number
- 3) ${}^{40}_{19}\text{K}$ ${}^{40}_{20}\text{Ca}$

Isotop is that sem element sem atomic number but different mass

Isobar ~~is that~~ different as that different number different atomic number but same is mass

Hybridization

In Hydrocarbon Structure, Carbon Complete their valency by $(=)$ bond, and $(\equiv)$ bond that arrangement is called Hybridization

$Sp \rightarrow$ Carbon Complete their valency by $(\equiv)$ bond

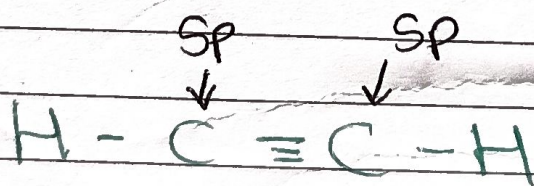
$Sp^2 \rightarrow$ Carbon Complete their valency by $(=)$ bond

$Sp^3 \rightarrow$ Carbon Complete their valency by $(-)$ bond

Note: $(-)$ bond carry out (σ) sigma bond

- $(=)$ bond carry out one $\pi(\pi)$ and one (σ) sigma bond

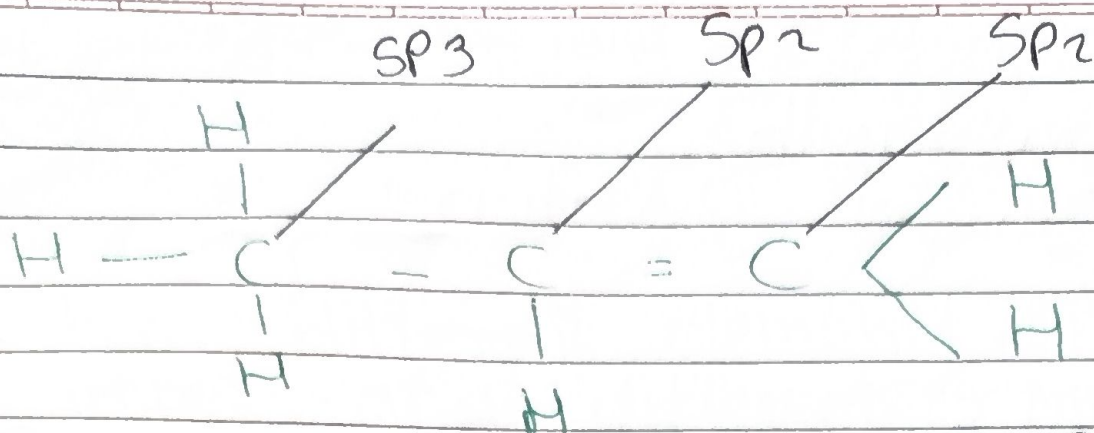
- $(\equiv)$ bond carry out two $\pi(\pi)$ and one (σ) sigma



ethyne

$$\sigma = 3$$

$$\pi = 2$$



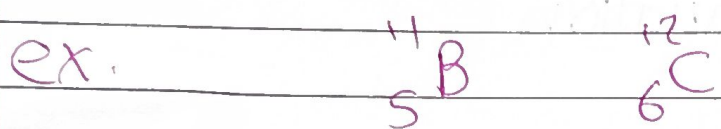
Propene

$$\sigma = 8$$

$$\pi = 1$$

★ Isotones

When different element, different atomic number and different atomic mass but same number of neutron is called Isotones.

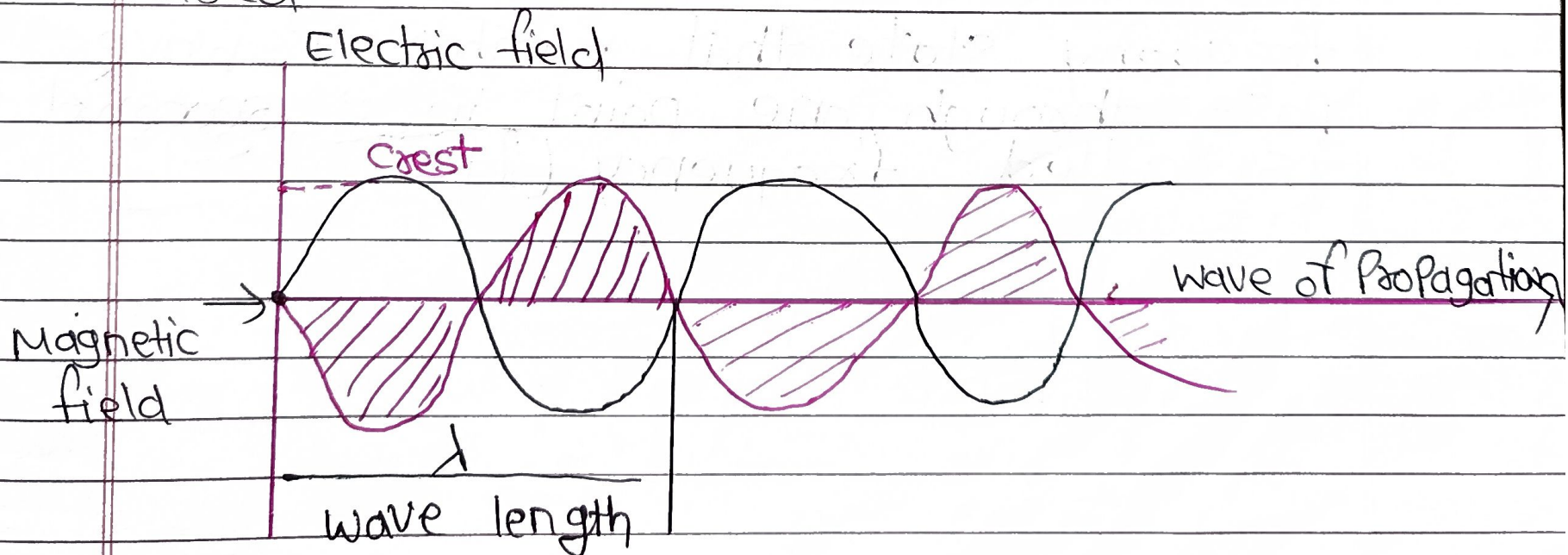


$$\text{No. of neutron} = B = 6$$
$$C = 6$$

★ electromagnetic wave

When electricity passed through magnetic material that gives waves is called electromagnetic wave.

In these wave formation [AC] current used



λ = Wave length
 δ = angle of deviation

$$\lambda = \frac{1}{\delta}$$

Wave length inversely proportional to angle of deviation

★ Wave length [λ]

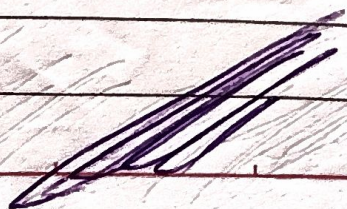
in [VIBGYOR] Red Colour have maximum wave length because it gives minimum angle of deviation

Wave length is the complete cycle of electromagnetic wave

★ frequency [ν / f]

frequency state that number of wave pass through one point in 1 second is called frequency [Hz] [s^{-1}]

$$\nu = \frac{1}{\text{time}}$$



★ Wave number ($\bar{\nu}$) (ν bar) / nv

Wave number defined as that total number of wavelength per unit length is called wave number.

$$\bar{\nu} = \frac{1}{\lambda}$$

★ Amplitude

Amplitude of A wave is the height of crest.

Note: In vacuume speed of light [electromagnetic wave radiation] $3 \times 10^8 \text{ m/s}^{-1}$ it denoted by 'c'.

★ What is the relation between Speed of light in vacuume, frequency and Wavelength.

$$C = \nu \lambda$$

$$\nu = \frac{C}{\lambda}$$

$$\lambda = \frac{C}{\nu}$$

C = Speed of light
in vacuume
 ν = frequency

λ = wavelength

★ Particle nature of electromagnetic radiation

→ Plank gives statement, energy of a substance [Material] is directly proportional to frequency

$$E \propto \nu \quad E = h\nu \quad \therefore h = \text{Plank Constant}$$

★ Emission of spectrum of Hydrogen

→ When substance irradiate with light, it absorbed energy. Atom, molecules, or ions which absorbed radiated light that state is called 'excited state'.

Such substance that ~~evolve~~ evolved light after radiation that substance is called radiated substance.

Note

$$1 \text{ \AA} = 10^{-10} \text{ m}$$

$$1 \text{ nm} = 10^{-9} \text{ m}$$

$$1 \text{ cm} = 10^{-2} \text{ m}$$

$$1 \text{ PM} = 10^{-12} \text{ m}$$

PYQ

Wave length of visible light 400nm
find this wavelength in term of
frequency

$$\lambda = 400\text{nm}$$
$$= 400 \times 10^{-9}\text{m}$$

$$C = 3 \times 10^8 \text{m/s}$$
$$V = ?$$

$$V = \frac{C}{\lambda}$$

$$= \frac{3 \times 10^8 \text{m/s}}{400 \times 10^{-9}\text{m}}$$

$$= \frac{3 \times 10^8 \times 10^9}{400}$$

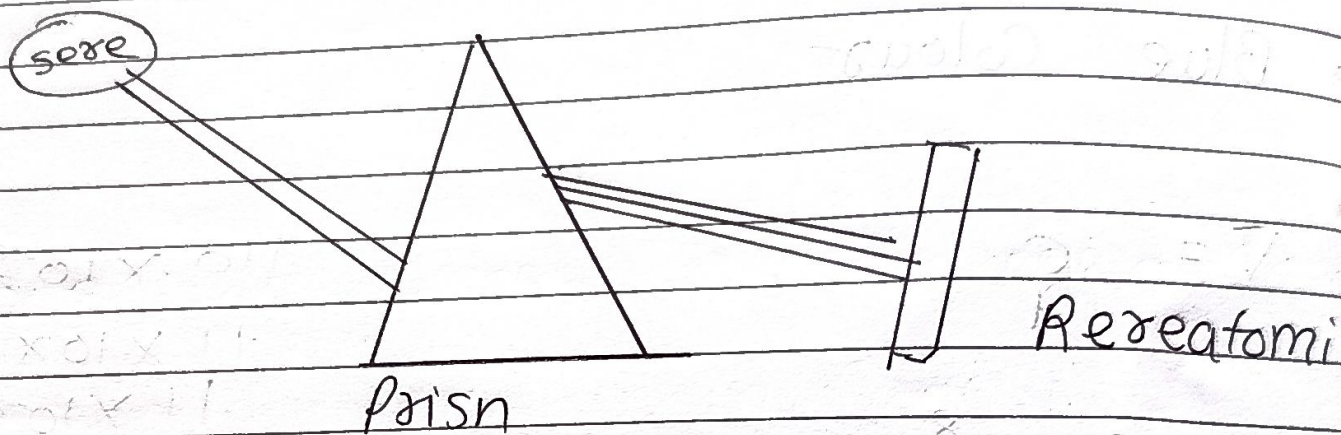
$$= \frac{3 \times 10^{17}}{400}$$

$$= \frac{3 \times 10^{17}}{4 \times 10^2}$$

$$= \frac{3 \times 10^{17} \times 10^{-2}}{4}$$

$$= 0.75 \times 10^{15} \text{Hz}$$

★ Hydrogen Spectrum



$n=1$	$n=2$	$n=3$	$n=4$	$n=5$
Lyman Series	Balmer Series	Paschen Series	Brackett Series	Pfund Series

Balmer state that some work of light are visible and some are must clearly seen by vedent length

$$= 109677 \left[\frac{1}{2^2} - \frac{1}{n^2} \right] \text{cm}^{-1}$$

$$n = 3, 4, 5, \dots$$

★ in Balmer series absorption between 4 different observe of light

Balmer State that $\lambda = 109,677$

$$\left[\frac{1}{2^2} - \frac{1}{n^2} \right]$$

$$n = 3, 4, 5, \dots$$

Rydberg series

$$\frac{1}{\lambda} = 109,677 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] \text{ cm}^{-1}$$

$$n_1 = 1, 2, 3, 4$$

$$n_2 = n+1, n+2, n+3, \dots$$

Q1 Name the series that gives Partially Visibility

→ Balmer series

Q2 Write the series of hydrogen spectrum

→ Lyman, Balmer, Paschen, Brackett, Pfund

Q3 Write the Balmer formula?

$$\rightarrow \bar{\nu} = 109,677 \left(\frac{1}{2^2} - \frac{1}{n^2} \right) \text{ cm}^{-1}$$

Q4 What is the value of n_1 and n_2 in Rydberg formula

$$n_1 = 1, 2, \dots, \infty$$

$$n_2 = n+1, n+2, \dots, \infty$$

Q5 Write the value of n in Balmer Series on the basis of Balmer formula

$$n = 3, 4, \dots, \infty$$

6. By Balmer formula what is the value of wavelength in Balmer series when $n=3$ $n=4$ $n=5$
 $n =$

7) What is the Rydberg formula

$$\rightarrow 109,677 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{cm}^{-1}$$

8 Name the series that have U.V rays and infra Red Ray

Lyman - U.V rays

Paschen, Brackett, Pfund - Infra red ray

9) Name the Scientist and write their formula to give common formula for all type of series

$$\rightarrow 109,677 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{cm}^{-1}$$

★ Angular Momentum ω (omega)

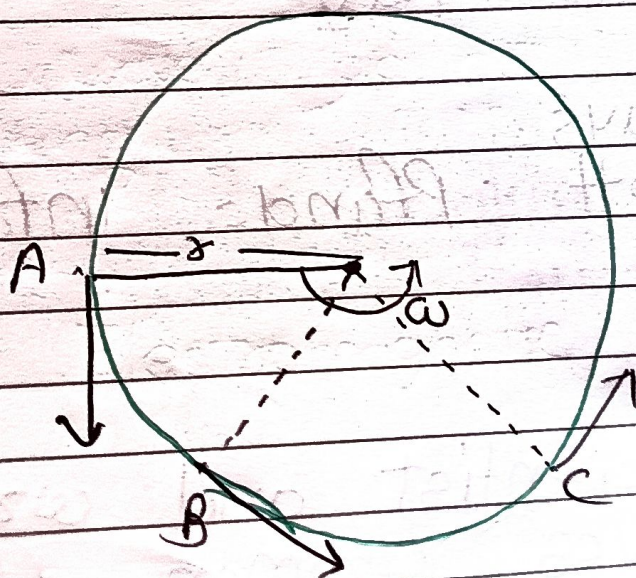
Angular momentum is defined as that product of Moment of inertia (I) and angular velocity (ω)

$$\text{Angular Momentum} = I \times \omega$$

$$I = \text{inertia}$$

$$\omega = \text{angular velocity}$$

Angular Momentum in Circular path



$$I = Ar^2$$

$$r = \frac{d}{2}$$

$$\omega = \frac{v}{r}$$

$d = 2r$ radius of circle
 $r =$ radius of circle
 $d =$ diameter of circle

Light

Maxwell

Plank (h)

Wavelength

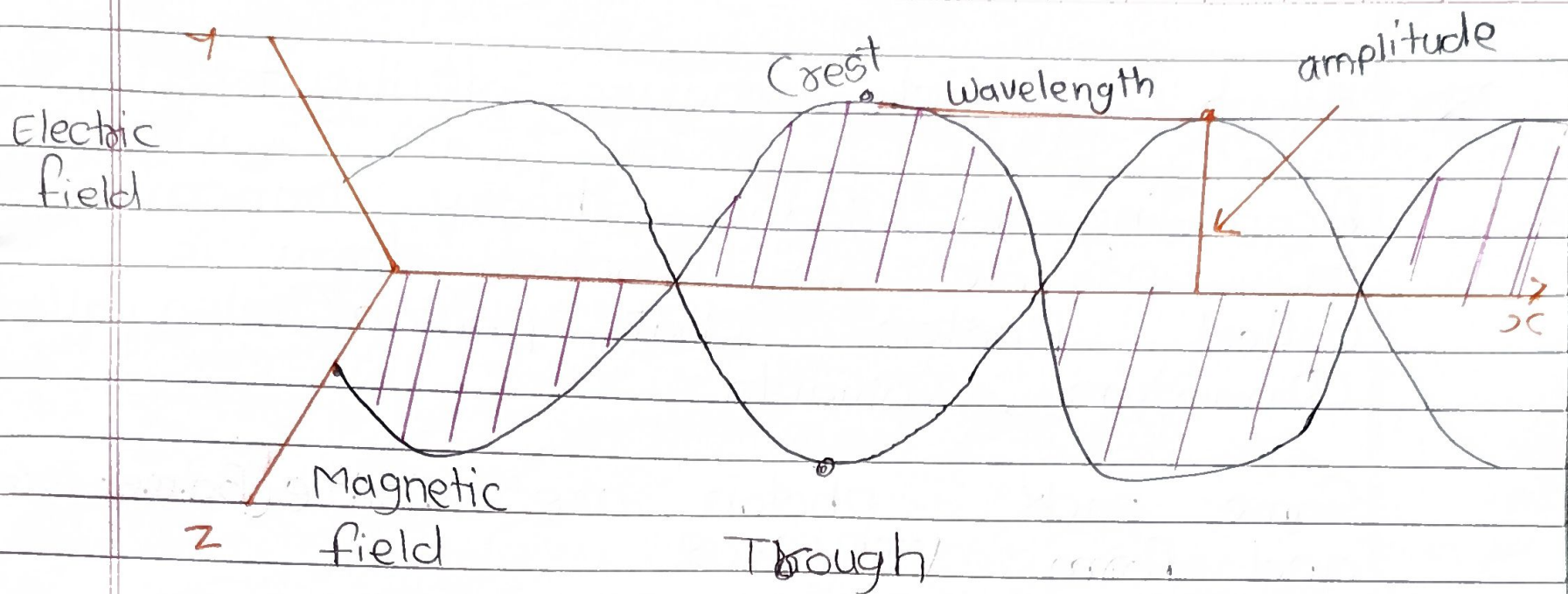
Particle nature

→ Reflection
Refraction
Diffraction

- 1) Some wave required medium for travelling ex. Sound wave
- 2) Some wave do not required medium for travelling ex. E.M.R. Electromagnetic radiation

★ EMR (Electromagnetic (Radiation)) Direction of propagation

Magnetic field, electric field and radiation are perpendicular to each other.



★ EMR occurs →

[Reflection
Refraction
Diffraction

EMR do not occurs

Photo electric

Black Board

★ Plank's particle nature of light

According to Plank's theory transmitted of particle in packed form is called photon. That photon also called Quantum / Quanta.

Same pack photon are visible [Balmer series] and form **VIBGYOR**.

V. Colour gives minimum wavelength and Red Colour have high wavelength.

★ Characteristic of Photon

1) travel with speed of light
[$c = 3 \times 10^8 \text{ m/s}$] in vacuum

SI Unit of energy = Joule / J

SI Unit of energy = $E = \text{eV}$ (electron volt)

$$\text{eV} = 1.6 \times 10^{-19} \text{ J}$$

$$h = 6.626 \times 10^{-34} \text{ J/s}$$

$$E = \frac{hc}{\lambda}$$

When $\lambda = \text{nm}$, when $\lambda = \text{\AA}$

$$hc = 1240 \text{ eV}$$

Q A light source of wavelength $\lambda = 2000 \text{\AA}$ emits 0.5 J energy, the number of photon emitted from the source

$$E = \frac{hc}{\lambda}$$

$$E = \frac{nhc}{\lambda}$$

$$0.5 \text{ J} = \frac{n \times 1240 \text{ eV}}{2000 \text{\AA}}$$

$$0.5 \text{ J} = \frac{n \times 1240 \times 1.6 \times 10^{-19}}{2000}$$

$$0.5 \times 100 = n \times 124 \times 8 \times 10^{-19}$$

$$n = \frac{50}{124 \times 8 \times 10^{-19}}$$

$$n = \frac{50 \times 10^{19}}{124 \times 8}$$

$$n = \frac{50 \times 10^{19}}{992}$$

$$0.5 \times 10^{19}$$

$$n = 5.0 \times 10^{17}$$

★ Photon Dissociation

Photon = light

Dissociation = Break down

★ Break down of light [Bond] required energy is called photo Dissociation.

★ Energy required for breakdown of bonding is called bond energy.

★ Bond energy defined for $\pm$ Mole

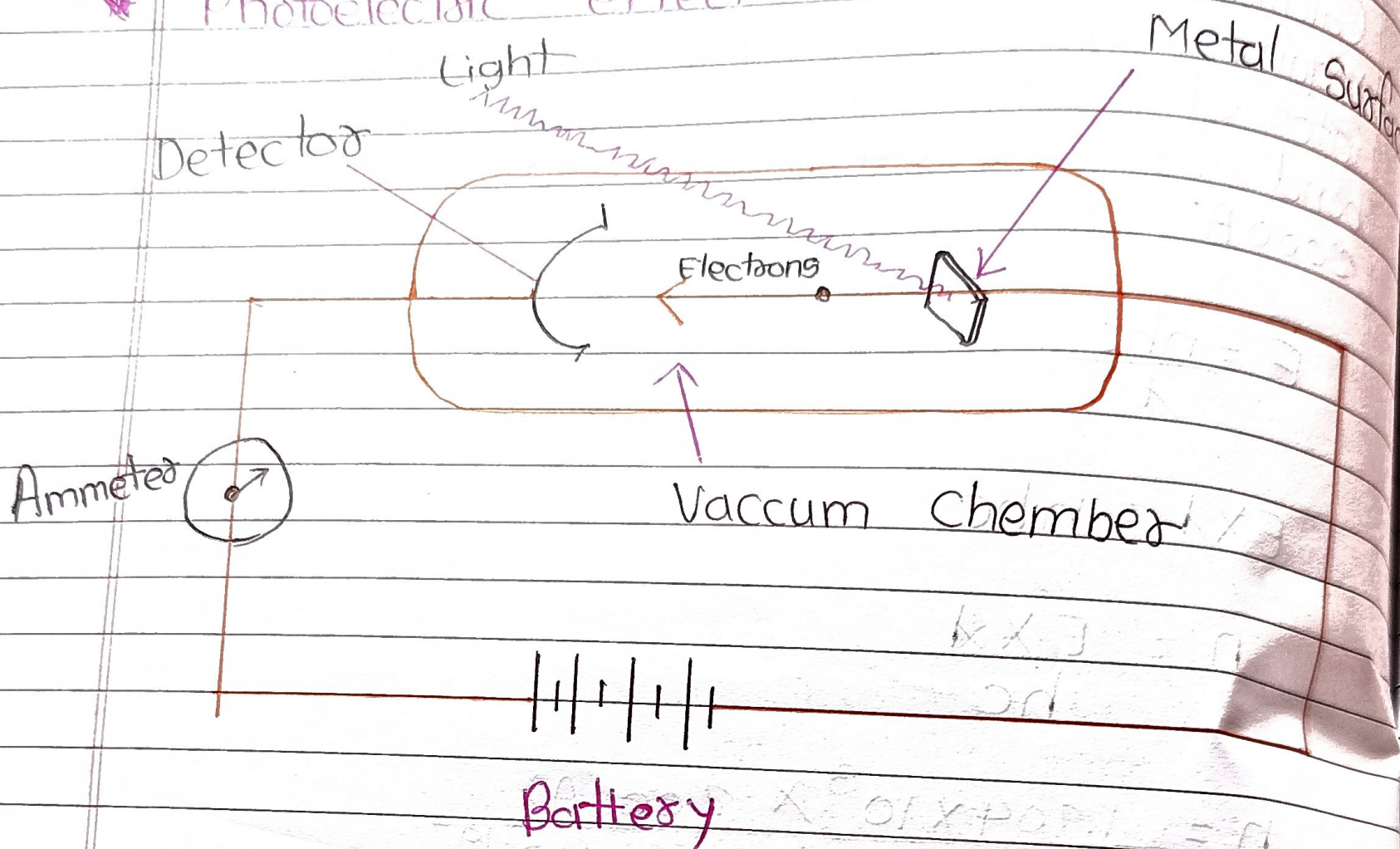
★ Bond energy = energy required for Break down 6×10^{23} bond

★ Energy for x mole of substance

$$= \frac{x}{N_A}$$

★ Energy required to Breakdown energy for per bond = $\frac{x}{N_A} = \frac{hc}{\lambda}$

★ Photoelectric effect



Note:

Ammeter	for	Current
Voltmeter	for	Voltage

ejected - Release

★ Photoelectric effect support particle nature of light.

★ When light incident at certain metal surface metal surface ejected electrons these is called photoelectric electron or photoelectron

★ Metal electron does not reach to detector, battery flow the current and e⁻ electron reach to detector this effect is called photoelectric effect.

★ Photoelectric Current

Motion of electron by the help of electric current is called photoelectric current.

What is the function of battery

Battery give the direction flow of current from cathode to anode

★ Work function and Threshold energy (ϕ)

Minimum energy required to elect and electron out of metal sheet is called work function. It represent by (ϕ) work function of each and every metal have different [Unique]

★ Work function for metal have fixed (each metal) at unit position

* Threshold frequency (ν_0)

It is defined as that minimum frequency of incident ray of light is called threshold frequency

$$\nu_0 = \frac{c}{\lambda}$$

$$c = 3 \times 10^8$$

Threshold wavelength (λ_0)

Maximum wavelength required to eject an electron for metal sheet is called threshold wavelength

wavelength represented by λ_0

$$E = hc = \frac{hc}{\lambda}$$

$$\phi = hc = \frac{hc}{\lambda}$$

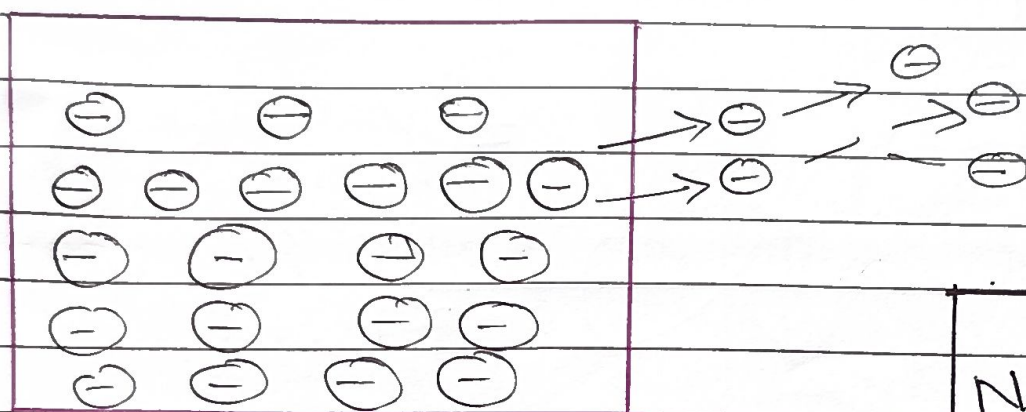
$$\boxed{\phi = \frac{hc}{\lambda}}$$

$\phi =$ work function It is also called threshold energy

★ Photoelectric equation ★

Photoelectric equation on: Based Conservation of energy principle

★ In photoelectric equation light incidents on metal surface for doing two work



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

$$P.E = mgh$$

★ To eject electron from metal surface [work function]

★ Maximum number of electron used kinetic energy for moving electron

photoelectric equation

$$E_i = \phi + K.E = [h\nu_i = h\nu_0 + K.E]$$

$$\phi = E_i - K.E = h\nu_0 = h\nu_i - K.E$$

$$\frac{nhc}{\lambda} = \frac{nhc}{\lambda_0} - K.E$$

$$\text{maximum K.E} = E_i - \phi$$

$$KE = h\nu - h\nu_0$$

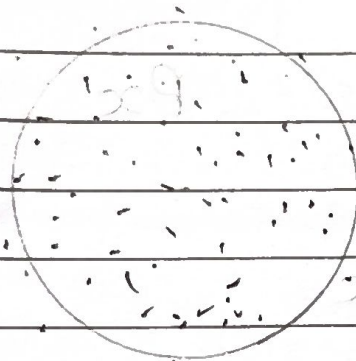
* Shapes of 's' 'p' 'd' orbitals

S orbital

total orbital = 1

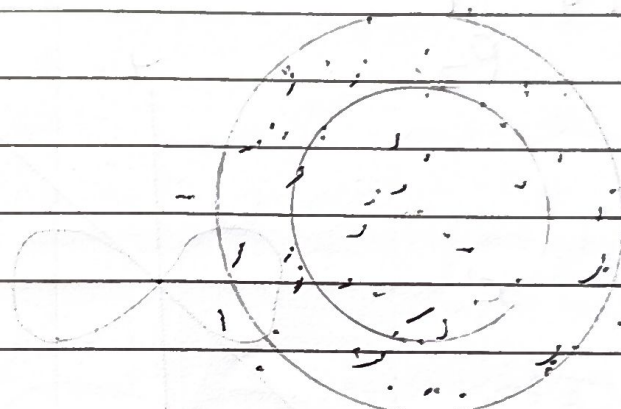
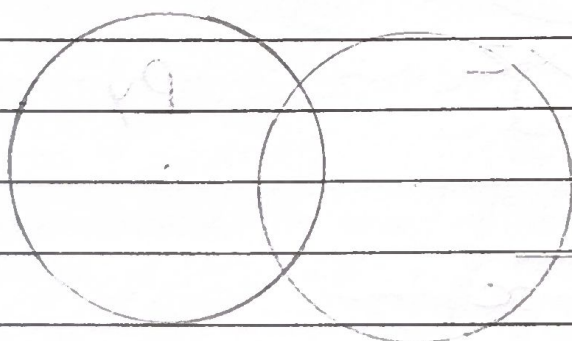
total electron = 2

1s



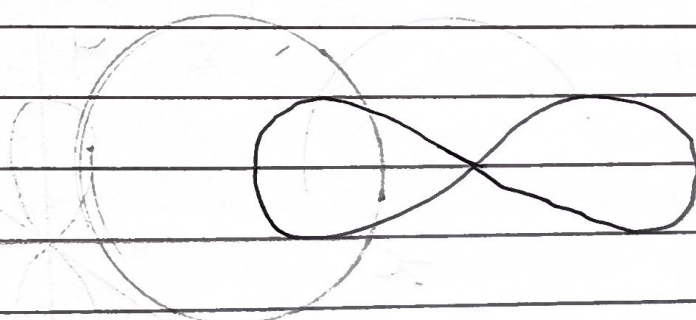
1s

S - S orbital



2s

S - p orbital



P orbital

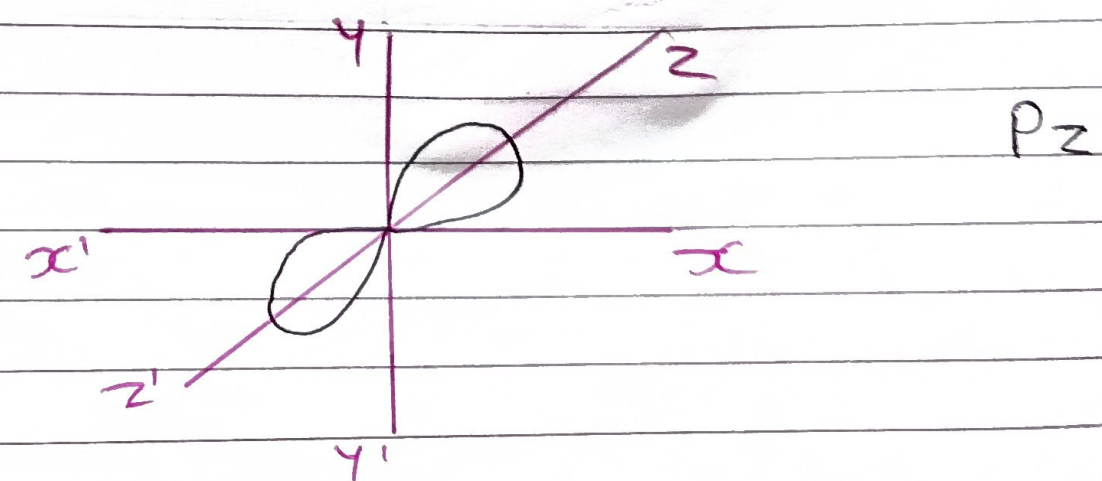
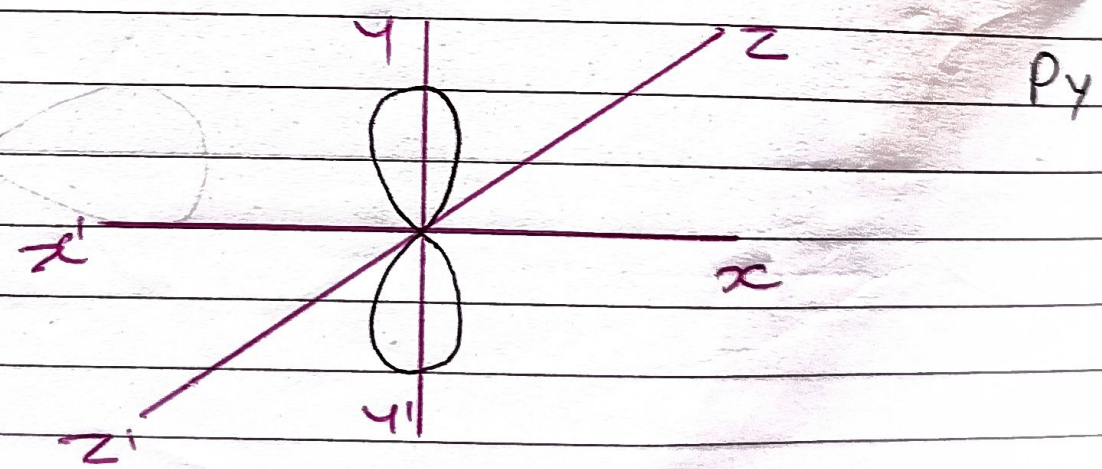
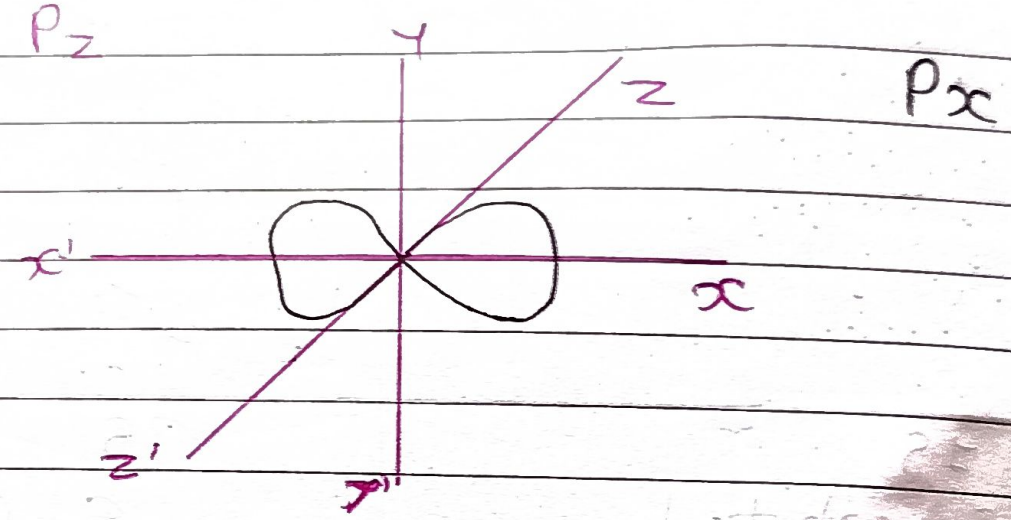
total orbital 3
total electron 6



P_x

P_y

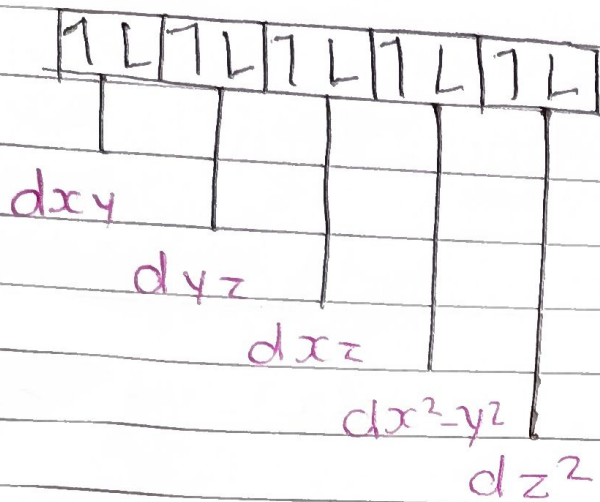
P_z



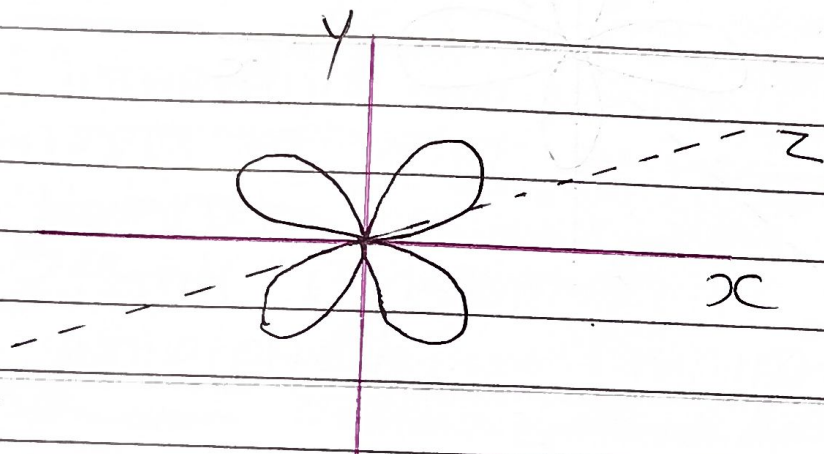
(Imp)

* 'd' orbital

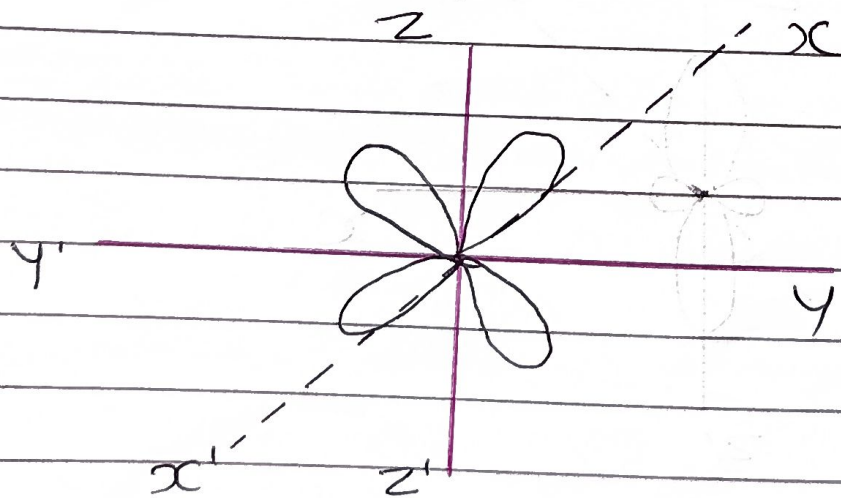
total orbital 5
total electron 10

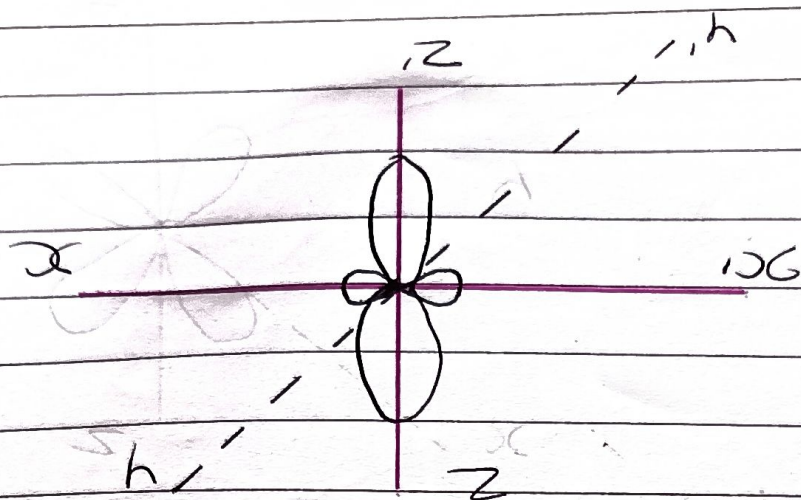


d_{xy} - orbital

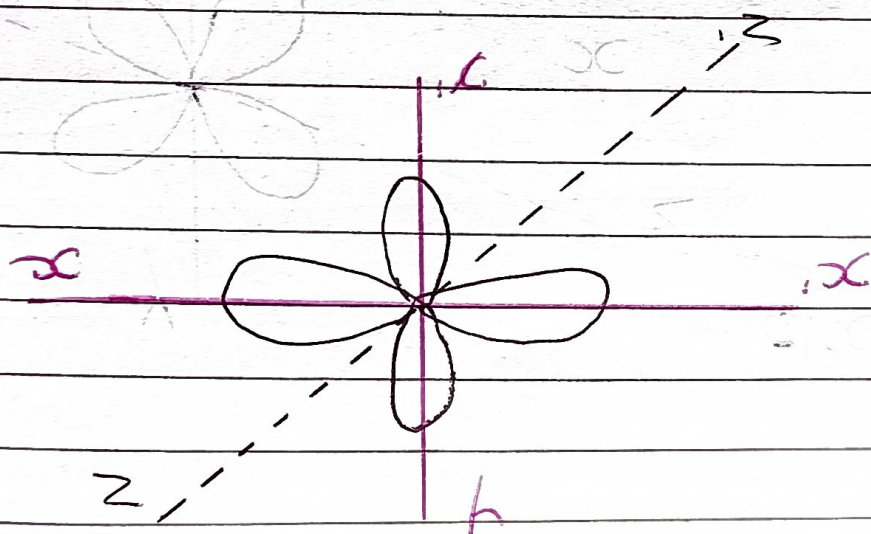


d_{yz} - orbital

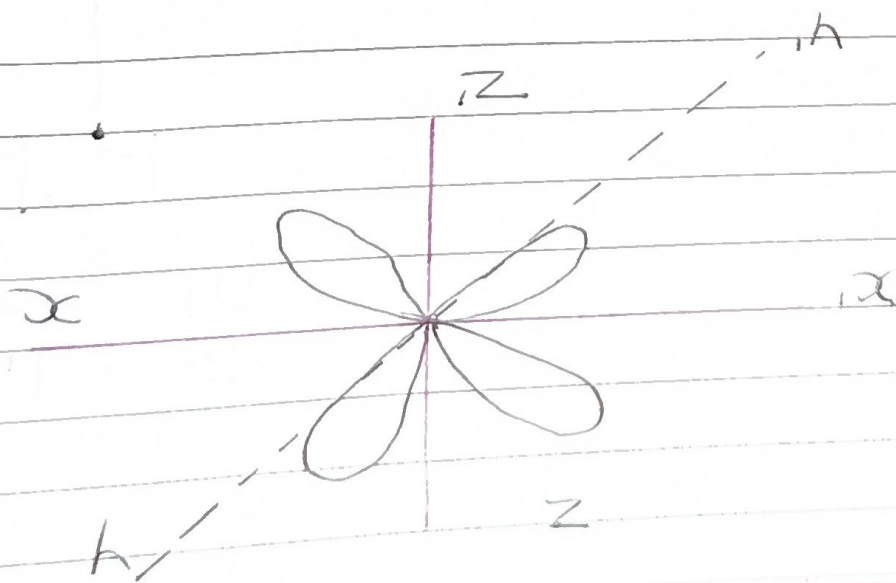




dz^2 - orbital



$dx^2 - y^2$



dxy

★ Dual Behaviour of Matter

According to de-Broglie photon have momentum as well as wavelength

Electron also have momentum as well as wavelength

Relation between momentum and wavelength

$$\lambda \propto \frac{1}{mv} \quad \Rightarrow \quad \lambda = \frac{h}{mv} \quad \Rightarrow \quad \boxed{\lambda = \frac{h}{p}}$$

p = Momentum of body

m = mass of the body

v = Velocity

h = Planck Constant

λ = wavelength (meter) $\rightarrow$ (SI unit)

Q) What will be the wavelength of a ball of mass 0.1 kg moving with a velocity of 10 ms^{-1}

$$h = 6.626 \times 10^{-34} \text{ J}$$

$$m = 0.1$$

$$v = 10 \text{ kg}$$

$$\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}}{(0.1 \text{ kg}) (10 \text{ ms}^{-1})}$$

$$= \frac{6.626 \times 10^{-34}}{1 \text{ (kg ms}^{-1}\text{)}}$$

$$\lambda = 6.626 \times 10^{-34} \text{ kg}^{-1} \text{ m}^1 \text{ s}^2 \text{ J}$$

2) Calculate the mass of photon with wavelength $3.6 \text{ \AA}$

$$\lambda = 3.6 = 3.6 \times 10^{-10} \text{ m}$$

$$m = \frac{h}{\lambda v} = \frac{6.626 \times 10^{-34}}{(3.6 \times 10^{-10} \text{ m}) (3 \times 10^8 \text{ m/s})}$$

$$= \frac{6.626 \times 10^{-34} \times 10^{10} \times 10^{-8}}{10.8}$$

$$= \frac{6626 \times 10^{-32}}{10800} = \frac{.613 \times 10^{-32}}{10.8} = 6.13 \times 10^{-34}$$