Physics Mega Revision #7

Modern Physics (Semiconductor & Communication)

Superfast Revision

Welcome Students

Complete Physics Mega Revision Timetable

15 Feb
Electrostatics
Current electricity
Capacitor
🎁 Surprise Gift 🎁

16 Feb
Calorimetry
Elasticity
Thermal Expansion
Heat Transfer
KTG
Thermodynamics
Fluid Mechanics

17 Feb
Magnetic effect of current
Magnetism and matter
Emi
AC

18 Feb
UD
Vector
Kinematics 1D
Kinematics 2D
NLM
Friction
Circular motion
Work power energy
COM

19 Feb
Ray optics
Optical Instruments
Wave optics
EM Waves
Errors in measurement

20 Feb
Rotation motion
Gravitation
SHM
Wave on string
Sound wave

21 Feb
Atomic structure
Dual nature of radiation
X-rays
Nuclear physics
Radioactivity
Semi conductor
Communication system

128 GB SD Card Included
Bounce Back
JEE
Main+Advanced
HURRY UP!
50% OFF for first 300 Students ONLY
Get Top Ranks in IIT-JEE/NEET with eSaral APP
Get it on Google Play

What you get inside the course?

- Study from Kota's **Top IITian Faculties**
- **650+ Hours of PCM Videos** Lectures with best Visualisation
- **30000+** Solved Qs
- Personalised date wise Time-table
- Live **4-Layered Doubt Solving** System
- Personalised 3-Layered **One to One Mentorship**
- **115** Fully Solved Topic wise segregated **Practice Sheets** with **homework index & video solutions**
- Solved **Prev 10 years Chapterwise Qs**
- Quick Revision Video Lectures and **90+ Mind Maps**
- **97 JEE Main** and **94 JEE advanced** 1hr Topic wise **Tests**
- 3 Hour Regular Review tests and Test Series
- Instant Test Analysis Report
- Regular Motivation and Strategy Sessions

Master Planners & Faculties

N.K. Gupta Sir

eSaral Math Faculty & Master Planner

- **IIT Kanpur**, Mechanical
- Ex **Vice President & Academic Head**, Allen, Kota
- Mentored many of **Rank 1** & **Top 100** Students
- **30+ years** of Teaching Experience
- **Mentored** over 3,00,000 Students

Master Planners & Faculties

Saransh Gupta Sir

eSaral Physics HoD

- **IIT Bombay**, CS
- **AIR-41** IIT-JEE
- **Air-71** AIEEE (JEE Main)
- **AIR-4** NSO
- **1%** In Top INPHO
- **8+** Years of Teaching Experience
- **Mentored** Lakhs of Students

Master Planners & Faculties

Prateek Gupta Sir
eSaral Chemistry Faculty

- **IIT Bombay,** Metallurgy
- **Online** Creativity & Visualization Expert
- **Mentored** Lakhs of Students

Course Details

Lectures

↓

Practice
- Sheets
- Prev. Yr.

↓

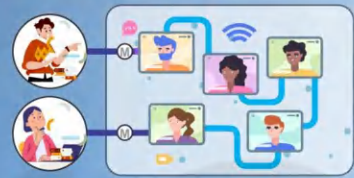
Tests
- Topic-Wise
- Review

- Study Plan
- Doubt Solving
- Mentorship

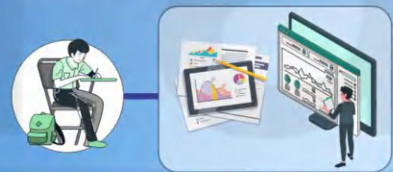
3 Layered Personalised Mentorship

eSaral है, तो सब सरल है।

PERSONAL ACADEMIC MENTOR

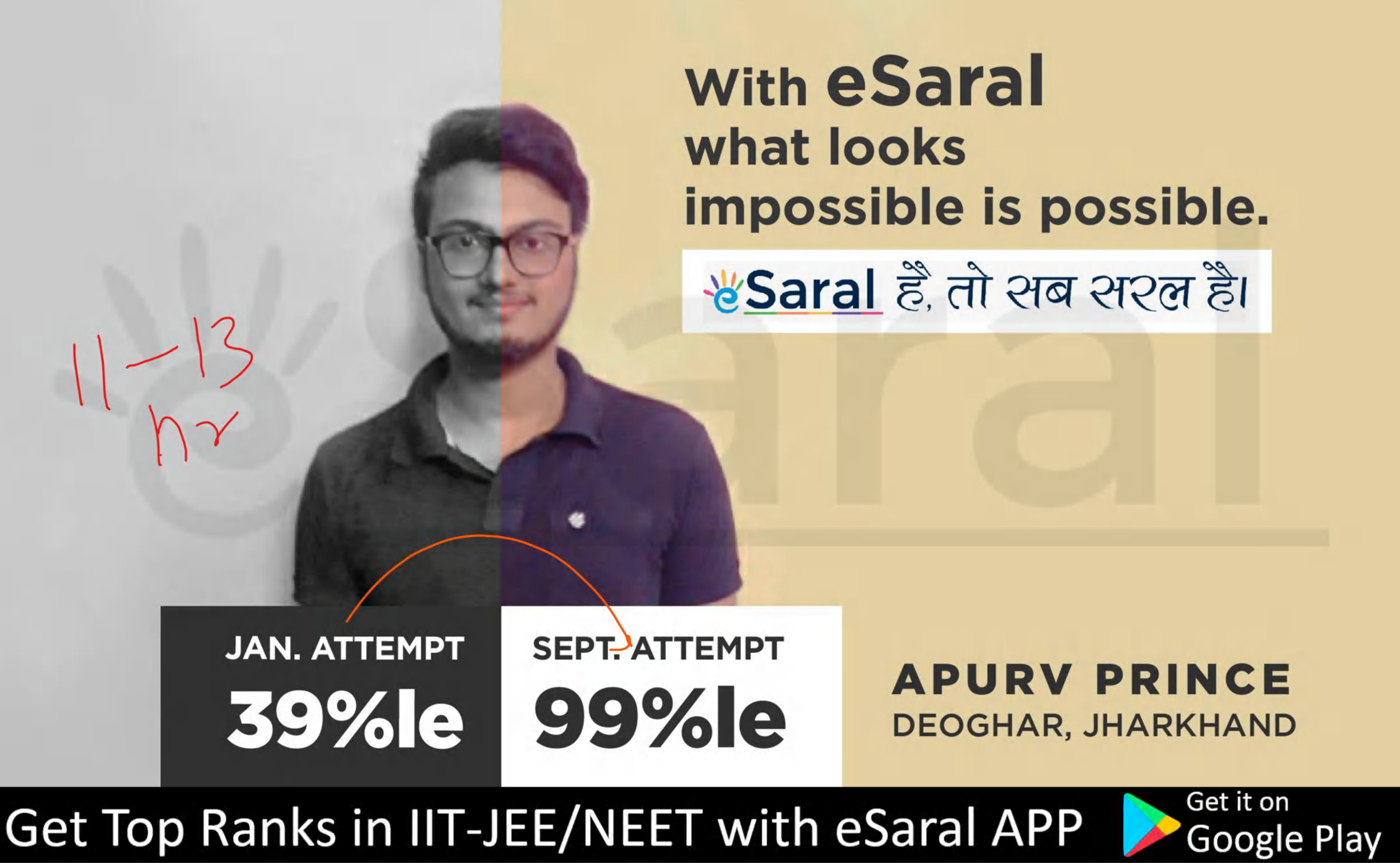


PROGRESS MENTOR FOR TRACKING PROGRESS



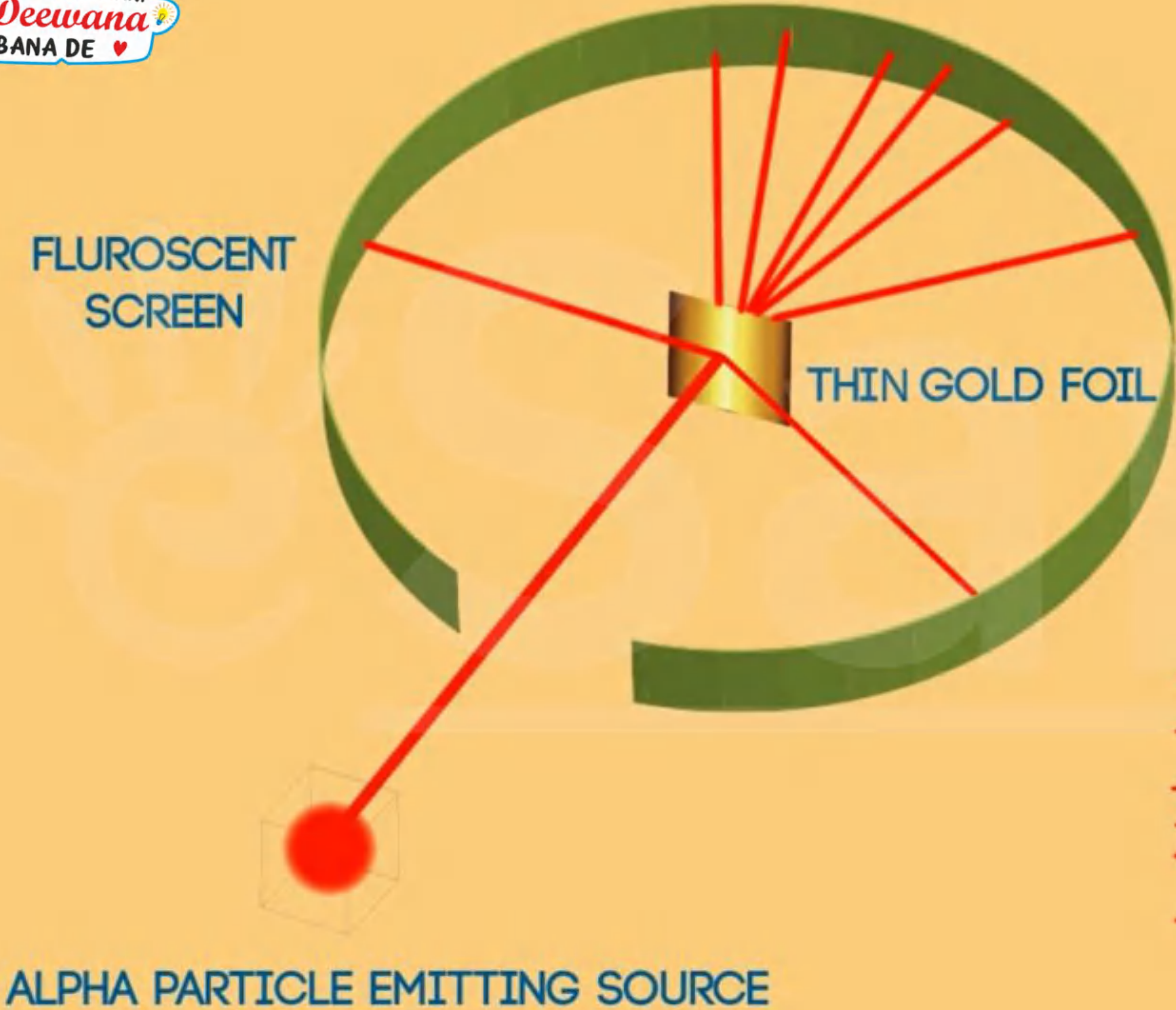
LIVE MENTORSHIP SESSIONS


eSaral
4 Layered DOUBT SOLVING
eSaral है, तो सब सरल है।
L1
L2
L3
L4
SOULTION OF PRACTICE SHEETS
DEDICATED DOUBT HOTLINE
Doubt
SOLVED
LIVE DOUBT SOLVING CLASSES
PERSONALISED CONNECT WITH FACULTIES

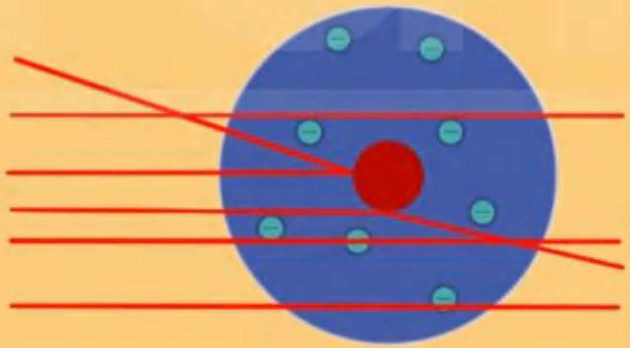

With eSaral
what looks
impossible is possible.
eSaral है, तो सब सरल है।
JAN. ATTEMPT
39%le
SEPT. ATTEMPT
99%le
APURV PRINCE
DEOGHAR, JHARKHAND
Get Top Ranks in IIT-JEE/NEET with eSaral APP
Get it on
Google Play

Atomic Structure
Superfast Revision

RUTHERFORD'S GOLD FOIL EXPERIMENT



RUTHERFORD'S MODEL OF AN ATOM



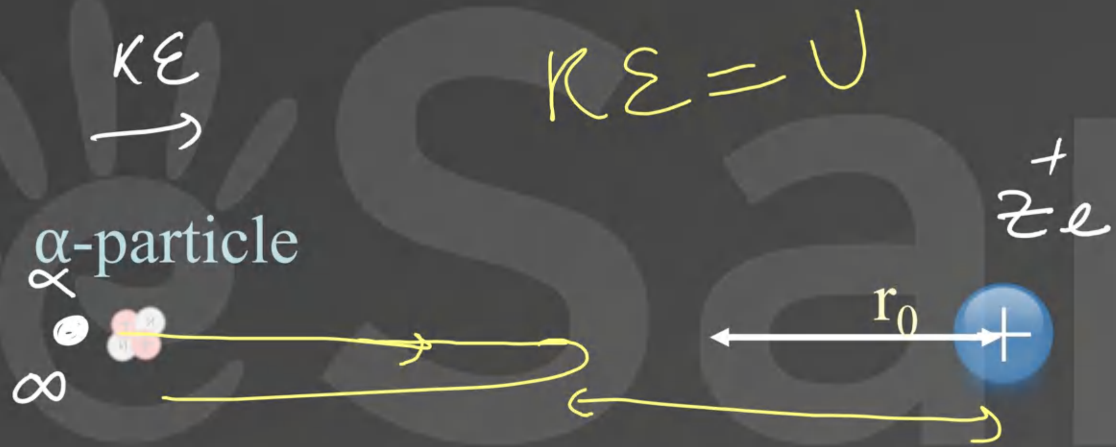
Rutherford's Gold Foil Experiment

1. Most of the α-particles (nearly 99.9%) went straight without suffering any deflection.

2. A few of them got deflected.

It was concluded that whole of the +ve charge is concentrated and the space occupied by this positive charge is very small in the atom.

Rutherford's Gold Foil Experiment



r_0 = distance of closest approach from the centre of the nucleus

$$r_0 = \frac{2\,k\,Z\,e^2}{K.\,E.}$$

Bohr's Model

$$mvr = \frac{nh}{2\pi} \quad \text{—} (1)$$

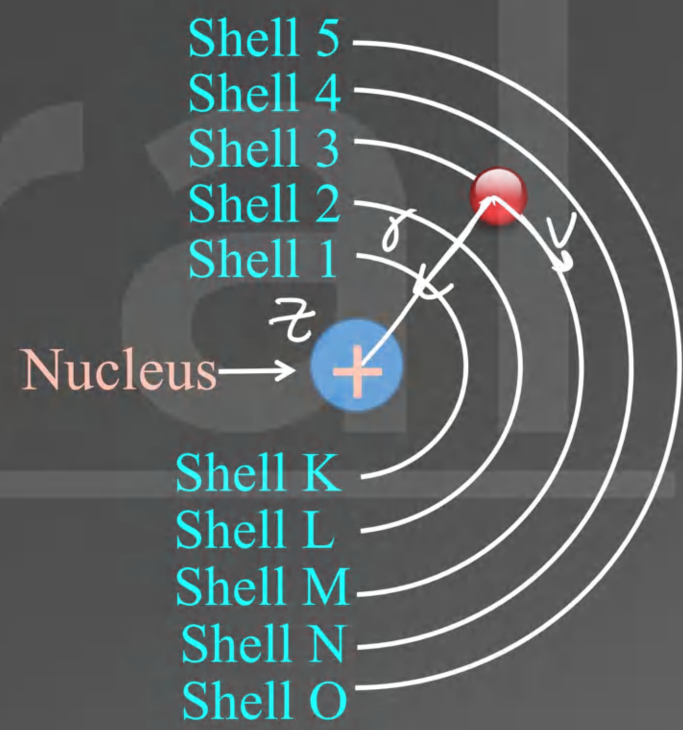
$$\frac{kq_1 q_2}{r^2} = \frac{mv^2}{r} \quad \text{—} (2)$$

$q_1 = e^-$ $q_2 = Ze$

$$r_n = 0.529 \frac{n^2}{Z} \text{ Å} = a_0 \frac{n^2}{Z}$$

TRICK

$$v = 2.2 \times 10^6 \frac{Z}{n} \text{ m/s}$$



Bohr's Model

Energy of Electron

$$E = Rhc\,\frac{Z^2}{n^2}$$

R is 'Rydberg Constant' $\approx 1.1 \times 10^{7}\ m^{-1}$

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

$1\text{eV} = 1.6 \times 10^{-19}$ J

Q) Calculate the energy of 1st,2nd Bohr's Orbit of hydrogen.

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

Z = 1

(a) Energy of 1st orbit

$$E = -13.6 \times 1\ \text{eV}$$

(b) Energy of 2nd orbit :

$$E = -13.6 \times 1/4$$

$$= -3.4\ \text{eV}$$

−0.85 eV — n = 4, 3rd excited state

−1.51 eV — n = 3, 2nd excited state

−3.4 eV — n = 2, 1st excited state

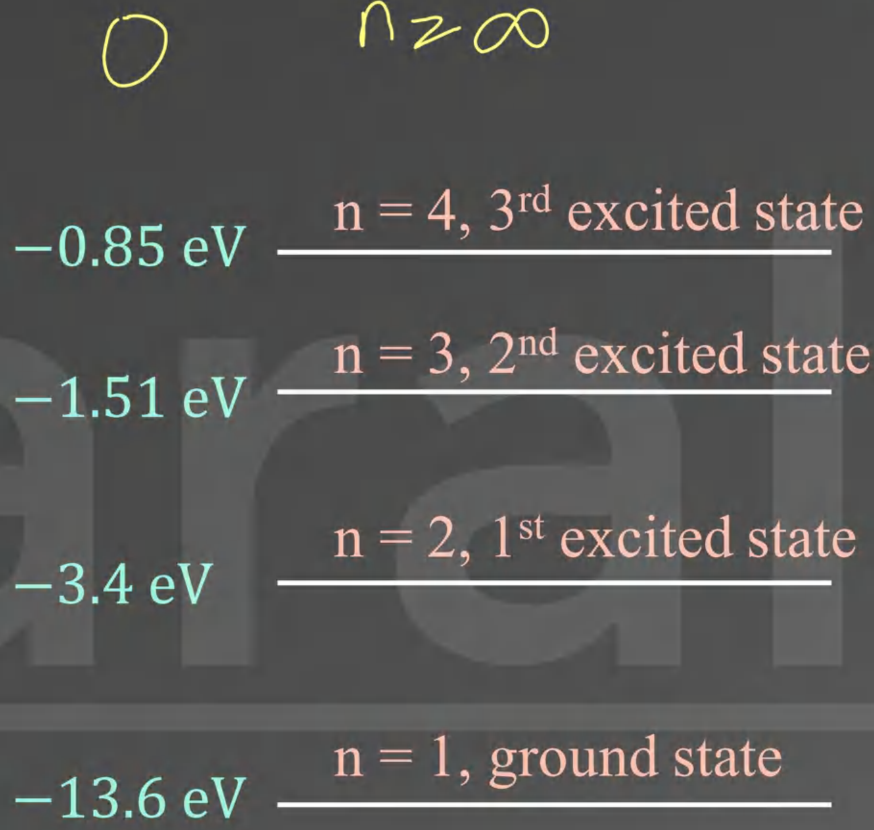
10.2 eV

−13.6 eV — n = 1, ground state

Energy required to move an electron from ground state of the atom to any other state of the atom is called excitation energy of that state.

Minimum energy required to move an electron from ground state to n = ∞ is called ionisation energy of the atom or ion.

Energy required to move an electron from any state to n = ∞ is called binding energy of that state.

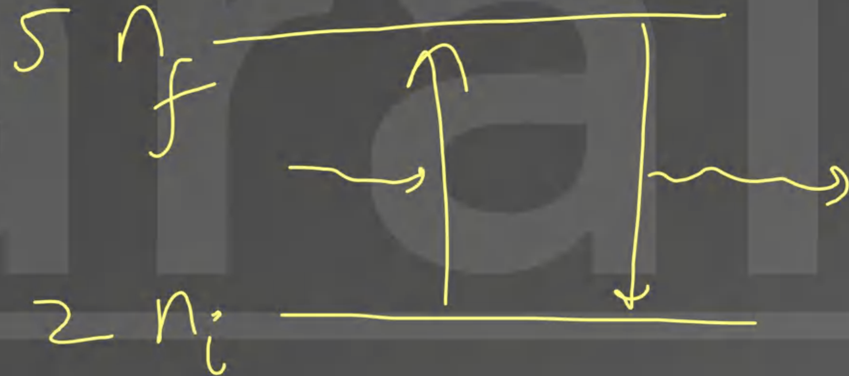


$$\Delta E = E_{\text{final state}} - E_{\text{initial state}}$$

$$\Delta E = Rhc\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]Z^2$$

$$13.6\left[\frac{1}{2^2} - \frac{1}{5^2}\right] =$$

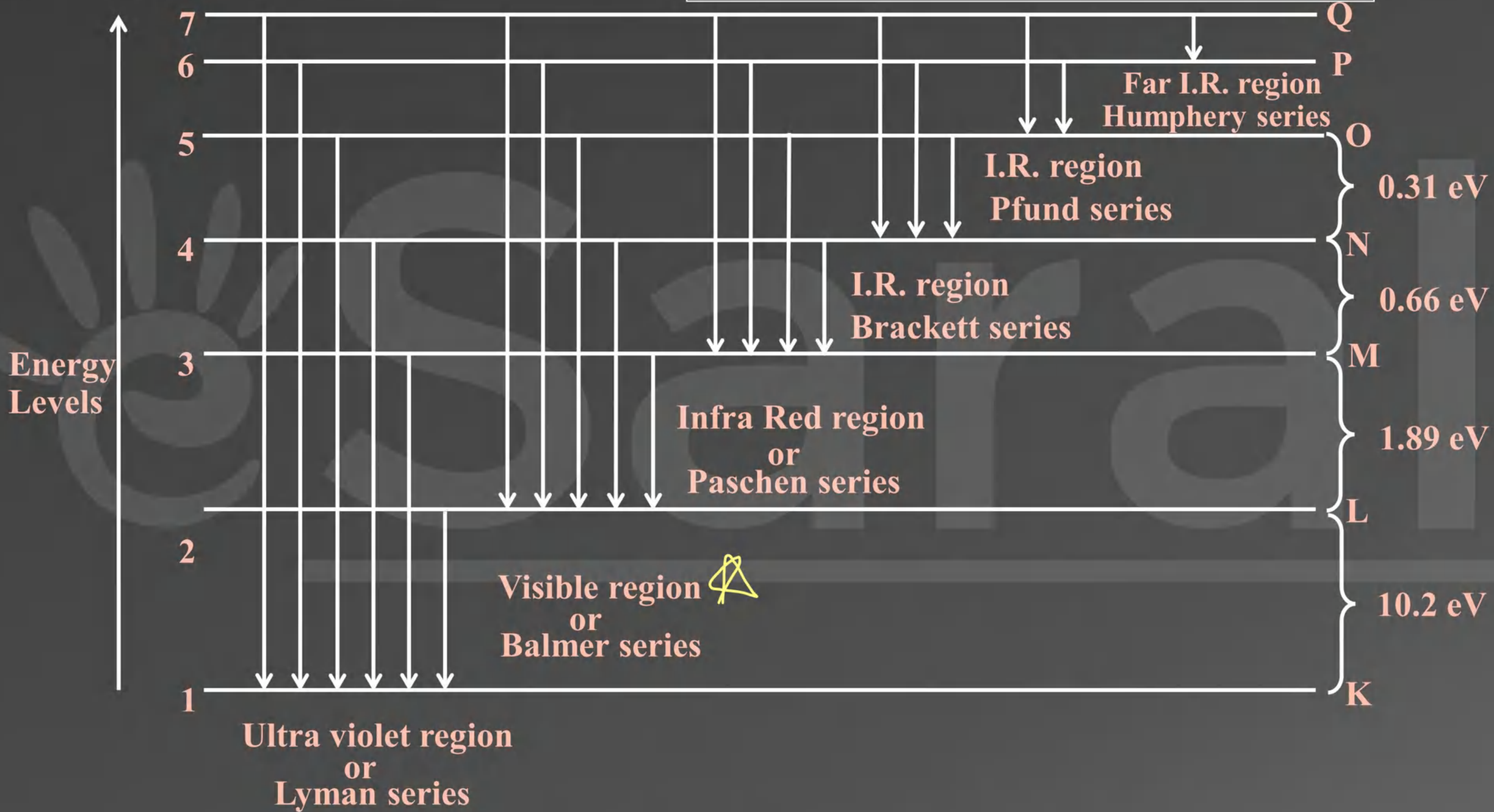
$$\boxed{\Delta E = 13.6\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]Z^2 \quad \text{(in eV)}}$$



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

Hydrogen Line Spectrum

Le Balm Pasta Bread Fund



Hydrogen Line Spectrum

First line of any series = α line

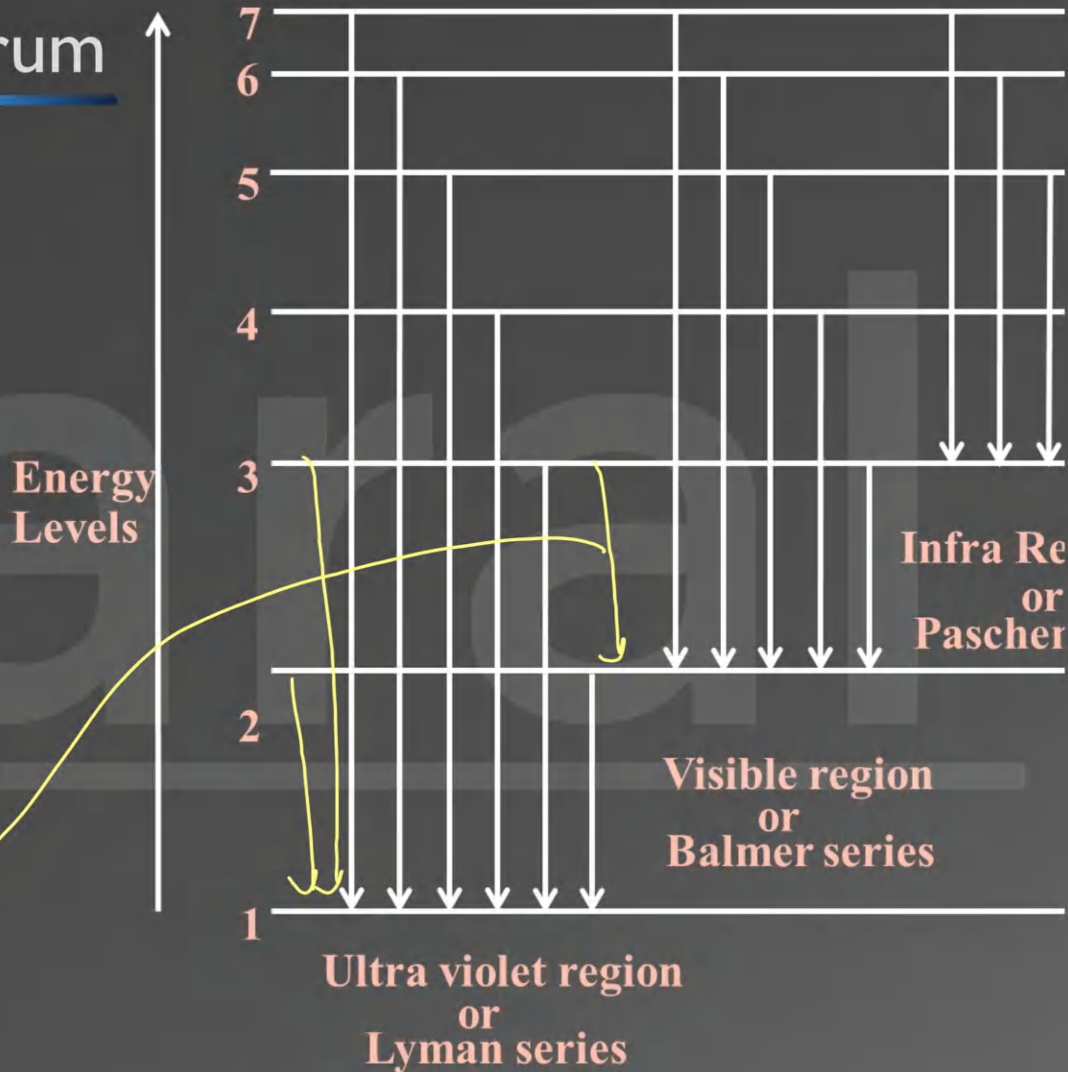
Second line of any series = β line

Third line of any series = γ line

$13.6\left[\frac{1}{2^2}-\frac{1}{3^2}\right]$

Lyman β

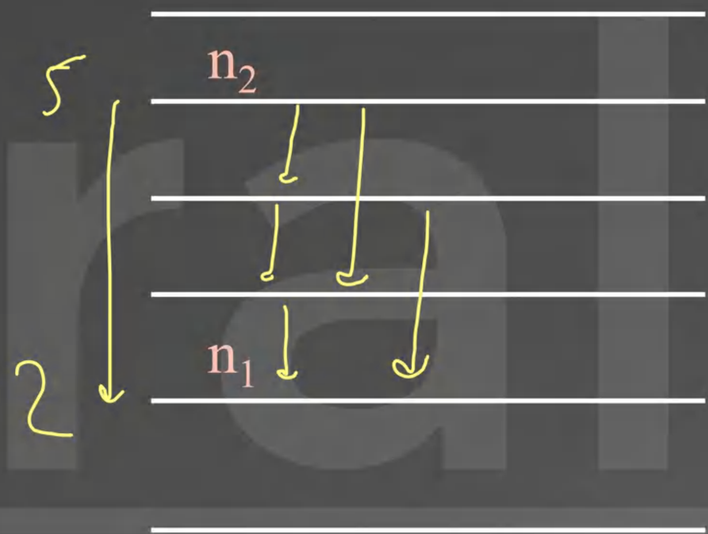
Balmer α



Total no. of emission lines between n_2 & n_1 $(n_2 > n_1)$ are

$$\frac{(n_2 - n_1 + 1)(n_2 - n_1)}{2}$$

$$\frac{(5-2+1)(5-2)}{2} = 6$$



A whole number of wavelength must fit into the circumference of the circle ($2\pi r$).

In n = 5 i.e. 5th Shell, Waves made = 5

$$2\pi r = 5\lambda$$

$2\pi r = n\lambda$

Rutherford's Gold Foil Experiment

1. Most of the α-particles (nearly 99.9%) went straight without suffering any deflection.
2. A few of them got deflected.

The distance of closest approach for α-particle is $r = \frac{2KZe^2}{K.E._\alpha}$

Bohr Model

Electrons can revolve only in those orbits whose angular momentum (mvr) is integral multiple of $\frac{h}{2\pi}$

$$\frac{k(Ze)e}{r^2} = \frac{mv^2}{r}$$

$$mvr = \frac{nh}{2\pi}$$

Radius of Bohr orbit:

$$r = \frac{n^2h^2}{4\pi^2 mKZe^2} \qquad r_n = 0.529\frac{n^2}{Z}\,\text{Å}$$

Bohr Radius 'a0' = 0.529 Å

Energy Of Electrons

$$E = -KE = \frac{PE}{2}$$

$$E = Rhc\,\frac{Z^2}{n^2} \qquad E = -13.6 \times \frac{Z^2}{n^2}\ \text{eV}$$

$1\text{eV} = 1.6 \times 10^{-19}$ J

R is 'Rydberg Constant' $\approx 1.1 \times 10^7\ m^{-1}$

Atomic Structure

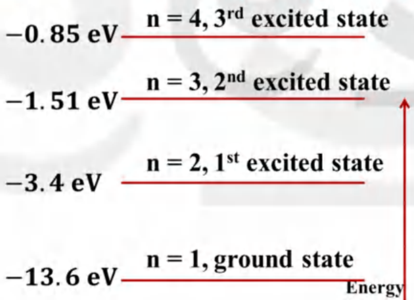
Energy During Transitions

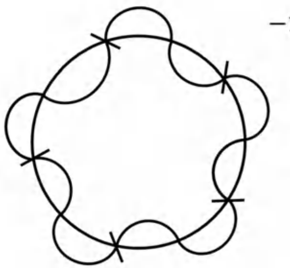
$\Delta E = E_{\text{final state}} - E_{\text{initial state}}$

$\Delta E =$ 1 (in eV)

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

For Hydrogen Atom

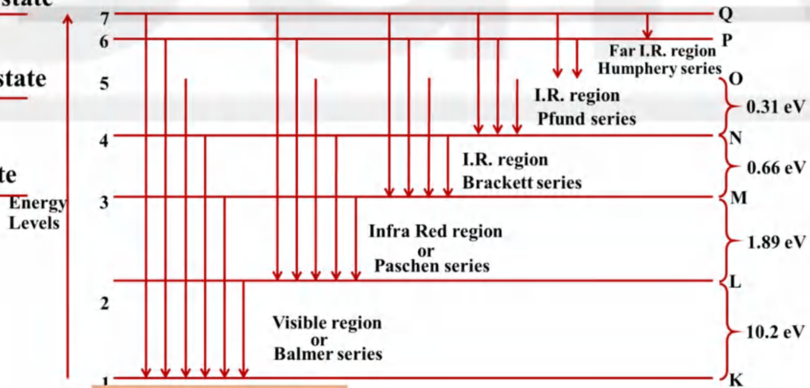




For n^{th} Shell

$2\pi r = n\lambda$

Hydrogen Line Spectrum

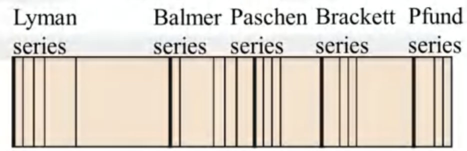


2

Velocity of electron:

$$v = \frac{2\pi KZe^2}{nh}$$

$$v = 2.2 \times 10^6\ \frac{Z}{n}\ \text{m/s}$$



Total no. of emission lines between n_2 & n_1 ($n_2 > n_1$) are

$$\frac{(n_2 - n_1 + 1)(n_2 - n_1)}{2}$$

eSaral

Bohr Model

Atomic Structure

Rutherford's Gold Foil Experiment

1. Most of the α-particles (nearly 99.9%) went straight without suffering any deflection.

2. A few of them got deflected.

The distance of closest approach for α-particle is $r = \dfrac{2KZe^2}{K.E._\alpha}$

Electrons can revolve only in those orbits whose angular momentum (mvr) is integral multiple of $\dfrac{h}{2\pi}$

$$\frac{k\,(Ze)\,e}{r^2} = \frac{mv^2}{r}$$

$$mvr = \frac{nh}{2\pi}$$

Radius of Bohr orbit:

$$r = \frac{n^2h^2}{4\pi^2 mKZe^2} \qquad r_n = 0.529\frac{n^2}{Z}\,\text{Å}$$

Bohr Radius 'a0' = 0.529 Å

Energy Of Electrons

$$E = -KE = \frac{PE}{2}$$

$$E = Rhc\,\frac{Z^2}{n^2} \qquad E = -13.6 \times \frac{Z^2}{n^2}\text{ eV}$$

$1\text{eV} = 1.6 \times 10^{-19}$ J

R is 'Rydberg Constant' $\approx 1.1 \times 10^7\ m^{-1}$

Energy During Transitions

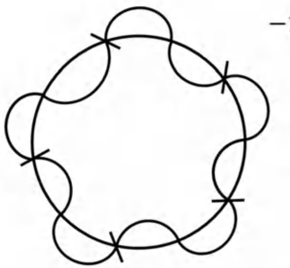
$$\Delta E = E_{\text{final state}} - E_{\text{initial state}}$$

$$\Delta E = 13.6\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]Z^2 \quad \text{(in eV)}$$

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

For Hydrogen Atom

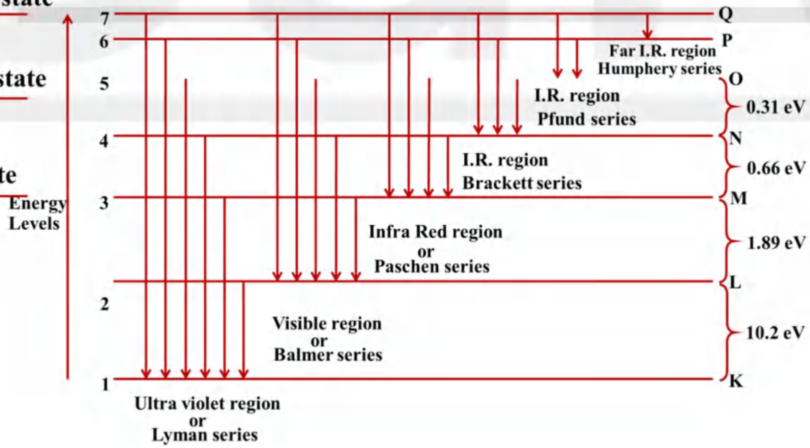
- −0.85 eV — n = 4, 3rd excited state
- −1.51 eV — n = 3, 2nd excited state
- −3.4 eV — n = 2, 1st excited state
- −13.6 eV — n = 1, ground state



For n^{th} Shell

$2\pi r = n\lambda$

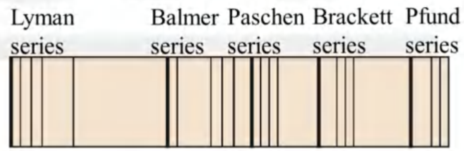
Hydrogen Line Spectrum



Velocity of electron:

$$v = \frac{2\pi KZe^2}{nh}$$

$$v = 2.2 \times 10^6\ \frac{Z}{n}\ \text{m/s}$$



Total no. of emission lines between n_2 & n_1 ($n_2 > n_1$) are

$$\frac{(n_2 - n_1 + 1)\,(n_2 - n_1)}{2}$$

Photoelectric Effect

Superfast Revision

Properties of Photon

Energy of a photon $E = \frac{hc}{\lambda} = h\nu$

Momentum of photon $P = \frac{h}{\lambda} = \frac{E}{c}$

$E = \frac{1242}{\lambda \text{ (in nm)}}$ in eV

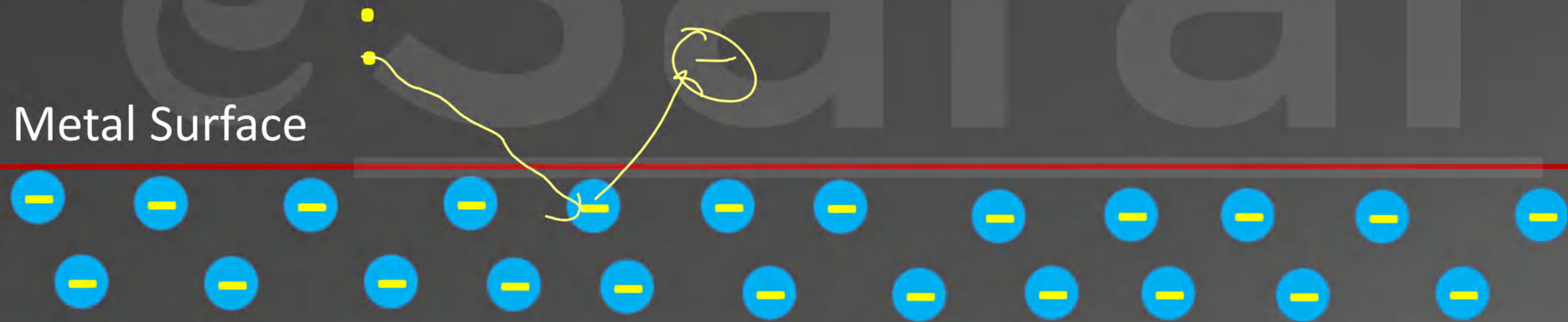
Planck's constant 'h' $= 6.626 \times 10^{-34}$ Js

$1\text{eV} = 1.6 \times 10^{-19}$ J

Photoelectric Effect

Phenomenon in which electrons are ejected when light is incident on surface is called **photoelectric effect.**

Ejected electrons are called **photo electrons.**



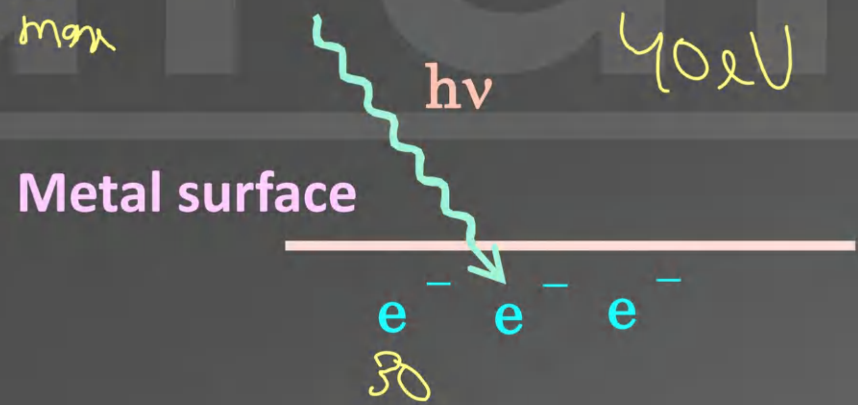
Photoelectric Effect

Minimum energy required to exit an electron from surface of the substance is called work function (Φ) of the substance.

$$0 \leq KE \leq h\nu - \phi$$

$$KE_{max} = h\nu - \phi$$

Einstein's equation



Photoelectric Effect

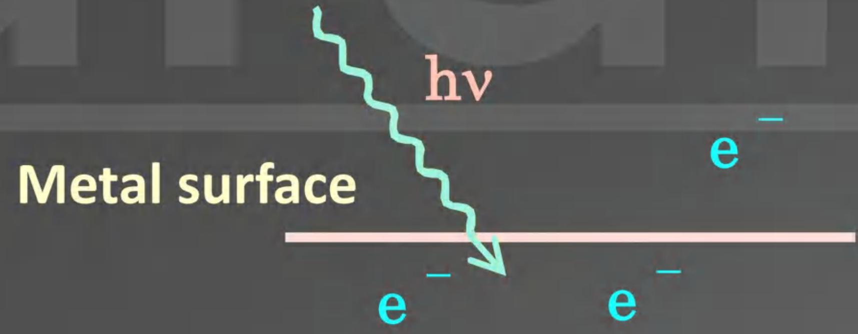
Minimum frequency for which electron just comes out is called threshold frequency (ν_0).

$$h\nu_0 = \phi$$

Photoelectric effect takes place for $\nu \geq \nu_0$.

$$KE_{max} = h\nu - \phi = h\nu - h\nu_0$$

$$KE_{max} = h(\nu - \nu_0)$$



Photoelectric Effect

Maximum wavelength for which e^- just comes out is called threshold wavelength (λ_0).

$$h\nu_0 = \frac{hc}{\lambda_0}$$

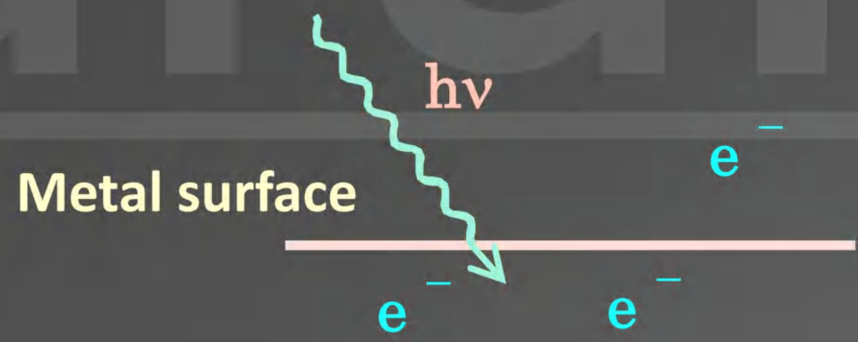
$h\nu_0$

$$\frac{hc}{\lambda_0} = \phi$$

Photoelectric effect will take place for $\lambda \leq \lambda_0$

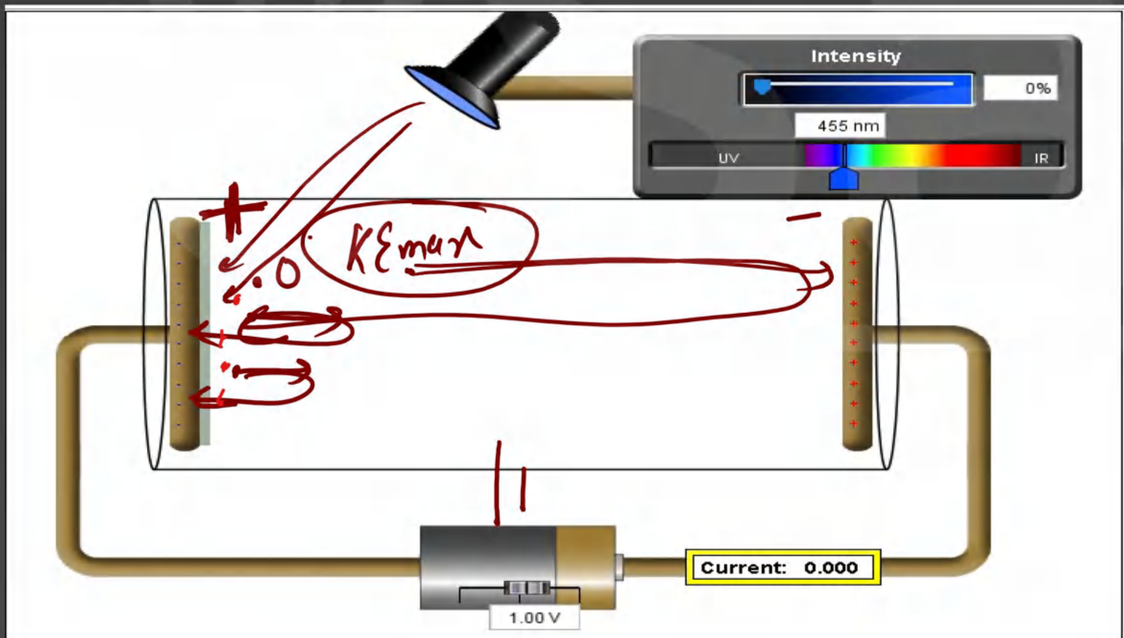
$$KE_{max} = \frac{hc}{\lambda} - \phi = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$

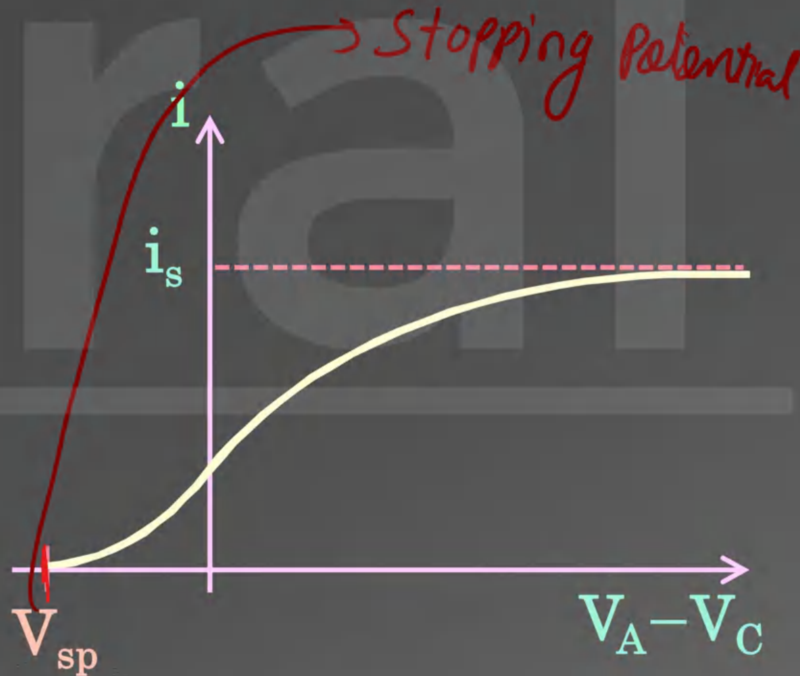
$$h\nu_0 = \frac{hc}{\lambda_0}$$



Photoelectric Effect

i_s : saturation current



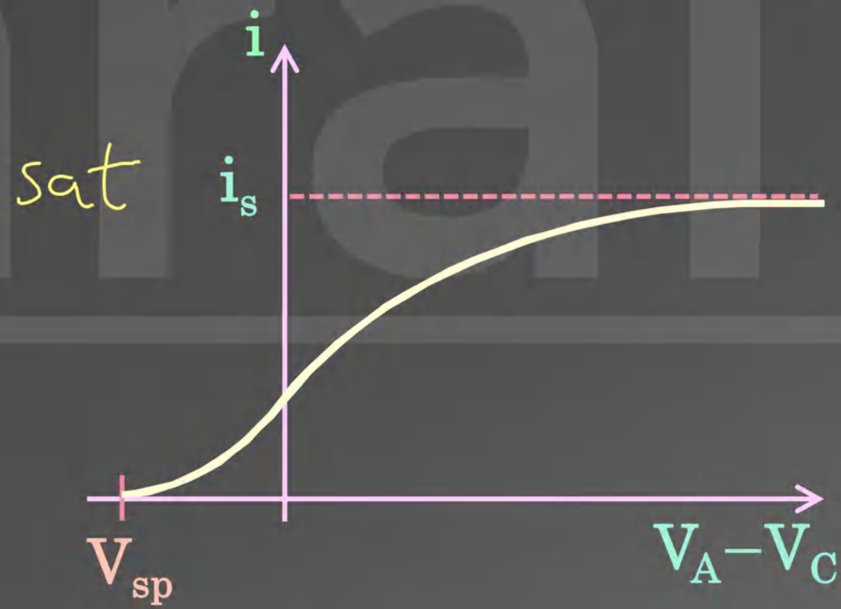


Photoelectric Effect

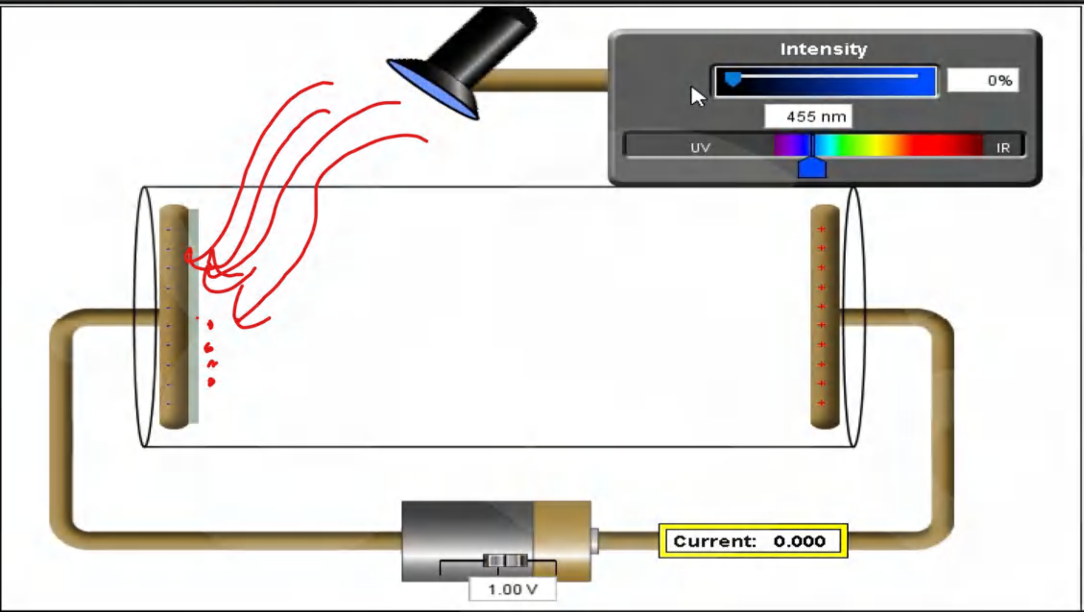
The value of $V_C - V_A$ at which photo current just stops is called Stopping Potential (V_{sp}).

The maximum value of photoelectric current is called saturation current.

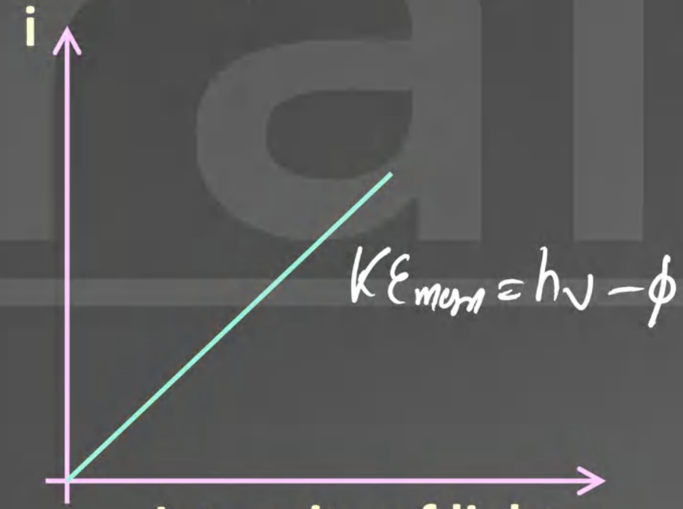
$$eV_{sp} = KE_{max} = h\nu - \phi$$



Photoelectric Effect



For $\nu \geq \nu_0$



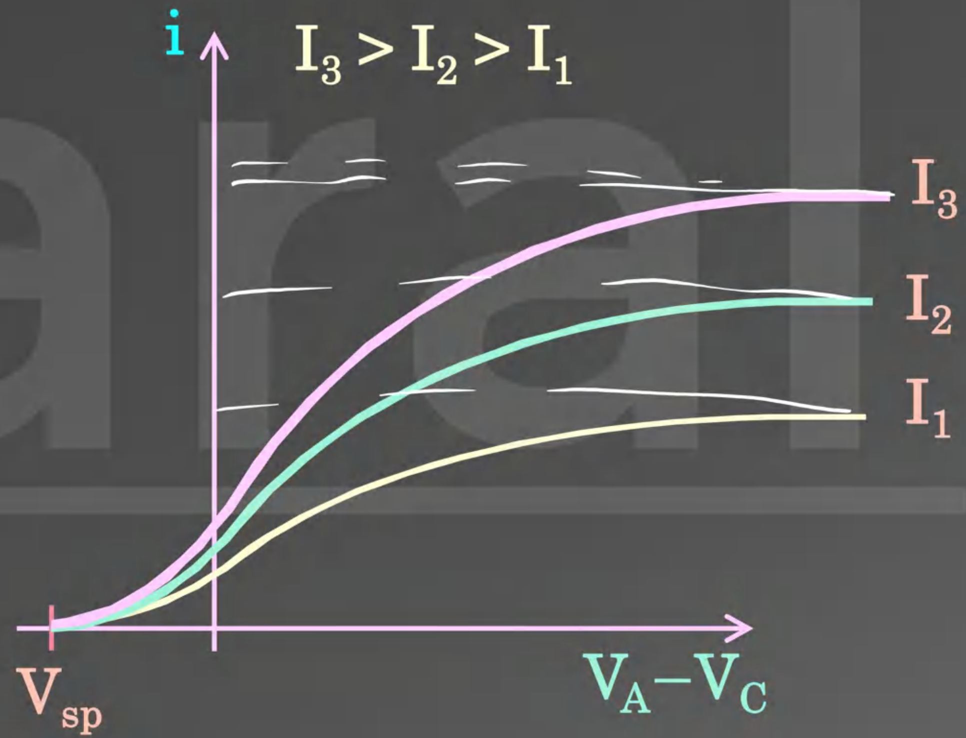
The number of photoelectrons emitted per second is directly proportional to the intensity of incident radiation

Photoelectric Effect

$$eV_{sp} = KE_{max} = h\nu - \phi$$

For a given frequency of incident radiation, the stopping potential is independent of its intensity.

Same metal



Photoelectric Effect

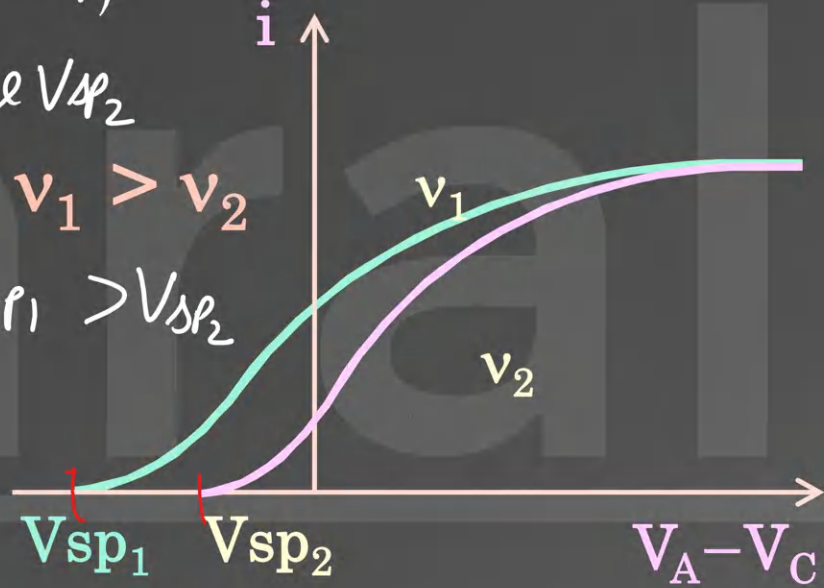
$\nu_1 > \nu_2$

$KE_{max} = h\nu_1 - \phi = eV_{sp_1}$

$\quad " \quad = h\nu_2 - \phi = eV_{sp_2}$

$\nu_1 > \nu_2$

$V_{sp_1} > V_{sp_2}$

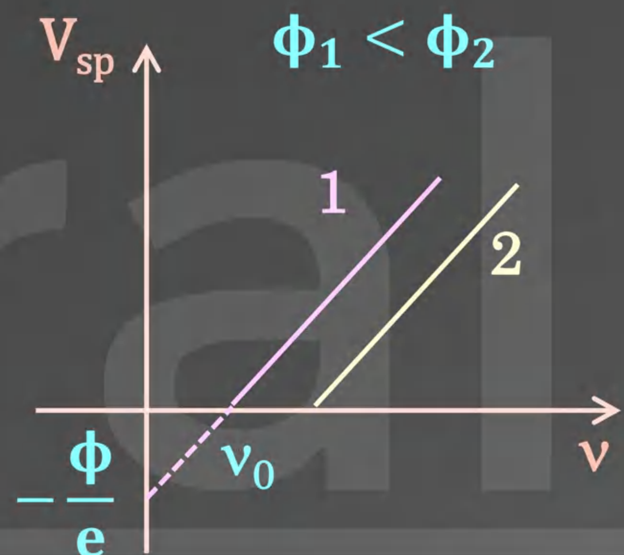


Graph between V_{sp} and ν

$$eV_{sp} = h\nu - \phi$$

$$V_{sp} = \left[\frac{h}{e}\right]\nu - \left[\frac{\phi}{e}\right]$$

slope $= \dfrac{h}{e}$ independent of metals



PHYSICS WAHI jo Deewana BANA DE

De Broglie Wavelength

$$\lambda = \frac{h}{p}$$

p → momentum

$$KE = \frac{p^2}{2m}$$

$$p = \sqrt{2m(KE)}$$

$$\lambda = \frac{h}{\sqrt{2m(KE)}}$$

→ p

$$KE = \frac{p^2}{2m}$$

α proton

De Broglie Wavelength

For an electron passed through potential difference V.

$$\lambda = \frac{h}{\sqrt{2m_e(eV)}}$$

$$\lambda = \sqrt{\frac{150}{V}}\,\text{Å} = \frac{12.27}{\sqrt{V}}\,\text{Å}$$

eV

10^{-10} m

$m_e = 9.1 \times 10^{-31}$ kg

Davisson and Germer Experiment

Davisson and Germer experiment confirms the wave nature of electrons and the de Broglie relation.

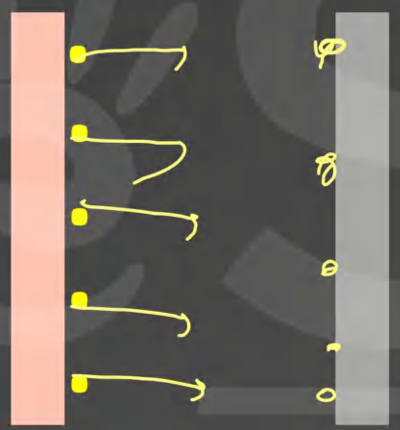
This experiment led to discovery of diffraction of electrons by crystals.

$$\lambda = \frac{12.27}{\sqrt{V}}\ \text{Å}$$

$$\lambda = \frac{1.227}{\sqrt{V}}\ \text{nm}$$

Q) Source is of power W. Find force exerted on wall if all photons are absorbed.

Source

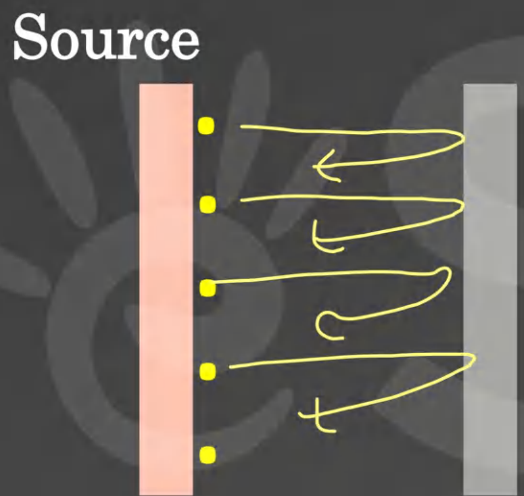


$$F = \frac{W}{c}$$

$P = F \times V$

$\frac{W}{c} = F$

b) Source is of power W. Find force exerted on wall if all photons are reflected.



$$\frac{2W}{c}$$

40% Abs

60% Reflect

(c) $F = \frac{2W}{c} \times \frac{60}{100} + \frac{W}{c} \times \frac{40}{100}$

De-Broglie wavelength

$\lambda = \frac{h}{p}$ $\quad \lambda = \frac{h}{\sqrt{2m\,K.E.}}$

For electron

1

eSaral

Particle of light is called as **'photon'**. It is packet of energy.

$E = \frac{hc}{\lambda} = h\nu = \frac{1242}{\lambda \text{ (in nm)}}$ in eV

Momentum of photon $P = \frac{h}{\lambda} = \frac{E}{c}$

Planck's constant 'h' $= 6.626 \times 10^{-34}$ Js

$1\text{eV} = 1.6 \times 10^{-19}$ J

Photon

Photoelectric Effect

$0 \le KE \le h\nu - \phi$

$(KE)_{max} = h\nu - \phi$ Einstein's Equation

$(KE)_{max}$ → Value between 0 to KE_{max}.

$h\nu$ → E_{photon}

ϕ → Work Function → Minimum energy required to exit an electron from surface of the substance is called work function (F) of the substance.

Threshold wavelength

Maximum wavelength for which e^- just comes out is called threshold wavelength (λ_0).

$\frac{hc}{\lambda_0} = \phi$ Photoelectric effect will take place for $\lambda \le \lambda_0$

$KE_{max} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$

Threshold frequency

Minimum frequency for which electron just comes out is called threshold frequency (ν_0).

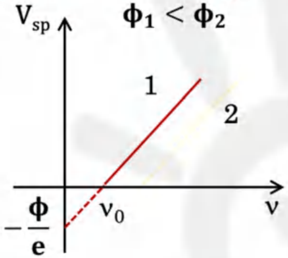
$h\nu_0 = \phi$

Photoelectric effect takes place for $\nu \ge \nu_0$.

$KE_{max} = h\nu - \phi = h\nu - h\nu_0$

$KE_{max} = h(\nu - \nu_0)$

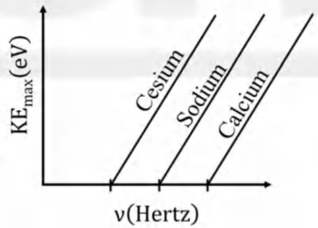
Graph between V_{sp} and n



$eV_{sp} = h\nu - \phi$

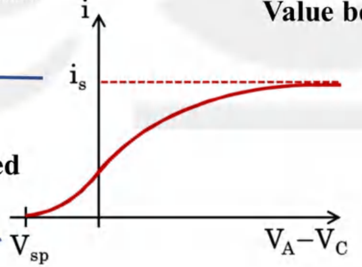
$V_{sp} = \left[\frac{h}{e}\right]\nu - \left[\frac{\phi}{e}\right]$

slope $= \frac{h}{e}$ independent of metals



Saturation Current i_s

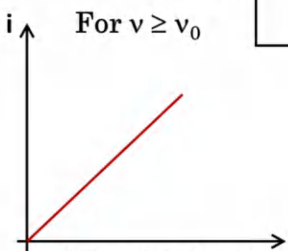
The maximum value of photoelectric current is called saturation current.

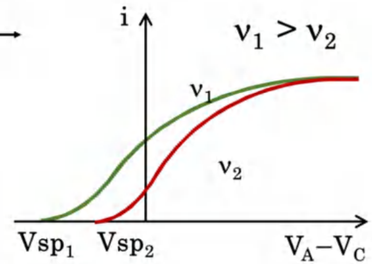


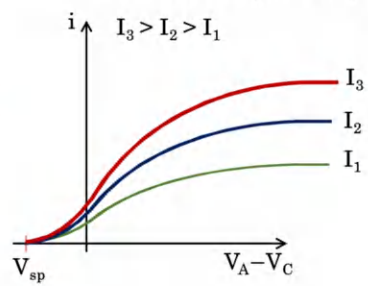
Stopping Potential V_{sp}

The value of $V_C - V_A$ at which photo current just stops is called Stopping Potential (V_{sp}).

2







Photoelectric Effect

De-Broglie wavelength

$\lambda = \frac{h}{p}$ $\lambda = \frac{h}{\sqrt{2m\,K.E.}}$

For electron

$\left(\lambda = \sqrt{\frac{150}{V}}\ \text{Å}\right)$

Photon

Particle of light is called as 'photon'. It is packet of energy.

$E = \frac{hc}{\lambda} = h\nu = \frac{1242}{\lambda\ (\text{in nm})}$ in eV

Momentum of photon $P = \frac{h}{\lambda} = \frac{E}{c}$

Planck's constant $'h' = 6.626 \times 10^{-34}$ Js

$1\text{eV} = 1.6 \times 10^{-19}$ J

Threshold wavelength

Maximum wavelength for which e^- just comes out is called threshold wavelength (λ_0).

$\frac{hc}{\lambda_0} = \phi$ Photoelectric effect will take place for $\lambda \le \lambda_0$

$KE_{max} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$

Threshold frequency

Minimum frequency for which electron just comes out is called threshold frequency (ν_0).

$h\nu_0 = \phi$

Photoelectric effect takes place for $\nu \ge \nu_0$.

$KE_{max} = h\nu - \phi = h\nu - h\nu_0$

$KE_{max} = h\,(\nu - \nu_0)$

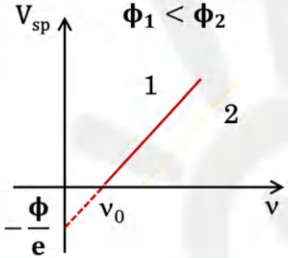
Photoelectric Effect

$0 \le KE \le h\nu - \phi$

$(KE)_{max} = h\nu - \phi$ Einstein's Equation

- $(KE)_{max}$ → Value between 0 to KE_{max}.
- $h\nu$ → E_{photon}
- ϕ → Work Function → Minimum energy required to exit an electron from surface of the substance is called work function (F) of the substance.

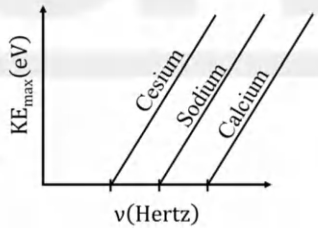
Graph between V_{sp} and n



$eV_{sp} = h\nu - \phi$

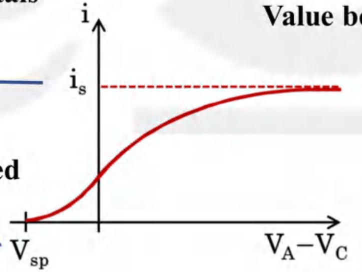
$V_{sp} = \left[\frac{h}{e}\right]\nu - \left[\frac{\phi}{e}\right]$

slope $= \frac{h}{e}$ independent of metals



Saturation Current i_s

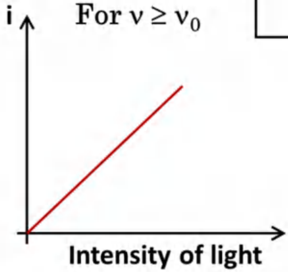
The maximum value of photoelectric current is called saturation current.

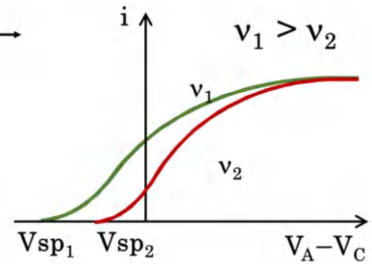


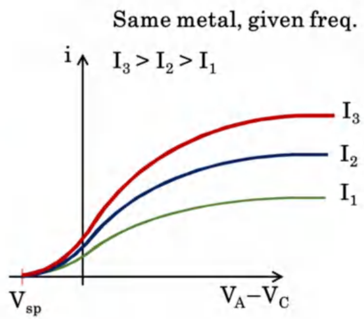
Stopping Potential V_{sp}

The value of $V_C - V_A$ at which photo current just stops is called Stopping Potential (V_{sp}).

$eV_{sp} = KE_{max}$







Nuclear Physics

Superfast Revision

Constituents of Nucleus

Protons and neutrons collectively known as Nucleons.

Atom is represented as

$^{A}_{Z}X$

- A → Mass Number (P+N)
- X → Symbol of Element
- Z → Atomic Number (P)

$^{1}_{1}H$ $^{4}_{2}He$

Number of neutrons $N = A - Z$

Size of Nucleus

Radius of a nucleus:

$$R = R_0 A^{1/3}$$

$$R_0 = 1.1 \times 10^{-15} \text{ m}$$

$$\text{Density of nucleus } (\rho) = \frac{\text{mass}}{\text{volume}}$$

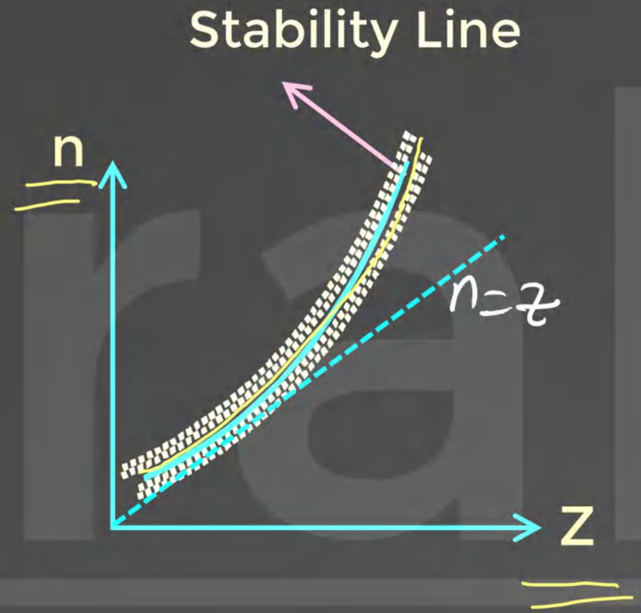
$$= \frac{m \times A}{\frac{4}{3}\pi R_0^3 A} = \frac{3\,m}{4\pi R_0^3}$$

ρ is independent of A

Nuclear Force

Force between nucleons which hold then together against coulomb repulsion (between protons) is **nuclear force.**

It is charge independent and very short range.



Atomic mass unit (amu)

$$1 \text{ amu (u)} = \frac{1}{12}(\text{mass of carbon}-12 \text{ atom})$$

$$1 \text{ amu} = 1.66 \times 10^{-27} \text{ kg}$$

$$\text{Mass of 1 proton} = 1.672 \times 10^{-27} \text{ kg} = 1.00727 \text{ u}$$

$$\text{Mass of 1 neutron} = 1.6749 \times 10^{-27} \text{ kg} = 1.0086 \text{ u}$$

$$\text{Mass of 1 electron} = 9.1 \times 10^{-31} \text{ kg} = 0.0055 \text{ u}$$

Mass and Energy

Mass m of a particle is equivalent to energy given by

$$E = mc^2$$ Rest Mass Energy of mass m

c → Speed of Light

$$1\ \text{amu} = 931\ \text{MeV}$$

$$= 931 \times 10^6\ \text{eV}$$

Nuclear Reactions

In nuclear reactions A and Z remains same on both sides.

$$^{A_1}_{Z_1}A + ^{A_2}_{Z_2}B \longrightarrow ^{A_3}_{Z_3}C + ^{A_4}_{Z_4}D$$

$$A_1 + A_2 = A_3 + A_4$$

$$Z_1 + Z_2 = Z_3 + Z_4$$

$$^{10}_{5}A + ^{2}_{1}H \rightarrow ^{4}_{2}X + ^{8}_{4}Y$$

$$^{A}_{Z}L \rightarrow ^{A}_{Z+1}Y + ^{0}_{-1}X$$

Mass Defect And Binding Energy of Nucleus

$$\underbrace{{}^{m}p}_{m_1} + \underbrace{{}^{n}n}_{m_2} \longrightarrow \underbrace{{}^{m+n}_{m}X}_{m_3} + \underbrace{\text{Energy}}_{\text{BE of nucleus}}$$

Mass defect $= \Delta m$

$= (m_1 + m_2) - m_3$

$BE = (\Delta m)c^2$

BE per nucleon $= \dfrac{(\Delta m)c^2}{A}$

$${}^{2}_{2}p + {}^{2}_{0}n \longrightarrow {}^{4}_{2}He$$

Q-value of a Reaction

$$A + B \longrightarrow C + D + \text{Energy}$$

$m_A \quad m_B \quad m_C \quad m_D$

Energy: Q-value of reaction

$$\text{Q-value} = [(m_A + m_B) - (m_C + m_D)]\,c^2$$

Δm

Q-value = it is difference of rest mass energy of reactants and products

(Q) Find the Q-value for the given reaction.

$$A \longrightarrow B + C + Q\text{-value}$$

25.1u 12 u 13 u

.1u

Sol. Q-value = (25.1–(12 + 13)) × 931

= 0.1 × 931 = 93.1 MeV

Q-value of a Reaction

React — Prod

A + B ⟶ C + D + Energy

BE = 950 MeV — BE = 1000 MeV

Q-value of reaction

50 MeV

If BE products > BE reactants then energy will be released

Q value = |BE products − BE reactants|

Q-value of a Reaction

$$A + B \longrightarrow C + D + \text{Energy}$$

Q-value of reaction

Q-value appears as kinetic energy

$$\text{Q-value} = (KE_C + KE_D) - (KE_A + KE_B)$$

Linear momentum is conserved.

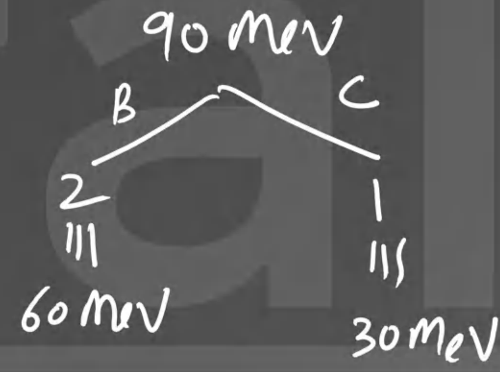
Q) ${}^{3A}_{Z}A \rightarrow {}^{A}_{Z_1}B + {}^{2A}_{Z-Z_1}C + Q\text{–value} \; (= 90\text{ MeV}).$

Initially A at rest. Find KE of B and C.

Sol.

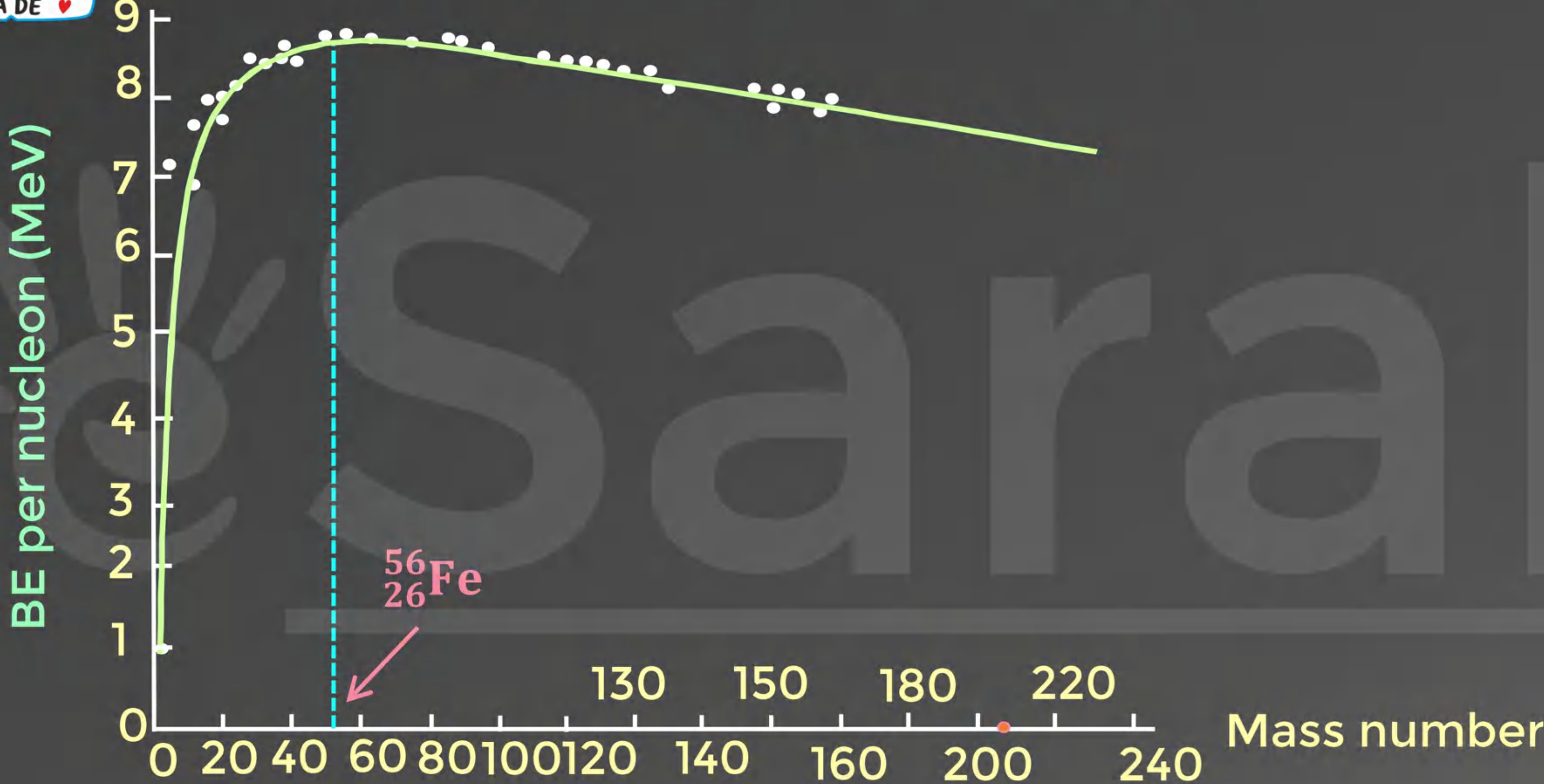
$3mv_A = mv_B + 2mv_C = 0$

$\Rightarrow v_B = -2v_C$



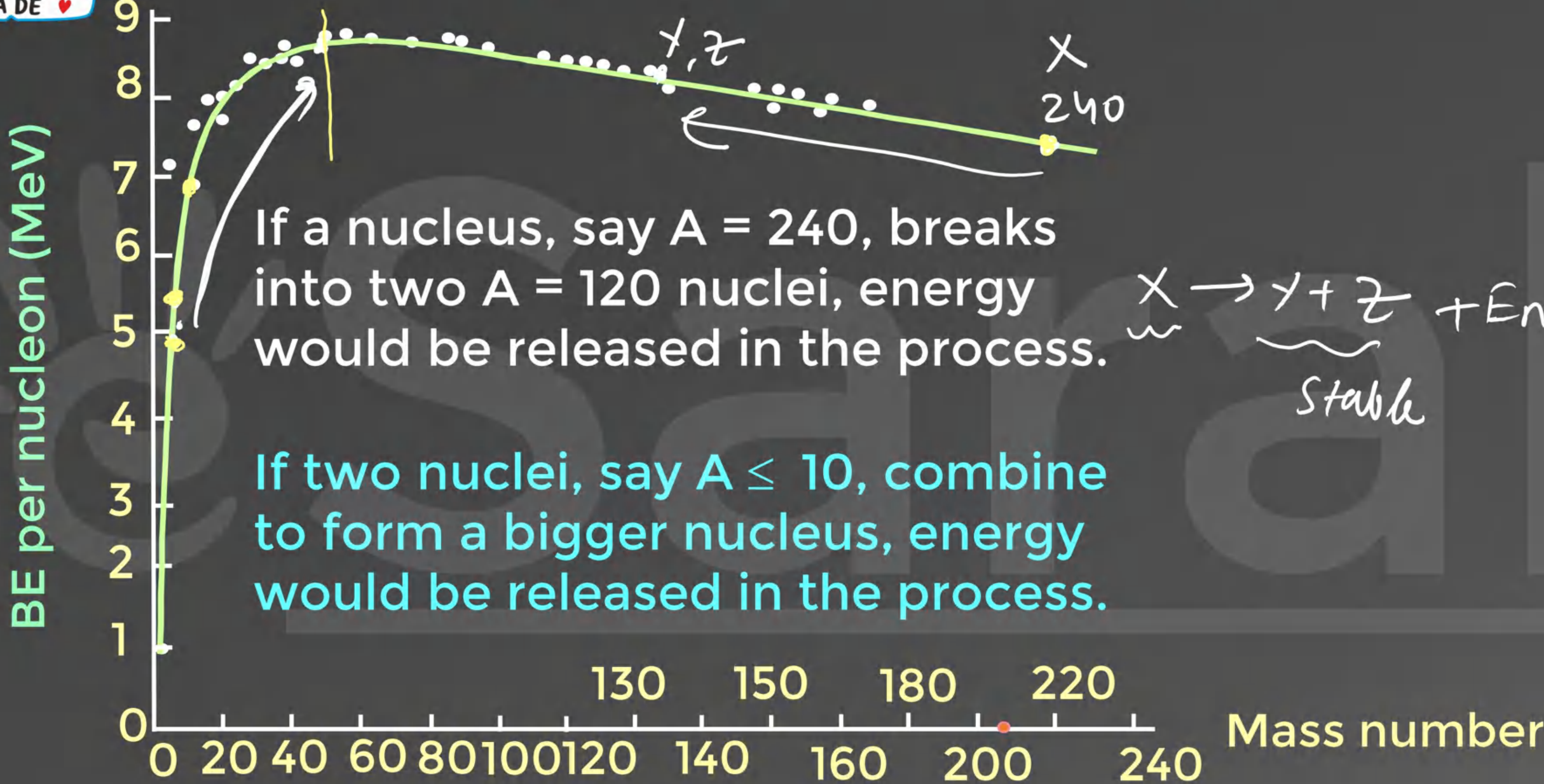
$KE_B = \frac{1}{2}m(2v)^2 = 2mv^2 \qquad \frac{1}{2}2mv^2 = mv^2$

Binding Energy/Nucleon Graph



Greater the BE/nucleon, more stable is nucleus.

Binding Energy/Nucleon Graph



If a nucleus, say A = 240, breaks into two A = 120 nuclei, energy would be released in the process.

If two nuclei, say A ≤ 10, combine to form a bigger nucleus, energy would be released in the process.

$X \rightarrow Y + Z$ + Energy

Stable

Radioactivity
Superfast Revision

α-particle: Doubly charged helium nucleus with 2 protons and 2 neutrons charge of + 2e.

$^{4}_{2}He$

β⁻ (electron): Mass m_e and charge –e $\quad {}^{0}_{-1}e^{-}$

β⁺ (positron): Mass m_e and charge +e $\quad {}^{0}_{+1}e^{+}$

γ-rays: Energetic photons having rest mass zero.

PHYSICS WAHI jo Deewana BANA DE

α-decay

$$\underset{\text{Mother Nuclei}}{\overset{m_x}{{}^{A}_{Z}X}} \longrightarrow \underset{\text{Daughter Nuclei}}{\overset{m_y}{{}^{A-4}_{Z-2}Y}} + \overset{m_{He}}{{}^{4}_{2}He} + \gamma - \text{rays}$$

Mass of Electron

$$\text{Q-value} = \{(m_x - Zm_e) - (m_y - (Z-2)\, m_e + m_Z - 2m_e)\}\, c^2$$

$$\text{Q-value} = (m_x - m_y - m_Z)\, c^2$$

Q-value = KE of products + Energy of γ-rays

(assuming reactants at rest)

β-decay

$^{1}_{0}n \longrightarrow ^{1}_{1}p + ^{0}_{-1}e^-$

$$^{A}_{Z}X \longrightarrow ^{A}_{Z+1}Y + ^{0}_{-1}e^- + \bar{\nu}$$

Antineutrino

TRICK

Antineutrino are like photons having rest mass zero.

They carry energy and momentum.

They are produced with electrons.

β-decay

$m_x \quad m_y \quad m_e$

$${}^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \bar{\nu}$$

$$Q \text{ value} = \{(m_x - Zm_e) - (m_y - (Z+1)\,m_e + m_e\}\,c^2$$

$$Q \text{ value} = (m_x - m_y)\,c^2$$

↓

Appears in antineutrino + KE of e^- and Y

$$0 < KE_{electron} < Q\text{-value}$$

$$0 \leq E_{\bar{\nu}} < Q\text{-value}$$

β^+-decay

$$\underset{m_x}{{}^{A}_{Z}X} \rightarrow \underset{m_y}{{}^{A}_{Z-1}Y} + \underset{m_e}{{}^{0}_{+1}e} + \underset{\text{Neutrino}}{\nu}$$

$$\text{Q-value} = \{(m_x - Zm_e) - (m_y - (Z-1)\,m_e)\}\,c^2$$

$$\text{Q-value} = (m_x - m_y - 2m_e)\,c^2$$

↓

Appears in neutrino + KE of e^+ and Y

β-decay is due to weak nuclear forces.

K – Capture

A proton in the nucleus combines with this electron and converts itself into a neutron.

In this process nucleus captures one of the atomic electrons from the K-shell.

A neutrino is also emitted in the process.

$${}^{A}_{Z}X + {}^{0}_{-1}e \rightarrow {}^{A}_{Z-1}Y + \nu$$

Q-value $= \{((m_x - Zm_e) + m_e) - (m_y - (Z-1)\,m_e)\}\,c^2$

Q-value $= (m_x - m_y)\,c^2$

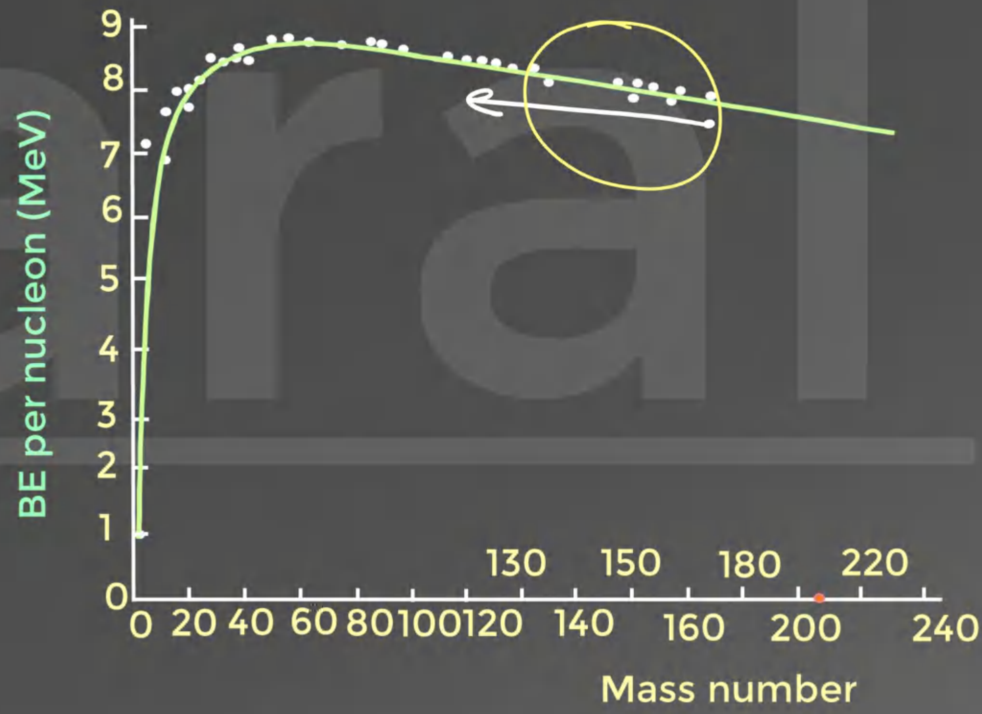
γ – Decay

$$ {}^{A}_{Z}X \longrightarrow {}^{A}_{Z}X + \gamma - \text{rays} $$

Excited De-Excited

Nuclear Fission

Heavy nuclei of mass number above 200 breaks up into two or more smaller nuclei in nuclear fission. Energy is released in this process.



Nuclear Fission

$$^{235}U + {}^{0}_{1}n \rightarrow X + Y + \underbrace{(2 \text{ or } 3) \text{ neutrons}}_{\text{avg}=2.5 \text{ neutrons}}$$

${}^{0}_{1}n$ = slow moving neutron i.e. thermal neutron

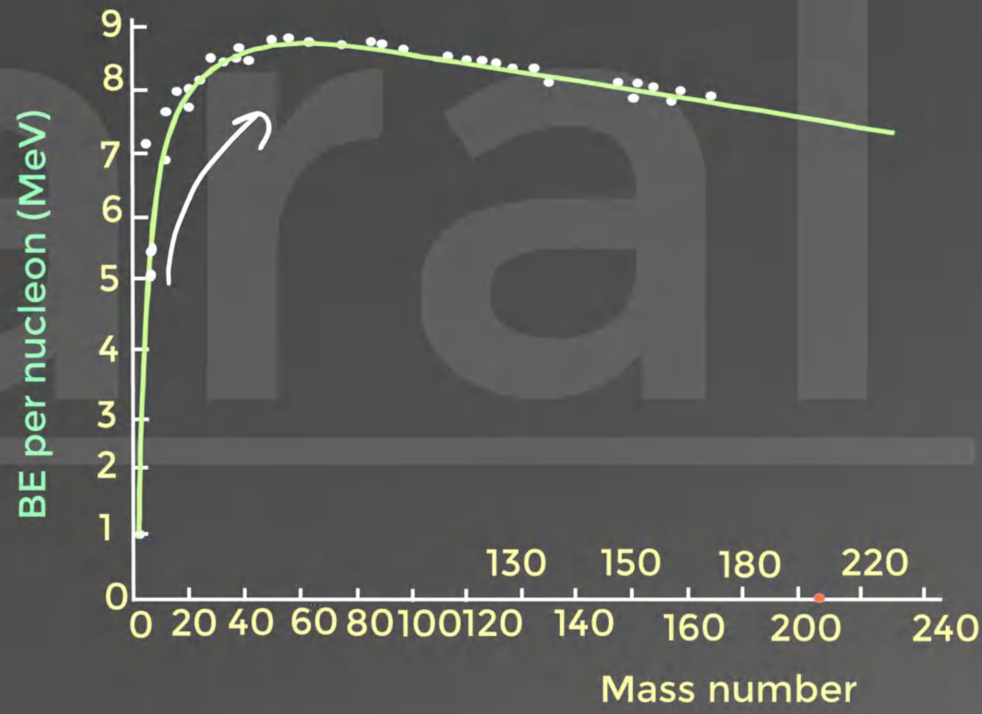
93% KE

7% γ-rays

Nuclear Fusion

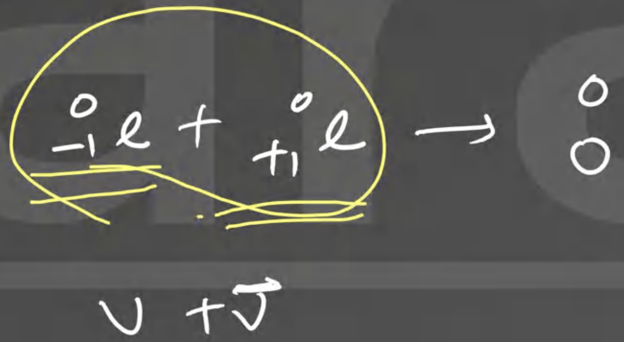
Sun

Light nuclei fuse (combine) together in nuclear fusion reaction. Energy released in fusion is much more than in fission per nucleon.



Anti Particle

A particle is called anti particle of other particle if on collision both can annihilate (destroy completely) and convert into energy.



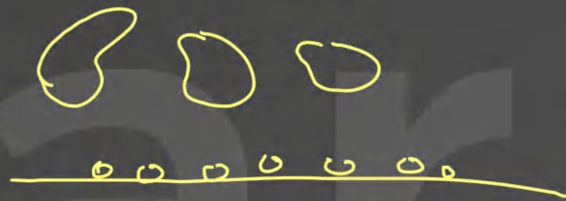
Electron and positron are anti particles.
Neutrino and antineutrino are anti particles.

Law of Radioactivity

TRICK

The decay is unaffected by change of physical condition.

Radioactive decay follows first order kinetics.



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

N = active nuclei at time t

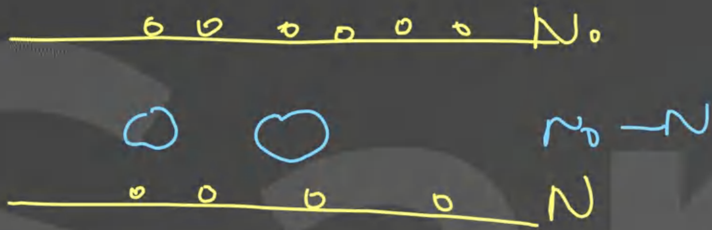
λ is decay constant of radioactive substance

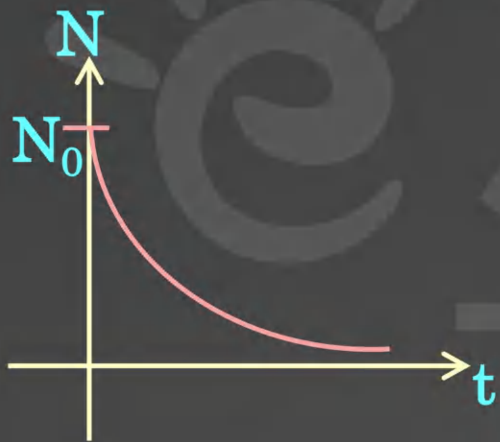
$$N = N_0 e^{-\lambda t}$$

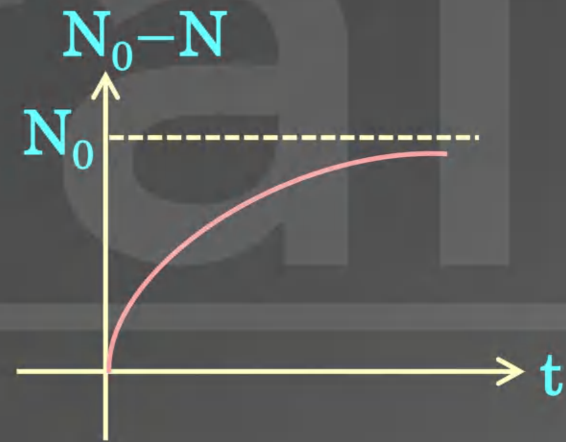
Law of Radioactivity

corn $\xrightarrow{\lambda}$ popcorn

	A	B
$t = 0$	N_0	0
$t = t$	N	$N_0 - N$







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

Number of nuclei decayed $= N_0 - N = N_0(1 - e^{-\lambda t})$

Half Life ($t_{1/2}$)

$\frac{1}{2}$

$t_{1/2} = 10\,sec$

$A \longrightarrow B$

	N_0	$\frac{N_0}{2}$	$\frac{N_0}{2^2}$	$\frac{N_0}{2^3}$
t	0	$10\,sec$	$20\,sec$	$30\,sec$

It is the time during which number of active nuclei reduce to half of initial value.

$$t_{1/2} = \frac{\ln 2}{\lambda} = \frac{0.693}{\lambda}$$

If at $t = 0$ no. of active nuclei N_0 then at t = half life the number of active nuclei will be $\frac{N_0}{2}$

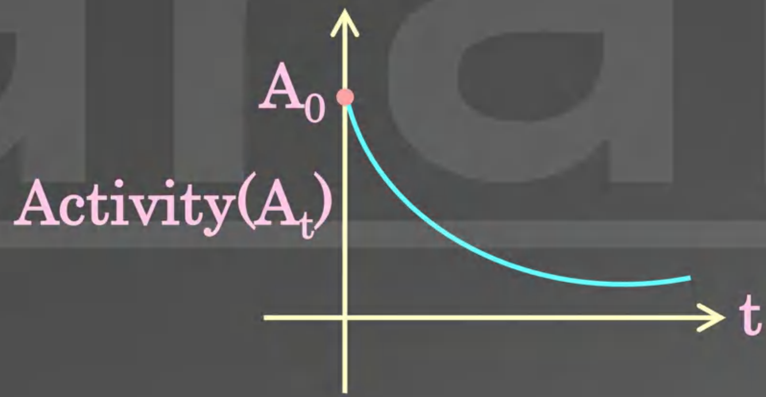
$$N = \frac{N_0}{2^{\frac{t}{t_{1/2}}}}$$

Activity

Activity is defined as rate of radioactive decay of nuclei.

$$A = \left| -\frac{dN}{dt} \right|$$

$$A = \lambda N$$



Activity

$$A = A_0 e^{-\lambda t}$$

Activity after time t ← A ; A_0 → Activity intially

λN

$A_0 = \lambda N_0 e^{-\lambda t}$

$$\Rightarrow A = \frac{A_0}{2^{t/t_{1/2}}}$$

SI unit is Becquerel (Bq)

1 becquerel (1 Bq)=1 decay/sec

Other unit is curie

$1\ \text{Ci} = 3.70 \times 10^{10}$ decays/sec

Activity per unit mass is called Specific Activity.

Average (Mean) Life

$$T_{avg} = \frac{\text{Sum of ages of all nuclei}}{\text{Number of nuclei}}$$

$$T_{avg} = \frac{1}{\lambda}$$

$$A \xrightarrow{\lambda_1} B \xrightarrow{\lambda_2} C\text{(stable products)}$$

$t = 0 \quad N_0 \qquad 0 \qquad 0$

$t = t \quad N_A \qquad N_B \qquad N_C$

$$\frac{dN_A}{dt} = -\lambda_1 N_A \qquad N_A = N_0 e^{-\lambda_1 t}$$

$$\frac{dN_B}{dt} = \lambda_1 N_A - \lambda_2 N_B$$

$$\frac{dN_C}{dt} = \lambda_2 N_B$$

Spontaneous Decay

$$A \xrightarrow{\lambda_1} B$$

$$A \xrightarrow{\lambda_2} C$$

$$\frac{dN_A}{dt} = -(\lambda_1 + \lambda_2)N_A$$

$N_B + N_C$

$N_0 - N_A = N_0(1 - e^{-(\lambda_1+\lambda_2)t})$

$$N_A = N_0 e^{-(\lambda_1+\lambda_2)t}$$

$\lambda_1 \longrightarrow N_B \qquad \frac{\lambda_1}{\lambda_1 + \lambda_2} N_0(1 - e^{-(\lambda_1+\lambda_2)t})$

$\lambda_2 \longrightarrow N_C \qquad \frac{\lambda_2}{\lambda_1 + \lambda_2} N_0(1 - e^{-(\lambda_1+\lambda_2)t})$

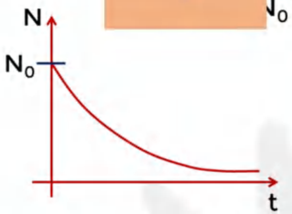
eSaral

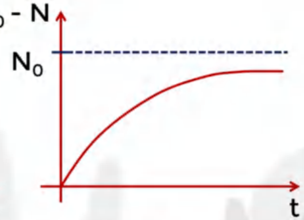
Spontaneous Decay

Law of Radioactivity

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

N = 1





Number of nuclei decayed $= N_0 - N$

$= N_0(1 - e^{-\lambda t})$

Half Life ($T_{1/2}$)

$T_{1/2} =$ 2

$$N = \frac{N_0}{2^{\frac{t}{t_{1/2}}}}$$

Mean or Average Life (T_a)

$$T_{avg} = \frac{\text{Sum of ages of all nuclei}}{\text{Number of nuclei}}$$

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

$A \xrightarrow{\lambda_1} B \quad A \xrightarrow{\lambda_2} C \quad \frac{dN_A}{dt} = -(\lambda_1 + \lambda_2)N_A$

$N_A = N_0 e^{-(\lambda_1+\lambda_2)t}$

- $\lambda_1 \longrightarrow N_B \quad \frac{\lambda_1}{\lambda_1 + \lambda_2} N_0(1 - e^{-(\lambda_1+\lambda_2)t})$
- $\lambda_2 \longrightarrow N_C \quad \frac{\lambda_2}{\lambda_1 + \lambda_2} N_0(1 - e^{-(\lambda_1+\lambda_2)t})$

Spontaneous decay of unstable nuclei is called radioactivity.

Radioactivity

γ – Decay

$${}^A_ZX \longrightarrow {}^A_ZX + \gamma - \text{rays}$$

K-capture

$${}^A_ZX + {}^{0}_{-1}e \rightarrow {}^{A}_{Z-1}Y + \nu$$

Q-value $= (m_x - m_y)\, c^2$

Nuclear Fission

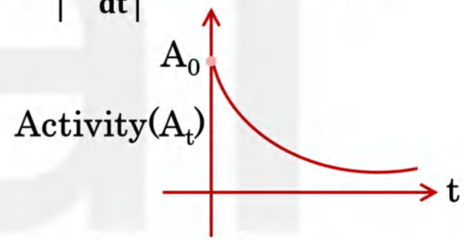
$${}^{235}U + {}^0_1n \rightarrow X + Y + \underbrace{(2 \text{ or } 3)\text{ neutrons}}_{avg=2.5\text{ neutrons}}$$

Nuclear Fusion

Light nuclei fuse (combine) together in nuclear fusion reaction. Energy released in fusion is much more than in fission per nucleon.

Activity

$A = \left|-\frac{dN}{dt}\right| \qquad A = \lambda N$



$\Rightarrow A = \frac{A_0}{2^{t/t_{1/2}}} \qquad A = A_0 e^{-\lambda t}$

SI unit is Becquerel (Bq)

1 becquerel (1 Bq)=1 decay/sec

Other unit is curie

1 Ci $= 3.70 \times 10^{10}$ decays/sec

α- decay

$$\underset{m_x}{{}^A_ZX} \longrightarrow \underset{m_y}{{}^{A-4}_{Z-2}Y} + + \underset{m_{He}}{{}^4_2He} + \gamma - \text{rays}$$

Q-value $= (m_x - m_y - m_Z)\, c^2$

Q-value = KE of products + Energy of γ-rays

β^- Decay

$${}^A_ZX \longrightarrow {}_{Z+1}^{A}Y + {}^{0}_{-1}e + \bar{\nu}$$

Q value $= (m_x - m_y)\, c^2$

$0 < KE_{electron} <$ Q-value

$0 \le E_{\bar{\nu}} <$ Q−value

β^+-decay

$$\underset{m_x}{{}^A_ZX} \rightarrow \underset{m_y}{{}^{A}_{Z-1}Y} + \underset{m_e}{{}^{0}_{+1}e} + \nu$$

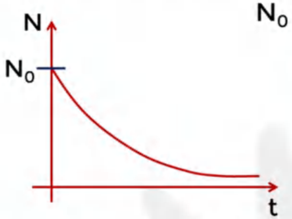
Q-value $= (m_x - m_y - 2m_e)\, c^2$

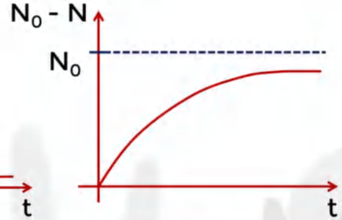
Spontaneous Decay

Law of Radioactivity

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

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





Number of nuclei decayed $= N_0 - N$

$= N_0(1 - e^{-\lambda t})$

$$A \xrightarrow{\lambda_1} B \qquad A \xrightarrow{\lambda_2} C \qquad \frac{dN_A}{dt} = -(\lambda_1 + \lambda_2)N_A$$

$$N_A = N_0 e^{-(\lambda_1+\lambda_2)t}$$

$\lambda_1 \longrightarrow N_B \qquad \dfrac{\lambda_1}{\lambda_1+\lambda_2} N_0\left(1 - e^{-(\lambda_1+\lambda_2)t}\right)$

$\lambda_2 \longrightarrow N_C \qquad \dfrac{\lambda_2}{\lambda_1+\lambda_2} N_0\left(1 - e^{-(\lambda_1+\lambda_2)t}\right)$

Spontaneous decay of unstable nuclei is called radioactivity.

Radioactivity

Nuclear Fission

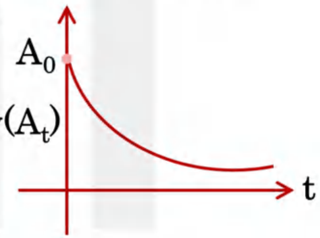
$$^{235}U + {}^{0}_{1}n \rightarrow X + Y + \underbrace{(2 \text{ or } 3) \text{ neutrons}}_{avg=2.5 \text{ neutrons}}$$

Nuclear Fusion

Light nuclei fuse (combine) together in nuclear fusion reaction. Energy released in fusion is much more than in fission per nucleon.

Activity

$$A = \left|-\frac{dN}{dt}\right| \qquad A = \lambda N$$



$$\Rightarrow A = \frac{A_0}{2^{t/t_{1/2}}} \qquad A = A_0 e^{-\lambda t}$$

SI unit is Becquerel (Bq)

1 becquerel (1 Bq)=1 decay/sec

Other unit is curie

1 Ci = 3.70×10^{10} decays/sec

Half Life ($T_{1/2}$)

$$T_{1/2} = \frac{\ln 2}{\lambda}$$

$$N = \frac{N_0}{2^{\frac{t}{t_{1/2}}}}$$

Mean or Average Life (T_a)

$$T_{avg} = \frac{\text{Sum of ages of all nuclei}}{\text{Number of nuclei}}$$

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

γ – Decay

$${}^{A}_{Z}X \longrightarrow {}^{A}_{Z}X + \gamma - \text{rays}$$

K-capture

$${}^{A}_{Z}X + {}^{0}_{-1}e \rightarrow {}^{A}_{Z-1}Y + \nu$$

Q-value $= (m_x - m_y)\, c^2$

α- decay

$$\overset{m_x}{{}^{A}_{Z}X} \longrightarrow \overset{m_y}{{}^{A-4}_{Z-2}Y} + + \overset{m_{He}}{{}^{4}_{2}He} + \gamma - \text{rays}$$

Q-value $= (m_x - m_y - m_Z)\, c^2$

Q-value = KE of products + Energy of γ-rays

β^- Decay

$${}^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \bar{\nu}$$

Q value $= (m_x - m_y)\, c^2$

$0 < KE_{electron} <$ Q-value

$0 \le E_{\bar{\nu}} <$ Q−value

β^+-decay

$$\overset{m_x}{{}^{A}_{Z}X} \rightarrow \overset{m_y}{{}^{A}_{Z-1}Y} + \overset{m_e}{{}^{0}_{+1}e} + \nu$$

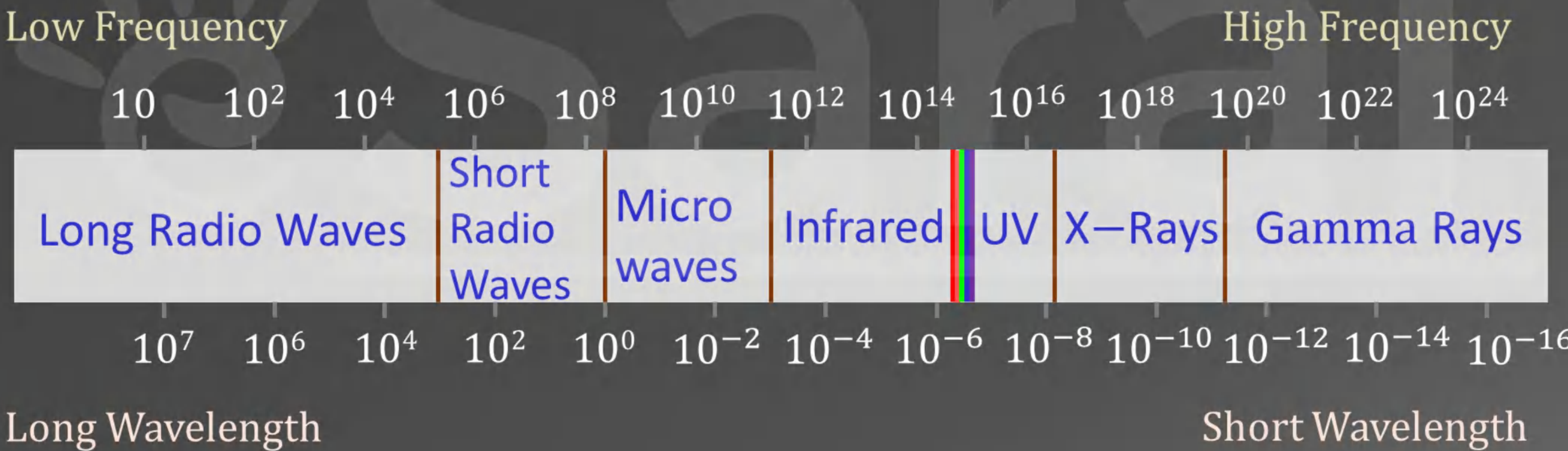
Q-value $= (m_x - m_y - 2m_e)\, c^2$

X-rays

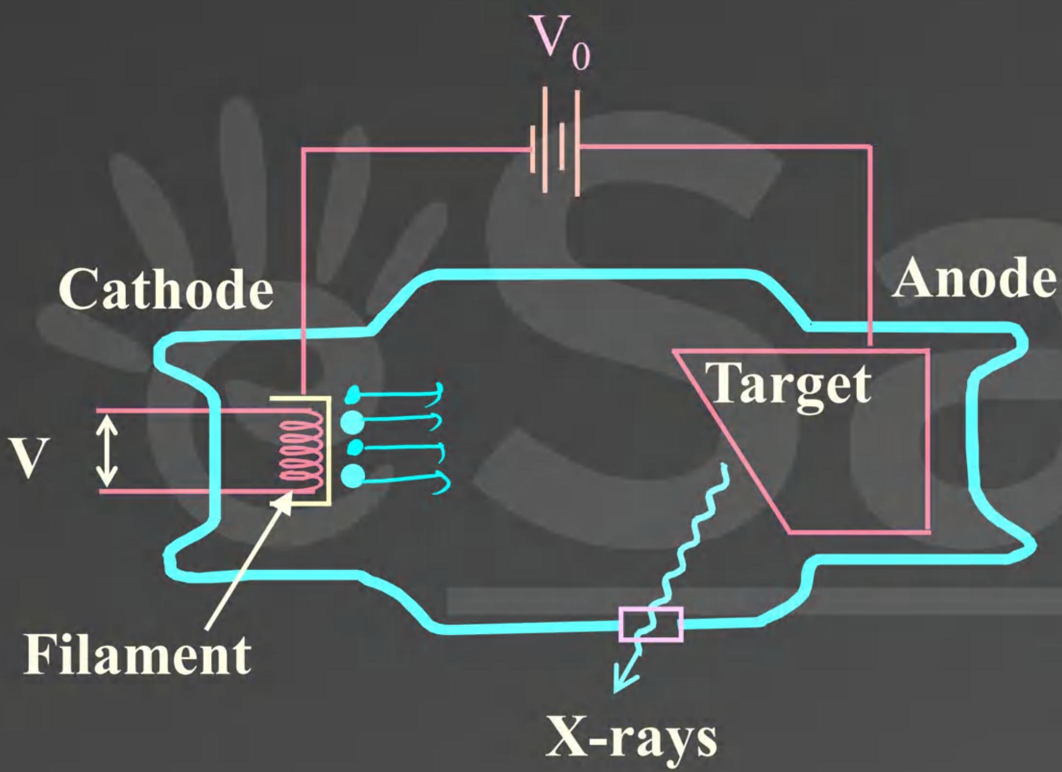
Superfast Revision

X-Rays

X-rays are electromagnetic waves having wavelength between 10^{-3} nm to 1 nm.



Coolidge Tube

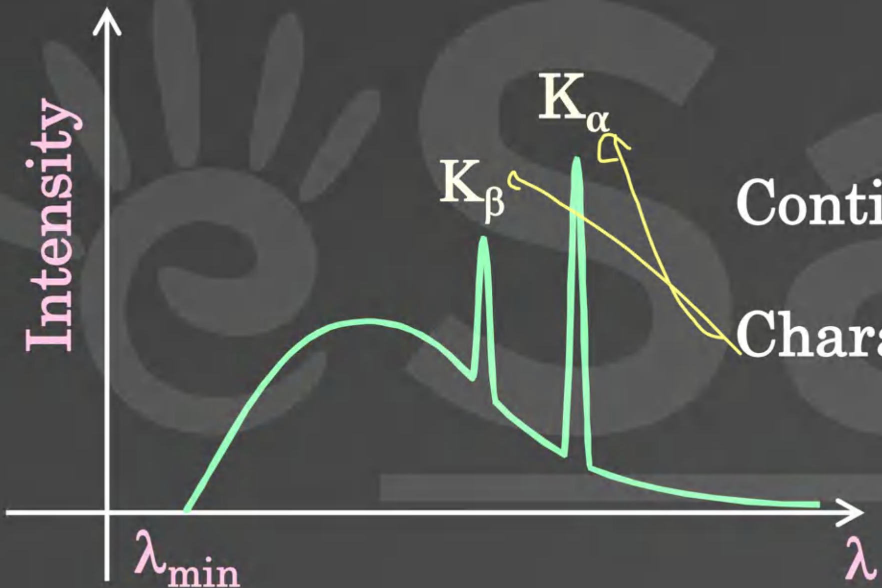


The filament is heated electrically and it emits electrons by Thermionic Emission.

Due to high potential difference (V_0) between anode and cathode these electrons accelerates and reach anode at high speed.

X-rays are produced as electrons collide with target material (Anode).

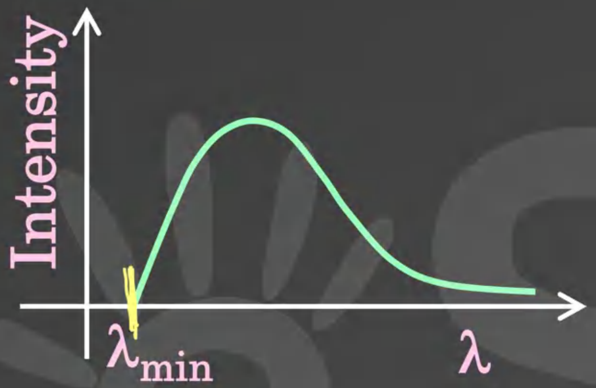
Analysis of X-rays



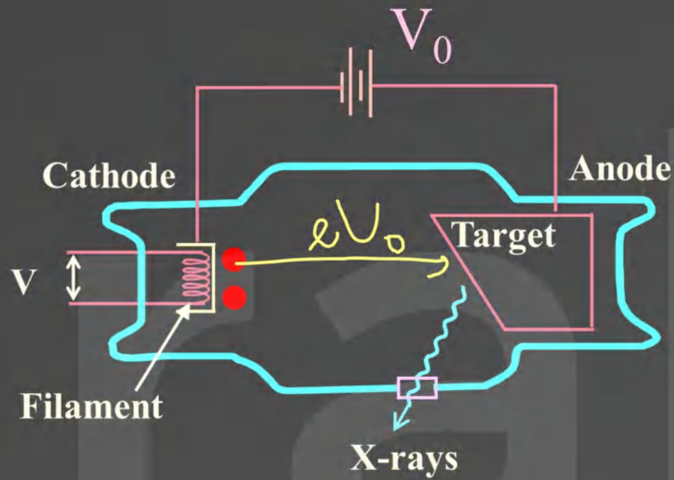
Continuous X-rays

Characteristic X-rays

Continuous X-rays



$eV_0 = \frac{hc}{\lambda_{min}}$

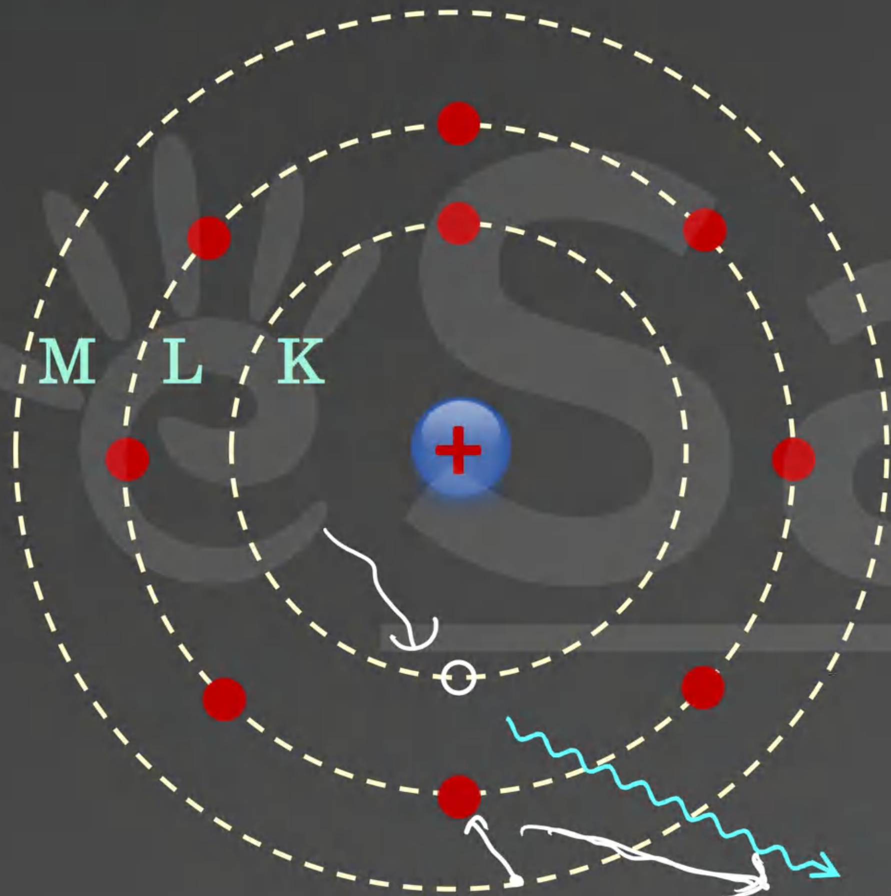


Minimum wavelength below which no X-rays is emitted is called Cutoff wavelength or Threshold wavelength.

$$\lambda_{min} = \frac{hc}{eV_0}$$

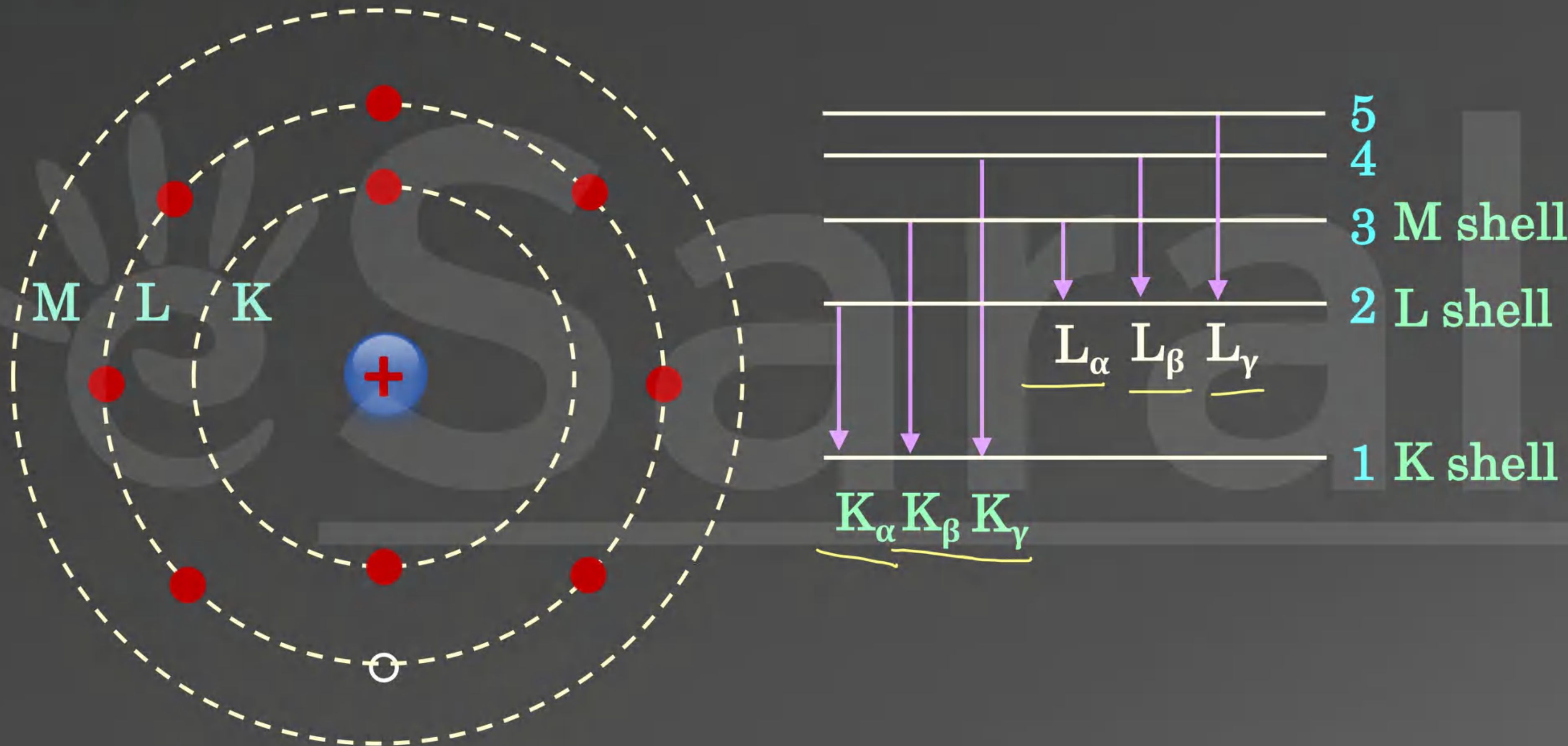
On ↑ filament voltage, number of electrons emitted ↑ (i.e. filament current ↑). This ↑ intensity of X-rays, keeping λ_{min} unchanged.

Characteristic X-ray



These are emitted when electron from cathode, knocks out an inner electron from target material and then it's position is filled by higher energy level electron.

Characteristic X-ray

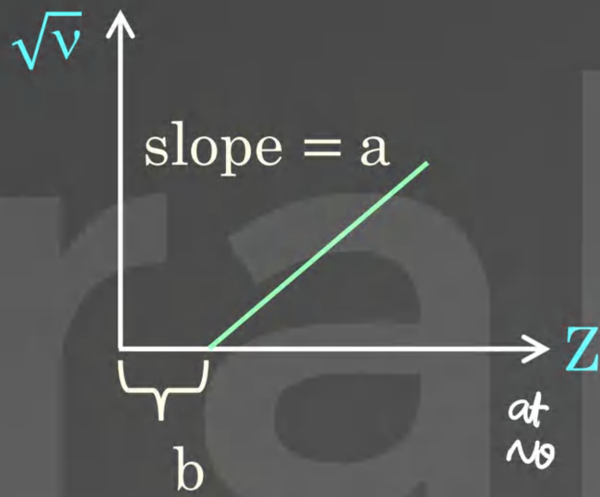


Moseley's Law

According to this law, frequency of radiation emitted (ν) is related to atomic number (Z).

$$\sqrt{\nu} = a\,(Z - b)$$

where a & b are constants



Moseley's Law

$$E = h\nu = Rhc\,Z^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

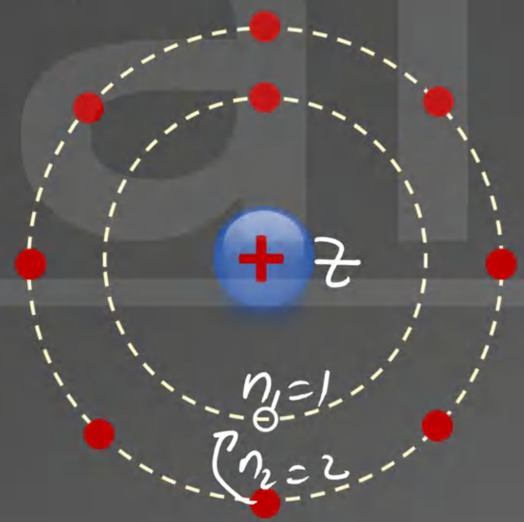
Z_{eff} = $(Z-1)$

For K_α : $n_1=1,\ n_2=2$

$$\sqrt{\nu} = \sqrt{\frac{3}{4}Rc}\,(Z-1)$$

For K_α : b=1

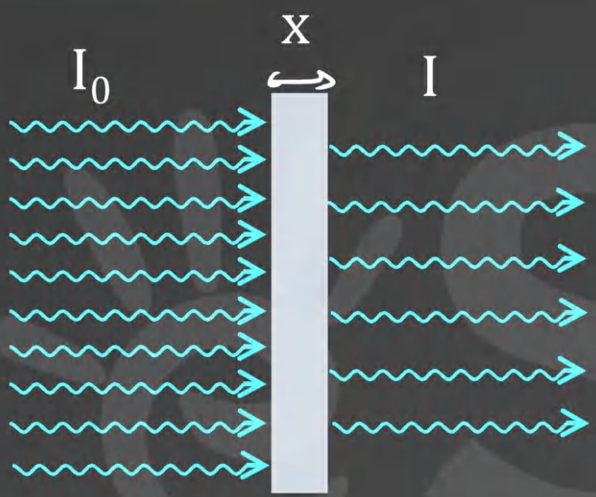
Shielding Effect



Uses of X-rays

- Radiography
- Determining Crystal Structure
- Treatement of Cancer
- Engineering Applications

Absorption of X-rays

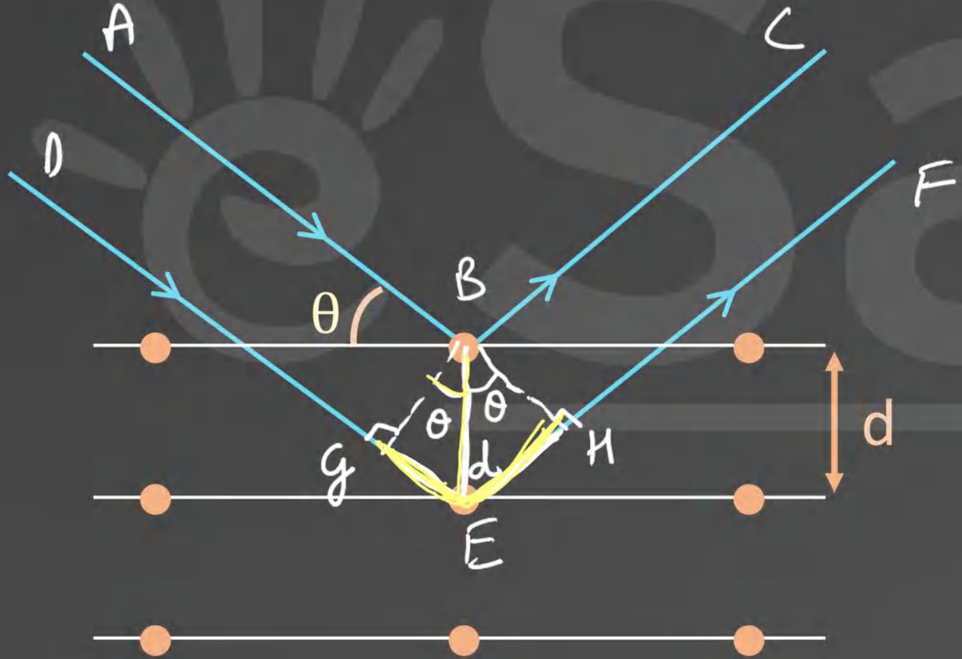


$$I = I_0 e^{-\mu x}$$

μ = Absorption Coefficient

Bragg's Law

Diffraction



Bragg's Angle

For Constructive Interference

$$2d \sin\theta = n\lambda$$

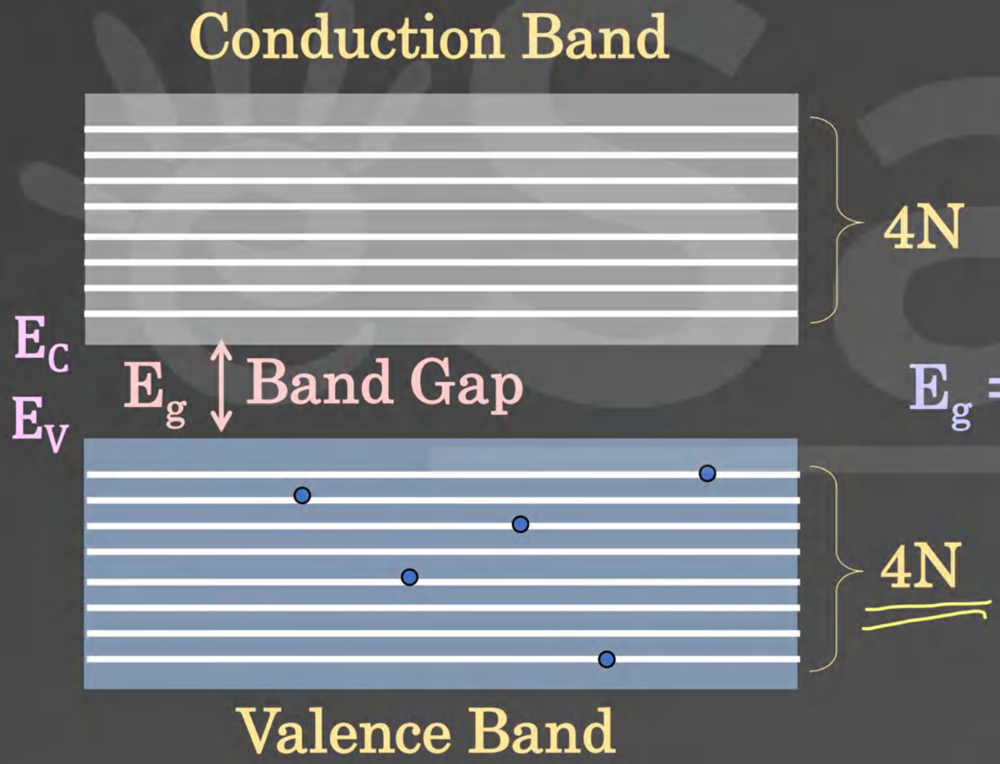
Integer

Bragg's Law

Semiconductor
Superfast Revision

	Conductor		Semiconductor		Insulator
σ	$10^{2} - 10^{8}$ mho/m	>	$10^{5} - 10^{-6}$ mho/m	>	$10^{-11} - 10^{-19}$ mho/m
ρ	$10^{-2} - 10^{-8}$ Ωm	<	$10^{-5} - 10^{6}$ Ωm	<	$10^{11} - 10^{19}$ Ωm
Eg	Copper, silver		Silicon, Germanium		Rubber, Glass

Energy gap between conduction band and valence band,

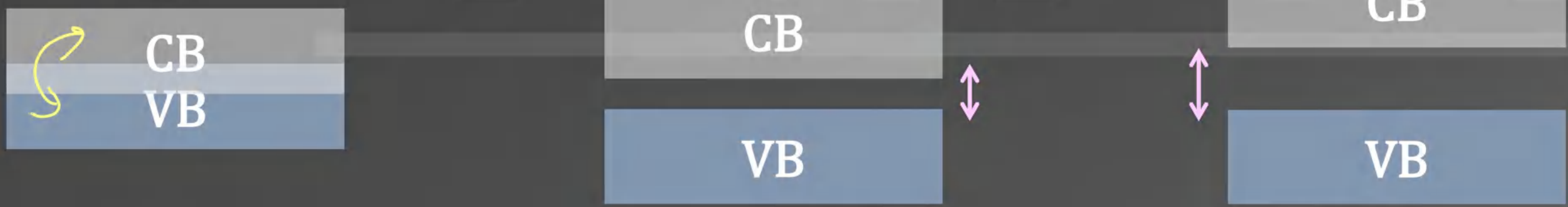


$$E_g = E_C - E_V$$

$Si : E_g = 1.1\ eV$

$Ge : E_g = 0.72\ eV$

Conductor	Semiconductor	Insulator



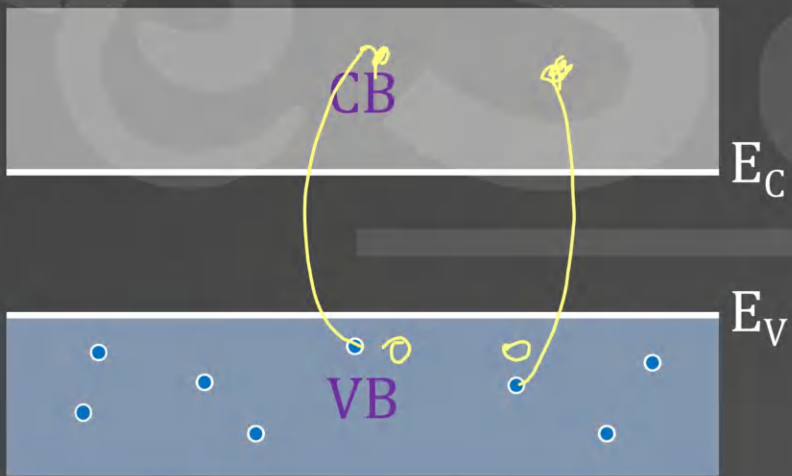
$\approx 0eV$	$E_g < 3eV$	$E_g > 3eV$

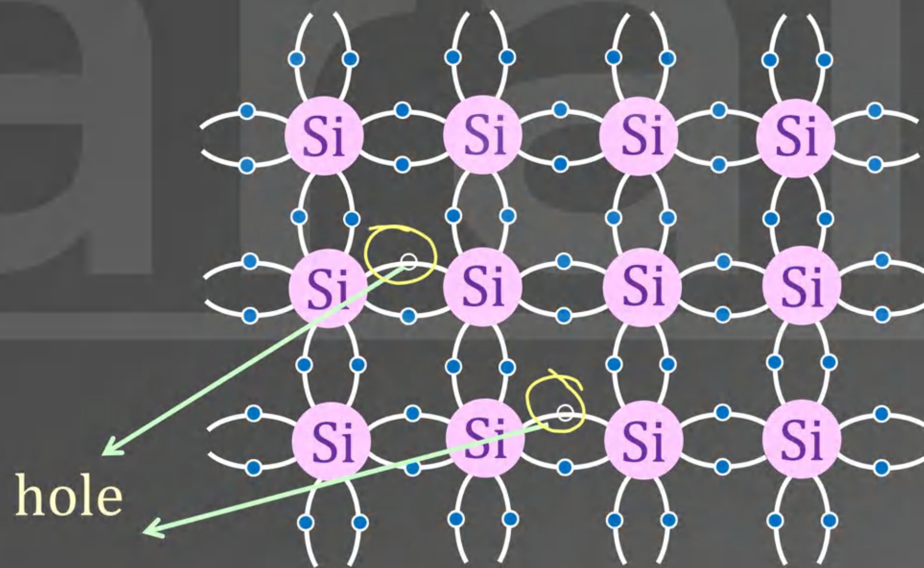
Intrinsic Semiconductor

Electron Hole Pair Generation

$$n_e = n_h = n_i$$

$$n_e \times n_h = n_i^2$$



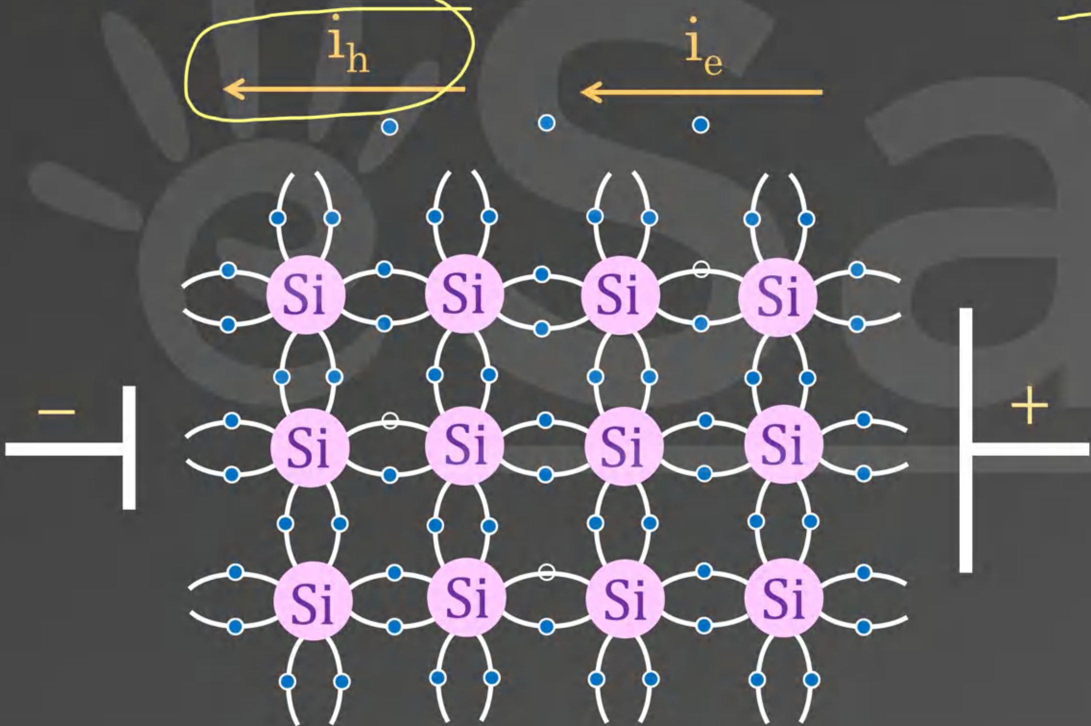


Who are the charge carriers?

Electron or hole

$$i = i_e + i_h$$

$$i = n_e e A v + n_h e A v$$



Extrinsic Semiconductor

Added impurity atoms are called Dopants.

Two types of dopants

(a) Pentavalent : Arsenic (As), Antimony (Sb), Phosphorous (P)

(b) Trivalent : Indium (In), Boron (B), Aluminium (Al)

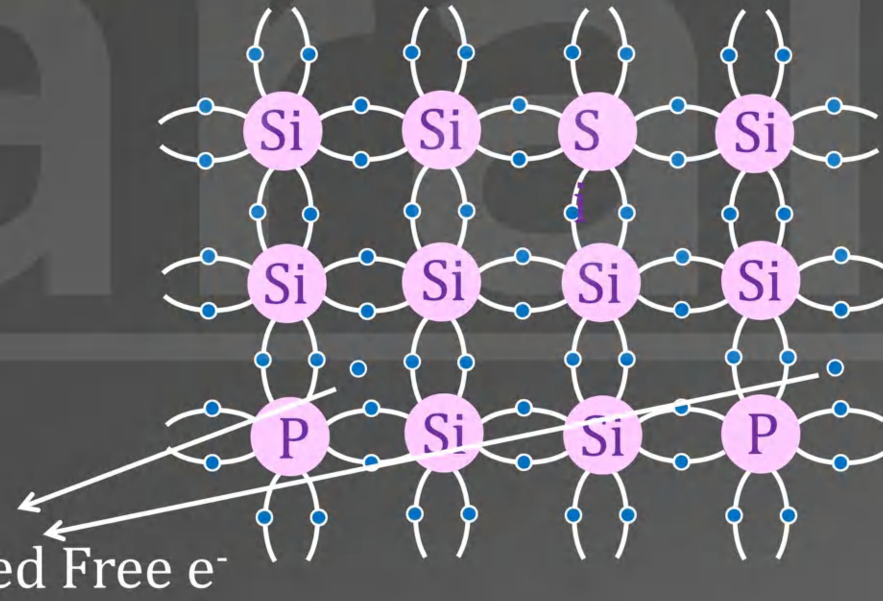
Extrinsic Semiconductor

n-type semiconductor (Pentavalent Dopant)

Majority Charge Carriers : Electrons

Minority Charge Carriers : Holes

$n_e >> n_h$



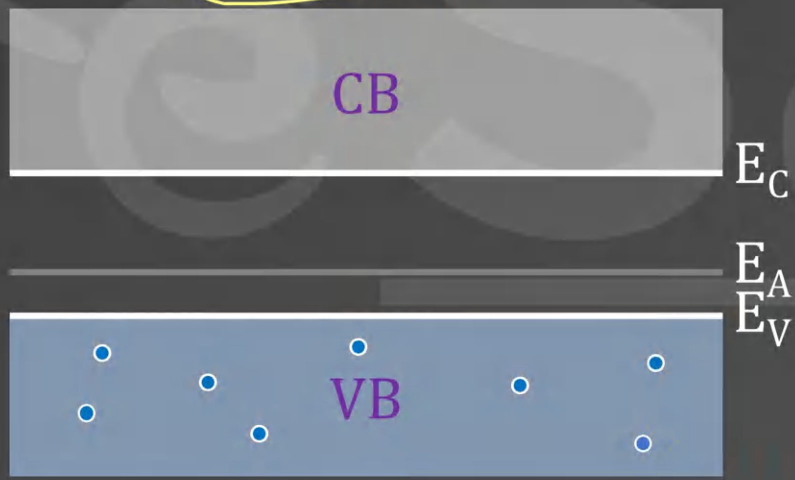
Extrinsic Semiconductor

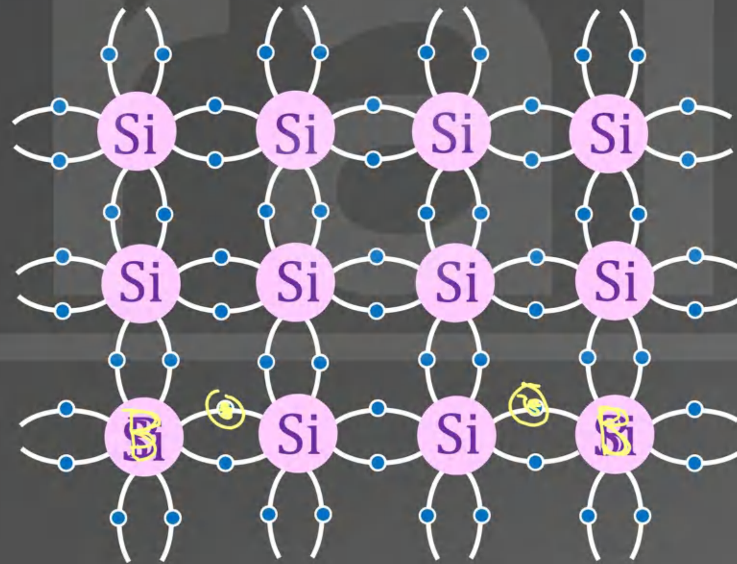
p-type semiconductor (Trivalent Dopant)

Majority Charge Carriers : Holes

Minority Charge Carriers : Electrons

$$n_h >> n_e$$





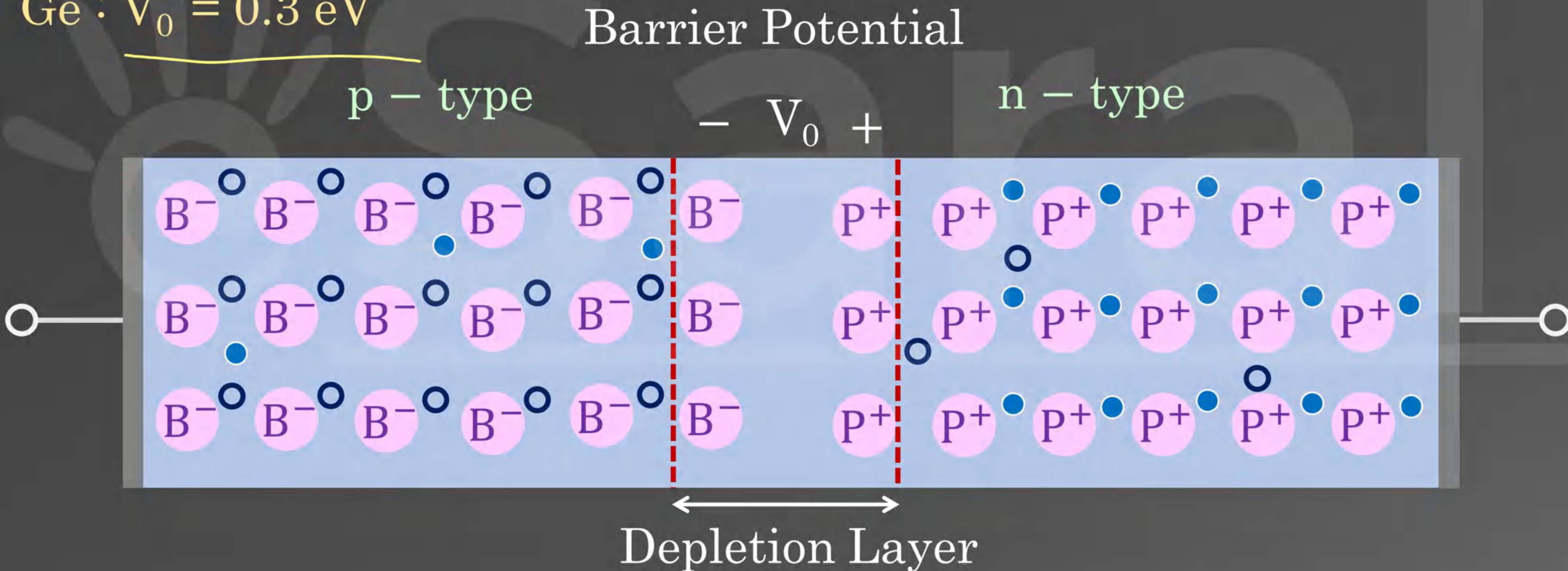
Extrinsic Semiconductor

$$n_e \times n_h = n_i^2$$

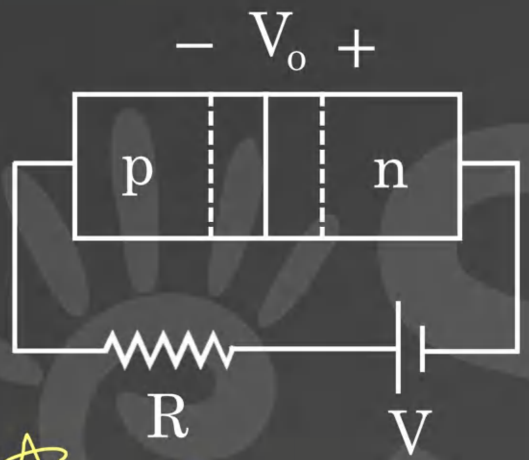
p-n junction diode

Si : $V_0 = 0.7$ eV

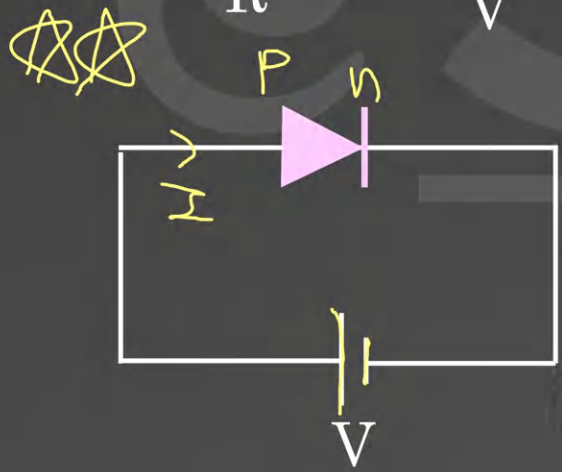
Ge : $V_0 = 0.3$ eV

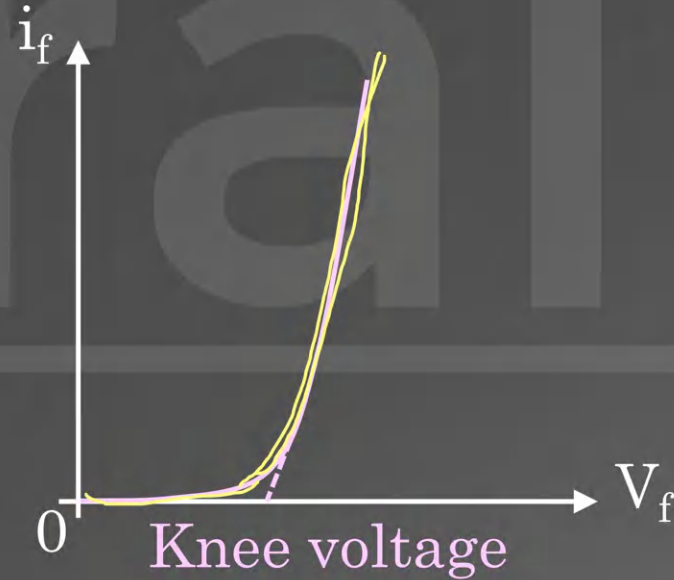


p–n Junction Diode Under Forward Bias

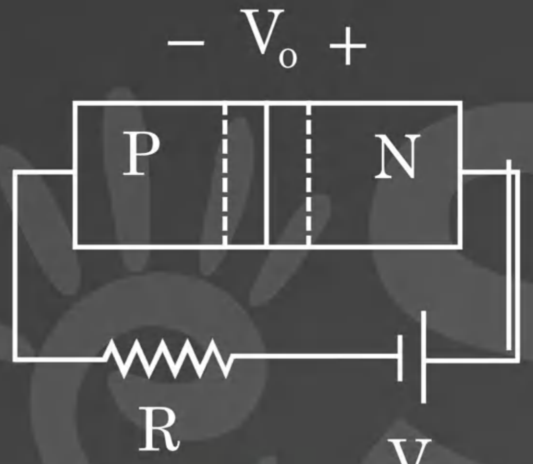


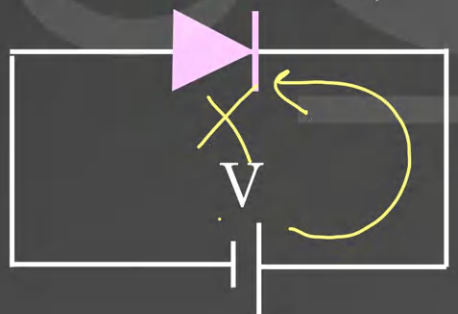
The total diode forward current is due to **Diffusion.**

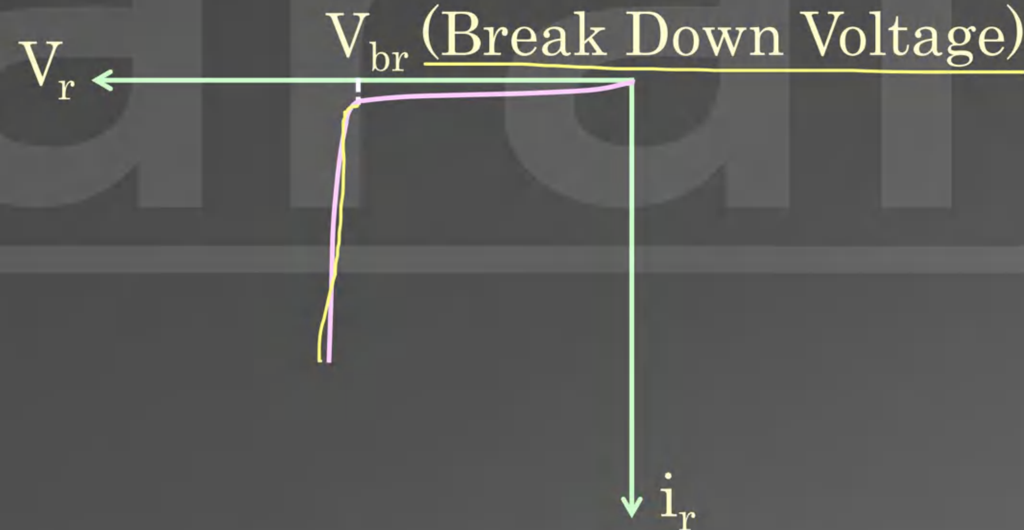




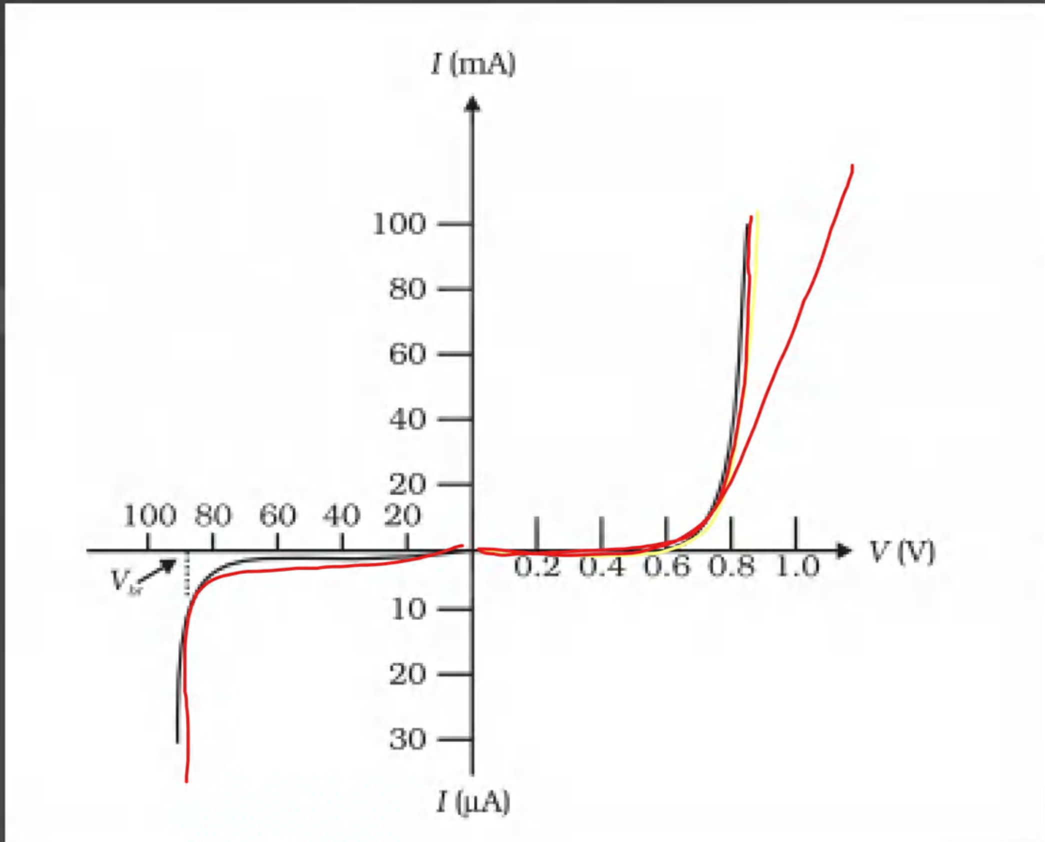
p—n Junction Diode Under Reverse Bias

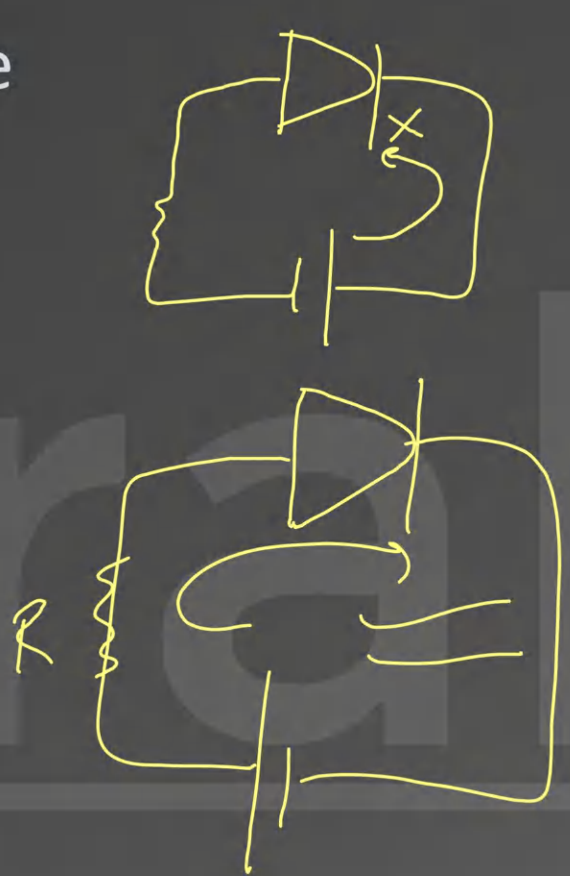






p-n junction diode

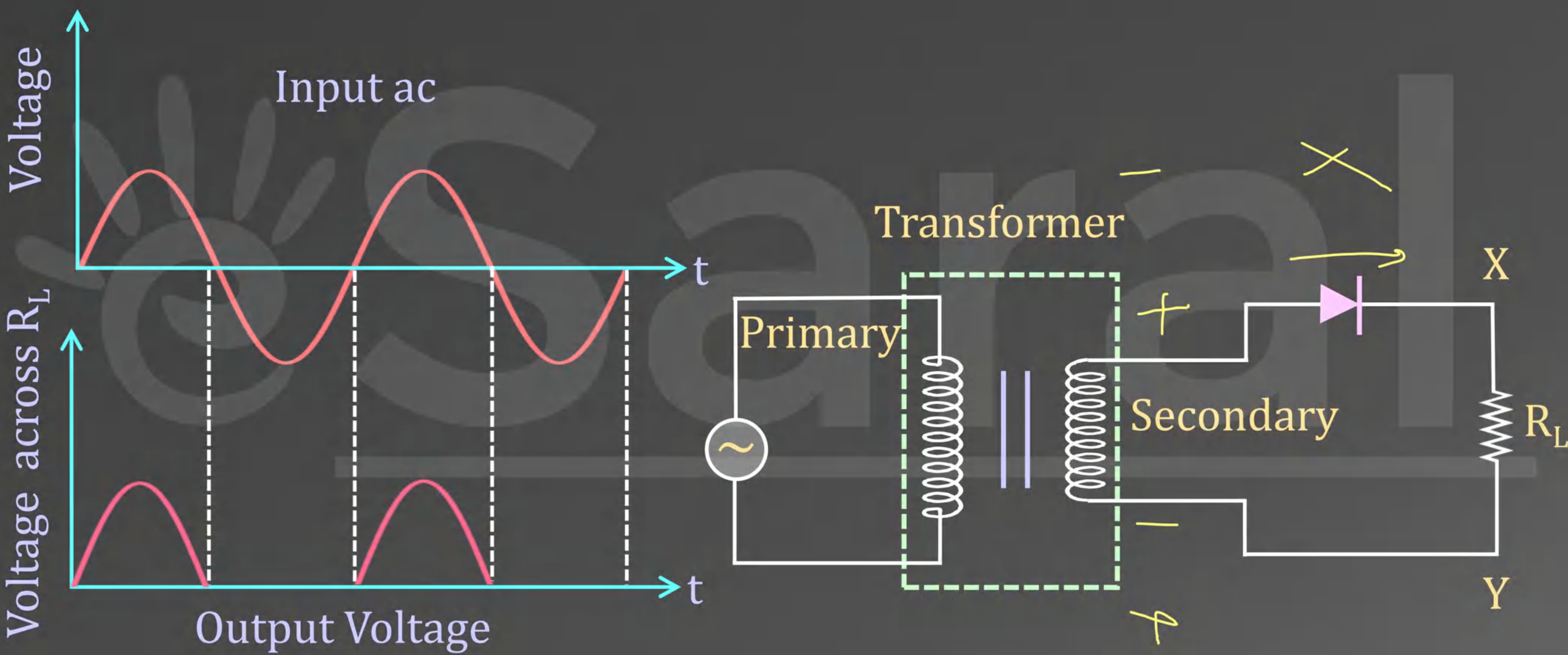




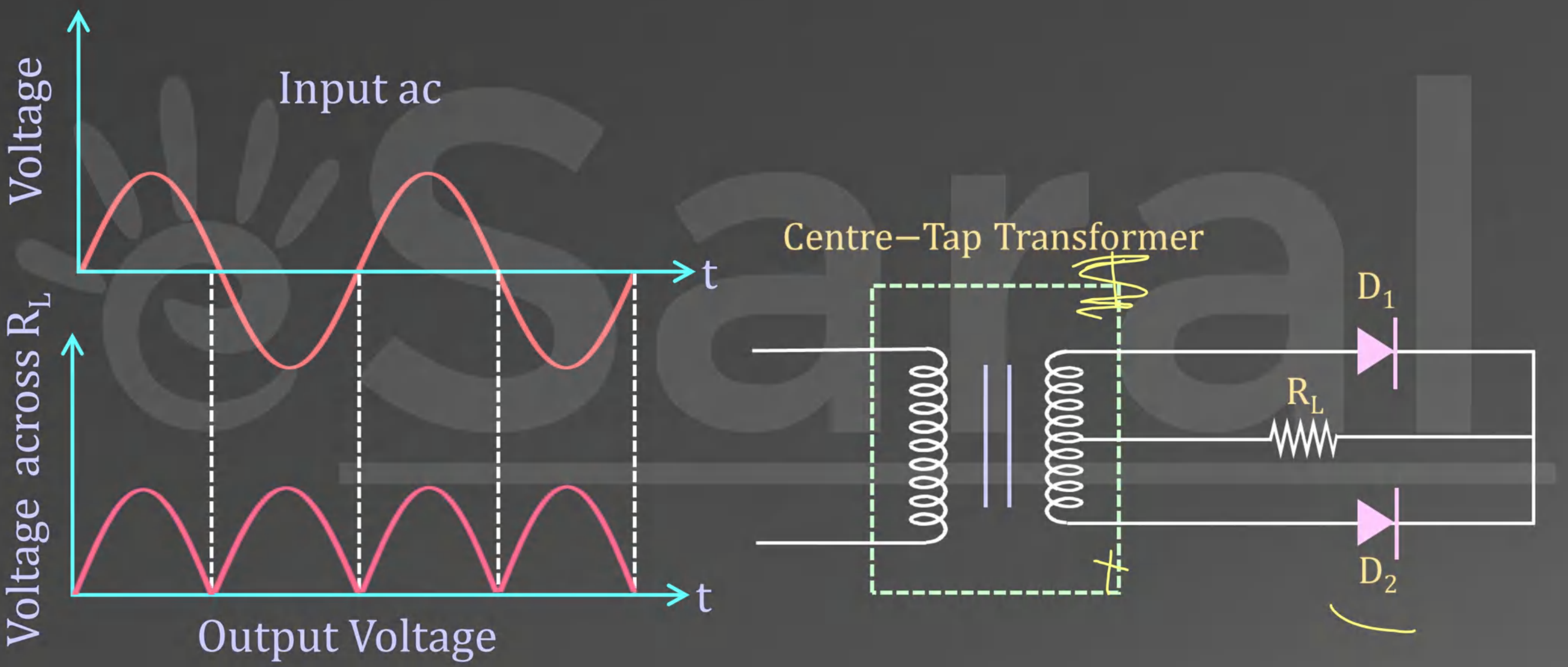
Rectifiers

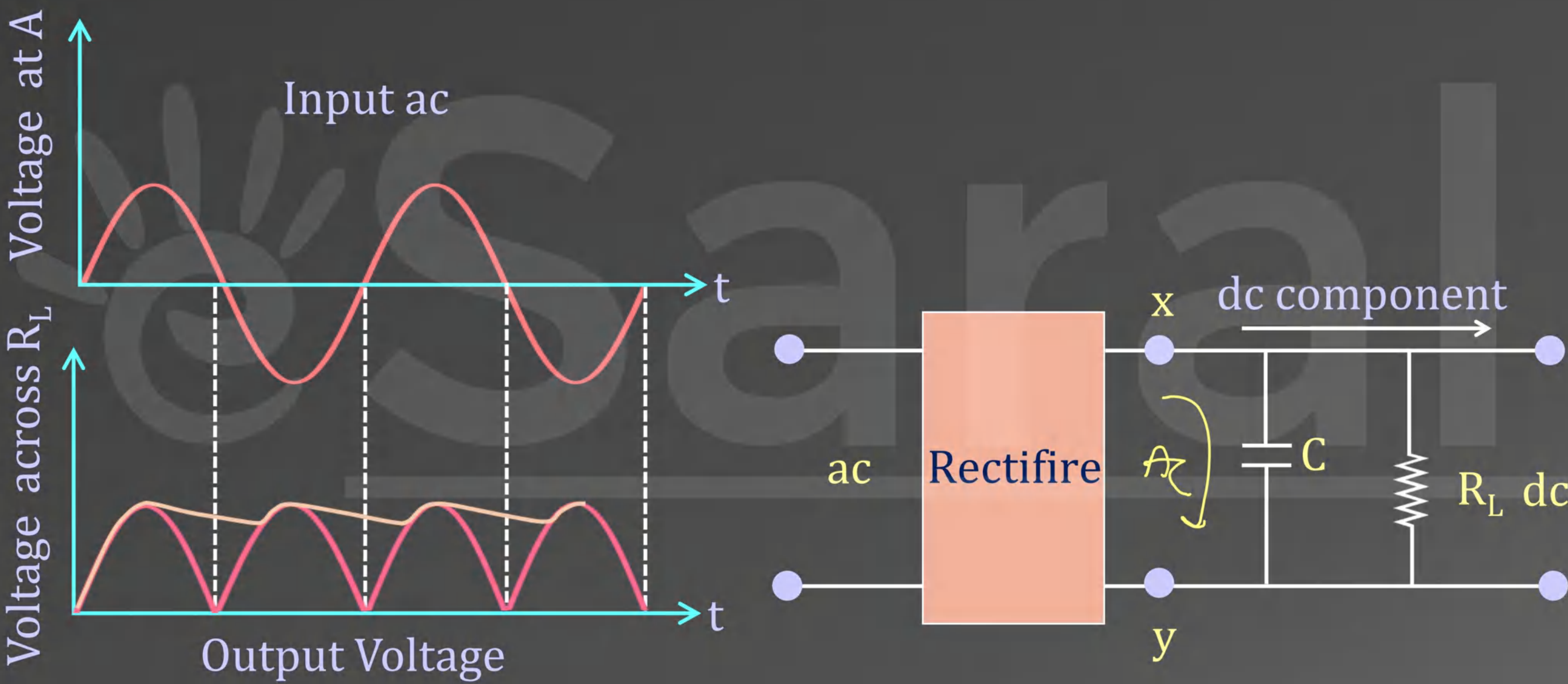
It is device which is used for converting Alternating Current into Direct Current

Half—Wave Rectifier



Full–Wave Rectifier

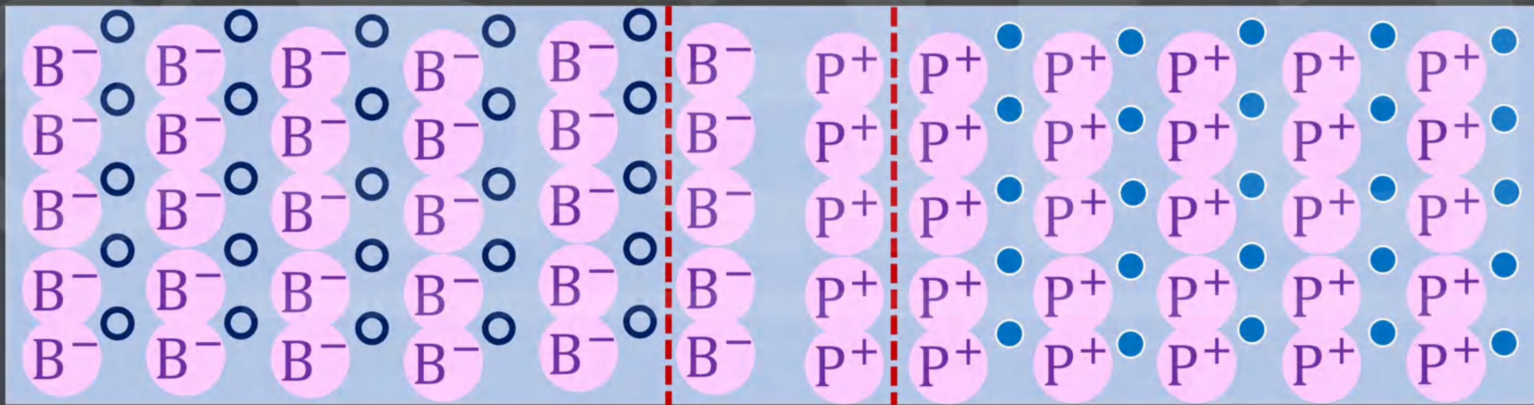



Voltage at A
Input ac
t
Voltage across R_L
Output Voltage
t
x
dc component
ac
Rectifire
C
R_L dc
y

Zener Diode

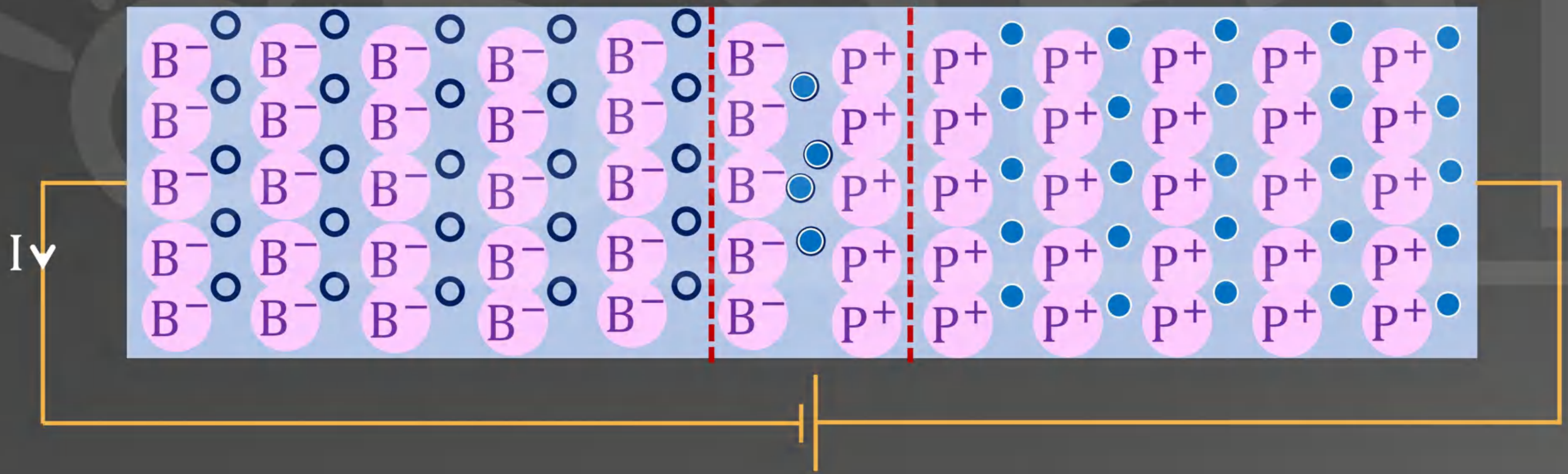
Depletion region formed is very thin ($< 10^{-6}$ m).

Zener diode is a fabricated by heavily doping p and n sides of the junction.

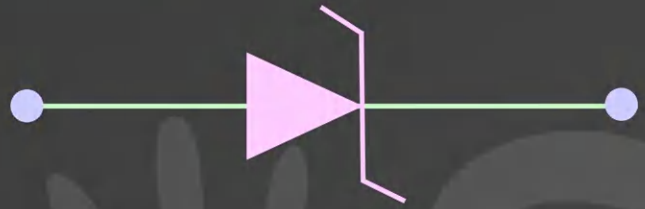


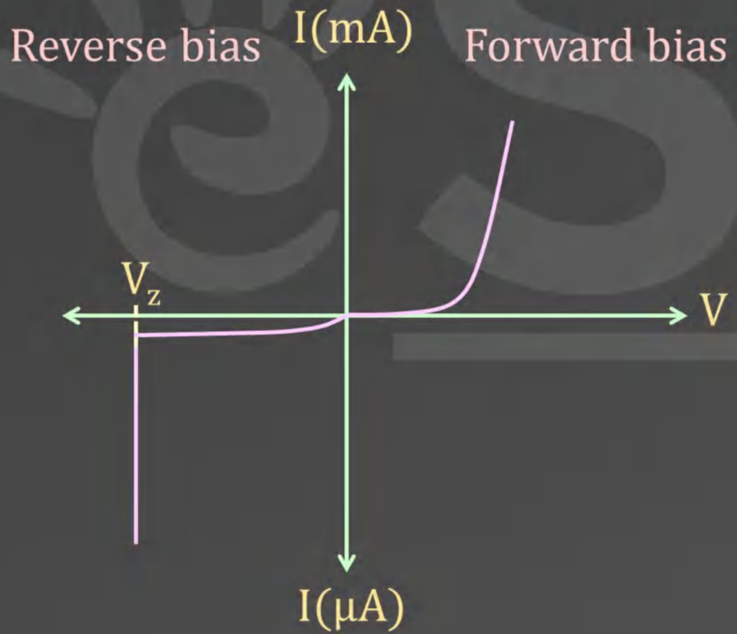
Zener Diode

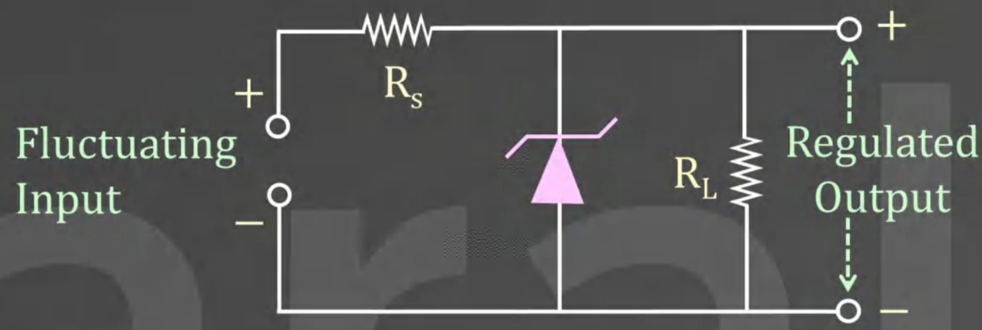
Reverse Bias



Zener Diode



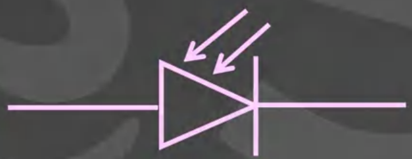


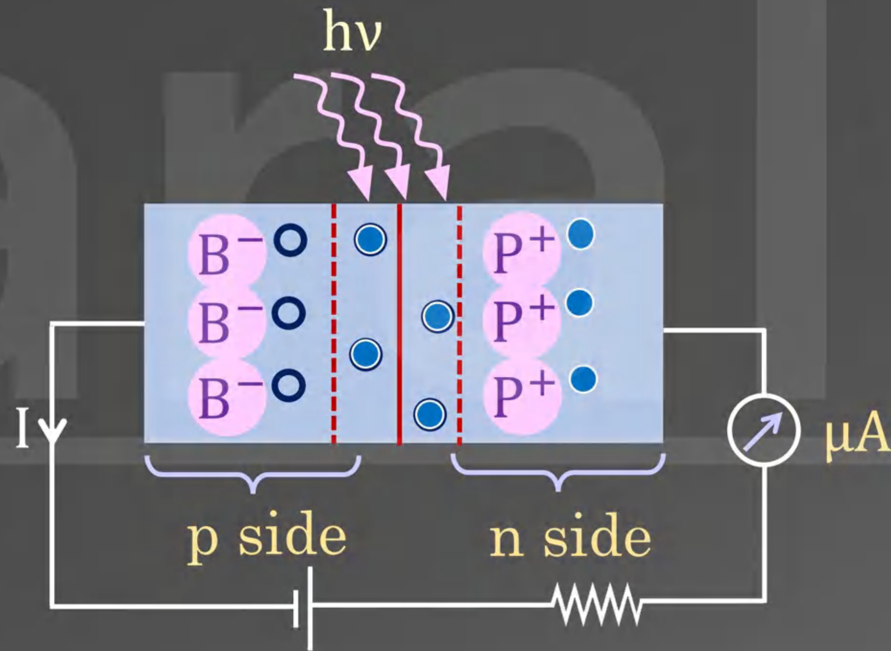


Zener diode acts as a **Voltage Regulator.**

Photodiode

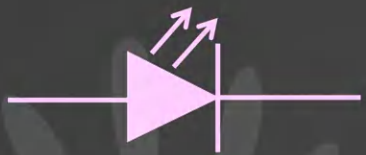
Photodiodes used for detecting optical signal (photodetectors).





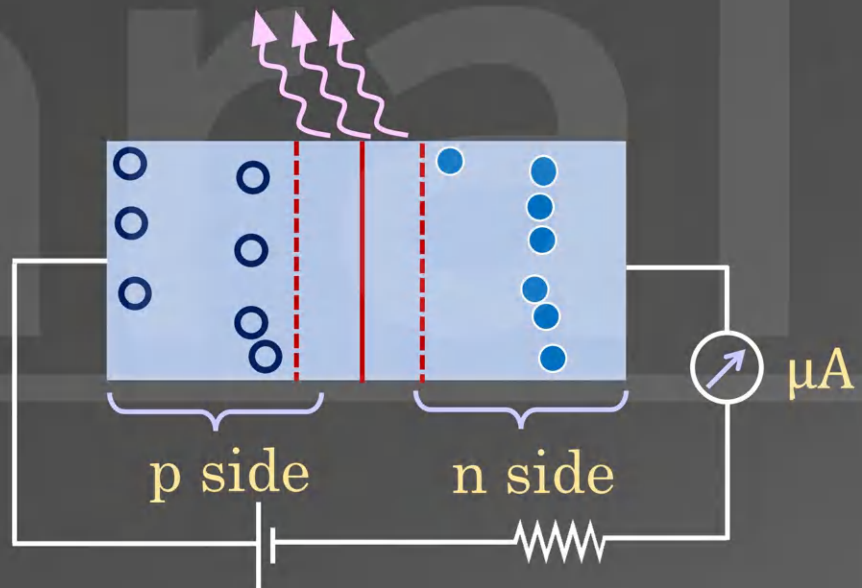
Photodiode operated under reverse bias.

Light Emitting Diode

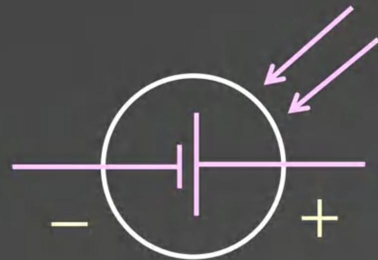


It is a heavily doped p-n junction which under forward bias emits spontaneous radiation.

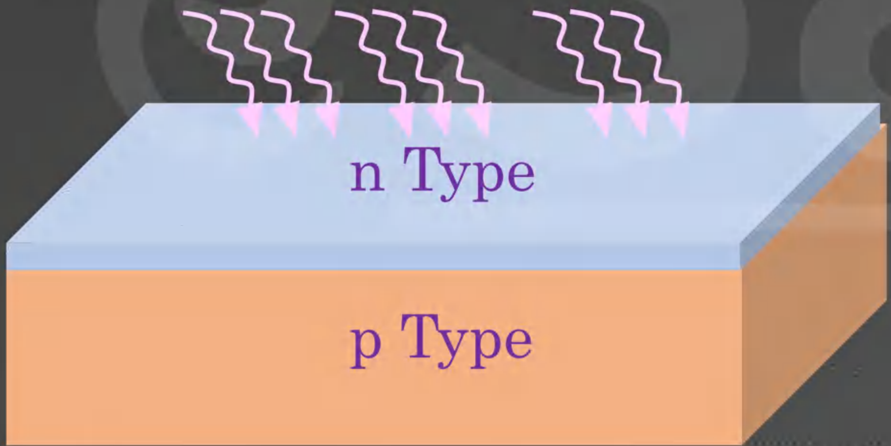
On recombination, the energy is released in the from of photons.

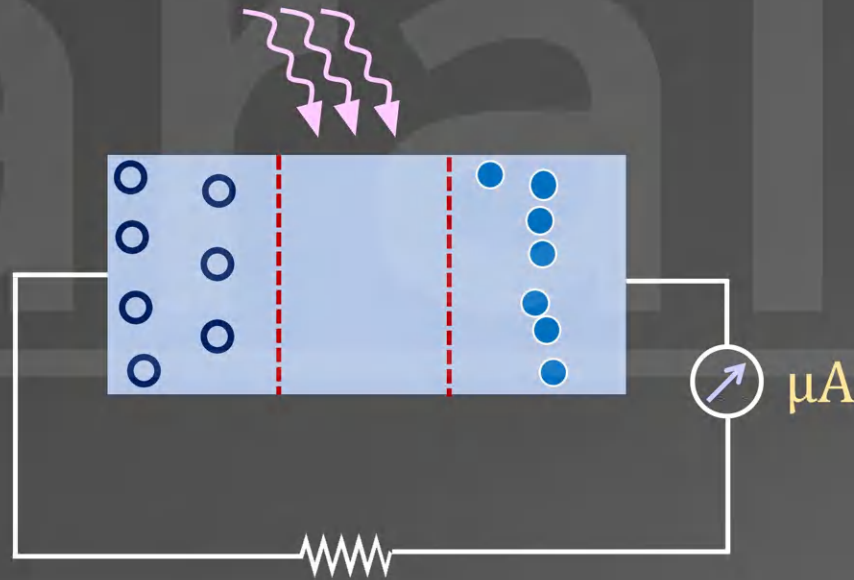


Solar Cell

Symbol: 

A thin n–Si is grown on the p–Si wafer.



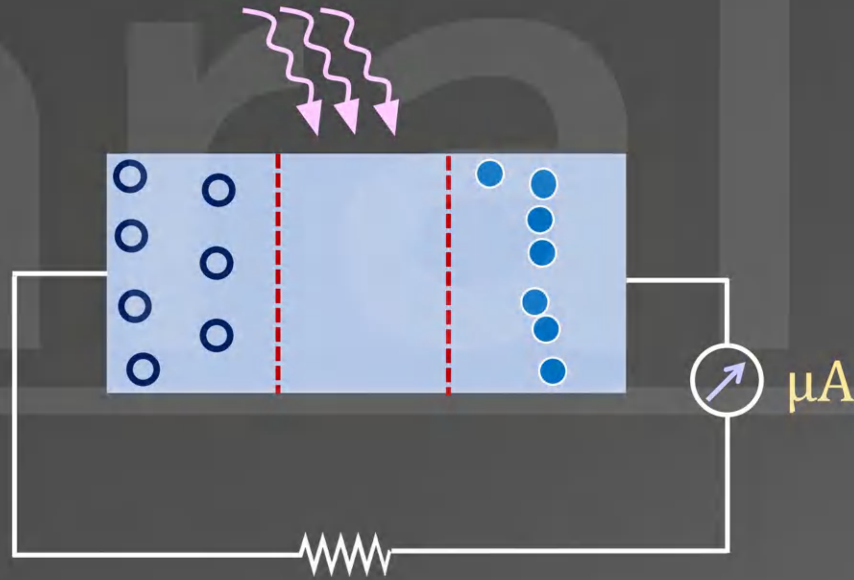


Solar Cell

Sunlight is not always required for a solar cell.

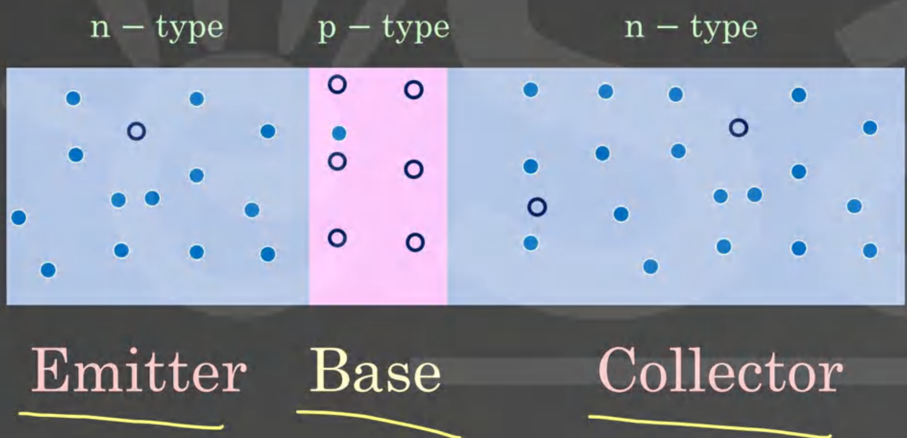
Electron – hole pair generated due to light with $h\nu > E_g$.

Separation of electron and holes due to electric field of the depletion region.

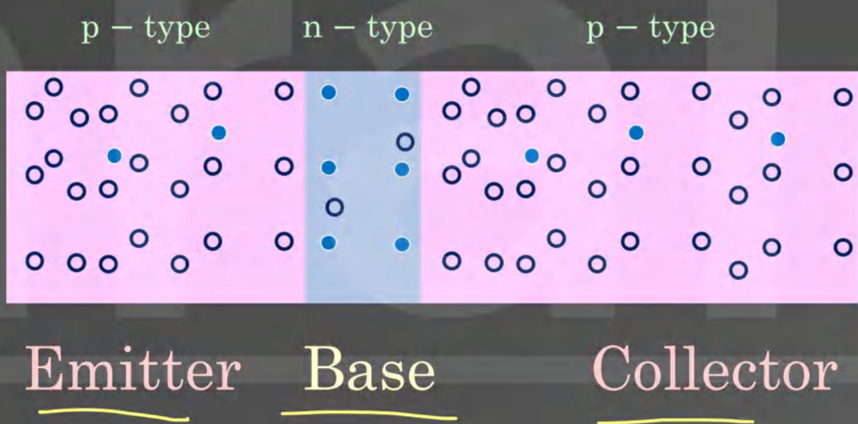


Transistors

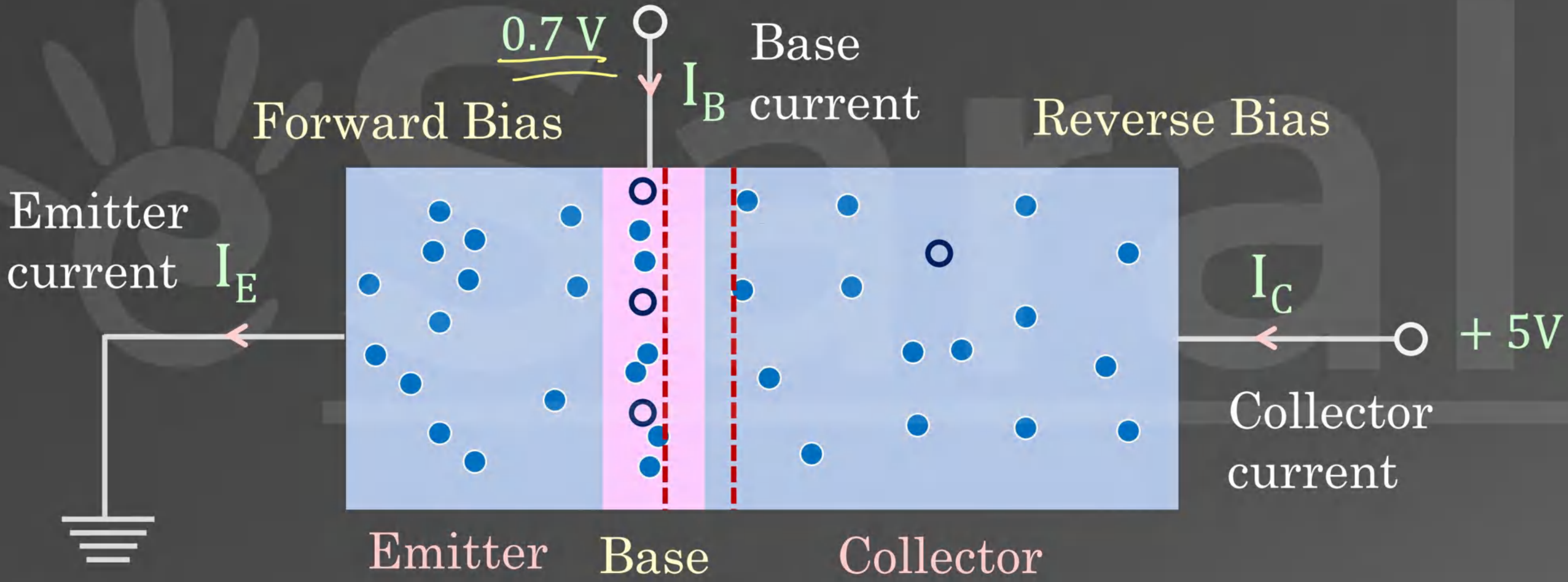
n-p-n Transistor



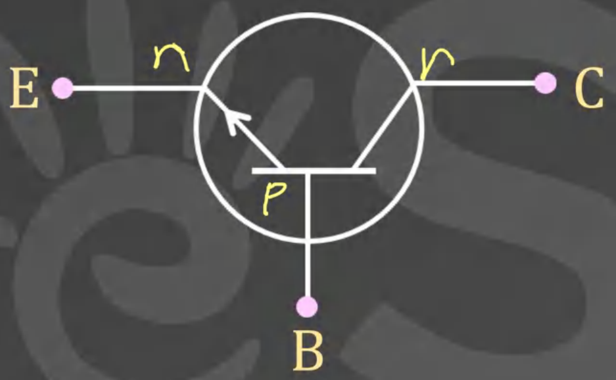
p-n-p Transistor



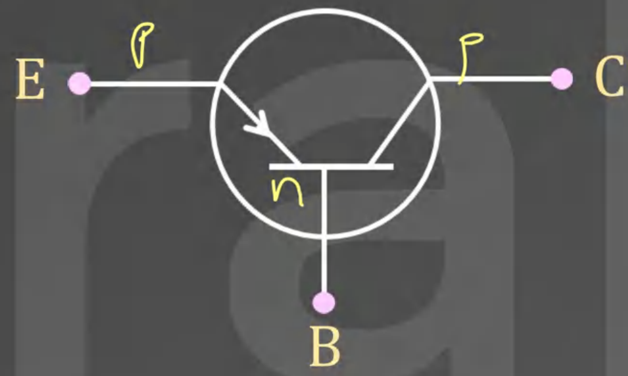
$$I_E = I_C + I_B$$


0.7 V
I_B
Base
current
Forward Bias
Reverse Bias
Emitter
current
I_E
I_C
+ 5V
Collector
current
Emitter
Base
Collector

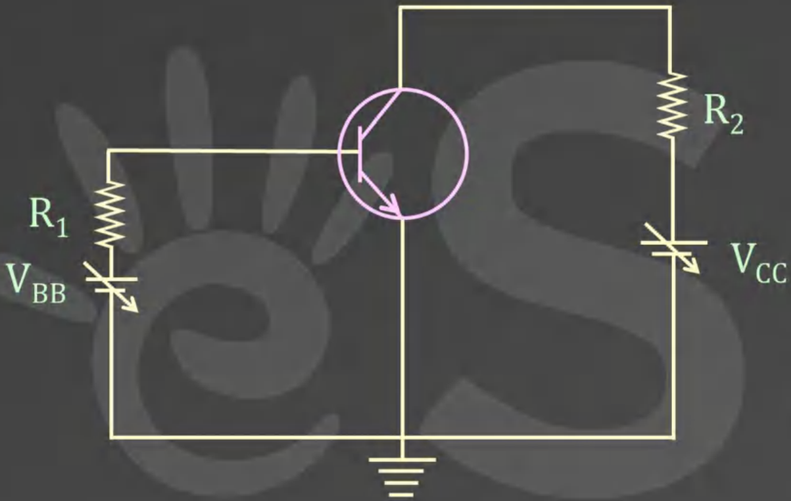
npn Transistor



pnp Transistor



Common– Emitter



The ratio of the change in I_C to the change in I_B at a constant V_{CE}, when the transistor is in active state .

Input Resistance

$$r_i = \frac{\Delta V_{BE}}{\Delta I_B}$$

Output Resistance

$$r_o = \frac{\Delta V_{CE}}{\Delta I_C}$$

Amplification Factor

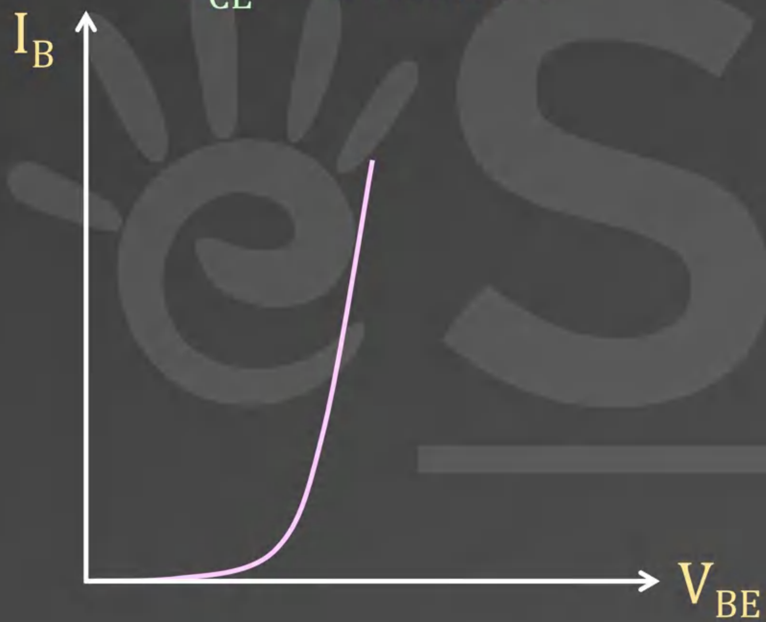
$$\beta_{ac} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}} \qquad \beta_{dc} = \frac{I_C}{I_B}$$

If We simply find the ratio of I_C and I_B

Common— Emitter

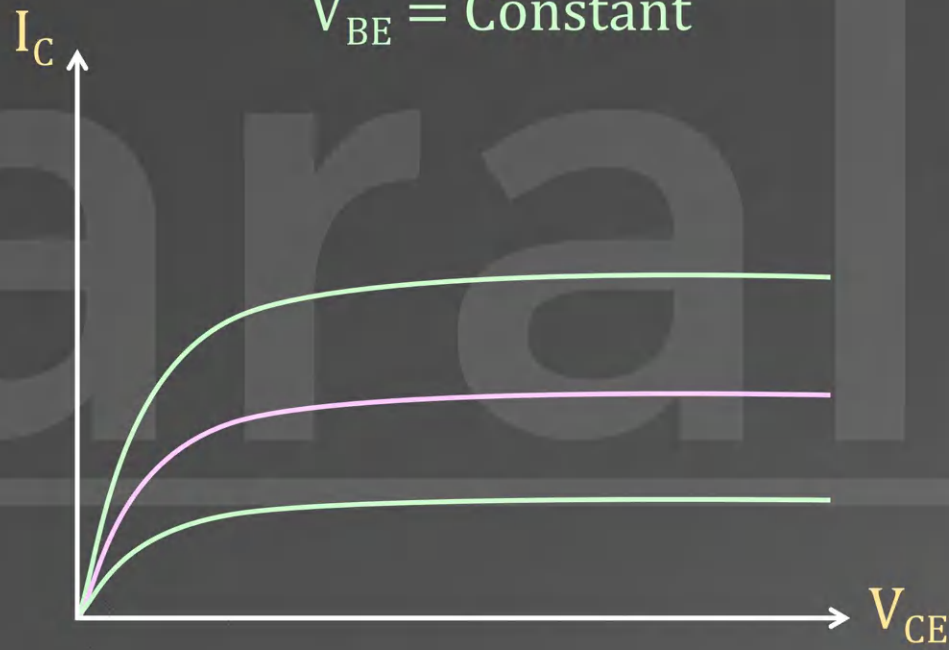
Input Characteristic Curve

V_{CE} = Constant

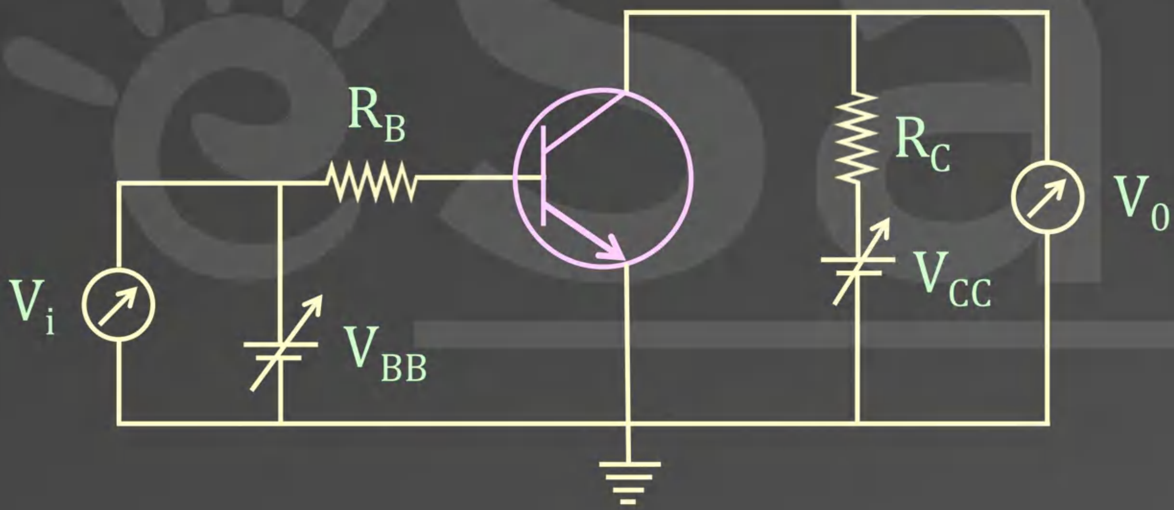


Output Characteristic Curve

V_{BE} = Constant



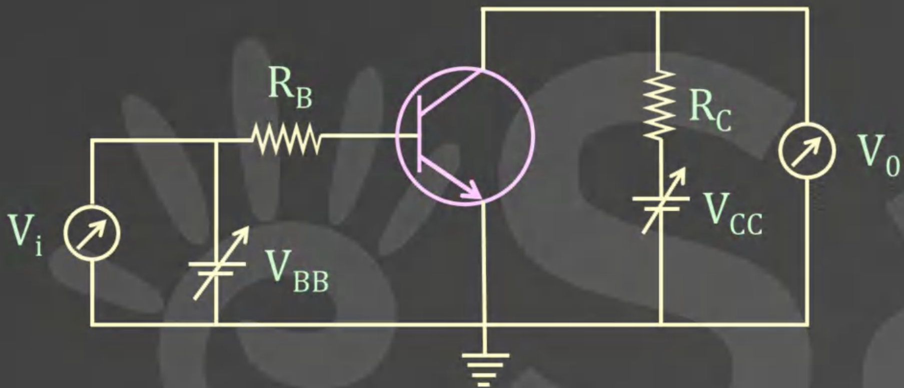
Transistor as a device

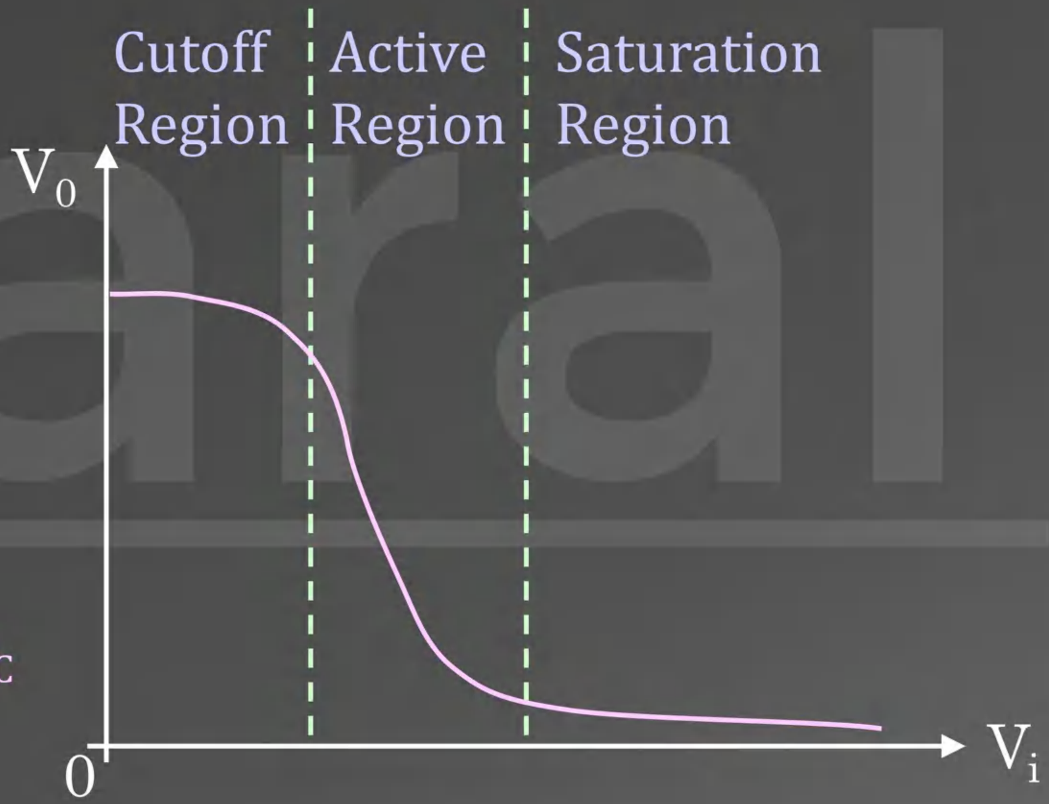


$$V_i = I_B R_B + V_{BE}$$

$$V_0 = V_{CC} - I_C R_C$$

Transistor as a Switch

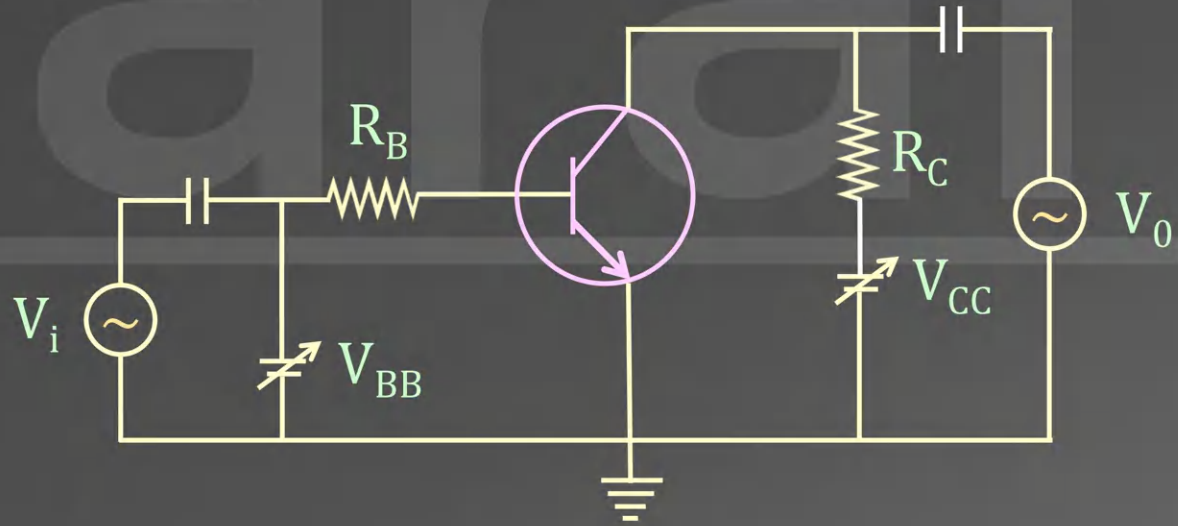




Transistor works as a Switch in Cutoff mode and Saturation mode.

$V_i = I_B R_B + V_{BE}$ $\quad$ $V_0 = V_{CC} - I_C R_C$

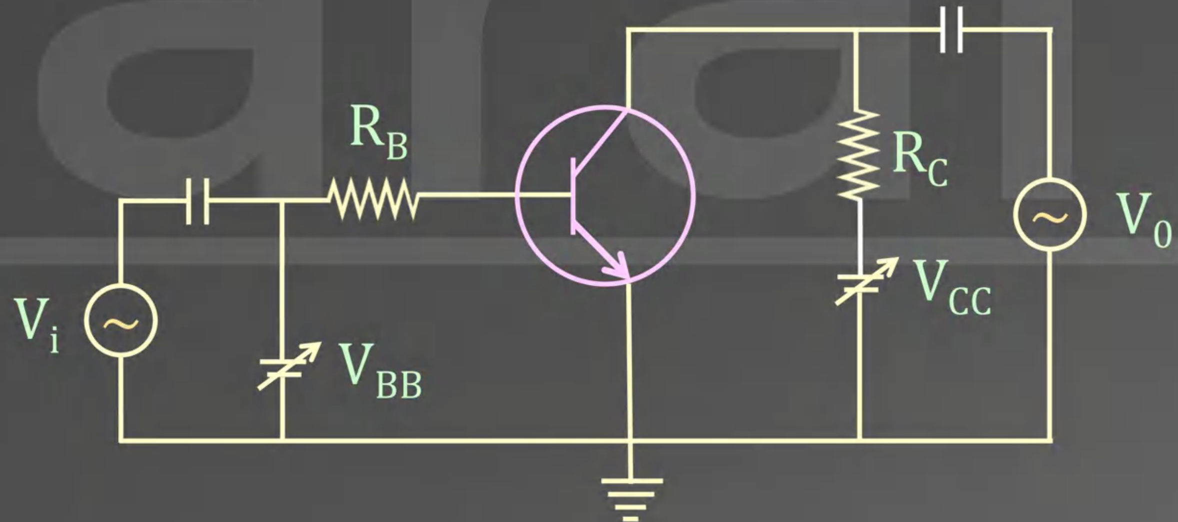
Transistor as a Amplifier



Voltage Gain

$$A_V = \frac{\Delta V_0}{\Delta V_i} = -\beta_{ac}\frac{R_C}{R_B}$$

Transistor as a Amplifier

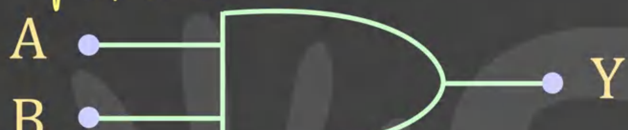


Power Gain

$$A_P = \beta_{ac} \times A_V$$

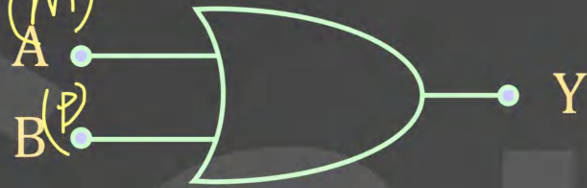
Logic Gates

AND Gate



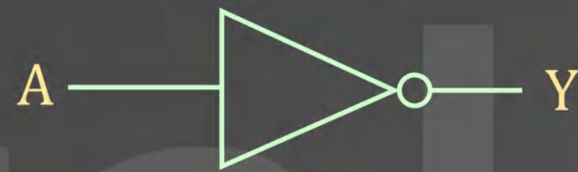
Input		Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate



Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

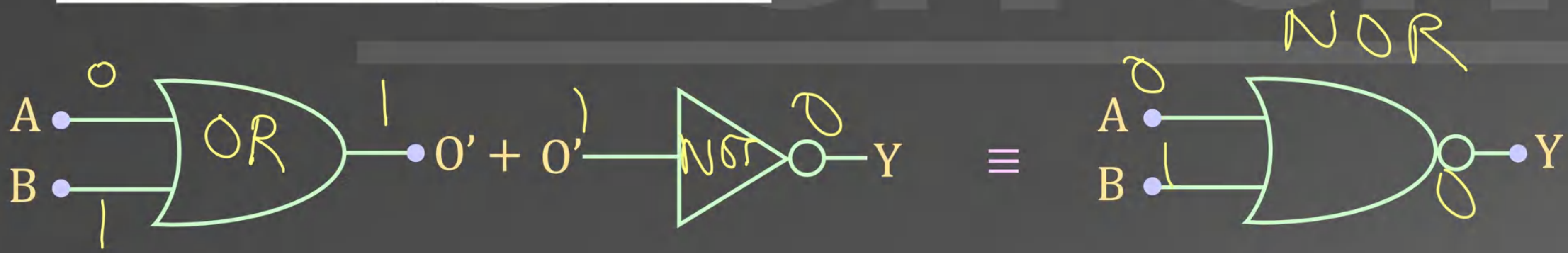
NOT Gate



Input	Output
A	Y
0	1
1	0

NOR Gate ≡ Not of OR

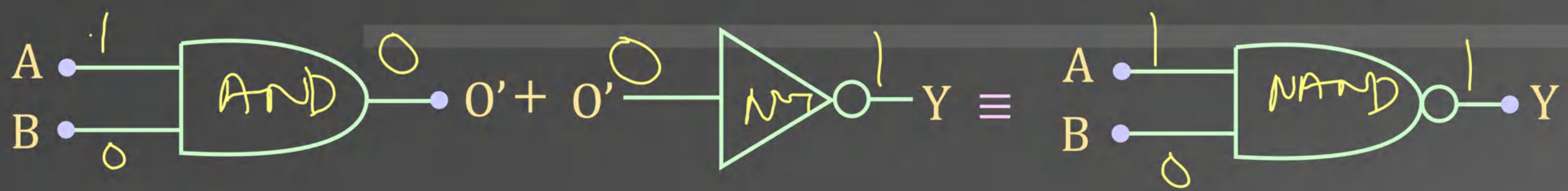
Input		Output		
A	B	OR	NOT	NOR
0	0	0	1	1
0	1	1	0	0
1	0	1	0	0
1	1	1	0	0



NAND Gate

NOT of AND

Input		Output		
A	B	AND	NOT	NAND
0	0	0	1	1
0	1	0	1	1
1	0	0	1	1
1	1	1	0	0

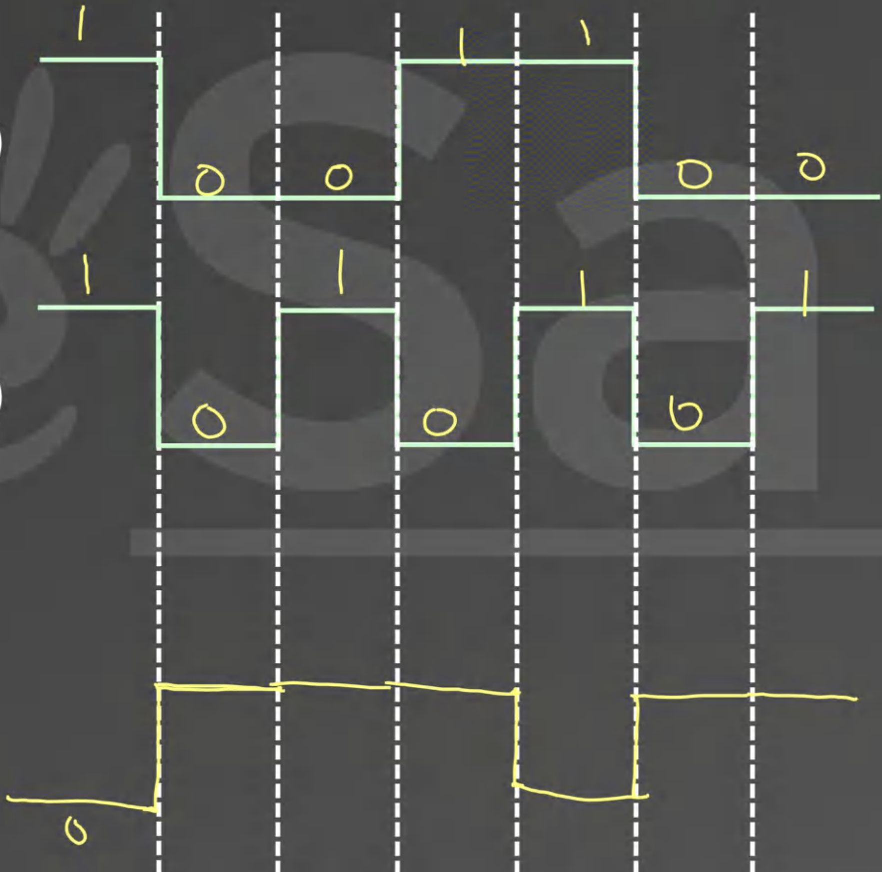


Q) Sketch the output Y from a NAND gate having inputs A and B given below.

A (input)

B (input)

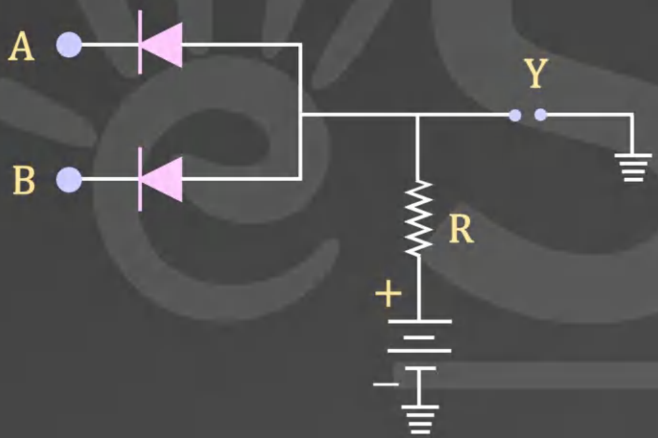
Sol.



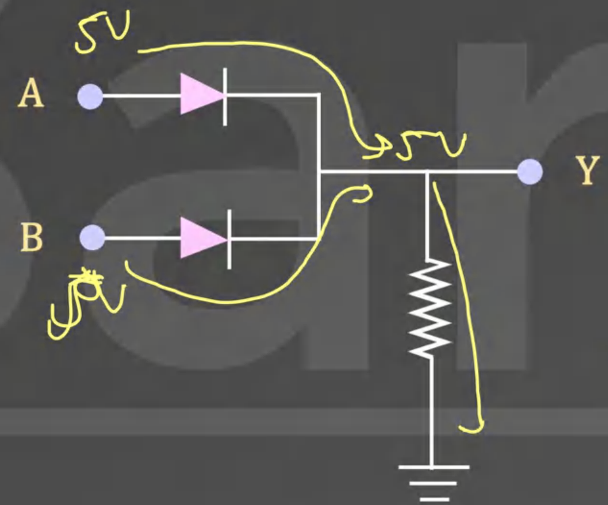
NAND

Input		Output
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

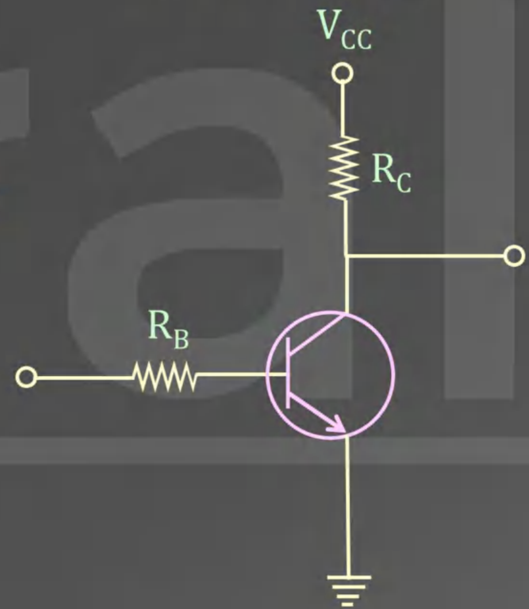
AND Gate



OR Gate

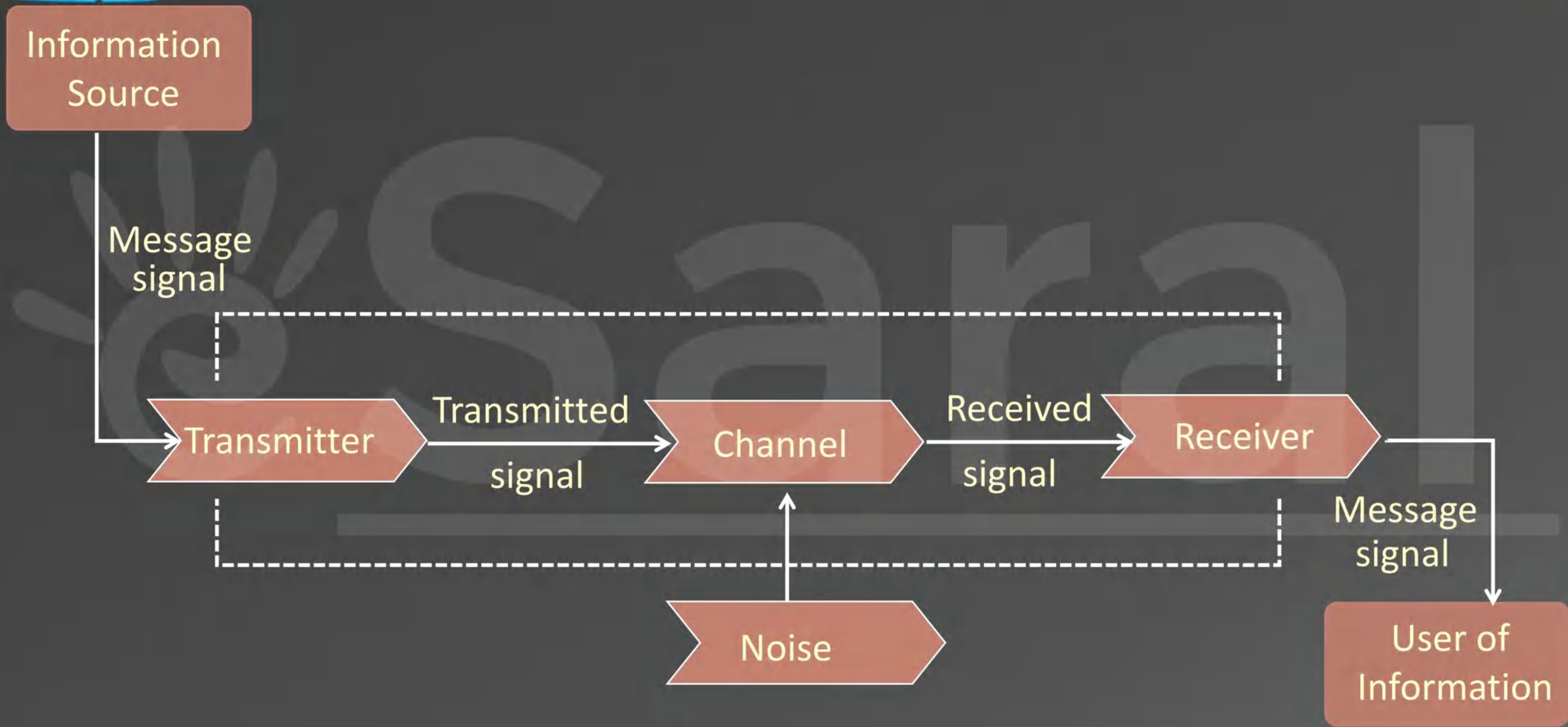


NOT Gate



Communication System

Superfast Revision


Information Source
Message signal
Transmitter
Transmitted signal
Channel
Received signal
Receiver
Noise
Message signal
User of Information

Bandwidth

The difference of maximum and minimum frequency in the range of each signal is called bandwidth of that signal.

Band Width of Transmission Medium

Standard AM broadcast	540kHz – 1600 kHz
FM broadcast	88–108 MHz
Television 	
VHF (very high frequencies)	54-72 MHz
TV	76-88 MHz
UHF (Ultra high frequency)	174-216 MHz
TV	420-890 MHz

Band Width of Transmission Medium

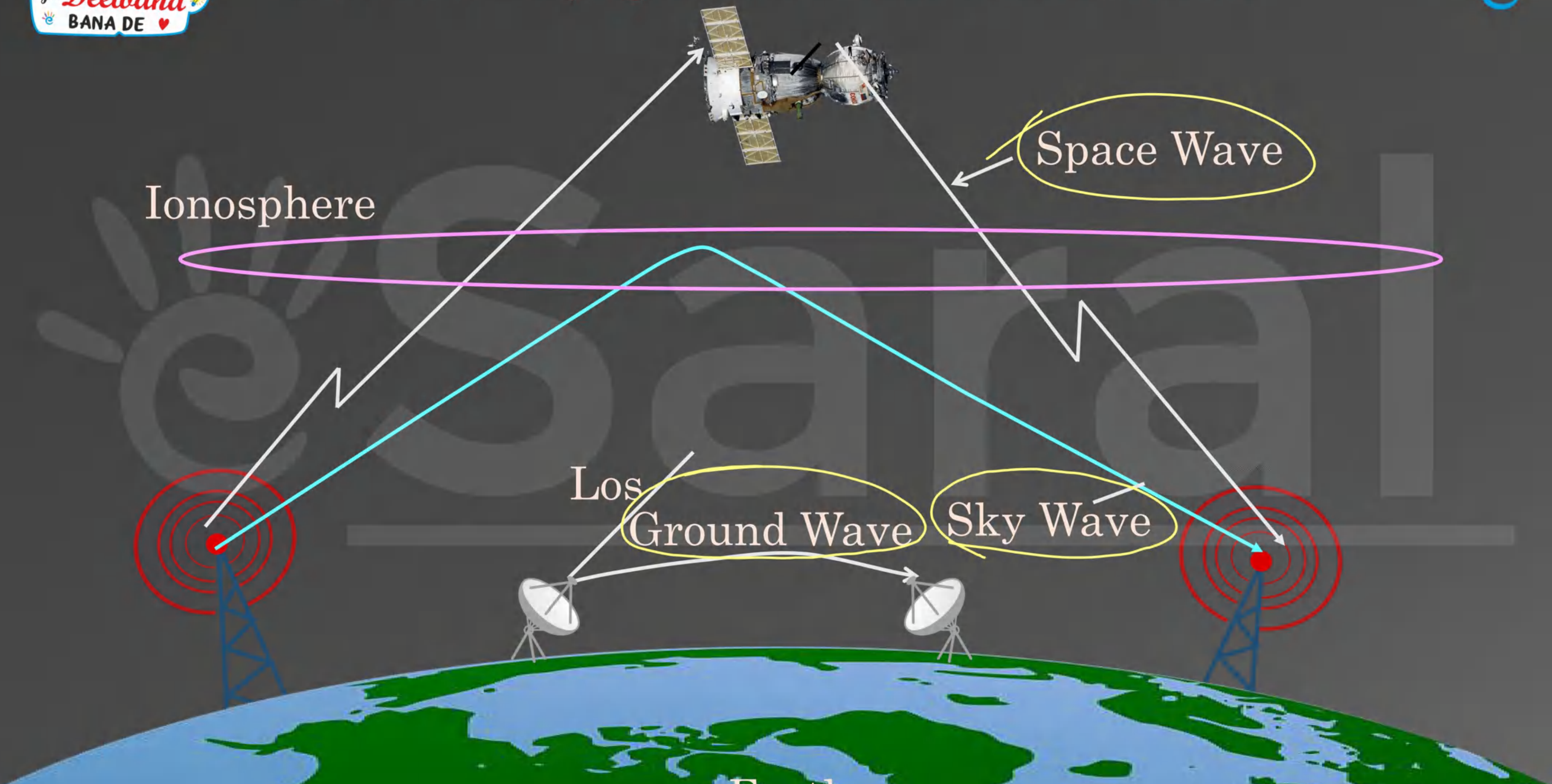
Cellular Mobile radio

Mobile to base Station	896-901 MHz
Base station to mobile	840-935 MHz

Satellite Communication

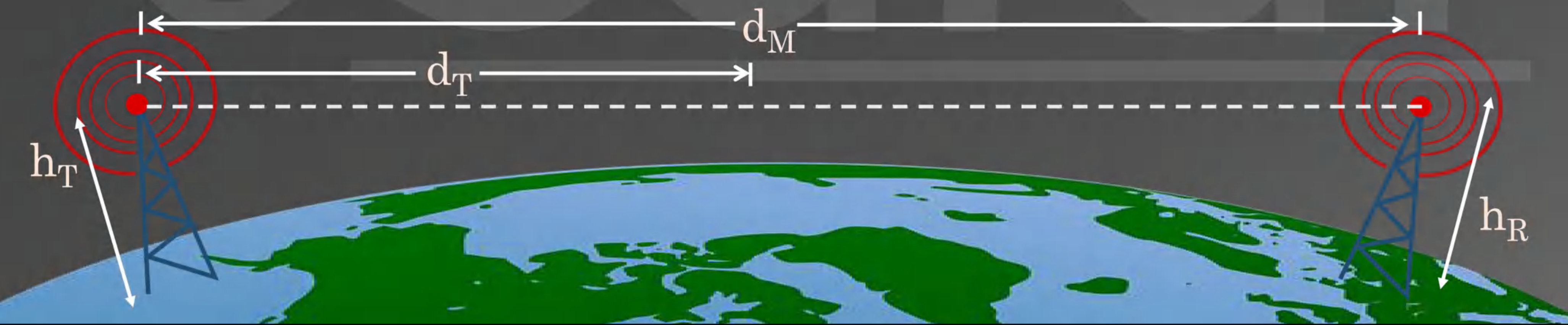
Up linking	5.925–6.425 GHz
Downlinking	3.7 – 4.2 GHz

Various Propagation Modes of EM Waves



Line of Sight Communication by Space waves

The distance to the horizontal d_T is given as $d_T = \sqrt{2Rh_T}$,
where R is the radius of the earth (approximately 6400 Km).
d_T is also called the radio maximum line-of sight distance.

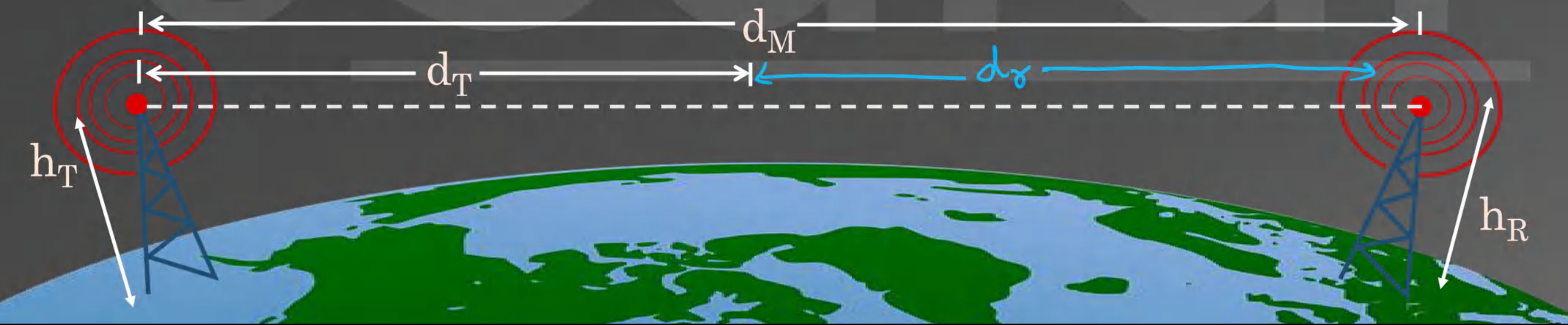


Line of Sight Communication by Space waves

d_M is the distance between the two antennas having heights h_T and h_R above the earth is given by:

$$d_M = \sqrt{2Rh_T} + \sqrt{2Rh_R}$$

where h_R is the height of receiving antenna.



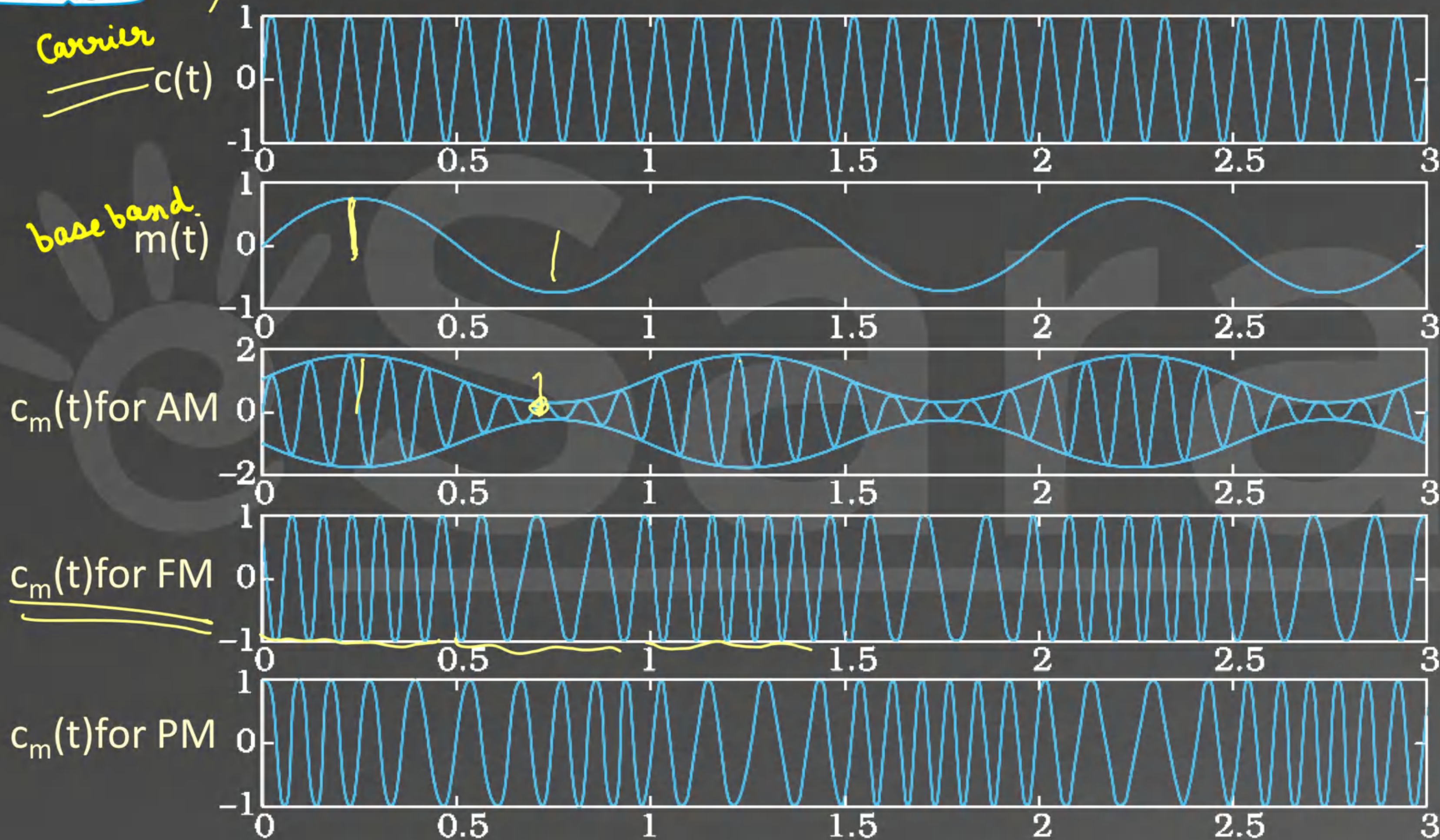
Modulation

It is a process by which any electrical signal called input / baseband or modulating signal, is mounted onto another signal of high frequency which is known as carrier signal.

The signal which results from this process is known as modulated signal.

Types of Modulation

- Amplitude modulation (AM)
- Frequency modulation (FM)
- Phase modulation (PM)


Carrier
c(t)
base band
m(t)
c_m(t)for AM
c_m(t)for FM
c_m(t)for PM
0 0.5 1 1.5 2 2.5 3

Difference Between AM,FM and PM

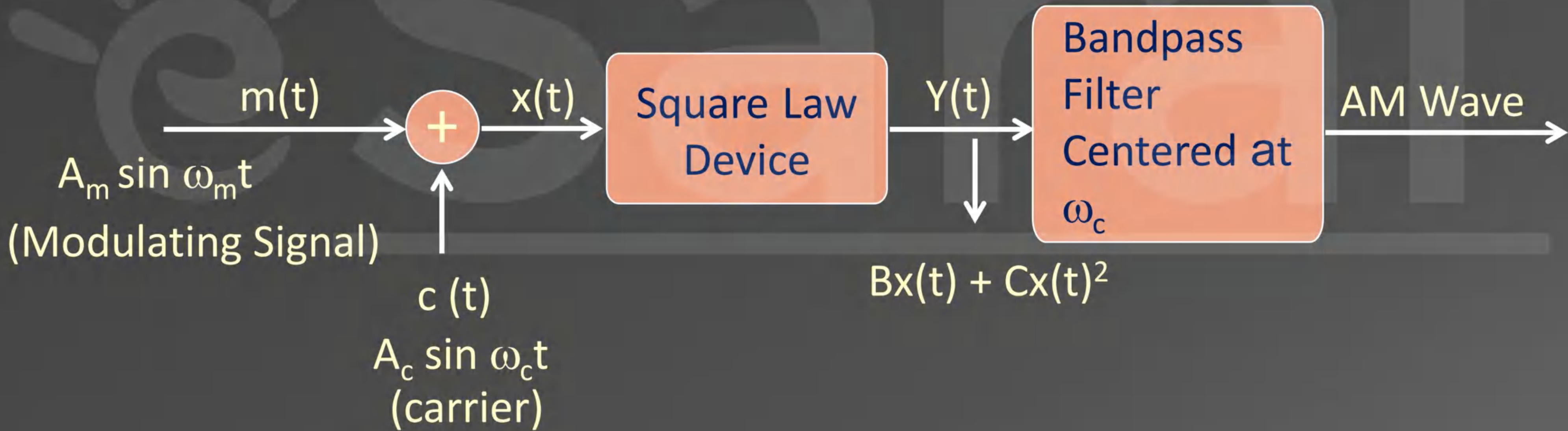
	AM	FM	PM
Definition	•The amplitude of the carrier wave is varied in accordance with the information signal	•The frequency of the carrier wave is varied in accordance with the information signal	•The phase of the carrier wave is varied in accordance with the information signal
Variation	Frequency and phase remains same.	Amplitude and phase remains same.	Amplitude and frequency remains same.

Amplitude Modulation

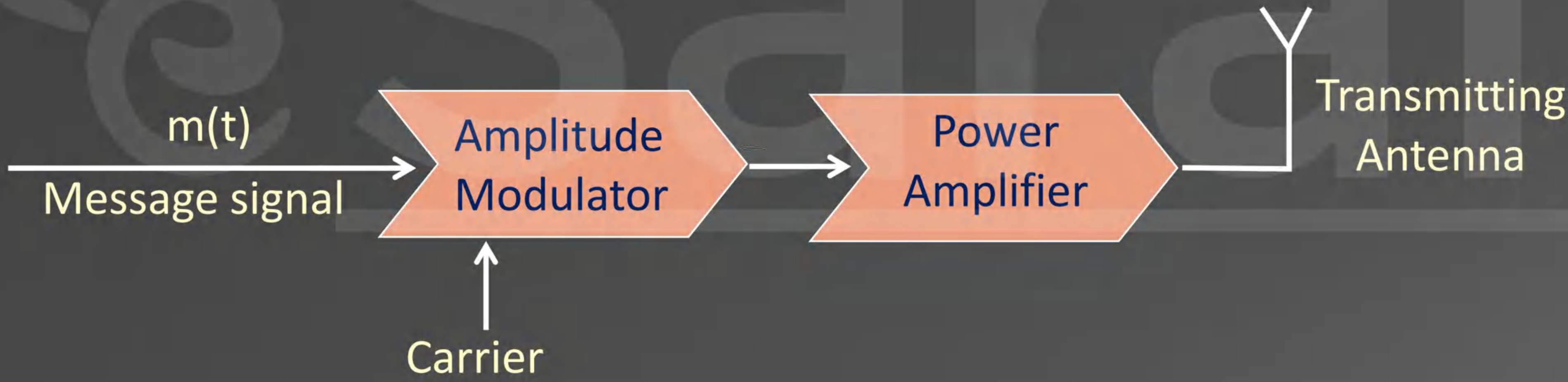
$$c_m(t) = A_c \sin\omega_c t + \frac{\mu Ac}{2}\cos(\omega_c - \omega_m)t - \frac{\mu Ac}{2}\cos(\omega_c + \omega_m)\,t$$

ω_c $\qquad$ $\omega_c - \omega_m$ $\qquad$ $\omega_c + \omega_m$

Block Diagram of a simple modulator for obtaining an AM signal



Production of Amplitude Modulated Wave



Detection of Amplitude Modulated Wave


Bounce Back
128 GB SD Card Included
JEE Main
For March, April and May Attempt
HURRY UP!
₹ 26000
₹ 13000
50% OFF for first 300 Students ONLY
https://www.esaral.com/Bounce_Back_JEE-21_Main
Link in Description
Get Top Ranks in IIT-JEE/NEET with eSaral APP
Get it on Google Play

Course Details

Lectures

Practice
- Sheets
- Prev. Yr.

Tests
- Topic-Wise
- Review

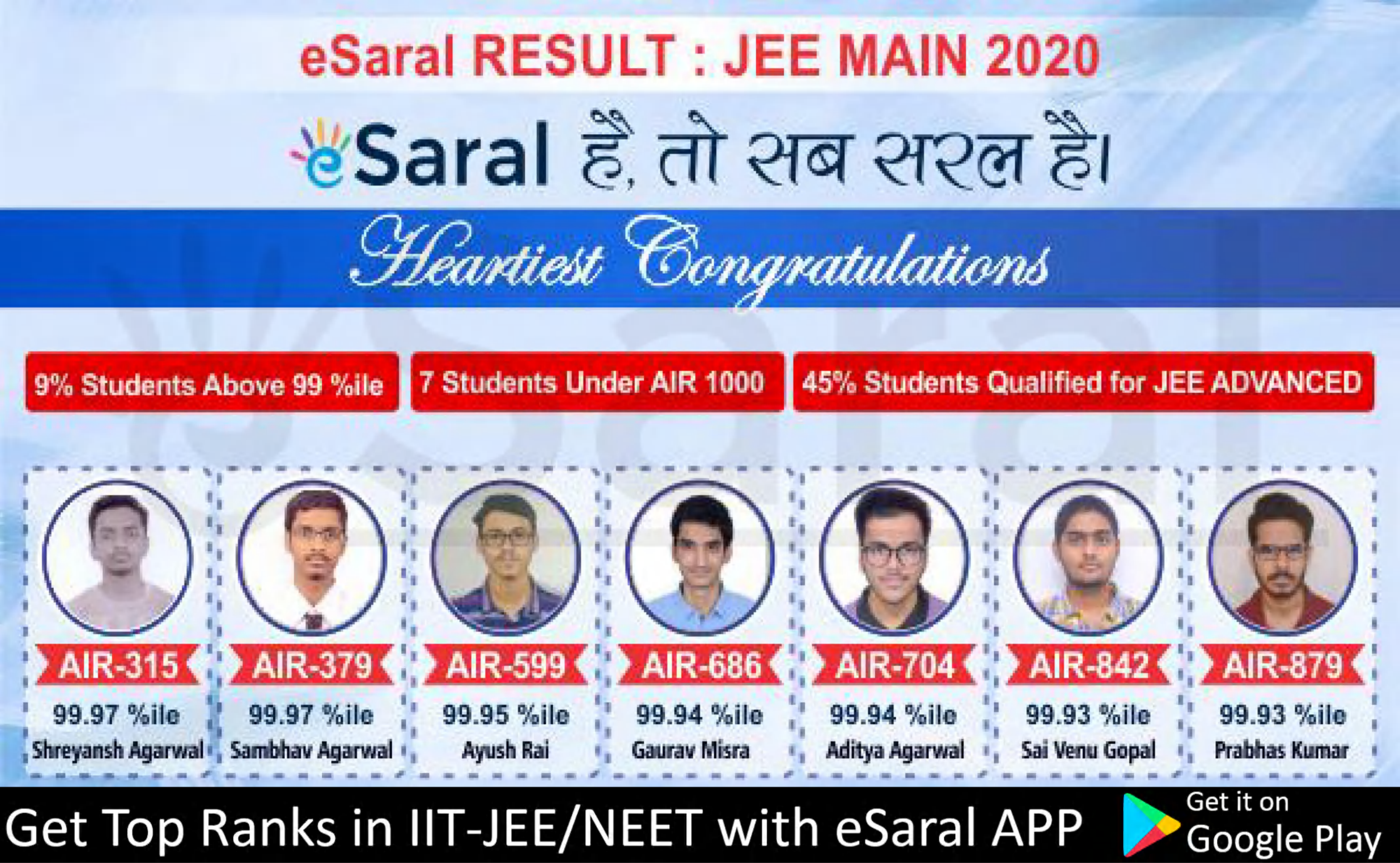
Study Plan

Doubt Solving

Mentorship


eSaral
4 Layered
DOUBT
SOLVING
eSaral है, तो सब सरल है।
L1
L2
L3
L4
SOULTION OF PRACTICE SHEETS
DEDICATED DOUBT HOTLINE
Doubt
SOLVED
LIVE DOUBT SOLVING CLASSES
PERSONALISED CONNECT WITH FACULTIES


With eSaral
what looks
impossible is possible.
eSaral है, तो सब सरल है।
JAN. ATTEMPT
39%le
SEPT. ATTEMPT
99%le
APURV PRINCE
DEOGHAR, JHARKHAND


eSaral RESULT : JEE MAIN 2020
eSaral है, तो सब सरल है।
Heartiest Congratulations
9% Students Above 99 %ile
7 Students Under AIR 1000
45% Students Qualified for JEE ADVANCED
AIR-315
99.97 %ile
Shreyansh Agarwal
AIR-379
99.97 %ile
Sambhav Agarwal
AIR-599
99.95 %ile
Ayush Rai
AIR-686
99.94 %ile
Gaurav Misra
AIR-704
99.94 %ile
Aditya Agarwal
AIR-842
99.93 %ile
Sai Venu Gopal
AIR-879
99.93 %ile
Prabhas Kumar
Get Top Ranks in IIT-JEE/NEET with eSaral APP
Get it on
Google Play


Outstanding eSaral RESULT in JEE ADVANCED 2020
eSaralites in Top 1000
CRL
AIR-468 Amogh v. Agarwal
AIR-932 Shreyansh Agarwal
AIR-966 Gaurav Misra
EWS
AIR-175 Prabhas Kumar
AIR-190 Apoorv Bansal
AIR-211 Vivek Kumar Singhal
AIR-240 Shiva Ganesh Reddy
AIR-295 Shikhar Gupta
AIR-635 Chitraansh Pandey
AIR-669 Harsh Vijayvargiya
AIR-782 Param Shah
AIR-802 Loveneesh Lawaniya
OBC
AIR-263 Abhay Saini
AIR-323 Gaurav Kumawat
AIR-541 Divy Soni
AIR-821 Siddhant Sekhar
AIR-909 Salman Hussain
eSaralites in Top 5000 (CRL)
AIR-1033 Aditya Agarwal
AIR-1224 Ashish Anand
AIR-1289 Pranav Jain
AIR-1330 Ayush Rai
AIR-1662 Vardan Jain
AIR-1670 Akshat Jain
AIR-1738 Shivam K Singhwal
AIR-2430 Aditya Anand
AIR-2577 Toshit Jain
AIR-3377 Sai Venu Gopal
AIR-3390 Pranay Kr. Jha
AIR-3537 Brijesh kumar
AIR-3622 Kshitij Shrivastava
AIR-3733 Priyam Goenka
AIR-4000 Vishnu Bhagawat
AIR-4906 Sonish Singhal
AIR-5000 Rohan Nain

Complete Physics Mega Revision Timetable

15 Feb
- Electrostatics
- Current electricity
- Capacitor
- 🎁Surprise Gift🎁

16 Feb
- Calorimetry
- Elasticity
- Thermal Expansion
- Heat Transfer
- KTG
- Thermodynamics
- Fluid Mechanics

39

17 Feb
- Magnetic effect of current
- Magnetism and matter
- Emi
- AC

18 Feb
- UD
- Vector
- Kinematics 1D
- Kinematics 2D
- NLM
- Friction
- Circular motion
- Work power energy
- COM

19 Feb
- Ray optics
- Optical Instruments
- Wave optics
- EM Waves
- Errors in measurement

20 Feb
- Rotation motion
- Gravitation
- SHM
- Wave on string
- Sound wave

21 Feb
- Atomic structure
- Dual nature of radiation
- X-rays
- Nuclear physics
- Radioactivity
- Semi conductor
- Communication system

MISSION ACCOMPLISHED MISSION