PHOTOELECTRIC EFFECT

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- Current Flowing due to the photoelectrons is called photoelectric current.

Experimental Study

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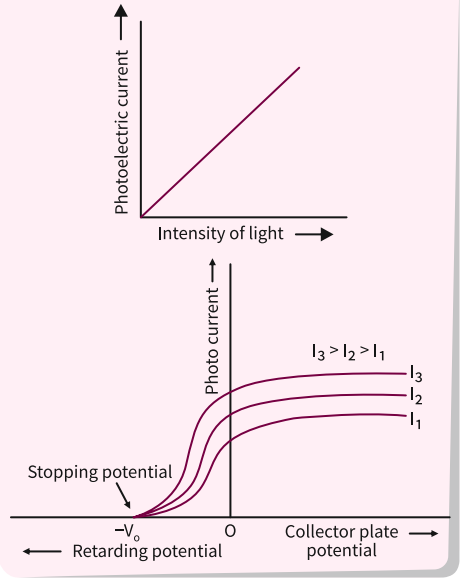
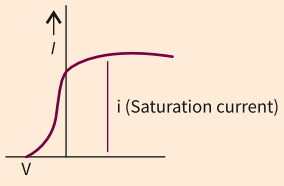
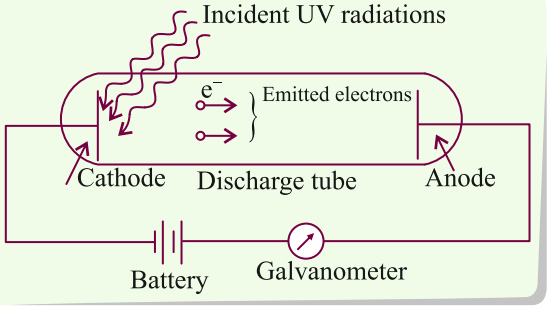
Effect of Intensity of Light



Effect of Potential



Here, $eV_0 = K.E._{max} = h\nu - \Phi_0$



WORK FUNCTION

- Minimum energy required for getting a free electron away from the metal surface.
- Work function $(\Phi_0) = h\nu_0$

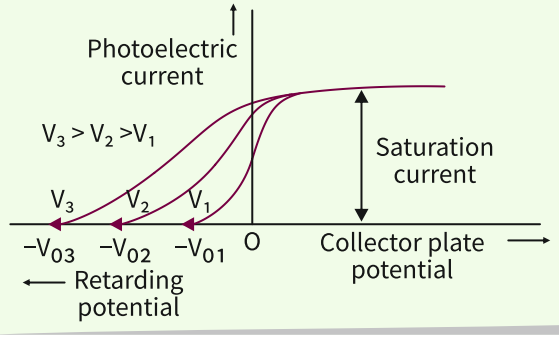
$\nu_0 = \frac{\varphi_0}{h}$ = threshold frequency

11. DUAL NATURE OF RADIATION AND MATTER

Photon Emitted Per Second

- $E = nh\nu$
- Power, $P = \frac{nh\nu}{t}$
- $\frac{n}{t} = \frac{P}{h\nu} = \frac{P\lambda}{hc}$
- Number of photon per second = $\frac{\text{Power}}{\text{energy of one Photon}}$

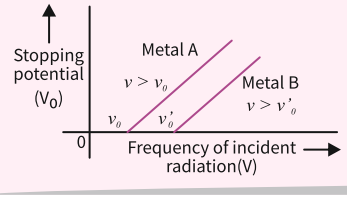
Effect of Frequency of Incident



STOPPING POTENTIAL

- Minimum negative potential required to stop the electron of maximum K.E.

$V_0 = \frac{K.E_{max}}{e} = \frac{h}{e}(\nu - \nu_0)$ Volts



Einstein's Photoelectric Equation

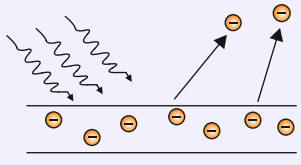
- The electron is emitted with maximum K.E

$K.E_{max} = h\nu - \Phi_0$

$h\nu = K.E_{max} + \Phi_0$

- Range of K.E.

$0 \le K.E._{photoelectrons} \le h\nu - \Phi_0$



Matter Wave

de – Broglie wavelength,

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

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

This is Bohr quantisation Condition

PLANCK'S QUANTUM THEORY OF LIGHT

- The energy of one photon is proportional to its frequency
- $E \propto \nu$, $E = h\nu$

  h = Planck's constant

  $= 6.62 \times 10^{-34}$ Js
- Energy of any light or radiation is integral multiple of hν.

  E = nhν
- Energy of one photon.

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

PROPERTIES OF PHOTONS

- Photon is just a packet of energy.
- Energy of photon does not change with medium.
- Photon can not be deflected by electric field and magnetic field.
- Momentum of photon $|P| = m \times c = \frac{h}{\lambda} = \frac{E}{c}$
- Intensity of light beam = $\frac{\text{Energy}}{\text{area} \times \text{time}}$

MATTER WAVE THEORY

- de – Broglie wavelength associated with moving particles,

  $\lambda = \frac{h}{p}$
- K.E of particle = $\frac{1}{2}mv^2 = \frac{p^2}{2m}$
- momentum, $p = mv = \sqrt{2m \times K.E}$

SPECIAL CASE FOR ELECTRON

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

FOR GASEOUS MOLECULES

$K.E = \frac{3}{2}KT$

$\Rightarrow \lambda = \frac{h}{\sqrt{2m \times \frac{3}{2}KT}}$

$\Rightarrow \lambda = \frac{h}{\sqrt{3mKT}}$

FOR UNCHARGED PARTICLES

$\Rightarrow \lambda = \frac{h}{mv} = \frac{h}{\sqrt{2m \times K.E}}$

FOR ACCELERATED CHARGED PARTICLES

$\lambda = \frac{h}{\sqrt{2m \times qV}}$

V = potential difference

LAWS

- No emission takes place below the threshold Frequency.
- Above threshold Frequency, no. of photoelectrons emitted per seconds is directly proportional to intensity of radiation.
- The emission of photoelectrons is an instantaneous process.
- Above threshold frequency, K.E (max) depends on Frequency.