

|4| Energy of photon →

$$E = h\nu = \frac{hc}{\lambda} = \frac{12400}{\lambda (\text{A}^\circ)} \text{ ev}$$

$$\lambda_{ph} = \frac{12400}{E_{ph}(\text{ev})} \text{ A}^\circ$$

* Penetration power (P.P)

$$I \uparrow, V \downarrow, E_{ph} \downarrow, P.P \downarrow$$

NOTE → * In a reflection freq, velo, wavelength & energy of one photon remains same but total energy may change.

QUESTION

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Y-ray	X-ray	U.V RAYS	VISIBLE	I.R	M.W	R.W
→ Wavelength $\lambda_{ph} < 0.01 \text{ A}^\circ$	0.01 A° - 100 A°	100 A° - 3800 A°	3800 A° - 7800 A°	7800 A° - 10 ⁶ A°	> 10 ⁶ A°	
Energy ranges	> 1.2 MeV \downarrow mega e-volt order	1.24 ev \downarrow kilo e-volt order	3.1 ev - 124 kev	1.3 ev - 3.7 ev	0.012 ev - 0.3 ev	< 0.124 ev

NOTE → * left to Right mass of photon ↓.
* P.E. E not possible from Intra, Radio Wave, microwave.

|5| Momentum of photon → momentum = mass × velocity

$$p = \frac{h}{\lambda} = \frac{E_{ph}}{c}$$

|6| Intensity [I] → Energy transferred per unit time, per unit area.

$$I = \frac{E}{At} = \frac{P}{A} \quad \begin{array}{l} \text{Power of radiation source} \\ \text{Area in which radiation distributed} \end{array}$$

Energy of radiation
= $N_{ph}(h\nu)$

NOTE → Intensity of Radiation only depend on power of Radiation source & distance from Radiation source. It is independent from color of radiation, freq & Wavelength of radiation.

|a| point source/spherical source →

$$r \uparrow, I \downarrow \quad a = \frac{1}{r^2}$$

$$I = \frac{P}{A} = \frac{P}{4\pi r^2} \propto \frac{1}{r^2}$$

|b| Linear/cylindrical source →

$$r \uparrow, I \downarrow \quad a = \frac{1}{\sqrt{r}}$$

$$I = \frac{P}{A} = \frac{P}{2\pi r L} \propto \frac{1}{r}$$

NOTE → If nature of source is not defined consider point source.

|7| No. of photons incident or, Incident per unit time →

$$I = \frac{E}{At}, \quad \frac{N_{ph}}{t} = N_{ph}$$

$$N_{ph} = \frac{IA}{hc} = \frac{IAh}{hc} = \frac{PA}{hc}$$

* $n_{ph} \propto P_d$

$|a| \rightarrow P = \text{same} \Rightarrow n_{ph} \propto A \quad \text{eg} \rightarrow \underline{\text{VIBRATOR}}$

$|b| \rightarrow \lambda = \text{same} \Rightarrow n_{ph} \propto P \quad \text{eg} \rightarrow (n_{ph})_{100} < (n_{ph})_{220\text{W}}$

$$n_{ph} = 5 \times 10^{24} \frac{I}{A} \frac{m^2}{m} = 5 \times 10^{24} \frac{I}{A} h$$

$$\frac{1}{hc} = 5 \times 10^{24} (\text{s.I})$$

|8| \rightarrow Quantum Efficiency (η_e) \rightarrow $\frac{\text{no. of emitted per unit time}}{\text{No. of photon Incident per unit time}}$

$\eta_e = \frac{\text{output}}{\text{Input}}$

$\eta = \frac{n_e}{n_{ph}}$

$n_e = \eta n_{ph} = \eta \left(\frac{P_d}{hc} \right)$

|9| \rightarrow Photoelectric current (i) \rightarrow

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

$i = n e^- (e) = n n_{ph} (e) = n \left(\frac{P_h}{hc} \right) (e) = n \left(\frac{I A d}{hc} \right) (e)$

$\frac{1}{hc} = 5 \times 10^{24} \text{ s.I}$

$= 5 \times 10^{24} \frac{I A d}{m^2 m} / \text{sec}$

[10] \rightarrow Force / pressure exerted on surface \rightarrow

|1| \rightarrow If surface is perfectly reflected \rightarrow

$|\vec{p}| \rightarrow$ change in momentum.

$\Delta \vec{p} \parallel = \vec{p}_f - \vec{p}_i = \frac{h}{d} \sin \theta = \frac{h}{d} \sin \theta = 0$

$\Delta \vec{p} \perp = \vec{p}_f - \vec{p}_i = -\frac{h}{d} \cos \theta - \frac{h}{d} \cos \theta = -\frac{2h}{d} \cos \theta \neq 0$

|10| \rightarrow Momentum transferred to the surface \rightarrow

$$|\Delta \vec{p} \parallel| = 0$$

$$|\Delta \vec{p} \perp| = \frac{2h}{d} \cos \theta$$

|b| \rightarrow Force \rightarrow

$F_{\parallel} = \frac{\Delta p \parallel}{dt} = 0$

$F_{\perp} = \frac{\Delta p \perp}{dt} = \frac{2h \cos \theta}{d}$

|c| \rightarrow Total force \rightarrow

$F_{\perp} = \frac{2P}{C} \cos \theta = \frac{2IA}{C} \cos \theta = 2ucos\theta$

|d| \rightarrow Pressure \rightarrow

$\frac{F_{\perp}}{A} = \frac{2P}{AC} \cos \theta = 2 \left(\frac{I}{C} \right) \cos \theta$

|b| \rightarrow If surface is perfectly absorbing \rightarrow

|i| \rightarrow Change in momentum \rightarrow

$$\Delta \vec{p}_{II} = \vec{p}_f - \vec{p}_i = 0, -\frac{h}{d} \sin \theta = -\frac{h}{d} \sin \theta^2$$

$$\Delta \vec{p}_L = \vec{p}_f - \vec{p}_i = 0, -\frac{h}{d} \cos \theta = -\frac{h}{d} \cos \theta^2$$

|ii| \rightarrow Momentum transfer to the surface \rightarrow

$$\Delta \vec{p}_{II} = \left[\frac{h}{d} \sin \theta \right], \Delta \vec{p}_L = \left[\frac{h}{d} \cos \theta \right]$$

|iii| \rightarrow Force \rightarrow

$$F_{II} = \frac{d \vec{p}_{II}}{dt} = \left[\frac{h I d \sin \theta}{t} \right]$$

$$F_L = \frac{d \vec{p}_L}{dt} = \left[\frac{h I d \cos \theta}{t} \right]$$

|iv| \rightarrow Total force \rightarrow

$$F_{II} = \frac{P}{c} \sin \theta = \frac{2A}{c} \sin \theta$$

$$F_L = \frac{P}{c} \cos \theta = \frac{IA}{c} \cos \theta$$

|V| \rightarrow Pressure \rightarrow

$$P_r = \frac{F_L}{A} = \frac{P}{AC} \cos \theta = \left(\frac{I}{c} \right) \cos \theta = u \cos \theta$$

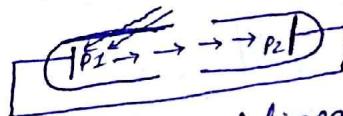
NOTE \rightarrow Pressure exerted by perfectly absorbing surface is half of perfectly reflecting surface.

$$P_r = 2 \left(\frac{I}{c} \right) \cos \theta \quad P_a = \left(\frac{I}{c} \right) \cos \theta$$

* If nature of surface is not defined consider perfectly reflecting surface.

* If angle of incidence is not defined consider radiation incident normally.

* If surface is perfectly reflecting, partially absorbing net press. on surface is scalar addition of reflecting & absorbing part.



2. Practical Explanation of P.E.E. or, Lenard & Milliken

|i| \rightarrow Effect of Intensity \rightarrow Photoelectric current \uparrow linearly with Intensity of Incident Radiation. i

$$* I \propto i \Rightarrow n_{ph}(\uparrow) = n_{electron}(\uparrow) = i(T)$$

$$i \propto I = \frac{P}{4\pi r^2} \propto \frac{1}{r}$$

$$i$$

$$y$$

$$* V < V_0 \Rightarrow i = 0$$

$$* V \geq V_0 \Rightarrow i \neq 0$$

$$V_0 \rightarrow \text{Threshold freq.}$$

$$i \propto V^0$$

|ii| \rightarrow Effect of freq. i

$$* V < V_0 \Rightarrow i = 0$$

$$* V \geq V_0 \Rightarrow i \neq 0$$

$$V_0 \rightarrow \text{Threshold freq.}$$

pitch of voltage \propto space charge
Intensity \propto no. of photons