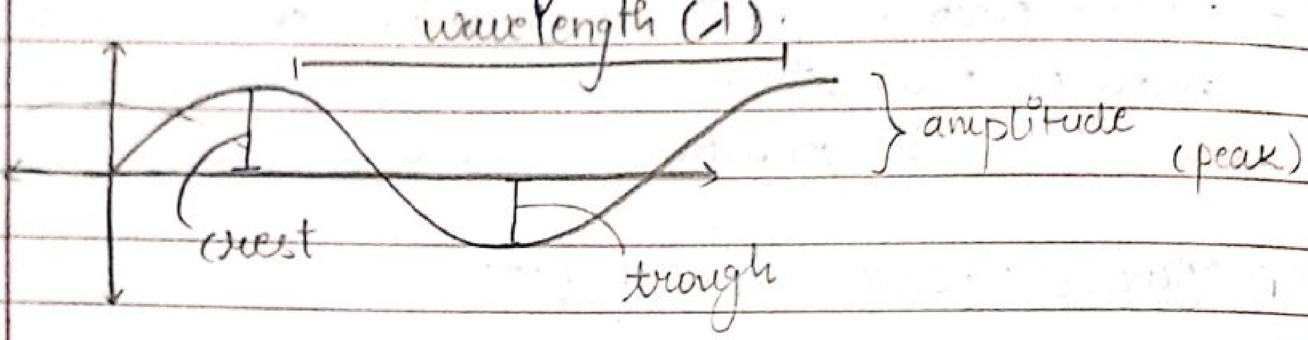
⇛ Characteristics of wave:



a) Wavelength: distance between two nearest (λ) crest or trough.
→ unit = nm (nanometre)

b) frequency: number of wave passing (ν) through a point within a second.
→ unit = per sec or hz (hertz)

c) Wave number: number of present in 1cm. ($\bar{\nu}$)(1/λ) → $1/\lambda = \bar{\nu}$ unit = cm.

d) Amplitude: height of crest or depth of trough.

⇛ Relation b/w velocity, frequency and wavelength:

$$c = \nu\lambda$$

Q:3 Radio city broadcast on frequency of 5090 Khz; find wavelength of EMR emitted by transmittor.

→ $\lambda = \frac{c}{\nu}$

$c = 3 \times 10^8$

$\lambda = \frac{3 \times 10^8}{5090 \times 10^3}$ → $\frac{3}{5090} \times 10^5$

Q:4 Source of EMR emit monochromatic radiation of 50 nm ; wave number find.

→ $\bar{\nu} = 1/\lambda$ → $\lambda = 50 nm$

→ $\bar{\nu} = \frac{1}{50 \times 10^{-9}}$ → $\frac{1}{50 \times 10^{-9}}$ m

11) Plank Quantam theory of EMR:-

- Some properties of light, like black-body radiation; Photoelectric effect cannot be explained by Maxwell wave theory.
- Planck suggested another theory called 'Quantam theory' to explain the nature of EMR.
- Planck suggest, particle like nature of EMR
- according to this theory, EMR (radiant energy) absorb or emit in form of small discrete packets of energy called 'Quanta' (singular) or 'Quantam' (plural).
- Quanta are mass-less (just like energy packs).
- in case of light, small packets of energy is called 'Photon'.
- energy of each quantam is directly proportional to frequency of light. ($e \propto \nu$)

$E = h\nu$ (h = Planck constant)

(1 joule = 10^7 erg) ($h = 6.62 \times 10^{-34}$ J sec)

$E = nh\nu$ n = no. of quanta → 6.62×10^{-27} erg.

or

($c = 3 \times 10^8$) $E = \frac{nhc}{\lambda}$ → $E = \frac{1240}{\lambda} eV$

- energy of single quanta is very small, generally measured in eV (electron volt). ($1 eV = 1.6 \times 10^{-19} J$)

6.62
2
19.86

Q:5 Calculate energy of one mole of photons of radiation whose frequency is 5×10^{14} Hz.

→ $E = h\nu$

($h = 6.62 \times 10^{-34}$ J/sec)

($\nu = 5 \times 10^{14}\ s^{-1}$) (given)

⟹ $E = (6.62 \times 10^{-34})(5 \times 10^{14})$

$= \boxed{3.313 \times 10^{-19} J}$

Q:6 100 watt bulb emits monochromatic light of wavelength 400nm. Calculate number of photons emitted per second by bulb.

⟹ power of bulb = 100 watt

→ 100 Js^{-1}.

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

→ $\frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{400 \times 10^{-9}}$ → $\frac{6.62 \times 3 \times 10^{-26}}{4 \times 10^{2} \times 10^{-9}}$

→ $\frac{1986 \times 10^{-26}}{4 \times 10^{-7}}$ → 4996.5×10^{-19}

→ $\boxed{4.988 \times 10^{-19}}$

Photoelectric Effect:-

- Plank suggested particle nature of light, when EMR absorbed or emitted by metals surface total energy in photoelectric effect can be explain by following 3 cases:

λ° = threshold wavelength

i) $E = E^\circ + KE$

ii) $h\nu = h\nu^\circ + \frac{1}{2} mv^2$

iii) $\frac{hc}{\lambda} = \frac{hc^\circ}{\lambda} + \frac{1}{2} mv^2$

# Case : 1
[E=E°] [Threshold energy / work function]

- Kinetic energy should be zero. (0).
- Total energy converted into 'work function'.

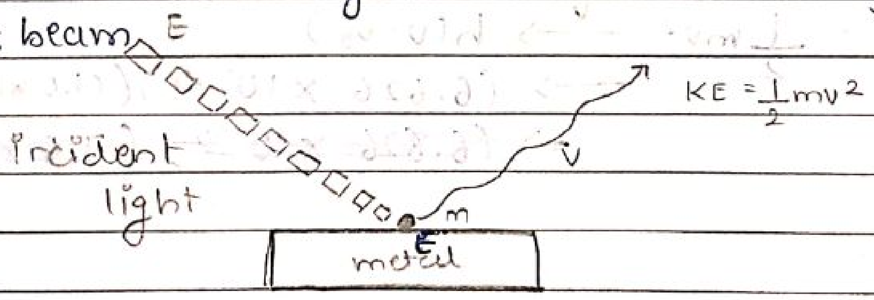
Case : 2
[E<E°]

- Photoelectric effect is not carried out.

Case : 3
[E>E°]

- Photoelectric effect is carried out and remaining energy converted to kinetic energy.

- the electrons are ejected from metal surface there is no time lag between the striking of light beam



⇒ Threshold energy or work function (E°):

→ minimum energy required for removal of an electron from metal surface is THRESHOLD ENERGY.

⇒ Threshold frequency (ν°):

→ minimum frequency required for removal of an electron from metal surface is THRESHOLD FREQUENCY.

Q:7 Work function of metal is 4 eV. To eject photoe- ~~light~~ of velocity zero from surface of metal, wavelength of incident light is:?

⇒ $E^\circ = 4\,eV$

$E = E^\circ + KE$

$= 4 + \frac{1}{2}(m)(0)^2$

$\therefore E = E^\circ \longrightarrow 4\,eV$.

$\frac{nhc}{\lambda} = 4 \longrightarrow \frac{1240}{\lambda} = 4$

$3100\,Å$

Q:8 Threshold frequency ν_0 for metal is $7.0 \times 10^{14}\,s^{-1}$. Calculate KE for e^- emitted. ($\nu = 1.0 \times 10^{15}$)

⇒ $KE = \frac{1}{2}mv^2 \longrightarrow h(\nu - \nu_0)$

$\longrightarrow (6.626 \times 10^{-35})((1.0 \times 10^{15}) - (7 \times 10^{14}))$

~~→ (6.626 × 10⁻³⁵) (7.0 × 10¹)~~

$\rightarrow (6.626 \times 10^{-34})(10-7 \times 10^{14} \times 10^{14})$

$\rightarrow (6.626 \times 10^{-34})(3 \times 10^{14})$

$\Rightarrow \boxed{1.988 \times 10^{-19}}$

Q:9 Energy req. to remove e^- from metal X is 3.31×10^{-20} wavelength of light that cannot photoeject electron from X is/are.

$\Rightarrow$

$E = E^\circ + KE$
$KE = E - E^\circ$
$= h\nu - h\nu^\circ$
$KE = h(\nu - \nu^\circ)$

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

$\rightarrow \lambda = \frac{hc}{E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{3.31 \times 10^{-20}}$

$\lambda = 6 \times 10^{-34+20+8}$

$= 6 \times 10^{-6}$

$\boxed{\lambda = 6\mu m}$

Q:10. Energy of 1mole photon of radiation of wavelength 300nm should be? (kJ/mole)

$\Rightarrow \lambda = 300nm \quad n = 1mole \quad h = 6.62 \times 10^{-34} \quad c = 3 \times 10^{8}$ | $E = \frac{nhc}{\lambda}$

$n = 1 \times 6.02 \times 10^{23}$

$\Rightarrow E = \frac{6.02 \times 10^{23} \times 6.62 \times 10^{-34} \times 3 \times 10^{8}}{300 \times 1000 \times 10^{-9}} \rightarrow \frac{6.62 \times 18 \times 10^{-34+31}}{300 \times 1000 \times 10^{-9}}$

kJ के लिए

39.12

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$$E = \frac{18 \times 6.62 \times 10^{-34+31}}{300 \times 10^{-9} \times 1000} \rightarrow \frac{18 \times 6.62 \times 10^{-3}}{3 \times 10^{-9+5}}$$

$$\rightarrow \frac{39.72 \times 10^{-3}}{10^{-4}} \rightarrow 39.72 \times 10 = \boxed{397.2}$$

Q:11 Energy required to break one mole 'Cl–Cl' bond in (Cl_2) is 242 KJ/mole. longest wavelength of light capable of breaking a single 'Cl–Cl' bond?

→ $E = 242$ $n = 1$ mole → 6×10^{23} $h = 6.62 \times 10^{-34}$ $\lambda =$ nm?

$C = 3 \times 10^{8}$

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

$$\Rightarrow 242 \times 10^{3} = \frac{6 \times 10^{23} \times 6.62 \times 10^{-34} \times 3 \times 10^{8}}{\lambda}$$

$$242 \times 10^{3} = \frac{18 \times 6.62 \times 10^{-3}}{\lambda}$$

$$\lambda = \frac{119.15 \times 10^{-3}}{242 \times 10^{3}}$$

$$= \frac{59.58 \times 10^{-3-3}}{121} \longrightarrow \boxed{4.92 \times 10^{-6}}$$

Q:12 Gas absorb photon of 355 nm (λ) and emit at 2 wavelengths. If one of the emittion is 680nm find out the wavelength of another.

⟹ $\lambda = 355$ nm → 680 (λ), ?

$h = 6.62 \times 10^{-34}$

$C = 3 \times 10^{8}$

$E = h\nu$

$\longrightarrow E = \frac{hc}{\lambda}$ ∴ $\frac{hc}{\lambda} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$

$E = E_1 + E_2$

$\Rightarrow \frac{1}{355} = \frac{1}{680} + E_2$

$\frac{(680)-(355)}{(680)(355)} = \frac{1}{\lambda_2}$ $\rightarrow \frac{325}{(680)(355)} = \frac{1}{\lambda_2}$

$\Rightarrow \frac{13}{9656} = \frac{1}{\lambda_2} \longrightarrow \lambda_2 = \frac{9656}{13}$ 742.76

742.76 (approx) 743 nm

∴ wavelength is 743 nm.

Q:13 One quantum absorbed per gaseous molecules of X_2 converting it into X atoms. If light absorbed has wavelength 1240 A°, then bond energy of X_2 be?

$\Rightarrow E = \frac{1240}{\lambda \text{ (in nm)}}$ here, $\lambda = 1240$ A° $= 124$ nm

∵ $E = \frac{1240}{124} \longrightarrow$ 10 ev/molecule