

Dual Nature of Matter And Radiation

1. Energy of a photon

$$E = h\nu = \frac{hc}{\lambda} \quad h \rightarrow \text{Planck's constant}$$

2. Number of photon emitted per second

$$N = \frac{P}{E} \quad P \rightarrow \text{Power}$$

$E \rightarrow \text{Energy}$

3. Momentum of photon

$$p = \frac{E}{c} = \frac{h\nu}{c} = \frac{h}{\lambda}$$

4. Work function

$$\phi_0 = h\nu_0 = \frac{hc}{\lambda_0}$$

$\nu_0 \rightarrow \text{threshold frequency}$

$\lambda_0 \rightarrow \text{threshold wavelength}$

5. Kinetic energy of photoelectron (By Einstein's photoelectric equation)

$$\begin{aligned} K_{\max} &= \frac{1}{2} m v^2 = h\nu - \phi_0 \\ &= h\nu - h\nu_0 \\ &= h(\nu - \nu_0) \\ &= hc \left(\frac{1}{\lambda} - \frac{1}{\lambda_0} \right) \end{aligned}$$

6. Maximum K.E of ejected photoelectron

$$K = \frac{1}{2} m v_{\max}^2 = eV_0$$

$e \rightarrow \text{charge of electron}$

$V_0 \rightarrow \text{stopping potential}$

$v \rightarrow \text{velocity}$

7. Kinetic energy of De-Broglie Waves

$$K = \frac{1}{2}mv^2 = \frac{p^2}{2m} \quad p \rightarrow \text{momentum}$$

8. Momentum of De-Broglie Waves

$$P = \sqrt{2mK} \quad K \rightarrow \text{Kinetic energy}$$

9. Wavelengths of De-Broglie Waves

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mK}}$$

10. De-Broglie Wavelength of an electron beam accelerated through a potential difference of V volts is

$$\lambda = \frac{h}{\sqrt{2meV}} = \frac{1.23}{\sqrt{V}} \text{ nm} = \frac{12.27}{\sqrt{V}} \text{ \AA}$$

$$V \rightarrow \text{potential difference}$$

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

11. De Broglie wavelength for a gas molecules of mass m at temp. T Kelvin

$$\lambda = \frac{h}{\sqrt{2mKT}} \quad K \rightarrow \text{Boltzmann constant}$$

$$T \rightarrow \text{temperature}$$

12. Value of hc

$$\begin{aligned} hc &= 6.6 \times 10^{-34} \times 3 \times 10^8 \\ &= 12400 \text{ eV \AA} \end{aligned}$$

* for same velocity

$$\frac{\lambda_1}{\lambda_2} = \frac{m_2}{m_1} \quad \left[\lambda = \frac{h}{mv} \right]$$

* for same potential difference V

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{m_2 q_2}{m_1 q_1}} \quad \left[\lambda = \frac{h}{\sqrt{2mqV}} \right]$$

* for same V

$$\frac{K_1}{K_2} = \frac{q_1}{q_2} \quad [K = qV]$$

* Energy of photon = $\frac{2\lambda mc}{h} \times \text{K.E of electron}$

$$eV_0 = h\nu - h\nu_0$$
$$V_0 = \frac{h}{e} \nu - \frac{h}{e} \nu_0 \quad - (1)$$

$$y = mx + c \quad - (2)$$

on comparing (1) and (2)

$$m = \frac{h}{e} \rightarrow \text{slope of the graph}$$