FORMULA SHEET Ch 11

Dual Nature of Matter And Radiation

1. Energy of a photon

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

$h \rightarrow$ Planck's constant

2. Number of photon emitted per second

$$N = \frac{P}{E}$$

$P \rightarrow$ Power
$E \rightarrow$ Energy

3. Momentum of photon

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

4. Work function

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

$\nu_0 \rightarrow$ threshold frequency
$\lambda_0 \rightarrow$ threshold wavelength

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

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

6. Maximum K.E of ejected photoelectron

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

$e \rightarrow$ charge of electron
$V_0 \rightarrow$ Stopping potential
$v \rightarrow$ velocity

7. Kinetic energy of De-Broglie Waves

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

8. Momentum of De-Broglie Waves

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

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

$$\lambda = \frac{h}{\sqrt{2meV}} = \frac{1.23}{\sqrt{V}}\,nm = \frac{12.27}{\sqrt{V}}\,A^o$$

$V \rightarrow$ potential difference

$1\,nm = 10^{-9}\,m \quad , \quad 1\,A^o = 10^{-10}\,m$

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

$$\lambda = \frac{h}{\sqrt{2mKT}}$$

$K \rightarrow$ Boltzmann constant
$T \rightarrow$ temperature

12. Value of hc

$$hc = 6.6 \times 10^{-34} \times 3 \times 10^{8}$$
$$= 12400\ eV\ A^o$$

* For same velocity

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

* For same potential difference V

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

* For same V

$$\frac{K_1}{K_2} = \frac{q_1}{q_2} \qquad \left[K = qV\right]$$

* Energy of photon $= \frac{2\lambda mc}{h} \times$ 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)

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