CONCEPT MAP

Dual Nature of Matter and Radiation

Matter Waves: The waves associated with the moving material particles are called matter waves.

Einstein's Photoelectric Equation:

$K_{max} = h\upsilon_e - \phi$

For $\upsilon = \upsilon_0$

or $eV_0 = h\upsilon = \phi_0$

$eV_0 = K_{max} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$

Photoelectric Effect: Phenomenon of emission of electrons from the surface of metals, when light radiations of suitable frequency fall on them.

Dual Nature of Radiation: Radiation has dual nature, wave nature and particle nature.

de Broglie Relation:

$\lambda = \frac{h}{p} = \frac{h}{mv}$

$\lambda = \frac{h\left(1 - \frac{v^2}{c^2}\right)^{1/2}}{m_0 v}$

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

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

$\lambda = \frac{h}{\sqrt{3mk_bT}}$

Davisson and Germer Experiment: They performed an experiment to study the wave nature of electrons as suggested by de Broglie.

The phenomena like interference, diffraction and polarization etc. which can be explained on the basis of electromagnetic (wave) nature of radiation only.

The phenomena like rectilinear propagation, reflection, refraction etc., which can be explained on the basis of either of the wave nature or of the particle nature of radiation.

The phenomena like photoelectric effect, compton effect etc., which can be explained on the basis of quantum (particle) nature of radiation.

Symbols Used:

V_0 = stopping potential
K = kinetic energy
h = Planck's constant
υ = incident frequency
υ_0 = threshold frequency
λ = incident wavelength
k_b = Boltzmann constant
λ_0 = threshold wavelength
c = velocity of light
m = mass of the particle
v = velocity of the particle
p = momentum of the particle
e = charge of the photoelectron
V = potential difference
m_0 = rest mass of particle