Compton Effect:

Relation between θ and ϕ :- $mv\cos\theta = h(\nu - \nu'\cos\phi)$ — (1)

$mv\sin\theta = h\nu'\sin\phi$ — (2)

$$\frac{(2)}{(1)} \quad \tan\theta = \frac{\nu'\sin\phi}{\nu - \nu'\cos\phi} = \frac{\sin\phi}{\nu/\nu' - \cos\phi}$$

$$= \frac{\sin\phi}{\frac{\lambda}{\lambda'} - \cos\phi} = \frac{\sin\phi}{1 + \frac{h(1-\cos\phi)}{m_0 c\lambda} - \cos\phi}$$

But.

$$\frac{\lambda'}{\lambda} = 1 + \frac{h}{m_0 c\lambda}(1-\cos\phi) \quad \therefore \tan\theta = \frac{\sin\phi}{1+\alpha(1-\cos\phi)-\cos\phi}$$

where $\alpha = \frac{h}{m_0 c\lambda} = \frac{h\nu}{m_0 c^2}$

$$\tan\theta = \frac{\sin\phi}{(1-\cos\phi)(1+\alpha)} = \frac{2\sin\frac{\phi}{2}\cos\phi/2}{(1+\alpha)2\sin^2\phi/2}$$

$$\boxed{\tan\theta = \frac{\cot\phi/2}{(1+\alpha)}}$$

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De Broglie's Hypothesis :-

After Planck, Einstein and Compton, De Broglie extended this wave particle duality to material particles.

frequency of Photon $E = h\nu$

$$P = \frac{E}{c} = \frac{h\nu}{c}$$

$$P = \frac{h}{\lambda} \quad \text{or} = \boxed{\lambda = \frac{h}{P}}$$ ~ De Broglie wavelength

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

De Broglie explain the stationary Bohr Orbits by fitting a standing wave around the circumference of an orbit. If λ is the wave length associated with the nth orbit and r is its radius

$$2\pi r = n\lambda$$

Combining this with the Bohr Postulate

$$mvr = \frac{nh}{2\pi}$$

$$n\lambda = 2\pi\left(\frac{nh}{2\pi mv}\right)$$

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

$$P = \frac{h}{\lambda} = \hbar k. \qquad k = 2\pi/\lambda$$

k is called Propagation vector

Non Relativstic :-

In terms of K.E. :-

$$K.E = \frac{P^2}{2m}$$

$$P = \sqrt{2mK}$$

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

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In terms of Accelerating Potential :-

$$K = qV$$

$$\lambda = \frac{h}{\sqrt{2mqV}} = \frac{12.3}{\sqrt{V}} \text{ Å}$$

Relativistic

In terms of Kinetic Energy :-

for a particle of rest mass m_0, the total Energy

$$E^2 = p^2c^2 + m_0^2c^4$$

$$E = K + m_0c^2$$

$$\lambda = \frac{h}{p}, \quad p = \frac{1}{c}\sqrt{(K+m_0c^2)^2 - m_0^2c^4}$$

In terms of Accelerating Potential :-

If a particle has charge q and is potential diff. V

$$K = qV$$

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Davison German Experiment :-

Electron gun.
Nickel crystal
Collector

$$\theta + \phi + \theta = 180$$

$$2\theta = 180 - \phi \quad \text{or} \quad \theta = \frac{180-50}{2} = 65$$

When beam of electron is incident on nickel crystal at a glancing angle $\theta = 65^\circ$ then sharp max. is obtained at angle 50° (Intensity of scatter electron is maximum.

Acc. to De Broglie.

$$\lambda = \frac{12.27}{\sqrt{V}} \text{ A}$$

When e are accelerated through 54 Volt

$$\boxed{\lambda = \frac{12.27}{\sqrt{54}} = 1.67 \text{ A}^\circ}$$

Bragg's Equation for max. diff. pattern

$$2d\sin\theta = n\lambda$$

$$d = 0.91 \text{ A}^\circ$$

for first Principal maxima $n = 1$

$$\lambda = 2 \times 0.91 \times \sin 65$$

$$\boxed{\lambda = 1.65 \text{ A}^\circ}$$

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