$$\boxed{\lambda' - \lambda = 4\pi \lambda_e \sin^2 \theta/2}$$

$$\lambda_e = \frac{\hbar}{mc}$$

→ change in wavelength $\Delta\lambda = \lambda' - \lambda$ depends on the angle of scattering angle θ ad. do not on the frequency.

→ This is what happens in particle collisions establishing the fact that radiations ~~beave~~ behaves like a beam of particle.

Wave Aspect of Particles:

a). de-Broglie's Hypothesis: Matter Waves:

→ A photon of frequency ω has a momentum

$$p = \frac{E}{c} = \frac{\hbar\omega}{c}$$

or interms of wavelength.

$$P = \hbar k = \frac{2\pi\hbar}{\lambda}, \quad k = \frac{2\pi}{\lambda}$$

$$\lambda = \frac{2\pi\hbar}{p} = \frac{h}{p} \text{ — photon wave-length}$$

The formula.

$$\lambda = \frac{h}{p} = \frac{h}{mv} \text{ — de-Broglie}$$

applies to material particles as well as photon.

→ Experimental Confirmation of de-Broglie's Hypothesis:

Davisson-Germer Experiment:

→ used X-ray diffraction method to study the wave behaviour of a particle.

→ An $\bar{e}$ beam is scattered at the surface of nickle crystal — as a result diffraction patterns are obtained.

→ The diffraction patterns are exactly similar to those obtained in X-ray diffraction

The condition is.

$$\boxed{\frac{nh}{d\sqrt{2me}} = \sqrt{V}\,\sin\theta}$$

→ Heisenberg's Uncertainty Principle

→ Classical concept: position and momentum are independent of each other and can be determined exactly at the same time.

→ Quantum Theory: It is impossible to know the exact position and the momentum of a particle at the same time".

$$\Delta x\,\Delta p_x \geq \hbar$$

If $\Delta x = 0$ – position exactly known.

then $\Delta p_x = \infty$

→ The uncertainty in the position of an $\bar{e}$ is of the order of wavelength of light i.e $\Delta x \sim \lambda$

→ Uncertainty in the momentum of an $\bar{e}$ is the order of momentum of photon, when photon of momentum $2\pi \hbar/\lambda$ hits the $\bar{e}$. i.e.

$$\Delta p \sim 2\pi \hbar/\lambda.$$

Since,

$$\Delta x \Delta p \sim \lambda . 2\pi \hbar/\lambda.$$

$$\Delta x \Delta p \sim 2\pi \hbar$$

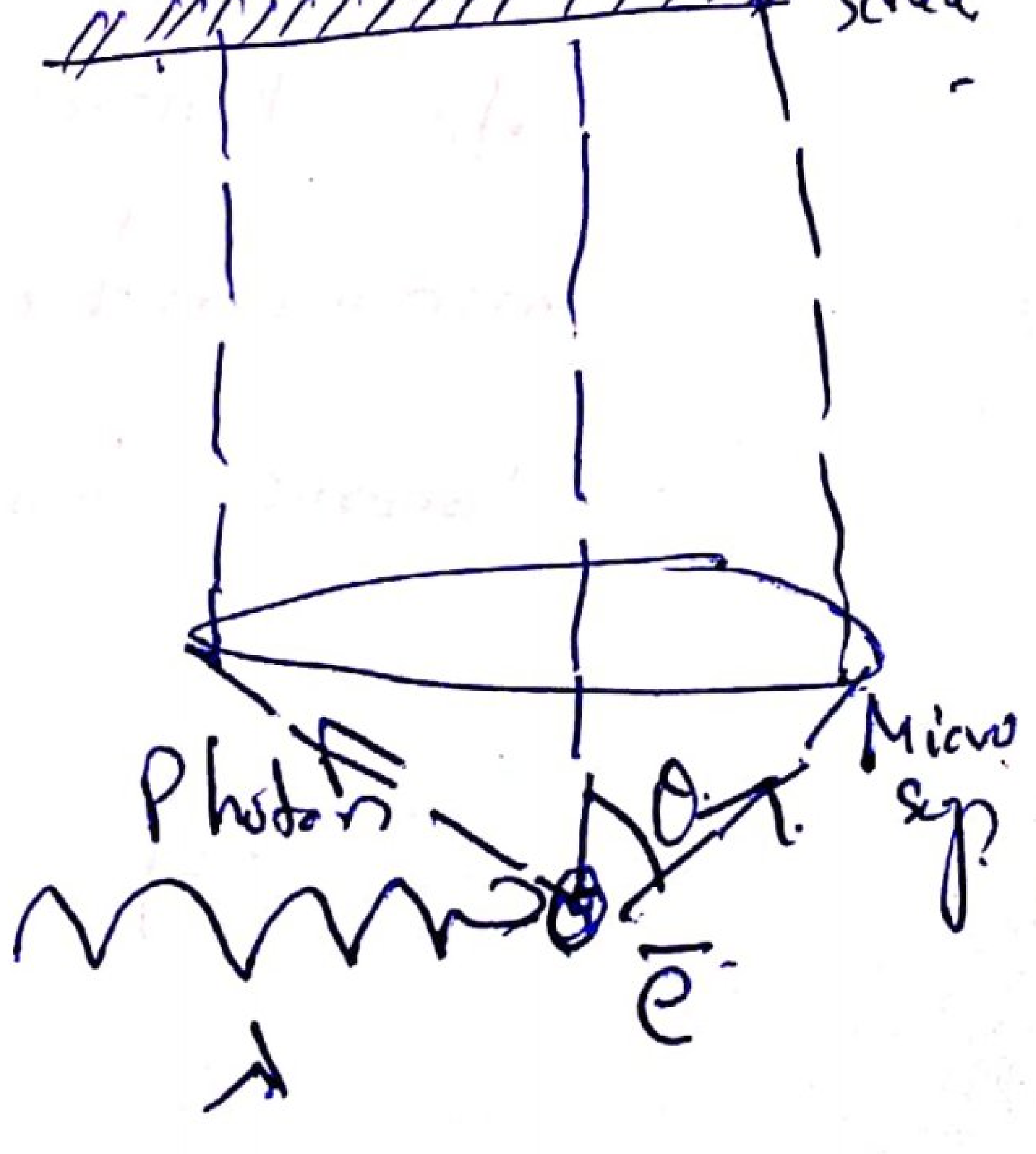
$$\boxed{\Delta x \Delta p \geq \hbar}$$

More precise picture the Heisenberg microscope,

The change in position

$$\Delta x \approx \frac{\lambda}{\sin\theta}$$

$$\Delta p_x \approx \frac{h}{\lambda} \sin\theta$$



Hence.

$$\Delta x \, \Delta p_x \sim h = 2\pi\hbar$$

$$\boxed{\Delta x \, \Delta p_x \gtrsim \hbar}$$

Wave fn. Ψ

"A matter wave is represented by a Complex variable quantity $\psi(x,t)$ called the wavefn."

Normalized to unity:

$$\int_{-\infty}^{\infty} |\psi(x,t)|^2 \, dx = 1$$

$$|\psi(x,t)|^2 \xrightarrow{\text{vanish}} 0, \text{ when } x \to \pm\infty$$

called norm.

probability.

Schrodinger wave Equation:

Basic Equ. of Quantum mechanics which describes propagation of material waves.

$E = \frac{p^2}{2m}$ – classical Equ. of motion

→ In quantum mechanics, particle is describe by wavefn

$$\psi(x,t) = A e^{i(kx-\omega t)}$$

$$-\frac{\hbar^2}{2m}\frac{\partial^2 \psi}{\partial x^2} = i\hbar \frac{\partial \psi}{\partial t}$$

time-dependent S.W.E

1D. – free particle

$$\hat{H}\psi = E\psi$$

$$\hat{H} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}, \quad \hat{E} = i\hbar\frac{\partial}{\partial t}$$

classical Hamiltonian. – $\frac{p^2}{2m}$.

$$p \longrightarrow -i\hbar\frac{\partial}{\partial x}$$

$$E \longrightarrow i\hbar\frac{\partial}{\partial t}$$