heisenberg uncertainity

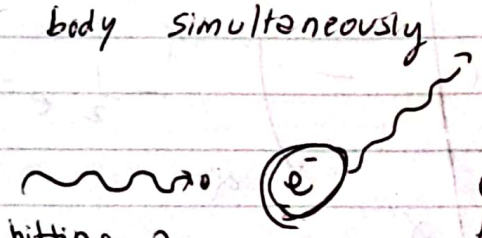
$\hbar = 10^{-34}$ J s / rad

$\sigma_x \sigma_p \geq \frac{\hbar}{2}$; $\Delta x \Delta p \geq \hbar/2$

1) heisenberg uncertainity principle has nothing to do with the measurement of (x), (p)

measurement ≠ theory

2) It's impossible to know the exact position & momentum of body simultaneously



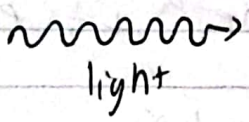
[x, p] → error

• hitting a ligth

electron changes position after the light hits the electron

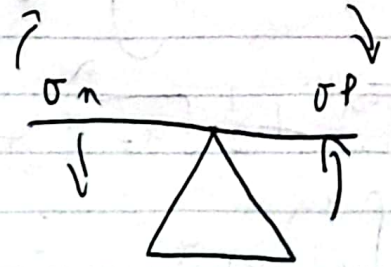
x ; p → location known, momentum not known

p ; x → momentum known, position not known



light

electron motion



increase mom, decrease motion → vise versa

⇒ heisenberg uncertainy only applicable in the quantum world but not classical world.

$$\sigma x \, \sigma p \geq \hbar/2 \quad ; \quad \Delta x \Delta p \geq \hbar/2$$

Subatomic particles

⇒ Because SAP like electrons have wave - particle duality,

1) hard to find exact location
2) hard to find the momentum
3) hard to distinguish between electron & wave

⇒ wave function : ψ [because the subatomic particle behaves as wave HUP exists]

$$\int_{-\infty}^{+\infty} |\psi|^2 dx = 1$$ [Because particle exists 100% from $-\infty$ to $+\infty$]

⇒ $p \propto \frac{1}{\lambda}$ [wave] : x : localise particle

⇒ to find position, we must localise the particle by summing up all the particle

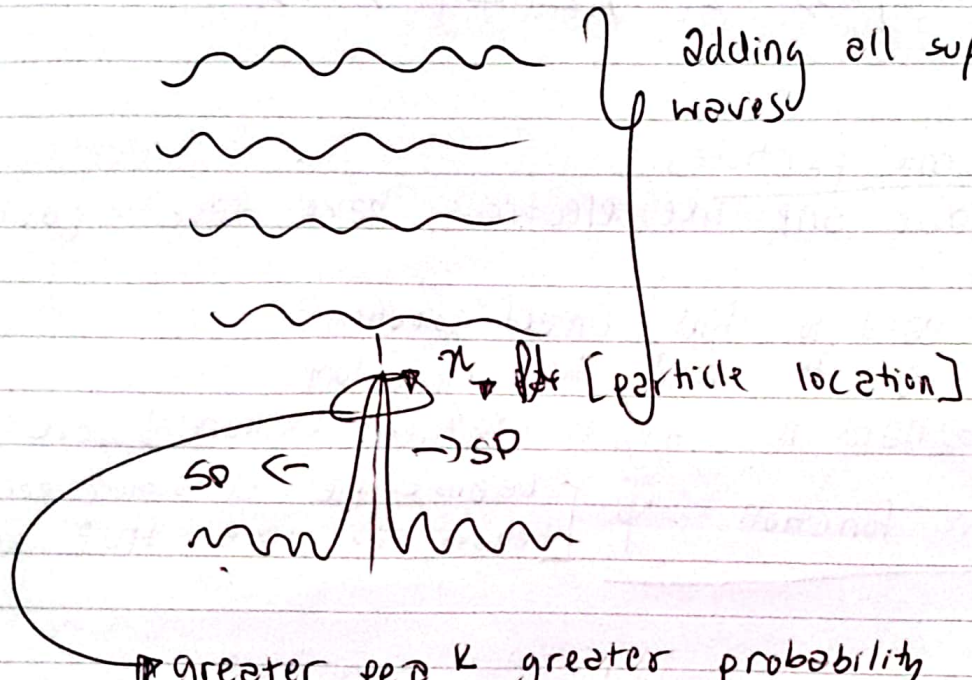
⇒ $\sigma x \, \sigma p \geq \hbar/2$ $\therefore \lambda \Rightarrow p = \hbar K = \frac{h}{\lambda}$

particle wave

[if i know the λ, i know the momentum]

⇒ Based on wavelength we can get momentum

⇒ To localize the location of particle, we must add all the super position waves



greater peak greater probability

we know the probability of where the particle may exist

λ being single wave leading to not finding momentum because we cannot find the momentum of a single wave

$$\sigma x \sigma p \geq \hbar/2$$ HUP

$\sigma x = \sqrt{\langle x^2 \rangle - \langle x \rangle^2}$

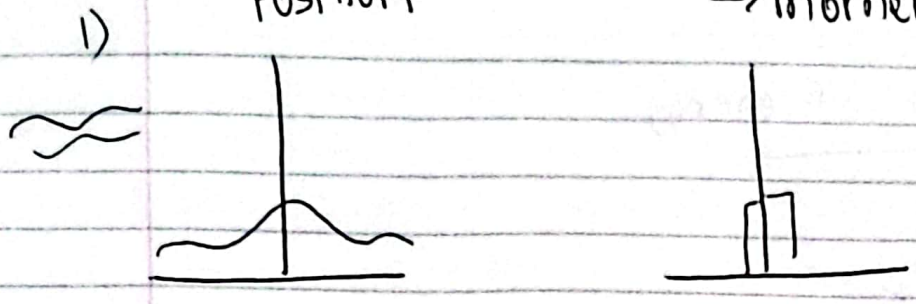
= Standard deviation [location]

$\sigma p = \sqrt{\langle p^2 \rangle - \langle p \rangle^2}$

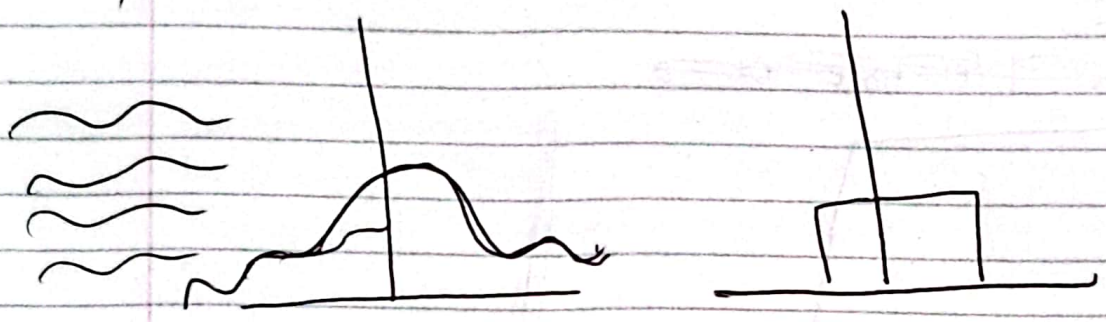
= SD [momentum]

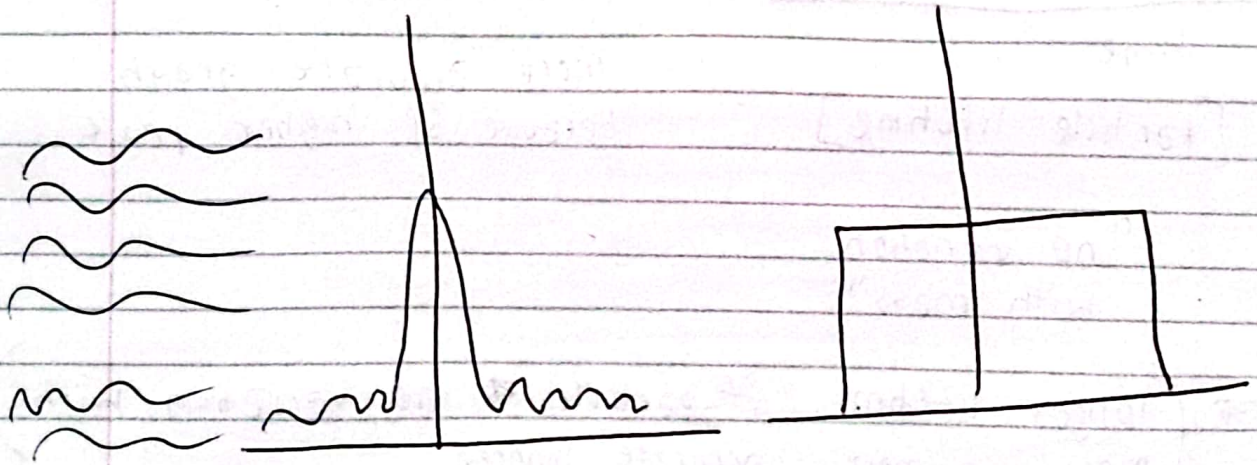
1) Position

Wavelength → momentum



2)





more waves

narrower peak graph

expanded wavelength

& vise versa for less waves

→ Adding more waves gives us the probability of where the particle exists but momentum graph is so expanded that we cannot find the momentum of the particle at a ~~spot~~ "almost" specified location