$c = \frac{d\nu}{t}$ $\Delta x \cdot \Delta p = \frac{h}{4\pi}$ $\nu = \frac{c}{\lambda}$

WAVE MECHANICS:

De-Broglie hypothesis:

Every moving particle is associated with a wave called the matter waves or de-broglie waves whose wavelength is λ.

Diff. b/w electromagnetic wave and matter waves →

	Matter waves	Electromagnetic waves
1)	matter waves are associated with moving particle whether the particles are charged or not.	1) These waves are associated with moving particle which is accelerated.
(2)	The velocity of matter waves depends upon the velocity of material particles.	2) Velocity of Emw is constant in a given medium.
3)	The velocity of matter waves is generally less than velocity of light.	3) The velocity of Electromagnetic waves is equal to the velocity of light.
4)	The matter waves have shorter wavelength given by de broglie eq^n $\boxed{\lambda = h/p}$	4) The wavelength of Electromagnetic waves are given by $\boxed{\lambda = \frac{c}{\nu}}$

⇒ Dual nature of light:

Light has dual nature first wave nature (like interference, diffraction.) particle nature (like photo electric effect, compton effect Black body radiation)

$E \Rightarrow$

De broglie wavelength for photons:

$$\boxed{\lambda \Rightarrow \frac{h}{mc}}$$

$\Rightarrow$ We know that,

$$E = mc^2 \rightarrow (1)$$

$$E = h\nu \rightarrow (2)$$

$$\nu = \frac{c}{\lambda} \quad - (3)$$

put eq^n (3) in eq^n (2)

$$E = \frac{hc}{\lambda} \quad - (4)$$

by eq^n (1) and eq^n (4)

$$mc^2 = \frac{hc}{\lambda}$$

$$\boxed{\lambda \Rightarrow \frac{h}{mc}}$$

for other particle of mass m moving with velocity v

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

We know that, $K.E \Rightarrow E_k \Rightarrow \frac{1}{2}mv^2$

$$\boxed{\lambda \Rightarrow \frac{hv}{2E_k}}$$

$\lambda \Rightarrow$

$\Rightarrow$ $K.E \Rightarrow \frac{1}{2}mv^2 \Rightarrow \frac{1}{2}\frac{m^2v^2}{m}$

$$2mK.E = (mv)^2$$

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

$\frac{12.27 \text{Å}}{\sqrt{V}}$

$\lambda = \frac{h}{\sqrt{2m K.E}}$

K.E for charge particle =

$E_k = eV$

e = charge
V = potential difference

$\lambda = \frac{h}{\sqrt{2m qV}}$

De-broglie wavelength of e^- (Non-relativistic case):

$E_k = qV$

$E_k = eV$

$\frac{1}{2}mv^2 = eV$

$v = \sqrt{\frac{2eV}{m_0}}$

$\lambda = \frac{h}{m_0 v}$

$\lambda = \frac{h}{\sqrt{2eVm_0}}$

for e^-, $m_0 = 9.1 \times 10^{-31}$ kg

$q = e = 1.6 \times 10^{-19}$ C

$h = 6.626 \times 10^{-34}$

$\lambda = \frac{6.626 \times 10^{-34}}{5.396\sqrt{10^{-31} \times 10^{-19}}}$

$\lambda = \frac{6.626 \times 10^{-34}}{5.396 \times 10^{-25}}$

$K \Rightarrow (m-m_0)c^2$

Imp

Ques → A particle of rest mass m_0 has a K.E → K so that its de broglie wavelength is given by $\lambda = \frac{hc}{\sqrt{K(K+2m_0c^2)}}$

Calculate the wavelength of the e^- of K.E = 1 MeV?

Derive expression of λ if $K.E << m_0c^2$:

Ques → Show that the de broglie wavelength for a material particle of rest mass m_0 and charge q acc from rest through a potential diff V volt relativisticly is given by

$$\lambda \Rightarrow \frac{h}{\sqrt{2m_0qV\left[1+\frac{qV}{2m_0c^2}\right]}}$$

Soln →

$$\lambda \rightarrow \frac{h}{mv}$$

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

$$\lambda^2 \Rightarrow \frac{h^2(c^2-v^2)c^2}{m_0^2c^3v^2 \cdot c}$$

$$\lambda \Rightarrow \frac{h}{}$$

$$\lambda^2 \Rightarrow \frac{h^2(c^2-v^2)c^2}{m_0c^2 \cdot m_0c^2v^2}$$

$$\lambda^2 = \frac{h^2c^2(c^2-v^2)}{(mc^2-K)^2 \cdot v^2}$$

$$\lambda^2 \Rightarrow \frac{h^2c^2(c^2-v^2)}{(m^2c^4+K^2-2Kmc^2)v^2}$$

$$\lambda \Rightarrow \frac{6.626\times10^{-34}\times3\times10^8}{\sqrt{3.2\times10^{-13}\times4838\times10^{-15}}}$$

$$\lambda \Rightarrow \frac{6.626\times\cancel{10^{-34}}\times3\times\cancel{10^8}}{39.34\times\cancel{10^{-14}}} \quad 10^{-26} \quad 10^{-12}$$

$$\lambda \Rightarrow 0.505\times10^{-12}$$

Sol^n →

$$\lambda \Rightarrow \frac{h}{mv}$$

$$m \Rightarrow \frac{m_0}{\sqrt{1-v^2/c^2}}$$

$$m^2 = \frac{m_0^2}{1-\frac{v^2}{c^2}}$$

$$m^2c^2 - m^2v^2 = m_0^2c^2$$

$$(mv)^2 = m^2c^2 - m_0^2c^2$$

$$mv \Rightarrow \sqrt{(m^2-m_0^2)c^2}$$

$$mv = \sqrt{c^2(m^2-m_0^2)}$$

$$\lambda \Rightarrow \frac{h}{mv} \Rightarrow \frac{h}{\sqrt{c^2(m^2-m_0^2)}} \Rightarrow \frac{hc}{\sqrt{c^2(m-m_0)c^2(m+m_0)}}$$

$$\lambda \Rightarrow \frac{hc}{\sqrt{kc^2(m+m_0)}}$$

$$\lambda \Rightarrow \frac{hc}{\sqrt{k(c^2(m-m_0)+2m_0c^2}}$$

$$\lambda \Rightarrow \frac{hc}{\sqrt{k(k+2m_0c^2)}}$$

Sol^n →

$$k << m_0c^2$$

$$k + 2m_0c^2 \simeq 2m_0c^2$$

$$\lambda \Rightarrow \frac{hc}{\sqrt{k\,2m_0c^2}}$$

$$\lambda \Rightarrow \frac{h}{\sqrt{k \cdot 2m_0}}$$

for e

$$k \Rightarrow 2 \times 1.6 \times 10^{-19} \times 10^6 \text{ J} \Rightarrow 3.2 \times 10^{-13}$$

$$\lambda \Rightarrow \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{\sqrt{3.2 \times 10^{-13}(3.2 \times 10^{-13} + 2 \times 9.1 \times 10^{-31} \times 9 \times 10^{16})}}$$

$$\lambda \Rightarrow \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{\sqrt{3.2 \times 10^{-13}(3.2 \times \frac{10^{-13}}{100} + 163.8 \times 10^{-15})}} \Rightarrow \frac{6}{\sqrt{3.2 \times 10^{-13} \times 483.8}}$$

51.1875×10^4

0.51×10^6 MeV

$m_0c^2 \Rightarrow 9.1 \times 10^{-31} \times 9 \times 10^{16}$

$\Rightarrow \cancel{\frac{51.1875 \times 10^{-14}}{1.6 \times 10^{-19}}}$

$\Rightarrow \cancel{51875}$

for proton - $K \Rightarrow 1 MeV$

$$m_0c^2 \Rightarrow 1.67 \times 10^{-27} \times 9 \times 10^{16}$$

$$\Rightarrow 15.03 \times 10^{-11} \ J$$

$$\Rightarrow \frac{15.03 \times 10^{-11}}{1.6 \times 10^{-19}}$$

$$\Rightarrow 9.39 \times 10^{8} \ eV$$

$$\Rightarrow 939 \times 10^{6} \ eV$$

Sol^n

$$\cancel{\lambda \Rightarrow \frac{h}{\sqrt{2mqV}}}$$

$$\cancel{m \Rightarrow \frac{m_0}{\sqrt{1 - v^2/c^2}}}$$

$$\cancel{m^2c^2 - m^2v^2 = m_0^2c^2}$$

$$\cancel{\lambda^2 = \frac{h^2}{2m_0qV}\left(1 - \frac{v^2}{c^2}\right)}$$

$$\cancel{\lambda \Rightarrow \frac{h}{\sqrt{2m_0qV}}\sqrt{1 - \frac{v^2}{c^2}}}$$

$$E^2 = p^2c^2 + m_0^2c^4 \quad -(1)$$

Total energy $= K + m_0c^2$

$$E = qV + m_0c^2 \quad -(2)$$

$$p^2c^2 \Rightarrow E^2 - m_0^2c^4$$

$$p^2 = \frac{E^2 - m_0^2c^4}{c^2}$$

$$\lambda \Rightarrow \frac{hc}{\sqrt{E^2 - m_0^2c^4}}$$

$$\lambda = \frac{hc}{(q^2V^2 + m_0^2c^4 + 2qVm_0c^2 - m_0^2c^4)^{1/2}}$$

$$\lambda \Rightarrow \frac{hc}{(q^2V^2 + 2qVm_0c^2)^{1/2}}$$

$$\lambda \Rightarrow \frac{h}{\left(\frac{q^2V^2}{c^2} + 2qVm_0\right)^{1/2}}$$

$$\lambda \Rightarrow \frac{h}{\sqrt{2m_0qV\left[1 - \frac{qV}{2m_0c^2}\right]}}$$

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Ques1) $V \Rightarrow 1250\, eV$

$E \Rightarrow 1250 \times 1.6 \times 10^{-19}$ J

$d \Rightarrow \frac{6.626 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 1250 \times 10^{-19}}}$

$d \Rightarrow \frac{6.626 \times 10^{-34}}{190.8310 \times 10^{-25}}$

$\cancel{d \Rightarrow 0.043 \times 10^{-6}}$

$d \Rightarrow 0.03472 \times 10^{-9}$

$d \Rightarrow 3.47 \times 10^{-18}$ m

Que) $V = 1.25 \times 10^{3}\, eV = 1250$

$d \Rightarrow \frac{12.28}{\sqrt{1250}}$ Å

$d \Rightarrow 0.347$ Å

$d = 0.347 \times 10^{-10}$ m

$d = 3.47 \times 10^{-11}$ m

Ans 2 $v \Rightarrow 2 \times 10^{8}$ m/s

$\cancel{d \Rightarrow \frac{6.626 \times 10^{-34}}{\sqrt{\ }}}$

$m \Rightarrow \frac{m_0}{\sqrt{1 - v^2/c^2}}$

$1 - \frac{4}{9}$

$m = \frac{1.67 \times 10^{-27}}{\sqrt{1 - \left(\frac{2}{3}\right)^2}}$

$m \Rightarrow \frac{1.67 \times 10^{-27} \times 3}{\sqrt{5}}$

$m \Rightarrow 2.2405 \times 10^{-27}$

42 $d \Rightarrow \frac{6.626 \times 10^{-34}}{2.2405 \times 10^{-27} \times 2 \times 10^{8}}$

$d \Rightarrow 1.47 \times 10^{-15}$ m

$d \Rightarrow 1.47 \times 10^{-5} \times 10^{-10}$ m

$d \Rightarrow 1.47 \times 10^{-5}$ Å

$\boxed{E = \frac{hc}{\lambda}}$

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Velocity of de-Broglie waves : Concept of wave particle :-

let us consider a material particle of mass m is moving with velocity v. The wavelength of matter waves associated with it will be given by →

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

Also, $E = h\nu$ —— (2)

by Einstein mass energy equivalence, $E = mc^2$ —— (3)

[redacted]

by eq^n (2) and eq^n (3) (representing the energy of same particle)

$$h\nu = mc^2$$

$$\nu \Rightarrow \frac{mc^2}{h} \quad \text{—— (4)}$$

$$v_p = \text{wave velocity} = \nu\lambda$$

$$v_p \Rightarrow \frac{\cancel{m}c^2}{\cancel{h}} \times \frac{\cancel{h}}{\cancel{m}v}$$

$$v_p = \frac{\cancel{h}c^2}{\cancel{h}v}$$

$$\boxed{\frac{v_p}{c} \Rightarrow \frac{c}{v}}$$

Clearly $\frac{c}{v} > 1$

$$\frac{v_p}{c} > 1$$

$$\boxed{v_p > c}$$

This is an unexpected result and is against to the theory of relativity. furthur, if it is so then particle will be left behind by the wave. In order to sort out these two problems Schrodinger suggested that a single wave is not associated with a moving matter particle but a group of slightly different frequencies and slightly different velocities is associated with it. This group of wave is known as wave packet.

Phase velocity and group velocity:

Let us consider two waves of angular frequencies ω_1, ω_2 having the propogation constants k_1 and k_2 are superimposing with each other. The wave eq^n of these waves—

$$y_1 = a\sin(\omega_1 t - k_1 x) \quad \text{— (1)}$$

$$y_2 = a\sin(\omega_2 t - k_2 x) \quad \text{— (2)}$$

$$y = y_1 + y_2$$

$$= a\left[\sin(\omega_1 t - k_1 x) + \sin(\omega_2 t - k_2 x)\right]$$

$$y = 2a\sin\left[\frac{(\omega_1+\omega_2)t - x(k_1+k_2)}{2}\right] \cdot \cos\left[\frac{(\omega_1-\omega_2)t - x(k_1-k_2)}{2}\right]$$

$$\frac{\omega_1+\omega_2}{2} \Rightarrow \omega, \quad \omega_1-\omega_2 = \Delta\omega$$

$$\frac{k_1+k_2}{2} = k, \quad k_1-k_2 \Rightarrow \Delta k$$

$$\Rightarrow \quad y \Rightarrow 2a\cos\left(\frac{\Delta\omega t - x\Delta k}{2}\right) \cdot \sin(\omega t - kx)$$

$$y = 2a\cos\left(\frac{\Delta\omega}{2}t - \frac{\Delta k}{2}x\right)\sin(\omega t - kx)$$

for a non-interacting wave :

$$\frac{\Delta\omega}{2}t - \frac{\Delta k}{2}x = \text{constant}$$

$$\frac{\Delta\omega}{2} - \frac{\Delta k}{2}\frac{dx}{dt} = \text{constant} = 0$$

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$$\frac{dx}{dt} = \frac{\Delta\omega}{\Delta K}$$

$$V_g = \frac{\Delta\omega}{\Delta K}$$

where V_g = group velocity.

- Group velocity: The velocity with which the entire wave packet moves is known as group velocity it is denoted by V_g and is given by

$$V_g = \frac{\Delta\omega}{\Delta K}$$

$\boxed{\text{or}}$

- velocity with which the amplitude part moves is known as group velocity.

for a given wavefront

$$\omega t - kx = \text{constant}$$

$$\omega - k\frac{dx}{dt} = 0$$

$$\frac{dx}{dt} = \frac{\omega}{k}$$

V_p = phase velocity = wave velocity = $\frac{\omega}{K}$

- Phase velocity ⇒ Avg. velocity of the component waves inside a wave packets is known as phase velocity and it is given by

$$V_p = \frac{\omega}{K}$$

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Diff b/w phase velocity and group velocity —

	Phase velocity	Group velocity
1)	It is the avg. velocity of the component waves inside a wave packet	It is the ~~avg~~ velocity of entire wave packets.
2)	It is given by $v_p = \omega/k$	It is given by $v_g = \Delta\omega/\Delta k$
3)	It is important for individual wave.	It is important for a group of waves
4)	It may exceeds the speed of light.	It is always equal to particle velocity.

(=) **Relation between group velocity and particle velocity:**

Let us consider a particle of mass m is moving with velocity v. The velocity of the wave packet associated with this particle will be given by $v_g = \frac{d\omega}{dk}$

$$v_g = \frac{d\omega / dv}{dk / dv}.$$

$$\omega = \frac{2\pi}{T} = 2\pi\nu = \frac{2\pi E}{h} = \frac{2\pi}{h}\left(\frac{1}{2}mv^2\right)$$

$$\boxed{\omega \Rightarrow \frac{\pi m v^2}{h}}$$

$$\frac{d\omega}{dv} = \frac{2\pi m v}{h}$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi m v}{h}$$

$$\frac{dk}{dv} = \frac{2\pi m}{h}$$

$\hbar = \frac{h}{2\pi} = 1.055 \times 10^{-34}$ $\Rightarrow \hbar$ $\boxed{m_p = m_e \times 1836}$

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then, $V_g = \frac{\frac{2\pi mv}{h}}{\frac{2\pi m}{h}} \Rightarrow v$

Tut

$d \Rightarrow \frac{h}{\sqrt{2meV}}$, $V = 1250\,eV \Rightarrow 1250 \times 1.6 \times 10^{-19}$

$d \Rightarrow \frac{6.626 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19} \times 1250 \times 1.6 \times 10^{-19}}}$

$d \Rightarrow \frac{6.626 \times 10^{-34} \times 10}{1.6 \times 10^{-19} \times 10^{-16} \sqrt{2 \times 9.1 \times 1250}}$

$d \Rightarrow \frac{66.26}{1.6}$

$d \Rightarrow \frac{6.626 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 1250 \times 1.6 \times 10^{-19}}}$

$d \Rightarrow \frac{6.626 \times 10^{-34}}{10^{-25} \sqrt{2 \times 9.1 \times 1250 \times 1.6}}$

$d \Rightarrow \frac{6.626 \times 10^{-34}}{10^{-25} \times 4 \times 5 \sqrt{10 \times 9.1}}$

$d \Rightarrow 3.46 \times 10^{-11}\,m$

Q2-

$m \Rightarrow \frac{9.1 \times 10^{-31}}{\sqrt{1 - 4/9}} \Rightarrow \frac{9.1 \times 10^{-31} \times 3}{\sqrt{5}}$

$\Rightarrow 12.20 \times 10^{-31}$

$d \Rightarrow \frac{6.626 \times \cancel{10^{-34}}}{12.20 \times \cancel{10^{-31}} \times 2 \times 10^{8}} \times 10^{-3}$

$d \Rightarrow \frac{0.5431}{2} \times 10^{-8} \times 10^{-3}$

$d \Rightarrow .02715 \times 10^{-8} \times 10^{-3}$

$d \Rightarrow 2.7 \times 10^{-9} \times 10^{-3}$

$d \Rightarrow 27.15 \times 10^{-10} \times 10^{-3}$

$d \Rightarrow 27.15 \times \mathring{A}$

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Q3 $\lambda \Rightarrow \dfrac{6.626\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times10^{6}\times1.6\times10^{-19}}}$ $K.E \Rightarrow 10^{6}\times1.6\times10^{-19}J$

$\lambda \Rightarrow \dfrac{6.626\times10^{-34}}{10\times10^{-23}\left(\sqrt{2\times9.1\times16}\right)\times4}$ 10^{-11}

$\lambda \Rightarrow \dfrac{6.626\times10^{-11}}{\sqrt{182}\times4}$

$\lambda_e \Rightarrow 0.1227\times10^{-11}$

$\lambda e \Rightarrow 1.227\times10^{-12}\ m$

Q4 → $v = 3\times10^{7}$

$\lambda \Rightarrow \dfrac{h}{p}$ $\Delta p \Rightarrow mv$

$\Delta p \Rightarrow 9.1\times10^{-31}\times3\times10^{7}$

$\Delta x.\Delta p = \dfrac{h}{2\pi}$

$\Delta x\times9.1\times\cancel{10^{-31}}\times3\times10^{7} = 1.055\times10^{-34}$

$\Delta x = \dfrac{1.055\times10^{-3}}{9.1\times3\times10^{7}}$

$\Delta x = 0.0386 4\times10^{-10}$

$\Delta x \Rightarrow 3.86\times10^{-12}$

Q5 → $\Delta P \Rightarrow 9.1\times10^{-31}\times5\times10^{0}\times\dfrac{0.003}{100}$

$\Delta P \Rightarrow 9.1\times10^{-31}\times0.015\times10$

$\Delta P \Rightarrow 9.1\times10^{-31}\times0.15$

$\Delta x.\Delta P = 1.055\times10^{-34}$

$9.1\times\cancel{10^{-31}}\times\Delta x = 1.055\times10^{-34}$

$\Delta x = \dfrac{1.055\times10^{-3}}{9.1}$

$\Delta x = 7.659\times10^{-4}\ m$

* Relation b/w phase velocity and group velocity (for dispersive medium)

$$V_p = \frac{\omega}{K}$$

$$\omega = V_p \cdot K$$

$$\frac{d\omega}{dk} = V_p + K\frac{dV_p}{dk}$$

$$\frac{d\omega}{dk} = V_p + K\frac{dV_p}{dk} \times \frac{d\lambda}{d\lambda}$$

$$\frac{d\omega}{dk} = V_p + K\frac{dV_p}{d\lambda} \times \frac{d\lambda}{dK} \quad \text{--- (1)}$$

$$k = \frac{2\pi}{\lambda}$$

$$\lambda = \frac{2\pi}{K}$$

$$\frac{d\lambda}{dK} = \frac{-2\pi}{K^2} \quad \text{--- (2)}$$

putting eq^n (2) in eq^n (1)

$$\frac{d\omega}{dk} = V_p + \frac{\cancel{K}dV_p}{d\lambda} \times \frac{-2\pi}{K^2}$$

$$\frac{d\omega}{dK} = V_p + \frac{dV_p}{d\lambda} \times \frac{-\cancel{2\pi}\,\lambda}{\cancel{2\pi}}$$

$$\frac{d\omega}{dK} = V_p - \lambda\frac{dV_p}{d\lambda}$$

$$V_g = V_p - \lambda\frac{dV_p}{d\lambda} \quad \text{--- (3)}$$

This eq^n 3rd is the req. relation b/w phase velocity and group velocity. for a dispersive medium;

$$V_p \neq f(\lambda).$$

$$\frac{dV_p}{d\lambda} = 0$$

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Heisenburg uncertainity principle:-

It is impossible to measure both the position and momentum of a particle simantaneously with accuracy. The product of uncertainity in position (Δx) and uncertainity in momentum (ΔP) is always greater than equals to $h/2\pi$

Mathematically-

$$\Delta x \cdot \Delta p \geq \frac{h}{2\pi}$$

where h = plank constant

$h = 6.626 \times 10^{-34}$ Js

Proof:

$$V_g = \frac{d\omega}{dk}$$

$$V_g = \frac{d\omega}{dp} \times \frac{dp}{dk} \rightarrow (1)$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{h/P} = \frac{2\pi p}{h}$$

$$p = \frac{kh}{2\pi}$$

$$\frac{dp}{dk} = \frac{h}{2\pi} \quad - (2)$$

from (1) and (2)

$$V_g = \frac{d\omega}{dp} \times \frac{h}{2\pi}$$

$$\frac{dx}{dt} = \frac{d\omega}{dp} \times \frac{h}{2\pi}$$

for big changes,

$$\frac{\Delta x}{\Delta t} = \frac{\Delta \omega}{\Delta P} \times \frac{h}{2\pi}$$

$$\frac{\Delta x\,\Delta p}{h/2\pi} = \Delta t\,\Delta \omega$$

We know that -

$$\Delta t \cdot \Delta \omega \geq 1$$

then, $\Delta x \cdot \Delta p \geq \frac{h}{2\pi}$

Application on uncertainity principle :-

1) Non existence of e^- inside the nucleus :

Let us assume that e^- is existing inside the nucleus

r = size of nucleus is 10^{-14} m

$\Delta x = 2r$

$\Rightarrow 2 \times 10^{-14}$ m

$\Rightarrow$ $\Delta p \cdot \Delta x \geq \frac{h}{2\pi}$

$$\Delta p = \frac{6.626 \times 10^{-34}}{2 \times 3.14 \times 2 \times 10^{-14}}$$

$\Rightarrow 5.278 \times 10^{-21}$ $kg\,m\,s^{-1}$

$$\begin{array}{r} 21 \\ 21 \\ \hline 42 \end{array}$$

$$E_K \Rightarrow \frac{5.278 \times 5.278 \times 10^{-42}}{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19} \times 10^{6}}$$

E_K = 95.5 MeV

Thus, for above calculation it is clear that if the e^- has to exist inside the nucleus then it should have min. K.E is equal to 95.5 MeV. But, from the exp. observation it has been observed that e^- in have nearly 2 to 3 MeV energy which is quite less than that of energy required for existing it inside the nucleus. Hence our assumption is wrong. i.e. e^- cannot exist inside the nucleus.

2) Radius of ~~first~~ Bohr' first orbit →