* de-Broglie wave associated with Bohr-orbit in H-atom

In Bohr's theory, electron is treated as a particle, But de-Broglie's theory suggested that matter and therefore, electron also, has a dual character, both as material particle and as a wave. He derived an expression for calculating the wave length λ of a particle of mass m moving with velocity v. A/c to which —

$$\lambda = \frac{h}{mv} \quad \text{—— (1)}$$

A/c to Einstein's mass-energy relationship —

$$E = mc^2 \quad \text{—— (2)}$$

and A/c to plank's eqs —

$$E = h\nu = \frac{hc}{\lambda} \quad \text{—— (3)}$$

on equating eqs — (2) & (3)

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

or $\lambda = \frac{h}{mc}$

on replacing c by v we have —

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

where, p is the momentum of the particle.

* Bohr's angular momentum from de-Broglie's Eq-

Let us consider an electron moving in a circular orbit of radius 'r' around a nucleus. The wave train would be shown as –

If the wave is to remain continually in phase, the circumference of the circular orbit must be an integral multiple of wave length 'λ'. i.e.

$$2\pi r = n\lambda = \frac{nh}{mv} = \frac{nh}{p}$$

Thus, the angular momentum –

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

Thus an electron can move only in those orbit for which the angular momentum is an integral multiple of $h/2\pi$. It is the reason that electrons are allowed to move only in certain fixed orbit.

The angular momentum of electrons in atoms is quantised. For $n = 1, 2, 3 \ldots\ldots$ the angular momentum will be –

$\frac{h}{2\pi}$, $\frac{h}{\pi}$, $\frac{3h}{2\pi}$ .... It can have only definite values.