T.D.C. Part-I ; Paper II, (Physical chem.)

de-Broglie's Theory :

Dual character of microparticle (electron).

"The microparticle (electron) shows dual character i.e., the character of particle as well as wave."

If an electron behaves like a microparticle of mass 'm', its energy may be given as

$$E = mc^2 \quad \text{——— (I)}$$ Einstein's formula

If an electron behaves as a wave of frequency 'ν', its energy is given by

$$E = h\nu \quad \text{——— (II)}$$ Plank's formula.

From eqn. (I) & (II)

$$mc^2 = h\nu$$

or, $$mc^2 = h\bar{\nu}c \qquad \left(\because \bar{\nu} = \bar{\nu}c = \frac{c}{\lambda}\right)$$

or, $$mc = h\bar{\nu}$$

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

or $$\text{mass} \times \text{velocity} = \frac{h}{\lambda} \qquad \left(p = \text{Momentum} = \text{mass} \times \text{velocity}\right)$$

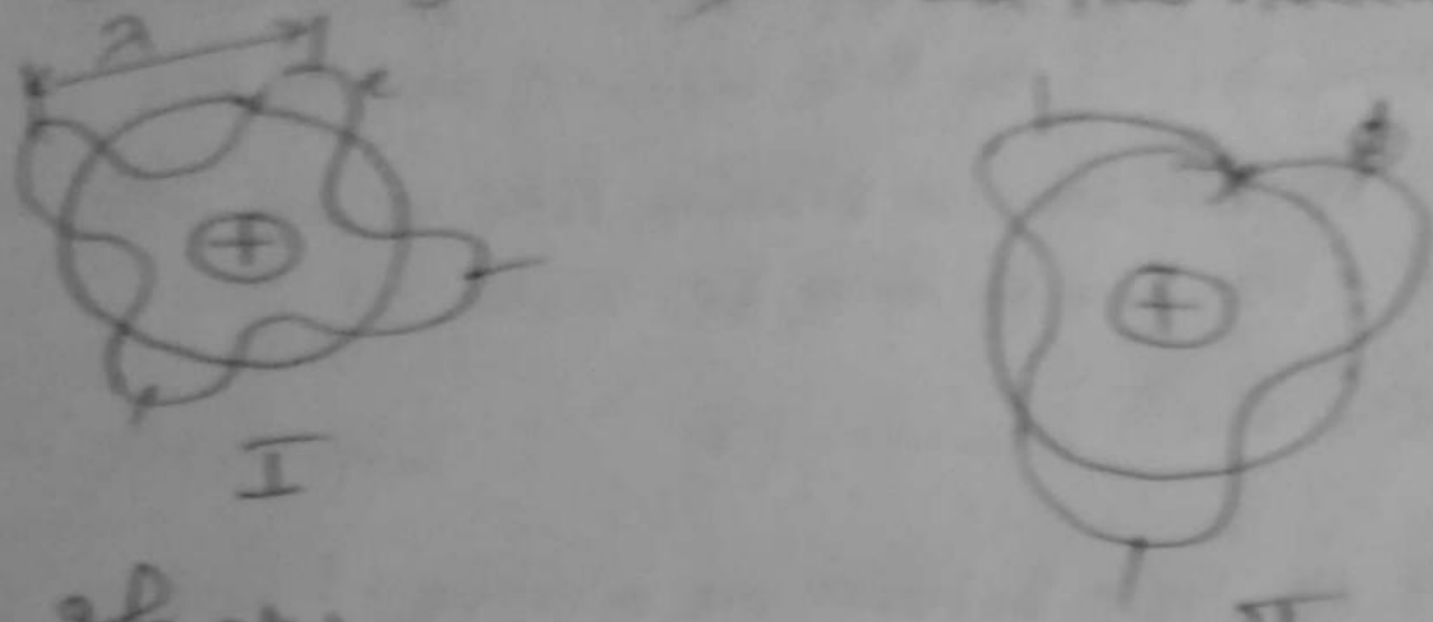
or $$p = \frac{h}{\lambda} \quad \text{——— (III)}$$

or $$\lambda = \frac{h}{p} \quad \text{——— (IV)}$$

Equations (III) & (IV) are called de-Broglie's equation which corelates λ (wavelength) to p (momentum = particle character).

Consequence with Bohr's Postulate

It may be further be shown that the Bohr's Postulates is direct consequence of de-Broglie's equation. A/c to Bohr's Atomic model, an electron moves in a stable (Stationary state) around the nucleus of an atom.



I II

If electron behaves a wave, two situations may arise here:

The situation (II) leads to the interference of wave and subsequently stationary state is not sustained (as wave is not in one phase)

Situation (I), represents the stationary state wave is in one phase.

For this situation, the circumference of the shell must be equal to $n\lambda$ (n = an integer)

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

From de Broglie's equation, $\lambda = \frac{h}{p}$

or $\lambda = \frac{h}{mxv}$ ($\because p = mxv$)

or, $2\pi r = \frac{nh}{mv}$

or $mvr = \frac{nh}{2\pi}$ ——— (V)

This is quantization of angular momentum which is the most important ~~posted~~ postulate of Bohr's Atomic model.

So, Bohr's postulates is the direct consequence of de-Broglie's equation.