SUBJECT - CHEMISTRY
CLASS - B.Sc(Hons) PART- III
PAPER - V
TOPIC - de-Broglie's equation
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de-Broglie's equation

If m be the mass of a particle and E be the energy associated with it then Einstein's equation is given as -

$$E = mc^2 \quad --- (I)$$

where c = velocity of light

According to planck's radiation theory, we know that

$$E = h\nu = \frac{hc}{\lambda} \quad --- (II)$$

where h = planck's constant and λ = wavelength of the radiation. planck's equation relates to photons both as a wave motion and as a stream of particles.

Hence from (I) & (II) we get.

$$mc^2 = \frac{hc}{\lambda} \quad \text{or} \quad mc = \frac{h}{\lambda}$$

If v be the velocity of electron, then we have

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

where p is the momentum of electron.

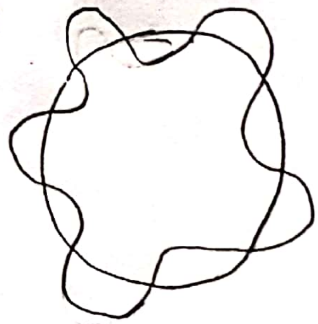
The equation(iii) is called de-Broglie equation, de-Broglie suggested That all small fastly moving particles like electron have certain amount of wave character. The equation (iii) considers both - wave nature for which characteristic is the wavelength and particle nature for which characteristic is the momentum (mv). Therefore, this de-Broglie relation is also called as wave-particle duality principle, Sometimes it is convenient or even necessary to express properties of electron in terms of particle while for some purposes, we use wave nature of electron.

Q Show that the Bohr's assumption of the angular momentum of an electron is an integral multiple of $h/2\pi$ which can be interpreted with the help of de-Broglie's equation

Ans. de-Broglie relation puts some restriction on the size of Bohr's orbits as electron behaves as the particle but its mode of propagation is wavy. for a wave to remain continually in one phase while moves around the nucleus of an atom, circumference of the orbit $(2\pi r)$ must be an integral multiple of wavelength $(n\lambda)$ -

i.e $\quad n\lambda = 2\pi r \quad --- (i)$

The de-Broglie's relation is given as



$$\lambda = \frac{h}{mv} \quad --(ii)$$

putting the value of λ from equation (ii) in (i), we get

$$n.\frac{h}{mv} = 2\pi r \quad \text{or} \quad mvr = \frac{nh}{2\pi}$$

Now mvr = moment of momentum = angular momentum.

Hence, the quantisation of angular momentum is the direct Consequence of de-Broglie's relation. though this much was assumed by N. Bohr. So if the circumference is larger or smaller Then the value suggested by equation (ii) the wave will be out of phase or we can say that de Broglie's relation offers a theoretical support to the Bohr's assumption.