Dual nature of electron.

(1) In 1924, the French physicist, Louis de Broglie suggested that if light has both particle and wave like nature, the similar duality must be true for matter. Thus an electron, behaves both as a material particle and as a wave.

(2) This presented a new wave mechanical theory of matter. According to this theory, small particles like electrons when in motion possess wave properties.

(3) According to de-Broglie, the wavelength associated with a particle of mass m, moving with velocity v is given by the relation

$\boxed{\lambda = \frac{h}{mv},}$ Where h = Planck's constant.

(4) This can be derived as follows according to Planck's equation, $E = h\nu = \frac{h.c}{\lambda}\left(\because \ \nu = \frac{c}{\lambda}\right)$

Energyof photon (on the basis of Einstein's mass energy relationship), $E = mc^2$

Equating both $\frac{hc}{\lambda} = mc^2 \ or \ \lambda = \frac{h}{mc}$ which is same as de-Broglie relation. $(\because \ mc = p)$

(5) This was experimentally verified by Davisson and Germer by observing diffraction effects with an electron beam. Let the electron is accelerated with a potential of V than the Kinetic energy is

$$\frac{1}{2}mv^2 = eV \ ; \ m^2v^2 = 2eVm$$

$$mv = \sqrt{2eVm} = P \ ; \ \lambda = \frac{h}{\sqrt{2eVm}}$$

(6) If Bohr's theory is associated with de-Broglie's equation then wave length of an electron can be determined in Bohr's orbit and relate it with circumference and multiply with a whole number

$2\pi r = n\lambda \ or \ \lambda = \frac{2\pi r}{n}$

From de-Broglie equation, $\lambda = \frac{h}{mv}$. Thus $\frac{h}{mv} = \frac{2\pi r}{n}$ or $mvr = \frac{nh}{2\pi}$

Note:For a proton, electron and an α -particle moving with the same velocity have de-Broglie wavelength in the following order: Electron > Proton > α - particle.

(7) The de-Broglie equation is applicable to all material objects but it has significance only in case of microscopic particles. Since, we come across macroscopic objects in our everyday life, de-Broglie relationship has no significance in everyday life.