De-Broglie Wave Theory, Heisenberg Uncertainty Principle

1. The wave nature of electron was first proposed by de Broglie and latter confirmed by Germer and Davisson by difracting electron beam passing through NICOL prism.
2. According to de Broglie any moving material particle has wave character. These waves are called matter waves.
3. The wave length of matter waves is given by $\lambda = \frac{h}{mv} = \frac{h}{p}$

   Where p = Momentum of the particle and λ is called the de Broglie wave length.

   h = Planck's constant $= 6.625 \times 10^{-34} J.\sec$

   v = Velocity of the particle, mv = p = Momentum of the particle
4. According to de Broglie's theory electron has dual nature i.e particle as well as wave nature.
5. An electron behaves as a standing or stationary wave which extends round the nucleus in a circular orbit.
6. If electron waves undergo constructive interference then the circumference of the Bohr's orbit is equal to an integral multiple of the wavelength of the electron wave and the electron wave is said to be in phase, $2\pi r = n\lambda$ (or) $\lambda = \frac{2\pi r}{n}$.
7. In case electron waves undergo destructive interference then the circumference of the Bohr's orbit $(2\pi r)$ is not equal to $n\lambda$, i.e. the electron wave is said to be out of phase.

8. The de Broglie wave length (λ) and kinetic energy of the electron are related as $\lambda = \frac{h}{\sqrt{2mkE}}$.

9. The de Broglie wave length is significant only for micro scopic partciles like electron, proton, atom, molecule etc and is insignificant for macro particles.

10. The number of electron waves (or wave lengths) in any orbit is equal to the principal quantum number "n".

11. The de Broglie wave length of electron in nth orbit of H -atom is $3.33XnA^0$.

12. If the de Broglie wave length of electron in1st orbit of H -atom is x, then the de Broglie wave length of electron in nth orbit is nx and the circumference of the nth orbit is $n^2\lambda$.

13. The ratio of de Broglie wave length of electron in first three orbits in H-atom is 1:2:3.

14. It is impossible to determine accurately and simultaneously the position and momentum of an electron in an atom. It is called Heisenberg's uncertainty principle.

The uncertainty principle equation is

$$\Delta x.\Delta p \geq \frac{h}{4\pi} \text{ Or } \Delta x.m\Delta v \geq \frac{h}{4\pi}$$

Where Δx = uncertainty in position, Δp = uncertainty in momentum

Δv = uncertainty in velocity, m = mass of the particle

15. The uncertainty principle is significant for microscopic particles only.