Heisenberg Uncertainty Principle :-

According to classical mechanics, the position and momentum of a moving particle (ie electron) can be determined with great accuracy.

When an electron is consider as a wave then it is not possible to know the exact location of the electron on the wave. It was pointed out by German Physicist Heisenberg in his Uncertainty Principle.

" It is impossible to determine exactly both the Position and momentum (i.e Velocity) of an electron or any other moving particle at the same time.

It means, When an electron behaves as a particle its position can be determined more or less accuracy / exactly, but at the same time there would be Uncertainty about its momentum or velocity.

Similarly if the velocity or momentum can be determined precisely, there would be uncertainty about its position.

The uncertainty arises from the fact that when a measurement is carried out, the electron under investigation is to be viewed with a sensitive instrument such as a microscope, and in this process the light particle interact with the electron and alters its motion (i.e velocity).

It is not possible, therefore to say about the velocity of electron.

Mathematical Interpretation :—

If ΔP is uncertainty in the determination of momentum and Δx be the uncertainty in the determination of position then Heisenberg's equation may be written as

$$\Delta P \cdot \Delta x \geq \frac{h}{2\pi}$$

Heisenberg's Equation may be stated as follows :—

The product of uncertainty in the simultaneous determination of the position and momentum of a particle is equal or greater than the Plank's constant

Statement of Heisenberg's in Case of Energy and Time.

Some times instead of measuring Position and momentum of the system, its Energy E and the time t for which it remains in that energy state are measured, In these case, the uncertainty in measuring energy and time is given by

$$\Delta E \times \Delta T \geq \frac{h}{2\pi}$$

where h is Plank Constant.

ΔE = Uncertainty in Energy

& ΔT = Uncertainty in time

— x —