* Heisenberg Uncertainty Principle:-

"It is impossible to determine the exact position and exact momentum (velocity) of a small moving particle with accuracy."

Thus, $(\Delta x)(\Delta P) \geq \frac{h}{4\pi}$

or $(\Delta x)\, m\, (\Delta V) \geq \frac{h}{4\pi}$

Where, Δx = uncertainty in the position of particle

ΔP = Uncertainty in the momentum of particle

ΔV = Uncertainty in the velocity of particle

m = mass of the particle.

Important Points:-

1). If Position of a small particle is determine accurately, then Δx (uncertainty) is small and therefore Δv should be high i.e. uncertainty in velocity is large. If velocity of small particle is determine accurately, uncertainty in its position is large.

2) Bohr's and Sommerfeld's atomic model's are against the uncertainty principle. Because in these atomic models both the position and velocity of the electron has been determined accurately.

* Significance of uncertainty principle in daily life :-

It has no significance in everyday life. Uncertainty principle is only for small moving particle (microscopic object) like electron, proton, neutron etc. It is not applicable to big particles (macroscopic object). for big particle mass 'm' is high and therefore product of (Δx) & (Δv) should be small. Thus uncertainty in the determination of their position and velocity both is low. Hence, for big particles position and velocity both may be determined accurately.

for examples:-

Let us suppose the mass of a particle is 1 mg (10^{-6} kg)

$$\Delta x \cdot \Delta v = \frac{h}{4\pi m} = \frac{6.626 \times 10^{-34} \text{ J sec}}{4 \times 3.141 \times 10^{-6} \text{ kg}}$$

$$= \frac{6.626 \times 10^{-34} \text{ kg m}^2 \text{ sec}^{-2} \times \text{sec}}{4 \times 3.141 \times 10^{-6} \text{ kg}}$$

$$= 0.53 \times 10^{-28} \text{ m}^2 \text{ sec}^{-1}.$$

The product $(\Delta v \cdot \Delta x)$ is extremely small. This show that uncertainty in position & velocity is very small. i.e. we can determine their position and velocity accurately. If the mass of the object is greater than 1 mg, the product $\Delta v \cdot \Delta x$ will be more small. Hence the values of uncertainties are negligible.

Problems :-

1). A microscope using suitable photons is employed to locate an electron in an atom within a distance of 0.1 Å. What is the uncertainty involved in the measurement of its velocity ? Given, Mass of electron = 9.1×10^{-31} kg.

$1 J = kg\ m^2\ sec^{-2}$.

Ans ⇒ $\Delta V = 0.579 \times 10^{7}\ m\ sec^{-1}$.

2). A cricket ball weighing 100g is to be located with in 0.1 Å. What is the uncertainty in its velocity ?

Given $m = 100g = 0.1\ kg$

Ans ⇒ $\Delta V = 0.527 \times 10^{-22}\ m\ sec^{-1}$.

3). The mass of an electron is 9.1×10^{-31} kg. Determine the Product of uncertainty in position and velocity.

Ans ⇒ $\Delta x \cdot \Delta V = 5.77 \times 10^{-5}\ m^2\ sec^{-1}$.

4). An electron has a speed of 500 $m\ sec^{-1}$ with uncertainty of ± 0.02 %. What is the uncertainty in locating its position.?

Ans ⇒ $\Delta x = 5.77 \times 10^{-9}$ m.

From

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