Unit-I Quantum Mechanics.

Quantum Mechanics:- (Microscopic)

" Science dealing with the behaviour of Matter & light on atomic & Subatomic Scale."

It attempts to describe the properties of Molecule atoms and their constituents (Electron, Protons, Neutrons and other subatomic Particle).

Classical Mechanics:-

Branch of Physics deals with the motion of object Smaller as well as large objects.

OR Classical Mechanics deals with the motion of bodies under the influence of force.

Classical Mechanics	Quantum Mechanics
I) Deals with Macroscopic objects	I) Deals with Microscopic objects
II) Based on Newton's Law of Motion.	II) Based on Schrodinger wave Equation.
III) In classical Mechanics Behaviour of Particle can be completly known.	III) In Quantum Mechanics there is some Uncertainity in determination of Position and Momentum of Particle.
IV) classical Mechanics deals with certainities	IV) Quantum Mechanics deals with Probablities.

Wave Particle Duality :-

"Wave Particle Duality Describe the properties of ~~both~~ Photons and subatomic Particles to exhibit the ~~Propert~~ of properties of both waves & Particles"

OR

"It is the concept of Quantum Mechanics that every particle or entity may be described as a Particle or wave".

Particle
- Masss
- Velocity
- Momentum
- Energy

Wave
- Frequency
- Wavelength
- Phase
- Amplitude
- Intensity

Light

Wave
↓
[X-Rays, Visible, IR]
↓
[Frequency, wavelength]
↓
[Interference, Diffraction]
↓
[Two waves Superimpose]
↓
[Radiations behave like wave]

Particle
↓
[Photons, quanta] $E = h\nu$
↓
[Energy, Momentum]
↓
[Photo Electric Effect, Blackbody Radiations]
↓
[Interaction of Matter in the Form of Photons]
↓
[Radiations behaves like Particle]

↘ ↙

[Wave Particle Duality]

De Broglie Hypothesis:-

Light wave can act as a wave sometimes and as a Particle at other times this is known as de Broglie Hypothesis.

Matter Waves:-

According to de Broglie Hypothesis any moving particle is associated with a wave. The wave associated with a particle known as de Broglie waves or matter waves.

The wavelength λ of matter waves associated with a particle moving with velocity v is inversely proportional to the magnitude of momentum of particle. Thus

$$\boxed{\lambda = \frac{h}{mv}} = \frac{h}{p} \quad (P = mv)$$

The relation $\lambda = \frac{h}{mv}$ is known as de-Broglie Equation and wavelength λ is called De-Broglie wavelength.

De-Broglie wavelength associated with an accelerated charge particle:-

If a charge particle, say an electron is accelerated by a potential difference of V volts, then its kinetic energy is given by

$$K.E = eV$$

$$\frac{1}{2}mv^2 = eV$$

$$v = \sqrt{\frac{2eV}{m}}$$

Then electron wavelength is given by -

$$\lambda = \frac{h}{mv} = \frac{h}{m}\sqrt{\frac{m}{2eV}}$$

$$\boxed{\lambda = \frac{h}{\sqrt{2emV}}}$$

De Broglie wavelength Expressed in term of Kinetic Energy:-

If a particle has K.E, kinetic Energy

$$K.E = \frac{1}{2}mv^2$$

$$= \frac{1}{2}mv^2 \times \frac{m}{m}$$

$$= \frac{m^2v^2}{2m} = \frac{p^2}{2m}$$

$$p = \sqrt{2m(K.E)}$$

(Substituting value of h, m & e)

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m(K.E)}} = \frac{12.28}{\sqrt{V}} A^\circ$$

De-Broglie wavelength Associated with a particle in thermal Equilibrium:-

For a particle in thermal Equilibrium at temperature T, then their kinetic Energy is given by -

$$K.E = \frac{3}{2}kT$$

$$\lambda = \frac{h}{\sqrt{2m(K.E)}} = \frac{h}{\sqrt{3mkT}}$$