

## Unit-1 Quantum Mechanics.

### Quantum Mechanics:- (Microscopic)

" Science dealing with the behaviour of Matter & light on atomic & subatomic scale."

It attempts to describe the Properties of Molecules 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

- I) Deals with Macroscopic objects
- II) Based on Newton's Law of Motion.
- III) In classical mechanics Behaviour of Particle can be completely known.
- IV) classical mechanics deals with certainties

#### Quantum Mechanics

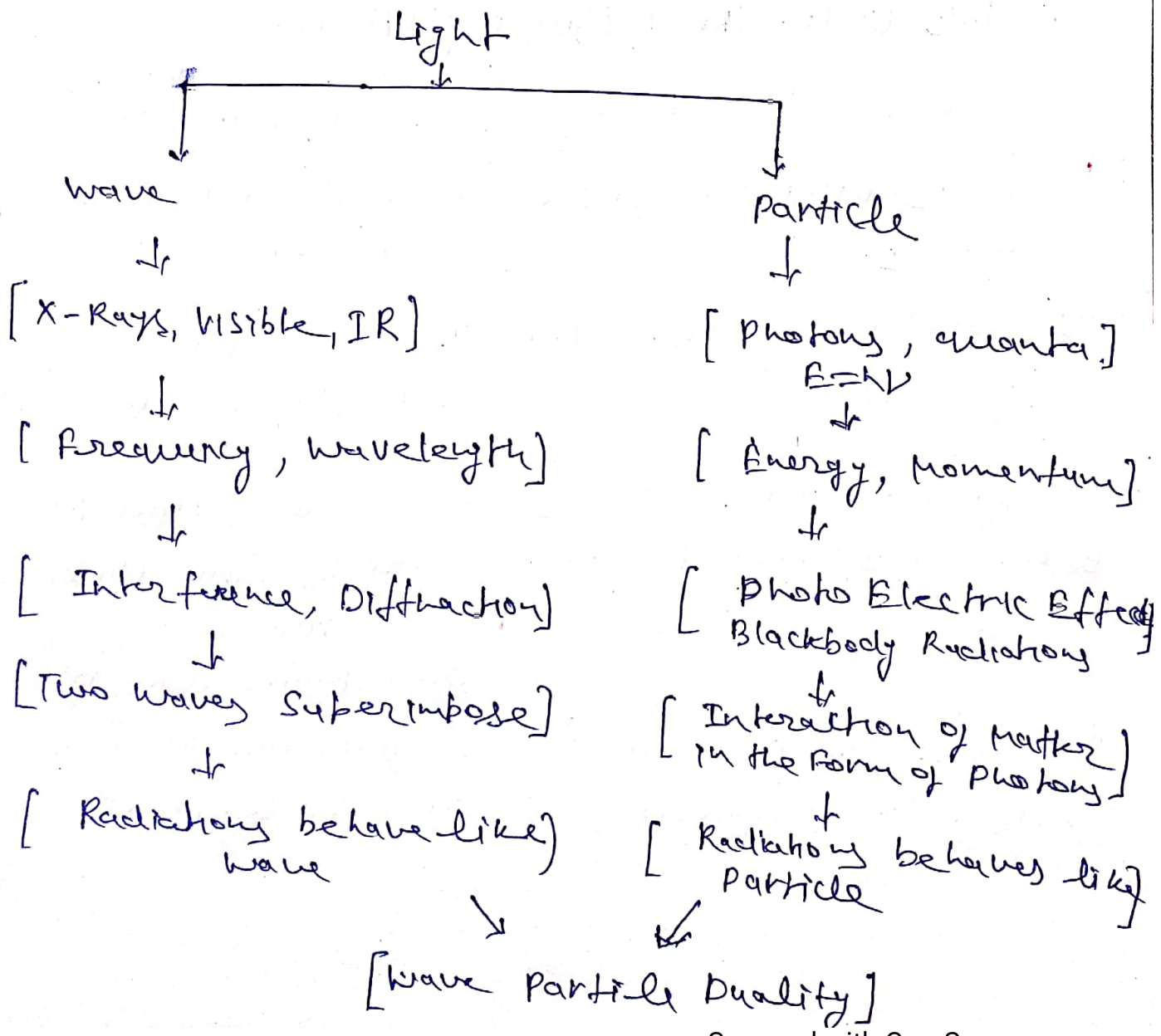
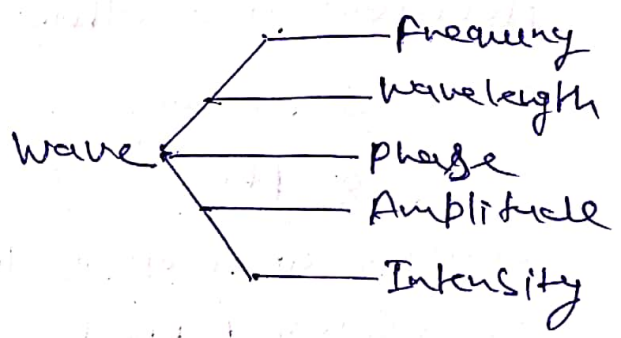
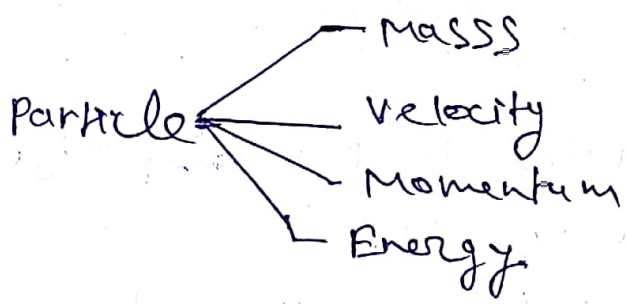
- I) Deals with Microscopic objects
- II) Based on Schrodinger wave Equation.
- III) In Quantum Mechanics there is some Uncertainty in determination of position and momentum of Particle.
- IV) Quantum Mechanics deals with probabilities.

# Wave Particle Duality :-

"Wave Particle Duality Describe the properties of both photons and subatomic particles to exhibit the 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"





## De Broglie Hypothesis - (4)

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,  $\lambda$  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  $\lambda$  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 - (5)

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

$$\lambda = \frac{h}{\sqrt{2emv}}$$

De Broglie wavelength Expressed in term of Kinetic Energy:-

If a particle has K.E, Kinetic Energy

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

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

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

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

(Substituting value of  $h/mv$ )  $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m(K.E)}} = \frac{12.28 \text{ \AA}}{\sqrt{V}}$

De-Broglie wave length. Associated with a particle in thermal Equilibrium:-

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

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

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