Module-1

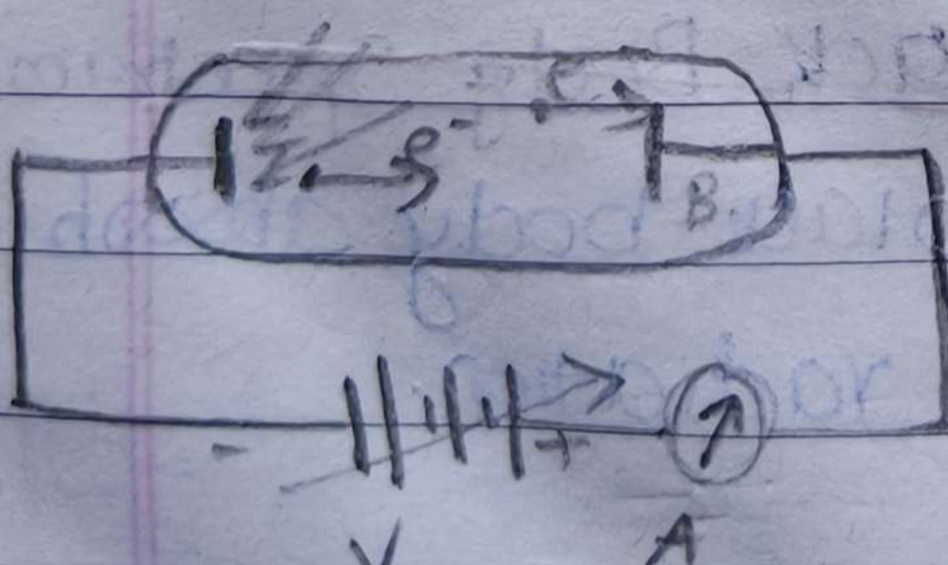
1. Classical Physics has many inadequencies. It explains wave nature of particles. But it was replaced by Quantum physics and explains the experimental observation through particle Nature.

~~Quanta: Discreate Unit of~~

P

Photon: Radiation consists of discreat energy packets.

① Photo electric effect:



Einstein.

when light with min. frequency called threshold frequency hits on a metal surface it emitts electrons and the remaining energy will used for its motion. (KE). This expt shows the particle Nature of photon.

* The emitted electrons are called Photo electrons.
* Min frequency → Threshold frequency (ν_0)
* The energy required to emit the electron from metal surface → work function (ϕ)

$\boxed{E = h\nu}$ h = Plank's constant

$h = 6.626 \times 10^{-36}$ J

$h\nu = h\nu_0 + KE.$

* Intensity of light → No: of electrons emitted.

$\phi = h\nu_0$

* frequency → energy & e^-

* Total energy

$E = h\nu_0 + \frac{1}{2}mv^2$

$$\boxed{h\nu = h\nu_0 + \frac{1}{2}mv^2}$$

② Compton Effect

Arthur Compton

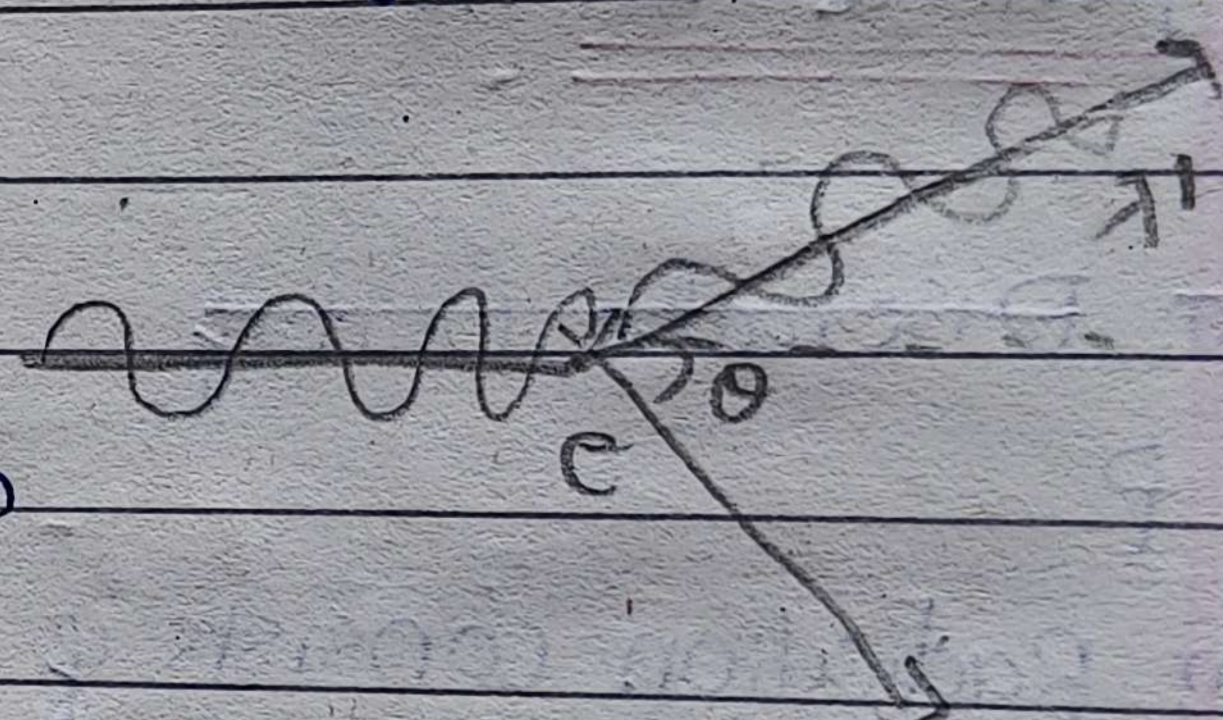
→ The compton effect [Proved that light behaves like particles bcz the interaction b/w Photon and e^- is like a collision b/w 2 Particles.

• The electron starts moving → it gain KE

• The photon loses some energy → Its wavelength increases

$$\Delta\lambda = \frac{h}{m_0 c}(1 - \cos\theta)$$

* wavelength change depends on scattering angle.



$\Delta\lambda = \frac{h}{m_0 c}$ - compton wavelength

③ Black Body Spectrum

• A black body absorb all radiation.

$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$ $\lambda = \frac{h}{mv}$

$\Delta E \cdot \Delta t \geq \frac{h}{4\pi}$

CLASS NO :
DATE :

- Its emit radiation depending on temp.
- Temp↑ – waveleng↓
  Temp↓ – λ↑ (wien's law)
- Temp↑ total radiatn↑.
  (stefan-Boltzmann law).
- in classical physics this expt is explained as UV catastrophe.

Black body.

$$u_\nu = \frac{8\pi h \nu^3}{c^3} \frac{d\nu}{\exp\left[\frac{h\nu}{kT} - 1\right]}$$

Plank's Hypothesis

1. $E = h\nu$ $P = \frac{h}{\lambda}$
2. $E = Nh\nu$
3. $E = \frac{Pc}{\sigma}$, $P = \frac{E}{c}$

- Wave nature → interference
  Diffraction
- Particle nature → photo electric effect
- De Broglie wavelength

$$\boxed{\lambda = \frac{h}{mv}}$$

Heisenberg's uncertainity Principle

We cannot know the exact position and exact momentum of a particle at the same time.

$$\Delta x \cdot \Delta P \geq \frac{h}{4\pi}$$

$$\Delta E \cdot \Delta t \geq \frac{h}{4\pi}$$

wave function (ψ) Psi

$(\psi)^2$ = Probability of finding the particle.

a particle like an e^- is described by a wave function.

- Max plank –
  $E = h\nu$
- Albert Einstein
  → photoelectric effect
- de Broglie – $\lambda = \frac{h}{mv}$
- Heisenberg –
  uncertainity principle
- Erwin Schrödinger
  → wave function

* The quantity that varies in matter wave, respect to space and time.

Properties
- Always single valued
- continious
- max value ($p = 1$.)

Schrödinger time independent equation

For one dimensional

$$\frac{\partial^2 \psi}{\partial t^2} = v^2 \frac{\partial^2 \psi}{\partial x^2}$$

For Three dimensional,

$$\frac{\partial^2 \psi}{\partial t^2} = v^2 \left[\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2}\right]$$

$$\frac{\partial^2 \psi}{\partial t^2} = v^2 \nabla^2 \psi. \quad -①$$

$$\psi = \psi_0 e^{-i\omega t}$$

$$\frac{\partial \psi}{\partial t} = \frac{\partial}{\partial t}(\psi_0 e^{-i\omega t})$$

$$= \psi_0 (-i\omega) . e^{-i\omega t}$$

$$= -i\omega\psi$$

$$\frac{\partial \psi}{\partial t} = -i\omega\psi$$

$$\frac{\partial^2 \psi}{\partial t^2} = \frac{\partial^2}{\partial t^2}(-i\omega\psi)$$

$$= \mp i\omega \cdot -i\omega\psi$$

$$= -\omega^2\psi \quad —(2)$$

Substituting (2) in (1)

$$v^2\nabla^2\psi = -\omega^2\psi$$

$$\omega = 2\pi\nu, \quad \omega^2 = 4\pi^2\nu^2$$

$$v^2\nabla^2\psi = -\omega^2\psi$$

$$\nabla^2\psi = \frac{-\omega^2}{v^2}\psi$$

$$\nabla^2\psi = \frac{-4\pi^2\nu^2}{v^2}\psi$$

$$\nu = \frac{v}{\lambda}, \quad \nu^2 = \frac{v^2}{\lambda^2}$$

$$\nabla^2\psi = \frac{-4\pi^2\nu^2}{v^2\lambda^2}\psi$$

$$= \frac{-4\pi^2}{\lambda^2}\psi$$

$$\lambda = \frac{h}{mv} \qquad \lambda^2 = \frac{h^2}{m^2v^2}$$

$$\frac{1}{\lambda^2} = \frac{m^2v^2}{h^2}$$

$$\nabla^2\psi = \frac{-4\pi^2 m^2v^2}{h^2}\psi$$

Total Energy, $E = K.E + P.E$

$$= \frac{1}{2}mv^2 + V$$

$$E = \frac{1}{2}mv^2 + V$$

$$\frac{1}{2}mv^2 = E - V$$

$$mv^2 = 2(E-V)$$

$$m^2v^2 = 2m(E-V)$$

$$\nabla^2\psi = \frac{-4\pi^2 \times 2m(E-V)}{h^2}\psi$$

$$\nabla^2\psi = \frac{-8\pi^2 m(E-V)}{h^2}\psi$$

$$\nabla^2\psi + \frac{8\pi^2 m(E-V)}{h^2}\psi = 0$$

$$\nabla^2\psi + \frac{2m(E-V)}{\hbar^2}\psi = 0$$