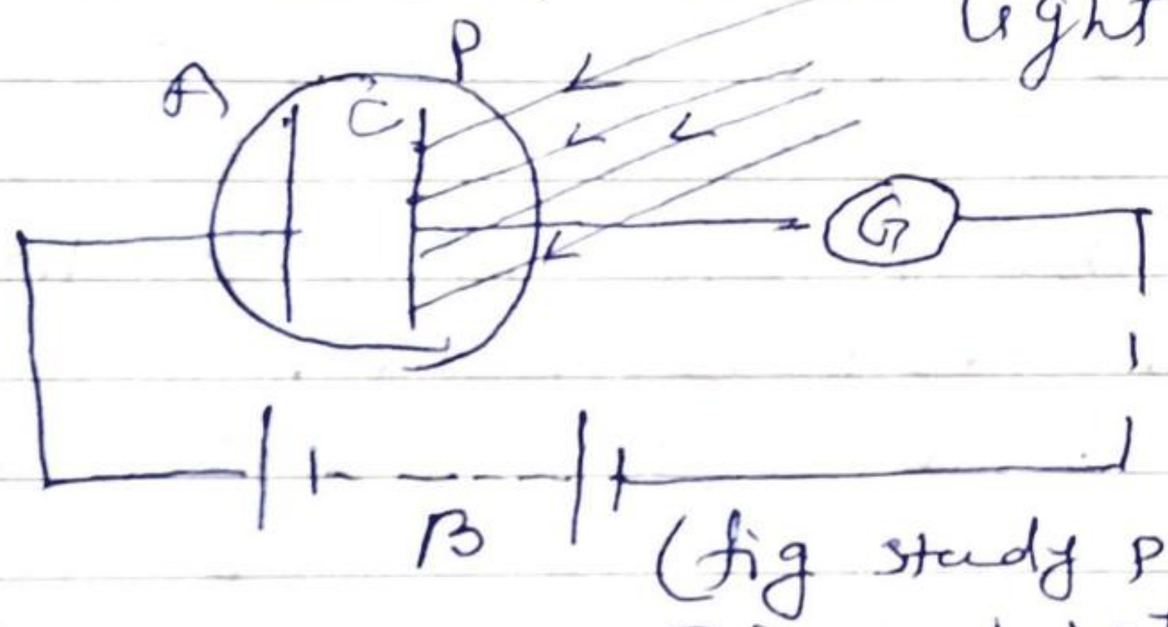
Photo electric effect

when electromagnetic ~~radi~~ radiation (X-rays, ultraviolet rays, γ rays) fall on a metal surface electrons are emitted from the surface. This process of emission of electrons from a metal plate, ~~when~~ by impact of light of suitable wavelength is called photoelectric effect and emitted electrons are known as the photoelectrons



(fig study P.E)

A, C — Two Zinc plates
P → Glass evacuated Quartz bulb
G — Galvanometer
B = Battery

when light allowed to fall on the cathode (C), Photoelectrons are emitted by the cathode (C) which are collected by anode (A) and a current flows in the circuit shown by galvanometer (G.)

Laws of Photoelectric effect →

(1) The kinetic energy (i.e the velocity) of the emitted photoelectrons depends upon the frequency (or the wavelength) of the incident light. The maximum velocity of

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the photoelectrons is directly proportional to the frequency of the incident light.

(2) The K.E of photoelectrons does not depend upon the intensity of the incident light.

(3) The number of photoelectrons emitted depends upon the intensity of the incident light and not upon the frequency (or the wavelength) of the incident light.

(4) There is no time lag between the incidence of light on a surface and the emission of photoelectrons. This process is instantaneous.

Explanation on the basis of Einstein's Photon theory →

Einstein in 1905 presented the Photon theory based on the Planck's quantum hypothesis. According to this theory, Photons each having the energy $h\nu$ are propagated like particles with the speed of light of high frequency radiation has photons of high energy and a high intensity beam has a large number of Photons.

Einstein said that energy of the incident photon = Work function + K.E of the Photoelectron.

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$$h\nu = \phi_0 + K \cdot E_{max}$$

ϕ_0 = Work function of the metal → Electrons cannot escape from a metal at normal temperature, because they are held within the metal by a potential barrier at the surface to overcome this barrier. "The minimum energy required by an electron to just escape from the metal surface is called the work function of the metal."

h = Planck's constant

$$\phi_0 = h\nu_0 = \frac{hc}{\lambda_0}$$

c = velocity of light

ν_0 = Threshold frequency of a metal → Electrons are emitted from a material only when the frequency of the incident light is equal or greater than the threshold frequency of the material.

$$\nu = \nu_0$$

ν ← frequency of incident radiation.

λ_0 = Threshold wavelength (λ_0) of a metal

The wavelength corresponding to the threshold frequency of a natural metal is called its threshold wavelength.

Condition for photo electric emission 2017

wavelength → $\lambda < \lambda_0$

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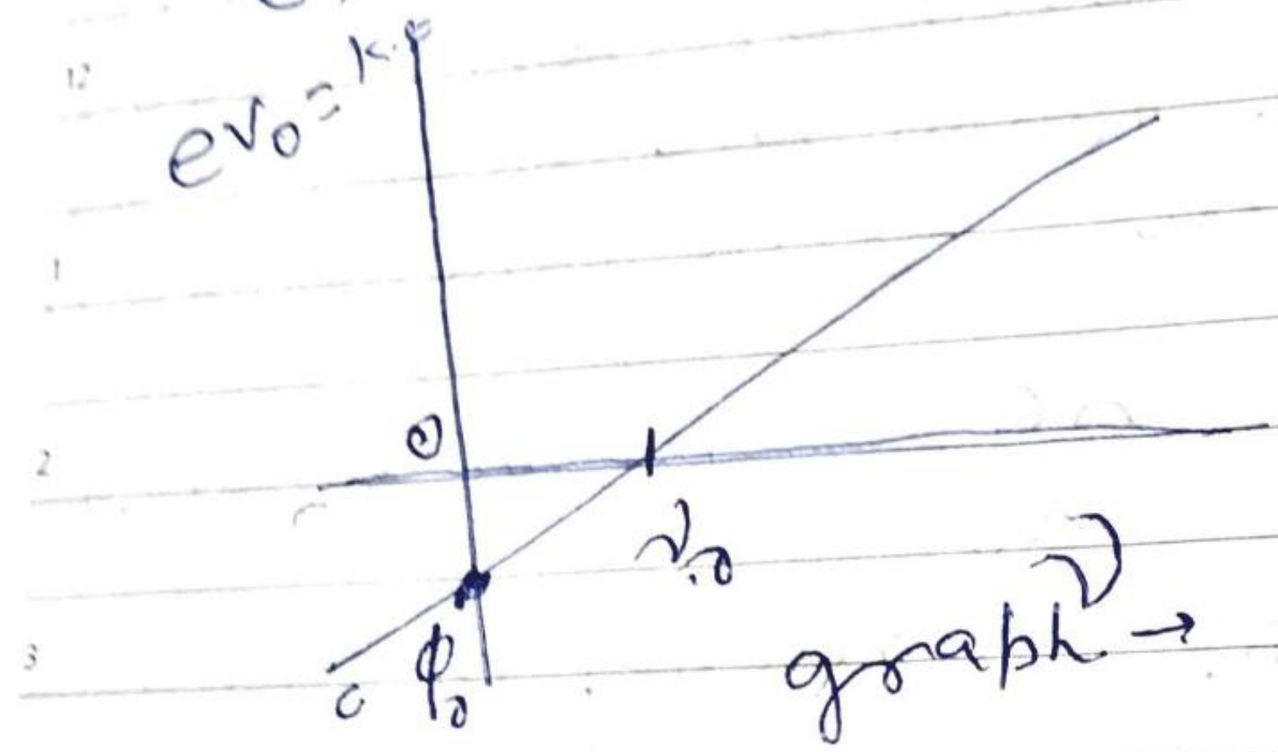
$K.E_{max} = \frac{1}{2} m v_{max}^2$

$h\nu = h\nu_0 + \frac{1}{2} m v_{max}^2$

$\boxed{\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{1}{2} m v_{max}^2}$

Einstein's Photoelectric equation



Light of different frequencies are allowed to fall on a photocell and the voltages applied to the electrodes to reduce the current to zero (i.e. the stopping potential V_0). A graph of the frequency ν against eV_0 (K.E of photoelectrons) is plotted, the graph will be straight line

(1) The slope of this st line gives the value of Planck's constant (h)

(2) The intercept one y-axis gives

(3) The intercept on the x axis gives

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