PHOTO ELECTRIC EFFECT

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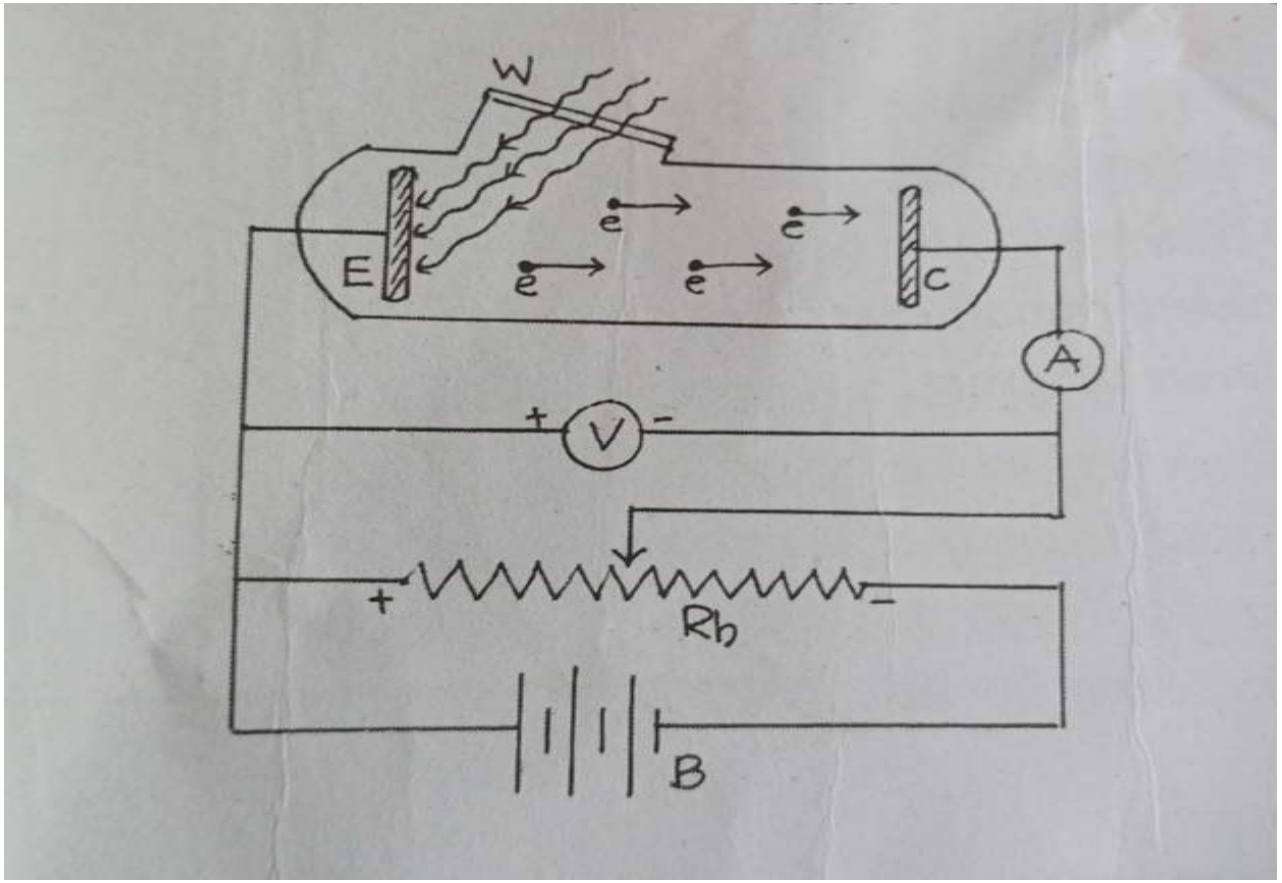
- Whenever a light or electromagnetic radiation of suitable wavelength is incident on certain substances ,especially metals,electrons are ejected from the surface of the substances.This is called Photoelectric effect.

- Since the effect is produced under the influence of light it is called Photoelectric effect.

- Ejected electrons are called photoelectrons.


W
E
C
e
e
e
e
A
+
V
-
+
Rh
-
B

Stopping Potential

When suitable radiations fall on electrode E,Photoelectrons are ejected out of the plates.Thep.d.across the electrodes E and C acts as a retarding potential.

Those photoelectrons with sufficient K.E can reach the electrode C against the repulsion and this results in photoelectric current in the circuit.

When the retarding potential is increased,C become more negative and the no. of electrons reaching the electrode is decreased.This will decrease the photoelectric current.

When the retarding potential becomes V_0 the ammeter reading becomes zero.No photoelectrons reach the electrode C and the photoelectric current is zero.This p.d is called **stopping potential/Retarding potential.**

The maximum kinetic energy K_{max} ,attained by the photoelectrons is completely used to do work against the stopping potential.

If v_m is the max.velocity ofe photoelectrons, then,

$K_{max} = \frac{1}{2} m v_m^2 = eV_0$ or $V_0 \propto K_{max}$

Laws of photoelectric emission

(i)Photoelectric current is directly proportional to the intensity of incident light.

(ii)For each photoelectric surface there is a minimum frequency of radiation at which emission begins.This minimum frequency is called Threshold frequency.

(iii)The velocity and Kinetic energy of the emitted photoelectrons depend on the frequency of the incident light,but is independent of the intensity of incident light.

(iv)Photoelectric emission is an instantaneous process.There is no time lag between the incidence of radiation and emission of photoelectrons.

The time lag if any is of the order of 3 x 10-9 seconds.

Einstein's Photoelectric equation

Based on Plancks quantum theory of radiation ,Einstein gave satisfactory explanation of photoelectric effect.

Acc. to quantum theory, light consists of small packets of energy called quanta or photons.The energy of a photon is hυ,where υ is the frequency of the light and h is the Planck's constant.

When a photon is incident on a metal ,The energy hυ is completely transferred to an electron in the metal.

A part of energy is gained by the electron is used to liberate it from the metal surface and other part is utilised in imparting Kinetic energy to the emitted electrons.

The minimum energy required to liberate an electron from the metal surface is the photoelectric workfunction W.

Let the kinetic energy of the photoelectron be $\frac{1}{2}mv^2$.

Then $h\nu = W + \frac{1}{2}mv^2$

This relation is called Einstein's photoelectric equation.

Threshold frequency is the minimum frequency of the incident radiation which can just eject photoelectrons from the given material.

At the threshold frequency υ_0 ,The velocity of photo electron is zero, then $W=h\upsilon_0$

$$h\upsilon = h\upsilon_0 + \frac{1}{2}mv_{\max}{}^2$$

$$h\upsilon = h\upsilon_0 + K.E$$

$$\frac{1}{2}mv_{\max}{}^2 = h(\upsilon - \upsilon_0)$$

Where v_{max} is the maximum velocity acquired by the electron and K.E is the Kinetic energy.

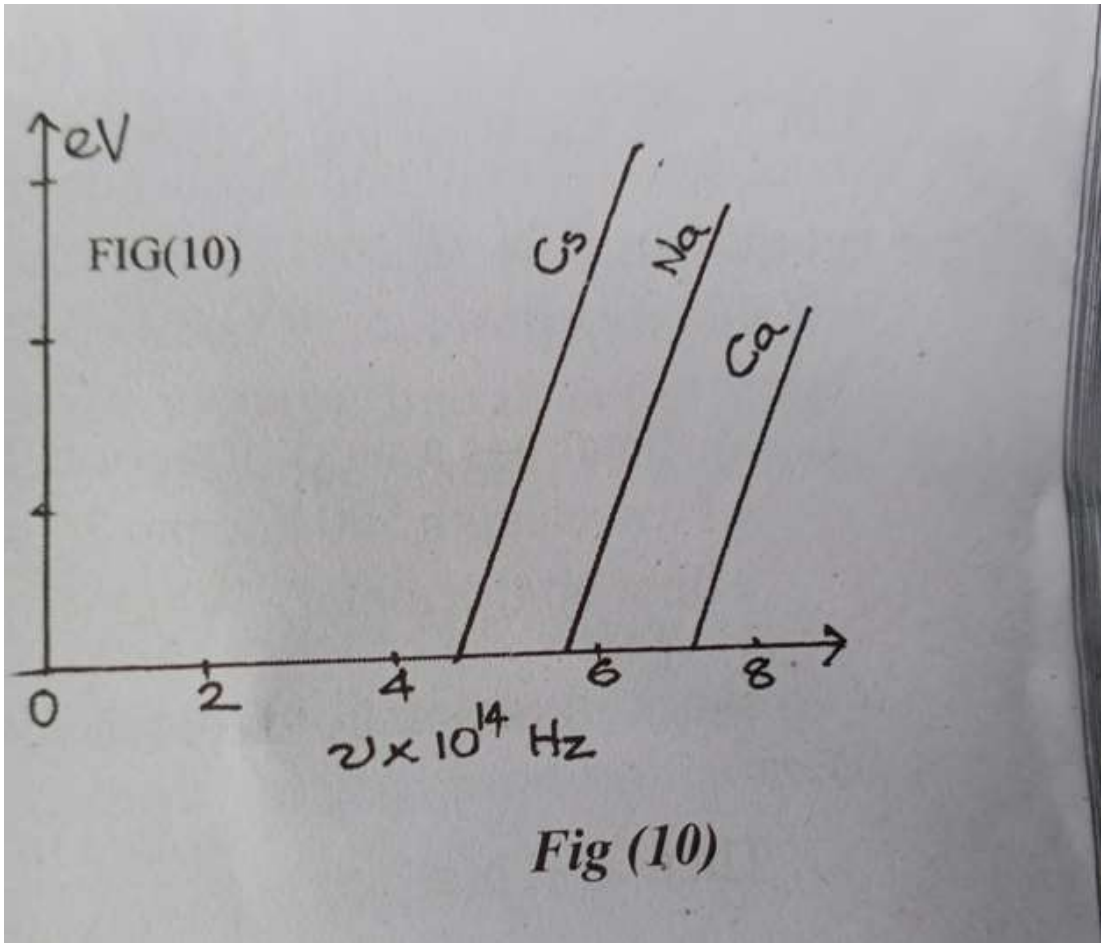


Fig (10)

Variation of photoelectric current at same frequency but different intensities

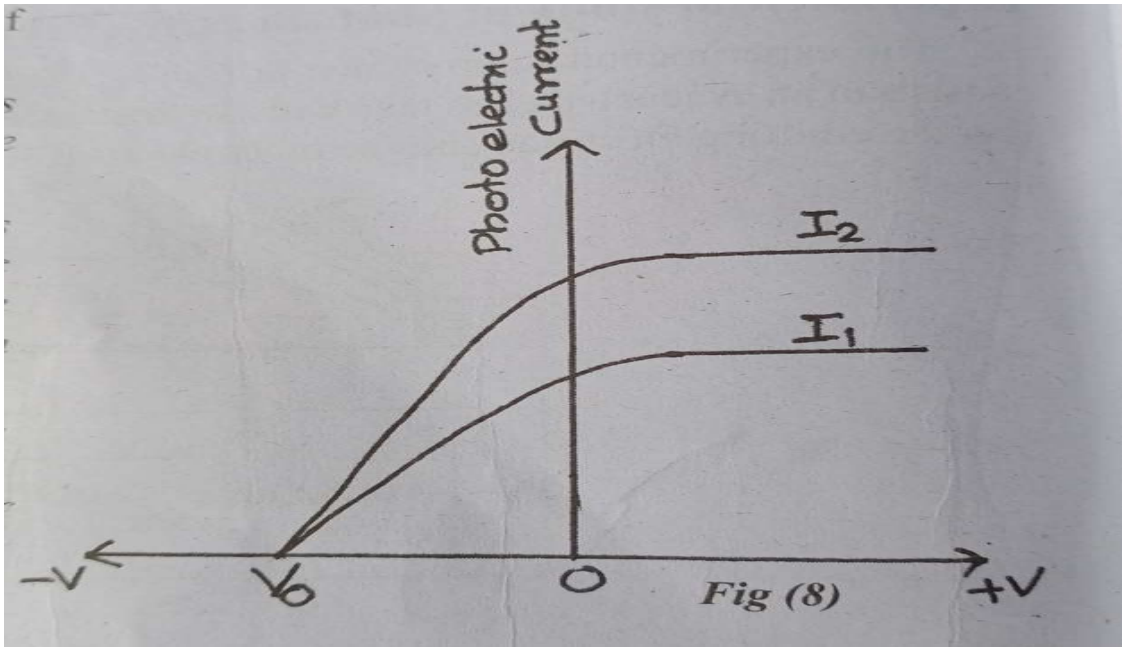


Fig (8)

Variation of Photoelectric current at constant intensity but different wavelengths

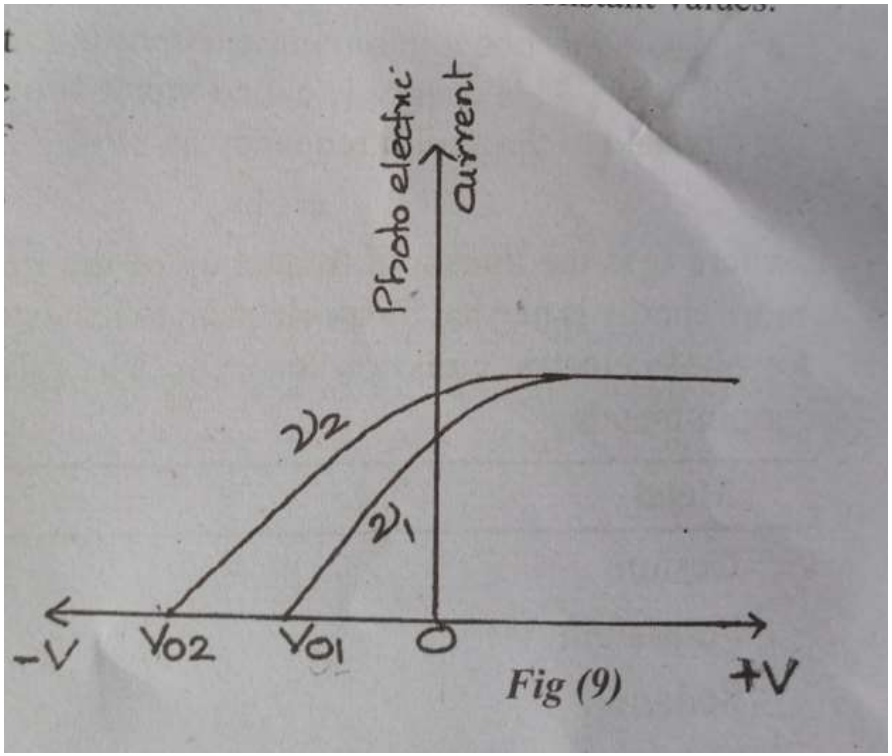


Fig (9)

On reducing the wavelength of light incident on a metal, the velocity of emitted photoelectrons will become

A) Zero

B) Less

C) More

D) Remains Unchanged

THANK YOU