PHY1701 (Engineering Physics) Lab Manual and Record

Date: 2021/01/07

Reg No: 20BDS0105

ADVANCED MATERIAL ANALYSIS THROUGH QUANTUM PHYSICS.

Apparatus available:-

- Photoelectric equipments
- filters

SLO :

Determination of Plank's Constant

Determination of 'work-function' of given metal.

Study of photoelectric effect.

Theory:-

Hertz noticed a spark between two metallic balls when a high frequency radiation is incident on it. This is called photoelectric effect. Photoelectric effect is the emission of electrons when electromagnetic radiations having sufficient frequency is incident on certain metal surfaces. We call the emitted electrons as photoelectrons and the current they constitute as photocurrent. The phenomenon was first observed by Heinrich Hertz in 1880 and explained by Albert Einstein in 1905 using Max Planck's quantum theory of light. As the first experiment which demonstrated the quantum theory of energy levels, photoelectric effect experiment is of great historical importance.

It has been observed that there must be minimum energy needed for electrons to escape from a particular metal surface and is called work function (ω). The work function can be expressed in terms of frequency as,

$$\omega = h\nu_0$$

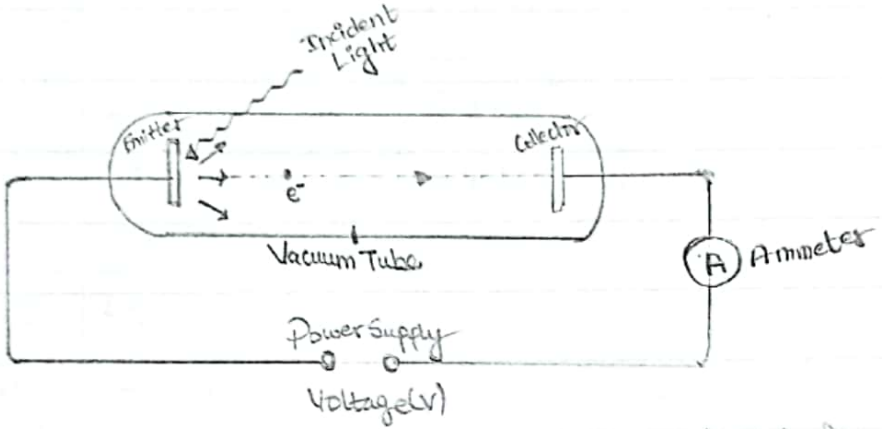

Fig:- Photoelectric Effect (Experimental Setup)

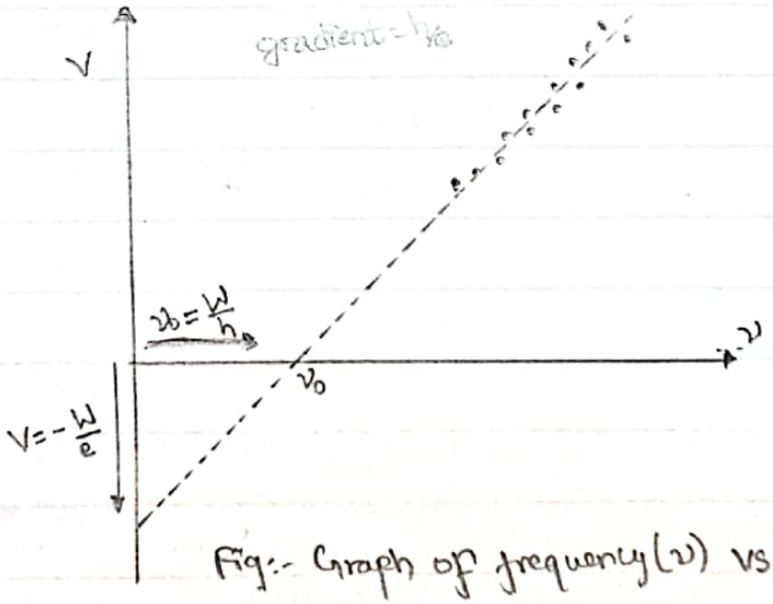

Fig:- Graph of frequency(ν) vs. stopping potential(V)

where h is the Planck's constant and V_0 is

The work functions for some metals are listed in the table.

Metal	Work function(eV)
Pt	6.4
Ag	4.7
Na	2.3
K	2.2
Cs	1.9

According to Einstein the photoelectric effect should obey the equation,

$$h\nu = KE + W$$

$$h\nu = eV_s + W$$

$$V_s = \frac{h}{e}\nu - \frac{W}{e}$$

Results:

Work function of given metal is 1.45eV.

Planck's constant $\approx 6.6 \times 10^{-34}$ Js

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S.No	Incident photon wavelength (nm)	Incident Photon frequency ~~wavelength~~ (sec^{-1})	Stopping Voltage (V).
1	460	6.52×10^{14} Hz	1.1
2	500	6×10^{14}	0.84
3	540	5.55×10^{14}	0.71
4	570	5.26×10^{14}	0.55
5	635	4.72×10^{14}	0.35

Sample Calculations:-

From graph, we get, slope of graph = $\frac{\Delta V}{\Delta \nu} = \frac{0.75}{1.8 \times 10^{14}} = 4.167 \times 10^{-15}$ Vs

y-intercept = 1.45 volt.

Then, $\frac{W}{e}$ = y-intercept

$\Rightarrow$ Work function (W) = e x y-intercept.

= 1.45 eV

Now, $\frac{h}{e}$ = slope of graph

$\Rightarrow$ plancks constant (h) = e x slope of graph.

$= 1.6 \times 10^{-19}$ C x 4.169×10^{-15} Vs

$= 6.67 \times 10^{-34}$ Js

$\approx 6.6 \times 10^{-34}$ Js (approximately).

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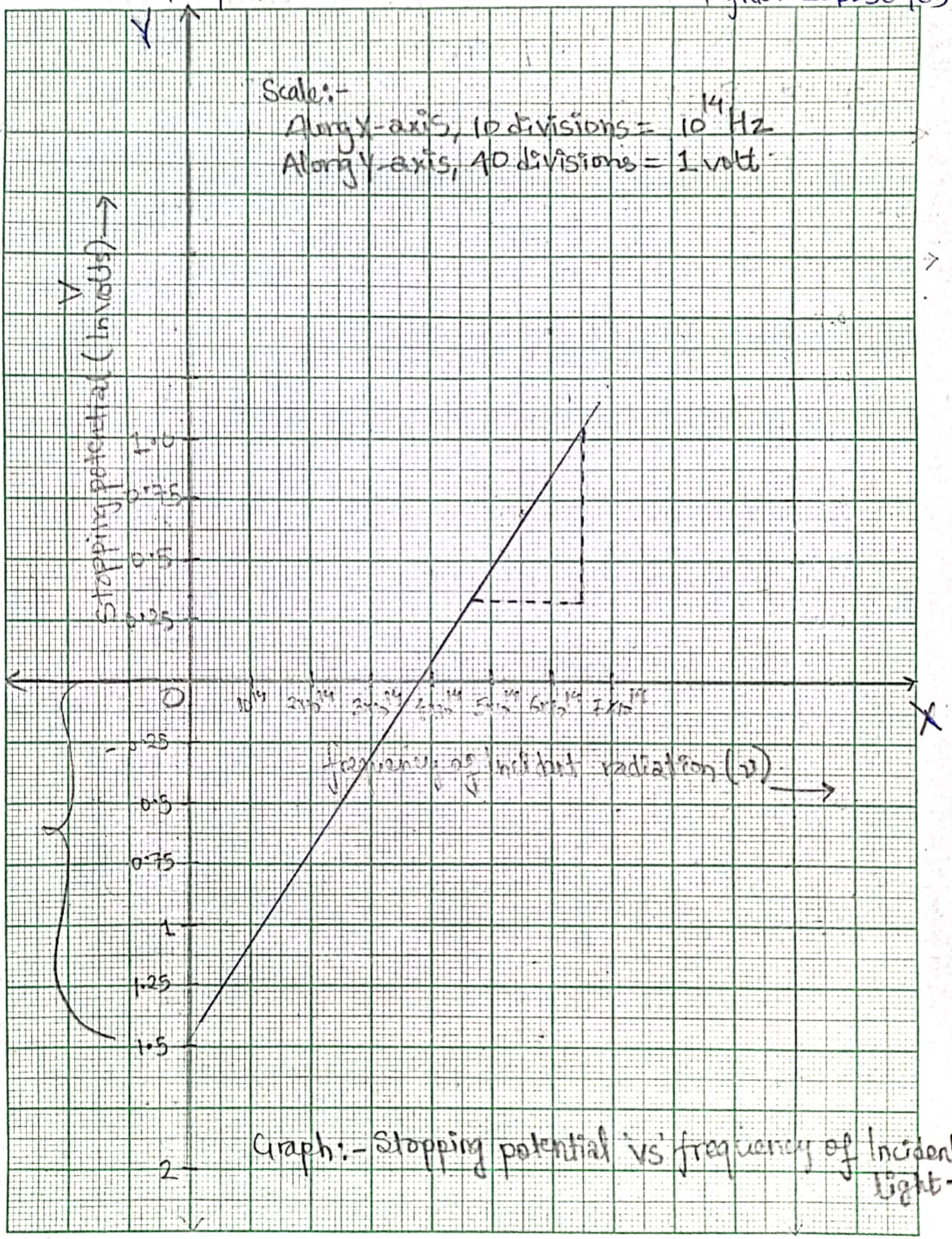

Graph:- Stopping potential vs frequency of incident light.