PH160 LAB 4

Name : Snehal Keshav Nalawade
ID : 202151160

Objective :

- To understand the phenomenon Photoelectric effect as a whole.
- To draw kinetic energy of photoelectrons as a function of frequency of incident radiation.
- To determine the Planck's constant from stopping potential versus frequency graph.
- To plot a graph connecting photocurrent and applied potential.
- To determine the stopping potential from the photocurrent versus applied potential graph.

Theory :

The **photoelectric effect** is the emission of electrons when electromagnetic radiation, such as light, hits a material. Electrons emitted in this manner are called photoelectrons.

$$hv = hv_0 + E$$

Where,
hu = Incident Radiation
Hv_0 = Work function
E = Maximum Kinetic Energy

$$h\nu - h\nu_0 = eV'$$

$$\Rightarrow \frac{h\nu}{e} - \frac{h\nu_0}{e} = V' \quad \text{— (A)}$$

But, $\frac{h\nu_0}{e}$ will be Constant for a given material.

$\therefore$ eq^n (A) represents a St. line eq^n of a graph plotted between applied frequency (ν) and stopping potential (V')

$\therefore$ Slope $= m = \frac{h}{e}$ — (i)

where $e = 1.602 \times 10^{-19}$ C

also, $m = \frac{y_2 - y_1}{x_2 - x_1}$ — (ii)

Observation :

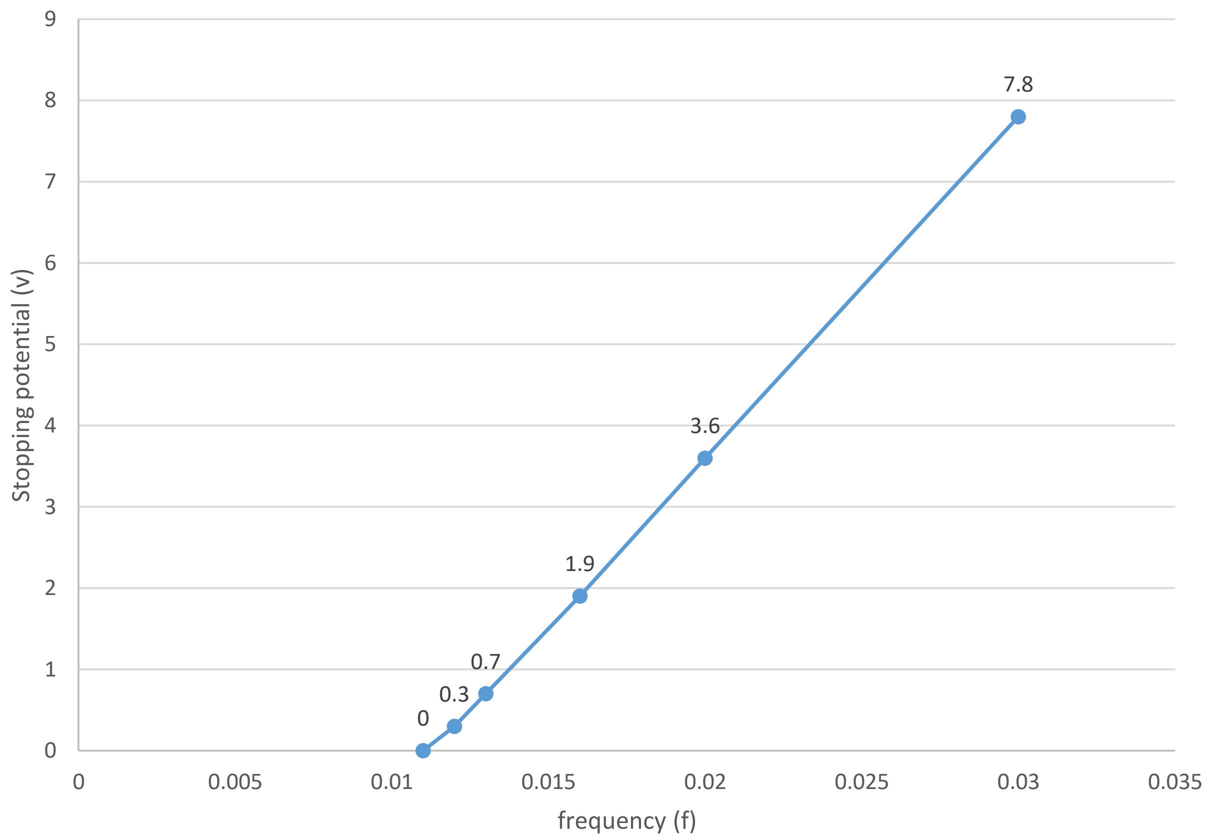
Copper

Sr. No.	wavelength (L) (nm)	frequency (f) (Hz) (*10^17)	Stopping potential (V') (v)	KE(max)=eV' (*10^(-19))
1	100	0.03	7.8	12.4956
2	150	0.02	3.6	5.7672
3	190	0.015789474	1.9	3.0438
4	230	0.013043478	0.7	1.1214
5	250	0.012	0.3	0.4806
6	264	0.011363636	0	0

1) $\frac{h}{e} = \frac{7.8-0}{(0.03-0.011)\times10^{17}}$

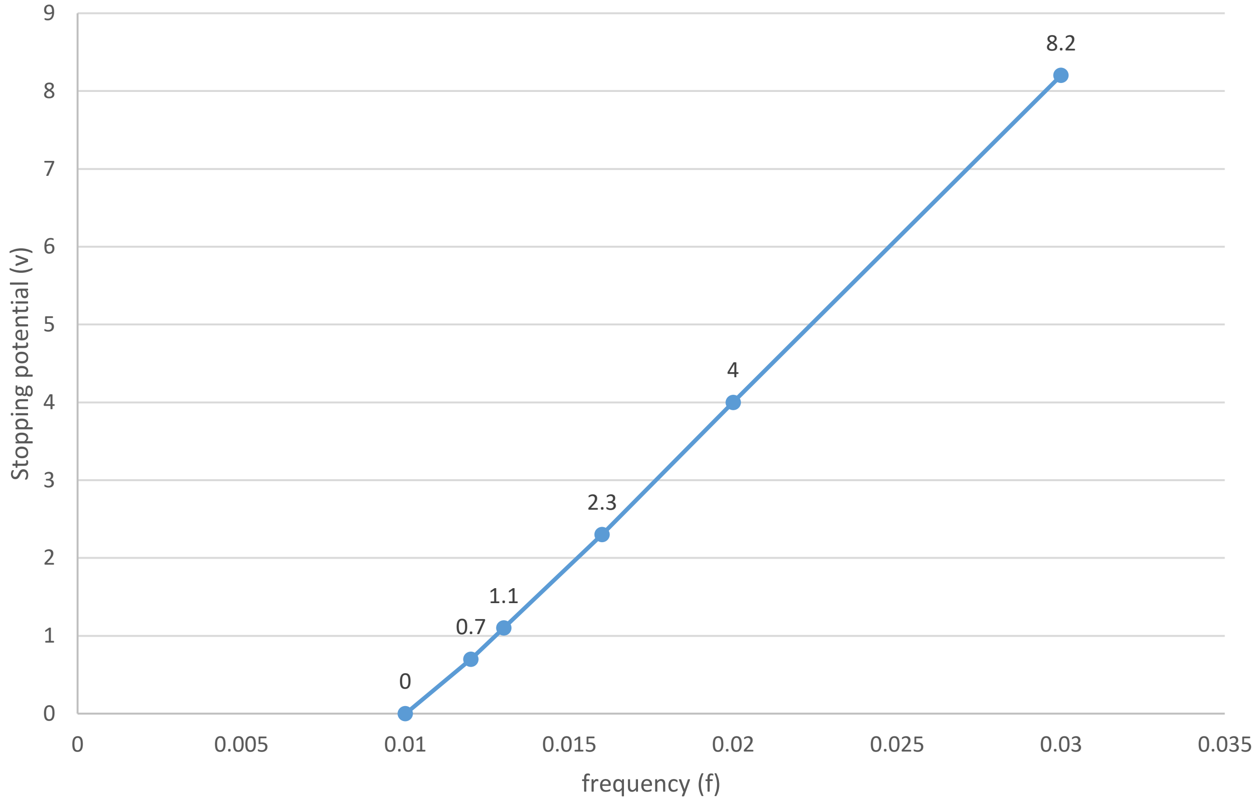
$\rightarrow \frac{h}{1.602\times10^{-19}} = \frac{7.8}{0.019\times10^{17}}$

$\Rightarrow h = 6.576\times10^{-34}$ Js



Zinc

Sr. No.	wavelength (L) (nm)	frequency (f) (Hz) (*10^17)	Stopping potential (V') (v)	KE(max)=eV' (*10^(-19))
1	100	0.03	8.2	13.1364
2	150	0.02	4	6.408
3	190	0.015789474	2.3	3.6846
4	230	0.013043478	1.1	1.7622
5	250	0.012	0.7	1.1214
6	290	0.010344828	0	0



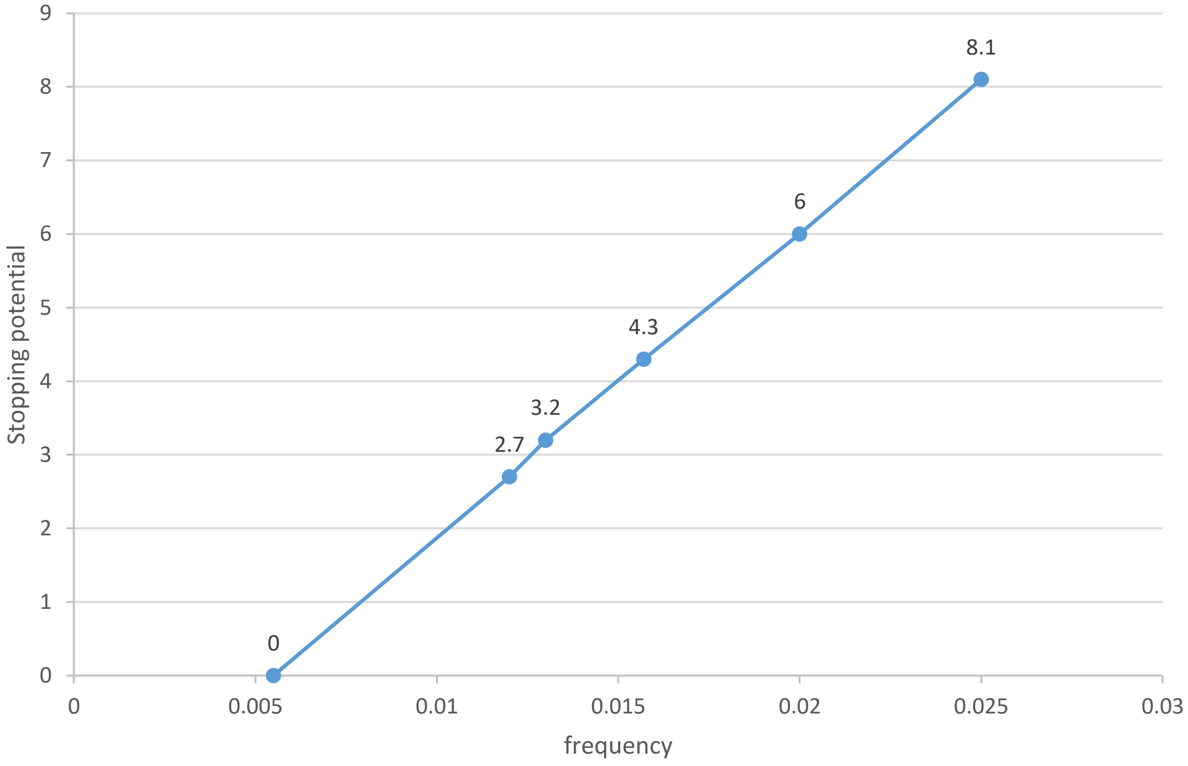
2) $\dfrac{h}{1.602\times10^{-19}} = \dfrac{8.2-0}{(0.03-0.01)\times10^{17}}$

$\Rightarrow \dfrac{h}{1.602\times10^{-19}} = \dfrac{8.2}{0.02\times10^{17}}$

$\Rightarrow h = 6.568\times10^{-34}$ Js

Sodium

Sr. No.	wavelength (L) (nm)	frequency (f) (Hz) (*10^17)	Stopping potential (V') (v)	KE(max)=eV' (*10^(-19))
1	120	0.025	8.1	12.9762
2	150	0.02	6	9.612
3	190	0.015789474	4.3	6.8886
4	230	0.013043478	3.2	5.1264
5	250	0.012	2.7	4.3254
6	543	0.005524862	0	0



3) $\frac{h}{1.602\times10^{-19}} = \frac{(8.1-0)\times10^{-17}}{(0.025-0.0055)}$

$\Rightarrow \frac{h}{1.602\times10^{-19}} = \frac{8.1\times10^{-17}}{0.0195}$

$\Rightarrow h = 6.654\times10^{-34}$ J-sec

∴ Average value of Plank's Constant will be :-

$$h = \frac{(6.576 + 6.568 + 6.654) \times 10^{-34}}{3} \text{ JS}$$

$$h = 6.599 \times 10^{-34} \text{ JS}$$

Since KE = eV' , therefore the graph between KE and frequency(f) for the above materials will be similar to their graph between V' and f.

Copper

Sr. No.	Voltage (V)	Photocurrent (I) (uA) (i.e. *10^-6)
1	0	3.86
2	-2	2.86
3	-4.4	1.66
4	-6.6	0.56
5	-7.8	0

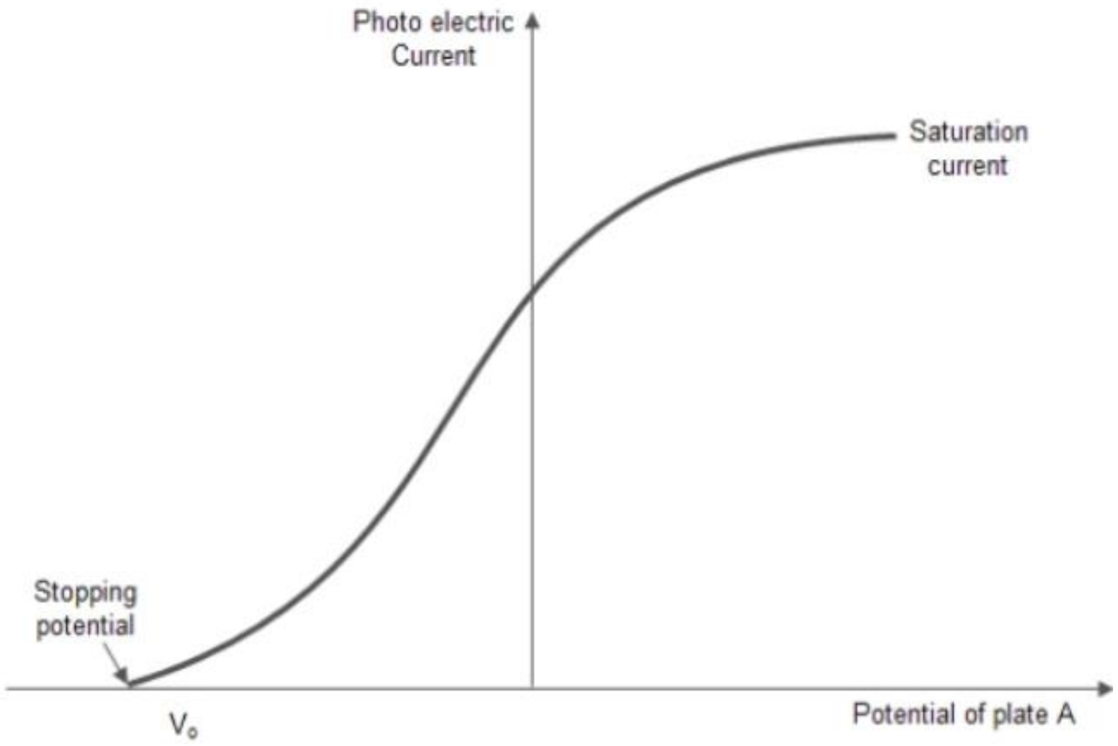
Zinc

Sr. No.	Voltage (V)	Photocurrent (I) (uA) (i.e. *10^ -6)
1	0	4.06
2	-1.8	3.16
3	-5	1.56
4	-6.8	0.66
5	-8.2	0

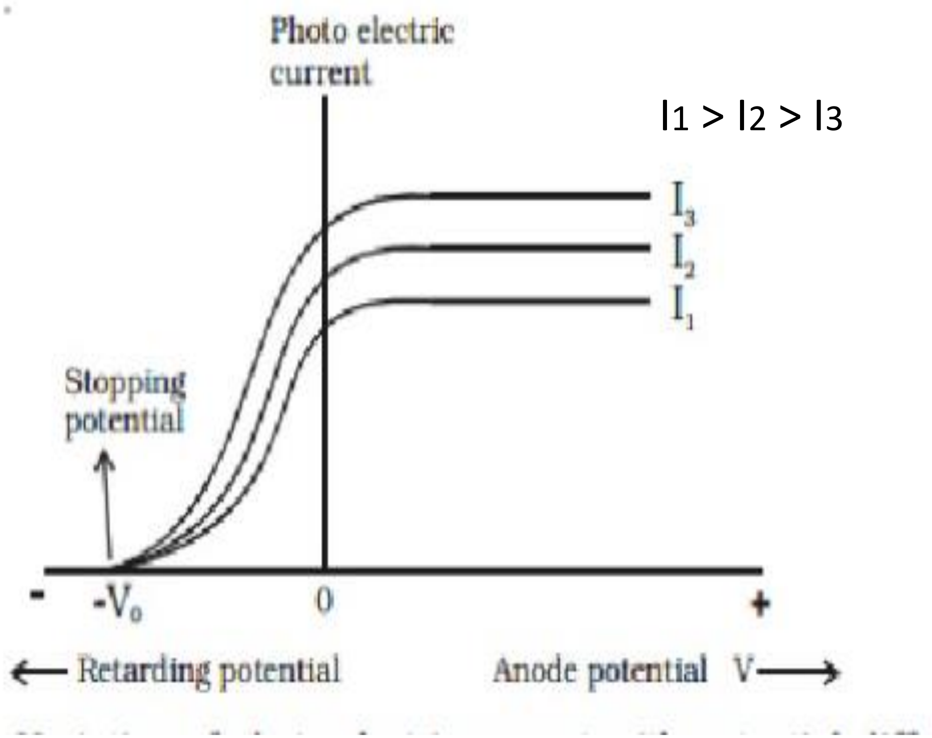
Sodium

Sr. No.	Voltage (V)	Photocurrent (I) (uA) (i.e. *10^-6)
1	0	4.03
2	-2.8	2.63
3	-4.6	1.73
4	-6.2	0.93
5	-8.1	0

The photocurrent vs applied voltage graph for the above considered materials will be like the one shown alongside :



The photocurrent vs applied potential graph for each one of the above considered materials (for three different intensities) will be similar to the graph given alongside :



In this graph, the applied potential for which photocurrent=0 is the stopping potential of that material. In This way V’ can be deduced from the photocurrent vs applied voltage graph.

Thank you