PH160 LAB 4

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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

In all the observations below, intensity is taken to be 5 w/sq.m and area of material is equal to 0.1 sq.cm.

$$hv - hv_0 = eV'$$

$$\rightarrow \frac{hv}{e} - \frac{hv_0}{e} = V' \quad —Ⓐ$$

But, $\frac{hv_0}{e}$ will be Constant for a given material.

$\therefore$ eqⁿ Ⓐ represents a st line eqⁿ of a graph plotted between applied frequency (v) and stopping potential (V')

$$\therefore \text{slope} = m = \frac{h}{e} \quad —(i)$$

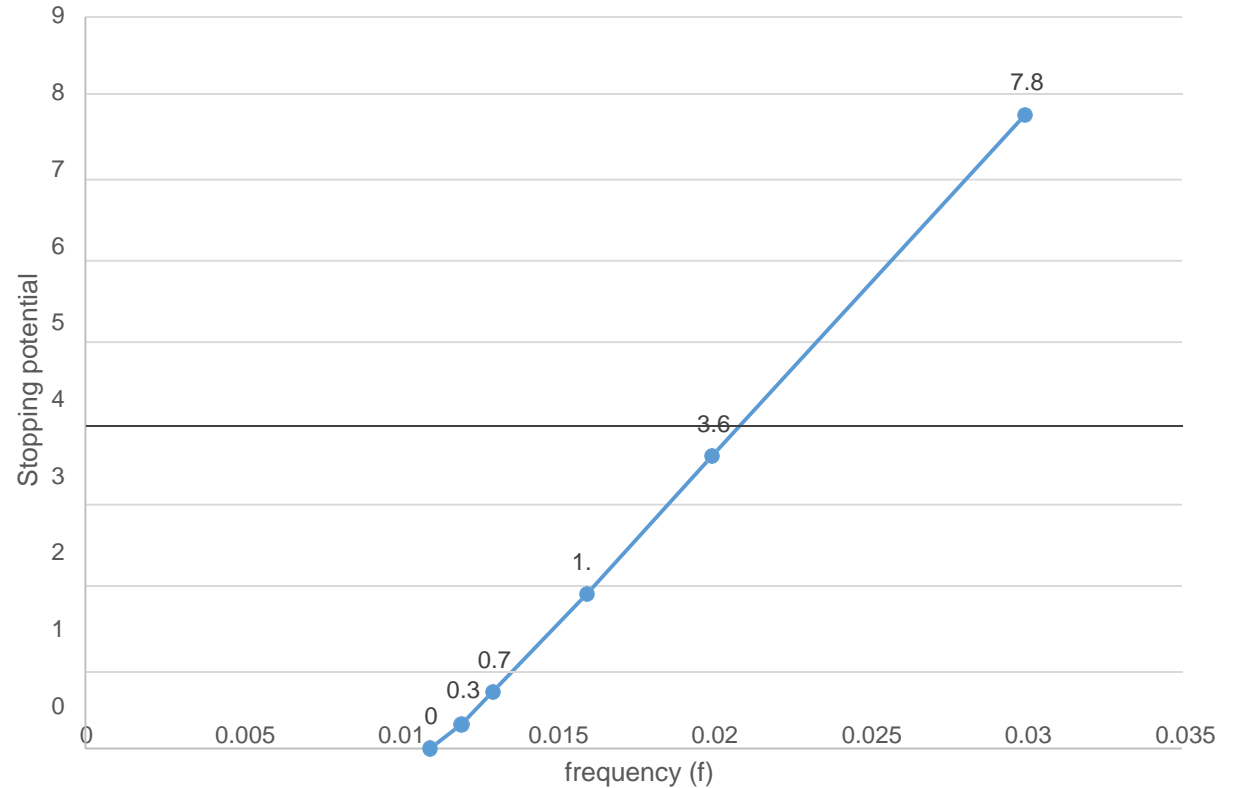where $e = 1.602 \times 10^{-19} C$

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

Observation :

Copper

Sr. No.	wavelength (L) (nm)	frequency (f) (Hz) (*10^17)	Stopping potential (V') (v)	KE(max)=e V' (*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

$$\frac{h}{e} = \frac{7.8 - 0}{(0.03 - 0.011) \times 10^7}$$

$$\rightarrow \frac{h}{1.602 \times 10^{-19}} = \frac{7.8}{0.019 \times 10^{17}}$$

$$\rightarrow h = 6.576 \times 10^{-34} \ Js$$

Zinc

| Sr. No.	wavelength (L) (nm)	frequency (f) (Hz) (*10^17)	Stopping potential (V') (v)	KE(max)=e V' (*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
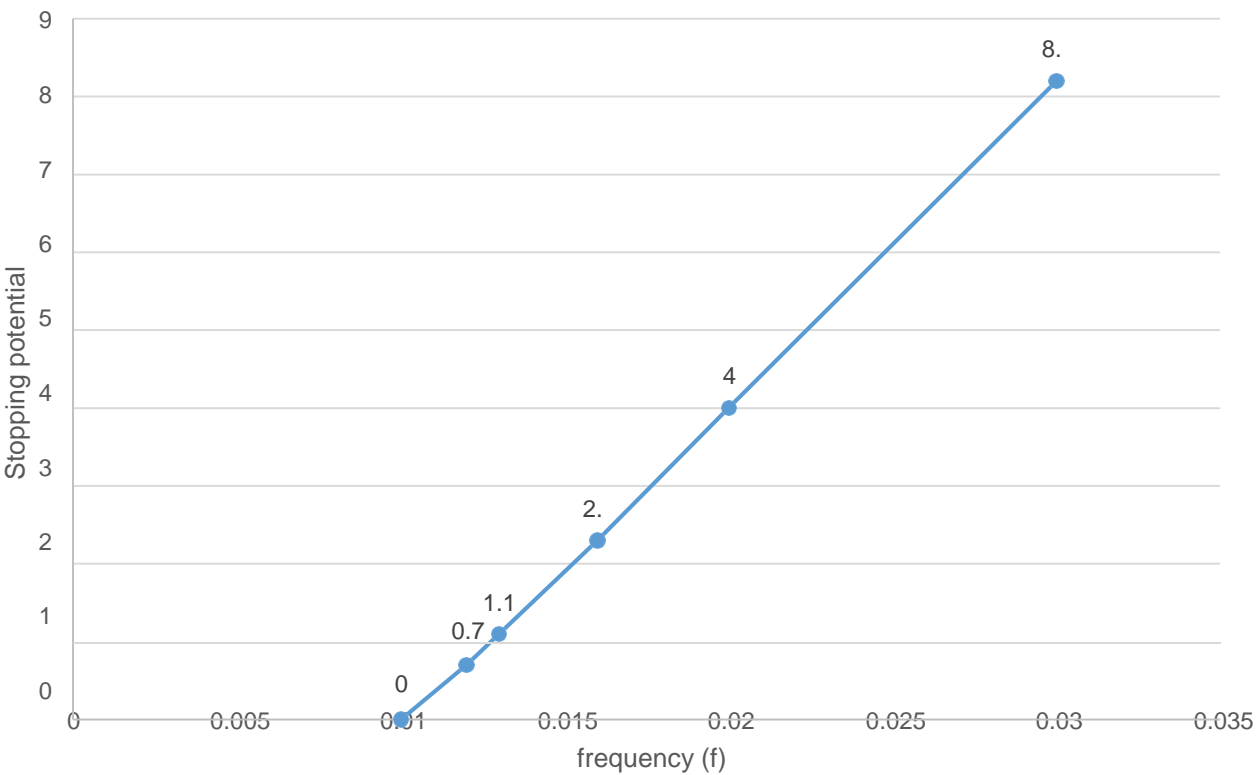
$$2) \quad \frac{h}{1.602 \times 10^{19}} = \frac{8.2 - 0}{(6.03 - 0.01) \times 10^{17}}$$

$$\Rightarrow \frac{h}{1.602 \times 10^{19}} = \frac{8.2}{0.02 \times 10^{17}}$$

$$\Rightarrow h = 6.568 \times 10^{-34} \, Js$$

Sodium

Sr. No.	wavelength (L) (nm)	frequency (f) (Hz) (*10^17)	Stopping potential (V') (v)	KE(max)=e V' (*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
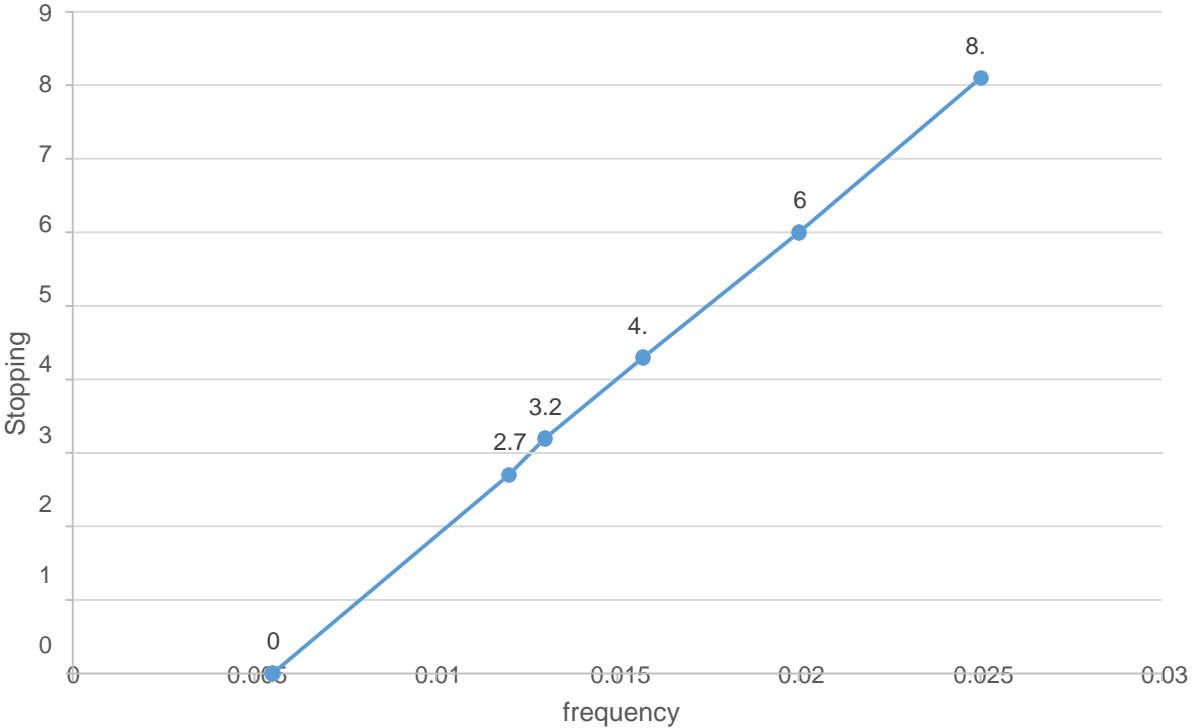
3) $\dfrac{h}{1.602 \times 10^{-19}} = \dfrac{(8.1-0) \times 10^{17}}{(0.025 - 0.0055)}$

$\Rightarrow h = \dfrac{}{1.602 \times 10^{-19}} = \dfrac{8.1 \times 10^{17}}{0.0195}$

$\Rightarrow h = 6.654 \times 10^{-34}$ J-sec

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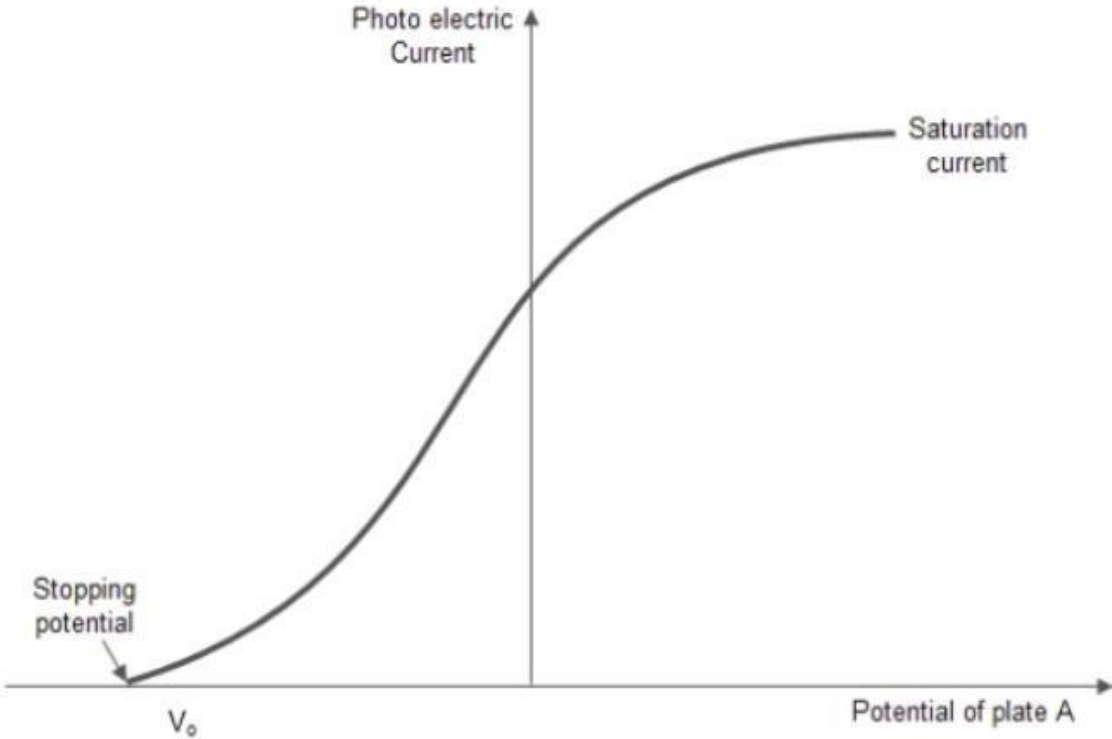
The photocurrent vs applied potential graph for each one of the above considered materials (for three different intensities) will be similar to the graph given alongside :

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.

Photo electric current

$I_1 > I_2 >$

I_3
I_2
I_1

Stopping potential

- -V_0 0   +

← Retarding potential   Anode potential V ⟶

Thank you