PH160 LAB 4

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Objective ::

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

Theory :

During his experiments on electromagnetic radiation (to demonstrate light consists of e-m waves), Hertz noticed a spark between the two metallic balls when a high frequency radiation incident on it. This is called photoelectric effect. Photoelectric effect is the emission of electrons when electromagnetic radiations having sufficient frequency 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.

The important observations on Photoelectric effect which demand quantum theory for its explanation are:

1. The Photoelectric effect is an instantaneous phenomenon. There is no time delay between the incidence of light and emission of photoelectrons.
2. The number of photoelectrons emitted is proportional to the intensity of incident light. Also, the energy of emitted photoelectrons is independent of the intensity of incident light.
3. The energy of emitted photoelectrons is directly proportional to the frequency of incident light.

Observation :

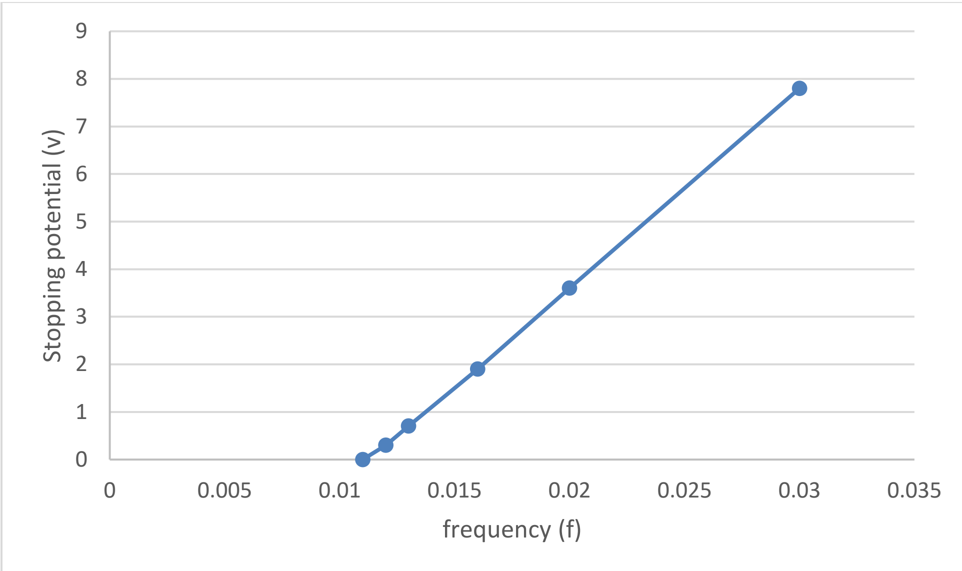
Copper :

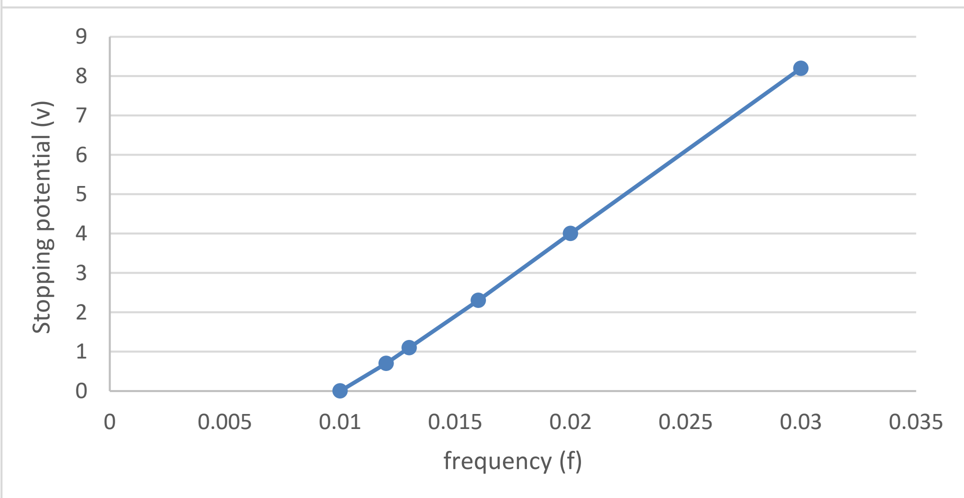
Sr.no.	Wavelength(nm)	Frequency(Hz)	Stopping Potential (-V)	$KE_{max} = e V_0$(eV)
1	100	30 x10^{14}	7.8	7.8 eV
2	150	20 x10^{14}	3.6	3.6 eV
3	190	15 x10^{14}	1.9	1.9 eV
4	230	13 x10^{14}	0.7	0.7 eV
5	264	11 x10^{14}	0	0 eV

Zinc :

Sr. no.	Wavelength(nm)	Frequency(Hz)	Stopping Potential (-V)	$KE_{max} = e V_0$(eV)
1	100	30x10^{14}	8.2	8.2 eV
2	150	20x10^{14}	4	4 eV

3	190	15 x10^{14}	2.3	2.3 e**V**
4	250	12 x10^{14}	0.7	0.7 e**V**
5	290	10 x10^{14}	0	0 e**V**





The slope of the plotted line is (h/e) from which "h",planck's

constant can be calculated as, (Note : here the area of plate is

0.1 cm^2 and intensity of light is 5 W/m^2)

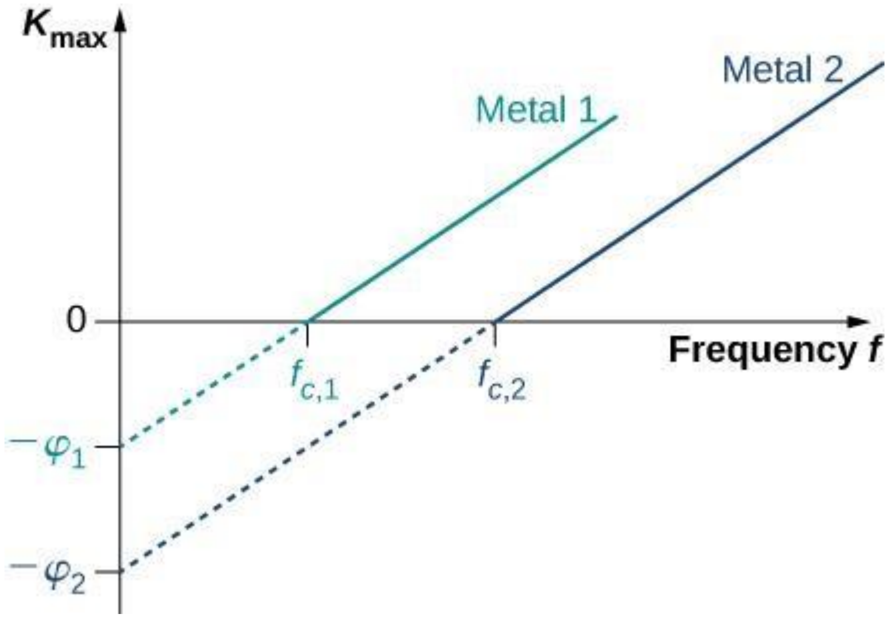
For Copper : h/e = (7.8-0)/(19x10^{14})

So, h = 6.576x10^{-34} Js

For Zinc : h/e = (8.2-0)/(20x10^{14})

So, h = 6.568x10^{-34} Js

Therefore, h = 6.572x10^{-34} Js (approx..)



For platinum :

for platinum : s.no	Voltage	Photocurrent for I1	Photocurrent for I2	Photocurrent for I3
1	0	9.87	19.75	29.62
2	-1	7.87	15.75	23.62
3	-1.5	6.87	13.75	20.62
4	-2	5.87	11.75	17.62
5	-3	3.87	7.75	11.62

(Note : Area of plate = 0.2 cm^2 wavelength = 110 nm)

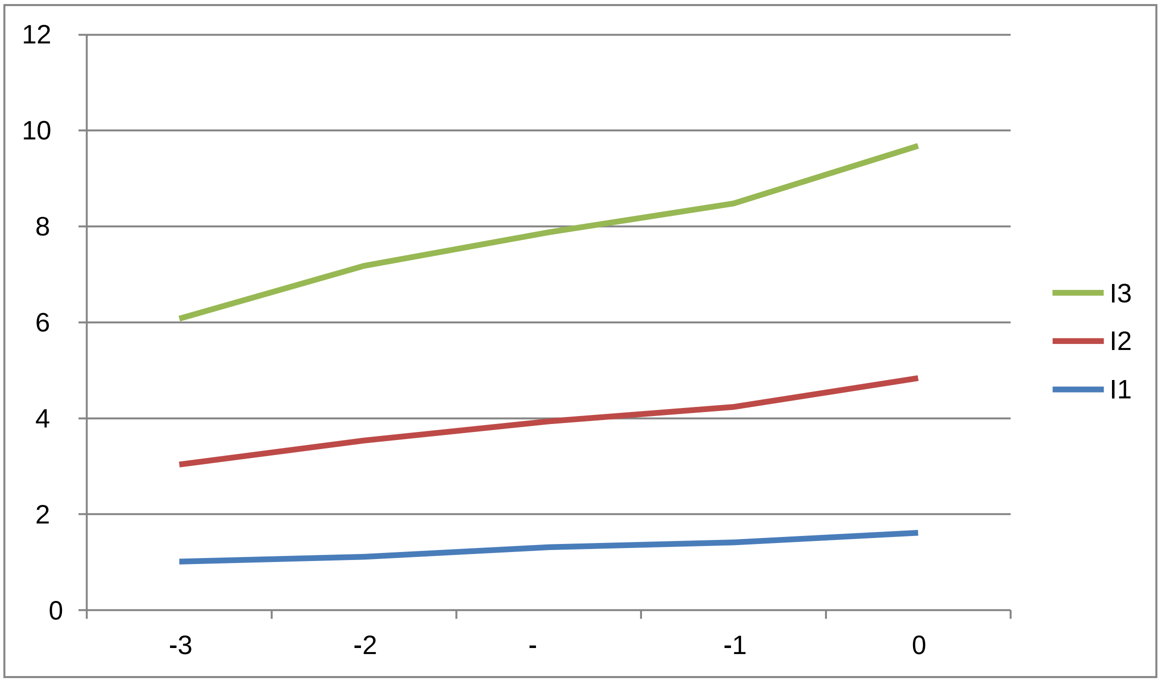
For Sodium :

s.no	Voltage	Photocurrent for I1 =10W/m^2	Photocurrent for I2 =20W/m^2	Photocurrent for I3 =30W/m^2
1	0	16.13	32.27	48.40
2	-1	14.13	28.27	42.40
3	-1.5	13.13	26.27	39.40
4	-2	11.13	24.27	36.40
5	-3	10.13	20.27	30.40

(Note : Area of plate = 0.2 cm^2 wavelength = 120)

I1 – Intensity 1, I2 – Intensity 2 , I3 – Intensity 3.

photocurrent is plotted on y – axis and on x – axis potential difference,



In this graph, Stopping potential will be equal to the potential at which photocurrent = 0.

Photoelectric current Vs Voltage :

- The current increases with intensity but reaches a saturation level for at a particular v
- No current flows for voltages less than or equal to v_o ,the stopping potential
- The stopping is independent of the radiation intensity

Conclusion :

- The photoelectric effect is caused when the photons in the light interact with electrons in the metal.
- Each of the photons interacts with one electron only
- The energy of the incident photon is used in liberating the electrons from surface
- The minimum energy required to eject electrons from the surface is called work function
- The energy of the incident photon should be greater than or equal to the work function.

Thank you