Indian Institute of Information Technology
Sonepat

Applied Sciences Lab (BSL-102)

EXPERIMENT-3

Submitted to

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Submitted By

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AIM:

To study Photoelectric Effect and calculate the Work Function (W) of Sodium(Na).

APPARATUS: -

A light source

A metal strip (Na) of specified area of cross section,

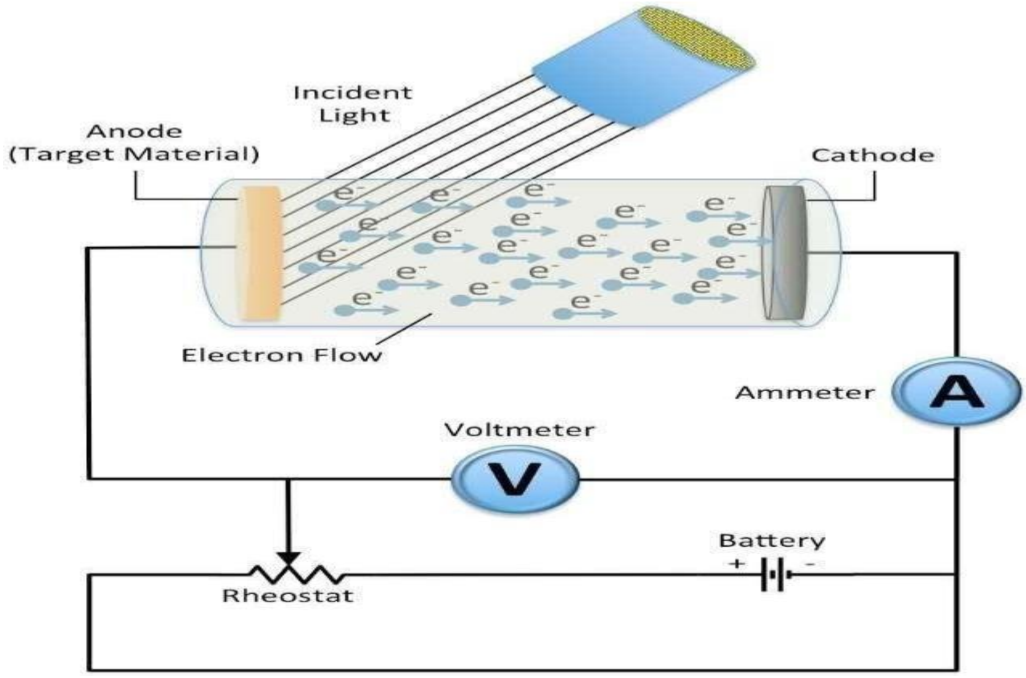
An ammeter

A voltage source

Connecting wires, clips, etc.

THEORY: -

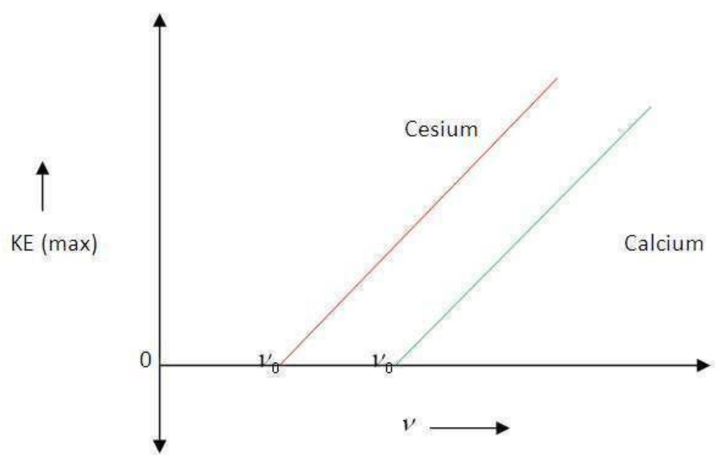
INTRODUCTION



Observed by Heinrich Hertz in 1880 and explained by Albert Einstein in 1905 using Max Planck's quantum theory of light, Photoelectric Effect is the phenomenon of emission of electrons when electromagnetic radiations having sufficient frequency incident on certain metal surfaces.

Emitted electrons are known as Photoelectrons and the current they constitute as Photocurrent.

IMPORTANT OBSERVATIONS



It is an instantaneous phenomenon. There is no time delay between the incidence of light and emission of photoelectrons.

The number of photoelectrons emitted is proportional to the intensity of incident light.

The energy of emitted photoelectrons is independent of the intensity of incident light.

The energy of emitted photoelectron is directly proportional to the frequency of incident light.

There must be a minimum energy needed for electrons to escape from a particular metal surface and that energy is called Work Function 'W' for that metal.

Every metal has its own characteristic value of Work Function (W) also denoted by ϕ

$$\boxed{\phi = h.v_o}$$

Where,

h = Planck's Constant (6.626×10^{-34} J-sec)

v_o = Threshold Frequency (frequency Minimum required for photoelectric effect).

According to Einstein,

$hv=KE_{max}+W$

$KE_{max}=hv-hv_0$

$KE_{max}=h(v-v_0)$

Increasing the reverse potential, the photocurrent gradually decreases and becomes zero at a particular reverse potential. This minimum applied reverse potential is called Stopping Potential (V_o).

Therefore,

$$KE_{max} = eV_o$$

PROCEDURE: -

Take the sample material (Sodium(Na)in this case) and set it steady.

Specify the area of the material, wavelength and intensity of incident light.

Switch “ON” the light source.

Firstly keep the wavelength of incident light constant.

Now measure current for different values of reverse voltage until current is zero.

Secondly keep the wavelength of incident light constant and reverse voltage as zero.

Now measure current for different values of Intensities.

Thirdly keep the Intensity of incident light constant.

Now measure current for different values of wavelength of the incident light until current is zero.

OBSERVATIONS: -

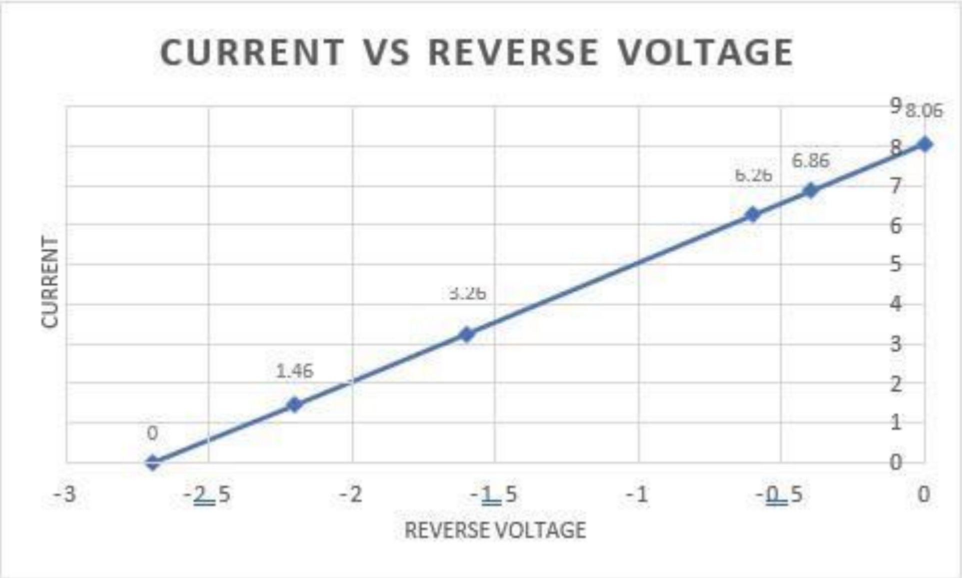
1) Sample Material:Sodium,

area =0.3 cm^2

Wavelength = 250nm

Intensity = 10W/m^2

Current(A)	Reverse voltage
8.06	0
6.86	-0.4
6.26	-0.6
3.26	-1.6
1.46	-2.2
0	-2.7



2) Sample Material:Sodium

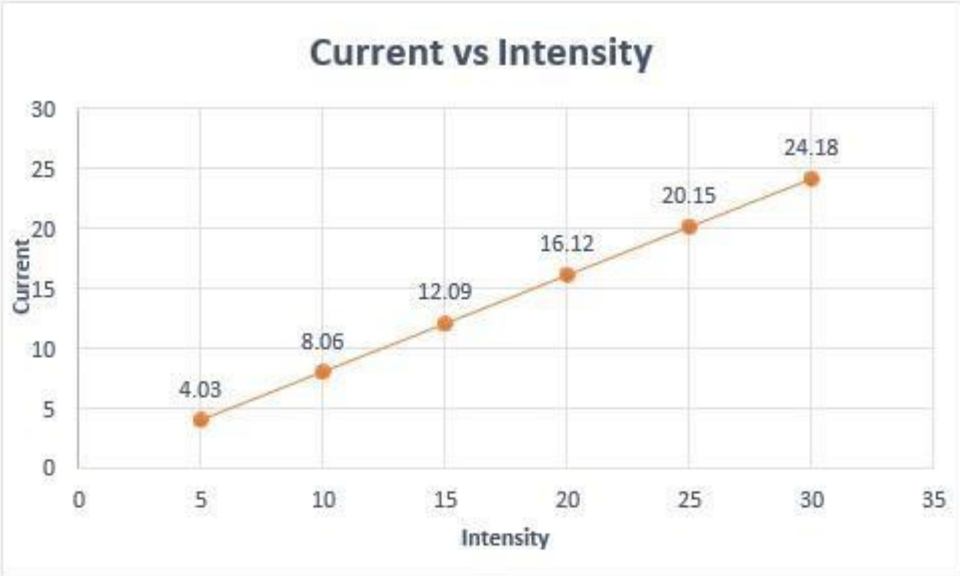
area = 0.3cm^2

Wavelength = 250nm

Reverse Voltage =0V

Current(uA)	Intensity(W/m^2)
4.03	5
8.06	10
12.09	15
16.12	20

20.15	**25**
24.18	**30**



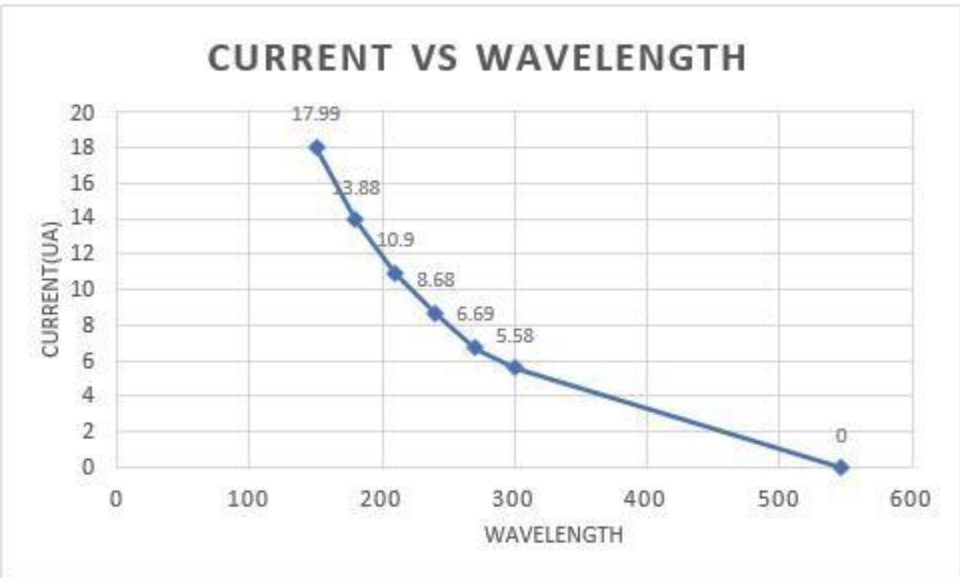
3)Sample Material:Sodium

area = 0.3cm^2 Intensity

= 10W/m^2

Reverse Voltage = 0V

Current(uA)	Wavelength
17.99	150
13.85	180
10.90	210
8.68	240
6.69	270
5.58	300
0	546



Calculation:

Work Function, = hc/λ – e*Vo

Where,

h = Planck's Constant (6.626 x 10-34J-sec)

c = speed of light (3 x 108m/sec)

λ = Wavelength of light

e = electron charge (1.6 x 10-19C)

Vo = stopping potential

Now, λ=250nm

Vo=2.7ev

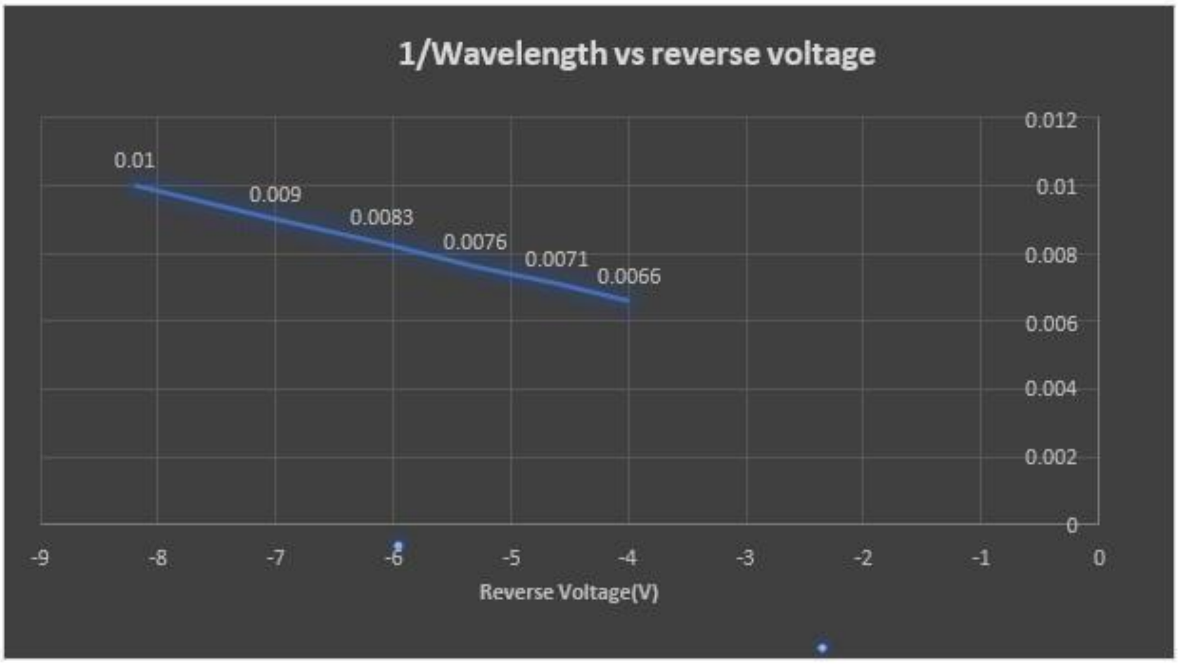
Work function = (124/25 – 2.7) eV=

(4.96-2.7)eV

=2.26eV

GRAPICAL CALCULATION.

S.no	Wavelength(nm)	1/Wavelength(1/nm)	Reverse voltage
1	100	0.0100	-8.32
2	110	0.0090	-7.0
3	120	0.0083	-6.1
4	130	0.0076	-5.3
5	140	0.0071	-4.6
6	150	0.0066	-4.0



1/Wavelength vs reverse voltage
0.01
0.009
0.0083
0.0076
0.0071
0.0066
0.012
0.01
0.008
0.006
0.004
0.002
0
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
Reverse Voltage(V)

We know that,

$$\phi = \frac{hc}{\lambda} - [e^{*} V_{\text{stopping potential}}]$$

where,

c = speed of light
h = plank's constant
V = stopping potential
e = electron charge

Now,

$V = -2V$, $\lambda = 200\ \text{nm}$

So,

$$\phi = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{200 \times 10^{-9}} - [1.6 \times 10^{-19} \times (-2)]$$

$$\phi = \frac{9.9 \times 10^{-26}}{10^{-7}} + 3.2 \times 10^{-19}$$

$$\phi = \frac{13.1 \times 10^{-19} \times 16}{1.6}$$

$$\boxed{\phi = 8.1875\ \text{eV}}$$

RESULT AND DISCUSSIONS

The theoretically calculated work function for Zinc material is 8.187 electron volt.

The graphically calculated value of Zinc material is 8.099 electron volt.

CONCLUSION

From this experiment we learnt about photoelectric effect and different materials and their work functions. Also,we learnt how we can use the photoelectric experiment.

Photoelectric Effect is the phenomenon of emission of photoelectrons from a certain metal when E.M. rays of certain sufficient frequency are made incident on it.

Every metal has its own characteristic value of Work Function.

For constant Intensities and different frequencies, the saturation value of current is same, but stopping potential is different.

For constant Frequencies and different Intensities, the stopping potential is same, but the value of saturation current is different.