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Netaji Subhas University of Technology

Department of Physics

A Project Report

On

DETERMINE PLANCK'S CONSTANT USING PHOTOELECTRIC EFFECT

SUBMITTED BY – GROUP 7

1.KARTIK DUA (2023UCM2340)

2.KUSHAGRA SAXENA (2023UCM2341)

3.NAVNITA SINGH (2023UCM2342)

4.SHAURYA GAUR (2023UCM2343)

5.HIMANSHU TUSHIR (2023UCM2344)

6.AKSHARA GUPTA (2023UCM2345)

7.SWARIT VARSHNEY (2023UCM2346)

8.KARTIK SUHAG (2023UCM2347)

LIST OF EXPERMENTS

1. To calibrate the given voltmeter and ammeter using the potentiometer.
2. To study the sparking potential of a given neon lamp.
3. To determine the resistivity of a semiconductor using four probe method.
4. To determine reverse saturation current and material constant.
5. To determine the susceptibility of a given $MnCl_2$ solution.
6. To study the hall effect
7. **To determine the Planck's constant using photo electric effect.**
6. He-Ne - LASER (Wavelength).

ACKNOWLEDGEMENT

We would like to thanks our gratitude towards our teacher **Dr. Dayanand**, whose guidance and advice helped us in the successful completion of this project . We are also grateful to the institute for providing the necessary facilities.

Certificate

- This is to certify Kartik Dua, Kushagra Saxena, Navnita Singh, Shaurya Gaur, Himanshu Tushir, Akshara Gupta, Swarit Varshney and Kartik Suhag of NSUT have completed this project towards submission for Physics of Material practical exam .
- It is hereby certified that this is a bonified work and authentic work done by them .

02.04.2024

(Dr. Dayanand)

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DEPENDENCE OF PHOTOELECTRONS

The number of photo electrons depends upon :

1.The nature of material

2. Frequency of incident radiation

3.Intensity of incident radiation

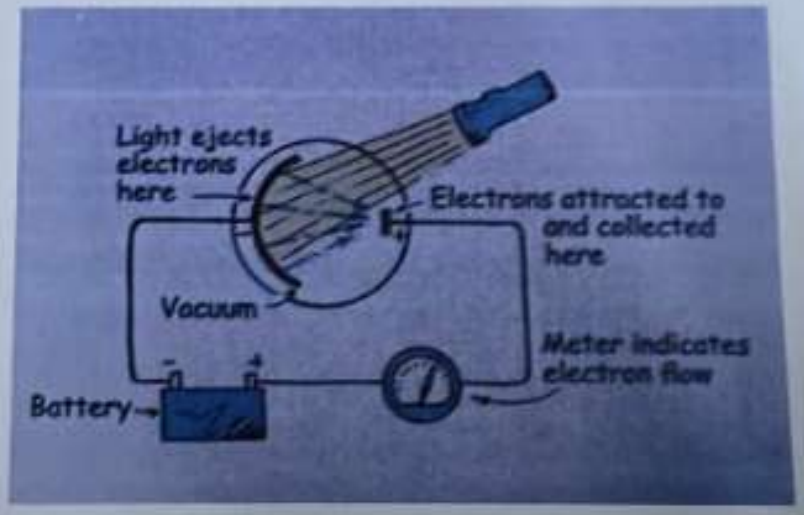
4. potential difference between the electrons

STOPPING POTENTIAL

The negative potential at which the photo electric current becomes zero is called stopping potential or cut-off potential. Stopping potential is that value of retarding potential difference between two plates which is just sufficient to halt the most energetic photoelectrons emitted. It is denoted by "V_0"

THEORY

Under the right circumstances light can be used to push electrons, freeing them from the surface of a solid. This process is called the photoelectric effect, a material can exhibit this phenomena is said to be photo emissive, and the ejected electrons are called photoelectrons



PROJECT

To determine the Planck's constant using photo electric effect.

4.Meter switch was left on the tube current and backing voltage was increased up until the current through the tube lead to zero.

5.Backing voltage was selected and exact voltage applied to the phototube in the reverse to stop all electrons from reaching anode was observed.

6. The same process was repeated for the filters of different colors and backing voltage for corresponding wavelength was noted down.

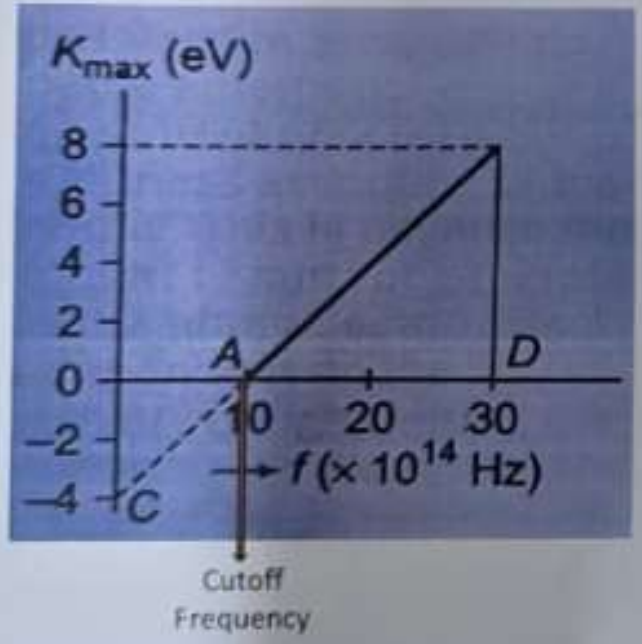
PROCEDURE

1. Presence of 9/12V battery was ensured. Instrument was switched to Experiment 1 and display was checked.
2. Tube current on meter switch was selected to monitor current through phototube. This step began by selecting 0-20 μA as this reduced to 0-200 μA as the backing voltage was increased the current through the tube reduced below 0.1μA.
3. One of the filters was inserted into the wider pair of slide grooves provided in the front of the light source.

APPARATUS REQUIRED

1. Photoelectric effect setup
2. Planck's constant setup
3. 5 standard graduated filters(each marked with highest wavelength)

EFFECT OF FREQUENCY



The graph shows that a threshold frequency is a minimum frequency below which no electrons escape from the metal surface. The photo electric effect occurs above the frequency while ceases below this frequency.

CALCULATIONS

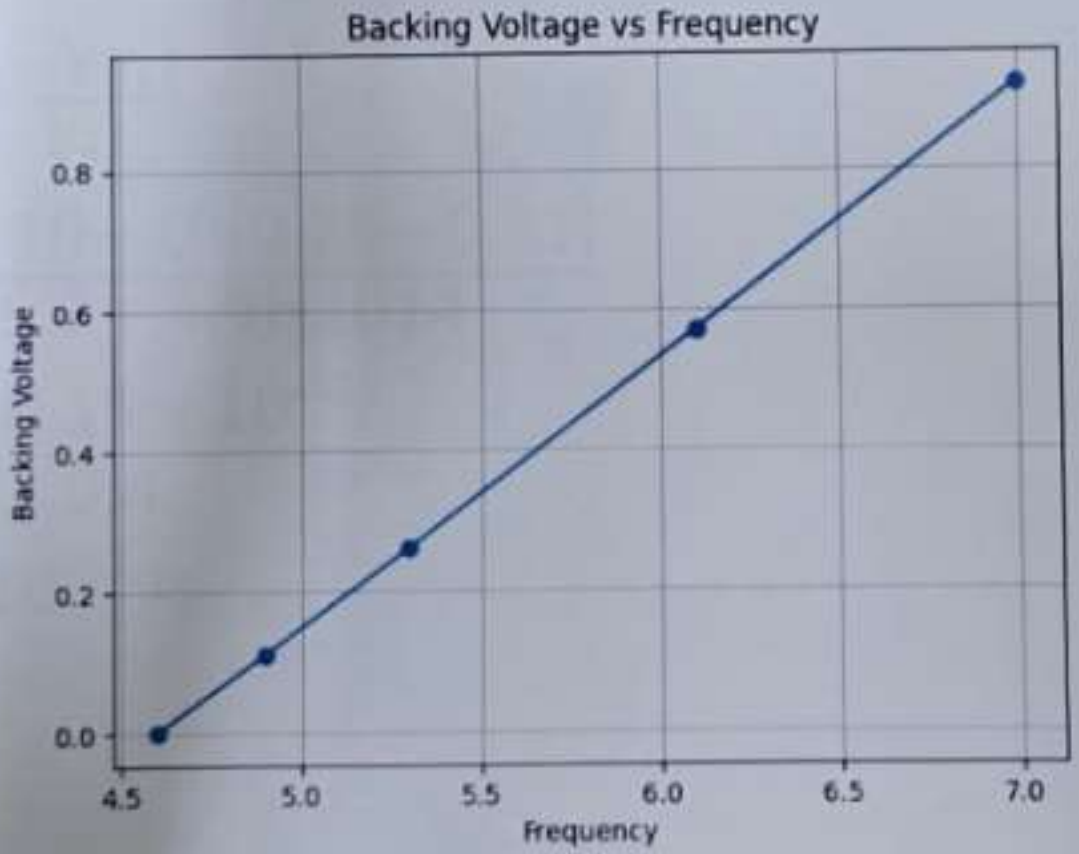
$$h = \frac{e(Vs_2 - Vs_1)}{(v_2 - v_1)}$$

$$h = \frac{1.6 \times 10{-}19(0.26 - 0.11)}{(5.3 - 4.9)\times 1014}$$

$$h = \frac{1.6 \times 0.15 \times 10^{-33}}{0.4}$$

$$h = 6.4 \times 10^{-34}\ Js$$

GRAPH


Backing Voltage vs Frequency
Backing Voltage
0.0
0.2
0.4
0.6
0.8
4.5
5.0
5.5
6.0
6.5
7.0
Frequency

OBSERVATIONS

S.No	Color	Wavelength (in nm)	Frequency ($\times 10^{14}$ Hz)	Backing Voltage (V_0)
1	Red	612	4.9	0.11
2	Orange	555	5.3	0.26
3	Yellow	492	6.1	0.57
4	Blue	428	7	0.92

FORMULA USED

The graph between the backing voltage and frequency is a straight line and equation of graph is given by

$eV = h\nu - \theta$

Here,

Θ=work function of material

V=Stopping potential

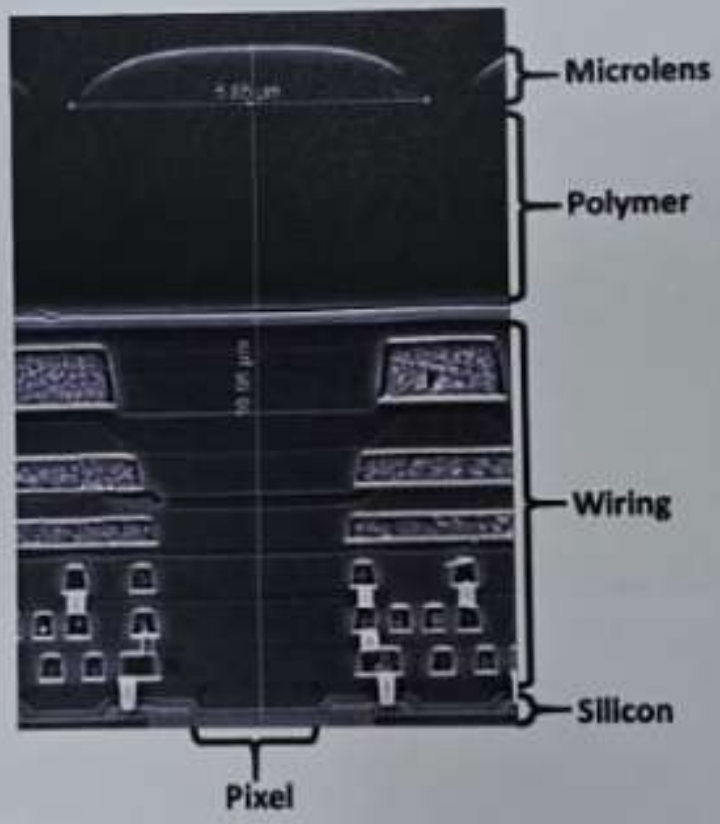
ν=Frequency of light

The slope of the equation is given by h/e, thus

$$h = \frac{e(Vs_2 - Vs_1)}{(\nu_2 - \nu_1)}$$

APPLICATIONS OF PHOTOELECTRIC EFFECT

Digital Cameras: Camera sensors are typically made of silicon split into millions of squares in a grid, these light-sensitive squares are pixels. When light hits a pixel, the material absorbs energy from the photons and releases an electron. These electrons are be stored, amplified and then converted into grey levels by the computer software, producing an image.



APPLICATIONS OF PHOTOELECTRIC EFFECT

Lighting sensors such as the ones used in Smartphone enable automatic adjustment of screen brightness according to the lighting. This is because the amount of current generated via the photoelectric effect is dependent on the intensity of light hitting the sensor.

RESULT AND ERROR

- Value of the Planck's Constant = $6.4*10^{-34}$ Js.

- Percentage error = $\frac{|6.4 - 6.62|*10^{-34}}{6.62*10^{-34}} \times 100$

  = 3.9%

PRECAUTIONS

1. Do not run the light source for a very long time.
2. Do not disturb setting while taking backing voltage readings.
3. The highest value should be recorded.
4. Voltage should be adjusted to get zero ampere.

BIBLIOGRAPHY

- Quora
- Wikipedia
- Google Images

APPLICATIONS OF PHOTOELECTRIC EFFECT

These devices are designed to convert sunlight into electricity by utilizing semiconductors that exhibit the photoelectric effect. When sunlight, composed of photons, strikes the surface of a Photovoltaic cell, it excites electrons in the semiconductor material, allowing them to break free from their atomic bonds and create an electric current. This flow of electrons is what generates the electricity that can be used to power homes, businesses, and more.

APPLICATIONS OF PHOTOELECTRIC EFFECT

Motion and Position Sensors: In this case, a photoelectric material is placed in front of a UV or IR LED. When an object is placed in between the LED and sensor, light is cut off and ne electronic circuit registers a change in potential difference

APPLICATIONS OF PHOTOELECTRIC EFFECT

X-Ray Photoelectron Spectroscopy(XPS): This technique uses kays to irradiate a surface and measure the kinetic energies of the emitted electrons. Important aspects of the chemistry of a surface can be obtained such as elemental composition, chemical composition, the empirical formula of compounds and chemical state.