Experiment 4

Aim: To calculate the different frequencies at constant intensity for copper using photoelectric effect.

Apparatus: Voltmeter, Ammeter, Rheostat, Battery

Introduction/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 photo electrons and the current they constitute as photo-current. 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.

The basic experimental set up which explains Photoelectric effect is as given below,

Circuit Diagram:

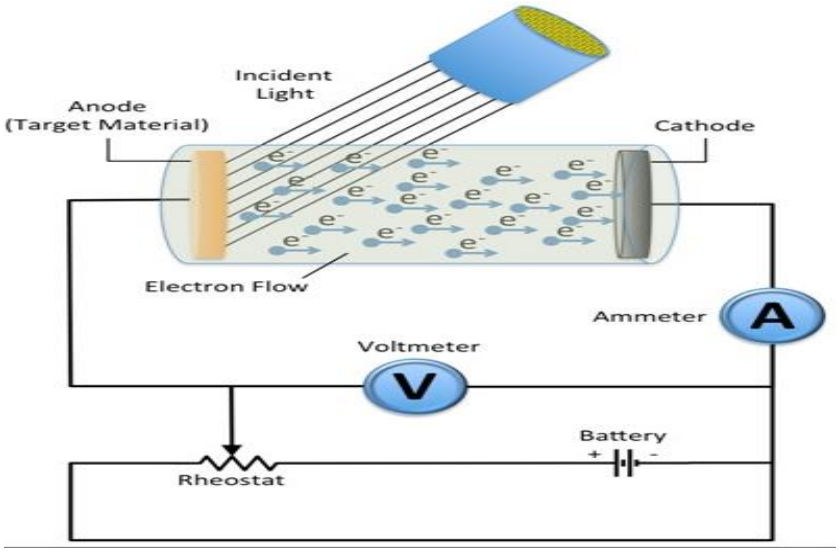

Fig 1: Shows the photoelectric Effect

It has been observed that there must be a minimum energy needed for electrons to escape from a particular metal surface and is called work function 'W' for that metal. The work function can be expressed in terms of frequency as,

$$W = h\nu_0 \ldots\ldots\ldots\ldots\ldots (1)$$

Where h is the Planck's constant and
ν_0 is the threshold frequency (minimum frequency for photoelectric effect).

According to Einstein the Photoelectric effect should obey the equation,

$$h\nu = KE_{max} + W \ldots\ldots\ldots (2)$$

Procedure:

1. Select the material for studying photoelectric effect.

2. Select area of the material, wave-length, intensity of incident light.

3. Switch on the light source.

4. Measure the reverse current for various reverse voltages.

5. Plot the current-voltage graph and determine the threshold voltage.

6. Repeat the experiment by varying the intensity for a particular wavelength of incident light.

7. Repeat the experiment by varying the wavelength for a particular intensity of the incident light

OBSERVATION TABLE:

1. Material - Copper

2. Area of plate - 0.4 cm^2

3. Intensity of light - 20 w/m^2 (constant)

S.No	Applied Reverse potential (V)	Current I_1 (micro amp)	Current I_2 (micro amp)	Current I_3(micro amp)
		Frequency (f1) (Wavelength – 130 nm)	Frequency (f1) (Wavelength – 130 nm)	Frequency (f1) (Wavelength – 130 nm)
1.	1	3.54	3.20	2.95
2.				
3.				

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Result(s): Plot graph between photocurrent and applied reverse voltage

Conclusion: The energy in light comes in small packets. Each of these packets is called a quantum of energy or a photon. From this representation it becomes clear that the low wavelength photons have high energy while the high wavelength photons have relatively low energy.