International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

Photoelectric Effect

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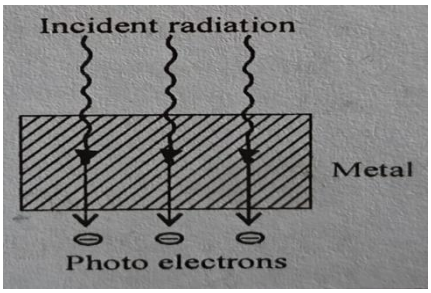
Abstract: ***The photoelectric effect occurs when you shine light on a metal piece and electrons are ejected from the metal. The electrons so emitted are called photoelectrons and the current flowing due to these photoelectrons is called photoelectric current or photocurrent. This behaviour is more understood able by assuming that the incident light consists of photons, each photon carrying a definite amount of energy. One of the electron s in an atom absorbs the photon energy and is ejected out of the atom. The energy of the photon is equal to the sum of the energy needed to eject out the electron and the kinetic energy gained by that electron. The value OF planck's constant h is determined from the observation of the photoemission of electrons from a metal surface.***

1. Introduction

Photoelectric effect was discovered by Hertz in 1887. In the photoelectric effect, electrons are emitted from a material when light is incident on its surface. Ordinarily an electron is bound to the material and cannot escape from it unless energy is supplied. The light must supply each emitted electron with sufficient energy to escape from the surface.

- To be emitted from the surface an electron must receive a minimum amount of energy is called the work function of the surface.
- The value of the work function depends on the material and on the condition of the surface.

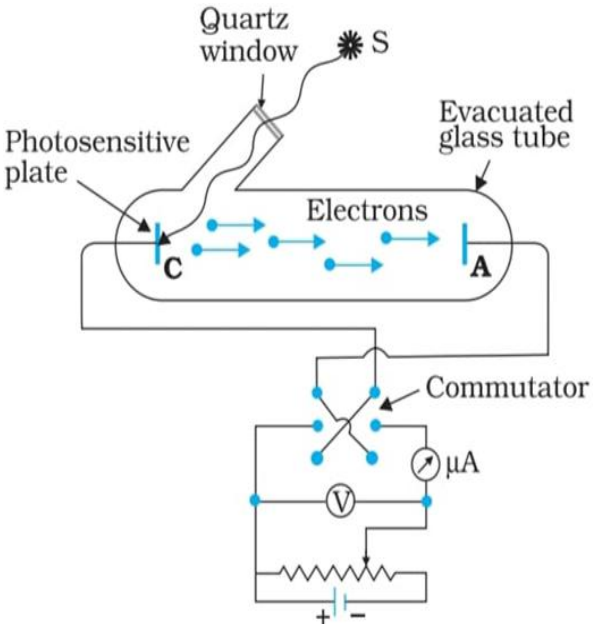
Cause of the photoelectric effect:
When the light is incident on the metal surface, photons penetrates the surface and are absorbed by orbital electrons. one electron absorbs only one electron. The energy of the photon is converted into the kinetic energy of electron. As a result, the electron is able to come out of metallic surface and thus photoelectric effect.



Work Function
In case of metal, the electrons are there in the form of an electron gas while in case of other substances electrons are present in the atoms. In order to eject these electrons from the surface of a substance (metal or non metal), so work function is defined as the minimum amount of energy required to eject an electron from the substance. It is denoted by Ø. It is different for different substances. It is measured in joules/electron or ergs/electron. The most convenient unit for measuring work function is electron volt (eV).

2. Experimental View

Photoelectric effect experiment showing light is also a particle. Below depicts a schematic view of the arrangement used for the Experimental study of the photoelectric effect. It consists of an evacuated glass/quartz tube having a thin photosensitive plate C and another metal plate A. Monochromatic light from the source S of sufficiently short wavelength passes through the window W and falls on the photosensitive plate C (emitter). A transparent quartz window is sealed on to the glass tube, which permits ultraviolet radiation to pass through it and irradiate the photosensitive plate C. The electrons are emitted by the plate C and are collected by the plate A (collector), by the electric field created by the battery. The battery maintains the potential difference between the plates C and A, that can be varied. The polarity of the plates C and A can be reversed by a commutator. Thus, the plate A can be maintained at a desired positive or negative potential with respect to emitter C. When the collector plate A is positive with respect to the emitter plate C, the electrons are attracted to it. The emission of electrons causes flow of electric current in the circuit. The potential difference between the emitter and collector plates is measured by a voltmeter (V) whereas the resulting photo current flowing in the circuit is measured by a microammeter (μA). The photoelectric current can be increased or decreased by varying the potential of collector plate A with respect to the emitter plate C. The intensity and frequency of the incident light can be varied, as can the potential difference V between the emitter C and the collector A.



Experimental arrangement for study of photoelectric effect

We can use the experimental arrangement of Fig. to study the variation of photocurrent with

a) Intensity of radiation,
b) Frequency of incident radiation,
c) The potential difference between the plates A and C, and
d) The nature of the material of plate C.

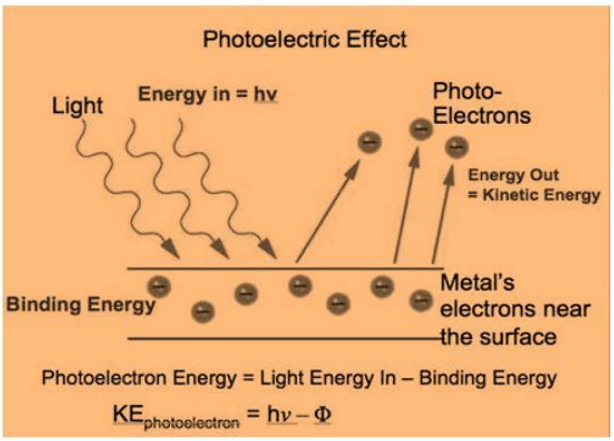
Light of different frequencies can be used by putting appropriate coloured filter or coloured glass in the path of light falling on the emitter C. The intensity of light is varied by changing the distance of the light source from the emitter.

3. Results and Conclusion

The electrons are ejected from the metal surface only as the beam of light strikes the surface.

1) The number of electrons is proportional to the intensity of radiation.
2) For each metal; there is a minimum frequency, below which photoelectric effect is not observed.
3) K. E. of electrons is proportional to the frequency of light.

When a photon of adequate energy strikes an electron in the atom of the metal, it transfers its energy to the electron, and the electron is expelled without any delay. Greater is the energy of the photon, greater will also be the kinetic energy of the ejected electron.



The conclusions of the photoelectric effect are listed below

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

References

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Author Profile

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