***Photo-electric effect***

*When light of sufficiently high frequency falls upon the metal surface, electrons are emitted from it. This phenomenona is known as photoelectric effect. The emitted electrons are called photo-electrons and the current constitutes by their electrons called photo-current.*

*OR: Ejection of electrons from a metal plate when illuminated by light or any other radiation of suitable wavelength (or frequency) is called photo-electric effect.*

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**Fig. 1**. Photo-electric effect

***Laws/ Characteristics of photo-electric emission***

The laws or characteristics of photoelectric emission are:

1. For a given metallic surface, there is a minimum frequency for which the incident light can eject the photo-electrons out of the metal. Light of frequency smaller than the particular value cannot eject electrons, no matter how long it falls on the surface.
2. The number of photo-electrons ejected depends upon the intensity of the incident light. Thus, the photo-electric current depends upon the intensity of the incident light.
3. Light of frequency higher than the *critical frequency* ejects electrons of different velocities. The maximum velocity, with which an electron is ejected, depends upon the frequency of the incident light. The *threshold frequency* is the minimum frequency which can eject and electron out of the metal.
4. The maximum kinetic energy of the ejected electrons increases linearly with the frequency of the incident light.

***Einstein’s photoelectric equation***

Einstein explained the photoelectric effect based on Planck’s theory of light. According to quantum theory, radiation is regarded as quanta of photons each of energy

moving in space with the velocity of light. Where, *h* = Planck’s constant & *ν* = frequency of radiation.

When a photon of energy *hν* is incident on a certain metallic surface, it is completely absorbed and imparts its energy to a single electron. Thus the photon energy is utilized in two purposes:

1. Partly for getting the electron free from the atom and away from the metal surface.
2. The balance of the photon energy is used up in giving the electron a kinetic energy.

The above phenomenona can be written as

Where, is the maximum photoelectron energy and is the work function which is the minimum energy needed for an electron to leave the metal.

Again *w0 = hν0*, Where, *ν0* is the threshold frequency which is the minimum frequency of the photon which can eject an electron out of the metal.

Equation (1) becomes

This is Einstein’s photoelectric equation.

***Stopping potential***

*The potential which is sufficient to emit the most energetic photo-electrons is called stopping potential.*

***Equation of stopping potential***

Einstein’s photoelectric equation is

We can write

From equation (1) and (2) we can write

This is the equation of stopping potential in photoelectric phenomenon.

***Mathematical Problems***

***Problem-1:*** *A photoelectric surface has a work function of 4eV. What is the maximum velocity of Photoelectrons emitted by light of frequency 1015 Hz incident on the surface?*

***Solution:*** We know,

Here,

***Problem-2:*** *Find the maximum velocity of photo-electrons emitted by radiation of frequency Hz from a photoelectric surface having a work function 4.0 eV.*

***Solution:*** Do yourself. (**Ans:**)

***Problem-3:*** *The wavelength of light falling on the surface of a metal of work function 2.3 eV is 4300 A0 with what velocity the electron will be emitted?*

***Solution:*** We know,

Here,

***Problem-4:*** *Calculate the threshold frequency and corresponding wavelength of radiation incident on a certain metal whose work function is. Given Plank’s constant.*

***Solution:*** We know,

Here,

Again, we know,

***Problem-5:*** *The stopping potential for electrons emitted from a metal due to photoelectric effect is found to be 1V for a light of 2500 A0. Calculate the work function of the metal in eV.*

***Solution:*** *W*e know,

Here,

Again, we know,