EMISSION

Metals are good conductors of electricity because they have free mobile electrons on their surfaces. These electrons on the surfaces of metals can be emitted by 3 major processes.

1. Thermionic Emission: This is defined as the emission of electrons from a hot filament or body (usually a metal). When metals are heated to a very high temperature, the bond between the electron and the nucleus (the proton in the nucleus) is broken and it is essentially set free. This process is called thermionic emission and it is the beginning of x-ray production.

2. High Field Emission: This emission occurs when metals are subjected to a very strong field. The electrons are forcefully removed.

3. Photoelectric Emission: This is defined as the emission of electrons from the surface of an illuminated object (or metal). When a light of high frequency or short wavelength falls on a metal, the metal's surface valence electrons can be emitted (meaning that the initial radiation is absorbed and the exposed surface emit electrons). Waves with high frequency and short wavelength are the electromagnetic waves. This phenomenon is called the photoelectric effect.

When a metal surface is exposed to a (monochromatic) electromagnetic wave of short wavelength (and high frequency),

The potential difference between the electrodes can be increased or decreased, or its polarity can be reversed.

The electrons are enclosed in an evacuated glass tube so that photoelectrons do not lose their kinetic energy on collisions with air molecules in the space between electrodes.

RIVUX-G is an acronym to remember some electromagnetic waves.

Gamma rays have the shortest wavelength and the highest frequency from the above waves

TERMS USED IN PHOTOELECTRIC EMISSION

1. Photoelectrons: The electrons that are emitted in this process are called photoelectrons. The target of the light from which the electrons are emitted is the photoelectrode and it is the anode. Photoelectrons are collected at the cathode, therefore otherwise called cathode rays.

2. Light Energy or Photon Energy: Light is a form of energy. The light energy is directly proportional to the frequency of the light

$E \propto f$

$E=hf$

From our knowledge of waves, $f=\frac{v}{\lambda}$

In photoelectric emission, $v=c$ (the speed of light)

$f=\frac{c}{\lambda}$

$E=\frac{hc}{\lambda}$

E = Photon energy
f = frequency of light
h = Planck's constant (6.63×10^{-34})
c = speed (or velocity) of light
λ = wavelength of the light

2. Threshold frequency: This is defined as the minimum frequency required before photoelectric emission can occur (or before the electron can be set free). The threshold frequency depends on the (nature of the) metal. It is represented as f_o or f_c

3. Work function: This is defined as the least amount of energy required before photoelectric emission can take place. The work function is directly proportional to the threshold frequency.

$\varphi \propto f_o$

$\varphi=hf_o$

4. Kinetic Energy of the Photoelectron: This is defined as the difference in the light energy supplied and the work function.

$KE=E-\varphi$

$KE=hf-hf_o$

$KE=h(f-f_o)$

This statement of the Kinetic energy was made by Albert Einstein.
It can be seen that the kinetic energy of a photoelectron depends on the frequency of light (or its wavelength). The Kinetic Energy of the photoelectron is however **independent** on the intensity of the light. However, the rate of emission depends on the intensity or density of the light

5. Stopping Potential: This is defined as the voltage required to heat the photoelectron.
From

$W=qV$

$KE=e\times V$

$V=\frac{KE}{e}$

e = Charge of the electron
KE = Kinetic Energy of the electron
V = Stopping Potential

CONDITIONS THAT MUST BE MET BEFORE PHOTOELECTRIC EMISSION CAN OCCUR

1. The frequency of light must be greater than the threshold frequency
2. The light energy must be greater than the work function

PHOTOELECTRIC EFFECT

This is defined as the process of generating electrical energy from light energy

PHOTOCELL

The photocell is used for converting light energy to electrical energy. The operation of the photocell is based on (the principle of) photoelectric effect

To create a photocell,

TOOLS FOR A PHOTOCELL

1. Evacuated glass tube: This is used so that photoelectrons do not lose their kinetic energy by colliding with air molecules
2. Two metals: 1 the anode and the other the cathode
3. A monochromatic source of light

PROCESSES

1. The two metals are separated with a gap within the tube
2. A beam of light is projected on to the anode.
3. Electrons are emitted from the anode and move towards the cathode

When this photocell is connected to a circuit, it can act as a key. The anode is connected to the positive side of the circuit or battery and the cathode to the negative side. When the beam of light is projected onto the anode and the electrons are moving to the cathode, it begins to conduct electricity and current can be read in the ammeter connected to the circuit. The stream of electrons can act as a wire or a connection between the cathode and the anode. This current that is read in the ammeter is called the **photocurrent**.
If the anode is connected to the negative side and the cathode to the positive side, you'll see that the voltage will slowly increase. The photocurrent will gradually die down and will eventually stop flowing completely at some value of the voltage. The potential difference at which the photocurrent stops flowing is called the **stopping potential**(V_s).

USES OF PHOTOCELL

1. It is used in the construction of burglar alarm

2. It is used in the construction of close circuit television (CCTV) camera
3. It is used in automatic opening and closing of doors
4. It is used for generating sound of varying intensities
5. It is employed in solar calculators
6. It is also used in automatic switches

CHARACTERISTICS OF PHOTOELECTRIC EFFECT

There are 3 characteristics of photoelectric effect that cannot be explained by classical physics. They are

1. The absence of lag time: When a ray of light strikes the anode, the electrons are emitted instantaneously even if the intensity of the light is very low. From classical physical or common sense, it should take some time before irradiated electrons could gain sufficient energy to the leave the electrode surface.

2. The independence of the kinetic energy of the photoelectrons on the intensity of incident radiation
3. The presence of a cut-off frequency