16. Electrons and Photons

Photoelectric effect

- Phenomenon of emission of electrons from the surface of metals when radiations of suitable frequency fall on them.

Work function of a metal

- It is the minimum energy required to liberate an electron from the surface of a metal without imparting any kinetic energy.

Factors affecting photoelectric effect:

- The number of photoelectrons ejected per second is directly proportional to the intensity of the incident light.
- For an incident radiation of frequency less than the threshold frequency, no emission of photoelectron is possible, even if the intensity is high.
- The maximum kinetic energy of the emitted photoelectron depends only upon the frequency (or wavelength) of the incident light, and is independent of the intensity of the incident light.

Einstein's Photoelectric Theory

- Light radiation consists of small packets of energy called quanta.
- One quantum of light radiation is called a photon, which travels at the speed of light.
- Energy of a photon, E = hν.

The energy of an an electron falling on a metal energy is used for:

- liberating the electron from the metal surface (= work function)
- imparting maximum kinetic energy kmax to the emitted photoelectrons

h nu equals capital phi subscript 0 plus 1 half m v squared subscript m a x end subscript

- Einstein’s Photoelectric Equation:
  K subscript m a x space end subscript equals space 1 half m v squared equals space h nu minus capital phi subscript 0
  , Here, K_{max}= Maximum kinetic energy of the emitted electrons, v = Maximum velocity of the electrons, ϕ_0= Work function of the metal

- **Photoelectric Cell**
  - It is a device that converts light energy into electrical energy.
  - It works on the principle of photoelectric effect.

Applications of photoelectric cell :

- Burglar alarm
- Sound reproduction in motion pictures

Properties of Photons

All photons of light of a particular frequency ν, or wavelength λ, have the same energy E ($=h\nu = hc/\lambda$) and momentum p ($= h\nu/c$), independent of the intensity of radiation.

By increasing the intensity of light of given wavelength, there is only an increase in the number of photons per second crossing a given area, with each photon having the same energy.

Photons are electrically neutral and are not deflected by electric and magnetic fields.

In a photon particle collision, the total energy and total momentum are conserved. However, the number of photons may not be conserved in a collision