Questions & Answers

Derive Einstein's photoelectric equation. Explain the photoelectric effect with the help of this equation.

Answer ✓ Verified

Hint: Photoelectric effect is a phenomenon in which the electrically charged particles are ejected from the material or within the material whenever it absorbs electromagnetic radiation. The effect is sometimes described as the ejection of electrons from a metal plate when light is incident on it.

Complete step-by-step answer:

First of all let us discuss the photoelectric effect in detail. The photoelectric effect is defined as the ejection of electrons when electromagnetic radiation, for example light, hits a material. Electrons emitted in this manner are known as photoelectrons. The photoelectric effect happens when light falls on a metal. Often electrons are being emitted. Light at any frequency will result in electrons to be emitted. Einstein's photoelectric equation is given as,

The energy of the incident photon is equal to the sum of the maximum kinetic energy of an electron and the work function.

This is based on energy conservation,

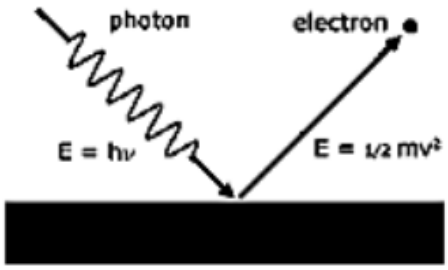
$$h\nu = \frac{1}{2}m{V_{\max}}^2 + W_0$$

Where W_0 the work function.

$$W_0 = \frac{h\nu_0}{\gamma}$$

ν_0 is the threshold frequency

As the intensity increases, the number of photons striking the metal surface at a unit time increases. So the number of ejected electrons increases. If frequency of incident radiation becomes less than the threshold frequency, the kinetic energy of photoelectrons will be negative. This is no physical meaning for this. The maximum kinetic energy increases linearly with frequency.



Note: The more intense the light falls, the more kinetic energy the emitted electrons will have. Study of the photoelectric effect led to necessary steps in understanding the quantum nature of light and electrons and influenced the formation of the concept of dual nature of a wave. The photoelectric effect is also commonly used to investigate electron energy levels in matter.

Related Questions

State two important properties of photons which are used to write Einstein's photoelectric equation. Define (i) Stopping potential and (ii) threshold frequency, using Einstein's equation and drawing necessary plots between relevant quantities.

Calculate the stopping potential if the maximum kinetic energy of the photoelectrons emitted by a photocell will be $3eV$.

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