

State Examination Commission – Physics Higher Level, 2005

Question 12(d)

One hundred years ago, Albert Einstein explained the photoelectric effect.

What is the photoelectric effect? (6)

Write down an expression for Einstein's photoelectric law. (9)

Summarise Einstein's explanation of the photoelectric effect (9)

Give one application of the photoelectric effect. (4)

What is the photoelectric effect? (6)

The **photoelectric effect** is a phenomenon in which electrons are emitted from the surface of a metal after the absorption of energy from electromagnetic radiation.

Write down an expression for Einstein's photoelectric law. (9)

$$hf = \phi + \frac{1}{2}mv_{\max}^2, \quad \text{where } h = \text{Planck's constant, } f = \text{frequency of incident radiation, } \phi = \text{work function of the metal and } \frac{1}{2}mv_{\max}^2 = \text{maximum kinetic energy of the emitted photoelectrons.}$$

Summarise Einstein's explanation of the photoelectric effect (9)

The photons of the radiation have a characteristic energy determined by their frequency. In the effect, if an electron absorbs the energy of one photon and has more energy than the work function, it is ejected from the material. If the photon energy is too low, the electron is unable to escape the surface of the material.

Electrons can absorb energy from photons when irradiated, but they follow an "all or nothing" principle. All of the energy from one photon must be absorbed and used to liberate one electron from atomic binding, or the energy is re-emitted. If the photon energy is absorbed, some of the energy liberates the electron from the atom, and the rest contributes to the electron's kinetic energy as a free particle.

Give one application of the photoelectric effect. (4)

It is used in the photocell, a device common in many types of electronic circuitry.