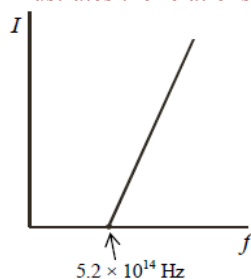


State Examination Commission – Physics Higher Level, 2009

Question 8

What is a photon? (6)

An investigation was carried out to establish the relationship between the current flowing in a photocell and the frequency of the light incident on it. The graph illustrates the relationship.



Draw a labelled diagram of the structure of a photocell. (12)

Using the graph, calculate the work function of the metal.

What is the maximum speed of an emitted electron when light of wavelength 550 nm is incident on the photocell?

Explain why a current does not flow in the photocell when the frequency of the light is less than 5.2×10^{14} Hz. (21)

The relationship between the current flowing in a photocell and the intensity of the light incident on the photocell was then investigated. Readings were taken and a graph was drawn to show the relationship.

Draw a sketch of the graph obtained. How was the intensity of the light varied?

What conclusion about the nature of light can be drawn from these investigations? (17)

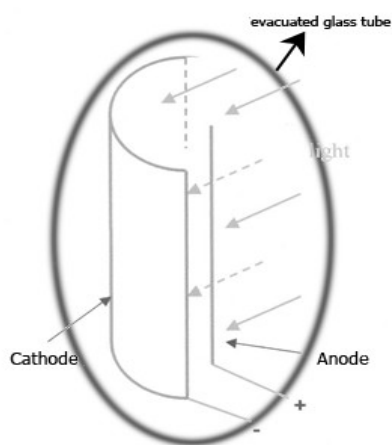
(Planck constant = 6.6×10^{-34} J s; speed of light = 3.0×10^8 m s⁻¹;
charge on electron = 1.6×10^{-19} C; mass of electron = 9.1×10^{-31} kg)

What is a photon? (6)

a discrete packet (quantum) of energy

An investigation was carried out to establish the relationship between the current flowing in a photocell and the frequency of the light incident on it. The graph illustrates the relationship.

Draw a labelled diagram of the structure of a photocell. (12)



Using the graph, calculate the work function of the metal.

The threshold frequency is 5.2×10^{14} Hz.

$$\phi = hf_0 = 6.6 \times 10^{-34} \times 5.2 \times 10^{14} = 3.432 \times 10^{-19} \text{ J}$$

What is the maximum speed of an emitted electron when light of wavelength 550 nm is incident on the photocell?

Energy of incident photon $E = hf = hc/\lambda = 6.6 \times 10^{-34} \times (3.0 \times 10^8)/(5.50 \times 10^{-7}) = 3.6 \times 10^{-19} \text{ J}$
therefore, max energy of emitted electron = $3.6 \times 10^{-19} - 3.432 \times 10^{-19} = 1.68 \times 10^{-20} \text{ J}$

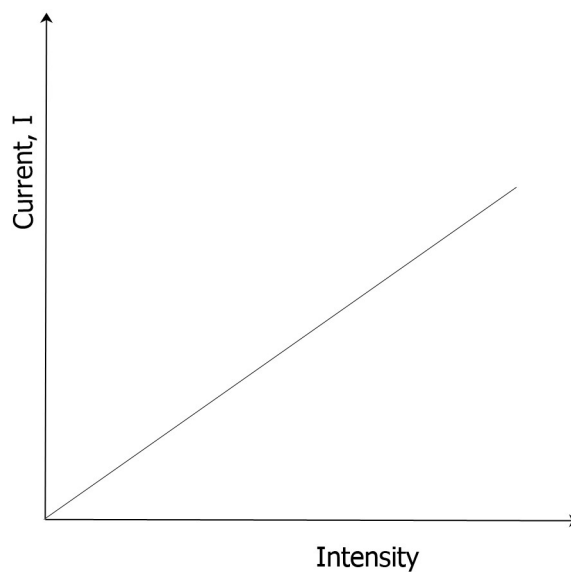
$\frac{1}{2}mv^2 = 1.68 \times 10^{-20}$, since m is given, solving for v gives
 $v = 1.92 \times 10^5 \text{ m s}^{-1}$

Explain why a current does not flow in the photocell when the frequency of the light is less than $5.2 \times 10^{14} \text{ Hz}$. (21)

Any radiation with a frequency below the threshold frequency, has insufficient energy to eject electrons from the surface of the metal.

The relationship between the current flowing in a photocell and the intensity of the light incident on the photocell was then investigated. Readings were taken and a graph was drawn to show the relationship.

Draw a sketch of the graph obtained. How was the intensity of the light varied?



The intensity of the light is inversely proportional to the square of the distance from the light source, so the distance to the light source was varied, and measured each time, and the current was plotted against $1/d^2$.

What conclusion about the nature of light can be drawn from these investigations? (17)

Light consists of discrete bundles of energy (photons), i.e., light is particulate in nature.