

Photon energy, work function and matter waves

Physics grades 11-12 (A Level · IB · Class 11-12) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test covers photon energy, the photoelectric effect, graph analysis and de Broglie wavelength. Show formulas, substitutions and units. Use $h = 6.63 \times 10^{-34} \text{ J s}$, $c = 3.00 \times 10^8 \text{ m/s}$, $e = 1.60 \times 10^{-19} \text{ C}$ and electron mass $9.11 \times 10^{-31} \text{ kg}$.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB E.2

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Photon energy (2 marks)

Calculate the energy of a photon of frequency $7.5 \times 10^{14} \text{ Hz}$.

Question 2 Work function (2 marks)

Define work function and threshold frequency, and state how they are related.

Question 3 Einstein's equation (3 marks)

The work function of a metal is 2.1 eV. Light of wavelength 450 nm falls on it. Calculate the maximum kinetic energy of the photoelectrons in eV and the stopping potential.

Question 4 Wave model failure (3 marks)

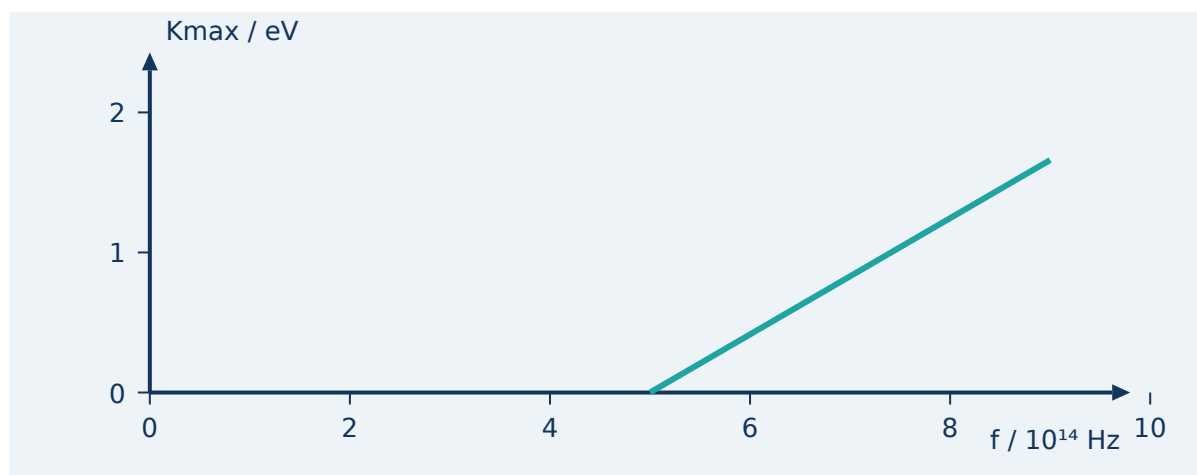
Explain why the wave model of light cannot explain why no electrons are emitted from a metal by bright light below the threshold frequency.

Question 5 Intensity (2 marks)

The intensity of light above threshold is halved. State the effect on the photocurrent and on K_{max} .

Question 6 Graph analysis (3 marks)

The graph shows K_{max} against frequency for a metal.



K_{max} against frequency.

- Read the threshold frequency. (1 mark)
- Calculate the work function in eV. (2 marks)

Question 7 de Broglie (3 marks)

Calculate the de Broglie wavelength of an electron moving at $4.0 \times 10^6 \text{ m/s}$.

Question 8 Duality evidence (2 marks)

Name one experiment that shows the particle nature of light and one that shows the wave nature of electrons.