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QUESTION WORKBOOK

The photoelectric effect

Quantum phenomena · Year 12

AQA 3.2.2.1 · CIE 22.1, 22.2 · OCR A 4.5.1, 4.5.2

10 questions · 30 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 State one observation of the photoelectric effect that the wave model of light cannot explain. [2]

A2 A photon has a frequency of 5.0×10^{14} Hz. Taking $h = 6.63 \times 10^{-34}$ J s, calculate its energy. [2]

A3 Define the work function of a metal. [2]

SECTION B · Standard

B1 A metal has a work function of 3.2×10^{-19} J. Calculate its threshold frequency ($h = 6.63 \times 10^{-34}$ J s). [3]

B2 Light of frequency 8.0×10^{14} Hz falls on a metal of work function 3.0×10^{-19} J. Calculate (a) the maximum kinetic energy of the emitted electrons and (b) their maximum speed ($m_e = 9.11 \times 10^{-31}$ kg). [4]

B3 Express the energy of the photon in the first calculation (5.0×10^{14} Hz, energy 3.32×10^{-19} J) in electronvolts ($e = 1.60 \times 10^{-19}$ C). [3]

B4 For the metal in the four-mark question ($E_{k(max)} = 2.30 \times 10^{-19}$ J), calculate the stopping potential needed to just prevent photoemission. [3]

SECTION C · Stretch

C1 A metal has a work function of 2.0 eV. Taking $h = 6.63 \times 10^{-34}$ J s, $c = 3.0 \times 10^{8}$ m s^{-1} and $e = 1.60 \times 10^{-19}$ C, calculate the longest wavelength of light that can release an electron. [4]

C2 Light of wavelength 400 nm falls on the same metal (work function 2.0 eV). Calculate (a) the maximum kinetic energy of the emitted electrons and (b) the stopping potential. [4]

C3 Explain, using the photon model, why increasing the intensity of light of a fixed frequency does not increase the maximum kinetic energy of the emitted electrons. [3]