



QUESTION WORKBOOK

Quanta and wave-particle duality

Turning points · Year 13

AQA 3.12.2.4, 3.12.2.5, 3.12.2.6

10 questions · 28 marks

NAVY SCREEN EDITION

SECTION A · Warm-up

A1 State what is meant by the ultraviolet catastrophe. [2]

A2 State Planck's interpretation of black-body radiation, and how it removes the catastrophe. [2]

A3 Give two observations about photoelectricity that classical wave theory cannot explain. [2]

SECTION B · Standard

B1 Calculate the de Broglie wavelength of electrons accelerated from rest through 150 V. [3]

B2 Calculate the de Broglie wavelength for an accelerating pd of 5.0 kV. [3]

B3 In a low-energy electron diffraction experiment the accelerating pd is made nine times larger. State and explain the effect on the ring pattern. [3]

B4 Explain the significance of Einstein's explanation of the photoelectric effect for the nature of electromagnetic radiation. [3]

SECTION C · Stretch

- C1** Estimate the anode voltage that gives electrons a de Broglie wavelength of 5.0×10^{-11} m, half the size of a typical atom. [4]

- C2** Outline the principle of operation of the transmission electron microscope. [3]

- C3** Outline the principle of operation of the scanning tunnelling microscope. [3]