



QUESTION WORKBOOK

Cathode rays and the electron

Turning points · Year 13

AQA 3.12.1.1, 3.12.1.2, 3.12.1.3

10 questions · 29 marks

NAVY SCREEN EDITION

SECTION A · Warm-up

A1 Describe how cathode rays are produced in a discharge tube. [2]

A2 State what is meant by thermionic emission, and why the electron gun that uses it must operate in a vacuum. [2]

A3 Define the specific charge of a particle, and state its SI unit. [2]

SECTION B · Standard

B1 Using $e/m = 1.76 \times 10^{11} \text{ C kg}^{-1}$, calculate the speed of electrons accelerated from rest through 3.0 kV. [3]

- B2** An electron beam passes undeflected through crossed fields of strength $E = 4.2 \times 10^4 \text{ V m}^{-1}$ and $B = 1.5 \times 10^{-3} \text{ T}$. Calculate the beam speed and explain why no deflection occurs. [3]

- B3** The beam of the previous question was accelerated through 2.23 kV before entering the fields. Determine the specific charge of its particles. [4]

- B4** Calculate the specific charge of the hydrogen ion (mass $1.67 \times 10^{-27} \text{ kg}$, charge $1.60 \times 10^{-19} \text{ C}$), and the ratio of the electron's specific charge to it. [3]

SECTION C · Stretch

- C1** Calculate the accelerating pd that gives electrons a speed of one tenth of the speed of light, and suggest why the simple formula should be used cautiously beyond this speed. [4]

- C2** Explain why Thomson's measurement of e/m was taken as evidence that atoms have internal structure. [3]

- C3** In a specific charge measurement, a student suggests removing the electric field and finding the speed from the magnetic deflection alone. Explain why the crossed-fields arrangement is used instead to find the speed. [3]