InkPhysics

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

PRINT EDITION

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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 $e/m = 1.76 \times 10^{11}$ 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 $E = 4.2 \times 10^{4}$ V m^{-1} and $B = 1.5 \times 10^{-3}$ 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 1.67×10^{-27} kg, charge 1.60×10^{-19} 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]