InkPhysics

QUESTION WORKBOOK

Millikan's oil drop experiment

Turning points · Year 13

AQA 3.12.1.4

10 questions · 28 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 Write down the condition for a charged oil droplet to hang stationary between horizontal parallel plates, defining every symbol. [2]

A2 State Stokes' law for the viscous force on a small sphere, and the conditions under which it applies. [2]

A3 State the conclusion Millikan drew from measuring the charges on hundreds of droplets. [2]

SECTION B · Standard

B1 A droplet of weight 1.632×10^{-14} N hangs stationary between plates 6.0 mm apart when the pd is 612 V. Calculate its charge, and state how many electrons' worth it carries. [3]

B2 With the field off, a droplet falls at a steady 1.2×10^{-4} m s^{-1}. Using $\eta = 1.8 \times 10^{-5}$ Pa s and oil density 880 kg m^{-3}, calculate the droplet's radius and mass. [4]

B3 The droplet of the previous question carries two electrons' worth of charge, 3.2×10^{-19} C. Calculate the pd needed to hold it stationary between plates 5.0 mm apart. [3]

B4 Explain why the falling measurement with the field switched off is an essential part of the experiment. [3]

SECTION C · Stretch

C1 Three droplets in one run carry charges 3.2×10^{-19} C, 4.8×10^{-19} C and 8.0×10^{-19} C. Show these support charge quantisation, and state the value of e they imply. [4]

C2 Combine Millikan's e = 1.60×10^{-19} C with Thomson's e/m = 1.76×10^{11} C kg^{-1} to find the mass of the electron. [3]

C3 A student's analysis of oil-drop data yields a droplet charge of 4.0×10^{-19} C. Explain why this result should send the student back to their working. [2]