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ANSWER BOOK

Magnetic flux density and the force on a wire

Magnetic fields · Year 13

AQA 3.7.5.1 · CIE 20.1, 20.2 · OCR A 6.3.1

10 questions · 30 marks

NAVY EDITION

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SECTION A · Warm-up

A1 $F = BIl$, where B is the magnetic flux density, I the current and l the length of wire in the field. It applies when the wire is perpendicular to the field. [2]

A2 $F = BIl = 0.20 \times 3.0 \times 0.15 = 0.09$ N. [2]

A3 Magnetic flux density B is the force per unit current per unit length on a wire at right angles to the field ($F = BIl$). One tesla is one N A^{-1} m^{-1}. [2]

SECTION B · Standard

B1 $B = F/(Il) = 0.50/(4.0 \times 0.25) = 0.50$ T. [3]

B2 $F = BIl \sin\theta = 0.30 \times 2.0 \times 0.10 \times \sin 30° = 0.030$ N. [3]

B3 $I = F/(Bl) = 0.18/(0.45 \times 0.080) = 5.0$ A. [4]

B4 The force depends on $\sin\theta$ between the wire and the field. At 90°, $\sin\theta = 1$ and the force is maximum; when the wire is parallel to the field, $\theta = 0°$ so $\sin\theta = 0$ and there is no force. [3]

SECTION C · Stretch

C1 $F = BIl = 0.60 \times 8.0 \times 0.050 = 0.24$ N. Equivalent mass $= F/g = 0.24/9.81 = 24.5$ g. [4]

C2 (a) $F = BIl = 0.25 \times 6.0 \times 0.12 = 0.18$ N. (b) $F = BIl \sin 45° = 0.18 \times \sin 45° = 0.127$ N. [4]

C3 Place a fixed horizontal wire between the poles of a magnet that sits on a top-pan balance. Passing a current makes the wire push on the magnet (by Newton's third law), changing the balance reading. Multiply the mass change by g to find the force, and repeat for different currents to show $F \propto I$. [3]