InkPhysics

QUESTION WORKBOOK

Magnetic flux density and the force on a wire

Magnetic fields · Year 13

AQA 3.7.5.1 · CIE 20.1.1, 20.1.2, 20.2.1, 20.2.2, 20.2.3, 20.4.1, 20.4.2, 20.4.3
OCR A 6.3.1(a), 6.3.1(b), 6.3.1(c), 6.3.1(d), 6.3.1(e)(i), 6.3.1(e)(ii), 6.3.1(f)

18 questions · 47 marks

NAVY SCREEN EDITION

SECTION A · Warm-up

A1 State the equation for the force on a current-carrying wire in a magnetic field and the condition under which it applies. [2]

A2 A wire of length 0.15 m carries a current of 3.0 A and lies perpendicular to a magnetic field of flux density 0.20 T. Calculate the force on the wire. [2]

A3 Define magnetic flux density and express the tesla in terms of other SI units. [2]

A4 On diagrams of magnetic fields, state what is represented by a circled cross and by a circled dot. [1]

A5 A wire carrying a current of 2.5 A passes between the poles of a U-shaped magnet. A 45 mm length of the wire lies at right angles to the field, which has flux density 90 mT. Calculate the force on the wire. [2]

SECTION B · Standard

B1 A 0.25 m length of wire carrying a current of 4.0 A experiences a force of 0.50 N when placed perpendicular to a magnetic field. Calculate the magnetic flux density. [2]

B2 A wire of length 0.10 m carrying a current of 2.0 A is placed at 30° to a magnetic field of flux density 0.30 T. Calculate the force on the wire. [2]

B3 A wire of length 0.080 m lies perpendicular to a magnetic field of flux density 0.45 T and experiences a force of 0.18 N. Calculate the current in the wire. [2]

B4 Explain why the force on a current-carrying wire in a magnetic field is a maximum when the wire is perpendicular to the field and zero when it is parallel to the field. [3]

B5 Two long, straight, parallel wires carry currents in opposite directions. State whether the wires attract or repel each other, and explain your answer by considering the force on one wire in the magnetic field of the other. [2]

B6 A rigid wire of length 0.060 m and mass 0.40 g rests on two supports between the poles of a magnet. The horizontal magnetic field of flux density 0.15 T is perpendicular to the wire. Calculate the current for which the magnetic force just supports the weight of the wire.
$g = 9.81\ \text{m s}^{-2}$ [3]

B7 A straight wire of length 70 mm carries a current of 3.2 A at 25° to a uniform magnetic field. The force on the wire is 8.4×10^{-3} N. Calculate the flux density of the field. [3]

SECTION C · Stretch

C1 In a current balance, a horizontal wire of length 0.050 m carrying a current of 8.0 A lies perpendicular to a magnetic field of flux density 0.60 T, so that the force on it is vertical. Calculate the force on the wire and the mass that has the same weight. $g = 9.81 \text{ m s}^{-2}$ [4]

C2 A wire of length 0.12 m carries a current of 6.0 A in a magnetic field of flux density 0.25 T. Calculate the force on the wire when it is perpendicular to the field, and when it is at 45° to the field. [4]

C3 Describe how the force on a current-carrying wire can be measured in the laboratory using a top-pan balance. [3]

C4 In the arrangement of required practical 10, a student measures the force on a wire for a range of currents, keeping 120 mm of the wire in the field throughout. The graph of force against current is a straight line through the origin with gradient 0.048 N A^{-1}. Explain why the gradient equals Bl and determine the flux density of the field. [3]

C5 A design for an actuator requires a force of at least 0.15 N on a straight wire held perpendicular to a magnetic field of flux density 0.28 T. Four wires are available.
Wire W: length in field 45 mm, maximum working current 8.0 A
Wire X: length in field 60 mm, maximum working current 10.0 A
Wire Y: length in field 85 mm, maximum working current 5.0 A
Wire Z: length in field 70 mm, maximum working current 9.0 A
Deduce which of the wires could provide the required force at their maximum working current. [4]

C6 A magnet stands on a top-pan balance and a fixed horizontal wire passes between its poles at right angles to the field, with 50 mm of the wire in the field. When the current in the wire is 3.5 A, the balance reading increases by 0.65 g. Determine the flux density of the field.

$g = 9.81\ \text{m s}^{-2}$ [3]