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QUESTION WORKBOOK

Magnetic flux and flux linkage

Magnetic fields · Year 13

AQA 3.7.5.3 · CIE 20.5.1, 20.5.2, 20.5.3 · OCR A 6.3.3(a), 6.3.3(b), 6.3.3(d)(ii)

18 questions · 49 marks

PRINT EDITION

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SECTION A · Warm-up

A1 State the equation for the magnetic flux through an area whose normal is parallel to the field, and give the unit of magnetic flux. [2]

A2 A magnetic field of flux density 0.20 T passes normally through an area of 0.05 m^2. Calculate the magnetic flux through the area. [2]

A3 Define the flux linkage of a coil and state its unit. [2]

A4 A circular loop of wire of diameter 8.0 cm lies with its plane perpendicular to a magnetic field of flux density 0.15 T. Calculate the magnetic flux through the loop. [2]

A5 State the angle between the normal to a coil and a magnetic field at which the flux linkage of the coil is half its maximum value. [1]

A6 The number of turns of a coil is doubled, the flux density it sits in is doubled and its area is halved. State and explain the effect on the flux linkage of the coil. [2]

SECTION B · Standard

B1 A coil of 200 turns and area 0.02 m^2 is placed with its plane perpendicular to a magnetic field of flux density 0.15 T. Calculate the flux linkage of the coil. [2]

B2 A coil of 100 turns and area 0.01 m^2 is placed in a magnetic field of flux density 0.30 T with the normal to its plane at 60° to the field. Calculate the flux linkage of the coil. [2]

B3 A magnetic flux of 8.0×10^{-3} Wb passes normally through an area of 0.04 m^2. Calculate the magnetic flux density. [2]

B4 A coil is rotated in a uniform magnetic field. Describe how the flux linkage varies with the orientation of the coil, and state the orientations that give maximum and zero flux linkage. [3]

B5 A 400-turn coil of area 1.2×10^{-3} m^2 is placed in a magnetic field of flux density 0.25 T. The flux linkage of the coil is 0.060 Wb-turns. Calculate the angle between the normal to the coil and the field. [3]

B6 At a certain location the Earth's magnetic field has flux density 49 μT and points at 66° below the horizontal. A 2000-turn coil of area 0.030 m^2 lies flat on a horizontal bench. Calculate the flux linkage of the coil. [3]

B7 A 250-turn coil of area 6.0×10^{-4} m^2 sits in a magnetic field of flux density 0.32 T with its plane at 35° to the field. Calculate the flux linkage of the coil. Go on to calculate the change in flux linkage when the coil is rotated so that it is face-on to the field. [4]

SECTION C · Stretch

C1 A coil of 50 turns and area 0.02 m^2 is placed in a magnetic field of flux density 0.40 T. Calculate the flux linkage when the normal to the coil is parallel to the field, and state its value when the normal is at 90° to the field. [3]

C2 A coil of 500 turns and area 0.008 m^2 lies with its plane perpendicular to a magnetic field. The flux density increases from 0.10 T to 0.30 T. Calculate the change in flux linkage of the coil. [3]

C3 Describe how a search coil can be used to measure the flux density of a magnetic field. [3]

C4 A student must choose a search coil to detect a weak alternating magnetic field. For a given field, the amplitude of the oscilloscope trace is proportional to the peak flux linkage of the coil. Two coils are available.
Coil P: 500 turns, area 1.5 cm^2
Coil Q: 2000 turns, area 0.80 cm^2
Deduce which coil the student should choose. [4]

C5 A student uses a search coil connected to an oscilloscope to investigate how the flux linkage of the coil depends on its orientation in an alternating magnetic field. Describe how the student should carry out the investigation and how the results confirm that the flux linkage is proportional to cosθ, where θ is the angle between the field and the normal to the coil. [6]