

7 (a) State Faraday's law of electromagnetic induction.

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..... [2]

(b) An aircraft is flying horizontally at constant speed v through the Earth's magnetic field, as shown in Fig. 7.1.

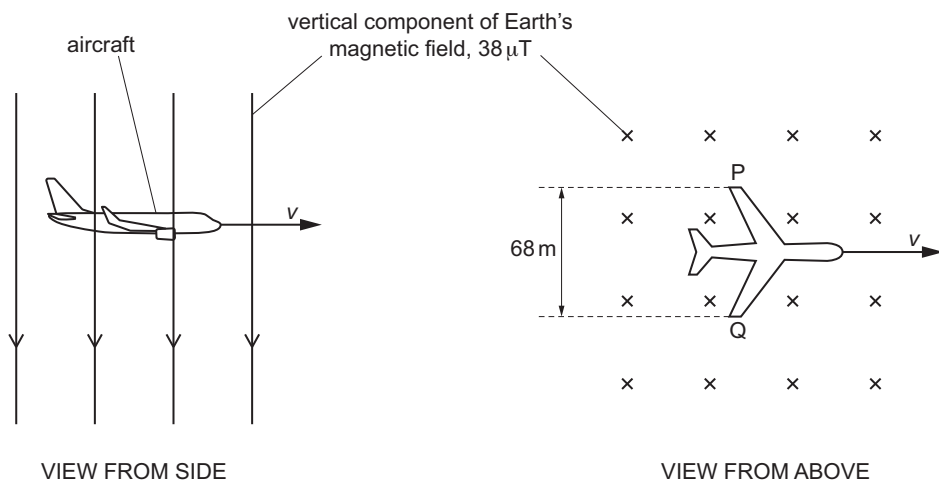


Fig. 7.1

At the location of the aircraft, the vertical component of the Earth's magnetic field is $38\mu\text{T}$ towards the ground.

The distance between the wingtips P and Q of the aircraft is 68 m.

As the aircraft moves through the magnetic field, an electromotive force (e.m.f.) of 0.54 V is induced between the wingtips P and Q.

(i) Calculate the magnetic flux cut by the wings of the aircraft in a time of 15 s. Give a unit with your answer.

magnetic flux = unit [2]

(ii) Determine the area of flux cut by the wings in a time of 15 s.

area = m^2 [2]

(iii) Use your answer in (b)(ii) to determine the speed v of the aircraft.

$v = \dots\dots\dots\text{ms}^{-1}$ [2]

(iv) Use Lenz's law of electromagnetic induction to explain which of the wingtips P and Q is at the higher induced potential.

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..... [3]

[Total: 11]

6 A rectangular coil PQRS of wire is free to rotate about its axis XY, as shown in Fig. 6.1.

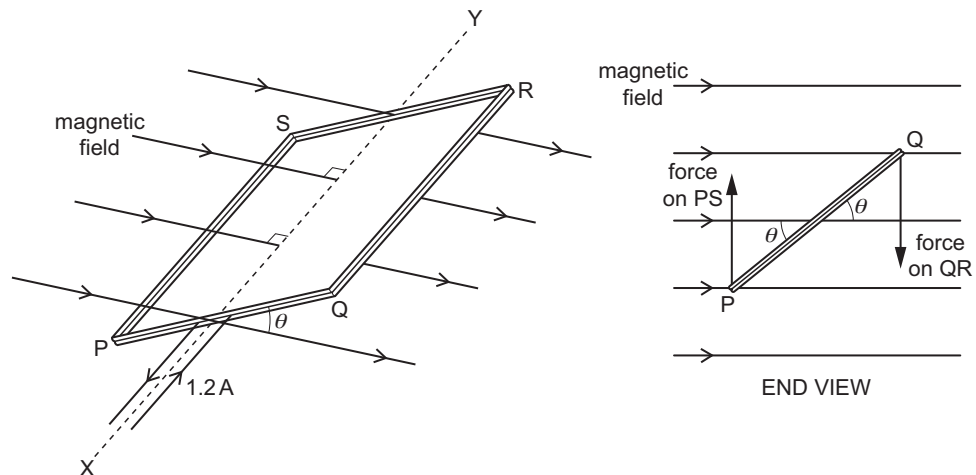


Fig. 6.1 (not to scale)

The coil has length QR of 5.4 cm, width PQ of 2.5 cm and has 190 turns of wire.
 The plane of the coil is at an angle θ to a uniform magnetic field of flux density $5.2 \times 10^{-3} \text{ T}$.
 The axis XY of the coil is normal to the field.
 The current in the coil is 1.2 A.

(a) (i) Calculate the magnitude of the force on side QR of the coil.

force = N [3]

(ii) Use your answer in (a)(i) to show that the torque τ on the coil is given by

$$\tau = 1.6 \times 10^{-3} \cos \theta \text{ Nm.}$$

[2]

(iii) Using the expression in (a)(ii) sketch, on the axes of Fig. 6.2, a graph to show the variation of the torque τ with angle θ for values of θ between 0 and 360° . Label the τ axis with an appropriate scale.

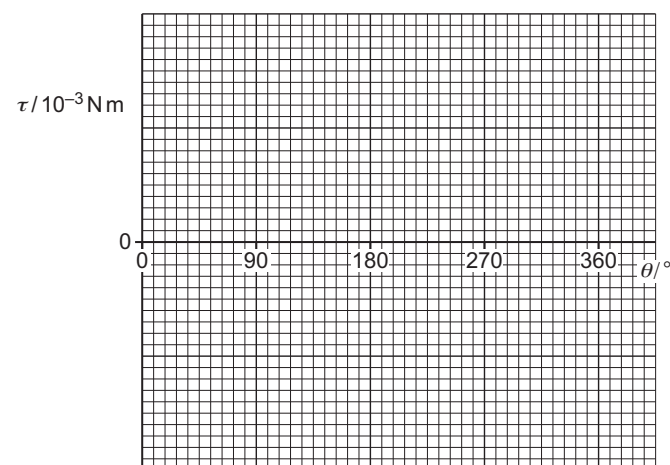


Fig. 6.2

[3]

(b) The coil is now replaced by an identical coil wound on a ferrous core.

Suggest, with a reason, how the torque on this coil compares with the torque on the original coil.

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 [2]

[Total: 10]

A circuit diagram showing a solenoid of length l connected to a switch S . The solenoid is represented by a series of loops, and its length is indicated by a double-headed arrow labeled l above it. The switch S is shown as a rectangular box with a diagonal line through it, indicating it is open.

Fig. 1.1

An alternating voltage is applied to the terminals. The peak value of the alternating voltage is E and the frequency is f . The peak value of the potential difference V across the resistor is determined using an oscilloscope.

It is suggested that V is related to f by the relationship

$$\frac{ES}{V} = \frac{KAN^2 f}{l}$$

where N is the number of turns on the coil and K is a constant.

Plan a laboratory experiment to test the relationship between V and f .

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine a value for K .

In your plan you should include:

- the procedure to be followed
- the measurements to be taken
- the control of variables
- the analysis of the data
- any safety precautions to be taken.

Diagram

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 1 Fig. 1.1 shows two identical cylindrical metal conductors P and Q, each of length L and cross-sectional area A .

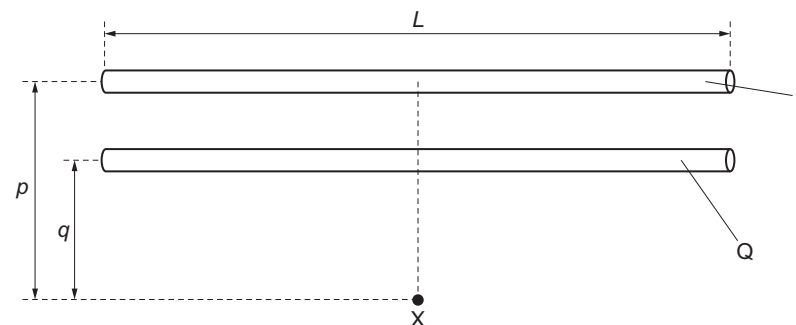


Fig. 1.1

The conductors are placed parallel to each other. The perpendicular distance from the midpoint of P to point X is p . The perpendicular distance from the midpoint of Q to point X is q .

The two conductors are electrically connected in parallel. This parallel combination is connected in series to a power supply and a resistor. The potential difference V between the ends of P is the same as the potential difference between the ends of Q.

The magnetic flux density at X due to the currents in the conductors is B .

It is suggested that B is related to p by the relationship

$$B = \frac{YAV}{Lp} + \frac{YZAV}{Lq}$$

where Y and Z are constants.

Plan a laboratory experiment to test the relationship between B and p .

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for Y and Z .

In your plan you should include:

- the procedure to be followed
- the measurements to be taken
- the control of variables
- the analysis of the data
- any safety precautions to be taken.

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.This image shows a full page of a document template designed for handwriting practice or as a general writing guide. It consists of approximately 28 evenly spaced horizontal dotted lines running across the width of the page. The background is plain white, and there are no margins, headers, footers, or other markings present.