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

.....

.....

..... [2]

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

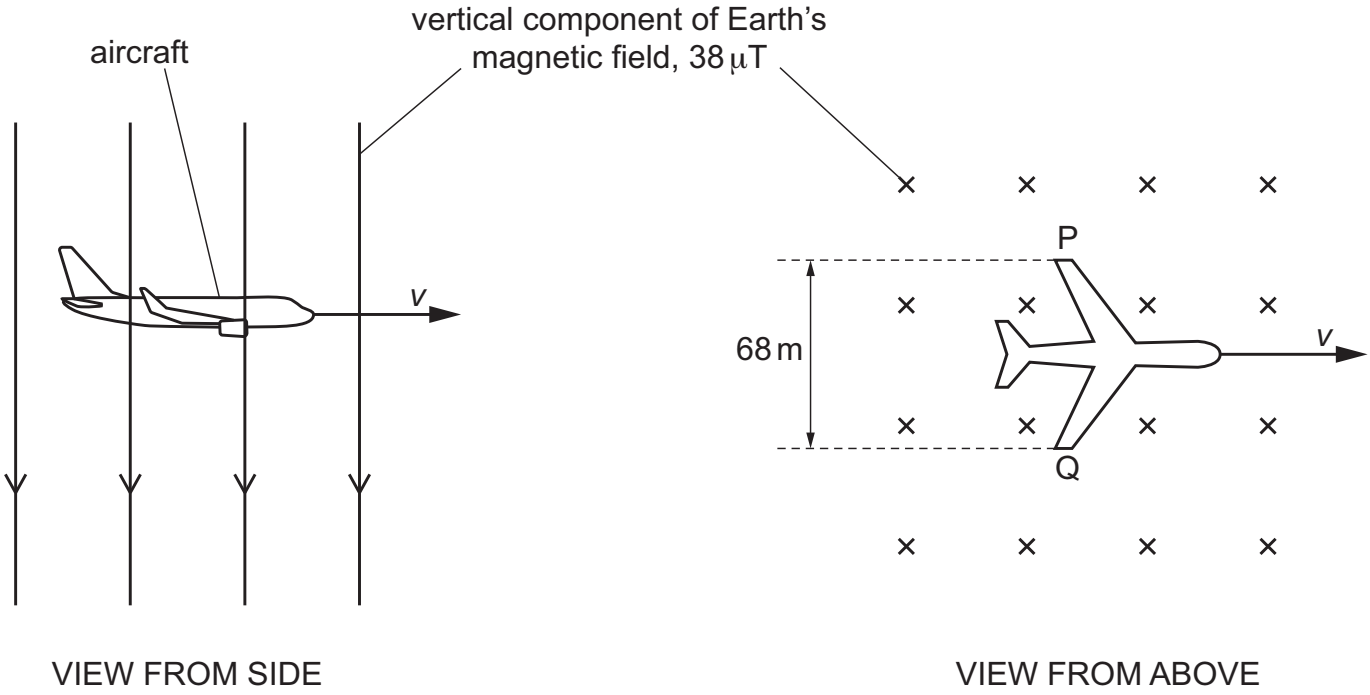

Fig. 7.1

At the location of the aircraft, the vertical component of the Earth's magnetic field is 38 μT 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 = ...$m\,s^{-1}$ [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.

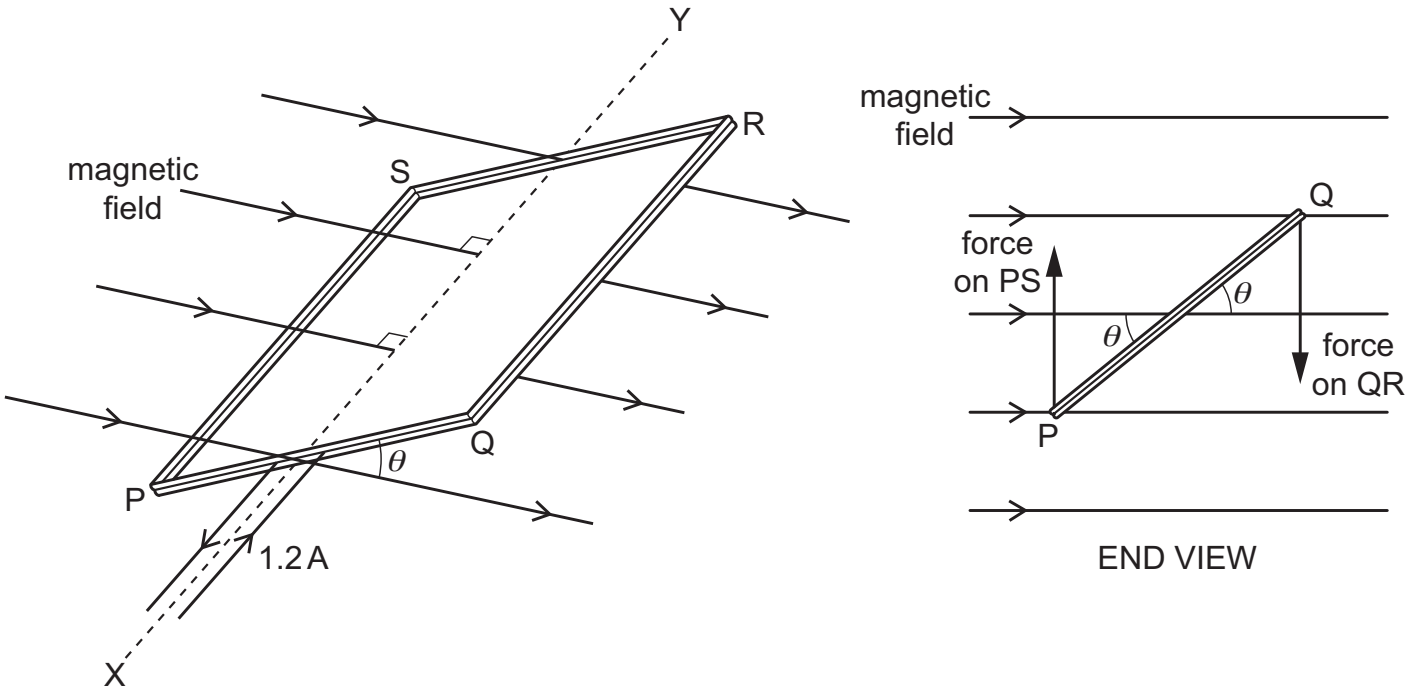

Fig. 6.1 (not to scale)

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 5.2×10^{-3} 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

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

[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.

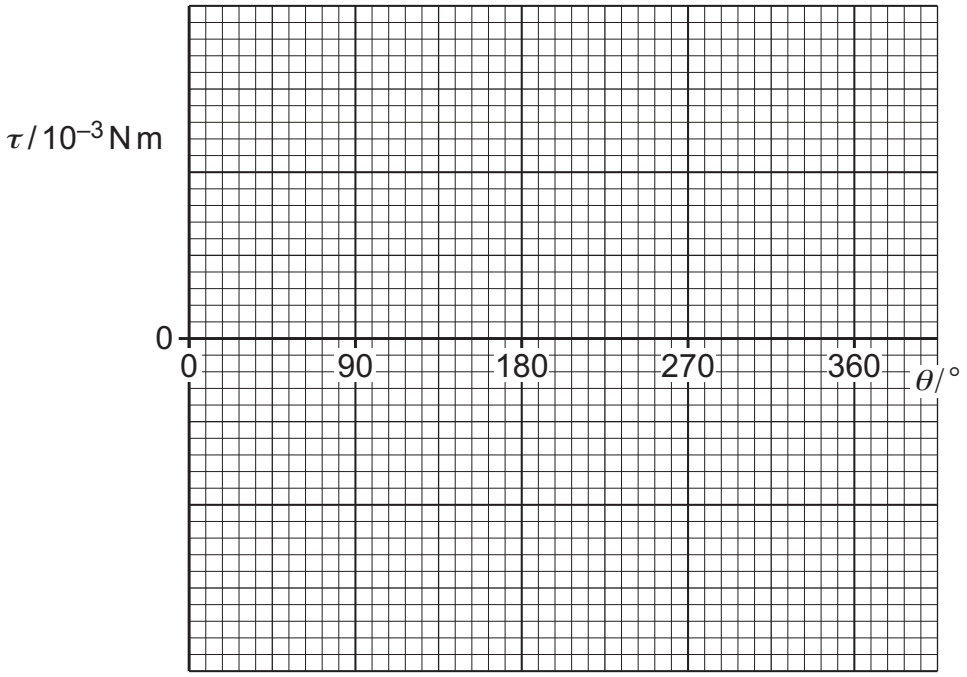

Fig. 6.2

[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.

.....

.....

..... [2]

[Total: 10]

1 Fig. 1.1 shows a thin coil of cross-sectional area A and length l connected to a resistor of resistance S and two terminals.

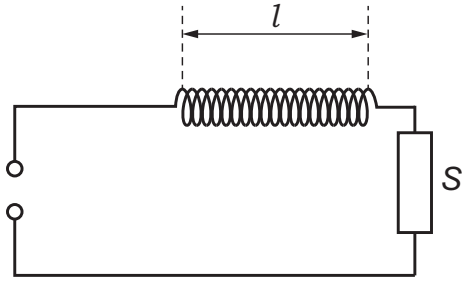

Fig. 1.1

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

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

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

[15]

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

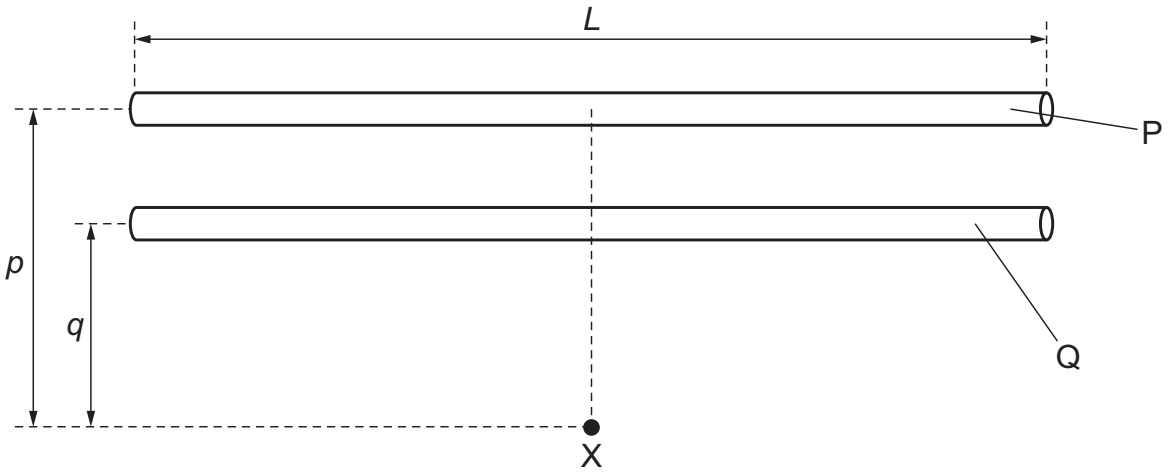

Fig. 1.1

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.

Diagram

[15]