20. Magnetic Fields

20.4 Magnetic fields due to currents

Paper 4

Question Paper

1 **(b)** A long, straight wire carries a current into the page, as shown in Fig. 7.1.



Fig. 7.1

On Fig. 7.1, draw four field lines to represent the magnetic field around the wire due to the current in it. [3]

(c) Two identical wires X and Y are placed parallel to each other. The wires both carry current into the page, as shown in Fig. 7.2.



Fig. 7.2

(i) Explain why the two wires exert a magnetic force on each other.

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..... [2]

(ii) On Fig. 7.2, draw an arrow to show the direction of the magnetic force exerted on wire X. Label your arrow F. [1]

(iii) The current in X is double the current in Y.

State how the magnetic force exerted on wire Y compares with the magnetic force exerted on wire X.

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..... [2]

(iv) The direction of the current in both wires is now reversed.

State, with a reason, the effect of this change on the direction of the force on wire X.

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..... [1]

2 **(b)** A long, straight wire P carries a current into the page, as shown in Fig. 6.1.

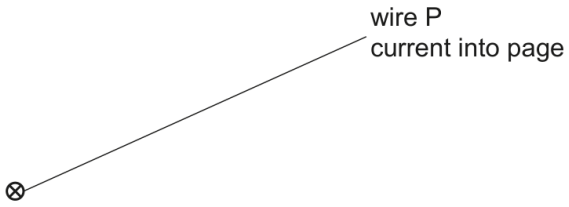


Fig. 6.1

On Fig. 6.1, draw four field lines to represent the magnetic field around wire P due to the current in the wire. [3]

(c) A second long, straight wire Q, carrying a current of 5.0 A out of the page, is placed parallel to wire P, as shown in Fig. 6.2.

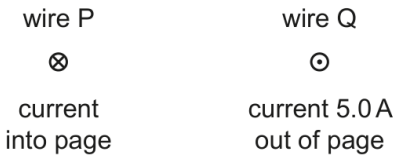


Fig. 6.2

The flux density of the magnetic field at wire Q due to the current in wire P is 2.6 mT.

(iii) The flux density of the magnetic field at wire P due to the current in wire Q is 1.5 mT.

Determine the magnitude of the current in wire P. Explain your reasoning.

current = ... A [2]

3 **(b)** A long air-cored solenoid is connected to a power supply, so that the solenoid creates a magnetic field. Fig. 6.1 shows a cross-section through the middle of the solenoid.

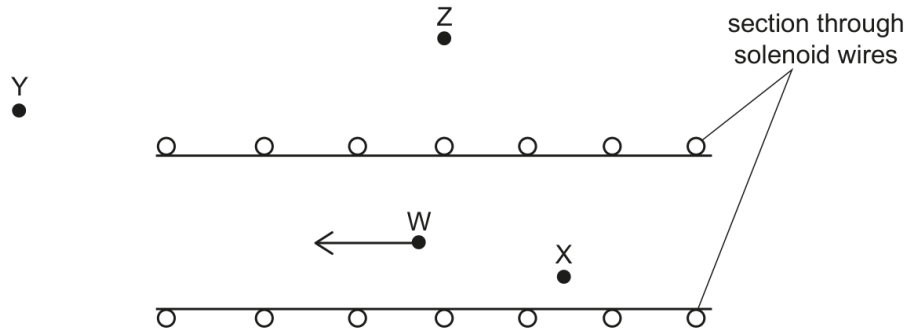


Fig. 6.1

The direction of the magnetic field at point W is indicated by the arrow. Three other points are labelled X, Y and Z.

(i) On Fig. 6.1, draw arrows to indicate the direction of the magnetic field at each of the points X, Y and Z. [3]

(ii) Compare the magnitude of the flux density of the magnetic field:

- at X and at W .....

.....

- at Y and at Z. .....

.....

[2]

(c) Two long parallel current-carrying wires are placed near to each other in a vacuum.

Explain why these wires exert a magnetic force on each other. You may draw a labelled diagram if you wish.

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..... [3]

4 (b) A loosely coiled metal spring is suspended from a fixed point, as shown in Fig. 9.1.

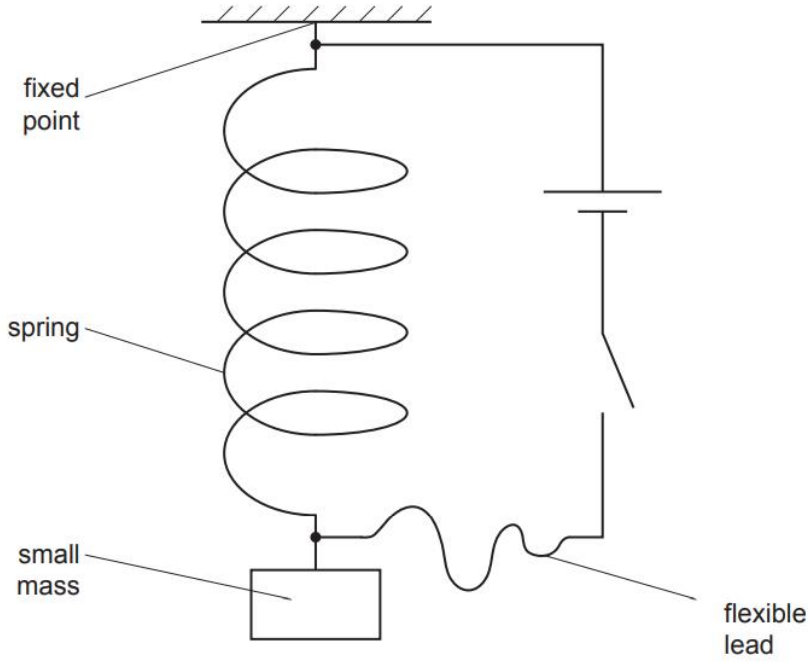


Fig. 9.1

Electrical connections are made to the ends of the spring by means of a flexible lead.

The length of the spring is measured before the switch is closed and then again after the switch is closed.

When the switch is closed, a magnetic field is set up around each coil of the spring.

By reference to these magnetic fields, explain why there is a change in length of the spring. State whether the spring extends or contracts.

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..... [4]

5 Two long straight parallel wires P and Q carry currents into the plane of the paper, as shown in Fig. 8.1.



Fig. 8.1

The current in P is I and the current in Q is $2I$.

(a) (i) On Fig. 8.1, draw an arrow to show the direction of the magnetic field at wire Q due to the current in wire P. Label this arrow B. [1]

(ii) On Fig. 8.1, draw another arrow to show the direction of the force acting on wire Q due to the current in wire P. Label this arrow F. [1]

(b) (i) State, with a reason, how the magnitude of the force acting on wire P compares with the magnitude of the force acting on wire Q.

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..... [2]

(ii) State how the direction of the force on wire P compares with the direction of the force on wire Q.

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..... [1]

6 **(a)** A long straight vertical wire A carries a current in an upward direction.
The wire passes through the centre of a horizontal card, as illustrated in Fig. 10.1.

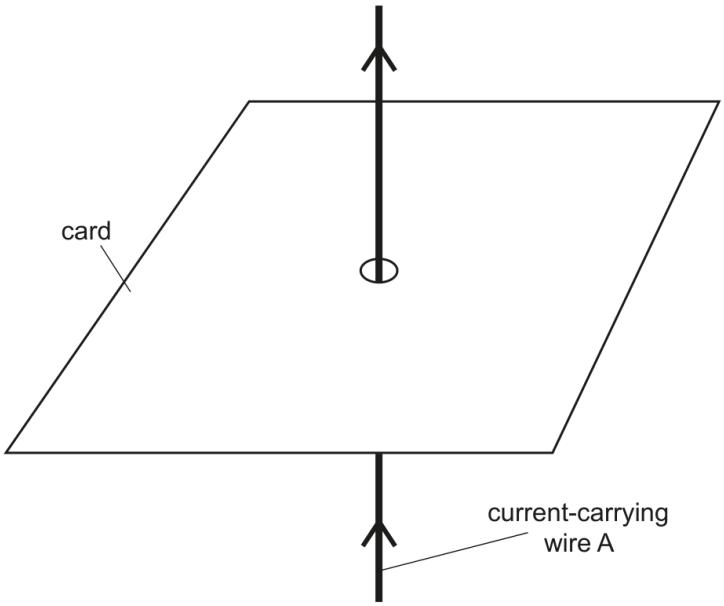


Fig. 10.1

The card is viewed from above. The card is shown from above in Fig. 10.2.

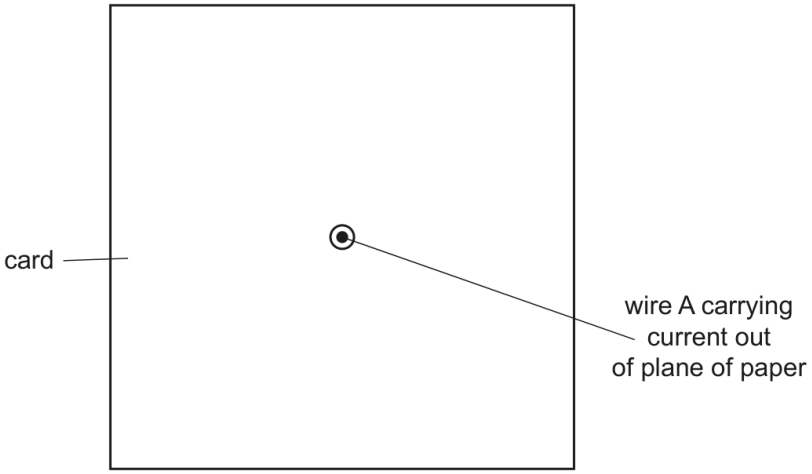


Fig. 10.2

On Fig. 10.2, draw four lines to represent the magnetic field produced by the current-carrying wire. [3]

(b) Two wires A and B are now placed through a card. The two wires are parallel and carrying currents in the same direction, as illustrated in Fig. 10.3.

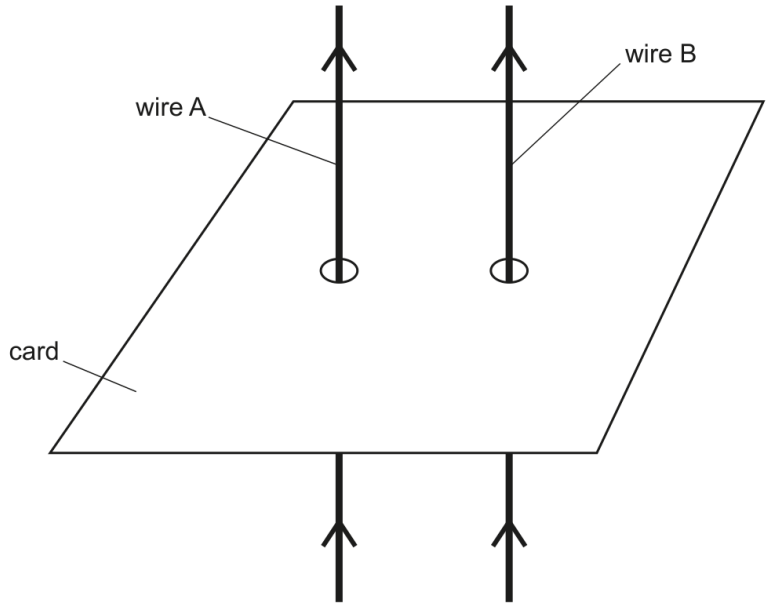


Fig. 10.3

(i) Explain why a magnetic force is exerted on each wire.

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..... [2]

(ii) State the directions of the forces.

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..... [1]

(c) The currents in the two wires are not equal.

Explain whether the magnetic forces on the two wires are equal in magnitude.

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..... [1]

7 A solenoid is connected in series with a battery and a switch, as illustrated in Fig. 8.1.

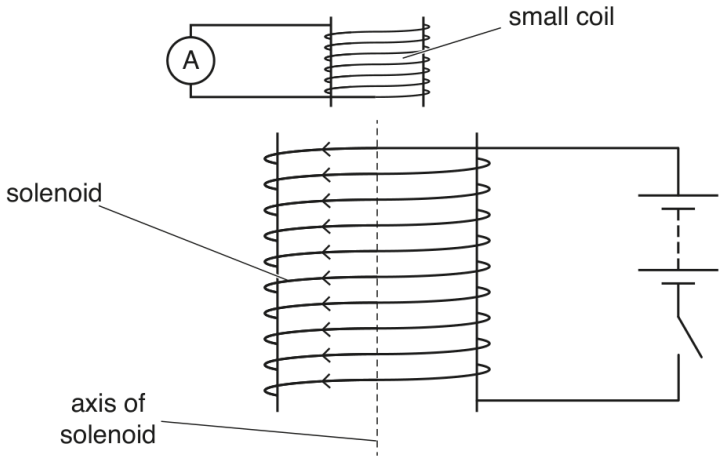


Fig. 8.1

A small coil, connected to a sensitive ammeter, is situated near one end of the solenoid.

As the current in the solenoid is switched on, there is a changing magnetic field inside the solenoid.

(a) (ii) On Fig. 8.1, draw an arrow on the axis of the solenoid to show the direction of the magnetic field inside the solenoid. Label this arrow P. [1]

8 **(a)** A long straight vertical wire carries a current I. The wire passes through a horizontal card EFGH, as shown in Fig. 8.1 and Fig. 8.2.

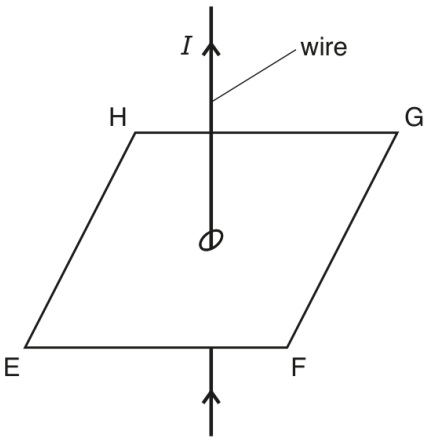


Fig. 8.1

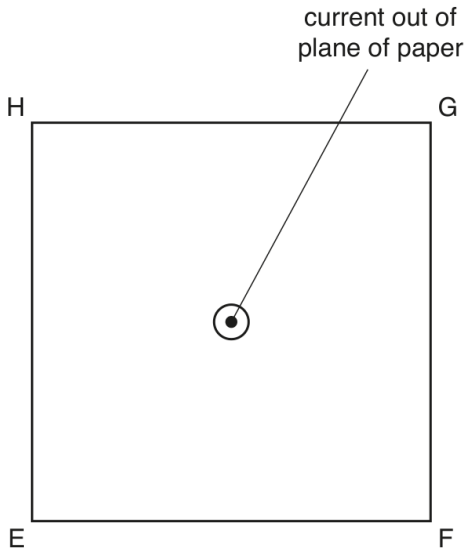


Fig. 8.2 (view from above)

On Fig. 8.2, draw the pattern of the magnetic field produced by the current-carrying wire on the plane EFGH. [3]

(c) The currents in wires P and Q are different in magnitude.

State and explain whether the forces per unit length on the two wires will be different.

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..... [2]