1. Nov/2020/Paper_41/No.8

A slice of a conducting material has its face QRLK normal to a uniform magnetic field of flux density *B*, as illustrated in Fig. 8.1.

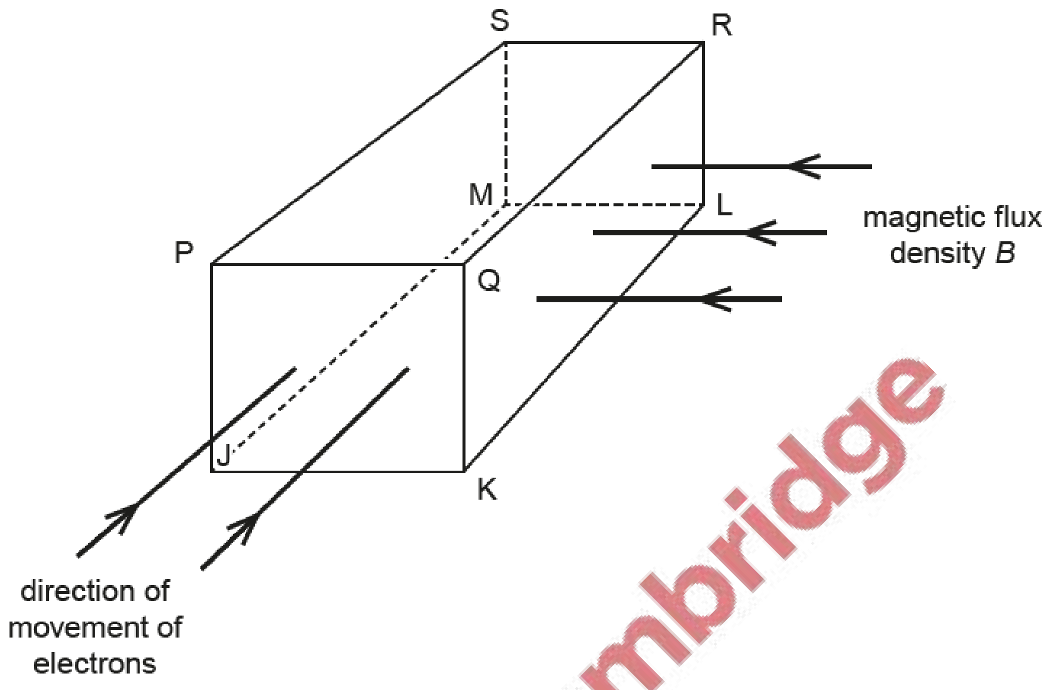

Fig. 8.1

Electrons enter the slice travelling perpendicular to face PQKJ.

(a) For the free electrons moving in the slice:

(i) state the direction of the force on an electron due to movement of the electron in the magnetic field

....

.... [1]

(ii) identify the faces, using the letters on Fig. 8.1, between which a potential difference is developed.

face .... and face .... [1]

(b) Explain why the potential difference in **(a)(ii)** reaches a maximum value.

....

....

.... [2]

(c) The number of free electrons per unit volume in the slice of material is $1.3 \times 10^{29}\,m^{-3}$.
The thickness PQ of the slice is 0.10 mm.
The magnetic flux density B is 4.6×10^{-3} T.

Calculate the potential difference across the slice for a current of 6.3×10^{-4} A.

potential difference = ... V [2]

(d) The slice in **(c)** is a metal.

By reference to your answer in **(c)**, suggest why Hall probes are usually made using semiconductors rather than metals.

....

....

.... [2]

[Total: 8]

2. Nov/2020/Paper_42/No.10

(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.

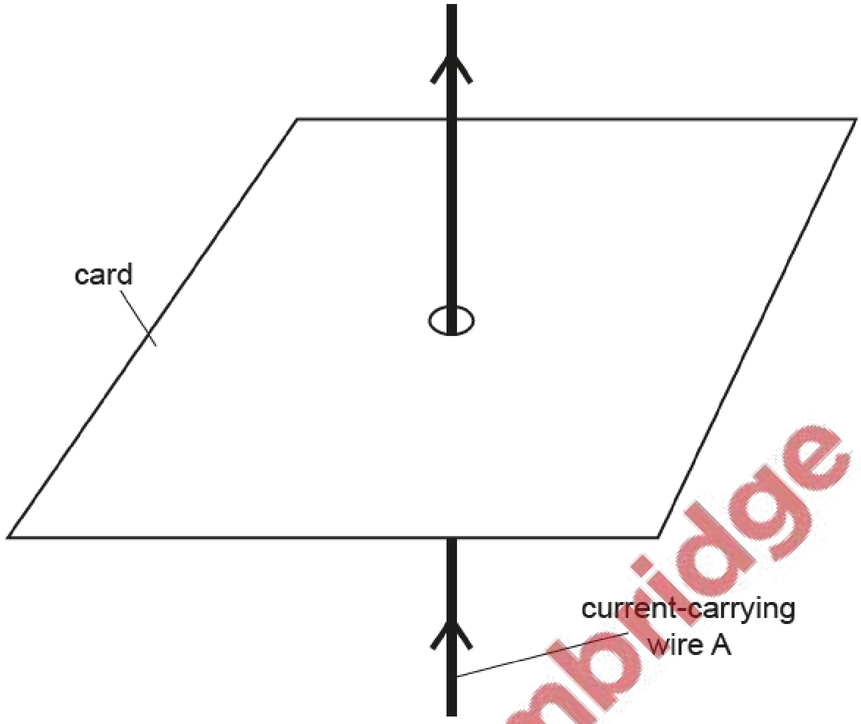

Fig. 10.1

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

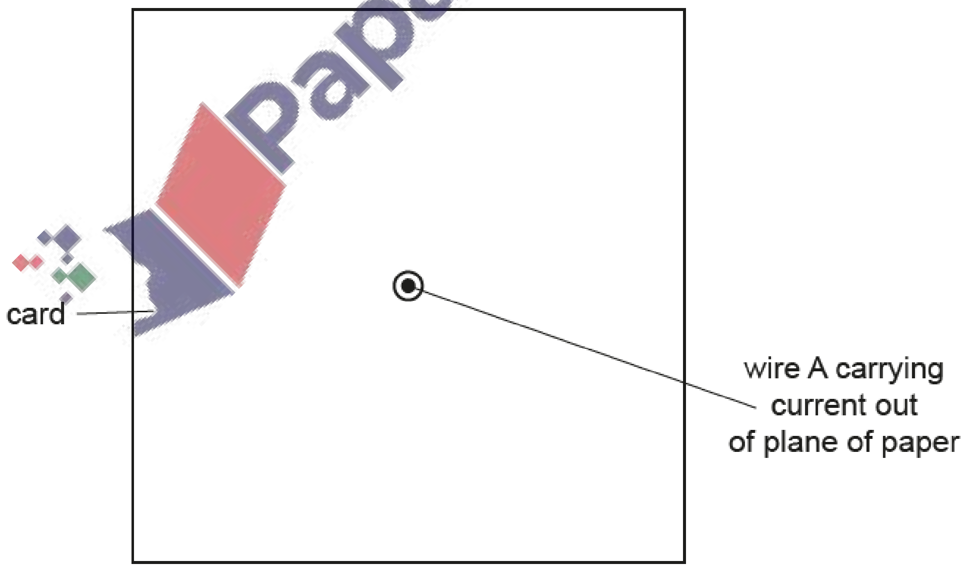

Fig. 10.2

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.

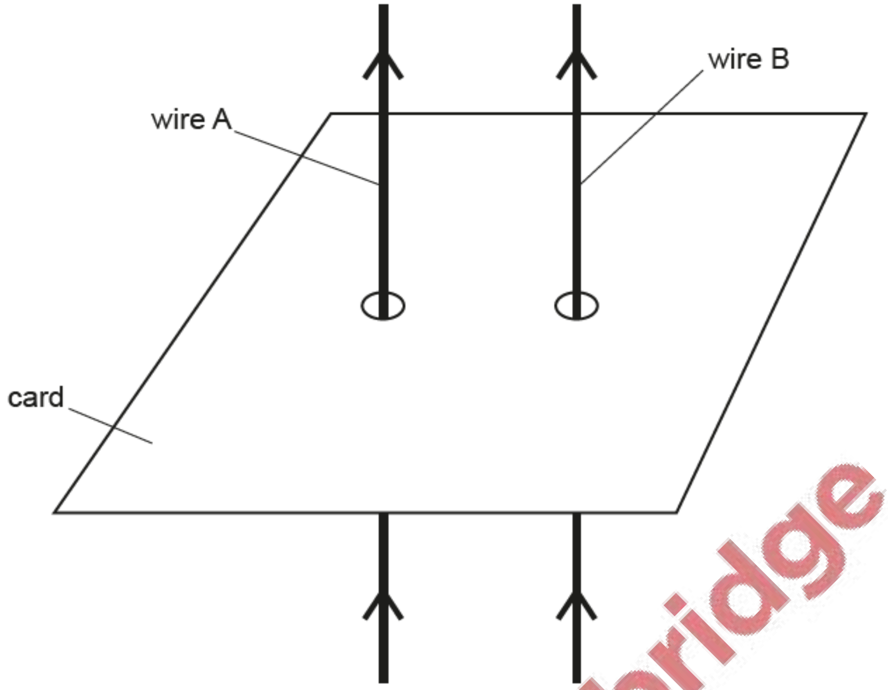

Fig. 10.3

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

....

....

....

.... [2]

(ii) State the directions of the forces.

....

.... [1]

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

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

....

....

.... [1]

[Total: 7]

3. June/2020/Paper_41/No.8

(a) Define the *tesla*.

....

....

....

.... [3]

(b) A magnet produces a uniform magnetic field of flux density *B* in the space between its poles.

A rigid copper wire carrying a current is balanced on a pivot. Part PQLM of the wire is between the poles of the magnet, as illustrated in Fig. 8.1.

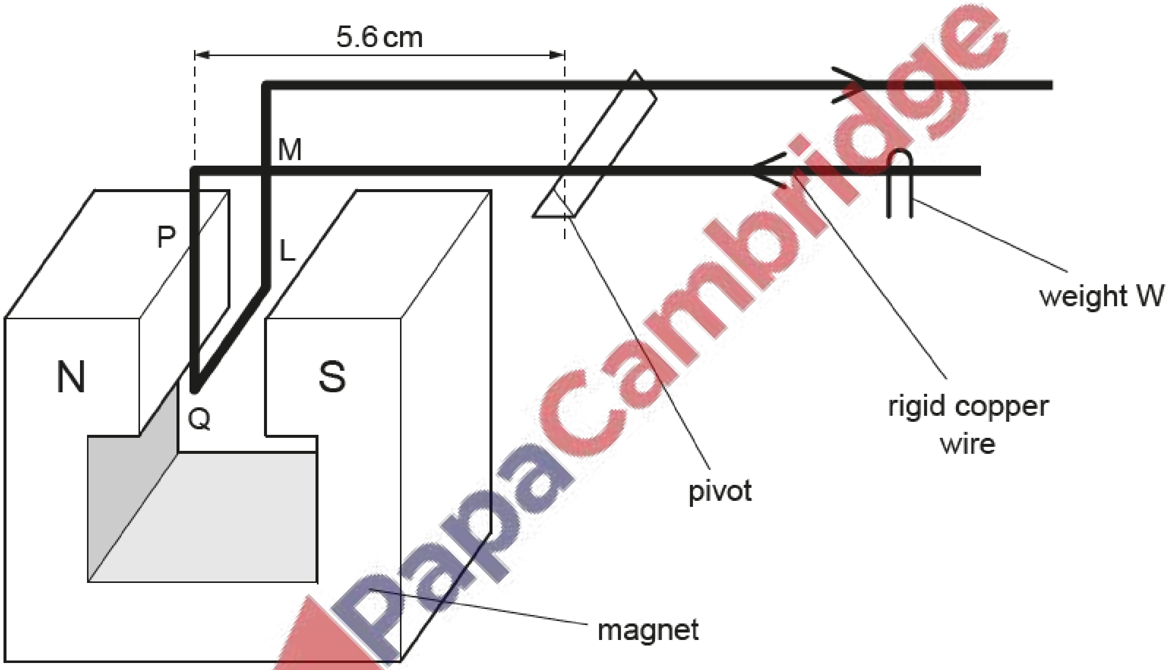

Fig. 8.1 (not to scale)

The wire is balanced horizontally by means of a small weight W.

The section of the wire between the poles of the magnet is shown in Fig. 8.2.

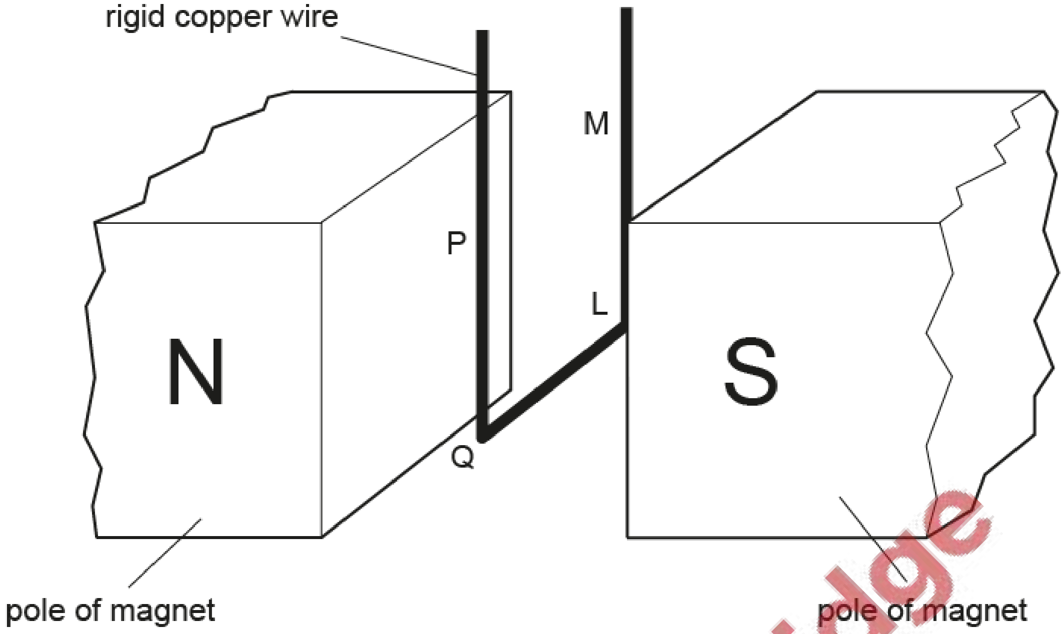

Fig. 8.2 (not to scale)

Explain why:

(i) section QL of the wire gives rise to a moment about the pivot

....

....

....

.... [3]

(ii) sections PQ and LM of the wire do not affect the equilibrium of the wire.

....

....

....

.... [2]

(c) Section QL of the wire has length 0.85 cm.

The perpendicular distance of QL from the pivot is 5.6 cm.

When the current in the wire is changed by 1.2 A, W is moved a distance of 2.6 cm along the wire in order to restore equilibrium. The mass of W is 1.3×10^{-4} kg.

(i) Show that the change in moment of W about the pivot is 3.3×10^{-5} N m.

[2]

(ii) Use the information in **(i)** to determine the magnetic flux density *B* between the poles of the magnet.

B = ... T [3]

[Total: 13]

4. June/2020/Paper_42/No.9

(a) An electron is travelling at speed v in a straight line in a vacuum. It enters a uniform magnetic field of flux density 8.0×10^{-4} T. Initially, the electron is travelling at right angles to the magnetic field, as illustrated in Fig. 9.1.

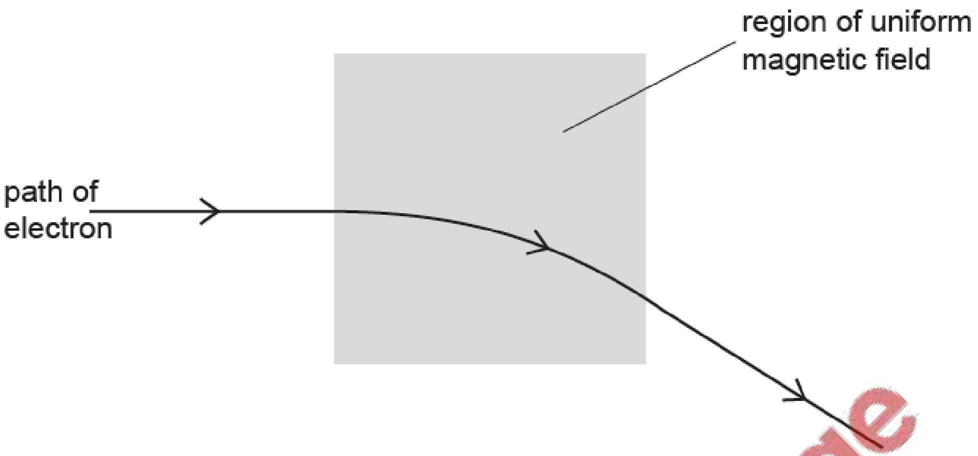

Fig. 9.1

The path of the electron in the magnetic field is an arc of a circle of radius 6.4 cm.

(i) State and explain the direction of the magnetic field.

....

....

.... [2]

(ii) Show that the speed v of the electron is $9.0 \times 10^{6}\,\mathrm{m\,s^{-1}}$.

[3]

(b) A uniform electric field is now applied in the same region as the magnetic field.

The electron passes undeviated through the region of the two fields, as illustrated in Fig. 9.2.

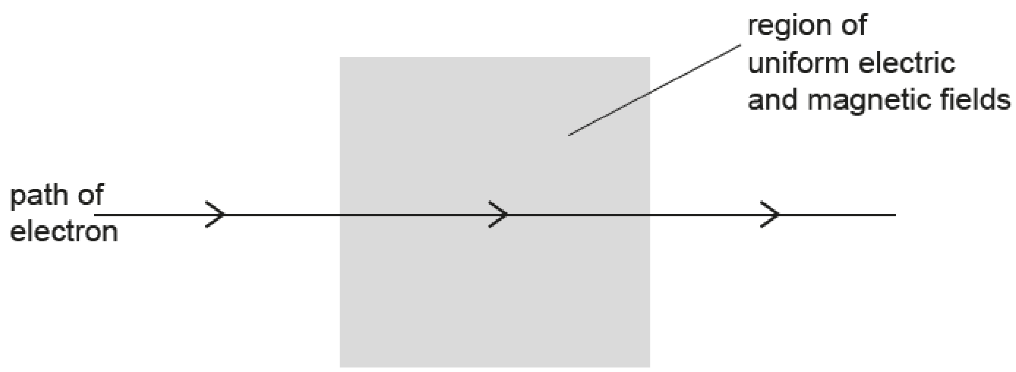

Fig. 9.2

(i) On Fig. 9.2, mark with an arrow the direction of the uniform electric field. [1]

(ii) Use data from **(a)** to calculate the magnitude of the electric field strength.

field strength = ... $N\,C^{-1}$ [2]

(c) The electron in **(b)** is now replaced by an α-particle travelling at the same speed v along the same initial path as the electron.

Describe and explain the shape of the path in the region of the magnetic and electric fields.

....

....

.... [2]

[Total: 10]

5. March/2020/Paper_42/No.8

(a) Explain what is meant by a *magnetic field*.

....

....

....

.... [1]

(b) The apparatus shown in Fig. 8.1 is used in an experiment to find the magnetic flux density *B* between the poles of a horseshoe magnet. Assume the magnetic field is uniform between the poles of the magnet and zero elsewhere.

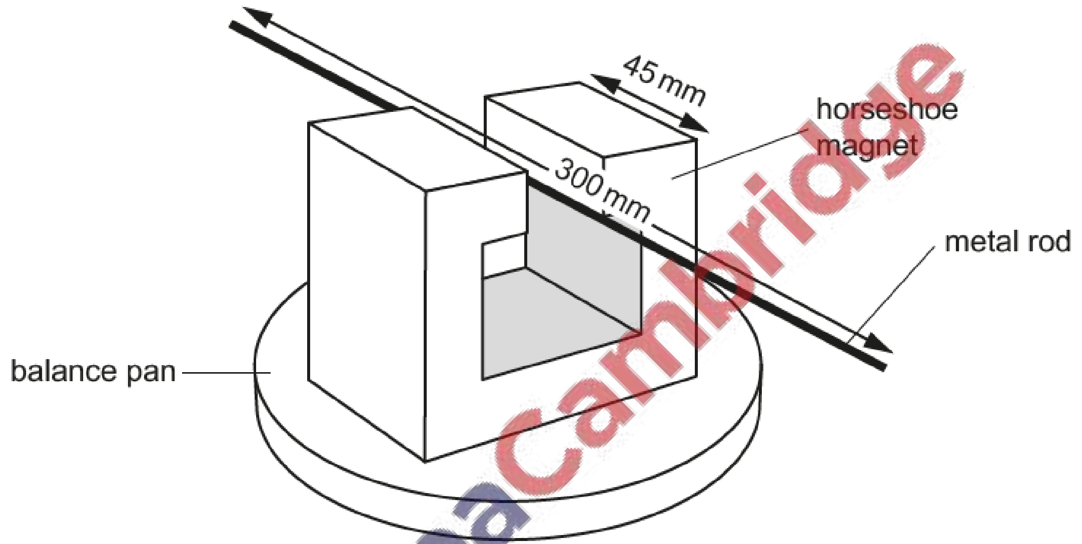

Fig. 8.1

The rigid metal rod of length 300 mm is fixed in position perpendicular to the direction of the magnetic field. The poles of the magnet are both 45 mm long. There is a current in the rod that causes a force on the rod. The balance is used to determine the magnitude of the force.

The variation with current *I* of the force *F* on the rod is shown in Fig. 8.2.

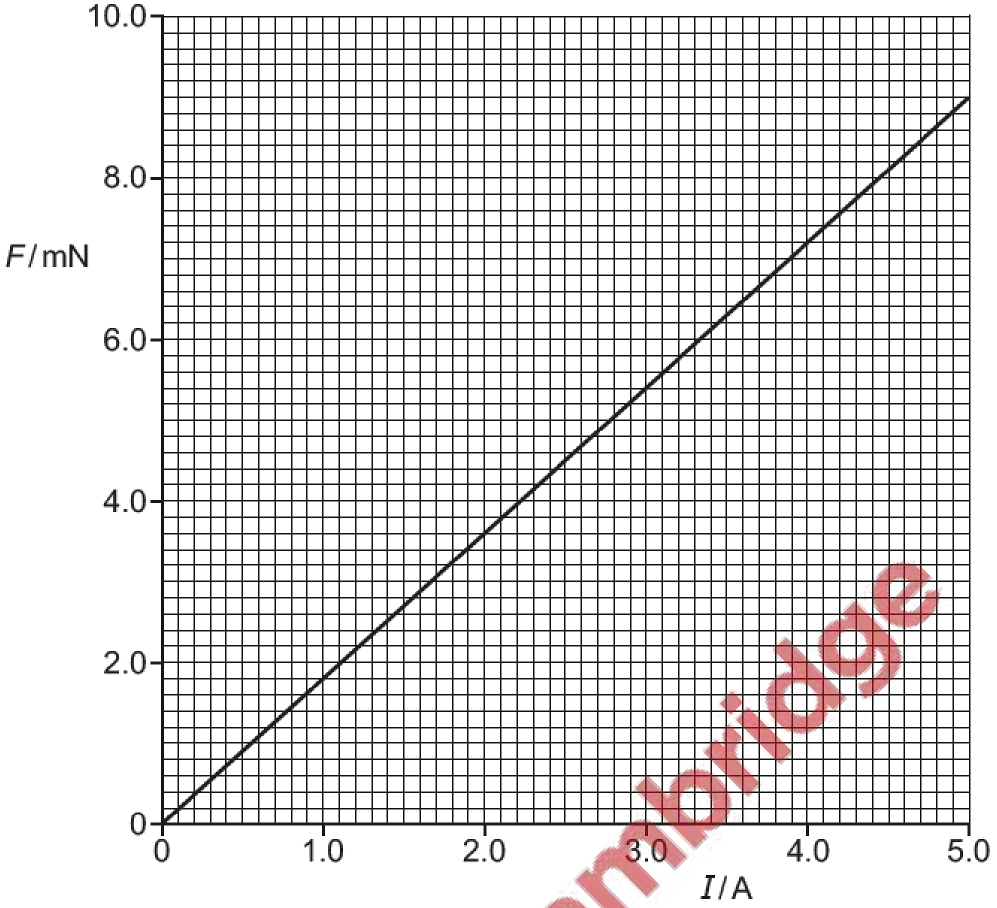

Fig. 8.2

Calculate the magnetic flux density *B*.

B = ... T [2]

(c) In a different experiment, electrons are accelerated through a potential difference and then enter a region of magnetic field. The magnetic field is into the plane of the paper and is perpendicular to the direction of travel of the electrons, as illustrated in Fig. 8.3.

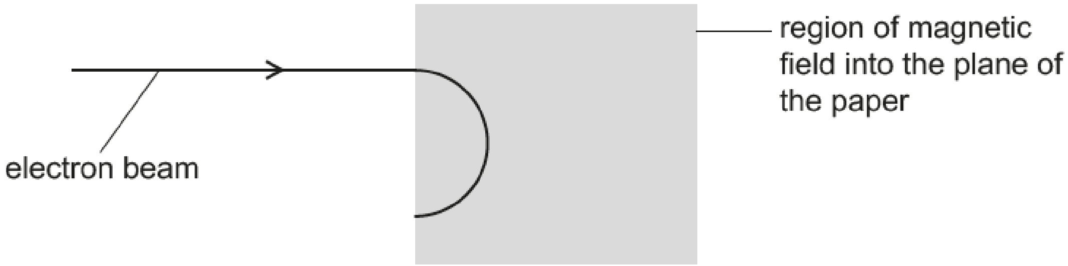

Fig. 8.3

(i) Explain why the electrons follow a circular path when inside the region of the magnetic field.

....

....

....

.... [3]

(ii) State the measurements needed in order to determine the charge to mass ratio, e/m_e, of an electron.

....

....

.... [2]

[Total: 8]