8 **(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. 8.1.

card

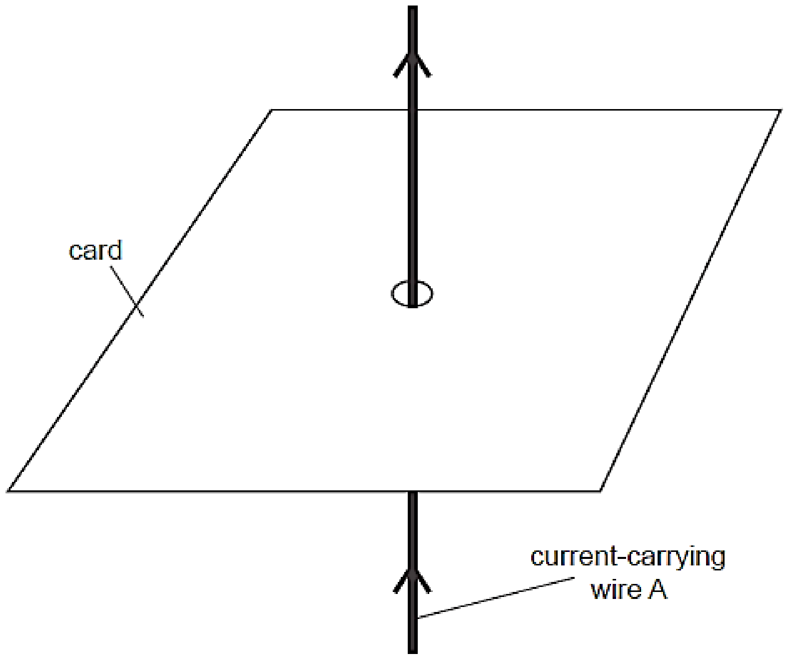

Fig. 8.1

The card is viewed from above. The card is shown from above in Fig. 8.2.

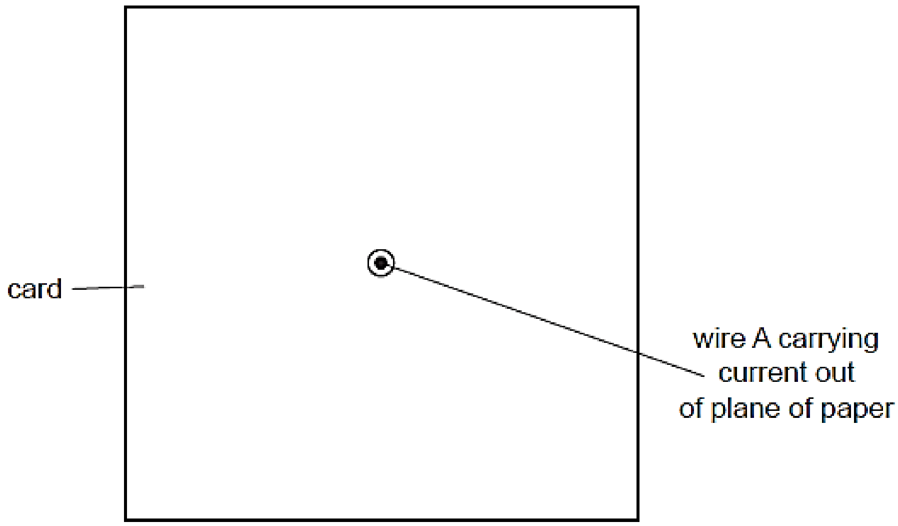

Fig. 8.2

(i) On Fig. 8.2, draw lines to represent the magnetic field produced by the current-carrying wire.

[2]

(ii) 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. 8.3.

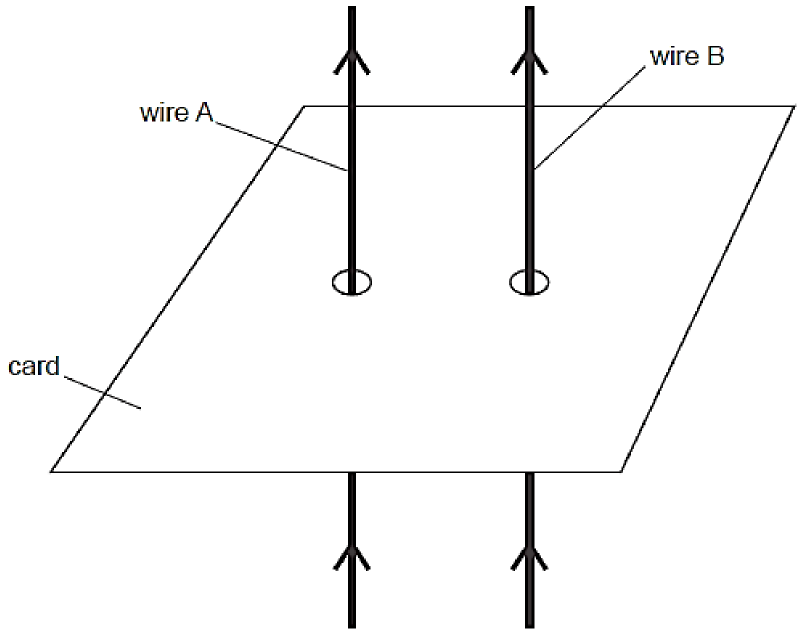

Fig. 8.3

1. Explain why a magnetic force is exerted on each wire.

....

....

....

.... [2]

2. The currents in the two wires are not equal.
Explain whether the magnetic forces on the two wires are equal in magnitude.

....

....

.... [1]

(b) Electrons are moving in a vacuum with speed 1.70×10^7 m s^{-1}. The electrons enter a uniform magnetic field of flux density 4.80 mT.
Fig. 8.4 shows the path of the electrons.

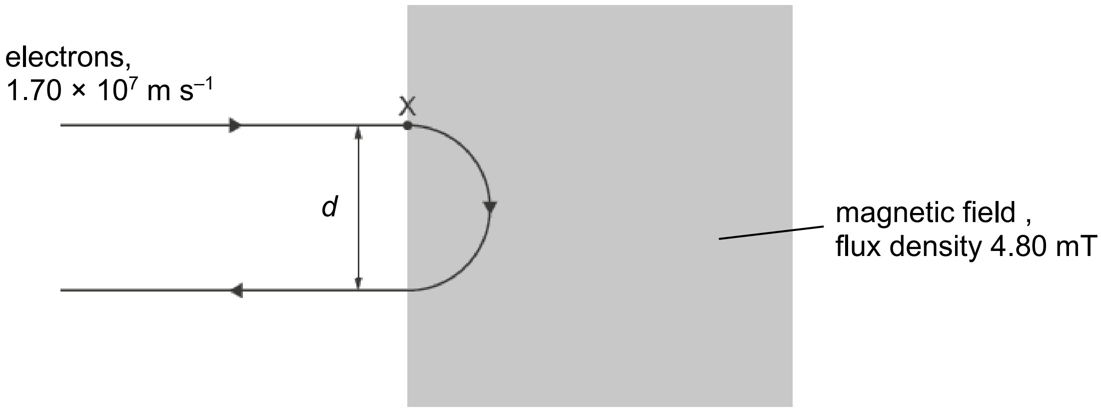

Fig 8.4

The path of the electrons remains in the plane of the page.

(i) Define magnetic flux density.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

(ii) State the direction of the magnetic field.

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [1]

(iii) Explain why the path of the electron in the magnetic field is the arc of a circle.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

(iv) Calculate the distance d between the path of the electrons entering the magnetic field and the path of the electrons leaving it.

d = ……………………………cm [3]

(v) Show that the duration which the electron is inside the magnetic field is approximately 3.7×10^{-9} s.

[1]

(vi) A uniform electric field of magnitude 18.0 kV m^{-1} is directed into the page in the same region as the magnetic field.

Use your answer in **(b)(v)** to determine the final speed of the electron as it leaves the fields.

final speed = …………………………… m s^{-1} [4]

(c) The magnitude and direction of the uniform electric field in part **(b)(vi)** is adjusted so that electrons with speed 1.7×10^7 m s^{-1} now travel in a straight path in the region of uniform fields, as shown in Fig. 8.5.

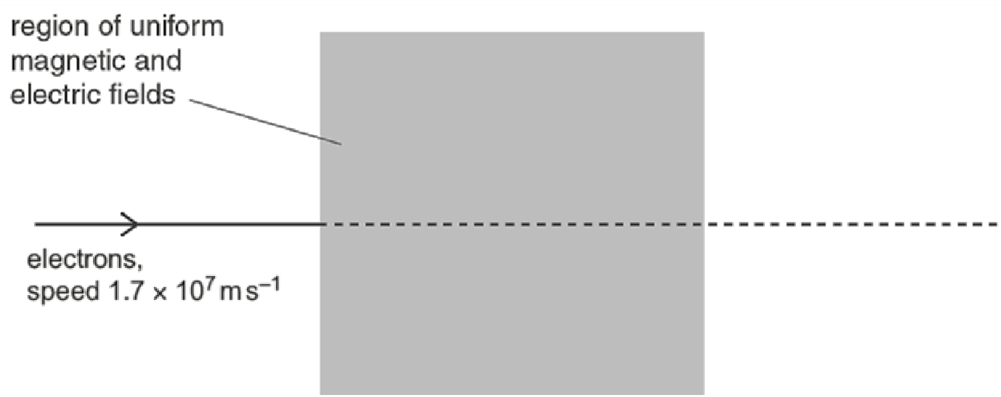

Fig 8.5

If the electrons are replaced with protons moving with speed 2.0×10^7 m s^{-1}, sketch the path of the protons on Fig. 8.5.

[2]

[Total: 20]