1. Nov/2021/Paper_41/No.8

(a) Define the *tesla*.

....

....

.... [2]

(b) A stiff metal wire is used to form a rectangular frame measuring 8.0 cm × 6.0 cm. The frame is open at the top, and is suspended from a sensitive newton meter, as shown in Fig. 8.1.

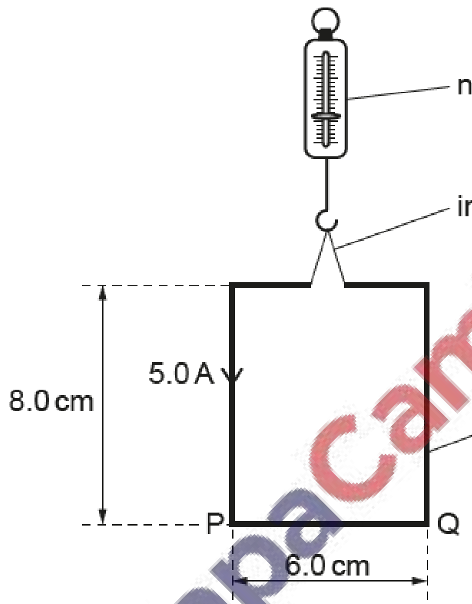

Fig. 8.1

The open ends of the frame are connected to a power supply so that there is a current of 5.0 A in the frame in the direction indicated in Fig. 8.1.

The frame is slowly lowered into a uniform magnetic field of flux density *B* so that all of side PQ is in the field. The magnetic field lines are horizontal and at an angle of 50° to PQ, as shown in Fig. 8.2.

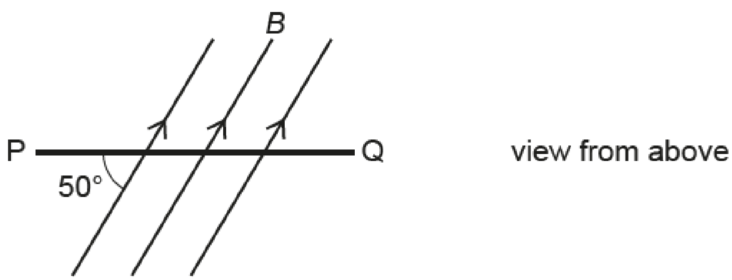

Fig. 8.2

When side PQ of the frame first enters the magnetic field, the reading on the newton meter changes by 1.0 mN.

(i) Determine the magnetic flux density B, in mT.

B = ... mT [2]

(ii) State, with a reason, whether the change in the reading on the newton meter is an increase or a decrease.

....

....

.... [1]

(iii) The frame is lowered further so that the vertical sides start to enter the magnetic field.

Suggest what effect this will have on the frame.

....

....

.... [1]

[Total: 6]

2. Nov/2021/Paper_42/No.8

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.

....

....

....

.... [2]

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

....

.... [1]

[Total: 5]

3. June/2021/Paper_41/No.9

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

....

....

.... [2]

(b) A rectangular piece of aluminium foil is situated in a uniform magnetic field of flux density B, as shown in Fig. 9.1.

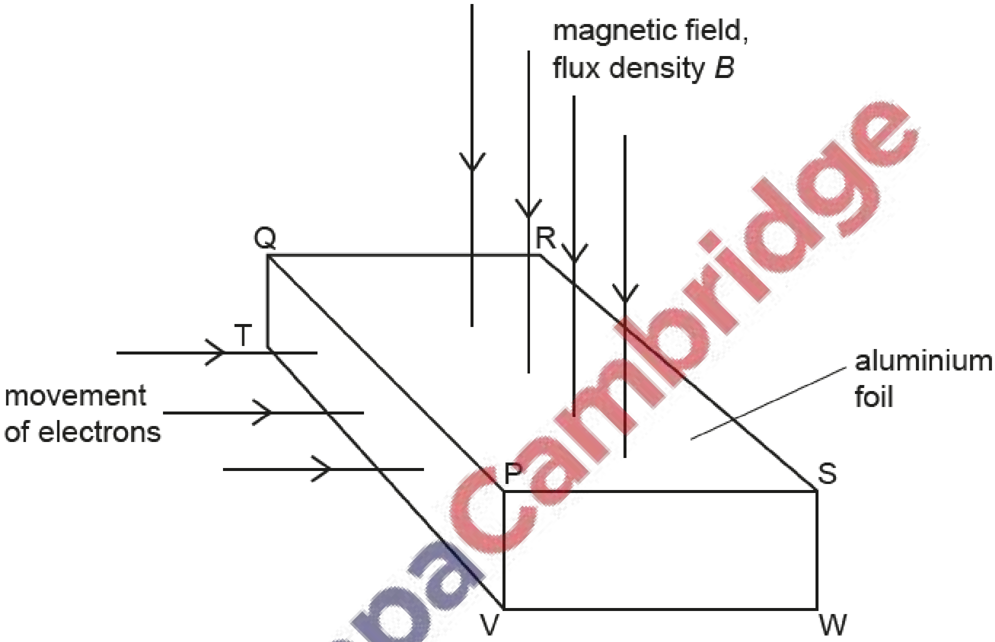

Fig. 9.1

The magnetic field is normal to the face PQRS of the foil.

Electrons, each of charge $-q$, enter the foil at right angles to the face PQTV.

(i) On Fig. 9.1, shade the face of the foil on which electrons initially accumulate. [1]

(ii) Explain why electrons do not continuously accumulate on the face you have shaded.

....

....

....

.... [3]

(c) The Hall voltage V_H developed across the foil in **(b)** is given by the expression

$$V_H = \frac{BI}{ntq}$$

where I is the current in the foil.

(i) State the meaning of the quantity n.

....

.... [1]

(ii) Using the letters on Fig. 9.1, identify the distance t.

.... [1]

(d) Suggest why, in practice, Hall probes are usually made using a semiconductor material rather than a metal.

....

.... [1]

[Total: 9]

4. June/2021/Paper_42/No.8

(a) Define *magnetic flux density*.

....

....

.... [2]

(b) Electrons, each of mass m and charge q, are accelerated from rest in a vacuum through a potential difference V.

Derive an expression, in terms of m, q and V, for the final speed v of the electrons. Explain your working.

[2]

(c) The accelerated electrons in **(b)** are injected at point S into a region of uniform magnetic field of flux density B, as illustrated in Fig. 8.1.

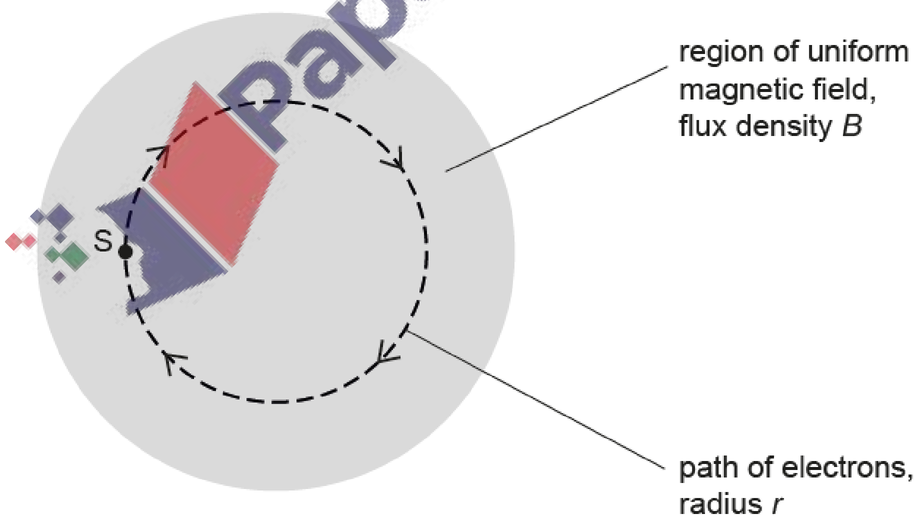

Fig. 8.1

The electrons move at right angles to the direction of the magnetic field. The path of the electrons is a circle of radius r.

(i) Show that the specific charge $\frac{q}{m}$ of the electrons is given by the expression

$$\frac{q}{m} = \frac{2V}{B^2 r^2}.$$

Explain your working.

[2]

(ii) Electrons are accelerated through a potential difference V of 230 V. The electrons are injected normally into the magnetic field of flux density 0.38 mT.
The radius r of the circular orbit of the electrons is 14 cm.

Use this information to calculate a value for the specific charge of an electron.

specific charge = ... C kg^{-1} [2]

(iii) Suggest why the arrangement outlined in **(ii)**, using the same values of B and V, is not practical for the determination of the specific charge of α-particles.

....

....

.... [2]

[Total: 10]

5. March/2021/Paper_42/No.8

(a) Two long straight wires P and Q are parallel to each other, as shown in Fig. 8.1. There is a current in each wire in the direction shown.

The pattern of the magnetic field lines in a plane normal to wire P due to the current in the wire is also shown.

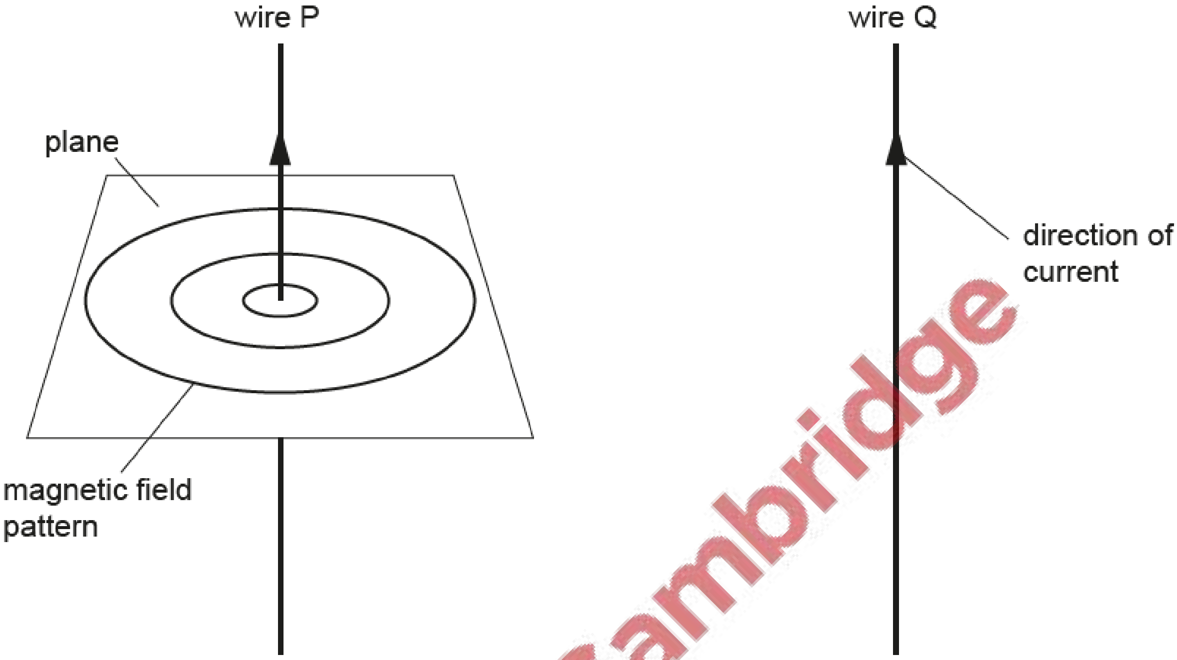

Fig. 8.1

(i) Draw arrows on the magnetic field lines in Fig. 8.1 around wire P to show the direction of the field. [1]

(ii) Determine the direction of the force on wire Q due to the magnetic field from wire P.

.... [1]

(iii) The current in wire Q is less than the current in wire P.

State and explain whether the magnitude of the force on wire P is less than, equal to, or greater than the magnitude of the force on wire Q.

....

....

.... [2]

(b) Nuclear magnetic resonance imaging (NMRI) is used to obtain diagnostic information about internal structures in the human body.

Radio waves are produced and directed towards the body. The radio waves affect the protons within the body.

(i) Explain why radio waves are used.

....

....

.... [2]

(ii) Explain why the radio waves are applied in pulses.

....

....

.... [2]

[Total: 8]