Section B

Answer **one** question from this Section in the spaces provided.

8 Fig. 8.1 shows a thin iron strip of length 8.0 cm, width 2.0 cm and thickness 2.0 mm. As iron is a conductor of electricity, it contains free electrons, one of which is shown in Fig. 8.1.

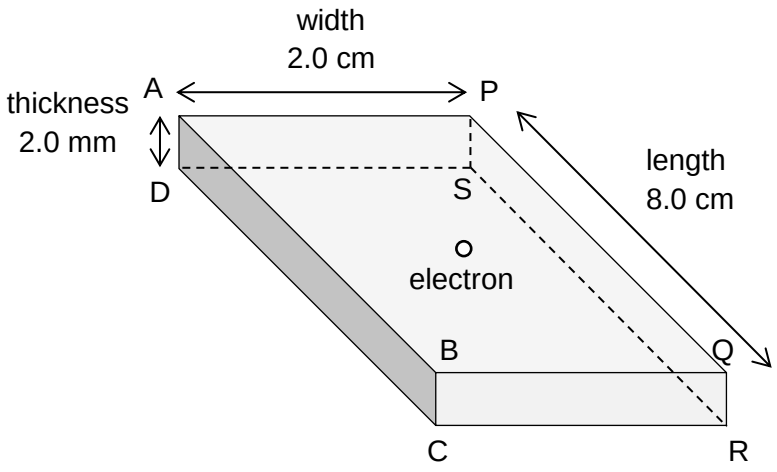

Fig. 8.1

(a) A small potential difference is applied to the iron strip such that face ABCD is at a potential 12 mV higher than face PQRS.

(i) Draw, on Fig. 8.1, an arrow to show the direction of the force on the free electron. Label as F_1. [1]

(ii) Calculate the magnitude of the force in **(a)(i)**.

force = ... N [2]

(iii) Determine the change in the electric potential energy of the electron when it moves across the entire width of the strip.

change in electric potential energy = ... J [2]

(b) Iron has a resistivity of $9.7 \times 10^{-8}\ \Omega$ m and an electron density of 8.8×10^{28} m^{-3}.

(i) Calculate the current in the iron strip when there is a potential difference of 12 mV across faces ABCD and PQRS.

current = ... A [3]

(ii) Hence, show that the drift velocity of the electrons is 4.4×10^{-4} m s^{-1}.

[1]

(c) A magnetic field of flux density 20 mT is now applied in the downward direction into face ABQP.

(i) Explain what is meant by a magnitude of *20 mT*.

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.....[1]

(ii) Draw, on Fig. 8.1, an arrow to show the direction of the force exerted by the magnetic field on the electron. Label as F_B. [1]

(iii) Calculate the magnitude of the force in **(c)(ii)**.

force = ... N [2]

(iii) Explain why a potential difference develops across faces APSD and BQRC.

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.....[1]

(iv) Draw, on Fig. 8.1, an arrow to show the direction of the force due to the potential difference/electric field in **(c)(iii)** on the electron. Label as F_E. [1]

(v) The potential difference in **(c)(iii)** eventually reaches a steady value. State the magnitude of the resultant force on the electron.

resultant force = ... N [1]

(vi) Hence calculate the value of the potential difference in **(c)(iii)**.

potential difference = ... V [2]

(vii) This iron strip can be used in a device called the Hall probe to determine the magnitude and direction of flux density in a region of space.

Briefly explain how this iron strip can be used to determine the direction of another magnetic field.

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.....[2]

[Total: 20]