9 **(a)** Define magnetic flux linkage.

………

………

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

(b) A solenoid of length 30.0 cm is wound evenly with 900 turns of insulated wire. The cross-sectional area of the solenoid is 3.2×10^{-4} m^2.

A flat coil having 250 turns of wire is wound tightly around the centre of the solenoid. A resistor of 35 Ω is connected to the coil as illustrated in Fig. 9.1.

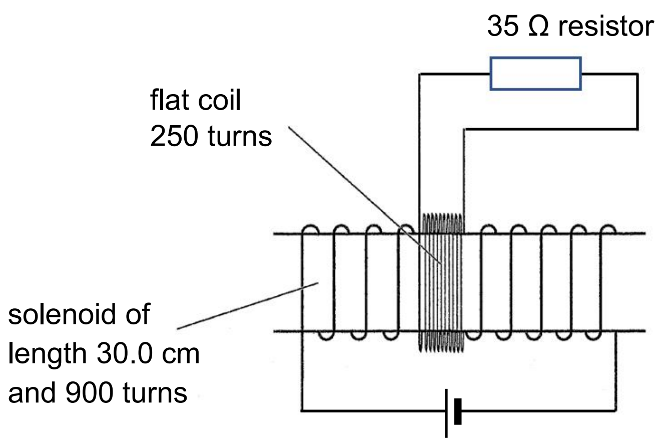

Fig. 9.1

(i) At a particular instant in time, the current through the solenoid is 2.0 A. Show that the magnetic flux through the coil is 2.41×10^{-6} Wb at that instant.

[2]

(ii) The current in the solenoid increases at a uniform rate from 0.0 A to 2.0 A in 0.45 s.

1. Calculate the magnitude of the e.m.f. induced in the flat coil during this period.

e.m.f. = ………………………… V [2]

2. Hence, calculate the amount of charge that flows through the resistor during this period.

charge = ……………………………… C [2]

3. Determine the amount of charge that passes through the solenoid during this period.

charge = ………………………….. C [2]

(c) A potential difference is applied between two horizontal plates, each 15.0 cm long and separated by 4.0 cm.

A uniform magnetic field is directed perpendicularly into the page between the two plates.

A beam of electrons moves in a straight line between the plates along a horizontal path halfway between the two plates as shown in Fig. 9.2.

Each electron has a velocity of 4.50×10^6 m s^{-1}.

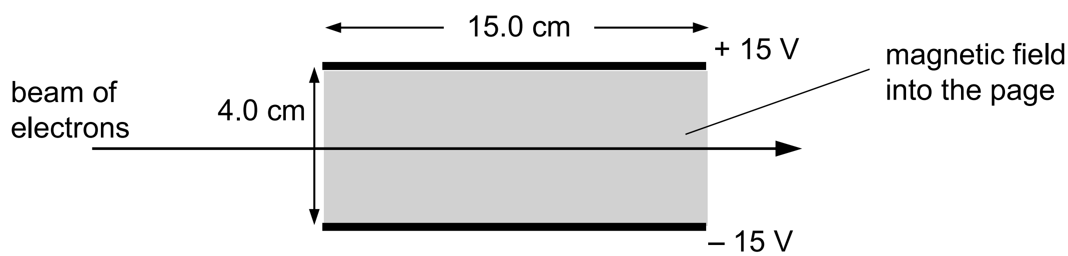

Fig. 9.2 (not drawn to scale)

(i) Determine the magnetic flux density of the magnetic field.

magnetic flux density = …………………….. T [2]

The undeflected beam of electrons enters a second region of uniform magnetic field as shown by the shaded region in Fig. 9.3. A magnetic flux density of 0.50×10^{-3} T is directed perpendicularly into the page.

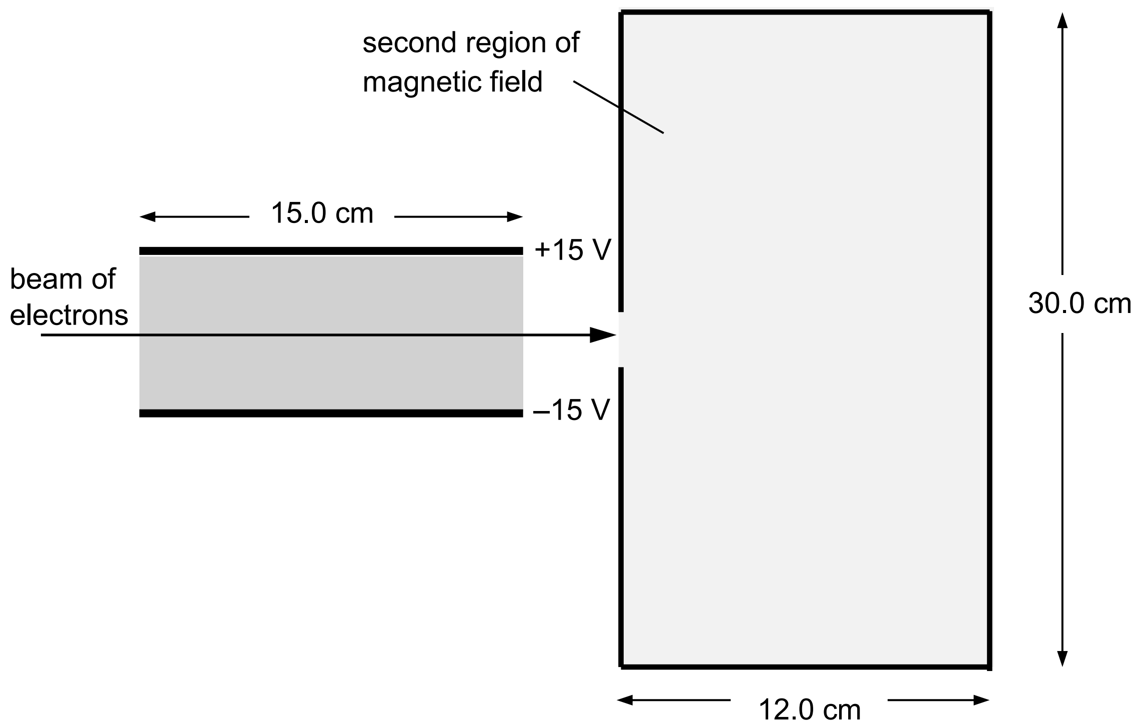

Fig. 9.3

(ii) Explain why the electrons move in a uniform circular motion inside the second region of magnetic field.

....

....

....

.... [2]

(iii) Calculate the radius of the path.

radius = ……………………… m [2]

(iv) The beam of electrons is now replaced by a beam of protons. The velocities of the protons before going between the two parallel plates ranges from of 3.00×10^6 m s^{-1} to 6.00×10^6 m s^{-1}.

Determine the speed of the protons that enters the second region of magnetic field.

speed = …………………… m s^{-1} [1]

(v) Sketch and label the respective paths of the electrons and protons inside the second magnetic field in Fig. 9.3.

[3]

[Total: 20]

End of Paper