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- (a) Fig. 5.1 shows two horizontal metal plates in a vacuum.

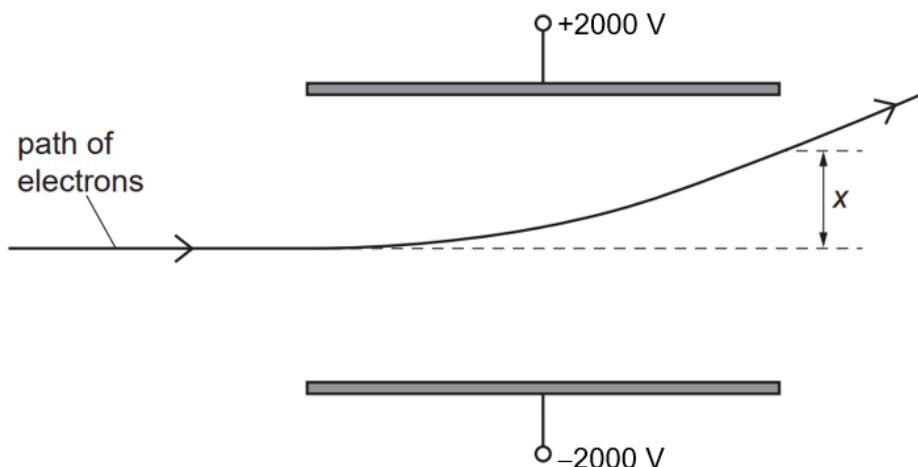


Fig. 5.1

The diagram is not drawn to scale.

Electrons travelling horizontally enter the region of uniform electric field between the charged plates and are deflected vertically.

The distance between the plates is 0.08 m.

The initial speed of the electrons is $6.0 \times 10^7 \text{ m s}^{-1}$.

The vertical deflection of the electrons at the far end of the plates is x .

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- (i) The length of each plate is 0.12 m.
Show that the time t taken by the electron to travel this length is $2.0 \times 10^{-9} \text{ s}$.

[1]

- (ii) Calculate the vertical deflection x of the electron.

$$x = \dots \text{m} \quad [3]$$

- (b) In a separate experiment, an electron is travelling at $5.0 \times 10^5 \text{ m s}^{-1}$ at an angle of 25° to the direction of the magnetic field as shown in Fig. 5.2a.
It forms a helix of radius $r = 0.029 \text{ m}$ as shown in Fig. 5.2b.

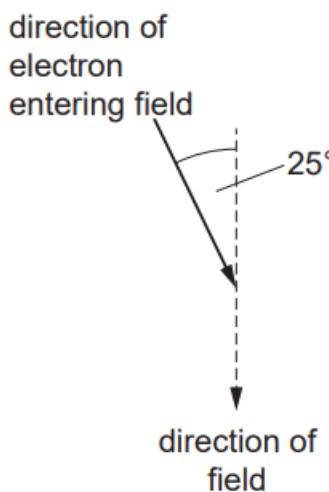


Fig. 5.2a

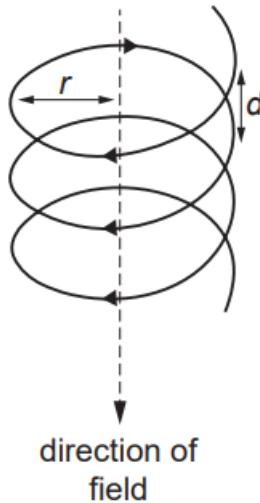


Fig. 5.2b

- (i) Explain why the electron follows this path.

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[2]

- (ii) Show that the time taken for the electron to complete each loop of the helix as shown in Fig. 5.2b is $8.6 \times 10^{-7} \text{ s}$.

[1]

- (iii) Hence, determine the distance d between adjacent loops in the helix as shown in Fig. 5.2b.

$$d = \dots \text{ m} \quad [1]$$

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