

- 6 Two parallel metal plates X and Y are separated by a distance of 0.041 m, as shown in Fig. 6.1.

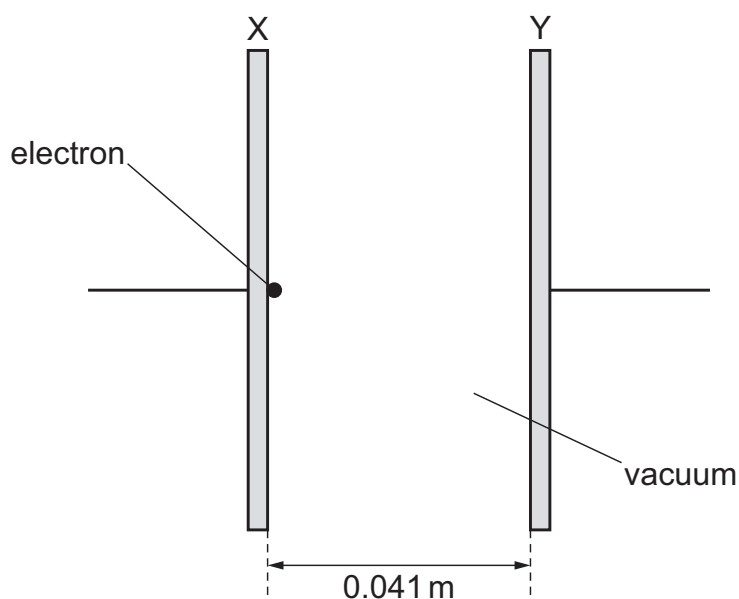


Fig. 6.1

There is a vacuum between the plates. An electron is at rest at the centre of plate X.

A potential difference (p.d.) of 58 kV is applied across the plates. This causes the electron to accelerate towards plate Y.

- (a) On Fig. 6.1, use the symbols + and – to indicate which of plates X and Y is the positive plate and which is the negative plate. [1]
- (b) (i) Calculate the electric field strength E between the plates. Give a unit with your answer.

$E =$ unit [2]

- (ii) Determine the acceleration of the electron.

acceleration = ms^{-2} [2]

(c) Many electrons are now accelerated from rest from plate X to plate Y in Fig. 6.1. When the electrons hit plate Y, the absorption of their kinetic energies results in the emission of electromagnetic waves.

(i) Show that the minimum wavelength of these electromagnetic waves is 21 pm.

[3]

(ii) State the region of the electromagnetic spectrum that contains these waves.

..... [1]

(iii) Explain how these electromagnetic waves may be used to form images of internal body structures.

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..... [2]

[Total: 11]

- 6 An electric field and a magnetic field are used to form a velocity selector. Charged particles, called ions, pass into a region of uniform electric and magnetic fields that is between parallel plates, as shown in Fig. 6.1.

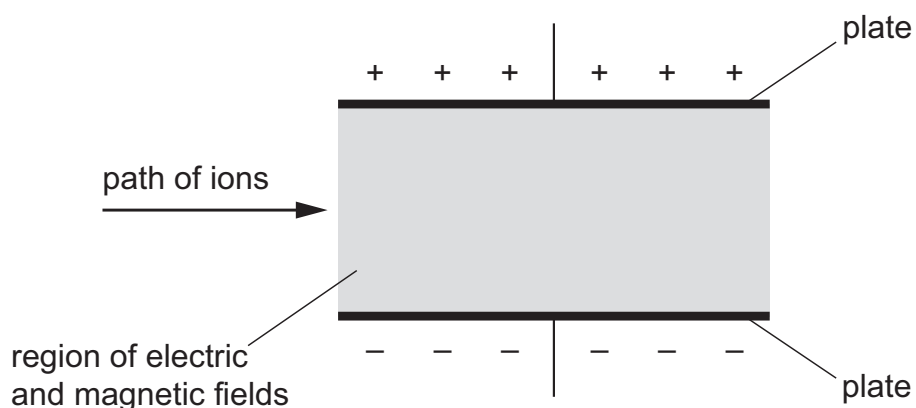


Fig. 6.1

- (a) The potential difference (p.d.) between the plates of the velocity selector is V . The separation of the plates is d and the magnetic flux density is B .

Show that the speed u of ions that pass undeviated through the velocity selector is given by

$$u = \frac{V}{Bd}.$$

[2]

- (b) Positive ions with kinetic energy $4.1 \times 10^{-17} \text{ J}$ and mass $3.2 \times 10^{-27} \text{ kg}$ pass undeviated through the velocity selector when V is equal to 980 V and d is equal to $3.6 \times 10^{-2} \text{ m}$.

Determine B .

$B = \dots\dots\dots \text{ T}$ [3]

(c) A proton passes undeviated through the velocity selector.

An alpha particle enters the velocity selector at the same speed as the proton.

State how the expression in (a) predicts that the alpha particle also passes undeviated through the velocity selector.

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..... [1]

(d) By reference to Fig. 6.1 and to the forces acting on a positive ion, determine the direction of the magnetic field. Explain your reasoning.

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.....
..... [3]

(e) The positive ions in (b) enter the velocity selector with greater kinetic energy.

On Fig. 6.1, sketch the path of these ions. [2]

[Total: 11]