

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

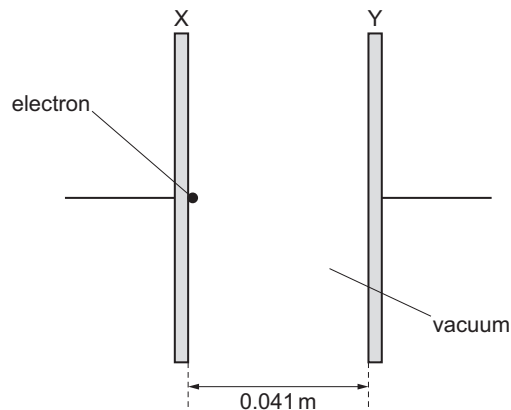


Fig. 6.1

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.

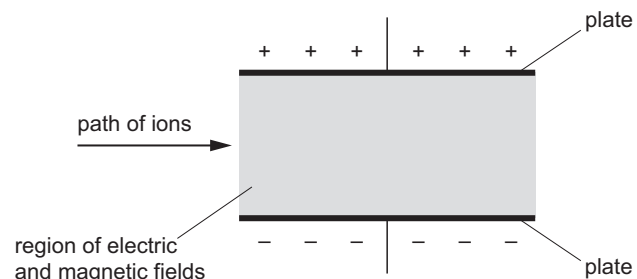


Fig. 6.1

- (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.

.....
 [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.

.....

 [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]