

7 (a) Define magnetic flux density.

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..... [2]

(b) A particle of mass m and charge $+Q$ moves at speed v into a region where there is a uniform magnetic field, as shown in Fig. 7.1.

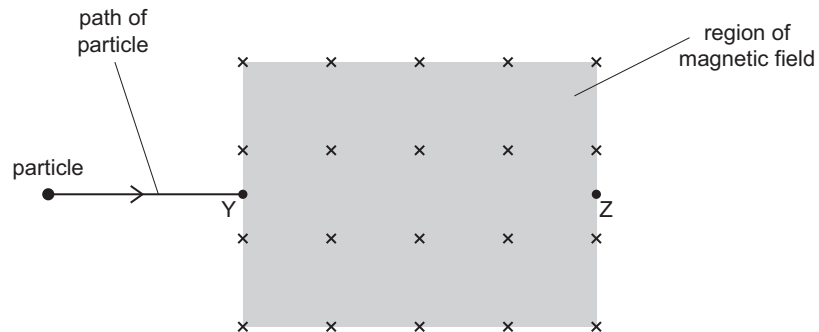


Fig. 7.1

The uniform magnetic field is into the page and has flux density B . The particle enters the region of the field at point Y.

(i) State an expression, in terms of some or all of m , Q , B and v , for the magnetic force F that acts on the particle when it is at point Y.

$F =$ [1]

(ii) On Fig. 7.1, draw an arrow at point Y to indicate the direction of the force in (b)(i). [1]

(iii) On Fig. 7.1, draw a line to show a possible path for the particle through the region of the magnetic field. [1]

(c) (i) Explain how an electric field can be used with the magnetic field to ensure that the particle in (b) now passes through point Z.

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..... [3]

(ii) Derive an expression for v in terms of B and the electric field strength E .

$v =$ [2]

[Total: 10]

- 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.

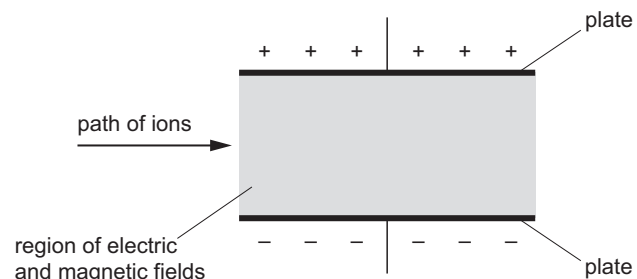


Fig. 6.1

- (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]