OCR
Oxford Cambridge and RSA

A level Physics B

H557/02 Scientific literacy in physics

Question Set 18

1 **Fig. 1.1** shows the basic components of a mass spectrometer. This is an instrument which separates ions according to the ratio of their charge to mass.

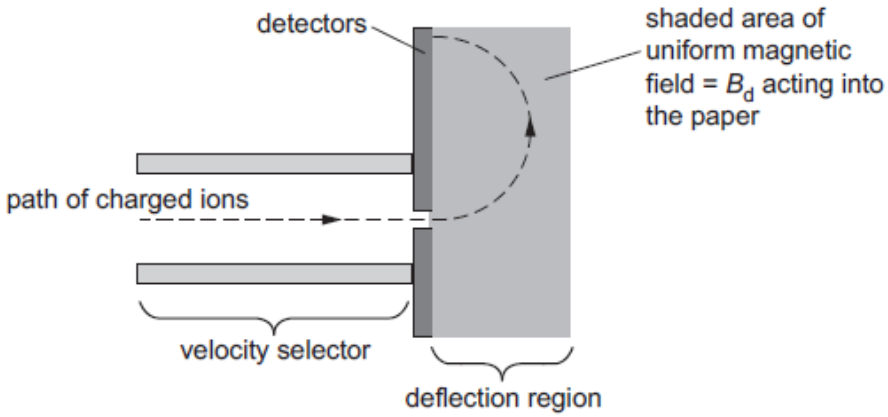

Fig. 1.1

Ions from an ion source (not shown in **Fig. 1.1**) pass into a region of uniform electric and magnetic fields called a velocity selector. Ions of different mass but with the same velocity will pass through to the deflection region. The ions are then deflected by a separate magnetic field in the deflection region and are detected by a bank of detectors. The position at which the ion is detected depends on the charge-to-mass ratio of the ion.

Fig. 1.2 indicates the uniform electric and magnetic fields in the velocity selector. The magnetic field is acting into the paper. A positive charge q is entering the selector at velocity v.

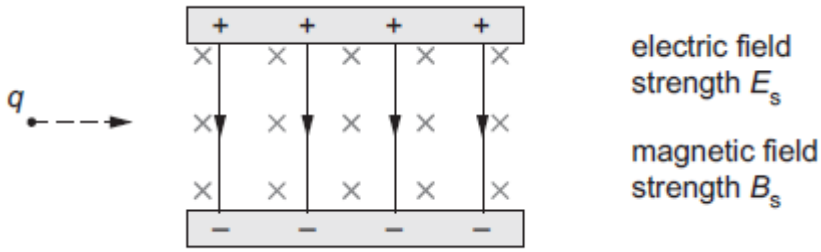

Fig. 1.2

(a) State how **Fig. 1.2** shows that the electric field is uniform within the selector.

[1]

(b) (i) A positive charge q moving horizontally through the selector at velocity v as shown in **Fig. 1.2** will experience a downwards electric force and an upwards magnetic force.

By considering the forces on the charge, explain why the charge will **not** be deflected when

$$v = \frac{E_s}{B_s}.$$

[2]

(ii) Show that the units of $\frac{\text{electric field strength}}{\text{magnetic field strength}}$ are equivalent to the unit of velocity.

[2]

(iii) Describe and explain the motion of charges moving through the region if their velocities are not equal to $\frac{E_s}{B_s}$.

[3]

(c) When charges enter the deflection region shown in **Fig. 1.3**, they experience a force due to the magnetic field.

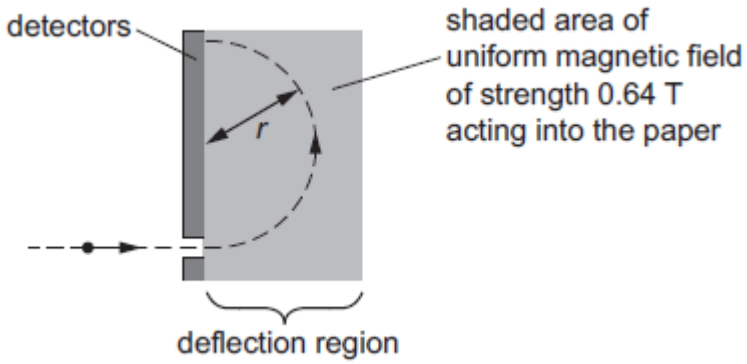

Fig. 1.3

(i) Show that the force on a proton moving at a velocity of $5.2 \times 10^6\,\text{m s}^{-1}$ at right angles to a field of strength 0.64 T is about $5.3 \times 10^{-13}\,\text{N}$.

[1]

(ii) Calculate the radius *r* of the path the proton will follow.

radius =.....m **[2]**

(iii) A beam of $^{12}_{6}C$ and $^{14}_{6}C$ singly charged positive ions with equal velocities enters a deflection region, travelling at right angles to a uniform magnetic field of unknown strength.

Showing your working, calculate the ratio:

$$\frac{\text{radius of path of } ^{14}_{6}C}{\text{radius of path of } ^{12}_{6}C}$$

[3]

Total Marks for Question Set 18: 14