

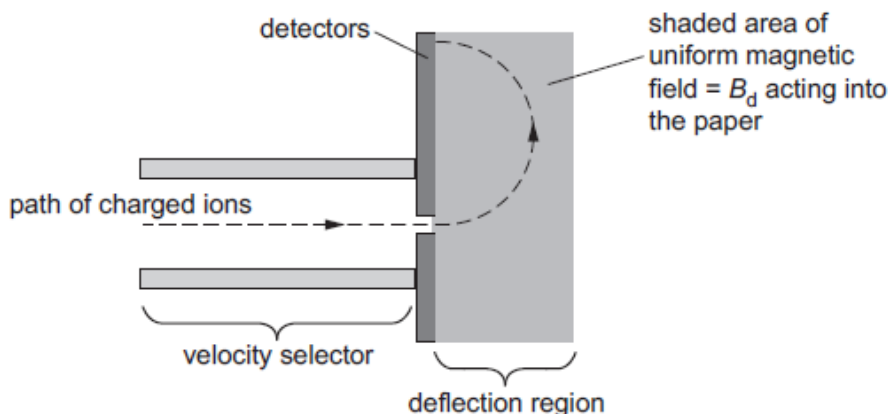
## **A level Physics B**

**H557/02** Scientific literacy in physics

### **Question Set 18**

1

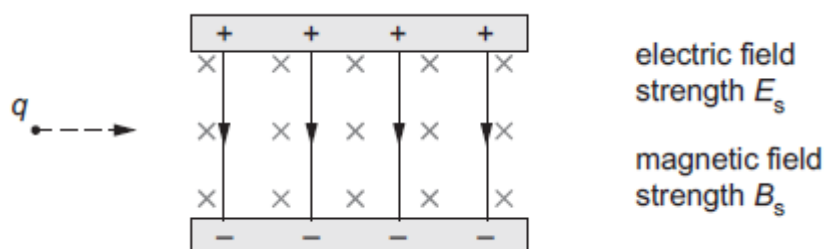
**Fig. 1.1** shows the basic components of a mass spectrometer. This is an instrument which separates ions according to the ratio of their charge to mass.



**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]

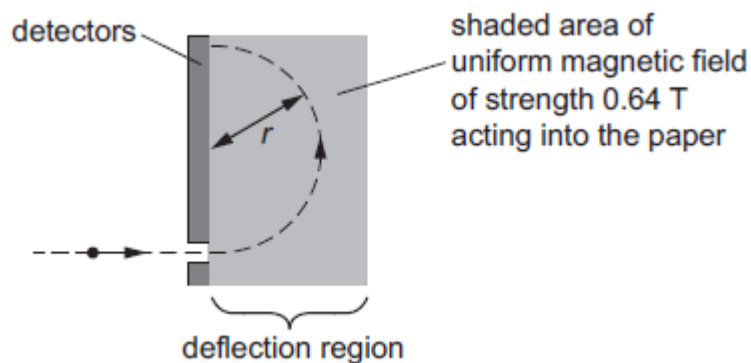
(ii) Show that the units of  $\frac{\text{electric field strength}}{\text{magnetic field strength}}$  are equivalent to the unit of velocity.

[2]

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

[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  $5.2 \times 10^6 \text{ ms}^{-1}$  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  $^{12}_6\text{C}$  and  $^{14}_6\text{C}$  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:

$$\frac{\text{radius of path of } ^{14}_6\text{C}}{\text{radius of path of } ^{12}_6\text{C}}$$

[3]

**Total Marks for Question Set 18: 14**

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