5 A mass spectrometer is a device used to analyse compounds and measure the charge-to-mass ratio of their constituent ions. In one such device shown in **Fig. 5.1**, a compound comprising two different elements is first vaporised and then ionised. The singly-charged ions of the two constituent elements are then accelerated, focused into a narrow beam, and then passed through a velocity selector, before they enter a magnetic field.

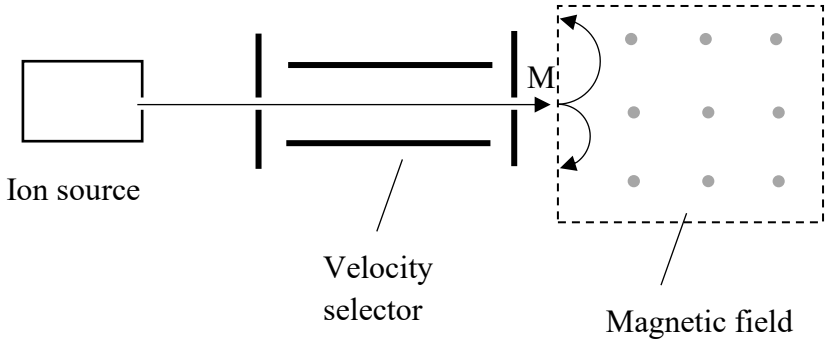

Fig. 5.1

(a) The electric field applied vertically downwards in the velocity selector has a strength of 1.21×10^3 V m^{-1}, while the magnetic field applied horizontally in the same space has a flux density of 0.015 T. This is shown in **Fig. 5.2**.

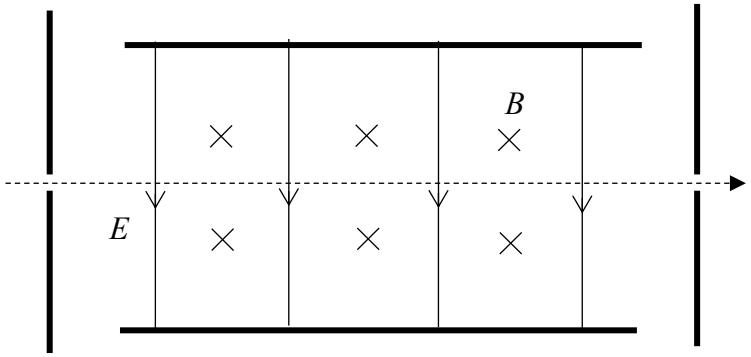

Fig. 5.2

(i) Calculate the speed that the ions must have for them to travel through the velocity selector in a straight path.

Speed = …….. m s^{-1} [2]

(ii) On **Fig. 5.2**, sketch the paths followed by the positive and negative ions that have speeds greater than that obtained in **(a)(i)**. Label the two paths **P** and **N** respectively. [1]

(b) After passing through the velocity selector, the singly-ionised ions enter a uniform magnetic field of flux density 1.6 T directed vertically out of the page at point M. They then follow the circular trajectories shown in **Fig. 5.3**.

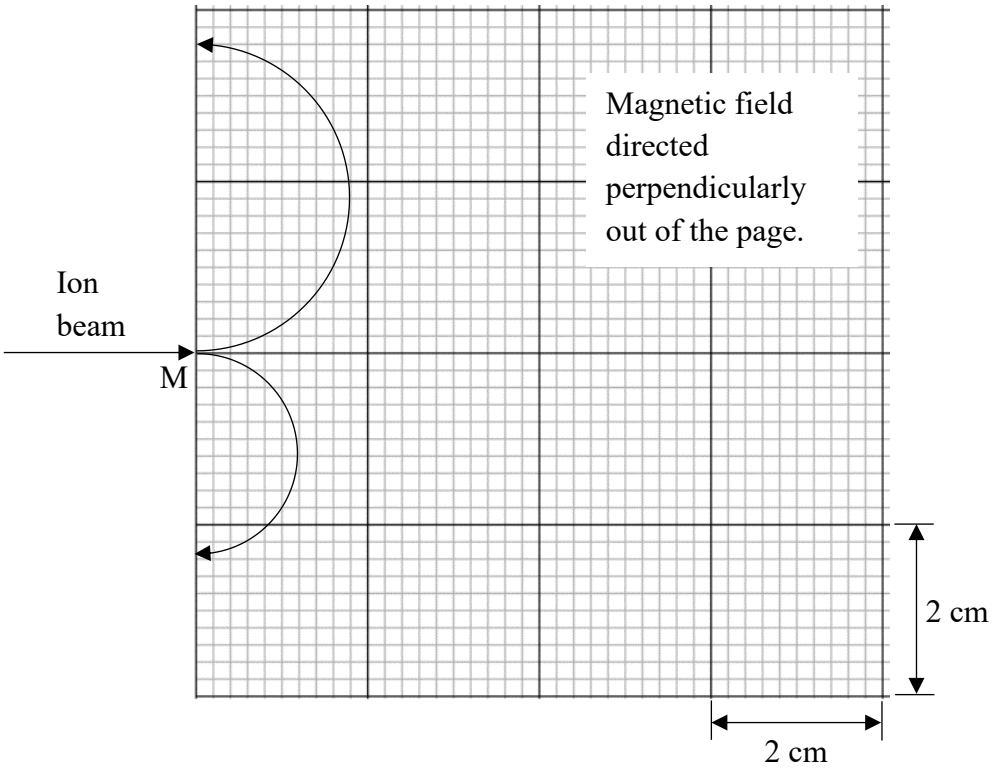

Fig. 5.3

(i) Use **Fig. 5.3** to determine the charge-to-mass ratios of the positive and negative ions in the compound.

Charge-to-mass ratio of positive ion = …….. C kg^{-1}

Charge-to-mass ratio of negative ion = …….. C kg^{-1} [4]

Fig. 5.4 shows the first three rows of the Periodic Table and provides information on the eighteen lightest elements.

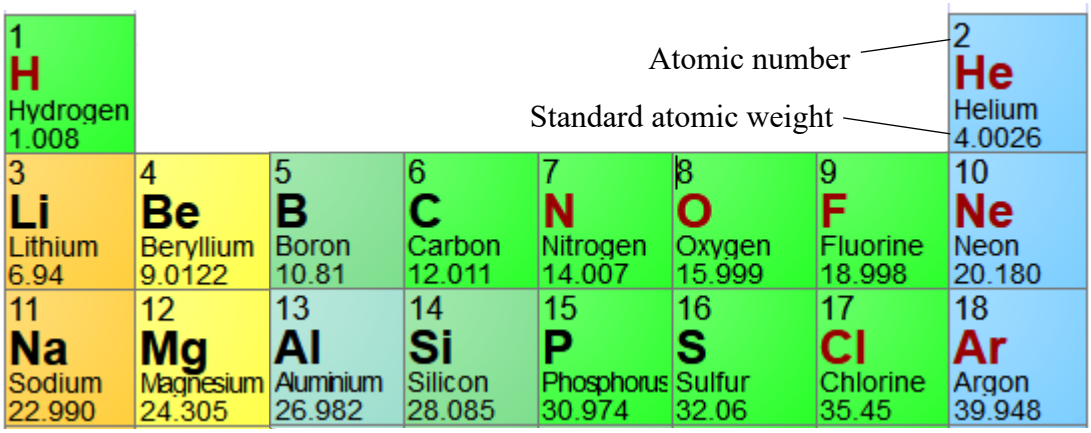

Fig. 5.4

(ii) Use your answer from **(b)(i)** to identify the compound used to produce the beam of positive and negative ions.

Identity of compound: …… [3]