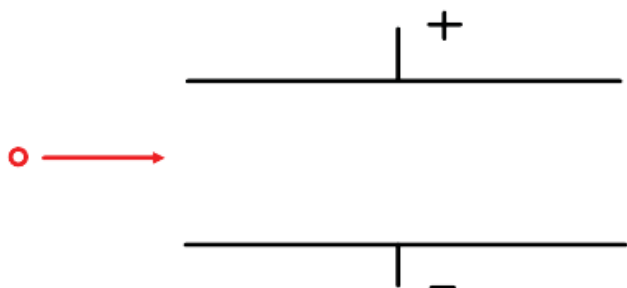




2. Mass spectrometers contain **velocity selectors** which reject ions that are moving at the wrong speed. They consist of a magnetic field and an electric field which exert opposing forces on a charged particle passing through.

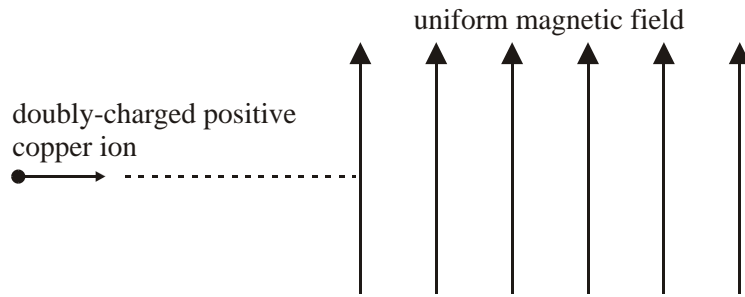


- a. The diagram above shows a charged particle entering a velocity selector. The magnetic field has not been labelled – add to the diagram so that the direction of the magnetic field is clear.

A singly charged positive ion of carbon-12 enters the selector with 5keV of energy and emerges undeflected. The mass of the ion is  $2.0 \times 10^{-26}$  kg.

- b. Calculate the speed of the ion.
- c. The magnetic flux density is 2T. The plates that produce the electric field are separated by 15mm. Calculate the voltage across the plates that results in the velocity selection calculated in part b.

3. (a)



The diagram above shows a doubly-charged positive ion of the copper isotope  ${}^{63}_{29}\text{Cu}$  that is projected into a vertical magnetic field of flux density 0.28 T, with the field directed upwards. The ion enters the field at a speed of  $7.8 \times 10^5 \text{ m s}^{-1}$ .

(i) State the initial direction of the magnetic force that acts on the ion.

.....

(ii) Describe the subsequent path of the ion as fully as you can. Your answer should include both a qualitative description and a calculation.

mass of  ${}^{63}_{29}\text{Cu}$  ion =  $1.05 \times 10^{-25} \text{ kg}$

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(5)

(b) State the effect on the path in part (a) if the following changes are made separately.

(i) The strength of the magnetic field is doubled.

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(ii) A singly-charged positive  ${}^{63}_{29}\text{Cu}$  ion replaces the original one.

.....  
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(3)

(Total 8 marks)