**6** A chlorine gas consists of two types of atoms: chlorine-35 and chlorine-37, of different masses. A researcher wants to separate these two atoms. He does this by using a device called the mass spectrometer as shown in Fig. 6.1.

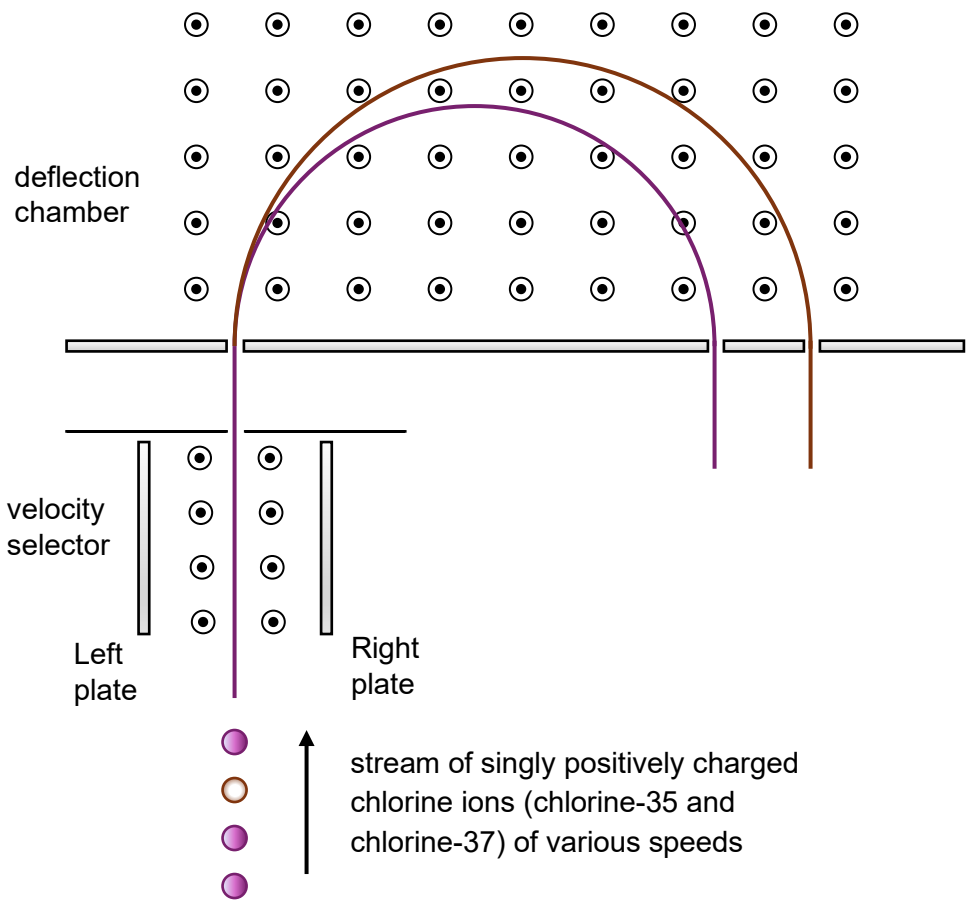


**Fig. 6.1 Mass spectrometer**

The researcher first ionises all the atoms into singly positively charged ions, and then sends the individual ions of various speeds through the velocity selector. The emerging ions then enter the deflection chamber where they are deflected by a uniform magnetic field.

**(a)** The first part of the device is the velocity selector where there is a uniform magnetic field, two charged parallel plates, and a slit to allow undeflected ions to emerge through, as shown in Fig. 6.1.

**(i)** State whether the left plate is at a higher or lower electric potential, explain your answer.

.....

.....

.....[2]

**(ii)** The flux density of the magnetic field in the velocity selector is 0.020 T. The field strength of the electric field between the plates is $1.50 \times 10^4$ V $m^{-1}$.

Calculate the speed of the emergent ions as they pass undeflected in the velocity selector.

speed = ..... m $s^{-1}$ [2]

**(iii)** Describe what happens to those ions that do not have the speed as calculated in **(a)(ii)** and suggest why it is called the velocity selector.

.....

.....

.....[2]

**(b)** The second part of the device is the deflection chamber where the flux density of the magnetic field is 0.020 T. The two different types of ions, chlorine-35 and chlorine-37, are deflected with different radii and hence are separated. Given that Chlorine-35 atom has a mass of 35*u* and chlorine-37 atom has a mass of 37*u*.

**(i)** Calculate the radius of the semi-circular path of the chlorine-35 ions.

radius = ..... m [2]

**(ii)** Given that the mass of the ions are unchanged, state the effect on your answers to **(a)(ii)** and **(b)(i)** if

**1.** the ions are singly negatively charged,

effect on **(a)(ii)** : .....

effect on **(b)(i)** : ..... [1]

**2.** the ions are still positively charged but are doubly charged.

effect on **(a)(ii)** : .....

effect on **(b)(i)** : ..... [1]