Answers 4.2

a) Calculate the velocity of a toluene molecular ion, *m/z* 92, after acceleration by a voltage of 5 kV.

The mass of the ion is approximately $92 \times 1.66 \times 10^{-27}$ kg = 1.53×10^{-25} kg
and the velocity is given by (Chap. 4.2):

$$v = \sqrt{\frac{2ezU}{m_i}}$$

Thus we have

$$v = \sqrt{\frac{2 \cdot 1.602 \times 10^{-19}\,\mathrm{C} \times 5000\,\mathrm{V}}{1.53 \times 10^{-25}\,\mathrm{kg}}} = 1.02 \times 10^{5}\,\mathrm{m\,s^{-1}}$$

b) How long will it take this ion to travel a distance of 1.0 m through a small magnetic sector mass analyzer to hit the detector?

The relationship between velocity and time *t* needed to travel the distance *s* is

$$t = \frac{s}{v}$$

which upon substitution of *v* becomes

$$t = \frac{s}{\sqrt{\frac{2ezU}{m_i}}}$$

As we have already calculated *v*, *t* is now easily obtained:

$$t = \frac{1.0\,\mathrm{m}}{1.02 \times 10^{5}\,\mathrm{m s^{-1}}} = 9.8 \times 10^{-6}\,\mathrm{s}$$

i.e., it takes approximately 10 µs.