1 mole = No. of atoms in 12 grams of Carbon-12

1 mole = 6.022×10^{23} atoms

$\therefore$ 6.022×10^{23} atoms have mass = 12 g/mol

1 atom of carbon-12 has mass = $\frac{12}{6.022 \times 10^{23}}$ grams

$\therefore$ 1 atom with relative mass 1, has mass = $\frac{1}{6.022 \times 10^{23}}$ g

So 1 atom with relative mass 49, has mass = $\frac{49}{6.022 \times 10^{23}}$ g

This equals 8.1368×10^{-23} grams

Converting to kg, this is 8.1368×10^{-26} kg

In a TOF mass spectrometer the time of flight, t, of an ion is shown by the equation:

$$t = d\sqrt{\frac{m}{2E}}$$

In this equation d is the length of the flight tube, m is the mass, in kg, of an ion and E is the kinetic energy of the ions.

In this spectrometer, the kinetic energy of an ion in the flight tube is 1.013×10^{-13} J. The time of flight of a $^{49}Ti^{+}$ ion is 9.816×10^{-7} s

b) Calculate the time of flight of the $^{47}Ti^{+}$ ion. Give your answer to the appropriate number of significant figures.

This question has two variables as both d and t for the $^{47}Ti^{+}$ ion are not known.

① Use the data given to find the length of the flight tube, d:

$t^2 = d^2 \times \frac{m}{2E} \Rightarrow d^2 = \frac{t^2 \times 2E}{m}$ (m is taken from part (a).)

$$d^2 = \frac{(9.816\times10^{-7})^2 \times 2 \times 1.013\times10^{-13}}{8.13...\times10^{-26}}$$

$d^2 = 2.399...$

$\Rightarrow d = 1.548...$ m

As a check, the lighter ion should travel the same distance faster.

② Use d to find t for the $^{47}Ti^{+}$ ion:

mass of $^{47}Ti^{+}$ ion $= 1.66...\times10^{-24} \times 47$ (using data from part (a).)

$= 7.80...\times10^{-23}$

$\Rightarrow t = 1.54... \times \sqrt{\frac{7.80\times10^{-23}}{2\times1.013\times10^{-26}}} = 9.613...\times10^{-7}$

$\Rightarrow 9.614\times10^{-7}$ s