## Extension Worksheet – Topic 6, Worksheet 3

**1** In 1910 Francis Aston showed that atoms of the element neon did not all have the same mass.

**a** Explain this observation. [2]

In a mass spectrometer, ions of charge $q$ and mass $m$ are accelerated from rest by a potential difference of $V$ volts. The accelerated ions enter a region of magnetic field of strength $B$ where they are bent into a semicircular path of radius $r$.

**b** Show that the mass to charge ratio of the ions, $\dfrac{m}{q}$, is given by the expression

$$\frac{m}{q} = \frac{B^2 r^2}{2V}$$ [4]

**c** In a particular experiment, singly ionised ions of neon were accelerated from rest by a potential difference of 490 V. After entering the region of a magnetic field of strength 0.150 T the ions were bent into two semicircular paths of radii 0.0951 m and 0.0996 m. Determine the masses of the ions in atomic mass units. [3]

**2** The diagram shows a few of the energy levels of caesium-137 and barium-137.
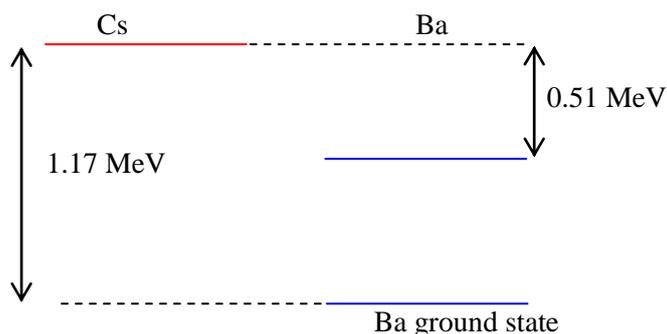


Nuclei of Cs 137 decay by beta decay into nuclei of Ba-137. The energy of the emitted electrons varies continuously from 0 up to 0.51 MeV.

**a** On the diagram above draw an arrow to indicate the beta decay of Cs-137. [1]

**b** Explain why the electron energy is not always 0.51 MeV. [2]

**c** Use the diagram above to suggest why a gamma ray photon is also produced in this decay. [2]

**d** Calculate the wavelength of the gamma ray photon. [2]

**3** In a living tree, the ratio of carbon-14 to carbon-12 atoms is constant at $1.3 \times 10^{-12}$. Carbon-14 is unstable with a half-life of 5730 years.

    **a** Suggest why this ratio will decrease after the tree dies. [2]

A 15 g piece of charcoal is found in an ancient archaeological site.

    **b** Calculate the number of atoms of carbon-12 in the piece of charcoal. [2]

    **c** The piece of charcoal has an activity of 1.40 Bq. Deduce that the ratio of carbon-14 to carbon-12 atoms in the charcoal is $4.85 \times 10^{-13}$. [3]

    **d** Deduce the age of the charcoal. [3]