

Chemguide – answers

MASS SPECTRA OF ELEMENTS

- Isotopes are atoms of the same element (and so with the same number of protons), but with different masses due to having different numbers of neutrons.
 - The relative atomic mass of an element is the weighted average of the masses of the isotopes on a scale on which a carbon-12 atom has a mass of exactly 12 units.
 - Because you only have 1+ ions, the m/z value tells you the relative isotopic masses.

Of 100 typical atoms,

$$\text{the total mass} = (0.56 \times 84) + (9.86 \times 86) + (7.00 \times 87) + (82.58 \times 88) = 8771.04$$

$$\text{Relative atomic mass} = 8771.04/100 = 87.7 \text{ (to 3 significant figures - no more!)}$$

(Actually, it is debatable here whether even 3 significant figures can be justified - the m/z values are only given to 2 significant figures, as is the abundance of the ^{84}Sr . If the 84 value is taken as the mass number, then that has to be exactly right. However, the actual mass, as found from the mass spectrometer, will be a little bit less than this. For example, the actual isotopic mass of ^{84}Sr is 83.913430. Some mass is converted to energy (binding energy) and released when atoms are formed from their constituent bits.

For exam purposes at this level, you would almost certainly be safe to quote to 3 significant figures.)

- Chlorine goes into the mass spectrometer as molecules, Cl_2 . Ionisation of these gives the lines at 70/72/74. But the Cl_2^+ ions aren't very stable and some of them split to give a Cl^+ ion and a chlorine atom. The Cl^+ ions give the lines at 35/37.

b)

m/z	caused by
35	$^{35}\text{Cl}^+$ ions
37	$^{37}\text{Cl}^+$ ions
70	Cl_2^+ molecular ions containing two ^{35}Cl atoms
72	Cl_2^+ molecular ions containing one ^{35}Cl and one ^{37}Cl atom
74	Cl_2^+ molecular ions containing two ^{37}Cl atoms

c) ^{35}Cl is approximately 3 times more abundant than ^{37}Cl .

d) 9 : 6 : 1

e) There is no way of predicting what proportion of the Cl_2^+ molecular ions will split up to give Cl^+ ions and a chlorine atom.