Worksheet

Lesson: Uses of Mass Spectrometry

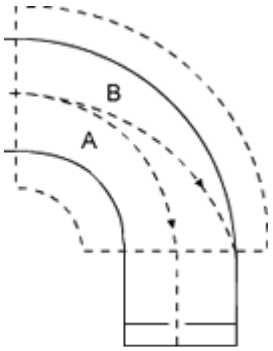
1. Mass spectra of two metals

1.1 Why is the relative atomic mass of chlorine 35.5 and not a whole number?

1.2 Silver consists of two isotopes: ^{107}Ag and ^{109}Ag. If both isotopes form singly charged ions in the mass spectrometer:

a. Which ion will follow the path marked **A** on the diagram?

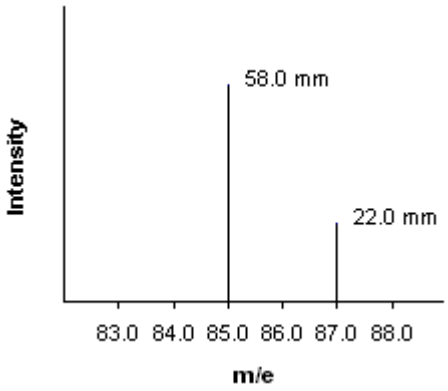
b. What must be done in the mass spectrometer to bring ion **B** on the detector?



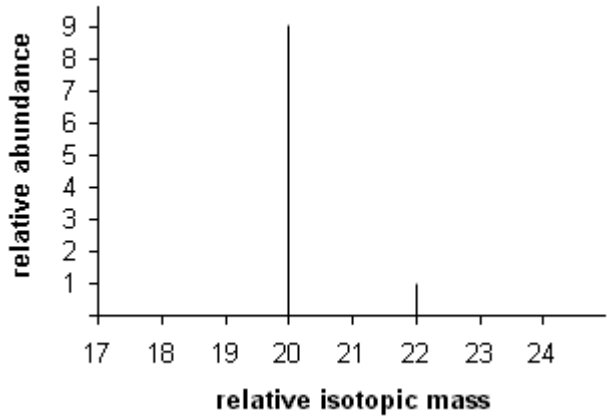
1.3 By referring to the peak heights on the mass spectrum of Rubidium shown in the diagram, calculate:

a. the relative abundance of the two isotopes

b. the relative atomic mass of rubidium.



1.4 The mass spectrum of neon is shown below.



Calculate the relative atomic mass of neon to one decimal place.

1.5 Lead consists of four stable isotopes. A very small amount of a sample of lead was inserted into a mass spectrometer to obtain its mass spectrum. The following results were obtained.

m/e	relative abundance
204	2.7
206	48.0
207	41.5
208	100.0

Calculate the relative atomic mass of lead.

1.6 Copper has two isotopes, ^{63}Cu and ^{65}Cu. The relative atomic mass of copper is 63.5. Find the relative percentage abundance of the two isotopes of copper.

2. Mass spectra of simple molecules

2.1 Bromine consists of two isotopes ^{79}Br and ^{81}Br, with relative abundance 50.5% and 49.5% respectively. Apart from the peaks at 79 and 81, due to Br^+ ions from these two isotopes, the mass spectrum of bromine also shows peaks at 158, 160 and 162.

a. What are the ions that give rise to these three peaks in the spectrum of bromine?

b. The relative heights of these three peaks are in the ratio 1:2:1. Can you explain this ratio, taking into account your answer to part (a) and the information about the relative abundance of the two bromine isotopes?

2.2 Using a mass spectrometer, analysis of the gases from a car exhaust showed the presence of a hydrocarbon with a molecular ion at mass 84. The empirical formula of the hydrocarbon was found to be CH_2. What is its molecular formula?

2.3 The mass spectrum of methyl chloride, CH_3Cl, shows two molecular ion peaks, one at 50 and one at 52, whereas methyl fluoride CH_3F, shows only one molecular ion peak, at 34. What is the reason for this? (Relative Atomic Mass: C = 12, H = 1, Cl = 35.5, F = 19)

2.4 A sample of carbon monoxide molecules are formed from the isotopes of carbon (^{12}C and ^{13}C) and the isotopes of oxygen (^{16}O and ^{18}O). The relative abundance of the isotopes of carbon and oxygen are as shown in the tables below:

Isotope	^{12}C	^{13}C
Relative Abundance	98.9%	1.10%

Isotope	^{16}O	^{18}O
Relative Abundance	99.8%	0.200%

a. How many peaks are there in the mass spectrum of carbon monoxide?

b. Identify the peaks and calculate the relative mass of each peak.

c. Calculate the relative abundance of the different types of carbon monoxide molecules present in the sample.

2.5 The mass spectrum of a sample of hydrogen chloride shows two prominent peaks at m/e 36.0 and 38.0, with relative heights of 75.8 % and 24.2 % respectively. Calculate the average relative molecular mass of this sample of hydrogen chloride.