Answer all the questions below then check your answers.

1.   Define the term 'isotope'.

2.   State the two pieces of information obtained from a mass spectrum.

3.   A sample of magnesium has three isotopes: Mg-24, Mg-25, Mg-26. Explain why these isotopes have the same chemical properties.

4.   The diagram below shows a sketch of the mass spectrum for a sample of chlorine (Cl_2). Identify the species responsible for the 5 peaks shown in the mass spectra.
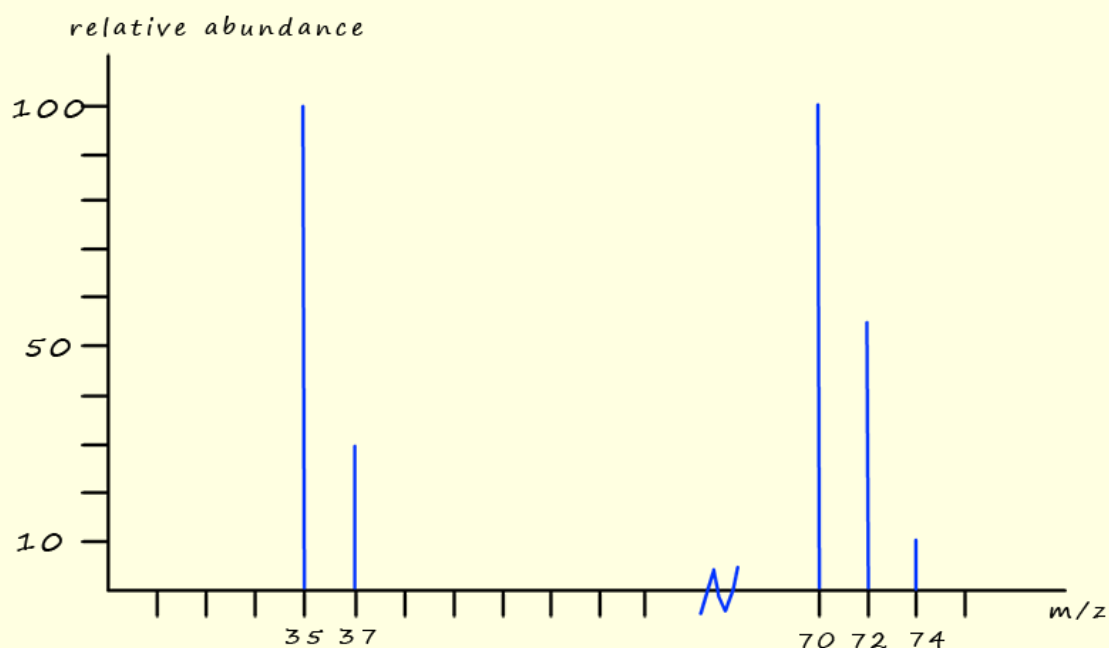
4. The element bromine has two isotopes: Br-79 and Br-81. Calculate the relative atomic mass of bromine given that the relative abundance of Br-79 is 50.7%.

5. The mass spectrum below is a simplified mass spectrum for the organic molecule butanone
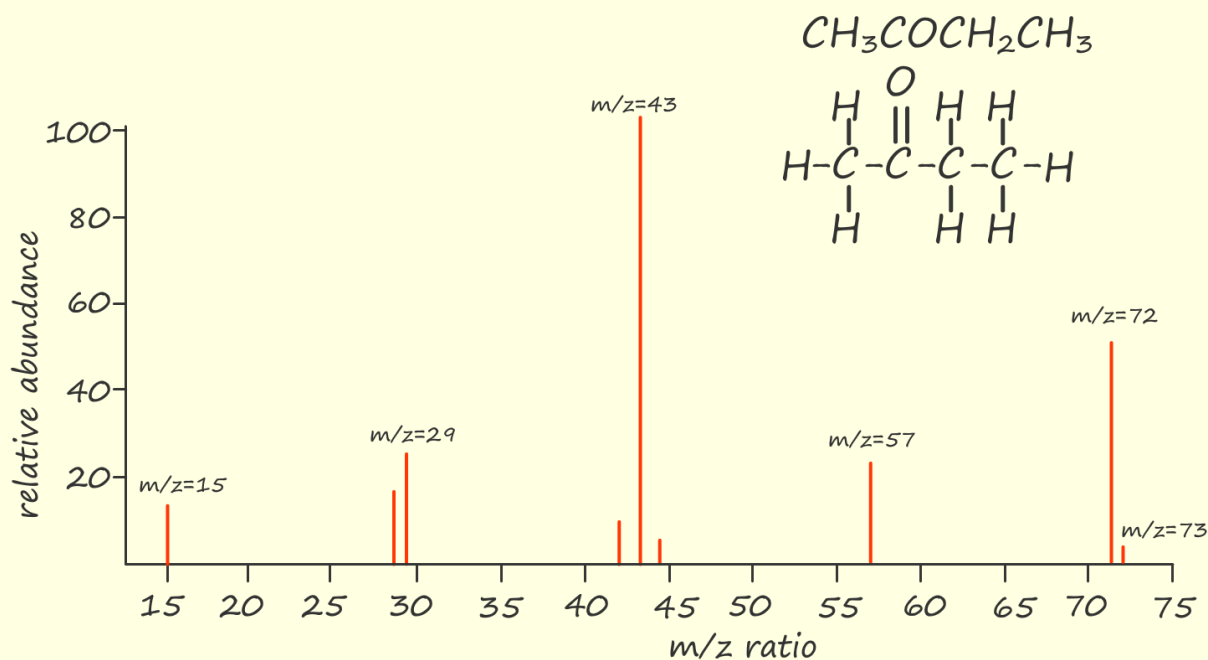
a. Identify the ion responsible for the molecular ion peak at m/z ratio of 72.

b. Identify the ion responsible for the following peaks:

   i. m/z ratio = 73

   ii m/z ratio = 57

   iii. m/z ratio = 43

   iv. m/z ratio = 29

   v. m/z ratio = 15

6. Define the term 'relative molecular mass' (Mr).

7. In a mass spectrometer, what does the m/z ratio represent?

8. An element has two isotopes with the following data:

   Isotope 1: Mass = 107 units, Abundance = 52%

   Isotope 2: Mass = 109 units, Abundance = 48%

   Calculate the element's relative atomic mass.

9. The mass spectrum of lead (Pb) shows four major peaks. These are:

   m/z =204: Abundance = 1.4%

   m/z =206: Abundance = 24.1%

   m/z =207: Abundance = 22.1%

   m/z =208: Abundance = 52.4% Calculate the relative atomic mass of lead.

10. The metal Chromium has four significant isotopes:

    Chromium-50: Abundance = 4.35%
    Chromium-52: Abundance = 83.79%
    Chromium-53: Abundance = 9.50%
    Chromium-54: Abundance = 2.36%
    Calculate the relative atomic mass of chromium.

Answers

1. Define the term 'isotope'.

   Isotopes are atoms of the same element with the same number of protons but a different number of neutrons.

2. State the two pieces of information obtained from a mass spectrum.

   The mass-to-charge ratio (m/z) of ions and the relative abundance of those ions.

3. A sample of magnesium has three isotopes: Mg-24, Mg-25, Mg-26. Explain why these isotopes have the same chemical properties.

   Isotopes have the same number of protons and electrons, thus the same electron configuration. Chemical properties are determined by electron configuration.

4. The diagram below shows a sketch of the mass spectrum for a sample of chlorine (Cl_2). Identify the species responsible for the 5 peaks shown in the mass spectra.
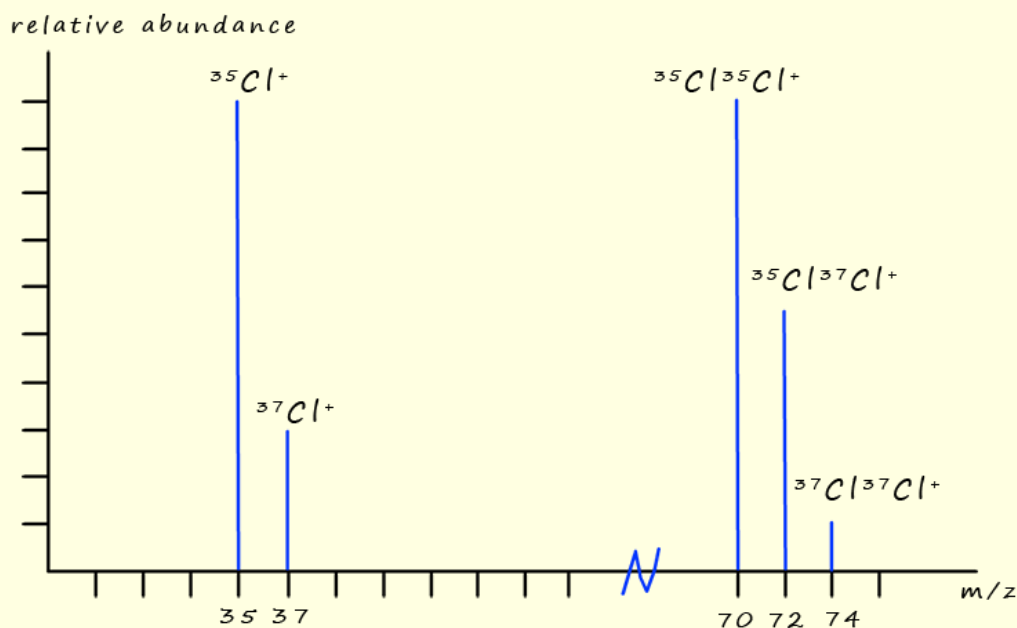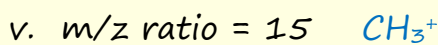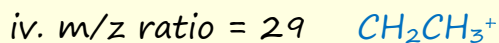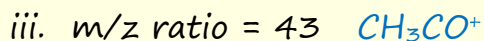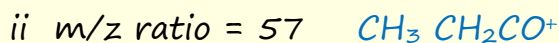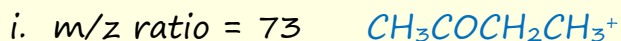
4. The element bromine has two isotopes: Br-79 and Br-81. Calculate the relative atomic mass of bromine given that the relative abundance of Br-79 is 50.7%.

$A_r = (79 * 0.507) + (81 * 0.493) = 79.91$

5. The mass spectrum below is a simplified mass spectrum for the organic molecule butanone
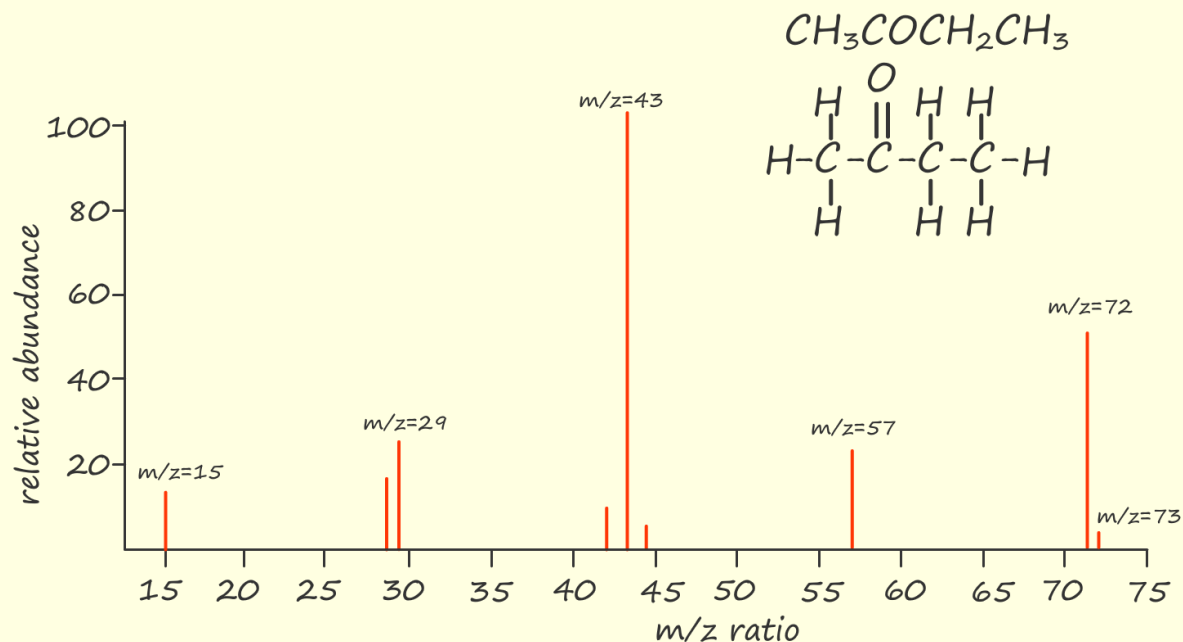
$CH_3COCH_2CH_3$

a. Identify the ion responsible for the molecular ion peak at m/z ratio of 72.

b. Identify the ion responsible for the following peaks:

i. m/z ratio = 73 $CH_3COCH_2CH_3^+$

ii m/z ratio = 57 $CH_3 CH_2CO^+$

iii. m/z ratio = 43 CH_3CO^+

iv. m/z ratio = 29 $CH_2CH_3^+$

v. m/z ratio = 15 CH_3^+

6. Define the term 'relative molecular mass' (Mr).

   The average mass of a molecule of a compound compared to one-twelfth (1/12) the mass of a carbon-12 atom.

7. In a mass spectrometer, what does the m/z ratio represent?

   The mass-to-charge ratio of an ion (most often this has a charge of +1).

8. An element has two isotopes with the following data:

   Isotope 1: Mass = 107 units, Abundance = 52%

   Isotope 2: Mass = 109 units, Abundance = 48%

   Calculate the element's relative atomic mass.

   A_r = (107 * 0.52) + (109 * 0.48) = 107.88

9. The mass spectrum of lead (Pb) shows four major peaks. These are:

   m/z =204: Abundance = 1.4%

   m/z =206: Abundance = 24.1%

   m/z =207: Abundance = 22.1%

   m/z =208: Abundance = 52.4% Calculate the relative atomic mass of lead.

   A_r = (204 * 0.014) + (206 * 0.241) + (207 * 0.221) + (208 * 0.524) = 207.2 (approximately)

10. Chromium has four significant isotopes:

Chromium-50: Abundance = 4.35%

Chromium-52: Abundance = 83.79%

Chromium-53: Abundance = 9.50%

Chromium-54: Abundance = 2.36%

Calculate the relative atomic mass of chromium.

A_r = (50 * 0.0435) + (52 * 0.8379) + (53 * 0.950) + (54 * 0.0236) = 52.06 approximately