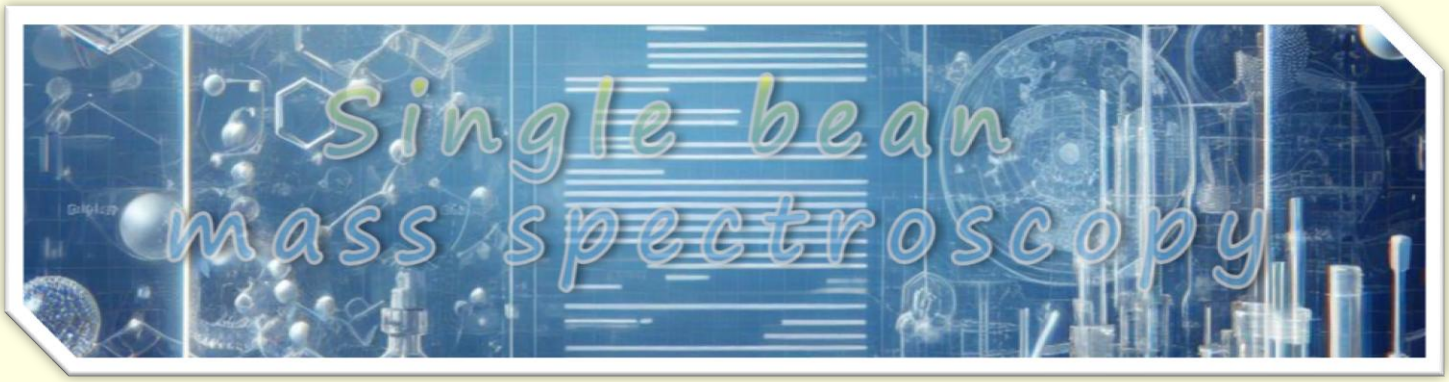



Answer all the questions below then check your answers

1. Name the four main stages in the operation of a single beam mass spectrometer.

2. What property determines the degree of deflection of ions in a mass spectrometer?

3. True or False: Ions with a smaller mass-to-charge ratio will be deflected more by the magnetic field than heavier ions.

4. Briefly describe the process of electron impact ionization.

5. A mass spectrum shows peaks at m/z 16 and m/z 32. Suggest possible identities for the ions responsible for these peaks.

6. Sketch a basic diagram of a single beam mass spectrometer and label the key components.

b. Why is it important to maintain a high vacuum within a mass spectrometer?

7. The element copper has two isotopes, copper-63 and copper-65. Explain why the mass spectrum of copper will show peaks at m/z 63 and m/z 65, assuming the ions have a 1+ charge.

8. A sample of neon contains three isotopes: neon-20 (90.5%), neon-21 (0.3%), and neon-22 (9.2%).

(a) Calculate the relative atomic mass of neon.

(b) Describe the appearance of the mass spectrum you would expect for neon, including the relative heights of the peaks.

9. Titanium has several isotopes. When analyzed in a mass spectrometer, the most abundant isotope produced two peaks: one at m/z = 48 and the other at m/z = 24. Explain how these peaks are formed.

## Answers

1. Name the four main stages in the operation of a single beam mass spectrometer.

   Ionisation, Acceleration, Deflection, Detection

2. What property determines the degree of deflection of ions in a mass spectrometer?

   Mass-to-charge ratio (m/z)

3. True or False: Ions with a smaller mass-to-charge ratio will be deflected more by the magnetic field than heavier ions.

   Answer: True

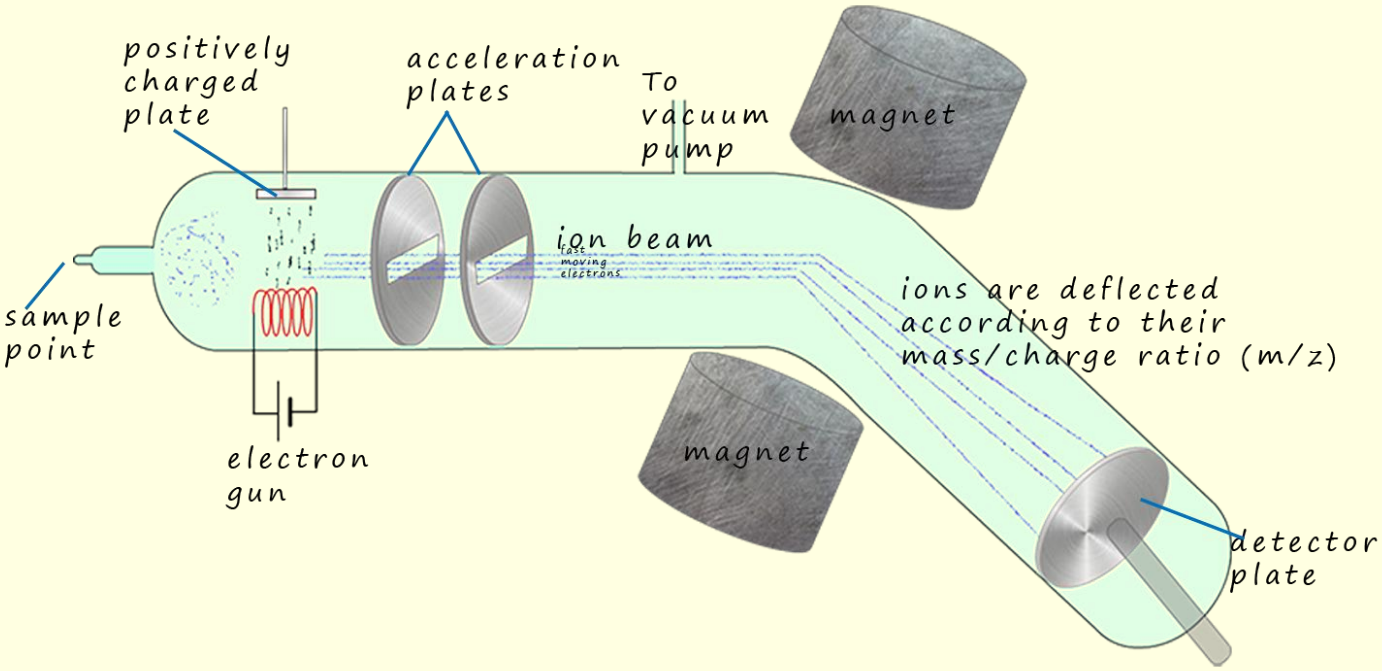
4. Briefly describe the process of electron impact ionization.

   The sample to be ionised is vaporised and high-energy electrons from an electron gun bombard the gaseous atoms, knocking off an electron to form positively charged ion.

5. A mass spectrum shows peaks at m/z 16 and m/z 32. Suggest possible identities for the ions responsible for these peaks.

   m/z =16 could be $O^+$, 32 could be $O_2^+$ or $S^+$

6. Sketch a basic diagram of a single beam mass spectrometer and label the key components.




b. Why is it important to maintain a high vacuum within a mass spectrometer?

To prevent collisions between the ions and air molecules. Collisions would alter the ion's path and likely prevent it from reaching the detector.

7. The element copper has two isotopes, copper-63 and copper-65. Explain why the mass spectrum of copper will show peaks at m/z 63 and m/z 65, assuming the ions have a 1+ charge.

The mass spectrometer separates ions based on their mass-to-charge ratio. Since both isotopes will predominantly form 1+ ions, their m/z value will be equal to their atomic mass.

8. A sample of neon contains three isotopes: neon-20 (90.5%), neon-21 (0.3%), and neon-22 (9.2%).

(a) Calculate the relative atomic mass of neon.

$A_r = (20 \times 0.905) + (21 \times 0.003) + (22 \times 0.092) = 20.18$

(b) Describe the appearance of the mass spectrum you would expect for neon, including the relative heights of the peaks.

- Peak at m/z 20: Largest peak (reflecting the 90.5% abundance)
- Peak at m/z 22: Medium-sized peak (reflecting the 9.2% abundance)
- Peak at m/z 21: Very small peak (reflecting the 0.3% abundance)

9. Titanium has several isotopes. When analyzed in a mass spectrometer, the most abundant isotope produced two peaks: one at m/z = 48 and the other at m/z = 24. Explain how these peaks are formed.

- Peak at m/z =48: Represents the titanium-48 isotope with a single positive charge (48), $^{48}Ti^{+}$
- Peak at m/z 24: Represents the titanium-48 isotope with a double positive charge (48 2+), $^{48}Ti^{2+}$