Mass Spectrometry

What is it used for?

- Find the abundance and mass of each isotope in an element allowing us to determine its relative atomic mass.
- Find the molecular mass of substances.

Stage 1: Ionisation

Method 1: Electron impact (for small Mrs)

1. The sample being analysed is vaporised.
2. High energy electrons are fired at it. The high energy electrons come from an "electron gun" which is a hot wire filament with a current.
3. This causes an electron to be knocked off.
4. This forms 1+ ions.

$$X_{(g)} \longrightarrow X^+_{(g)} + e^-$$

they have to have a positive charge in order to be attracted to the negative plate

Method 2: Electrospray ionisation (for high Mrs)

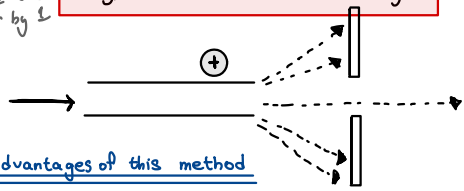
good for proteins (big molecules)

1. Sample is dissolved in a volatile solvent (eg water or methanol)
2. It is injected through a fine hypodermic needle (attached to positive terminal of a high-voltage supply) to give a fine mist (aerosol)
3. Particles are ionised by gaining a proton (i.e an H^+ ion which is one proton)

Protonation

$$X_{(g)} + H^+ \longrightarrow XH^+_{(g)}$$

this method will increase the mass number by 1

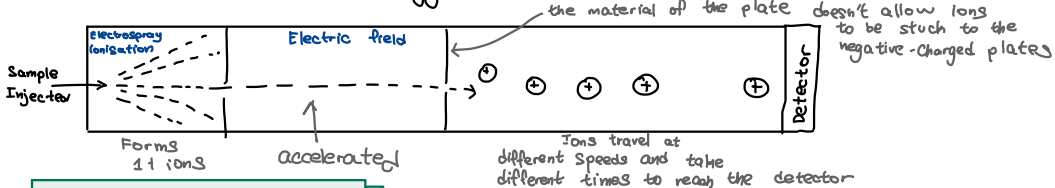


Advantages of this method

- Less fragmentation
- Could use for big molecules like proteins

Stage 2: Acceleration

The positive ions (gained from previous page) are accelerated using an electric field so that they all have the same kinetic energy.



Stage 3: Flight Tube

The positive ions travel through a hole in the negatively charged plate into a tube. Lighter ions travel faster and reach the detector in less time than the heavier particles that move slower and take longer to reach the detector.

↑ This is because $KE = \frac{1}{2}mv^2$ (energy and velocity is constant)

Stage 4: Detection

- The positive ions hit a negatively charged electric plate.
- When they hit the detector plate, the positive ions are discharged by gaining electrons from the plate.
- This generates a movement of electrons and hence an electric current that is measured.
- The size of the current gives a measure of the number of ions hitting the plate.

Mass Spectrum

- The mass spectrum shows the mass to charge (m/z) ratio and abundance of each ion that reaches the detector.
- Given that most ions are 1+, the m/z is effectively the mass of each ion.

Mass Spectrum of an organic compound