Mass Spectrometer

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1 Introduction

A mass spectrometer is a device used to determine the proportion of each isotope present in a sample of an element, making use of basic magnetic force on a moving charged particle. The modern techniques of mass spectrometry was devised by Aurthur Jeffery Dempster and J.W. Anston in 1918 and 1919 respectively. The mass spectrometer has four major processes; vaporisation, ionisation, acceleration, deflection and detection.

2 Exploration

Vaporisation:The sample is injected and vaporised to produce gaseous atoms/molecules

Ionization: Atoms/molecules are bombarded with high energy electrons to produce positive ions an example is illustrated below using magnesium:

Mg + e- = $Mg^{+} + 2e-$

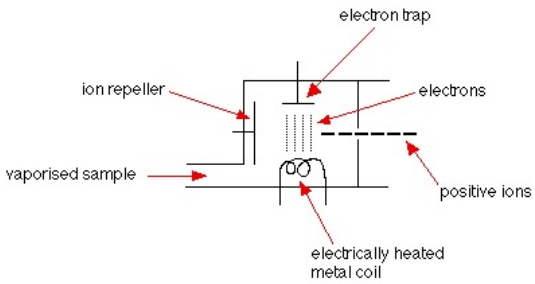

Figure 1: Figure 1:Ionisation in a mass spectrometer

Acceleration ion: The positive ions are accelerated in the magnetic field using positive and negative plates in the mass spectrometer

Deflection: The positive ions are deflected in a magnetic B field. The selected perpendicular velocity goes through the B field causing the positive ion to deflect. The radius of the pass and the position on the detector is as function of the mass of the particle.

$r=mv^2/qB$

If a charge moves into a magnetic field with direction perpendicular to the field.It will follow a circular path. The magnetic force, being perpendicular to the velocity provides the centripetal force.

$$r = \frac{mv}{qB}$$

If the velocity is produced by an accelerating voltage:

$$r = \frac{mv^2}{2} = q\ \Delta V$$

What is velocity selection? This is the process by which the a velocity selector in the mass spectrometer uses opposing and electric and magnetic forces match for a specific particle field

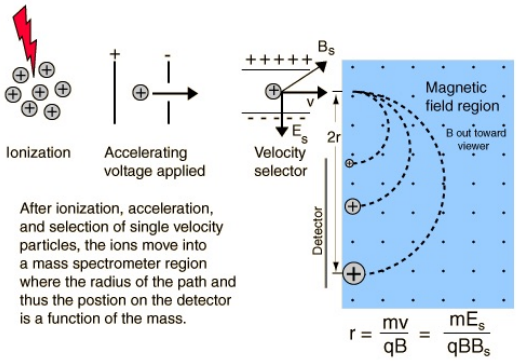

Figure 2: Figure 1:A graphical illustration of the mass spectrometer

Detection: For one paticular magnetic field, particles only one m/z pass through the spectrometer. These hit the detector and produce a signal in the form of electric current. Which is proportional to the number of ions hitting the detector.The magnetic field is varied to scan the whole range of m/z values

3 Bibliography

Owen, S. (2011). Atomic Structure. In Chemistry for the IB diploma. Cambridge: Cambridge University Press.

Mass Spectrometer. (n.d.). Retrieved November 1, 2015.