MassSpectro

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1 Physical Principles

The thought process behind the mass spectrograph is reflected below:
For example, there is a moving object subject to a sideway force

That is subject to a side way force.
It will move in a curve as it deviates out of its initial path due to the sideway force.

In an attempt to reproduce this phenomena, it is possible to launch a cannonball and stand sideways next to its projected motion while squirting water from a

hose-pipe. Because the canon ball is heavy, this might only make an insignificant difference.

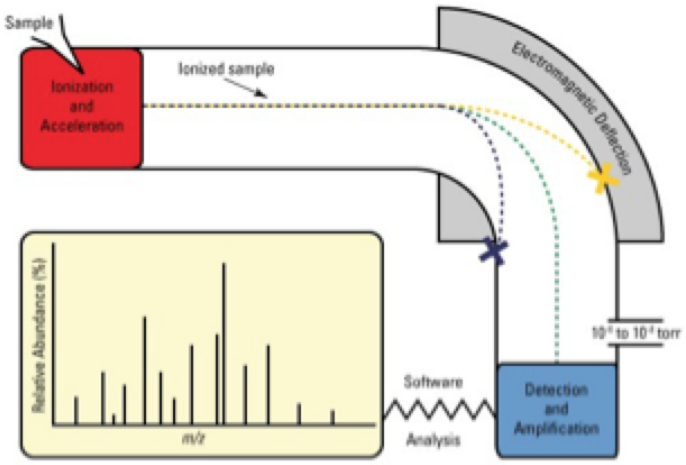
On the other hand, launching a tennis ball, which is not as massively heavy as a cannonball, its projected motion after being subject to the sideway force, hose pipe water, deviates drastically as seen on the diagram below.

It's safe to assume that the amount of deflection as a result from a sideway force depends on the mass of the ball. By defining the variables of speed of the moving object and size of the sideway force, it is possible to calculate the mass of the moving object if you know what sort of path it was deflected through. Essentially, this observation leads to the conclusion that the heavier the ball, the less deflection.
Source : http://www.chemguide.co.uk/analysis/masspec/howitworks.html

2 Physical Principles examined

John B. Fenn (2002 Nobel Laureate in Chemistry)
" Mass spectrometry is the art of measuring atoms and molecules to determine their molecular weight. Such mass or weight information is sometimes sufficient,

frequently necessary, and always useful in determining the identity of a species."
As for reference to the previous example, in a mass spectrometer, the moving object is individual molecules, the sideway force is the external magnetic field.
A mass spectrometer determines the mass of a molecule by measuring the mass-to-charge ratio of its ions. Ions are generated by inducing either the loss or gain of a charge from a neutral species. Once formed, ions are electrostatically directed into a mass analyzer where they are separated according to mass to charge. ration and finally detected.
The result of molecular ionization, ion separation, and ion detection is a spectrum that can provide molecular mass.



3 Basics of Mass Spectroscopy

Ionization : the process by which an atom or a molecule acquires a negative or positive charge by gaining or losing electrons to form an ion.

Ion : an atom or molecule with a net electric charge due to the loss or gain of one or more electrons.

- Four basic components : a sample inlet, an ionization source, a mass analyzer and an ion detector.

- Sample molecules are introduced into the instrument through a sample inlet.

- The sample molecules are converted to ions in the ionization source

- Converted ions are electrostatically propelled into the mass analyzer.

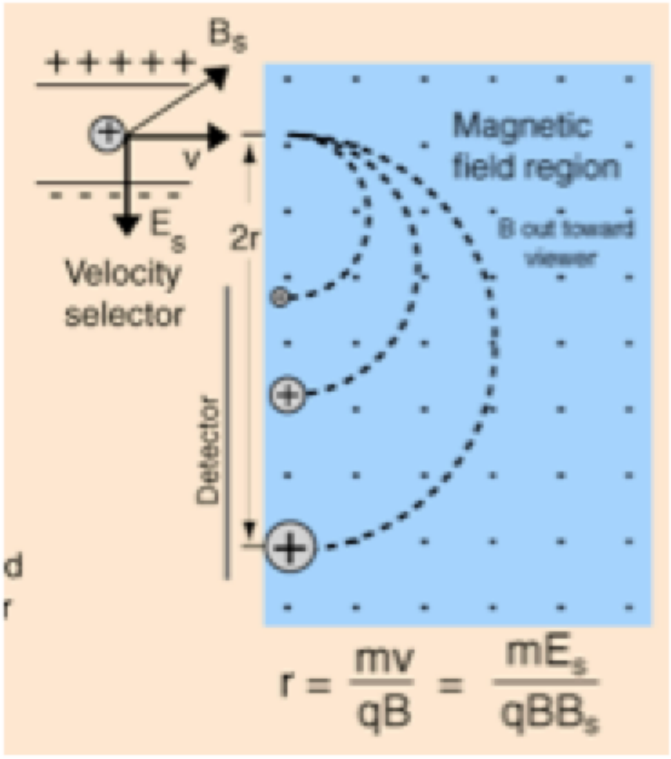
- Ions are then separated according to their mass to charge ratio within the mass analyzer.

- The detector converts the ion energy into electrical signals, which are then transmitted to a computer.

Source : https://masspec.scripps.edu/mshistory/whatisms$_d$*etails.phpBasics*

4 Relevant formulae

After ionization, acceleration and selection of single velocity particles, the ions move into a mass spectrometer region where the radius of the path and thus the position on the ion detector is a function of the mass



When 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.

F = qvB = mv2/r

Thus

R = mv2 /qvB = mv/qB