THE MASS SPECTROMETRY EXPERIMENT

How can we "weigh" something as small as a molecule? In mass spectrometry, the balance between two different physical phenomena can be used to measure mass.

- One of these phenomena is inertia; a moving object with more mass can't slow down or turn as quickly as an object with less mass.
- The second phenomenon is the interaction of a charged particle with a magnetic field.

When placed in a magnetic field, a charged particle (such as an electron or proton) will be attracted toward one end of the field. When coupled with the phenomenon of inertia, this magnetic attraction can be used to differentiate between particles with different mass.

- Because an ion moving very fast has inertia, it tends to keep moving in a straight line.
- If a magnetic field is placed across the path of the ion, the ion will deviate from its path because of magnetic attraction.

Suppose two particles moving parallel to each other enter into a magnetic field at the same time. One of these particles is heavier than the other. Both are deflected a little bit from their original path, but one of the particles -- the heavier one -- does not turn as easily and so it is not deflected as much. If we can measure how far each particle is deflected, we may be able to get an idea of the mass in each case.

- The heavier the ion, the less it will deviate from its path, because its inertia keeps carrying it forward.

- The lighter the ion, the more sharply it will deviate from its path, because it hasn't much inertia to keep it going straight.

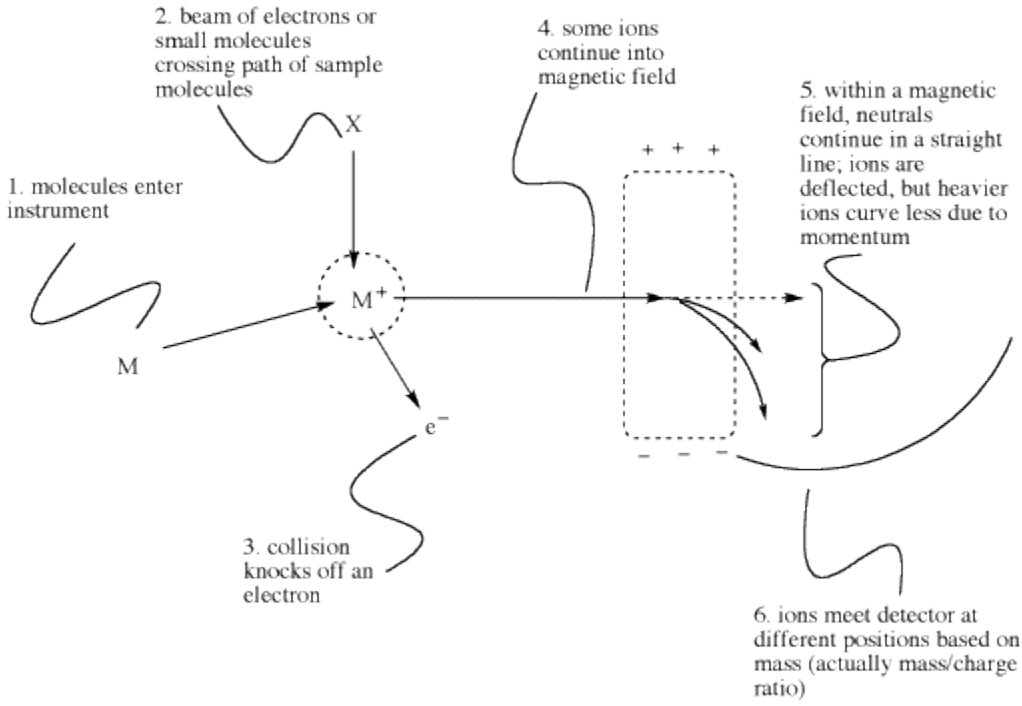

Figure MS2. A very approximate schematic of a typical mass spectrometry experiment.

Mass spectrometry only works with ions, not with neutral molecules. That means a neutral molecules must become charged in order to do this experiment. It is common to generate a cation from the molecule by removing one electron. The electron is knocked off the molecule in a collision. The collision can be caused in two different ways:

- The molecule can be sent through a stream of high-energy electrons. This method is called electron ionization.
- The molecule is sent through a stream of small molecules, such as ammonia or methane. This method is called chemical ionization.

- Electron ionization frequently results in the molecule falling to pieces because of the high energy of the electrons.
- Chemical ionization results in a "softer" collision because momentum can be dissipated through various bonds in both colliding molecules. Chemical ionization results in less fragmentation of the target molecule.
- However, after chemical ionization, the ionizing molecule sometimes sticks to the target molecule, leading to a greater "molecular" mass. For example, if ammonia is used for ionization, an extra mass may be observed at 17 amu higher than expected.

The reason the x-axis on a mass spectrum is labeled m/z (mass-to-charge ratio) is to acknowledge that there are really two factors contributing to the experiment.

Source : http://employees.csbsju.edu/cschaller/Principles%20Chem/structure%20determination/ms%20experiment.htm