Foundatin Chemistry

Introduction

All lectures will take place within the Great Hall and all practicles shall take place in lab C18. This can be accesed from the left hand corridor of Engineering Central. All notes are available on the Blackboard.

Recommended Reading

- Chemistry : molecules, matter, and change / Peter Atkins, Loretta Jones

Testing

There will be tests on Blackboard throughout the year which will make up 10% of the final mark. There will also be two practicals, each worth 7.5%, and a final end-of-year test worth 75%

Lecture 2: Structure and Bonding 09/10/17

Atomic number (Z) - The number of protons in an atom's nucleus

Atomic mass (A_r) - The number of protons and neutrons within an atomic nucleus

Isotopes - The same element (so the same Z) but with a different A_r, meaning more neutrons within the nucleus

Volatile - Evaporate at normal (room) temperatures and pressures

Semiconductor - A material with an electrical conductivity less than a conductor, such as copper, but greater than an insulator, such as glass. Their resistance decreases as temperature increases, which is the opposite of how metals behave.

The A_r displayed on some Table of Elements is a decimal as the A_r is the average of all isotopes of that element. For example, 99% of naturally occuring carbon is ^{12}C and 1% is ^{13}C, meaning that:

$$\begin{aligned} A_r(C) &= \frac{99}{100}(12) + \frac{1}{100}(13) \\ &= 12.011 \end{aligned}$$

Mass Spectrometer

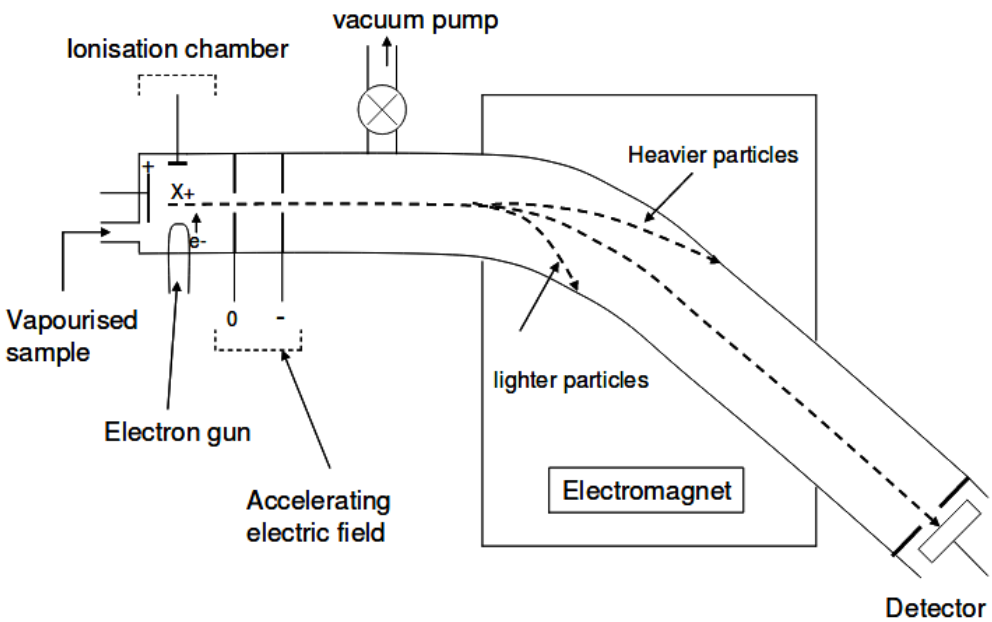
A mass spectrometer is used to measure the atomic mass of an element. This is a five step process.

1. The sample is vapourised
2. The vapour is bombarded by an electron beam, ionising it positively
3. The ions are accelerated by an electric field. The strength of this field is known
4. The ions are deflected by a magnetic field. The strength of this field is known
5. Ions are detected by a plate

Volatile samples are injected into the ionization chamber, while involatile samples are first vapourised with pre-heating. The mass spectrometer is held under vacuum. In the ionisation chamber when the electrons collide with the vapourised atoms the electron stream can knock electrons out of the outer shell.

$$\underbrace{e^-}_{\text{high-energy electron}} + \underbrace{X}_{\text{Sample atom}} \rightarrow \underbrace{X^+}_{\text{Positive ion}} + \underbrace{e^-}_{\text{electron knocked out of X}} + \underbrace{e^-}_{\text{retreating high-energy electron}}$$

The positive then pass through holes in two charged plates, accelerating the ion forwards. These ions pass through the magnetic field generated by the electromagnet and are deflected dependant on their mass. Constant electric and magnetic fields are applied so only ions of a particular mass are deflected to the ion detector. Lighter ions are deflected the most while heavier ions are deflected more. Therefore gradually increasing the magnetic or electric field allows ions of different masses to hit the detector.
Masses can be calculated from the known fields, but the instrument is normally calibrated with a known mass. The relative peak heights give the relative abundance of different ions present.



Molecules have more complex spectometry graphs than atoms as they can be made of different isotopes of the same atom. For example Cl_2 can be $^{35}Cl-^{35}Cl$, $^{35}Cl-^{37}Cl$, or $^{37}Cl-^{37}Cl$.

Patterns in the periodic table

The simplest classification in the periodic table is to split it into metals, metalloids, and non-metals.

Metals - Metals are typically lustrous solids which conduct electricity and have high melting points. They have a gigantic metallic structure and often act as reducing agents in reactions.

Non-Metals - Non-metals are typically solids, liquids or gasses, that have a discrete molecular structure and do not conduct electricity. They generally have low melting points.

Metalloids - These have characteristics between metals and non metals, being reasonably strong solids with a giant molecular structure. They are neither conductors nor insulators and have very high melting points. These materials are semiconductors.

Groups

There is still a lot of variation within these groups so more refined groups are needed in order to make predictions about how elements will react. The elements are broken up into columns, called groups, and these are defined by the number of electrons in an elements outer shell. The number of electrons in the outer shell controls the chemical properties and the bonding to other atoms, meaning that all elements within a group react similarly. For example, when reacting with water all group 1 metals form a metal hydroxide and hydrogen gas.
Elements also belong to a certain period, which is the row in the periodic table that they are in. As the period increases reactions tend to become much more violent. For example, in group 1 Lithium, a period 1 element, gently reacts with water, while caesium, also group 1 but period 6, explodes violently.

Another pattern shown by the periods is the trend from metal to non-metal, although there are also trends in the elements chemical properties. For example, in forming oxides.

Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_2	CLO	Formula of the oxide
0.5	1	1.5	2	2.5	2	1	Number of oxygens per atom in oxides

Lecture 3: Structure of the atom 10/10/17

Most of the material in this section was convered in Fundamentals of Materials lectures 1 and 2.
The ionisation energy is the amount of energy required to displace a valence electron from an atom or ion. Using a graph of the Number of ionisations (x-axis) against the log(ionisation energy) (y-axis) we can tell how many shells an atom has and also how many atoms are in each of these shells. We can use known high energy x-rays to find ionisation energy.

Physical/ Inorganic Titration 16/10/17

O xidisation

I s

L oss (of electrons)

R eduction

I s

G ain (of electrons)

The pattern of ionisation energy of each atom repeats each period, although tends lower as you go further down the periodic table.