

Ri Christmas Lectures 2012[®]: The Modern Alchemist

Teaching Resource - Atomic Structure and the Periodic Table

Overview:

This resource contains an overview of Atomic structure which covers Protons, Neutrons, and Electrons, the Nucleus, Electron Shells (and Orbitals), and the Periodic Table. This material is supported by video clips from the Royal Institution Christmas Lectures[®] 2012.

The Atom:

Atoms are the fundamental building blocks of everything we see around us. They can be grouped into 118 different Elements, which make up all compounds in the Universe.

From a Chemists point of view, atoms are made of three components: Protons, Neutrons, and Electrons.

Within the atom, the Protons and Neutrons can be found at the centre, within what is known as the Nucleus. Electrons are found around the outside of the Nucleus.

Protons, Neutrons, and Electrons:

Protons carry a relative positive charge, and have a relative mass of 1. The number of Protons in the nucleus determines which Element the atom is, and it is the number of Protons which gives an element its 'Atomic Number'.

Neutrons carry no charge, and have a relative mass of 1. Neutrons make up the rest of the mass of the Nucleus (along with Protons). The number of neutrons that the nucleus contains can vary within different atoms of the same element. This gives rise to Isotopes of an Element.

A note on Isotopes - Isotopes of an element are made of atoms which contain the same number of Protons and Electrons, but different numbers of Neutrons (and therefore, a different Relative Atomic Mass). For example, the Element Hydrogen has three Isotopes: Protium (the most common), Deuterium, and Tritium. Each has 1 Proton, and 1 Electron; however, Protium has no neutrons (overall Relative Atomic Mass: 1), Deuterium has 1 (overall Relative Atomic Mass: 2), and Tritium has 2 (overall Relative Atomic Mass: 3).

- A class activity in order to explain isotopes could take the form of allowing groups of students to construct isotopes using a paper nucleus and sweets to represent protons, neutrons, and electrons.

Electrons carry a relative negative charge, and have very little (almost no) mass. In a neutral atom, the number of electrons will equal the number of

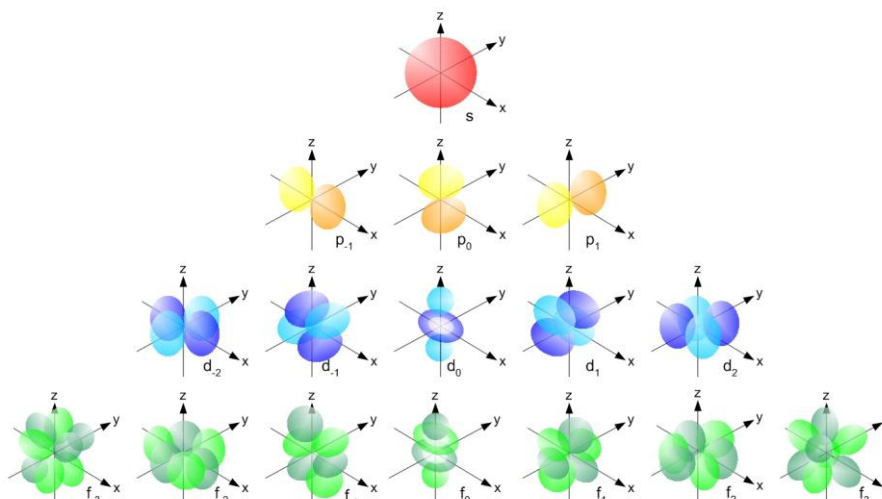
Protons in the Nucleus. An atom with a differing amount of Protons and Electrons will carry a net charge, and is known as an Ion. Positively charged

Ions are known as Cations, while negatively charged Ions are known as Anions.

Electron Energy Levels and Sub Levels:

One of the most important properties of an atom is the number of electrons that it has, and the configuration of those electrons.

- Electrons are located around the Nucleus of an atom in discrete energy levels sometimes known as 'Shells'. In the ground state, Electrons will always be found in the lowest possible energy level.
- Within each electronic energy level, there are sub levels known as Orbitals.
- There are four commonly considered types of Orbital, s, p, d, and f. Each has a unique shape. Each energy level (shell) contains one s Orbital, three p Orbitals, five d Orbitals, and nine f Orbitals. Each Orbital can hold a maximum of two electrons.
- The orbital series (s, p, d, and f shown)¹.



Video clip: Atomic Structure and The Elements Song - Introducing the Periodic Table

With the aid of the cast of Loserville, and the audience of the 2012 Christmas Lectures[®], Dr Peter Wothers explains atomic structure, and discovers the Elements present in the Periodic Table. This video covers the structure of the atom, and introduces the shape of the Periodic Table. This video can be used as a link between teaching of the Elements, and the start of the exploration of the Periodic Table.

[Atomic Structure and the Periodic Table](#)

(Running Time: 3 min 52 secs)

¹ Orbital Image from chemwiki.ucdavis.edu - Creative commons attribution - Non-commercial

The Periodic Table:

One of the most versatile tools available to the Chemist is the Periodic Table. The Periodic Table contains all 118 elements and a variety of information about each.

- A fully interactive Periodic Table is available here: [RSC Visual Elements Periodic Table](#)

The History of the Periodic Table:

- The first Periodic Table (in a form that we would still recognise today) was proposed by Dmitri Mendeleev in 1869. He proposed organising the elements into a table ordered according to their atomic mass. Although it is worthy of note that Mendeleev's table was based upon the previous work of Antoine-Laurent de Lavoisier, and Stanislao Cannizzaro (See the additional resources below).
- Mendeleev's table has been subsequently improved upon by various scientists including Henry Mosely, and Glenn Seaborg, leading to the Periodic Table we see today.
- A more detailed history of the development of the Periodic Table can be found [here](#)².
- The history and development of the Periodic Table could make an interesting homework, or research project.

Periods, Groups, and Blocks:

The periodic table can be divided in several ways:

- A period is one row of the periodic table across. I.e. Hydrogen and Helium can be found in the first period.
- A group consists of one column of the Periodic Table, and is the most common division. All of the elements in a group have the same number of outer electrons, and thus have similar reactivity. For example, Group 7 (17) elements have 7 outermost electrons, and tend to react strongly with one electron donors.
- Blocks are the result of splitting the Periodic table according to which Orbital type their outermost electrons are found in (See below). Thus, carbon is a p-block element, therefore, its outermost electron can be found in a p orbital.

View the full 2012 Ri Christmas Lectures[®] - The Modern Alchemist, along with behind the scenes footage, and related content, at the [Ri Channel](#)³.

² Visual Elements Periodic Table, www.rsc.org/periodic-table

³ The Ri Channel, www.richannel.org