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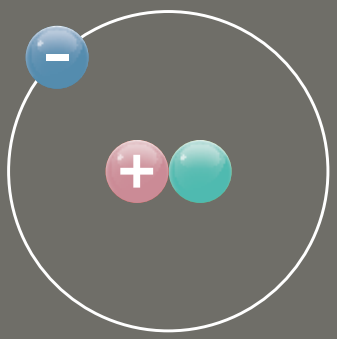
Basic Chemistry

This document is designed to give attendees the opportunity to gain/review knowledge of basic chemistry concepts prior to the course commencing. For those who have previously had limited experience with chemistry, exposure to the terminology and basic concepts explained below will help avoid difficulties.



electron
proton
neutron

Atoms

Atoms are the building blocks of everything. An atom consists of a central nucleus, containing protons [positively charged] and neutrons [no charge], which is usually surrounded by one or more electrons [negatively charged] orbiting the nucleus in layers or“shells”. See the simplified diagram on the left.

Elements

During the course you will often hear us refer to **elements**. **An element is a substance made up of a single type of atom.** To distinguish between elements, each element is assigned an atomic number (we rarely refer to these numbers during the course). The **atomic number** is the number of **protons** in the nucleus of an atom of that element. You will see on the supplied Periodic Table, the atomic number for hydrogen (H) is 1, while helium (the next element in the table) has an atomic number of 2. Magnesium has an atomic number of 12, which means it has 12 protons in its nucleus.

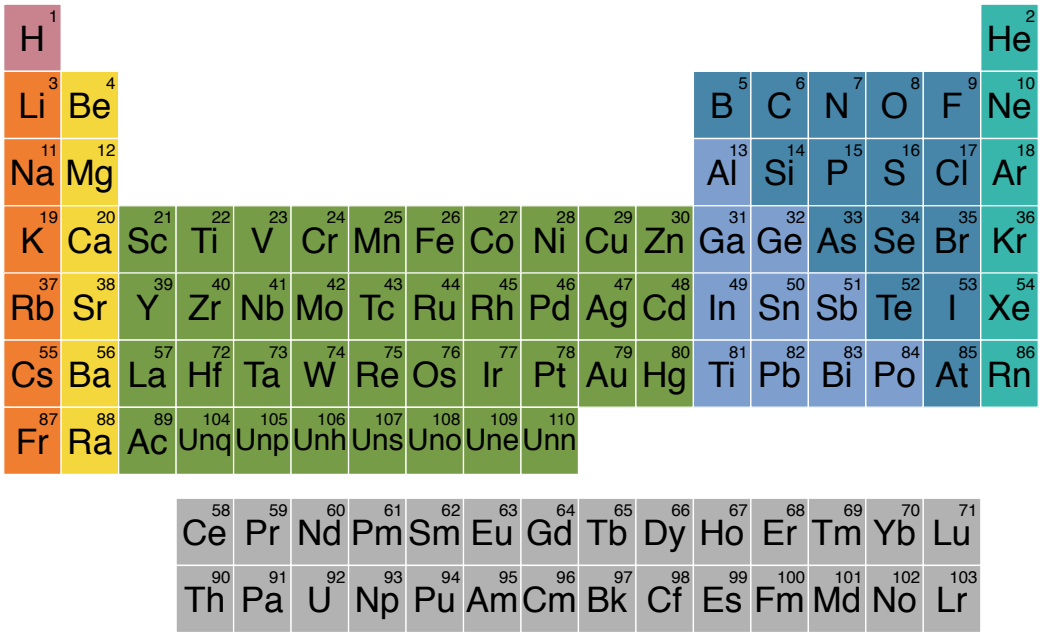
The **Periodic Table** arranges all the known elements in an informative array. Elements are arranged left to right and top to bottom in order of increasing atomic number.

Elements that lie in the same column on the periodic table (called a "group") behave in a similar fashion chemically. For instance, all the column 18 elements, on the far right of the table, are inert gases (e.g. helium (He), neon (Ne), argon (Ar) etc).

You can also see the **abbreviated symbols** for all of the elements on the Periodic Table. Often, the abbreviation makes perfect sense (e.g. C for carbon) and sometimes it does not (e.g. K for potassium, Na for sodium) as many are derived from the Latin name for the element. There is an abundance of elements on earth and in living systems; 98 elements are found in nature and several more exotic, manmade elements also exist.

Periodic Table of the Elements

- hydrogen
- alkali metals
- alkali earth metals
- transition metals
- poor metals
- nonmetals
- noble gases
- rare earth metals



Those elements that we will look at during the seminar include:

§ Calcium (Ca)
§ Magnesium (Mg)
§ Potassium (K)
§ Sodium (Na)
§ Phosphorus (P)
§ Nitrogen (N)
§ Sulphur (S)
§ Aluminium (Al)
§ Silicon (Si)
§ Chlorine (Cl)
§ Carbon (C)
§ Hydrogen (H)
§ Oxygen (O)
§ Zinc (Zn)
§ Copper (Cu)
§ Boron (B)
§ Iron (Fe)
§ Manganese (Mn)
§ Cobalt (Co)
§ Molybdenum (Mo)
§ Selenium (Se)

This list is solely so you become familiar with the names of the elements that we will be referring to. It is not important that you remember the abbreviations for these elements or do any study into their functions/chemical behaviour.

Ions

Atoms that have extra electrons or are missing electrons have a net negative or positive electrical charge and are called ions (pronounced *eye-ons)*. Ions can interact with other ions due to the electrical attraction between opposite charges.

Many of the elements listed above typically exist in nature as ions. Those that have a **net positive charge** are referred to as **cations**, while those with a **net negative charge** are anions. Many anions are composed of two or more different elements. The table below categorises these, showing the most common form(s) of the ion. The net charge is denoted as a superscript after the element abbreviation.

Cations

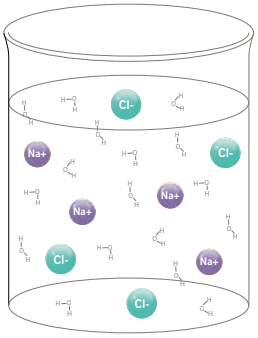
Calcium (Ca^{2+})
Magnesium (Mg^{2+})
Potassium (K^{+})
Sodium (Na^{+})
Aluminium (Al^{3+})
Zinc (Zn^{2+})
Copper (Cu^{2+})
Iron (Fe^{2+} or Fe^{3+})
Manganese (Mn^{2+})
Cobalt (Co^{2+})

Anions

Phosphate PO_4^{3-} (contains P)
Sulphate SO_4^{2-} (contains S)
Chloride Cl^{-}
Molybdate MoO_4^{2-} (contains Mo)
Carbonate CO_3^{2-} (contains C)
Borate BO_3^{3-} (contains B)
Nitrate NO_3^{-} (contains N)

Salts

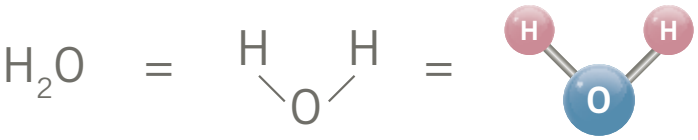
Salts are composed of cations and anions, e.g. sodium (Na^{+}) + chloride (Cl^{-}) = table salt; magnesium (Mg^{2+}) + sulphate (SO_4^{2-}) = epsom salts. Soluble fertilisers are often composed of salts. When soluble salts dissolve, they separate into **ions** – e.g. calcium nitrate dissociates into calcium (Ca^{2+}) ions and nitrate (NO_3^{-}) ions.



Molecules

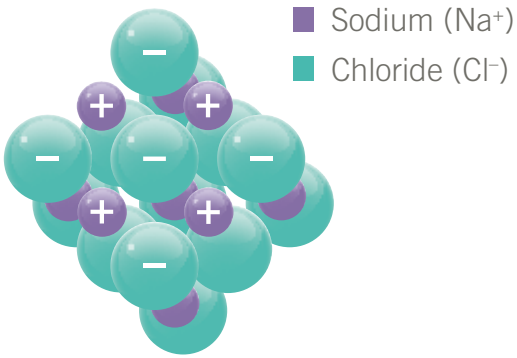
Molecules are made up of two or more atoms that are held together by chemical bonds. Some molecules contain hundreds or even thousands of atoms that join together in chains that can attain considerable lengths. **A group of like molecules forms a compound.**

E.g. The Water Molecule. The formula for a molecule of water is **H_2O**. "H" means hydrogen, "2" means 2 hydrogen atoms, and the "O"means oxygen.



The hydrogen atoms form what is termed a 'covalent bond' with the oxygen atom. For our purpose, it is not important to be able to distinguish between different chemical bonds, although a brief overview of a different type of bond, an ionic bond, is given below.

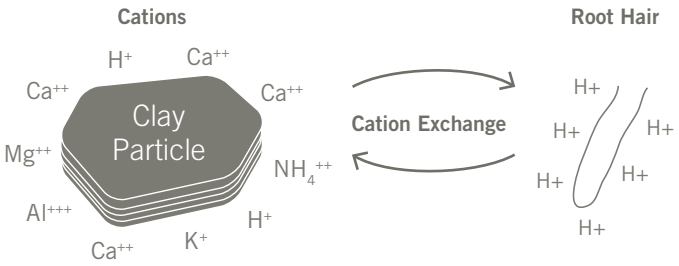
Ionic bonds are produced when atoms can obtain a stable number of electrons by giving up or gaining electrons. For example Na (sodium) can donate an electron to Cl (chlorine) generating Na^{+} and Cl^{-}. The ion pair is held together by strong electrostatic attraction.



Ionic bonding in sodium chloride (NaCl)

CEC

Short for Cation Exchange Capacity, which is the capacity of a soil to exchange cations (e.g. calcium, potassium, magnesium) from the solution phase of the soil for cations (e.g. aluminium, iron, sodium) already present on the surface of soil particles. It is a measure of how strongly the soil can retain nutrients so that they are not leached into groundwater.

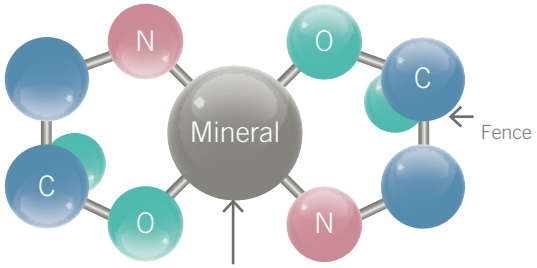


Colloids – Clay colloids are negatively charged mineral components of the soil that can hold and exchange cations and therefore contribute to the soil CEC.

Humus Colloids – Humus is an organic colloid in the soil that possesses both positive and negative charges and can therefore hold and exchange both cations and anions.

Chelation

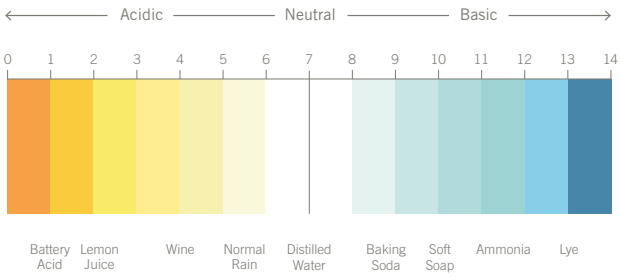
Chelation originates from a Greek word meaning **'claw'**. A **chelator** is a chemical or organic agent, which can surround or enclose a cation to form a chelation complex. The chelated cation is then no longer able to react with anions to form insoluble salts. This maintains the cation in a plant available form. **Humic acid, fulvic acid and amino acids** are examples of natural chelators.



The protected Mineral in a Chelate

pH

Soil pH measures the amount of **hydrogen ions** (H^+) in your soil and expresses that concentration as a number on a scale between 1 (being extremely acidic) to 14 (being extremely alkaline) with 7 being neutral (i.e. no free hydrogen). Soil pH is the result of the interaction between the base (alkaline) and acidic cations in the soil. pH can fluctuate through daily, seasonal or annual cycles however to maintain a stable pH trend in the soil, the base cations (calcium, magnesium, potassium and sodium) must be in a prescribed balance referred to as Base Saturation.



These concepts may seem complex but will become clearer during the seminar, even for those of you with no chemistry background. See you at the seminar!

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