Atoms and Molecules

The Periodic Table

- Arranged in 7 periods (horizontal rows) and 18 groups or families (vertical rows)
- A dark “staircase” line separates the metals (left side) from the non-metals (right side)
- The elements that border this line have properties of both metals and non-metals and are called metalloids.

The Periodic Table

- Atomic number is the number of protons
- Atomic mass is the number of protons plus neutrons
- The period number is the number of electron shells

Groups

- Alkali metals (1)
- Alkaline earth metals (2)
- Chalcogens (16)
- Halogens (17)
- Noble gases (18)

Parts of the Atom

- Atoms have a nucleus (containing protons and neutrons) surrounded by electron clouds
- The atoms of elements in Period 1 have one electron “shell.” This “shell” contains a maximum of 2 electrons.
- Period 2 atoms add a second “shell” which can hold a maximum of 8 electrons.
- Period 3 atoms add a third “shell” which can hold a maximum of 18 electrons.

Valence Shell

- The outermost “shell” of an atom is known as the **valence shell**
- The electrons in the valence “shell” are called **valence electrons**.

Number of Valence Electrons

Group	Number of Valance Electrons
1	1
2	2
13	3
14	4
15	5
16	6
17	7
18	8

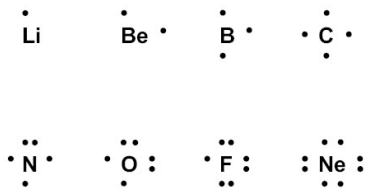
Lewis Dot Diagrams (Electron Dot Diagrams)

- A Lewis dot diagram is a convenient shorthand way to represent an atom and its valence electrons.
- Diagrams in which dots are placed around the chemical symbol of an element to illustrate the valence electrons.

Drawing Lewis Dot Diagrams

- Each dot represents one valence electron.
- In the dot diagram, the chemical symbol represents the core of the atom (nucleus plus the all the inner electrons).
- Atoms in the same family will have similar Lewis dot diagrams, except for helium (He) which has only two valence electrons.

- The Lewis dot diagrams for the elements in the second period are as follows:



Ions

- An atom that loses or gains electrons is called an ion.
- If the atom loses electrons, it becomes positively charged.
- If the atom gains electrons, it becomes negatively charged.
- Atoms gain or lose electrons so that they become like the nearest noble gas.

Positive Ions

- Called Cations
- Lose electrons
- Metals usually form cations
- Charge is equal to the number of electrons lost
  - Li^{+} has lost one electron
  - Mg^{2+} has lost two electrons

Negative Ions

- Called Anions
- Gain electrons
- Usually non-metals are anions
- Charge is equal to the number of electrons gained
  - Cl^- has gained one electron
  - O^{2-} has gained two electrons

Lewis Dot Diagrams for Ions

- Draw the Lewis dot diagram for the atom adding or subtracting valence electrons as needed
- Indicate the charge

Noble Gases

- Noble gases (group 18) have 8 electrons in the valence "shell" (it is full)
  - Helium (He) is an exception (the first shell can only hold 2 electrons)
- Noble gases usually do not form ions

Forming Compounds

- When two atoms collide, valence electrons on each atom interact.
- A chemical bond forms between the atoms if their valence electrons make a new arrangement that has less energy than their previous arrangement.
- Usually that means that the atoms want to be like their nearest noble gas.

Forming Compounds

- An atom may acquire a valence “shell” like a noble gas by:
  - Losing electrons (becoming cations)
  - Gaining electrons (becoming anions)
  - Sharing electrons

Bond Types

- There are two types of bonds that are formed between atoms:
  - Ionic
  - Covalent

Ionic Bond

- An ionic bond is formed between cations and anions.
- The cation (+) is attracted to the anion (-).
- Substances with ionic bonds are known as ionic compounds.

Covalent Bonds

- When two atoms **share** electrons, it is known as a covalent bond.
- Substances with covalent bonds are known as molecular compounds.
- A covalent bond consists of two shared electrons.

More about Covalent Bonds

- When two electrons are shared it is called a single bond.
- When four electrons are shared it is called a double bond.
- When six electrons are shared it is called a triple bond.

Diatomic Molecules

- Non-metals can bond ionically with metals.
- Non-metals can also bond with each other by forming covalent bonds.
- Some atoms can share electrons with another atom of the same element
  - Diatomic molecule