

Atoms and Molecules

The Periodic Table

- Arranged in 7 periods (horizontal rows) and 18 groups or families (vertical columns)
- 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

1	2	3	4	5	6	7	8
1 H							2 He
3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra						

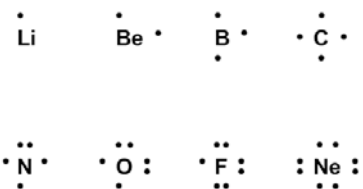
Lewis Dot Diagrams (Electron Dot Diagrams)

- 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 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
 - Mg²⁺ 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
 - O²⁻ has gained two electrons

Ions

	+1	+2		+3		-3	-2	-1	
1	H								2
3	Li	Be							He
11	Na	Mg							Ne
19	K	Ca							Ar
37	Rb	Sr							Kr
55	Cs	Ba							Xe
87	Fr	Ra							Rn

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

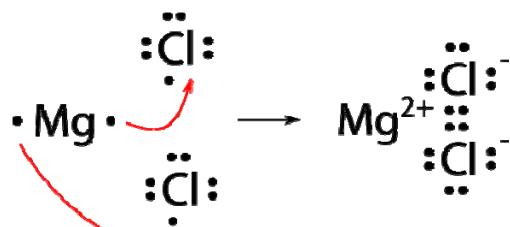
- An atom may acquire a valence “shell” like a noble gas by:
 - Losing electrons (becoming cations)
 - Gaining electrons (becoming anions)
 - Sharing electrons

Bond Types

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

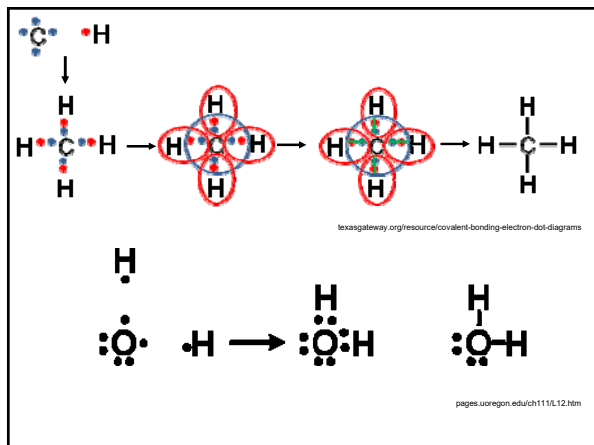
Ionic Bond

- A metal atom loses electrons and becomes a cation
- A non-metal atom takes the electrons and becomes an anion
- The cation (+) is attracted to the anion (-)
- Substances with ionic bonds are known as ionic compounds.



Covalent Bonds

- Two non-metal atoms share some of their valence electrons with each other
- Each pair of shared electrons is referred to as a covalent bond
- Substances with covalent bonds are known as molecular compounds



Diatomic Molecules

- A diatomic molecule is a molecule containing two of the same non-metal atoms
- Most elements exist naturally as single atoms
- Seven elements only exist naturally as diatomic molecules
 - N₂, O₂, F₂, Cl₂, Br₂, I₂, H₂

