Chem 145

Chapter 1

Introduction to organic chemistry

Leaning objectives:

By the end of this lecture the student will know:

- **What is Organic Chemistry?**
- **How are organic compounds are made from indiviual elements?**
- **Types of bond in organic compounds and their significant**
- **Different methods of representing chemical bonding**

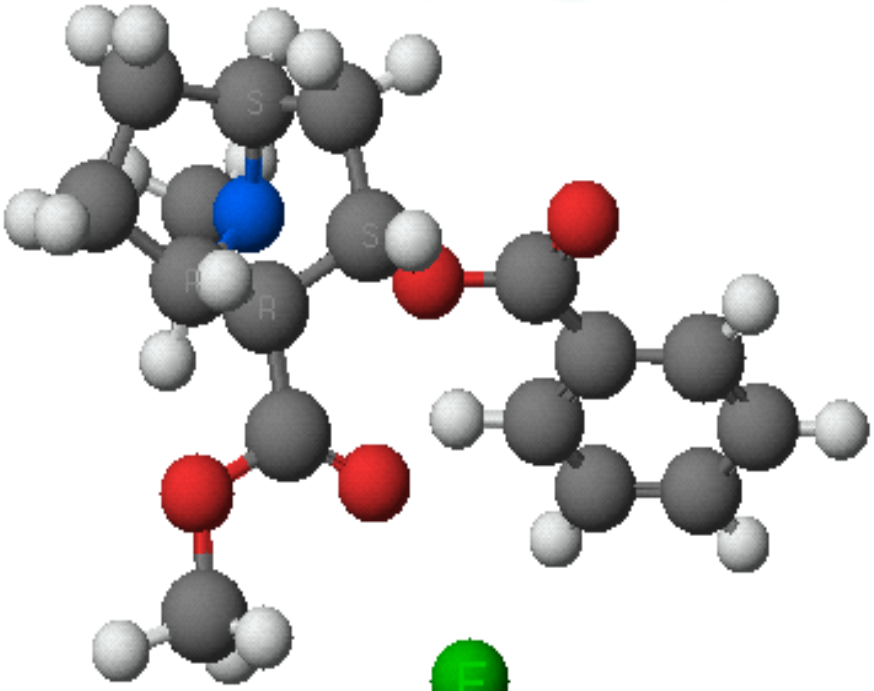
What is organic chemistry?

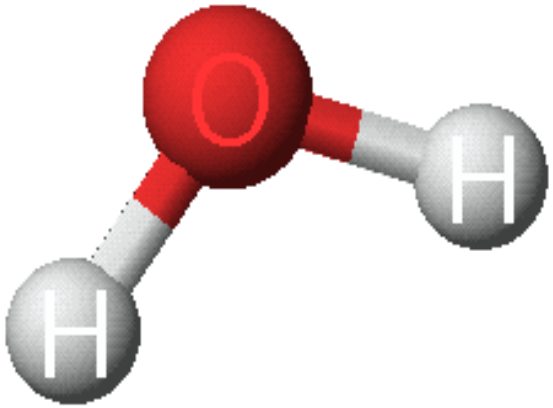
- The word *Organic* can be a biological or chemical term.
- In Biology it means any thing that is living or has lived. The opposite is Non-Organic.
- In Chemistry, an Organic compound is one containing Carbon atoms. The opposite term is Inorganic.
- Organic compounds can may contain in addition to C & H other elements such as O, S, N, Cl,--
- Thus organic chemistry is the science explaining how are organic molecules are made, their physical and chemical properties

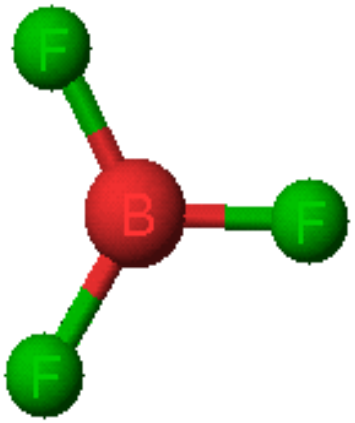
Examples of organic compounds

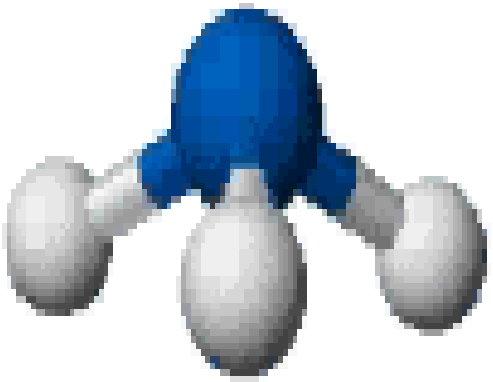
1) DNA: the giant molecules that contain all the genetic information for a given species.
2) Proteins: blood, muscle, and skin.
3) Enzymes: catalyze the reactions that occur in our bodies.
4) Petroleum: furnish the energy that sustains life.
5) Polymers: Cloths, cars, plastic, kitchen appliances
6) Medicine

CHEMICAL BONDING







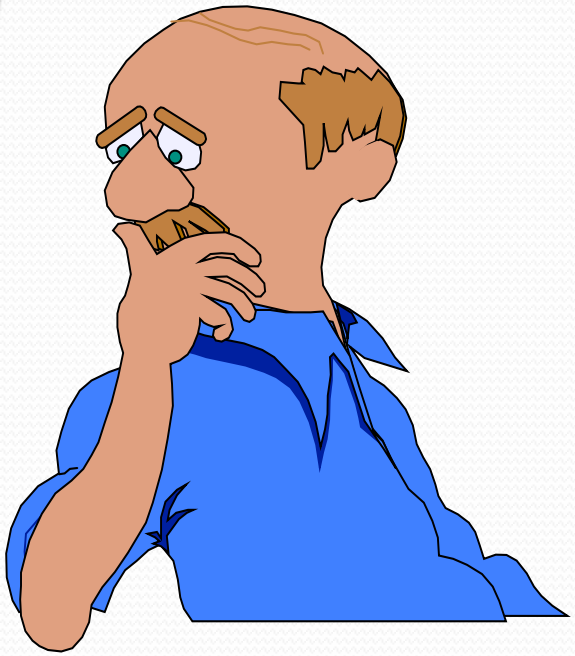


Chemical Bonding

Problems and questions –

How is a molecule or polyatomic ion held together?

Why are chemical bonds important?

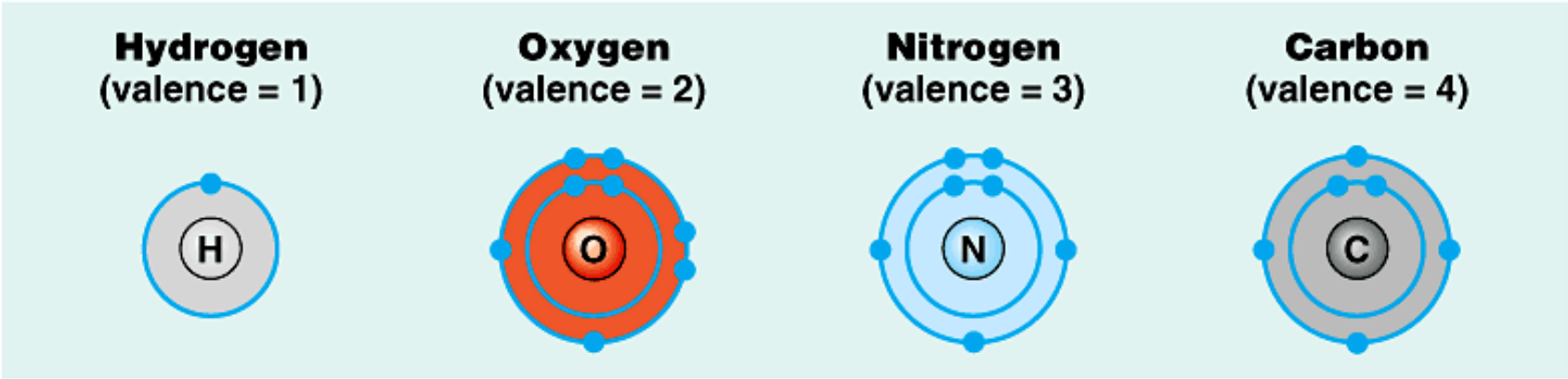


Important concepts in chemical bonding

- The attractive force which holds together the constituent particles (atoms, ions or molecules) in chemical species is known as chemical bond.
- Each bond is made up of two electrons.
- Tendency of atoms of various elements to attain stable configuration of eight electrons in their valence shell is the cause of chemical combination.
- The principle of attaining a maximum of eight electrons in the valence shell or outermost shell of atoms is known as octet rule.
- The tendency of an atom to take part in chemical combination is determined by the number of valence electrons (electrons in the outermost shell of an atom).
- The atoms acquire the stable noble gas configuration of having eight electrons in the outermost shell (called octect rule) by mutual sharing (covalent bond which is usually between two non metals) or by transfer of one or more electrons (ionic bonds which is usually between a metal and a nonmetal). N.B.: there are other minor types of chemical bonding that will not be discussed here.
- The valency of an element is (number of electrons an atom loses, gains or mutually shares to attain noble gas configuration).

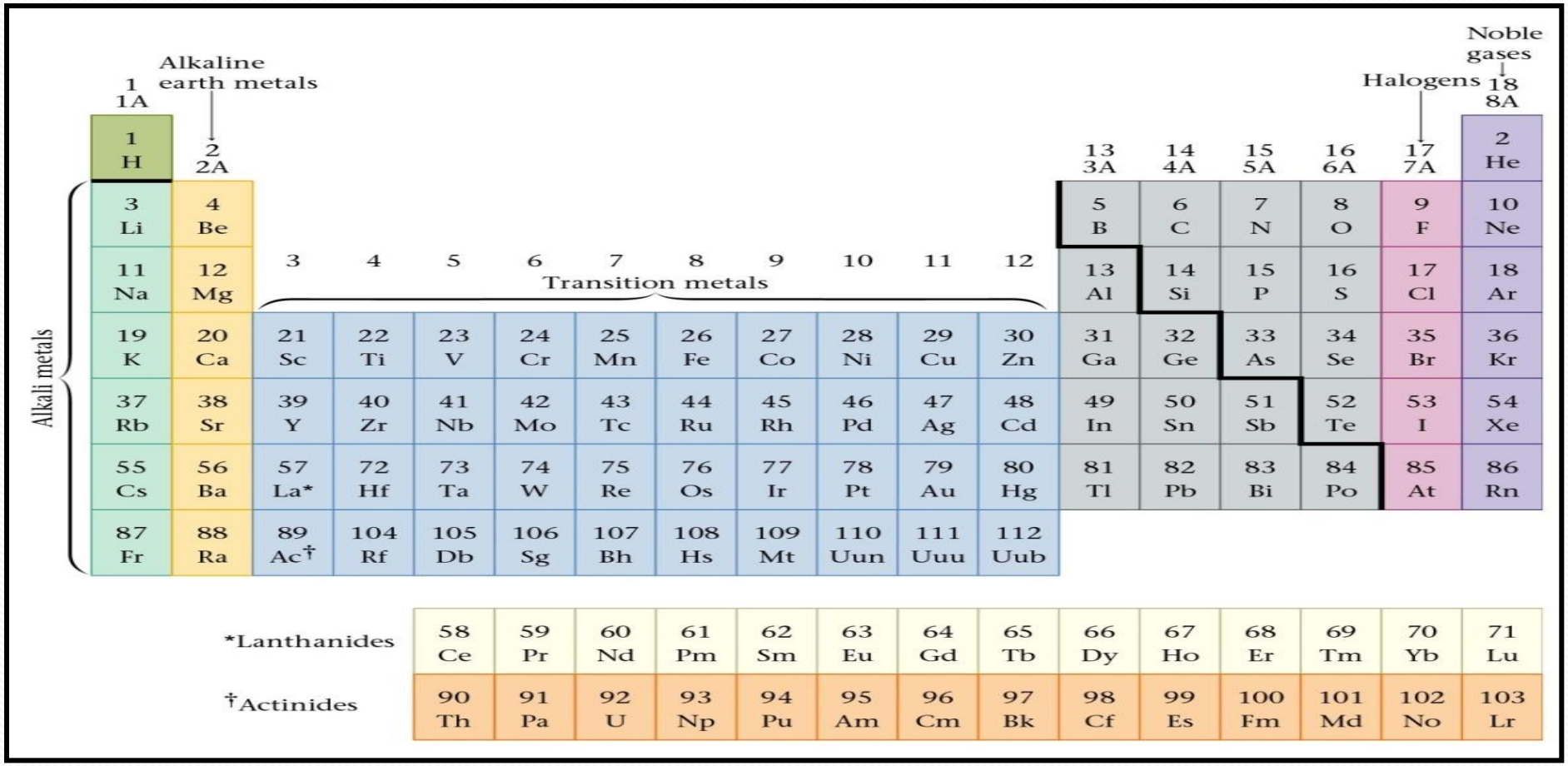
The structural theory

- 1. The atoms can form a fixed number of bonds (valence)



Review of Valence Electrons

Number of valence electrons of a main (A) group atom = Group number



Two Main Types of Chemical Bonding

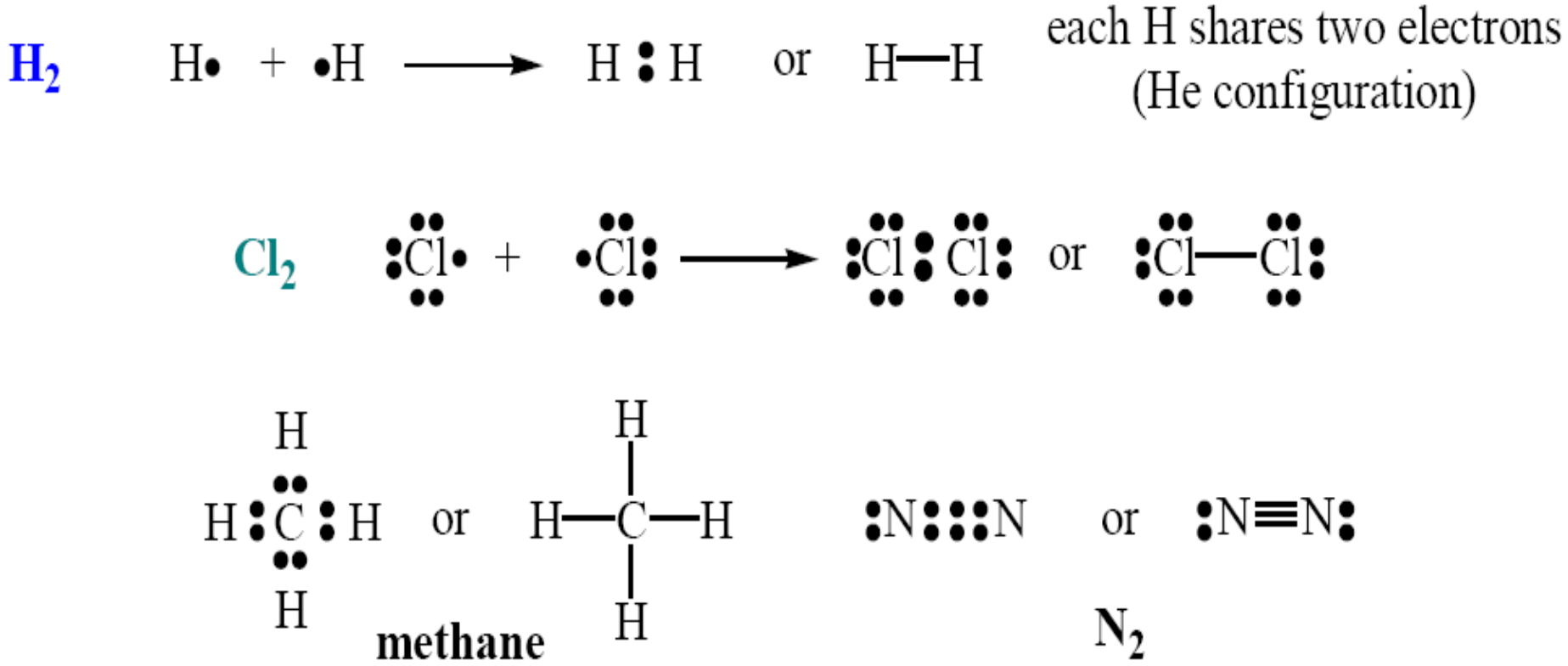
Covalent Bonds;

single or multiple

polar or non polar

Ionic Bonds

Covalent Bond



Characteristics of Covalent Compounds

Covalent compounds results when two atoms share valence electrons between them.

1. The covalent compounds do not exist as ions but they exist as neutral molecules:

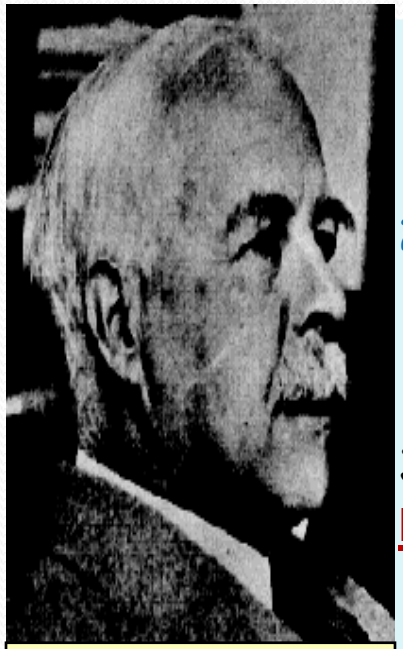
   This is due to there is no transfer of electrons from one atom to another and therefore no charges are created on the atom.

2. Covalent bonds are rigid and directional therefore different shapes of covalent molecules are seen e.g. HCl is linear.

3. Most of the covalent molecules are non polar and are soluble in nonpolar solvents like benzene, ether etc and insoluble in polar solvents like water. Carbon tetrachloride (CCl_4) is a covalent nonpolar molecule and is soluble in benzene.

4. Some of them are polar due to sometimes in a covalent bond the electrons are not shared equally between the two atoms thus, one of the atoms partially "pulls" the bonding electrons toward itself, creating an unequal sharing of those bonding electrons. This is called a POLAR COVALENT BOND.

Chemical bonding in Molecules by Lewis (electron dot) structures



G. N. Lewis
1875 - 1946

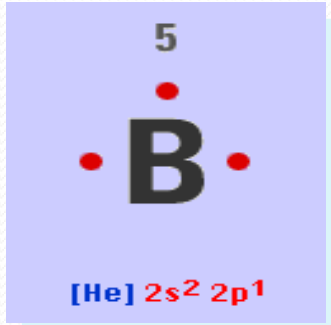
Rules:

1. The symbol of the element is written first. This represents the nucleus of the element with all the inner electrons that do not take part in the bond formation.
2. The valence electrons (electrons in the OUTERMOST energy level) are then written as dots or small cross marks around the symbol. They are spread in a pair on four sides of the symbol.
3. In case of ions the charge is shown with the symbol

Examples:

B^5 its electronic configuration is $1s^2\ 2s^2\ 2p^1$;
so the outer energy level is 2,
with 3 valence electrons These can be represented by Lewis structure.

Q1:Draw Lewis structure for Cl

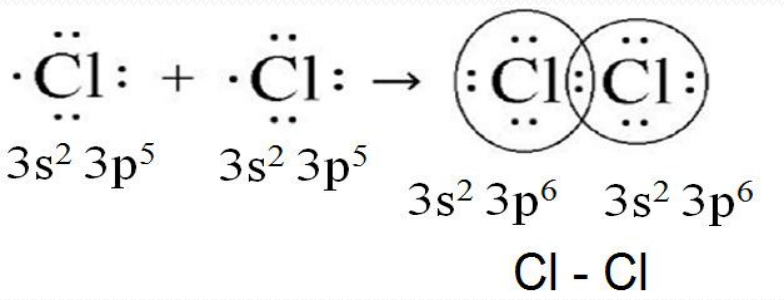


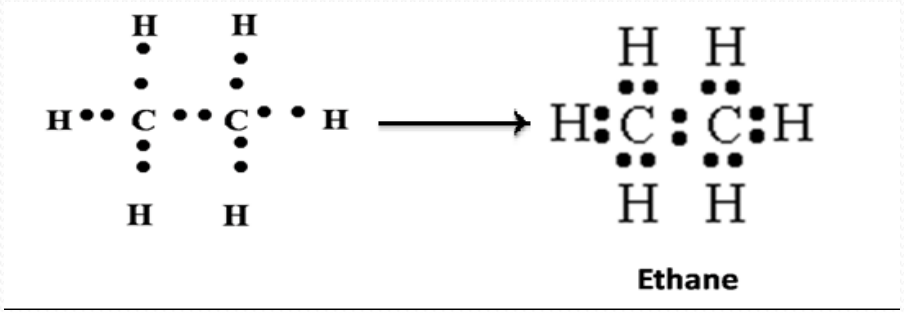
Covalent bonds can be visualized with the aid of Lewis dot structures

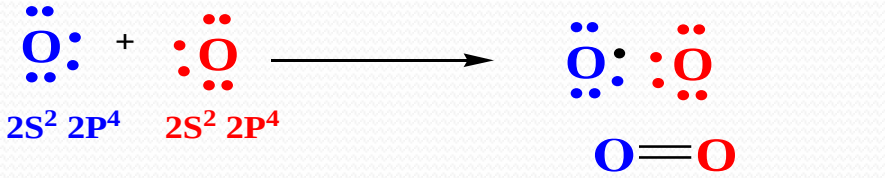
If two atoms share one electron pair, bond is known as single covalent bond and is represented by one dash (–).

If two atoms share two electron pairs, bond is known as double covalent bond and is represented by two dashes (=).

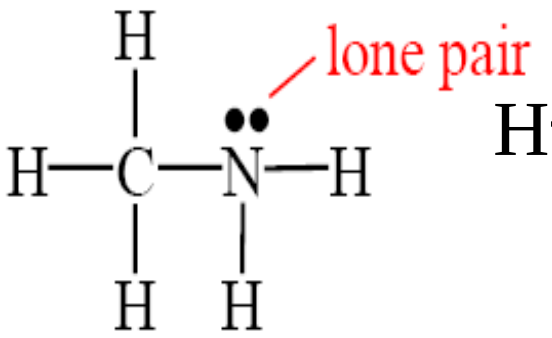
If two atoms share three electron pairs, bond is known as triple covalent bond and is represented by three dashes (≡).



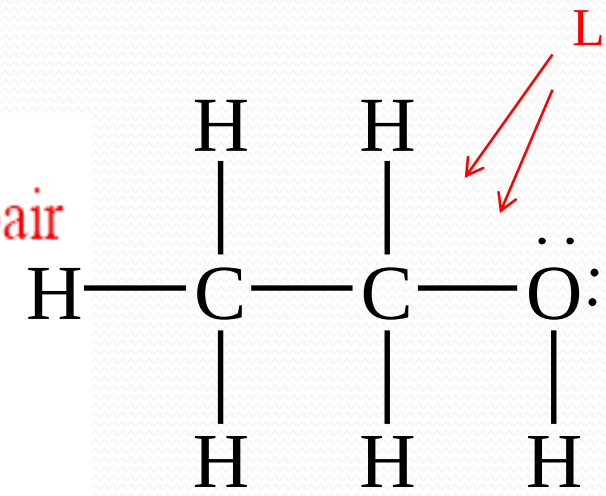




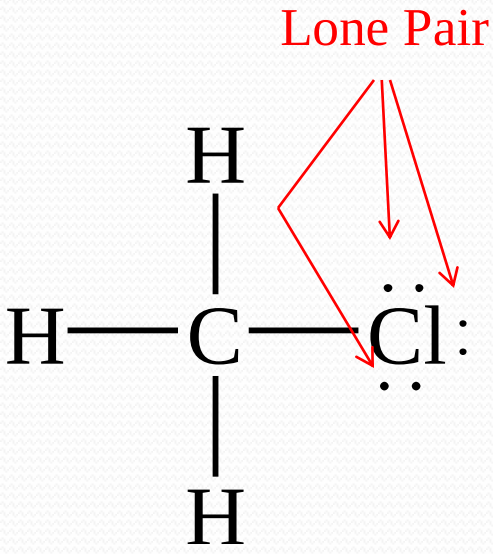
Lone Pairs



Methyl amine



Ethanol

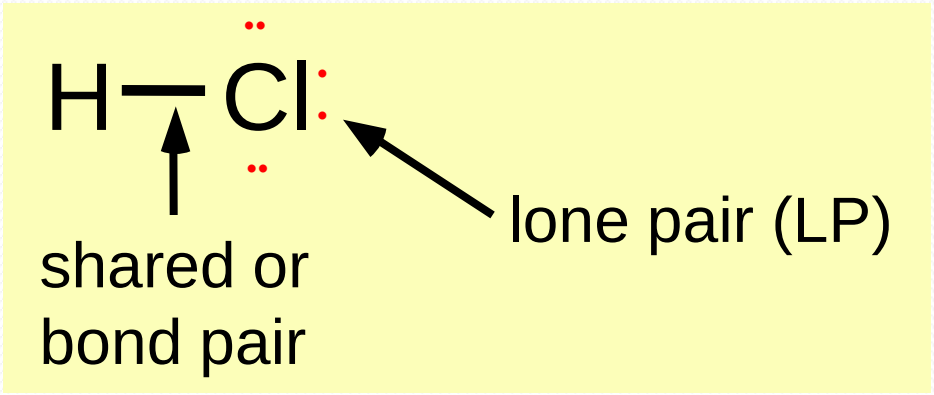


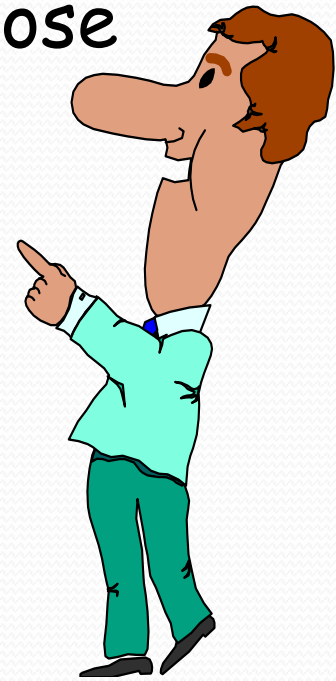
Chloro methane

: nonbonding electrons ⇒ affect the reactivity of the compound

Types of valence electrons

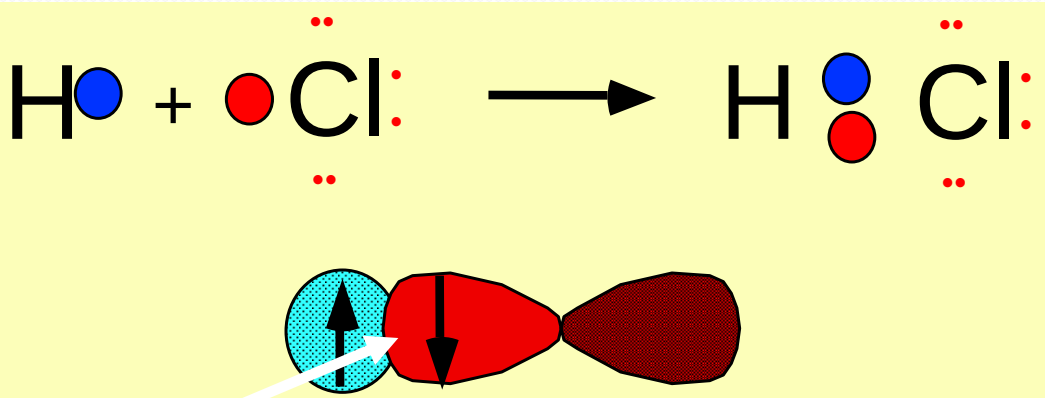
- Valence electrons of an atom which are shared with others are called **BOND PAIRS** and those are unshared are called **LONE PAIRS.**





Bond Formation

A bond can result from an **overlap** of atomic orbitals on neighboring atoms.



Overlap of H (1s) and Cl (2p)

Note that each atom has a single, unpaired electron.

Electronegativity Difference:types of bonds and polarity

- If the difference in electronegativities (usually called ΔEN) between the atoms in a molecule as follows:

ΔEN greater than **2 & up 4.0**: the bonding in this molecule is Ionic

ΔEN between 1.6 and 2.0 and if a metal is involved, then the bond is considered ionic. If only nonmetals are involved, the bond is considered polar covalent.

ΔEN between 0.5 and 1.6 the bonding in this molecule is Covalent and **Polar**

ΔEN between 0.0 to 0.5: the bonding in this molecule is Covalent and it is **Non-Polar**

The type of bond can usually be calculated by finding the difference in electronegativity of the two atoms that are going together.

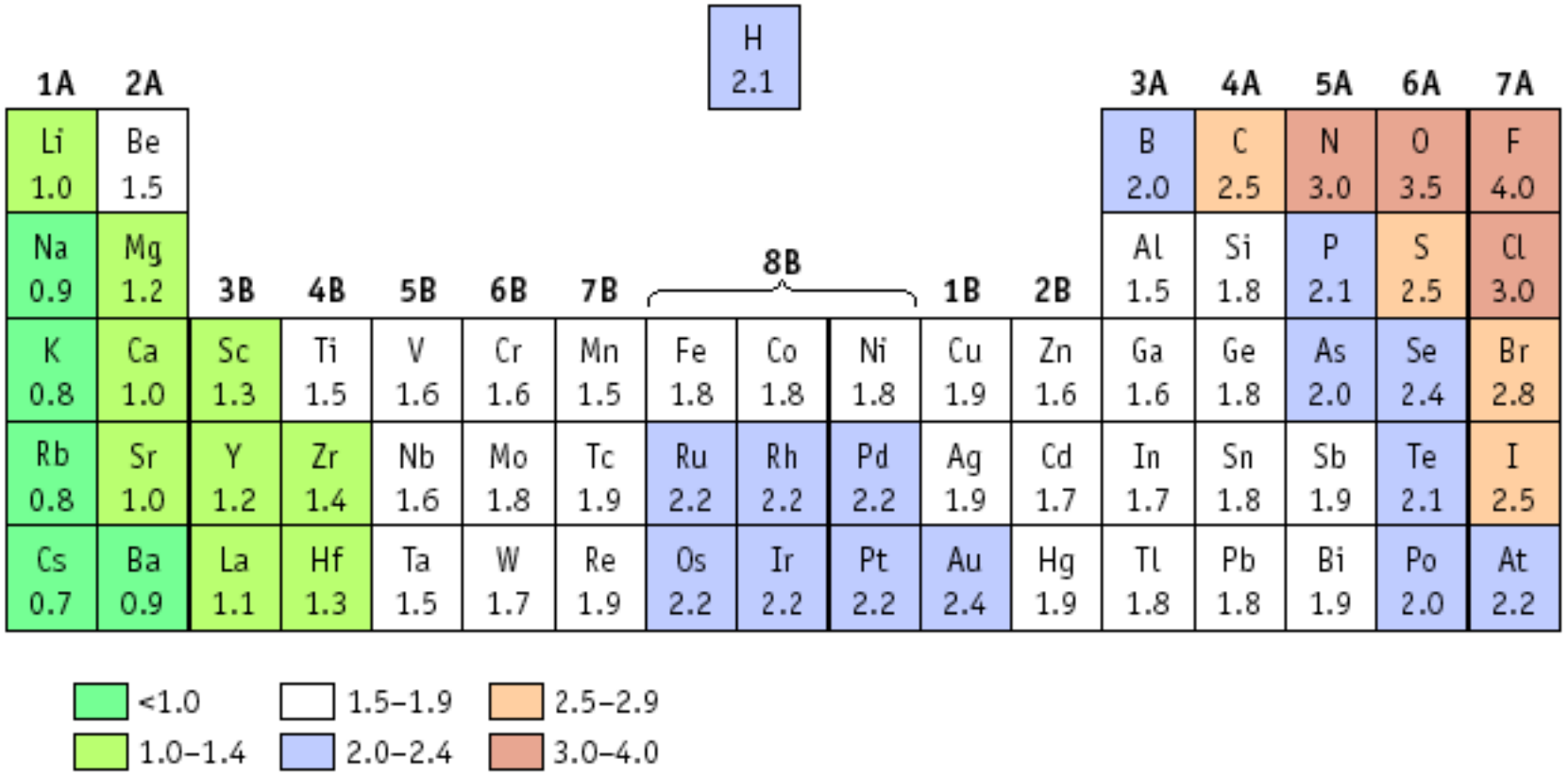
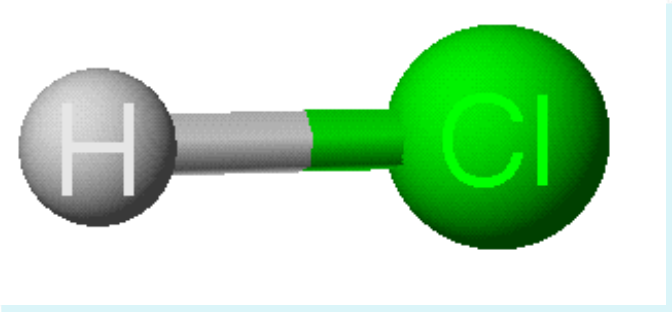


Figure 9.9 Electronegativity values for the elements according to Pauling. Trends for electronegativities are the opposite of the trends defining metallic character. Nonmetals have high values of electronegativity, the metalloids have intermediate values, and the metals have low values.

Example 1: NaCl

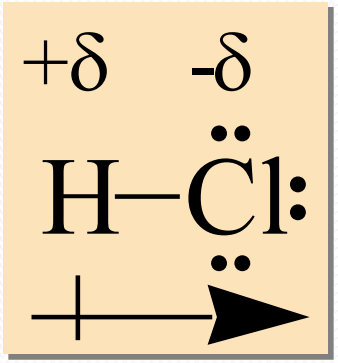
EN_{Na} = 0.8, EN_{Cl} = 3.0, Difference ΔEN is 2.2, so this is an ionic bond

Example 2: HCl



The difference in electronegativity between H & Cl atoms = 0.9

thus HCl is **Covalent & POLAR** because it has a positive end and a negative end due to difference in electronegativity where;



Cl has a greater share in bonding electrons than does H.

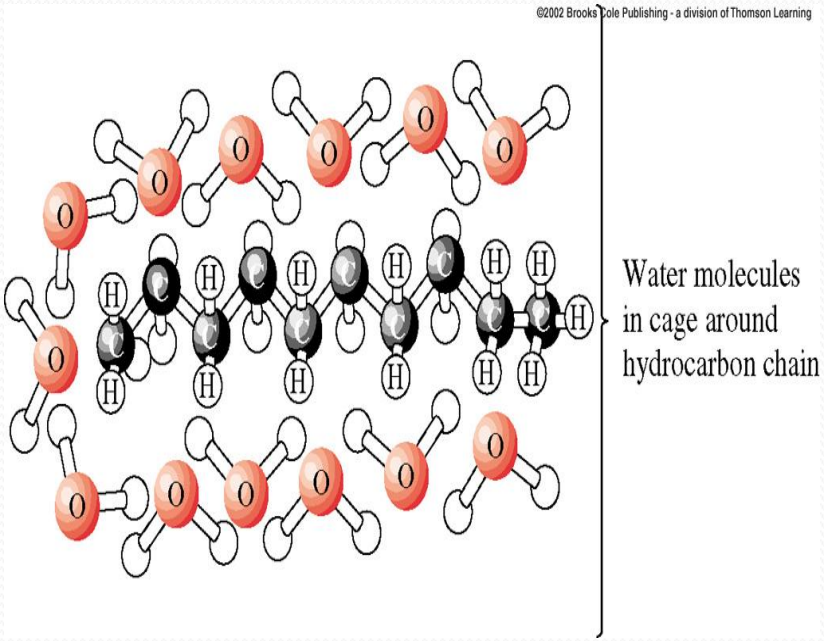
Cl has slight negative charge (-δ) and H has slight positive charge (+ δ)

Example 3

Molecules such as Cl_2, H_2, F_2 are covalent non polar since the difference in electogegativity is zero

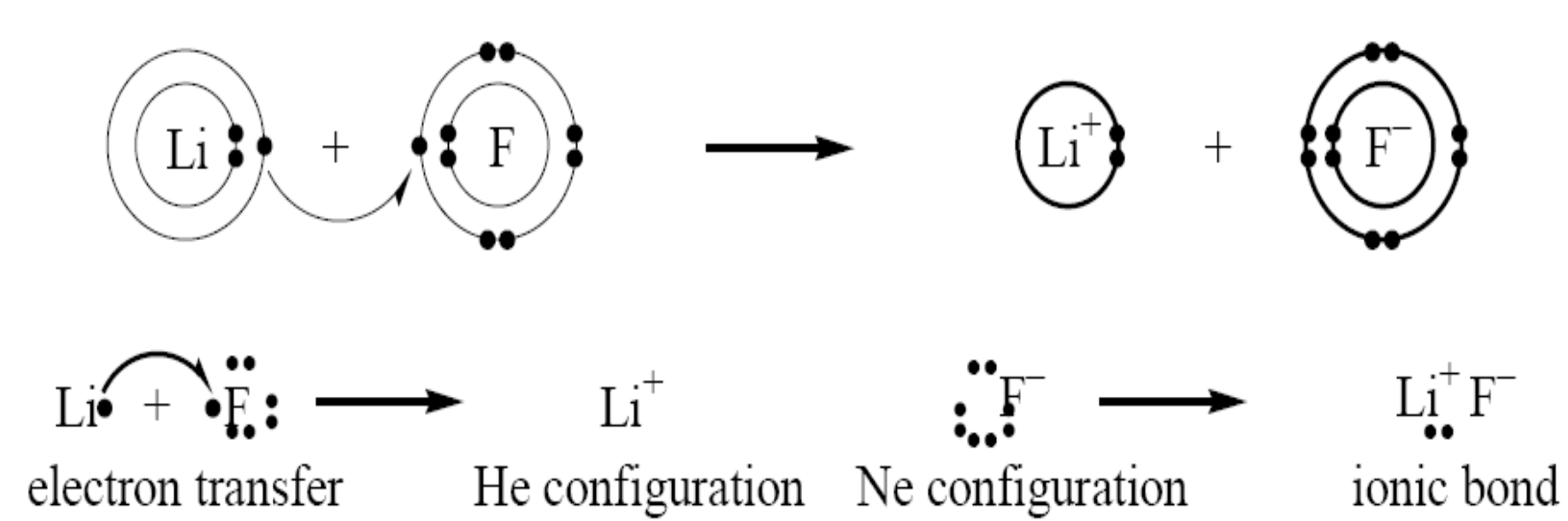
Bond Polarity and Chemical Bonding

- This is why oil and water will not mix ! Oil is nonpolar, and water is polar.
- The two will repel each other, and so you can not dissolve one in the other



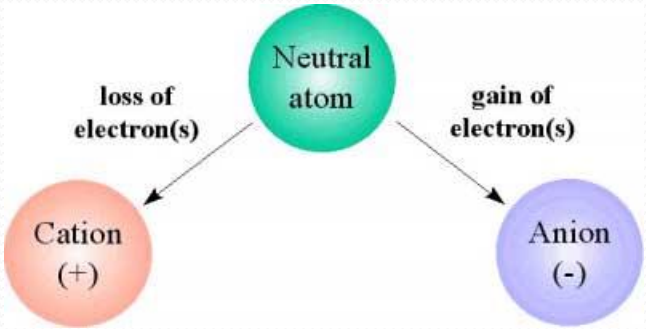
- "Like Dissolves Like"
- Polar dissolves Polar
- Nonpolar dissolves Nonpolar

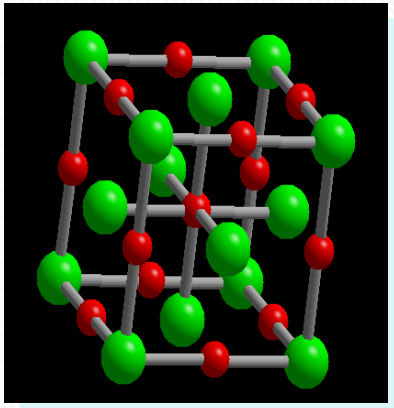
Ionic Bonds


Li + F
Li+ + F−
Li + F
Li+
F−
Li+ F−
electron transfer
He configuration
Ne configuration
ionic bond

General Properties of Ionic Compounds

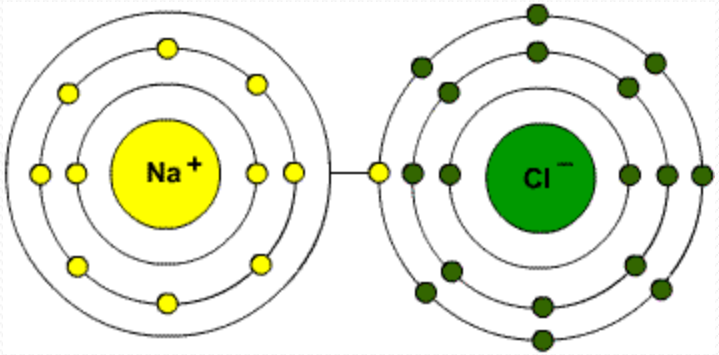
- **Ionic compounds** are formed when **one atom gains a valence electron from a different atom,** forming a **negative ion (anion)** and a **positive ion (cation)** respectively. These oppositely charged ions are attracted to each other, **forming an ionic bond**. Therefore **ionic bonds** are **usually between metals and nonmetals** ; opposite ends of the periodic table.
- They do not exist as separate molecules . Rather, they form ionic solids, three dimension networks in which each cation is surrounded by anions and each anion is surrounded by cations.
- **They have high melting and boiling points** and this ionic compounds are **generally soluble in water and other polar solvents**
- **Ionic compounds are good conductors of electricity** in the solutions or in their molten states.





Sodium chloride

Sodium Chloride (NaCl) is a bonding of the Na^+ ion and the Cl^- ion.



Sodium lets Chlorine use its valance electron

Thank You for your kind attention !

Questions?

Comments