Chemical Bonds

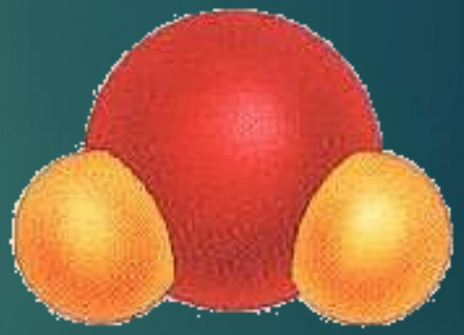
I. WHY ATOMS COMBINE

- Chemical Formulas
- Chemical Bonds
- Stability

A. Chemical Formula

- **Shows:**
  1) elements in the compound
  2) ratio of their atoms

H_2O



1 oxygen atom

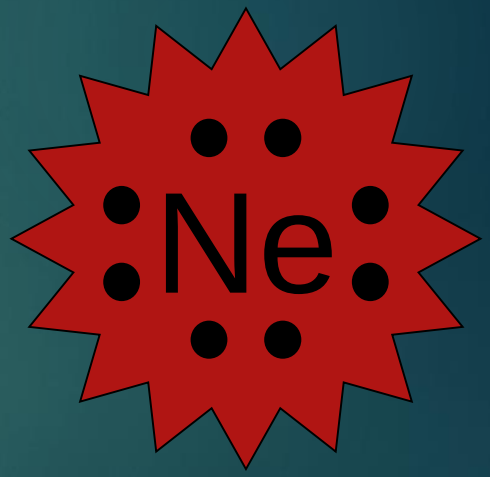
2 hydrogen atoms

B. Chemical Bond

- Strong attractive force between atoms or ions in a molecule or compound.
- **Formed by:**
  - transferring e^- (losing or gaining)
  - sharing e^-

C. Stability

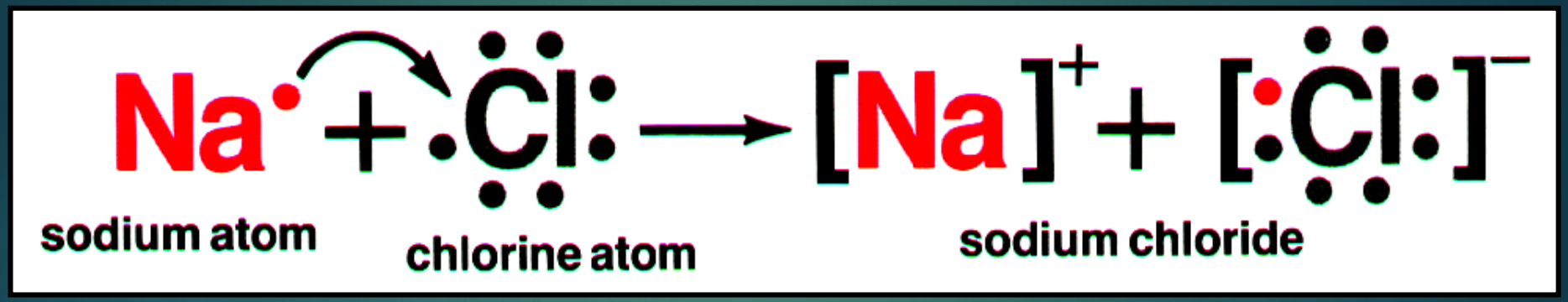
- **Octet Rule**
  - most atoms form bonds in order to have 8 valence e^-
  - want a full outer energy level
  - like the Noble Gases



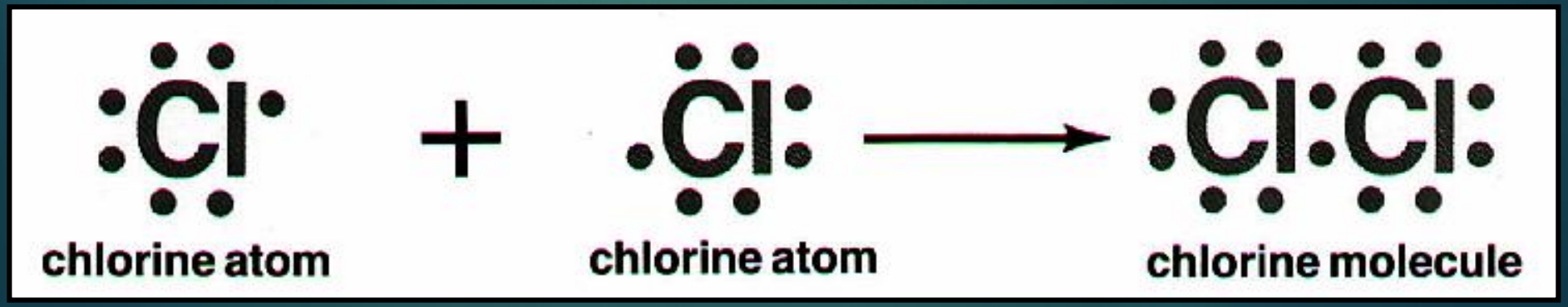
- Stability is the driving force behind bond formation!

C. Stability

- Transferring e^-



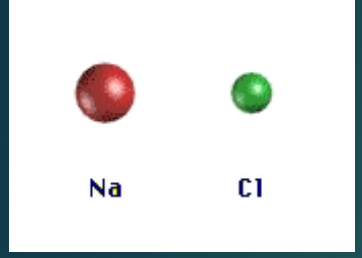
- Sharing e^-



Chemical Bonds

II. KINDS OF CHEMICAL BONDS

- Ionic Bond
- Covalent Bond
- Comparison Chart



A. Ionic Bond

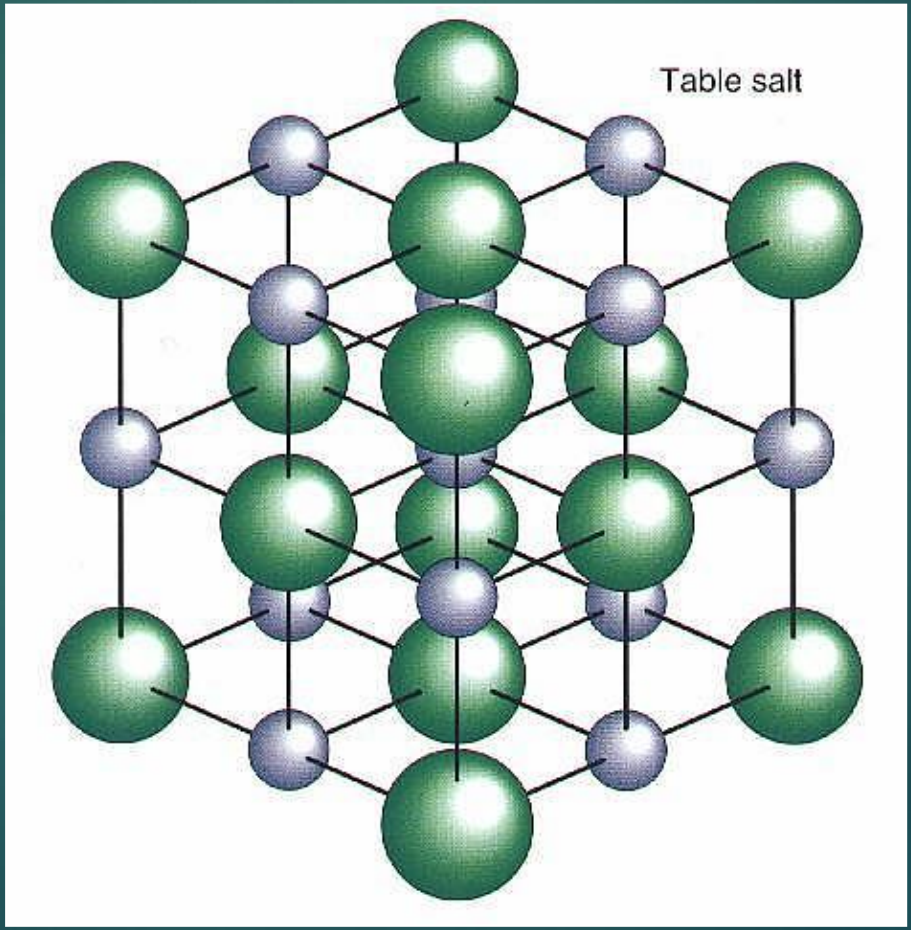
- Attraction between 2 oppositely charged ions.
  - **Ions** are charged atoms.
  - A **cation** is a positively charged ion (Forms when an atom loses an e^-)

    Formed by metals.
  - An **anion** is a negatively charged ion (Forms when an atom gains an e^-)

    Formed by nonmetals.
  - Ionic bonds are formed by **transferring** e^- from a metal to a nonmetal.

A. Ionic Bond

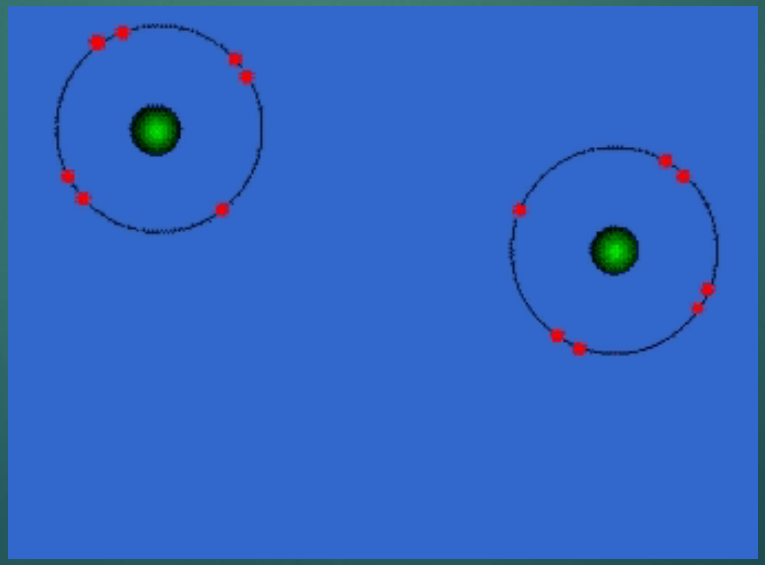
- ions form a 3-D crystal lattice



NaCl

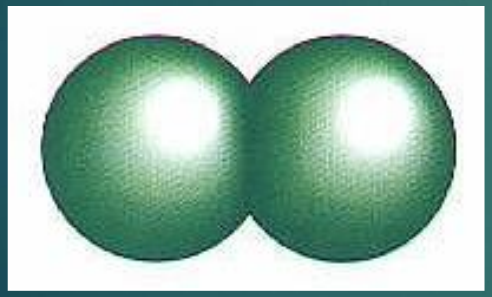
B. Covalent Bond

- Attraction between neutral atoms.
  - formed by **sharing** e^- between two nonmetals

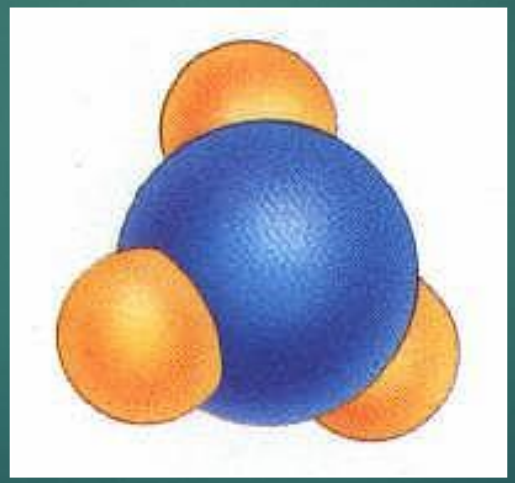


B. Covalent Bond

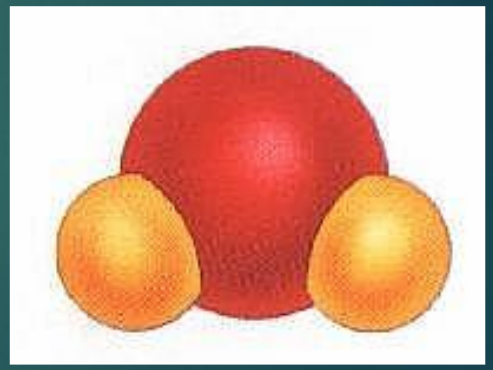
- covalent bonds result in molecules



Cl_2



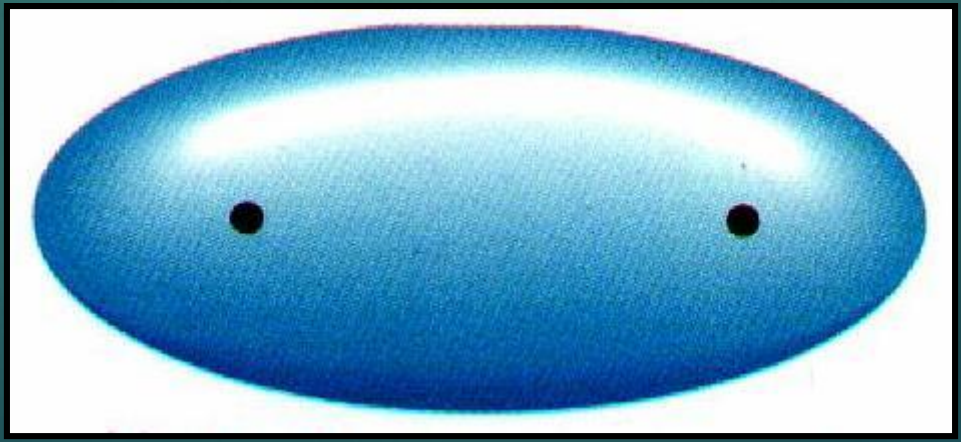
NH_3



H_2O

B. Covalent Bond

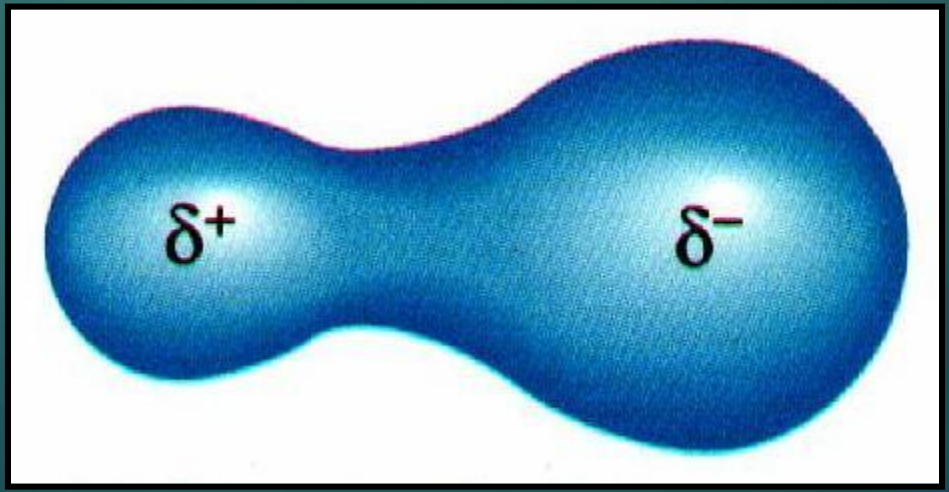
- **Nonpolar Covalent Bond**
  - e^- are shared equally
  - usually identical atoms



B. Covalent Bond

- **Polar Covalent Bond**
  - e^- are shared unequally between 2 different atoms
  - results in partial opposite charges

δ^+



δ^-

C. Comparison Chart

	IONIC	COVALENT
Electrons	transferred from metal to nonmetal	shared between nonmetals
Melting Point	high	low
Soluble in Water	yes	usually not
Conduct Electricity	yes (solution or liquid)	no
Other Properties	crystal lattice of ions, crystalline solids	molecules, odorous liquids & gases
Types of Elements	Metal and Nonmetal	Nonmetal ONLY

Both types of bonds

- Some compounds have a mixture of ionic and covalent bonds.
- These generally contain POLYATOMIC IONS.
- Polyatomic ions are groups of non-metal elements bonded covalently together that have an overall charge
- Generally polyatomic ions will form an ionic bond with metal.
- They are easy to recognize because they have three or more elements in the compound.
- Examples: Na_3PO_4, $Al_2(SO_3)_3$

Practice

What type of compound is show or described below?

1. $NaCl$
2. CO_2
3. H_2O
4. Fe_2O_3
5. $Ga(C_2H_3O_2)_3$
6. High melting point
7. Liquid or Gas
8. Doesn't dissolve in water

1. Ionic
2. Covalent
3. Covalent
4. Ionic
5. Both
6. Ionic
7. Covalent
8. Covalent

Chemical Bonds

III. NAMING MOLECULAR COMPOUNDS

- Molecular Names
- Molecular Formulas

A. Molecular (Covalent) Names

- Write the names of both elements.
- Change the final ending to -ide.
- Add prefixes to indicate subscripts.
- Only use *mono*- prefix with second element.

Covalent Naming Prefixes

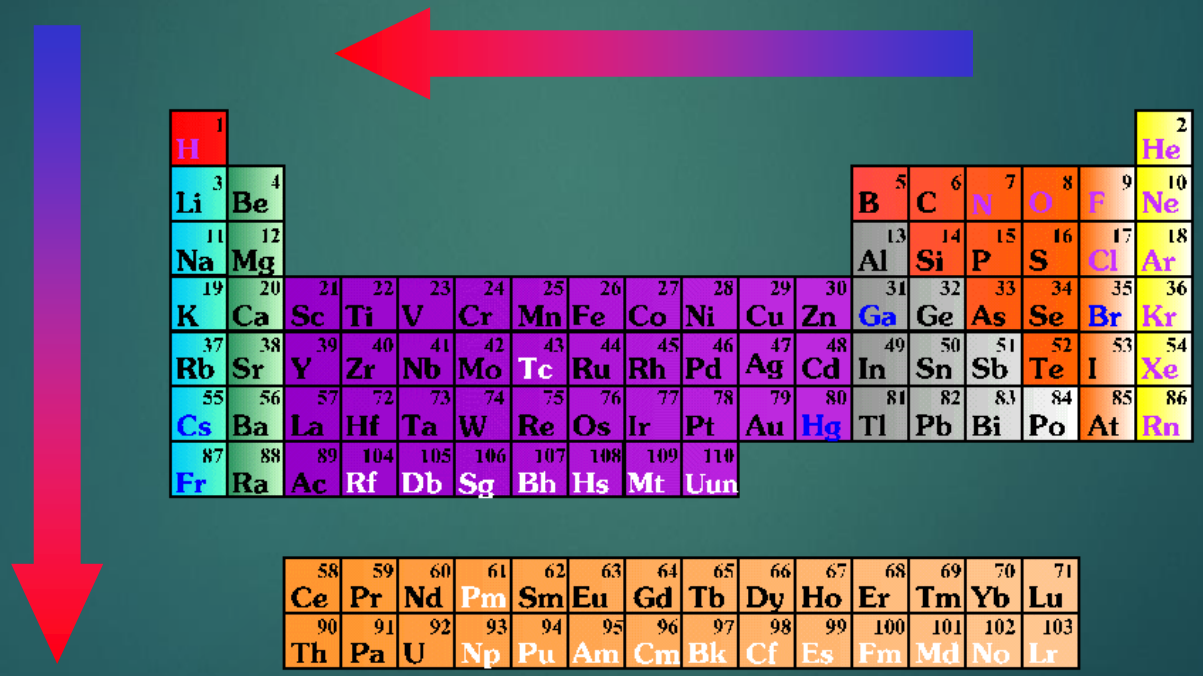
PREFIX	SUBSCRIPT
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

A. Molecular Names

- **CCl_4**
  - carbon tetrachloride
- **N_2O**
  - dinitrogen monoxide
- **SF_6**
  - sulfur hexafluoride

B. Molecular Formulas

- Write the more metallic element first.



- Add subscripts according to prefixes.

B. Molecular Formulas

- **phosphorus trichloride**
  - PCl_3
- **dinitrogen pentoxide**
  - N_2O_5
- **dihydrogen monoxide**
  - H_2O

B. Molecular Formulas

- **The Seven Diatomic Elements**

Br_2 I_2 N_2 Cl_2 H_2 O_2 F_2

In nature, these elements are never alone!

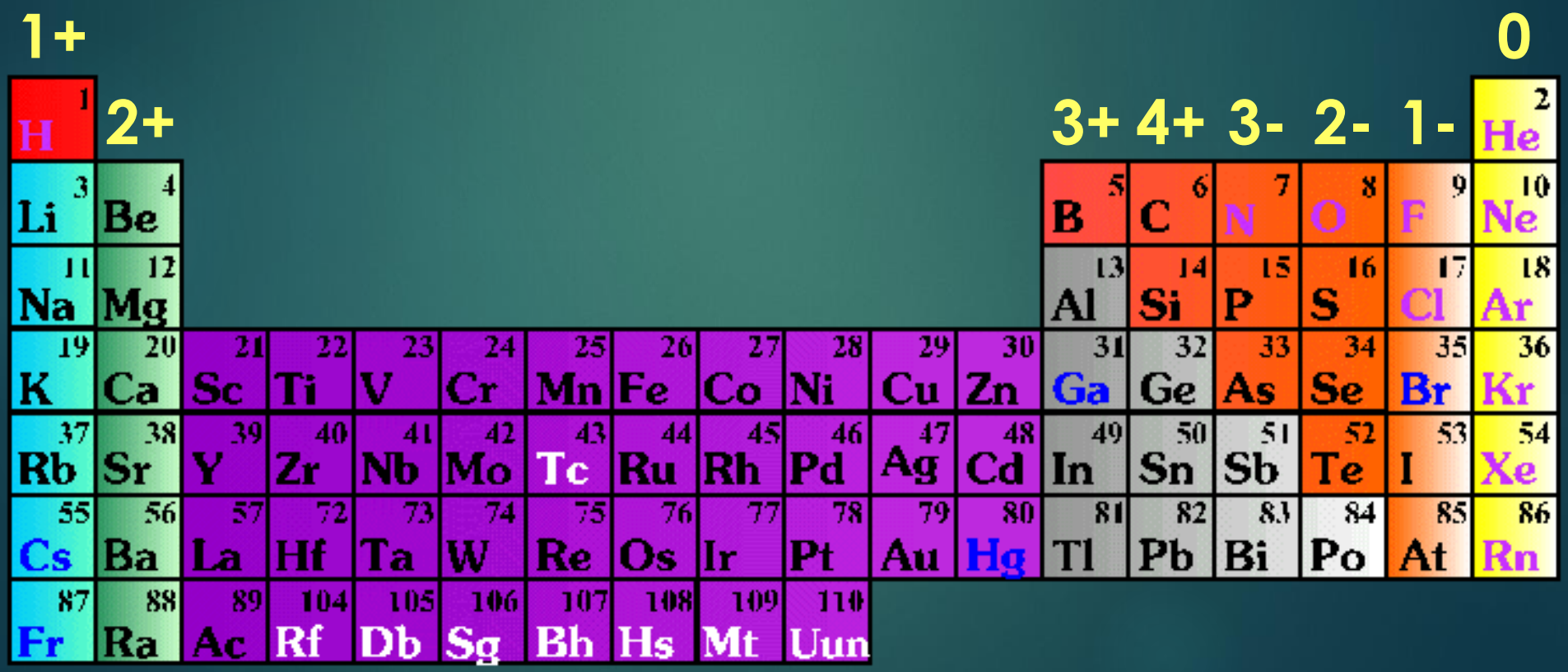
Chemical Bonds

IV. NAMING IONIC COMPOUNDS

- Oxidation Number
- Ionic Names
- Ionic Formulas

A. Oxidation Number

- The charge on an ion.
- Indicates the # of e^- gained/lost to become stable.



Oxidation Chart

Group #	1	2	13	14	15	16	17	18
Valence e^-	1	2	3	4	5	6	7	8
Oxidation #	+1	+2	+3	+/- 4	-3	-2	-1	0

B. Ionic Names

- Write the names of both elements, cation first.
- Change the anion's ending to -ide.
- If there is a polyatomic ion, write the name of the polyatomic ion.

B. Ionic Names

- **NaBr**
  - sodium bromide
- **Na_2CO_3**
  - sodium carbonate
- **$SnCl_4$**
  - Tin chloride

Writing Ionic Formulas

- Crisscross method.
- IF the charges don't balance the number of the charge becomes the subscript for the opposite element or polyatomic ions.
- Example

$$Mg^{+2} \quad N^{-3} \qquad = Mg_3N_2$$

- The charges BALANCE and thus disappear.

Writing Formulas

- Example 2: Al^{+3} SO_4^{-2}
  - Remember to use parentheses when more than one polyatomic ion is needed.
  - $Al_2(SO_4)_3$
- Example 3: Na^{+1} $C_2H_3O_2^{-1}$
  - $NaC_2H_3O_2$
  - Remember If charges cancel, just write the symbols

C. Ionic Names to Formulas

Look at the given name

- Write each ion. Put the cation first.
- Overall charge must equal zero.
  - If charges cancel, just write the symbols.
  - If not, crisscross the charges to find subscripts.
- Use parentheses when more than one polyatomic ion is needed.

C. Ionic Formulas

- **potassium chloride**
  - $K^+ \; Cl^- \quad \Rightarrow \quad KCl$
- **magnesium nitrate**
  - $Mg^{2+} \; NO_3^- \quad \Rightarrow \quad Mg(NO_3)_2$
- **aluminum oxide**
  - $Al^{3+} \; O^{-2} \quad \Rightarrow \quad Al_2O_3$

Mixed Names to Formulas

Covalent Names

- Have prefixes in the name
- Use the prefix to write the chemical formula
- Write what the name tells you to write.
- Dinitrogen hexaphosphide
- N_2P_6

Ionic Names

- NO PREFIXES
- Must write ions and balance charges.
- Remember NO charges in chemical formulas.
- Will see polyatomic items. (end in ite or ate)
- Calcium phosphide
- Ca^{+2} P^{-3}
- Ca_3P_2

Mixed Formula to Names

Covalent Formulas

- **Have ONLY nonmetals**
- Write the name of each element
- Change the end of the 2nd element to ide
- ADD PREFIXES to show the number of atoms
- CO
- Carbon monoxide

Ionic Formulas

- **Have metal and nonmetal**
- Write the name of each element
- Change the end of the 2nd element to ide
- IF 3 or more elements in compound use polyatomic list to fide its special name.
- K_3N
- Potassium nitride

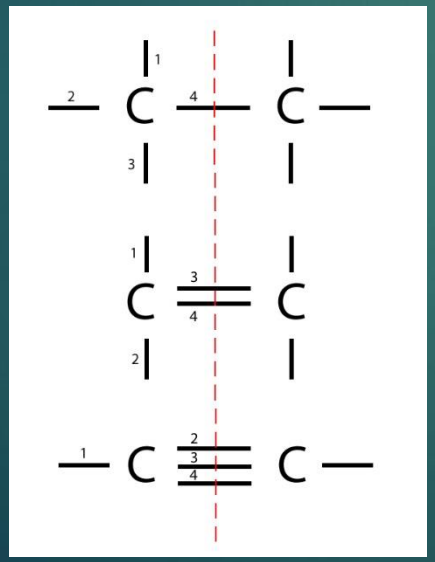
Chemical Bonds

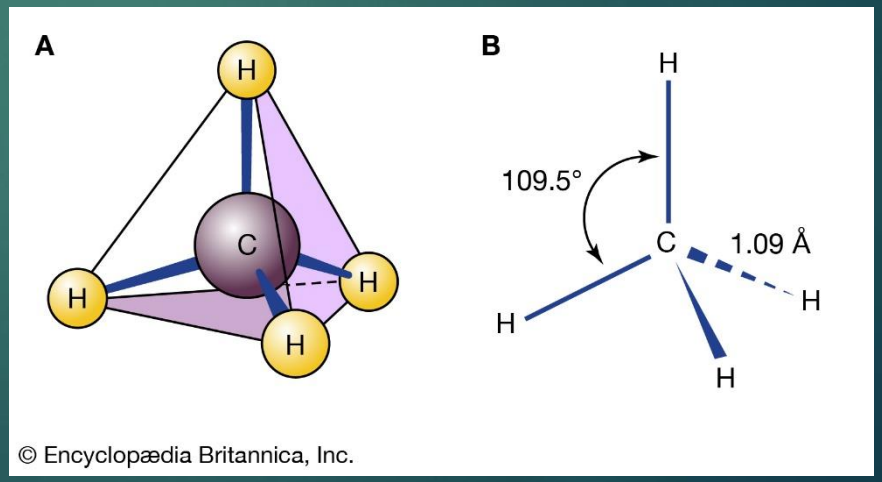
V. ORGANIC COMPOUNDS

- Structure of organic compounds
- Polymers
- Biochemical compounds

A. All organic compounds contain carbon

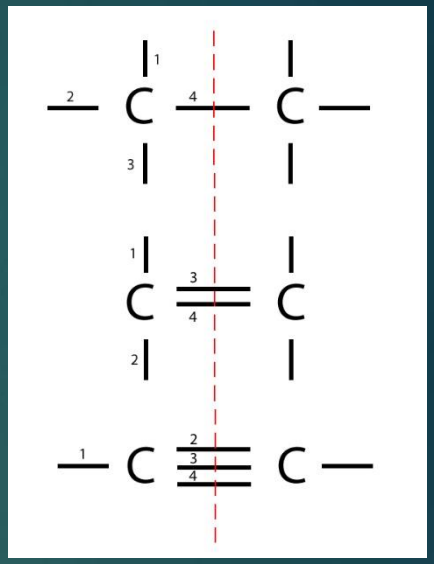
- Carbon forms up to 4 covalent bonds with other atoms.
- A carbon atom may share up to 3 electrons with another carbon atom to form a triple bond (or 2 for a double)



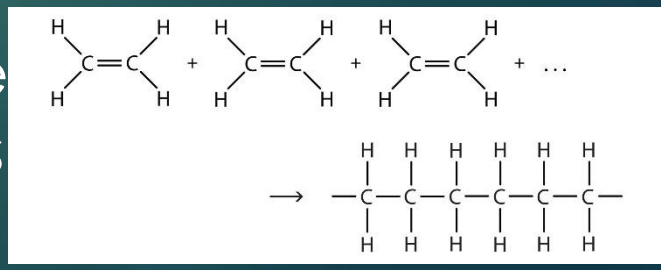


A. All organic compounds contain carbon

- Organic compounds with all single bonds are called **alkanes**.
- Organic compounds with a double bond are called **alkenes**.
- Organic compounds with a triple bond are called **alkynes**.



- Polymers are long chains made of smaller molecules or subunits



A. All organic compounds contain carbon

- Biochemical compounds are compounds that are essential to life
- Examples
  - Carbohydrates are made of glucose
  - Proteins are made of amino acids
  - DNA is made of nucleotides