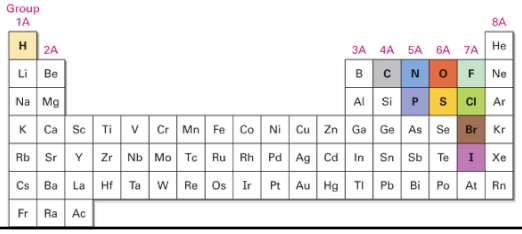
Chemical Bonding Theory

Organic Chemistry
Mrs. Dormer

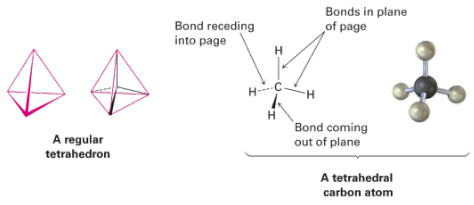
Origins of Organic Chemistry

- Organic chemistry is study of carbon compounds.
- Why is it so special?
- 90% of more than 30 million chemical compounds contain carbon.
- Examination of carbon in periodic chart answers some of these questions.
- Carbon is group 4A element, it can share 4 valence electrons and form 4 covalent bonds.



Development of Chemical Bonding Theory

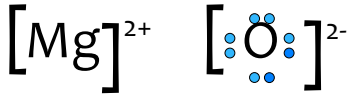
- Kekulé and Couper independently observed that carbon always has four bonds
- van't Hoff and Le Bel proposed that the four bonds of carbon have specific spatial directions
  - Atoms surround carbon as corners of a tetrahedron



The Nature of Chemical Bonds

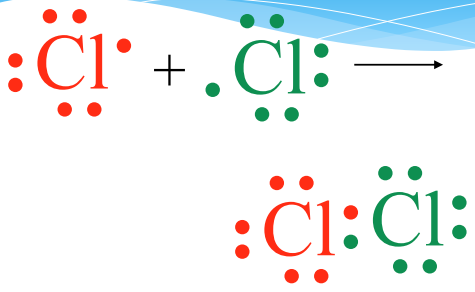
- Atoms form bonds because the compound that results is more stable than the separate atoms
- Ionic bonds in salts form as a result of electron transfers
  - Sodium Chloride
  - Magnesium Oxide

Ionic Bonding



Magnesium Oxide

- Organic compounds have covalent bonds from sharing electrons



The Nature of Chemical Bonds

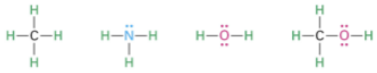
- **Lewis structures** (electron dot) show valence electrons of an atom as dots
  - Hydrogen has one dot, representing its 1*s* electron
  - Carbon has four dots ($2s^2\ 2p^2$)

Electron-dot structures (Lewis structures)

Line-Bond Structures

- **Kekulé structures** (line-bond structures) have a line drawn between two atoms indicating a 2 electron covalent bond.
- Stable molecule results at completed shell, octet (eight dots) for main-group atoms (two for hydrogen)

Line-bond structures (Kekulé structures)



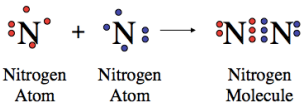
Methane (CH_4) | Ammonia (NH_3) | Water (H_2O) | Methanol (CH_3OH)

The Nature of Chemical Bonds

- Atoms with one, two, or three valence electrons form one, two, or three bonds.
- Atoms with four or more valence electrons form as many bonds as they need electrons to fill the *s* and *p* levels of their valence shells to reach a stable octet.
- Carbon has four valence electrons ($2s^2\ 2p^2$), forming four bonds (CH_4).

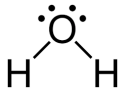
The Nature of Chemical Bonds

- Nitrogen has five valence electrons ($2s^2\ 2p^3$) but forms only three bonds (NH_3).



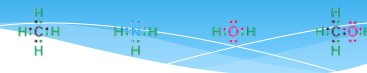
Nitrogen Atom + Nitrogen Atom → Nitrogen Molecule

- Oxygen has six valence electrons ($2s^2\ 2p^4$) but forms two bonds (H_2O)

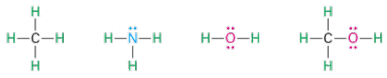


The Nature of Chemical Bonds

Electron-dot structures (Lewis structures)



Line-bond structures (Kekulé structures)



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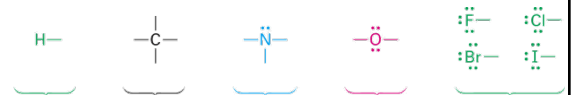
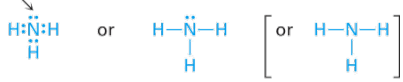


One bond | Four bonds | Three bonds | Two bonds | One bond

Non-Bonding Electrons

- Valence electrons not used in bonding are called **nonbonding electrons**, or **lone-pair electrons**
  - Nitrogen atom in ammonia (NH_3)
    - Shares six valence electrons in three covalent bonds and remaining two valence electrons are nonbonding lone pair

Nonbonding, lone-pair electrons



Ammonia