

Chemical Bonds & Molecular Attractions

(Chapter 15)

Student Learning Outcomes: Compare the electron-dot structure to the shell model; determine the type of chemical bond; and differentiate between chemical bonds and molecular attractions.

1. *How does an electron dot structure compare to the shell model?*
2. *What is a chemical bond?*
3. *What is an ionic bond?*
4. *What is a metallic bond?*
5. *What is a covalent bond?*
6. *What are the four molecular attractions?*

How does an electron dot structure compare to the shell model?

- ❖ **The Lewis electron dot symbols represent the valence electrons of the main group elements.**
- ❖ The electron dot structure is based on the **octet rule**.
 - The number of unpaired electrons is equal to the group number for **Groups 1A – 3A**.
 - The number of unpaired electrons follows the octet rule for **Groups 4A – 8A**.

Example: Oxygen

Go To: <http://hyperphysics.phy-astr.gsu.edu/hbase/pertab/perlewis.html>

Question: What is the electron dot structure? How does it compare to the group number?

H C Ar Na

- ❖ Only unpaired electrons are available to form chemical bonds.

What is a chemical bond?

- ❖ **A chemical bond is an attraction between atoms.**

- ❖ The chemical bond puts each atom in a lower energy state.

What is an ionic bond?

- ❖ **Ionic bonds form between positive and negative ions.**

Outer Shell	Electrons	Ion	Example	Group	Symbol
Mostly Full	Gained	Negative	Oxygen	6A	O²⁻
Mostly Empty	Lost	Positive	Beryllium	2A	Be²⁺

- ❖ **The number of unpaired electrons determines the charge.**

- ❖ The two ions are drawn close together by the electric force.

Question: Ionic bonds are usually formed between metals from the left side of the periodic table and nonmetals from the far right side of the periodic table. Why?

- ❖ The charges must balance to give a net charge of zero when atoms bond.

Example: Na + Cl

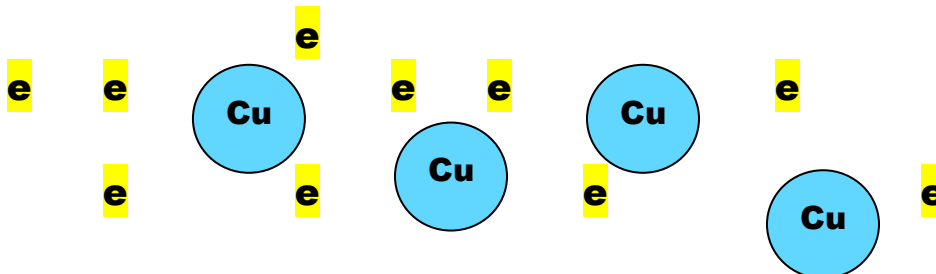
- ❖ Ionic bonds are the **strongest** of all chemical bonds.

Question: What is the chemical formula? What is the name of the compound?

1. Mg + S
2. Ca + Br
3. Rb + Se

What is a metallic bond?

- ❖ **Metallic bonds form in metals as all electrons are shared among all the nuclei in the metal.**



- ❖ Two or more types of metals may be present in a metallic bond, with ions **homogeneously** distributed throughout alloy.
- ❖ Metals can conduct heat and electricity well because of the free electrons.
- ❖ The malleability of metals is a result of nucleons and electrons being able to rearrange themselves easily in the bond.
- ❖ Metallic bonds are the **weakest** of the three types of chemical bonds.

What is a covalent bond?

- ❖ **Covalent bonds are formed between atoms that share pairs of electrons in the inter-nuclear region (between the atoms).**
- ❖ Each atom has use of the shared pairs of electrons.
- ❖ The pull on the shared electrons from each nucleus, bonds the atoms together.
- ❖ Covalent bonds usually occur between nonmetals in groups III, IV, and V.
- ❖ There can be 1, 2, or 3 pairs of electrons shared.
 - H – H 2e **single bond**
 - O = O 4e **double bond**
 - N ≡ N 6e **triple bond**
- ❖ In a **polar molecule**, the electron pairs are pulled closer to the atom with the greatest electronegativity.
 - A polar molecule may have a slightly negative end and a slightly positive end. (**dipole**)
 - The bond pair spends more time orbiting the atom with the greatest electronegativity.
- ❖ The amount of polarity depends on the difference in electronegativity between the atoms.

- ❖ In general, the farther apart (left and right) two atoms are on the periodic table, the more polar the bond will be.
- ❖ If the dipole pairs in a molecule do not cancel each other, then the molecule is polar.

Questions: Which are polar molecules? Which bond would be the most polar?

1. CO
2. CO₂
3. H₂O
4. NH₃
5. Polar molecules tend to have higher boiling points. **Why?**
6. Polar molecules and non-polar molecules do not mix. **Why?**

What are the four molecular attractions?

- ❖ Molecular attractions are the small **electrical attractions** between polar molecules.
- ❖ There are 4 types of molecular attractions between molecules.
 1. **Ion-dipole**
 2. **Dipole-dipole**
 3. **Dipole-induced dipole**
 4. **Induced dipole-induced dipole**
- ❖ Molecular attractions usually do not result in a chemical reaction. However, a large number of molecular attractions *can* “break” ionic bonds.

Example: Water and Salt

- ❖ **Molecular attractions result in surface tension.**
- ❖ **Hydrogen bonding is a special form of a dipole-dipole molecular attraction.**
 - The dipole-dipole attraction is enhanced because a hydrogen atom bonds with a very electronegative atom.
- ❖ This interaction is called hydrogen bonding because it only occurs when hydrogen is part of one or both of the interacting dipoles.
- ❖ Water has a high heat of fusion and heat of vaporization because a huge amount of energy is needed to separate hydrogen bonds
- ❖ **Water molecules are strongly attracted to each other because each is a relatively strong dipole, and each is a hydrogen bond type dipole.**