

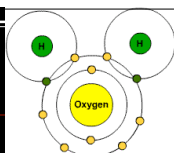
Chemical Bonding

Part 2: Covalent Bonds, Chemical Formulas, Structural Diagrams

Covalent Bonding



Bond with me



- A chemical bond forms when atoms **transfer** or **share electrons**.
- For example, in a water molecule, each hydrogen atom shares its single electron with the oxygen at the center.
- This way, all of the atoms are happy with full shells.
- Almost all elements form chemical bonds easily - which is why most matter is found in compounds.

Types of bonds

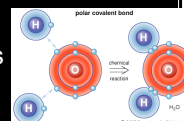
- There are a couple different types of bonds.
 1. **Ionic** Bond
 2. **Covalent** Bond
 3. **Metallic** Bond
- Now, we are going to talk about covalent bonds.

Review: Covalent Bonding

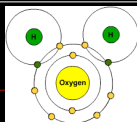
Single Covalent Bonding

Cooperating Covalents

- What is a covalent bond?
- A bond formed by **shared electrons**.
- Also, **molecules** are groups of atoms that are held together by covalent bonds in a specific ratio & shape.
- [UCSD SuperComputer Center Animation](#)

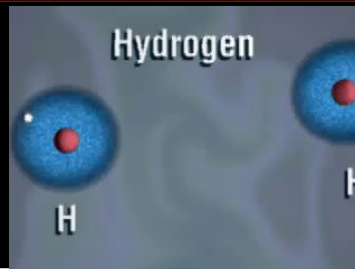


Covalent Bonds

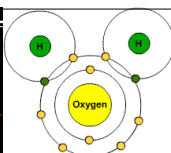


- A **covalent bond** is formed when atoms **share** electrons.
- The bonds between oxygen and hydrogen in a water molecule are covalent bonds.
- There are two covalent bonds in a water molecule, between the oxygen and each of the hydrogen atoms.
- Each bond represents one electron.
- In a covalent bond, electrons are **shared** between atoms, not transferred.

Special information about Hydrogen bonding



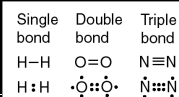
"M" is for Molecule



- A group of atoms held together by covalent bonds is called a **molecule**.
- Water is a molecule, and so is sugar.
- Other examples of molecules are
 - methane (CH₄)
 - ammonia (NH₃)
 - oxygen (O₂)
 - nitrogen (N₂).

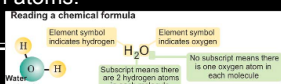
Fancy Bonding

- Sometimes, atoms share more than one electron.
- Occasionally, they can share 2 or even 3 electrons.
- These are called **double** and **triple** bonds.



Chemical Formulas

- Molecules are represented by a **chemical formula**.
- The chemical formula tells you the **exact number** of each kind of atom in the molecule.
- For example, the chemical formula for water is H₂O.
- The **subscript** 2 indicates there are two hydrogen atoms in the molecule.
- The chemical formula also tells you that water always contains twice as many hydrogen atoms as oxygen atoms.



Chemical Formula Take 2

- Water is a simple molecule, so the formula is pretty easy.
- Let's look at a more complex molecule.
- Baking soda, or sodium bicarbonate, is NaHCO₃.
- That means it has:
 - 1 Sodium (Na)
 - 1 Hydrogen (H)
 - 1 Carbon (C)
 - 3 Oxygen (O)

You Try it!

- Let's see how you do it. Next to each formula, write the name and number of each element.

Chemical Formula	Elements - #
C_6H_6	
NH_3	
$Al(OH)_3$	
$CO(NH_2)_2$	

You Try it!

Chemical Formula	Elements - #
C_6H_6	Carbon - 6 Hydrogen - 6
NH_3	
$Al(OH)_3$	
$CO(NH_2)_2$	

You Try it!

Chemical Formula	Elements - #
C_6H_6	Carbon - 6 Hydrogen - 6
NH_3	Nitrogen - 1 Hydrogen - 3
$Al(OH)_3$	
$CO(NH_2)_2$	

You Try it!

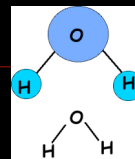
Chemical Formula	Elements - #
C_6H_6	Carbon - 6 Hydrogen - 6
NH_3	Nitrogen - 1 Hydrogen - 3
$Al(OH)_3$	Aluminum - 1 Oxygen - 3 Hydrogen - 3
$CO(NH_2)_2$	

You Try it!

Chemical Formula	Elements - #
C_6H_6	Carbon - 6 Hydrogen - 6
NH_3	Nitrogen - 1 Hydrogen - 3
$Al(OH)_3$	Aluminum - 1 Oxygen - 3 Hydrogen - 3
$CO(NH_2)_2$	Carbon - 1 Oxygen - 1 Nitrogen - 2 Hydrogen - 4

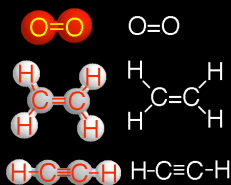
Structural Diagram

- The shape of a molecule is also important to its function and properties.
- For this reason, molecules are represented by **structural diagrams** which show the shape and arrangement of atoms.
- A single bond is represented by a bold short line.
- For example, water would look like this:



Structural Diagram - take 2

- Double and triple bonds are indicated by **double** and **triple** lines.
- Here are some examples:



Structural Diagram - take 3

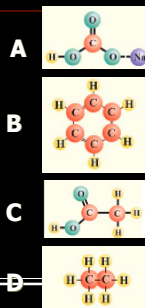
- Of course, real molecules are **3-dimensional**, not flat as shown in a structural diagram.
- For example, methane - CH_4 - has the shape of a 4-sided pyramid called a tetrahedron.

Chemical Formula	Diagram with Electrons	Flat Structural Diagram	3D Structural Diagram
CH_4			

You Try it!

Match the structural diagram with its chemical formula.

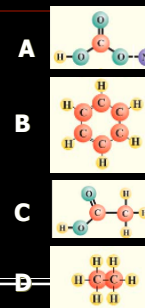
- C_2H_6
- NaHCO_3
- $\text{HC}_2\text{H}_3\text{O}_2$
- C_6H_6



You Try it!

Match the structural diagram with its chemical formula.

- C_2H_6 - D
- NaHCO_3 - A
- $\text{HC}_2\text{H}_3\text{O}_2$ - C
- C_6H_6 - B



Lewis Dot Molecules

- We've already seen how you draw a Lewis dot structure.
- The dots represent the valence electrons of an atom.
- We can draw Lewis dot structures for molecules too.
- Each element forms bonds to reach one of the magic numbers of valence electrons: **2** or **8**.
- In dot diagrams of a happy molecule, each element symbol has either 2 or 8 dots around it.



Lewis Dot Molecule - Example

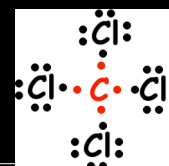
- Draw the dot diagram for carbon tetrachloride, CCl_4 .
- List the elements in the molecule
 - Carbon
 - Chlorine

Lewis Dot Molecule - Example

- Draw the dot diagram for carbon tetrachloride, CCl_4 .
- 1. List the elements in the molecule
 - Carbon - 4
- 2. Determine how many valence electrons each element has.
 - Chlorine - 7

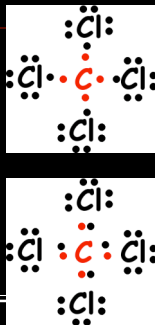
Lewis Dot Molecule - Example

- Draw the dot diagram for carbon tetrachloride, CCl_4 .
- 1. List the elements in the molecule
 - Carbon - 4
 - Chlorine - 7
- 2. Determine how many valence electrons each element has.
- 3. Match the elements so that each atom has 8 (or 2 for H & He) electrons.



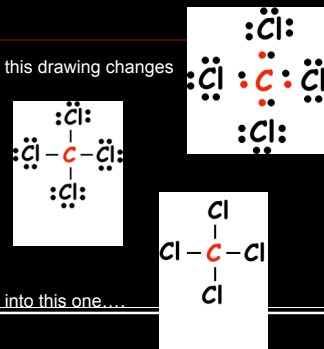
Lewis Dot Molecule - Example

- Notice that with this molecule, each atom has 8 electrons.
- The shells are all full!!!
- Each chlorine atom shares an electron with carbon.
- In return, carbon shares its electrons with chlorine.
- We can change the drawing to look like this...



Lewis Dot Molecule - Example

- Eventually, this drawing changes into...
- This one...
- And finally, into this one....



Time for a little music!

What Kinds Of Bonds Are These?

Lyrics & Music © 2005, Mark Rosengarten

You Try it!

- Now, time for you to draw dot diagrams of molecules!!
- And count some atoms!