

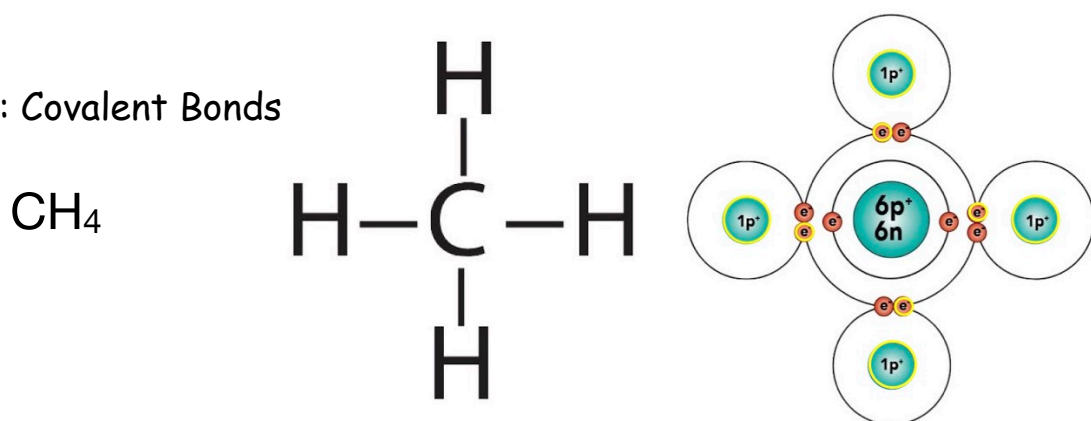
Experiment 3

Covalent Bonding and Molecules

Things To Know:

Molecules are different from ionic compounds. Ionic compounds are formed when one or more electrons are transferred from a metal to a nonmetal. Molecules are formed when nonmetal atoms share electrons and form a covalent bond. A covalent bond consisting of one pair of shared electrons is called a single bond. A line represents a pair of electrons. The formula showing the bonds as lines is called a Lewis structure.

Figure 8: Covalent Bonds



Carbon is in the second row of the periodic table and has electrons in two energy levels. Carbon is in column 4A and has four electrons in the valence energy level. Carbon shares its valence electrons with four hydrogen atoms. Both carbon and hydrogen attain a filled outer energy level.

When two pairs of electrons are shared between two atoms, a double covalent bond is formed. Carbon dioxide, CO₂, has a double bond on each side of the carbon atom as shown in Figure 9. Lone pairs of electrons are visible on the Lewis structure. You can see that both

carbon and oxygen atoms have eight electrons in the valence energy level. The lone pairs of electrons are not shown on the models because they are not involved in bonding.

A triple bond results when three pairs of electrons are shared between two atoms. Carbon forms four bonds to meet the octet rule. In hydrogen cyanide, HCN, there is a single bond between hydrogen and carbon atoms and a triple bond between carbon and nitrogen atoms as shown in Figure 10.

Figure 9: Double Bonds in Carbon Dioxide

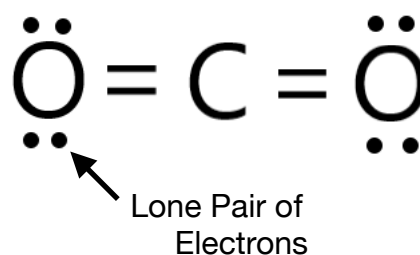


Figure 10: Triple Bond in Hydrogen Cyanide



What To Do:

Let's build some molecules!

1. Use the Introduction to Chemistry Model Set to build the molecules in Activity Table 4. A line in the Lewis structure represents a bond. Use the short (25 mm) gray bonds to attach the hydrogen atoms to the molecule. Use the black (40 mm) bonds for C-O or C-C bonds. Use the long (51 mm) gray bonds to build double and triple bonds as shown in Figure 11.
2. Lone pairs of electrons are not shown on the molecular model.
3. Research and write the uses for each molecule.

Figure 11: Double and Triple Bonds in Molecules



Double Bond



Triple Bond

Activity Table 4: Molecules

Molecular Formula and Name	Lewis Structure	Research: Uses of Molecule
CH ₄ Methane	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	
CO ₂ Carbon Dioxide	$\ddot{\text{O}}=\text{C}=\ddot{\text{O}}$	
HCN Hydrogen Cyanide	$\text{H}-\text{C}\equiv\text{N}:$	
H ₂ O Water	$\begin{array}{c} \cdot\cdot \\ \text{O} \\ \cdot\cdot \\ / \quad \backslash \\ \text{H} \quad \text{H} \end{array}$	
O ₂ Oxygen	$\ddot{\text{O}}=\ddot{\text{O}}$	
N ₂ Nitrogen	$:\text{N}\equiv\text{N}:$	
H ₂ S Hydrogen Sulfide	$\begin{array}{c} \cdot\cdot \\ \text{S} \\ \cdot\cdot \\ / \quad \backslash \\ \text{H} \quad \text{H} \end{array}$	
CH ₃ CH ₂ OH Ethanol	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\ddot{\text{O}}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	

Discussion Questions for Experiment 3

1. How do atoms form covalent bonds?
2. Describe how to distinguish a covalent bond from an ionic bond?
3. What is the name for a neutral group of atoms held together by covalent bonds?
4. How many pairs of electrons are shared in a double bond?