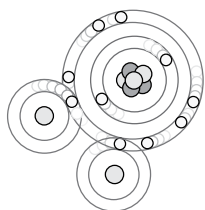


Lesson 8 Bonding/Compounds

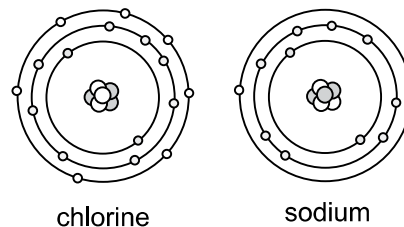
Lesson 8 —Day 1



The chemical attraction, or **bonding**, of atoms to one another when forming a molecule depends on the structure of the atoms.

When an atom has less than eight electrons in its outer shell, it is unstable. By bonding to another atom and filling its outer level, it becomes a stable atom. Atoms primarily bond together through ionic or covalent bonds. During ionic bonding, atoms gain or lose electrons. During covalent bonding, atoms share electrons.

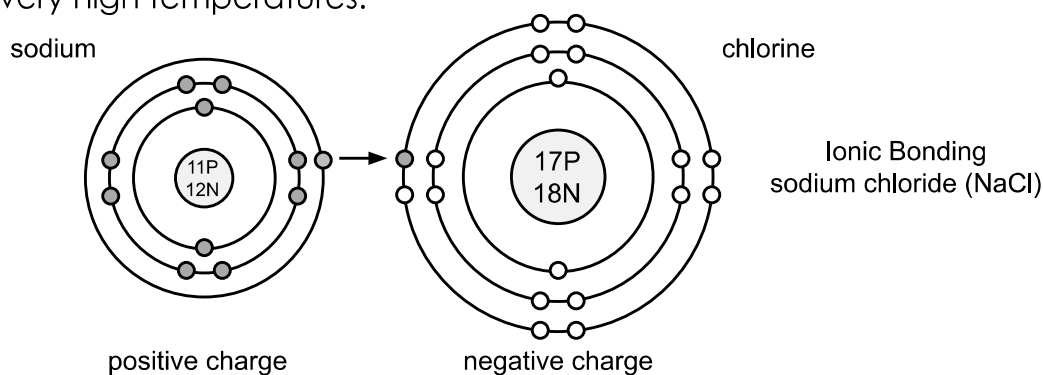
For example, a chlorine atom has seven electrons in its outer shell leaving space for one more. Sodium has one electron in its outer level.



Ionic bonding (ahy on ik) occurs when the chlorine atom draws in the sodium electron to fill its outer shell. The chlorine atom now has 18 electrons and 17 protons. When an atom has more electrons than protons it has a negative charge. The sodium atom now has 10 electrons and 11 protons. When an atom has more protons than electrons it has a positive charge.

Since chlorine and sodium now have opposite charges, they are held together by ionic bonding. These oppositely charged ions are strongly attracted to each other. The sodium and chlorine atoms form an ionic bond, sodium chloride, which is table salt.

An ionic bond is difficult to break. Ionic molecules usually form solids and can only be melted at very high temperatures.



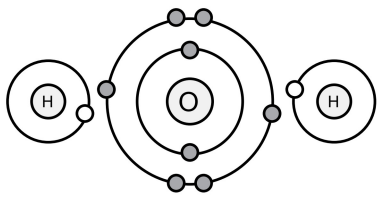
Materials:

SP Lesson 8 Day 1
8.5"x11" paper or cardstock
Molecules Shutter Fold
Matchbook

Vocabulary Words:

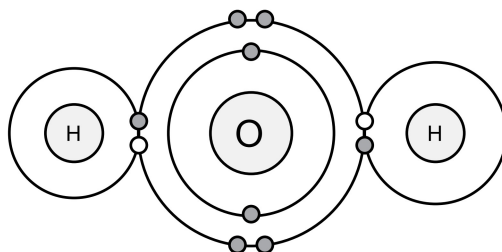
Hand out vocabulary strip for this lesson. Encourage your students to use the words while talking about the material and in their written work.

bonding
ionic bond
covalent bond
metallic bond
free electrons



Hydrogen atoms contain one electron in their outer energy shells. Oxygen atoms contain six electrons in their outer energy shells. When a water molecule is formed, the atoms share electrons in their outer energy shells. This is called **covalent** (koh **vey** luhnt) **bonding**.

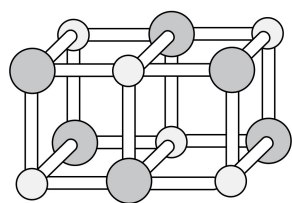
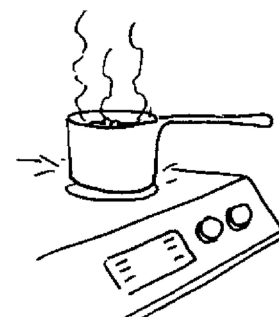
Covalent bonds between atoms are strong; however, they are usually liquids or gases at room temperature. These molecules do not conduct electricity well because they are not charged particles.



Covalent Bonding
water (H₂O)

The melting and boiling points are low in covalent bonds, so a small amount of energy is needed to break the bond.

Whether by ionic or covalent bonding, the atoms in these molecules form a stable outer shell by bringing eight electrons into it.



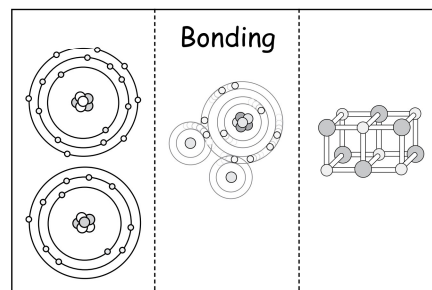
Metallic bonding is a type of bonding found only in metals. Unlike ionic or covalent bonds, metallic bonds do not share electrons between atoms. The atoms cling together because of **free electrons** moving between them. Free electrons are formed when electrons gain enough energy to break free from their atom.

Free moving electrons form strong bonds in metals. Heat and electricity are conducted well. They also give the metal a high melting and boiling point so large amounts of energy are needed to break the bonds.

Molecules Shutter Fold

Hand out SP Lesson 8 Day 1, **Molecules** Shutter Fold, and 8.5"x11" paper or cardstock.

Make a Half Book with the 8.5"x11" paper by folding it into a Hamburger with the fold at the top. Title it *Bonding*. Cut out 8A and glue it on the cover. Cut on the dotted lines making three tabs. Label each tab by the type of bonding the image represents, *covalent*, *ionic*, and *metallic*.



Under each tab:

H-H Draw a picture of the image and color the neutrons yellow, the protons blue, and the electrons red.



Complete H-H . Write words or phrases about each type of bonding. Ex:

covalent: share electrons, liquids or gas

ionic: gain or lose electrons, charged atoms, solids.

metallic: positive ions and free electrons, metals



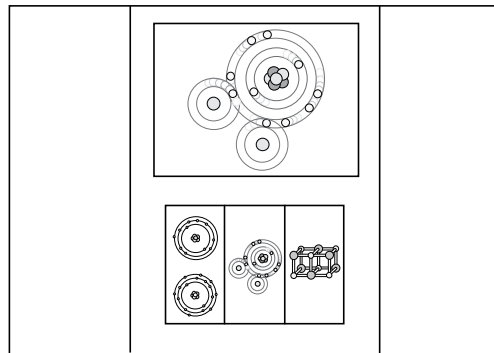
Describe each type of bonding, including their properties. Ex:

covalent – In covalent bonding, the atoms share electrons in their outer energy shells. These bonds are strong; however, they are usually liquids or gases at room temperature. These molecules do not conduct electricity well because they are not charged particles.

ionic – An ionic bond is difficult to break because oppositely charged ions are strongly attracted to each other. Ionic molecules usually form solids and can only be melted at very high temperatures. The sodium and chlorine atoms form sodium chloride, which is table salt.

metallic - Metallic bonding is a type of bonding found only in metals. The atoms cling together because of free electrons moving between them. They form strong bonds in metals. Heat and electricity are conducted well. They also give the metal a high melting and boiling point so large amounts of energy are needed to break the bonds.

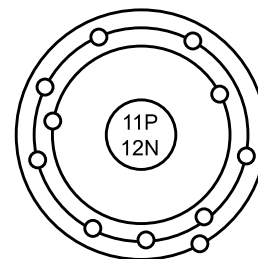
Glue the Half Book on the bottom of the middle section inside the *Molecules* Shutter Fold.



Atom Matchbook

Materials: matchbook

Cut out and glue 8B on the cover of the Matchbook. Open the Matchbook and draw a picture of a sodium atom. Sodium atoms have 11 protons and 12 neutrons in the nucleus, 2 electrons in the first shell, 8 electrons in the second shell, and 1 electron in the third shell. Write *sodium* on the outside bottom tab of the Matchbook.



sodium

Lesson 8

—Day 2

We know matter is anything that has mass and takes up space. Elements are basic substances that cannot be broken down into any other substance. The atoms in a bar of gold are still gold; therefore, gold is considered an element.

We've studied elements in previous lessons and learned there are 94 natural elements.

Materials:

SP Lesson 8 Day 2
Molecules Shutter fold
8.5"x11" paper or cardstock

Vocabulary Words:

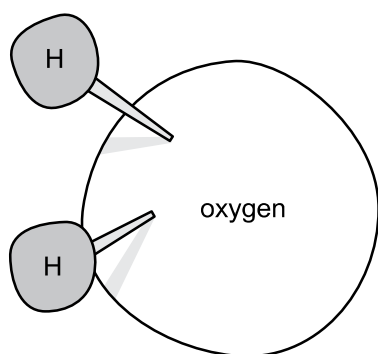
Hand out vocabulary strip for this lesson. Encourage your students to use the words while talking about the material and in their written work.

compound

formula

hazardous

Law of Constant Composition



This ball and stick model represents water.

A **compound** is a type of molecule where atoms of different elements bond together. Each element loses its own specific physical and chemical properties and becomes a new substance. Water is a good example of a compound. Water is a combination of the element hydrogen and the element oxygen. Both are gases. However, when they join together as a compound, they create a liquid called water.

Formulas are used to explain compounds. Formulas tell us two things:

- 1) the elements included in the compound

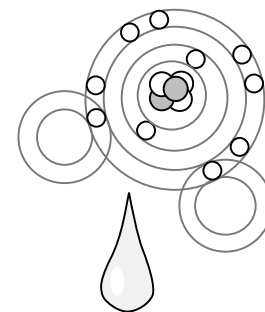
Hydrogen = H

Oxygen = O

- 2) the number of elements in each compound

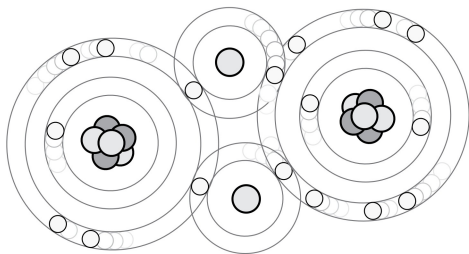
H_2O

The formula for water is H_2O . The elements in the compound are hydrogen and oxygen. The number (subscript) designates the number of atoms in each element. There are two hydrogen atoms and one oxygen atom in water. In formulas, with one atom of an element, no number is listed.



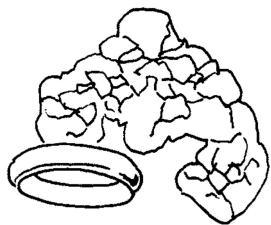
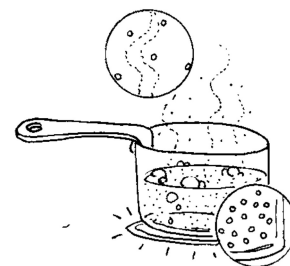
Water is a very common substance. We drink it, wash with it, and swim in it. It is safe to get it into our eyes.

The compound formula for hydrogen dioxide is H_2O_2 . As you can see, the elements are the same, hydrogen and oxygen, but the number of atoms for each element is changed. There are two hydrogen atoms and two oxygen atoms in hydrogen dioxide.



By making this one change, the substance is transformed from a safe substance, water, to one that is **hazardous** (**haz er duhs**) or harmful, hydrogen dioxide.

Elements in a compound cannot be easily separated. They are bonded firmly. Energy, usually in the form of electricity or heat, is needed to separate compounds. Breaking bonds requires energy and forming bonds releases energy.



A few elements, such as helium and neon, never combine to form compounds. Others do not combine easily, such as gold and platinum.

Look at the following formulas.

CO_2 = 1 carbon atom
2 oxygen atoms

NH_3 = 1 nitrogen atom
3 hydrogen atoms

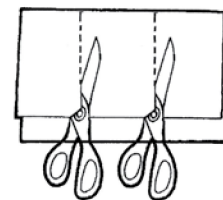
The **Law of Constant Composition** states that a pure compound always contains the same elements in the same proportions.

For example, sodium chloride is a compound of table salt, of salt in mines, and it can be made in a laboratory, but it is always the same salt containing one sodium atom and one chlorine atom.

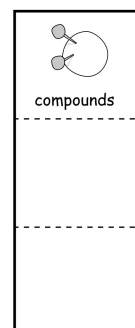
Molecules Shutter Fold

Hand out SP Lesson 8 Day 2, **Molecules** Shutter Fold, and 8.5"x11" paper or cardstock. Note: If using a file folder, trim all 8.5"x11" papers a little so that they more easily fit into the Shutter Fold.


Make a 3 Tab Book by folding the 8.5"x11" paper into a Hotdog. Fold the Hotdog into thirds. Open and cut the top creases to form three tabs.




Turn the book so that the fold is on the left side. On the top tab, glue 8A. Label the tab *Compounds*. Open and glue 8B on the right-hand side.



H-H Color the molecule.

 On the left-hand side, write phrases about compounds. *Ex: different elements bond to create a new substance, need energy or create energy to bond, not easily separated.*

 Explain compounds. *Ex:*
In a compound, atoms of different elements bond together. Each element loses its own specific physical and chemical properties and becomes a new substance. Energy is needed to create the compound or energy is given off when the compound is created.

On the second tab, glue 8C on the front. Label the tab *Formulas*. Glue 8D on the inside.

H-H Copy the number of atoms in each compound.

 Count and write the number of atoms in each compound. *Ex: CH₄, O₂N, NH₃*

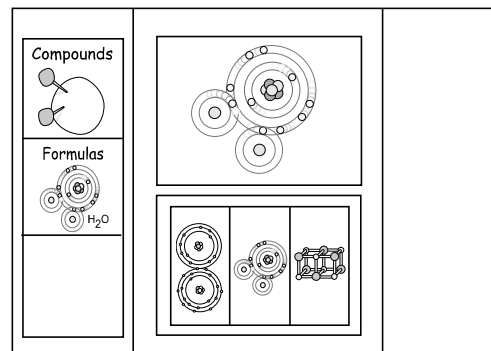
 Complete . Write the two things a formula tells us. Give an example. *Ex:*
Formulas are used to explain compounds. Formulas tell us two things:

1) *the elements included in the compound: ex: Hydrogen = H, Oxygen = O*

2) *the number of elements in each compound: H₂O*

The bottom tab will be completed in a later lesson.

Glue this Hotdog to the inside left tab of the *Molecules* Shutter Fold.



Lesson 8

—Day 3

Collect materials for the activities you choose:

small plate
butter
water
dishwashing detergent
vinegar
lemon juice
orange juice
milk
pickle juice
six cups
baking soda

Choose one or more activities to complete today.

1. Using an Internet Search Engine, research ionic, covalent, and metallic bonding.
2. Compound Activity

Materials: small plate, butter, tap water, detergent

Smear a little butter on the plate. Hold the plate under the tap water. Does the water make the plate clean? Add a little dishwashing detergent to the butter and mix it with your fingers. Hold the plate under the tap water again. What happened this time?

3. Chemical Reaction Activity

Materials: water, vinegar, lemon juice, orange juice, milk, pickle juice, six cups, baking soda

Measure a $\frac{1}{4}$ cup of liquid into each cup. Add a teaspoon of baking soda to each cup. What happened to each cup as you added the baking soda? Which liquid had a chemical reaction?

4. Read *How Do Molecules Stay Together?* by Madeline J. Hayes (gr. 1-3) or *Amber's Atoms: The First Ten Elements of the Periodic Table* by E. M. Robinson (gr. 2-4).

Matter Matters

One inch of rain is equal to 10 inches of snow.

