

Bonding Basics

Lesson Objectives:

As a result of this lesson, students will be able to:

- 1 – Identify the number of valence electrons in a given atom.
- 2 – Describe and demonstrate how an ionic bond forms.
- 3 – Describe and demonstrate how a covalent bond forms.
- 4 – Predict the type of bond that will occur between two elements.

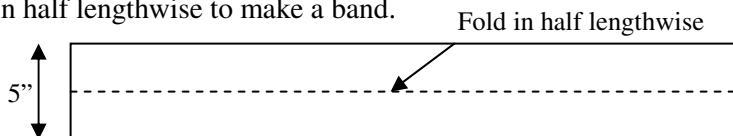
Materials Needed:

Construction Paper
Pipe Cleaners
Ping pong balls labeled with negative signs
Paperclips
Periodic Tables
Lesson Worksheets

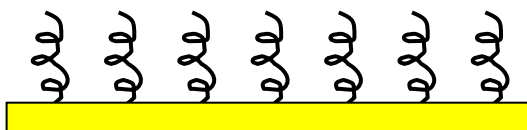
Preparation:

1 – Create a set of 18 atomic headbands. If you have a larger class, you may want to pair up the students for this activity.

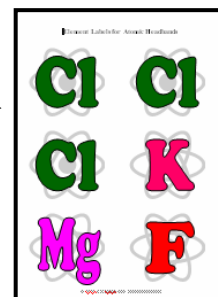
- Cut 5" strips length-wise from large pieces of white or colored construction paper. Laminate if possible and then fold in half lengthwise to make a band.



- Coil all of the pipe cleaners you need to make a spring-like structure. Most headbands will need 8 pipe cleaners except for Hydrogen, which needs only 2 pipe cleaners.
- Insert the ends of 8 pipe cleaners in the middle. Staple the pipe cleaners to the inside rim of the band to hold them in place. You will want to cover the inside rim with tape or strip of paper to prevent cuts from the staples.



- Bend the headband to make a circle and slide one end into the other. Use a paperclip to hold it in place. To make the headbands larger, create an extension piece using a smaller piece of construction paper. Slide one end in the folded end of the headband and staple in place. Attach a paperclip to hold the other end in place, while allowing the headband to slide to make it larger or smaller.
- Print the Element Labels on card stock and laminate if possible. Use glue or staples to attach one label to the front of each headband.



2 - Label ping pong balls with negative signs and use a compass point or other sharp object to make two small holes in each one. The holes need to be large enough to fit the diameter of the pipe cleaner, but small enough that the ping pong balls won't fall off. Sort the ping pong balls into Ziploc bags with 8 per bag. You will need a few bags with just 2 balls for the Hydrogen atoms.



*Tracy Trimpe and Lindsay Bogner
This lesson was developed during Lindsay's
student teaching experience.*

Lesson Directions:

Step 1 – Distribute headbands and bags of ping pong balls to each student or groups of students.

Step 2 - Instruct the students to add ping pong balls to the headbands to represent the number of valence electrons that are in each atom.

Step 3 – Have students work together to complete Section A on their worksheet related to valence electrons and oxidation numbers and then discuss their answers.

Step 4 – Review the basics of ionic bonds by completing the information in Part B.

Step 5 – Demonstrate the formation of an ionic bond using the elements in Example B1. Ask the students with the headbands for Sodium and Chlorine to come to the front of the classroom. Ask the students the following questions as you demonstrate the bond:

1 – How many valence electrons does Sodium have? (1)

2 – How many valence electrons does Chlorine have? (7)

3 – How many electrons does Chlorine need to complete its outer shell? (1)

4 – How many electrons does Sodium need to lose to be left with a complete shell? (1)

DO: Have the student with the Sodium headband remove the ping pong ball (electron) and place it on a pipe cleaner on the Chlorine headband.

5 – Since Sodium lost one electron, what is its charge? (1+)

6 - What do we call a positively charged ion? (cation)

7 – Since Chlorine gained one electron, what is its charge? (1-)

8 - What do we call a negatively charged ion? (anion)

9 – Do the charges balance? (Yes)

10 - What is the chemical formula for this compound? (NaCl)

11 – What is the name of this compound? (Sodium Chloride or salt.)

DO: Review the formation of the bond by drawing the Lewis structures for the elements and use an arrow to show the transfer of electrons from Sodium to Chlorine. Finish the example by writing the chemical formula with the charges and without. (Note: See the answer key for more details.)

Step 6 – Repeat this process for the other ionic bond examples. Some of the compounds will require more than two students to participate. Once your students have the basic idea they may be able to draw the bond structures on their own.

Step 7 – Discuss the information about covalent bonds in Part C.

Step 8 - Demonstrate the formation of a covalent bond using the element in Example C1. Ask the students with the Hydrogen headbands to come to the front of the classroom. Ask the students the following questions as you demonstrate the bond:

1 – How many valence electrons does Hydrogen have? (1)

2 – How many electrons does Hydrogen need to have a complete shell? (1)

DO: Since Hydrogen isn't likely to give up an electron, it must share one with another atom. Have the students stand close to one another and "share" the electrons. Demonstrate this by placing the pipe cleaner from one headband into the "electron" on the other headband. Repeat for the second electron so both students are attached to one another.

3 – How many electrons does each Hydrogen atom now have? (2 – 1 of its own and 1 that is shared)

DO: Use your hand to "draw" a circle around a Hydrogen atom and the two electrons it has in its outer shell. You could also use rope or string to form a circle around each atom and its electrons.

4 - What is the chemical formula for this compound? (H₂)

5 – What type of covalent compound is this? (Diatomic)

DO: Review the formation of the bond by drawing the Lewis structures for the elements and use circles to show how the electrons are shared between the two atoms. Finish the example by writing the chemical formula. (Note: See the answer key for more details.)

Note: In my experience, the covalent bonds are the most difficult for students to visualize so you may want to do most of these together and discuss each one.

Also available ...

The original Bonding Basics lesson is available at <http://sciencespot.net/Pages/classchem.html#Anchorbond>. The answer keys for the ionic and covalent worksheets have more details about each bond that may help if you have questions about how to demonstrate them to your students.

Bonding Basics

Name _____

Section A: Complete the chart using a periodic table to help you.

Element	Atomic Symbol	Total # of Electrons	# of Valence Electrons	# of Electrons Needed to Gain or Lose (to Fill Outer Shell)	Oxidation Number
Chlorine					
Potassium					
Magnesium					
Fluorine					
Aluminum					
Sodium					
Nitrogen					
Oxygen					
Carbon					
Iodine					

Answer these questions:

- An atom that gains one or more electrons will have a _____ charge.
- An atom that loses one or more electrons will have a _____ charge.
- An atom that gains or loses one or more electrons is called an _____.
- A positive ion is called a _____ and a negative ion is called an _____.

Section B: Ionic Bonds

What is an ionic bond?

- Atoms will transfer one or more _____ to another to form the bond.
- Each atom is left with a _____ outer shell.
- An ionic bond forms between a _____ ion with a positive charge and a _____ ion with a negative charge.

Example B1: Sodium + Chlorine

Example B2: Magnesium + Iodine

Example B3: Potassium + Iodine

Example B4: Sodium + Oxygen

Example B5: Calcium + Chlorine

Example B6: Aluminum + Chlorine

Challenge: What are some other ionic bonds that can be formed by the elements you see? Write the chemical formula for the compound and its name.

Section C: Covalent Bonds

What is a covalent bond?

- Atoms _____ one or more electrons with each other to form the bond.
- Each atom is left with a _____ outer shell.
- A covalent bond forms between two _____.

Example C1: Hydrogen + Hydrogen

Example C2: 2 Hydrogen + Oxygen

Example C3: Chlorine + Chlorine

Example C4: Oxygen + Oxygen

Example C5: Carbon + 2 Oxygen

Example C6: Carbon + 4 Hydrogen

Bonding Basics

ANSWER KEY

Section A: Complete the chart using a periodic table to help you.

Element	Atomic Symbol	Total # of Electrons	# of Valence Electrons	# of Electrons Needed to Gain or Lose (to Fill Outer Shell)	Oxidation Number
Chlorine	Cl	17	7	Gain 1	1-
Potassium	K	19	1	Lose 1	1+
Magnesium	Mg	12	2	Lose 2	2+
Fluorine	F	9	7	Gain 1	1-
Aluminum	Al	13	3	Lose 3	3+
Sodium	Na	11	1	Lose 1	1+
Nitrogen	N	14	4	Gain 3	3-
Oxygen	O	8	6	Gain 2	2-
Carbon	C	6	4	Gain or Lose 4	4+ or 4-
Iodine	I	53	7	Gain 1	1-

Answer these questions:

- An atom that gains one or more electrons will have a **NEGATIVE** charge.
- An atom that loses one or more electrons will have a **POSTIVE** charge.
- An atom that gains or loses one or more electrons is called an **ION**.
- A positive ion is called a **CATION** and a negative ion is called an **ANION**.

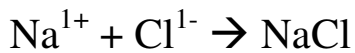
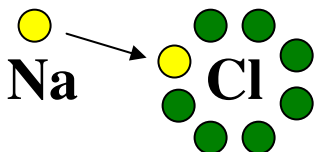
Section B: Ionic Bonds

ANSWER KEY

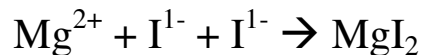
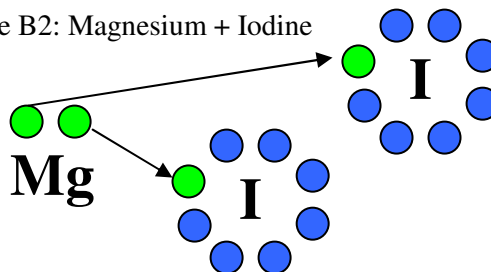
What is an ionic bond?

- Atoms will transfer one or more **electrons** to another to form the bond.
- Each atom is left with a **complete** outer shell.
- An ionic bond forms between a **metal** ion with a positive charge and a **nonmetal** ion with a negative charge.

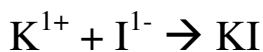
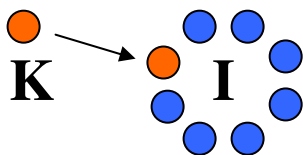
Example B1: Sodium + Chlorine



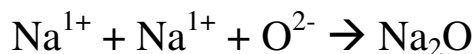
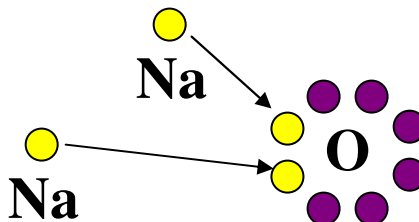
Example B2: Magnesium + Iodine



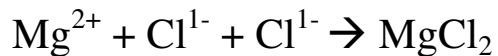
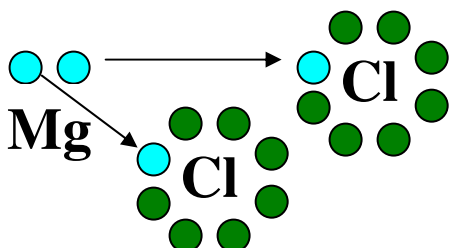
Example B3: Potassium + Iodine



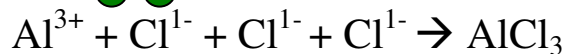
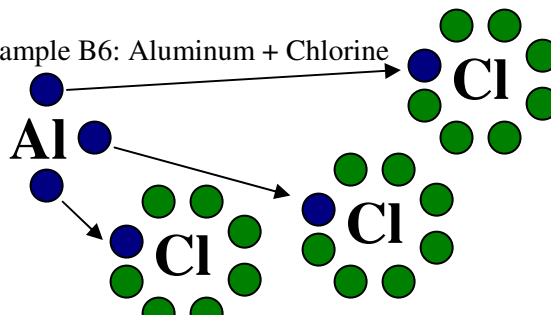
Example B4: Sodium + Oxygen



Example B5: Calcium + Chlorine



Example B6: Aluminum + Chlorine



Challenge: What are some other ionic bonds that can be formed by the elements you see? Write the chemical formula for the compound and its name.

Answers will vary.

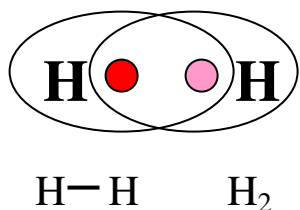
Section C: Covalent Bonds

ANSWER KEY

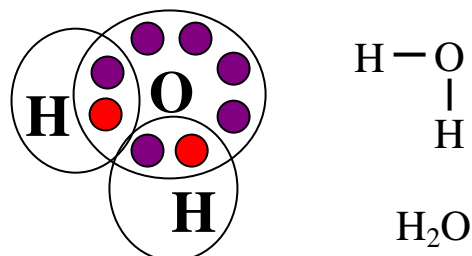
What is a covalent bond?

- Atoms share one or more **electrons** with each other to form the bond.
- Each atom is left with a complete outer shell.
- A covalent bond forms between two **nonmetals**.

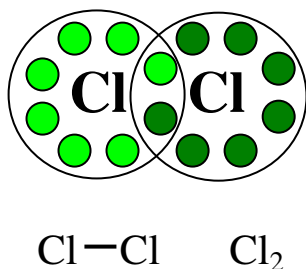
Example C1: Hydrogen + Hydrogen



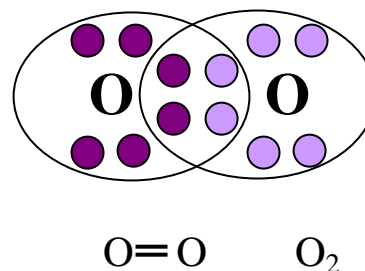
Example C2: 2 Hydrogen + Oxygen



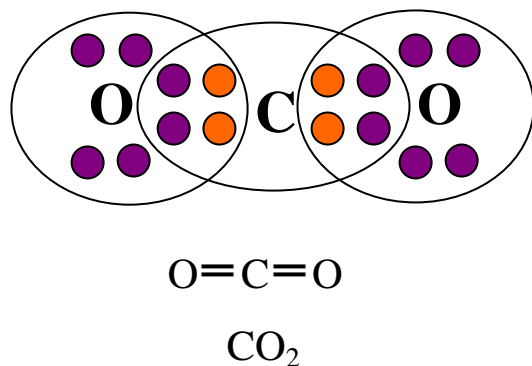
Example C3: Chlorine + Chlorine



Example C4: Oxygen + Oxygen



Example C5: Carbon + 2 Oxygen



Example C6: Carbon + 4 Hydrogen

