Simulation: Ionic & Covalent Bonding

FOR THE TEACHER

Thanks to
Dreyfus Foundation

Summary

In this simulation, students investigate both ionic and covalent bonding. Students will have the opportunity to interact with many possible combinations of atoms and will be tasked with determining the type of bond and the number of atom needed to form each. The simulation visually differentiates between the transferring of electrons when forming an ionic compound and the sharing of electrons when forming a covalent compound so that students can have a complete understanding of each. Finally, students will become familiar with the molecular formula, as well as the naming system for each type of bond and geometric shape, when applicable.

Grade Level

Middle and High school

Objectives

By the end of this simulation, students should be able to

- Correctly determine if a bond is ionic or covalent.
- Predict the number of atoms needed in a molecular formula.
- Distinguish between the general locations of metal atoms versus non-metal atoms on the periodic table.
- Determine the number of valence electrons for an atom.
- Create a Lewis dot structure for an atom, and a molecule.
- Predict the charge of an ion.
- Use the electronegativity values of atoms to help predict whether an ionic or covalent bond is most likely to form.
- Predict the molecular shape of a covalent molecule based upon its Lewis dot structure.
- Determine the proper naming system to use for ionic versus covalent compounds.

Chemistry Topics

This simulation supports students' understanding of

- Ionic Bonding
- Covalent Bonding
- Molecular Formula
- Naming Compounds
- Lewis Dot Structures
- Molecular Shapes
- Electronegativity

Time

Teacher Preparation: minimal
Lesson: 45 -60 minutes

Materials

- Computer, tablet or phone with internet access
- Student Activity handout
- http://www.teachchemistry.org/bonding

Safety

- No specific safety precautions need to be observed for this activity.

Teacher Notes

- This simulation could be used as an introduction to bonding, to help students differentiate between ionic or covalent bonding or alternatively it could be used near the end of the bonding unit to reinforce the differences between ionic and covalent bonding.
- Teachers could also choose to focus on only the ionic compounds or on only the covalent compounds in this simulation, depending on what is appropriate in their curriculum structure.
- Students should understand the basic organization of the periodic table, including how to identify a metal or non-metal based on the location of an element periodic table prior to using the simulation.
- Students should be introduced to Lewis Dot structures in advance of using this simulation, as well as how to determine the number of valence electrons in an atom.
- This simulation is intended to display bonding at a particle level, so the user can identify the transferring of electrons in an ionic bond versus the sharing of electrons in a covalent bond.
- Students should become more familiar with how to predict charges of ions in an ionic bond during this simulation.
- The basic molecular shape is displayed for each of the covalent compounds in this simulation. Students will become aware of the following geometric shapes: linear, bent, and trigonal pyramidal.
- Students can easily access the simulation using this link: http://www.teachchemistry.org/bonding

FOR THE STUDENT

Lesson

Simulation: Ionic and Covalent Bonding

Background

In this investigation you will bond select atoms. Based upon the types of atoms that you choose to combine, you will create either an ionic compound or a covalent compound. You will have the opportunity to analyze the differences between these different types of compounds and to predict the number of atoms needed to create each, as well as learn how to appropriately name them.

1. Describe the difference between an atom and a molecule:

2. Where are metal atoms located on the periodic table? Where are non-metal atoms located on the periodic table?

3. What subatomic particle(s) participate in chemical bonding?

4. In your own words, define *valence electron*.

5. How can you determine the number of valence electrons in an atom using the periodic table?

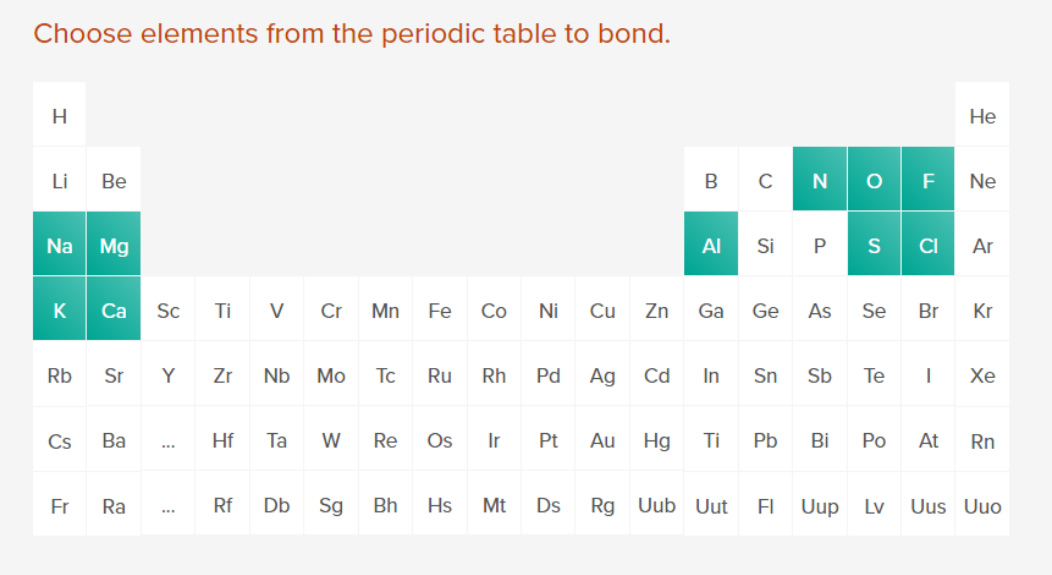
6. Draw a Lewis Dot Structure for the following atoms:

a. Strontium (Sr) b. Carbon (C) c. Iodine (I) d. Xenon (Xe)

*Check your answers before moving on to the next portion of the activity.

Procedure

Using your computer, tablet or mobile device, navigate to the website: http://www.teachchemistry.org/bonding. You should see the picture below on your screen.



Part 1: Ionic Bonding

1. Choose Sodium (Na).
    a. What *type of element* is it?

    b. How many valence electrons does it have?

2. Choose Fluorine (F).
    a. What *type of element* is it?

    b. How many valence electrons does it have?

3. Answer the question on the screen, "What type of bond is this combination likely to form?"

    a. Circle: Ionic or Covalent?

    b. Choose the appropriate number of atoms to make the bond. Record the number of each atom below:

4. Watch the final animation closely (it will play continuously).
    a. Describe the change in the number of valence electrons in the atoms as the bond is successfully formed:

    b. What does the positive (+) charge indicate (mention specific subatomic particles in your answer)?

    c. What does the negative (-) charge indicate (mention specific subatomic particles in your answer)?

d. What is the final overall charge?

e. Record the name and molecular formula for the compound below:

Reset the selected data using the reset symbol.

5. Choose Calcium (Ca).
   a. What *type of element* is it?

   b. How many valence electrons does it have?

6. Choose Chlorine (Cl).
   a. What *type of element* is it?

   b. How many valence electrons does it have?

7. Answer the question on the screen, "What type of bond is this combination likely to form?"

   a. Circle: Ionic or Covalent?

   b. Choose the appropriate number of atoms to make the bond. Record the number of each atom below:

8. Watch the final animation closely (it will play continuously).
   a. Why were more than 2 total atoms needed to create this compound?

   b. Explain what happened to the valence electrons in <u>each</u> atom.

   c. What is the final overall charge?

   d. Record the name and molecular formula for the compound below:

   e. Have you noticed a pattern between the charge of the ion and the number of valence electrons it has? Explain how you can predict the charge based on the number of valence electrons, or the location of the element on the periodic table.

Reset the selected data using the reset symbol.

9. Using a periodic table, complete the table below, then <u>use the simulation to check each of your predictions</u>:

Atom #1	Number of Valence Electrons	Prediction of charge	Atom #2	Number of Valence Electrons	Prediction of charge	Molecular Formula	Name of compound
Na			**O**				
K			**F**				
Mg			**Cl**				
Ca			**N**				
Al			**S**				

Part 2: Covalent Bonding

1. You will first investigate 5 *diatomic* molecules. Diatomic molecules are made up of 2 atoms.

    a. Select 2 fluorine atoms. How many valence electrons are in each fluorine atom?

    b. Is a fluorine atom a metal or a non-metal?

    c. Did the combination of these atoms create a covalent or ionic bond?

    d. How are the valence electrons organized to form a bond between these atoms?

    e. How is this different from the ionic bonds formed in the previous part of the activity?

    f. What shape does this molecule form?

2.

    a. Select 2 oxygen atoms. How many valence electrons are in each oxygen atom?

    b. Is an oxygen atom a metal or a non-metal?

    c. Did the combination of these atoms create a covalent or ionic bond?

    d. How are the valence electrons organized to form a bond between the atoms?

    e. How is this bond different from the bond in the fluorine molecule in question 1?

f. What shape does this molecule form?

3. Make predictions in the following table. Once completed, check your answers using the simulation.

Lewis dot structure for single atom	Cl	S	N
Lewis dot structure for diatomic molecule (Cl_2, S_2, N_2)			
Molecular formula			
Name of shape			

4. More than two atoms can also be combined to form a covalent molecule. These molecules may form different shapes and will also follow a particular naming system. Select the following combinations of atoms, and complete the rest of the table as you interact with the simulation:

1^{st} atom choice	2^{nd} atom choice	Predict Formula	Molecular Name	Shape
S	F			
N	Cl			
Cl	F			

Part 3: Critical thinking

1. What are the differences between ionic and covalent bonds? Be sure to refer to *valence electrons* in your response.

2. How is naming ionic and covalent compounds different? Use specific examples in your answer.

3. Based on your knowledge of ionic and covalent bonds, complete the missing portions of the following table:

Name	Formula	Ionic or Covalent?

Beryllium bromide		
	PF_3	
Sulfur diiodide		
Strontium Phosphide		
	Cs_3N	
	H_2O	