

Name: _____ Date: _____

Student Exploration: Covalent Bonds

Vocabulary: covalent bond, diatomic molecule, Lewis diagram, molecule, noble gases, nonmetal, octet rule, shell, valence, valence electron

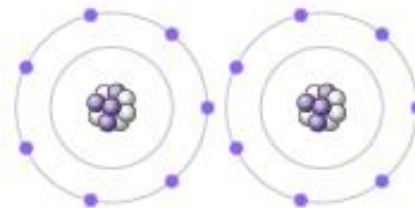
Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

1. There are eight markers in a full set, but Flora and Frank each only have seven markers. Flora is missing the red marker, and Frank is missing the blue marker.

What can they do so that each has a full set of markers? _____

Gizmo Warm-up

Just like the students described above, **nonmetal** atoms can share electrons. As you will see in the *Covalent Bonds* Gizmo™, atoms form bonds in this way.



To begin, check that **Fluorine** is selected from the **Select a substance** menu. Click **Play** (▶) to see the electrons orbiting the nucleus of each atom.

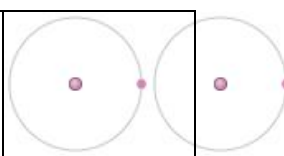
1. The outermost electrons in each atom are called **valence electrons**. How many valence electrons does each fluorine atom have? _____

2. Click **Pause** (⏸). Drag an electron from the left atom to the right atom. Click **Play**.

What happens? _____

3. Click **Pause**, drag an electron from the right atom to the left, and then click **Play**.

What happens now? _____

Activity A: Sharing electrons	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Click Reset. • Select Hydrogen. 	
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Introduction: The electrons that orbit the nucleus of an atom are arranged into **shells**. The first shell contains up to two electrons and the second contains up to eight electrons. Most elements are stable when they have eight valence electrons—a rule of thumb known as the **octet rule**. (Elements with less than five electrons are stable with *two* valence electrons.)

Question: What happens when atoms share electrons?

1. **Predict:** Each hydrogen atom has one valence electron, but it needs two electrons to be stable. How can both hydrogen atoms each achieve a stable configuration?

2. **Form a bond:** Drag the electrons so that they move around both hydrogen atoms. Click **Play** to observe them in orbit, and then click **Check**. You have created a **covalent bond**.

Congratulations, you have completed a **molecule** of hydrogen! Because the molecule has two atoms, it is a **diatomic molecule**.

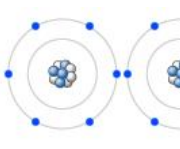
3. **Draw a diagram:** Covalent bonds are shown in **Lewis diagrams**. In a Lewis diagram, dots represent unshared valence electrons and dashes represent pairs of shared electrons.

Turn on **Show Lewis diagram**. What is the Lewis diagram for hydrogen, H₂? **H H**

4. **Form a bond:** Now select **Fluorine** and create a molecule of fluorine, F₂. Take a snapshot of this molecule and add it to your document. (Be sure to label each molecule you add.)

What is the Lewis diagram for fluorine, F₂? **F F**

5. **Think and discuss:** How is the formation of covalent bonds similar to kids sharing markers? How is it different? If possible, discuss your answer with your classmates and teacher.

Activity B: Building molecules	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Click Reset. • Turn off Show Lewis diagram. • Select Oxygen. 	
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Question: How do atoms share more than one pair of electrons?

1. Observe: Like fluorine and most other elements, oxygen atoms are most stable with a full complement of eight valence electrons.
 - A. How many valence electrons does each oxygen atom have now? _____
 - B. How many more electrons does each oxygen atom need to be stable? _____
2. Form a bond: Drag electrons back and forth until the molecule of oxygen (O₂) is stable. Click **Check** to confirm your molecule is stable.

How many *pairs* of shared electrons are there in a stable molecule of oxygen? _____

3. Draw a diagram: Draw a Lewis diagram of the oxygen molecule in the space below at left. To check your work, turn on **Show Lewis diagram**. Draw the correct diagram on the right.

Practice diagram: O O Actual: O O

4. Practice: Create covalent bonds and stable molecules for the remaining substances. Take a snapshot of each completed molecule and add it to your document. Draw Lewis diagrams for each one. (As above, draw the diagram on your own before checking your work.)

Nitrogen	N	N			H	
			Ammonia	H	N	H
Chlorine	Cl	Cl			H	
			Methane	H	C	H
Water	H	O			H	
Carbon dioxide	O	C			O	
			Silica	O	Si	O

5. Think and discuss: The last column of the periodic table contains the **noble gases**, elements that do not easily form chemical bonds.

Why don't these gases tend to form chemical bonds? _____
