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.

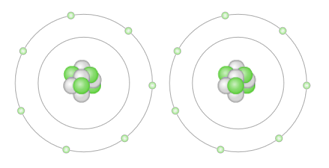
What can they do so that each has a full set of markers? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Otto and Olivia each have six markers. Otto is missing the purple and green markers, and Olivia is missing the black and brown markers. What can they do so that each has a full set?

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

What happens? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

What happens now? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Activity A:**  **Sharing electrons** | Get the Gizmo ready:   * Click **Reset**. * Select **Hydrogen**. |  |

**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?

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1. 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**. Click the **camera** (snapshot camera) icon to take a snapshot of your completed molecule. Right-click the image, and click Copy Image. Paste the image below:

|  |  |  |
| --- | --- | --- |
| **Activity B:**  **Building molecules** | Get the Gizmo ready:   * Click **Reset**. * Turn off **Show Lewis diagram**. * Select **Oxygen**. |  |

**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.
   1. How many valence electrons does each oxygen atom have now? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. 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? \_\_\_\_\_\_\_\_