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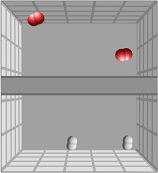
**Student Exploration: Limiting Reactants**

**Vocabulary:** chemical equation, chemical formula, chemical reaction, coefficient, limiting reactant, molecule, product, reactant, subscript

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

Imagine you and your friends are making hot dogs. A complete hot dog consists of a wiener and a bun. At the store, you buy four packages of eight wieners and three bags of 10 buns.

1. How many total hot dogs can you make? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Which ingredient limited the number of hot dogs you could make? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Which ingredient will you have leftovers of? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



**Gizmo Warm-up**

Just as ingredients can be put together to make a new food, substances can combine during a **chemical reaction** to produce new substances. The substances that undergo change are called **reactants**. The new substances are **products**.

Sometimes during a chemical reaction, one type of reactant will be used up before the other reactants. This reactant is the **limiting reactant**. Using the *Limiting Reactants* Gizmo, you can determine which reactant is limiting in various scenarios.

To begin, make sure **H2 + O2 becomes** **H2O** is selected. The small “2” in H2, O2, and H2O is a **subscript**. Subscripts represent the number of atoms in a **molecule**.

1. Use the sliders to set the number of **O2 molecules** and **H2 molecules** to two.
   * 1. How many hydrogen molecules (H2) are there? \_\_\_\_\_\_\_ Hydrogen atoms? \_\_\_\_\_\_\_
     2. How many oxygen molecules (O2) are there? \_\_\_\_\_\_\_ Oxygen atoms? \_\_\_\_\_\_\_
2. How many H2O molecules do you think will form when these four molecules react? \_\_\_\_\_\_\_
3. Click **Play** (Play). How many H2O molecules actually formed? \_\_\_\_\_\_\_

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| **Activity A:**  **Water reaction** | Get the Gizmo ready:   * Make sure **H2 + O2 becomes** **H2O** is selected. * Click **Reset** (Reset). |  |

**Goal: Identify a limiting reactant.**

1. Count: H2O is the **chemical formula** for water. In order to produce a single molecule of water, how many hydrogen atoms are needed? \_\_\_\_\_\_\_ Oxygen atoms? \_\_\_\_\_\_\_
2. Predict: Set the number of **O2 molecules** to five and the number of **H2 molecules** to eight.
   * 1. How many oxygen atoms are present? \_\_\_\_\_\_\_ Hydrogen atoms? \_\_\_\_\_\_\_
     2. How many water molecules could form from these reactants? \_\_\_\_\_\_\_
     3. After the molecules react, which reactant will be left over? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     4. Which reactant will be the limiting reactant? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     5. Click **Play** and wait until **Reaction complete** is shown. What happened? \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Test: Click **Reset**.Set the number of **O2 molecules** to 10.
   * 1. How many hydrogen molecules (H2) will be needed for there to be no excess reactants? \_\_\_\_\_\_ Use the slider to set the number of **H2 molecules** to this value.
     2. How many water molecules will be formed? \_\_\_\_\_\_\_
     3. Click **Play**. What happened? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Challenge yourself: Run the Gizmo with five **O2 molecules** and nine **H2 molecules**.
   * 1. How many of each molecule do you think will be produced by this reaction?

O2: \_\_\_\_\_\_\_ H2: \_\_\_\_\_\_\_ H2O: \_\_\_\_\_\_\_

* + 1. Click **Play**. How many were actually produced? O2: \_\_\_\_\_ H2: \_\_\_\_\_ H2O: \_\_\_\_\_
    2. How do you explain this result? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Activity B:**  **Methane reaction** | Get the Gizmo ready:   * Select **C + H2 becomes** **CH4**. |  |

**Goal: Predict the results of a chemical reaction.**

1. Count: CH4 is the chemical formula for methane. In order to produce a single molecule of methane, how many carbon (C) atoms are needed? \_\_\_\_\_\_\_ Hydrogen atoms? \_\_\_\_\_\_\_
2. Predict: Set the number of **C atoms** to 14 and the number of **H2 molecules** to 10.
   * 1. How many total hydrogen atoms are there? \_\_\_\_\_\_\_
     2. How many methane molecules could form from these reactants? \_\_\_\_\_\_\_
     3. After the atoms react, which reactant will be left over? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     4. Which reactant will be the limiting reactant? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     5. Click **Play** and wait until **Reaction complete** is shown. What happened? \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Test: Click **Reset**.Set the number of **C atoms** to seven.
   * 1. How many hydrogen molecules (H2) will be needed for there to be no excess reactants? \_\_\_\_\_\_\_ Use the slider to set the number of **H2 molecules** to this value.
     2. How many methane molecules will be formed? \_\_\_\_\_\_\_
     3. Click **Play**. What happened? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Solve: For each **chemical equation** below, write the number of product molecules that will form from the reaction. Then, circle the limiting reactant. (Note: The **coefficients** in front of the reactants indicate the number of reactant molecules or atoms present.)
5. 5C + 6O2 🡪 \_\_\_\_\_\_\_ CO2
6. 4Na + 8Cl2 🡪 \_\_\_\_\_\_\_ NaCl
7. 3CO2 + 4H2O 🡪 \_\_\_\_\_\_\_ H2CO3
8. 7N2 + 9H2 🡪 \_\_\_\_\_\_\_ NH3
9. 10Zn + 16HCl 🡪 \_\_\_\_\_\_\_ ZnCl2 + \_\_\_\_\_\_\_ H2