

Name: _____ Date: _____

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.)

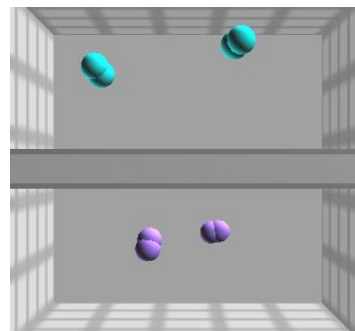
Imagine you and your friends are making hot dogs. A complete hot dog consists of a wiener and a bun. At the store, you buy four packages of eight wieners and three bags of 10 buns.

- How many total hot dogs can you make? _____
- Which ingredient limited the number of hot dogs you could make? _____
- Which ingredient will you have leftovers of? _____

Gizmo Warm-up


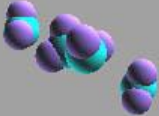
Just as ingredients can be put together to make a new food, substances can combine during a **chemical reaction** to produce new substances. The substances that undergo change are called **reactants**. The new substances are **products**.

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**.

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

Activity A: Water reaction	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Make sure H₂ + O₂ becomes H₂O is selected. • Click Reset (). 	
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Goal: Identify a limiting reactant.

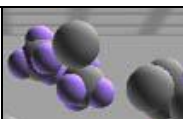
- Count: H₂O is the **chemical formula** for water. In order to produce a single molecule of water, how many hydrogen atoms are needed? _____ Oxygen atoms? _____
- Predict: Set the number of **O₂ molecules** to five and the number of **H₂ molecules** to eight.

 - How many oxygen atoms are present? _____ Hydrogen atoms? _____
 - How many water molecules could form from these reactants? _____
 - After the molecules react, which reactant will be left over? _____
 - Which reactant will be the limiting reactant? _____
 - Click **Play** and wait until **Reaction complete** is shown. What happened? _____

- Test: Click **Reset**. Set the number of **O₂ molecules** to 10.

 - 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.
 - How many water molecules will be formed? _____
 - Click **Play**. What happened? _____
- Challenge yourself: Run the Gizmo with five **O₂ molecules** and nine **H₂ molecules**.

 - How many of each molecule do you think will be produced by this reaction?
O₂: _____ H₂: _____ H₂O: _____
 - Click **Play**. How many were actually produced? O₂: _____ H₂: _____ H₂O: _____
 - How do you explain this result? _____

Activity B: Methane reaction	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Select C + H₂ becomes CH₄. 	
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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.
 - A. How many total hydrogen atoms are there? _____
 - B. How many methane molecules could form from these reactants? _____
 - C. After the atoms react, which reactant will be left over? _____
 - D. Which reactant will be the limiting reactant? _____
 - E. Click **Play** and wait until **Reaction complete** is shown. What happened? _____

3. Test: Click **Reset**. Set the number of **C atoms** to seven.
 - A. 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.
 - B. How many methane molecules will be formed? _____
 - C. 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.)
 - A. $5\text{C} + 6\text{O}_2 \rightarrow \text{_____ CO}_2$
 - B. $4\text{Na} + 8\text{Cl}_2 \rightarrow \text{_____ NaCl}$
 - C. $3\text{CO}_2 + 4\text{H}_2\text{O} \rightarrow \text{_____ H}_2\text{CO}_3$
 - D. $7\text{N}_2 + 9\text{H}_2 \rightarrow \text{_____ NH}_3$
 - E. $10\text{Zn} + 16\text{HCl} \rightarrow \text{_____ ZnCl}_2 + \text{_____ H}_2$