Name: _____   Date: _____

Student Exploration: Limiting Reactants

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

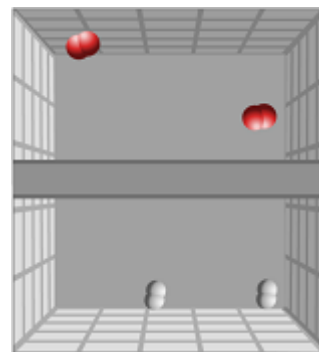**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)
Imagine you and your friends are making hot dogs. A complete hot dog consists of a wiener and a bun. At the store, you buy four packages of eight wieners and three bags of 10 buns.

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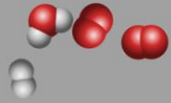
Sometimes during a chemical reaction, one type of reactant will be used up before the other reactants. This reactant is the **limiting reactant**. Using the *Limiting Reactants* Gizmo, you can determine which reactant is limiting in various scenarios.

To begin, make sure **$H_2 + O_2$ becomes H_2O** is selected. The small "2" in H_2, O_2, and H_2O is a **subscript**. Subscripts represent the number of atoms in a **molecule**.

1. Use the sliders to set the number of **O_2 molecules** and **H_2 molecules** to two.

    A. How many hydrogen molecules (H_2) are there? _____   Hydrogen atoms? _____

    B. How many oxygen molecules (O_2) are there? _____   Oxygen atoms? _____

2. How many H_2O molecules do you think will form when these four molecules react? _____

3. Click **Play** (▶). How many H_2O molecules actually formed? _____

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

Goal: Identify a limiting reactant.

1. Count: H_2O 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.
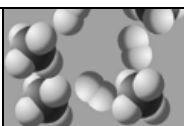
    A. How many oxygen atoms are present? _____ Hydrogen atoms? _____

    B. How many water molecules could form from these reactants? _____

    C. After the molecules 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 **O₂ molecules** to 10.

    A. How many hydrogen molecules (H_2) 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 water molecules will be formed? _____

    C. Click **Play**. What happened? _____

4. Challenge yourself: Run the Gizmo with five **O₂ molecules** and nine **H₂ molecules**.

    A. How many of each molecule do you think will be produced by this reaction?

    O_2: _____ H_2: _____ H_2O: _____

    B. Click **Play**. How many were actually produced? O_2: _____ H_2: _____ H_2O: _____

    C. How do you explain this result? _____

    _____

    _____

Activity B:	Get the Gizmo ready:
Methane reaction	• 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.

   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. $5C + 6O_2 \rightarrow$ _____ CO_2

   B. $4Na + 8Cl_2 \rightarrow$ _____ $NaCl$

   C. $3CO_2 + 4H_2O \rightarrow$ _____ H_2CO_3

   D. $7N_2 + 9H_2 \rightarrow$ _____ NH_3

   E. $10Zn + 16HCl \rightarrow$ _____ $ZnCl_2 +$ _____ H_2