Limiting Reactants

Name Key Period _____ Date _____

What is a limiting reactant?

How can you tell if you are working a limiting reactant problem?

An analogy … sandwiches!

Lets use this recipe (equation) for a sandwich …

2 pieces of bread + 3 slices of meat + 1 piece of cheese → 1 sandwich

How many complete sandwiches can be made with the following quantities found in my frig?

20 pieces of bread
24 slices of ham
12 slices of cheese

To solve this question, we will focus on only one reactant at a time, and temporarily assume that all of the other ingredients are present in sufficient quantity to use up that one reactant. The math is as follows:

20 pieces of bread X 1 sandwich / 2 slices of bread = 10 sandwiches

24 slices of ham X 1 sandwich / 3 slices of ham = 8 sandwiches

12 slices of cheese X 1 sandwich / 1 slices of cheese = 12 sandwiches

What we just did was to determine how many sandwiches could potentially be made from each ingredient. **Whatever ingredient produces the smallest quantity of the product is the limiting reactant**. A reaction will stop, or in this case sandwiches will stop being made as soon as the limiting reactant is used up. To put it another way, the quantity of products formed will be **"limited"** by the ingredient that is used up first.

What is the limiting reactant in this sandwich analogy? _____

A real example to consider …

How many grams of barium sulfate would be formed from the reaction of 50.00 g of barium chloride with 50.00 g of sodium sulfate? Which reactant is the limiting reactant?

Begin by writing a balanced equation:

$BaSO_4$
$(1)\times 137.3 = 137.3$
$(1)\times 32.1 = 32.1$
$(4)\times 16.0 = 64.0$

208.3 g/mol 142.1 g/mol 233.4 g/mol

$\underline{1}\ BaCl_2 + \underline{1}\ Na_2SO_4 \rightarrow \underline{1}\ BaSO_4 + \underline{2}\ NaCl$

50.00 g 50.00 g ? g

$BaCl_2$
molar mass
$Ba(1)\times 137.3 = 137.3$
$Cl(2)\times 35.5 = 71.0$
208.3 g/mol

Do the calculations:

50.00 g $BaCl_2$

$$\frac{\text{mol}}{208.3\ \text{g}} \quad \frac{1\ \text{mol}\ BaSO_4}{1\ \text{mol}\ BaCl_2} \quad \frac{233.4\ \text{g}}{\text{mol}} = 56.02\ \text{g}\ BaSO_4$$

$Na(2)\times 23.0 = 46.0$
$S(1)\times 32.1 = 32.1$
$O(4)\times 16 = 64.0$

50.00 g Na_2SO_4

$$\frac{\text{mol}}{142.1\ \text{g}} \quad \frac{1\ \text{mol}\ BaSO_4}{1\ \text{mol}\ Na_2SO_4} \quad \frac{233.4\ \text{g}}{\text{mol}} = 82.13\ \text{g}\ BaSO_4$$

Evaluate:
The actual amount of product, $BaSO_4$ produced by this reaction is the lesser of the two amounts above.

How much product, $BaSO_4$, is actually formed? 56.02 g $BaSO_4$

Remember, the reactant in an equation that produces the least amount of product, (the amount actually produced) is called the **"Limiting Reactant."**

What is the limiting reactant in the above reaction? $BaCl_2$