

Limiting Reactants

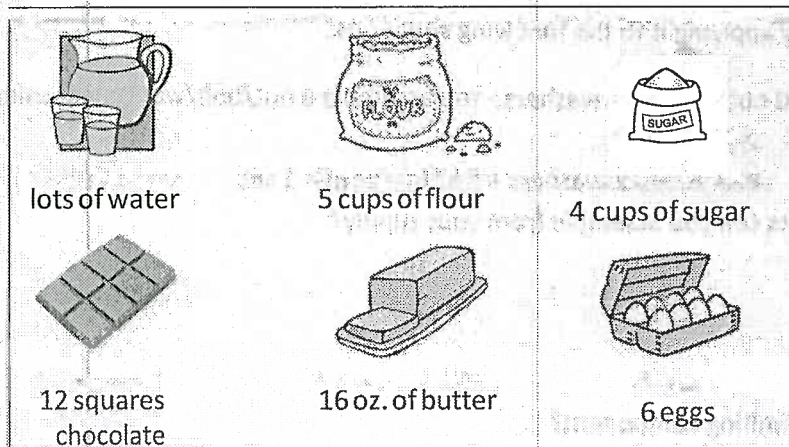
Why?

A baker is in a hurry to prepare a cake for a special order that has just been received. There is no time to go shopping, so only the ingredients that are in the bakery can be used. What if one ingredient is short of the required amount called for in the recipe? Can a cake still be made?

A cake recipe calls for:

- 2 tsp of water
- 4 cups of flour
- 8 squares of chocolate
- 4 cups of sugar
- 8 oz. of butter
- 4 eggs

Ingredients on hand:



Key Questions:

1. According to Model 1, how much of each ingredient is necessary to make a cake?

Water	Flour	Chocolate	Sugar	Butter	Eggs

2. If you follow the recipe, using only the ingredients on hand in the model, how much of each ingredient will be left over after you have baked the cake?

Water	Flour	Chocolate	Sugar	Butter	Eggs

3. Which of the ingredients on hand were excess for the recipe?

4. Which of the ingredients on hand were consumed completely in making the cake?

5. Which of the ingredients limit or prevent you from making a second cake?

6. What would be a good definition for the term *limiting ingredient*?

Test your methodology by applying it to the following situations.

7. You have 50 bolts, 150 nuts, and 150 washers. You assemble a nut/bolt/washer set using the following recipe or equation:

$$2 \text{ washers} + 1 \text{ bolt} + 1 \text{ nut} = 1 \text{ set}$$

a. How many sets can you assemble from your supply?

b. Which is the limiting component?

8. Suppose it takes (among other things) one body and four wheels to make a car. Represent this in an equation.

a. An assembly line has 50 bodies and 160 wheels. How many cars can be produced?

b. What limits the number of cars that can be produced?

Now let's do a chemical problem.

Example 1: A chemist has 203 grams of $\text{Mg}(\text{OH})_2$ and 164 grams of HCl . The chemist wants to prepare MgCl_2 , which can be used for fireproofing wood. How much MgCl_2 can the chemist produce, and how much water will be formed?

- Write a balanced equation.
- Determine (a) how many grams of MgCl_2 would be formed from 203g of $\text{Mg}(\text{OH})_2$ then (b) how many grams of MgCl_2 would be formed from 164g of HCl ?
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- Identify which reactant is the limiting reactant – (the reactant that forms LESS product)
- Determine the amount, in grams, of MgCl_2 and H_2O that will be formed, based on the limiting reactant.
- How much of the excess reactant remains after the reaction is completely consumed? Hint – you have to first calculate how many grams of the non-limiting reactant were used.
- Determine whether the reaction obeys the Law of Conservation of Mass (use masses calculated above))

Mass of Reactants

Grams of $\text{Mg}(\text{OH})_2$ =

Grams of HCl =

Total mass of
reactants =

Mass of Products

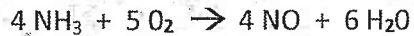
Grams of MgCl_2 =

Grams of H_2O =

Total mass of
products =

Example 2:

One of the steps in the commercial process for converting ammonia to nitric acid involves the conversion of NH_3 to NO .



In a certain experiment, 2.50 grams of NH_3 reacts with 2.85 grams of O_2 .

a. Determine how much of one product can be produced using all of **each** reactant (you can pick either product).

b. Identify which reactant is the limiting reactant – it is the one that produces the least amount of product.

c. Determine the amount, in grams, of each product (NO and H_2O) that will be formed, based on the limiting reactant.

d. How much of the excess reactant remains after the reaction is completely consumed?