

Determining Limiting Reagent

This presentation will demonstrate a step-by-step process by which one can determine the limiting reagent of a given reaction.

636/584-6688 General_tutoring@eastcentral.edu



Step 1: Begin with a balanced chemical equation with given amounts of both reactants.

- ▶ A. One of given amounts will be the limiting reagent; it will be completely used up in the course of the reaction.
- ▶ B. The other reactant will be the excess reagent; there will be some of this reactant left over when the reaction is complete.

Step 2: Convert given masses to moles.

(A) If the given amounts are expressed as grams, convert each to moles. Label the results of these calculations as **MOLES HAVE**.

(B) If the given amounts are expressed as moles, skip to step 3.

Step 3: Calculate moles that are used of one of the reactants.

- ▶ (A) Choose one of the two moles calculated from Step 2.
- ▶ (B) Convert that number of moles to moles of the other substance by multiplying by a mole/mole ratio where the coefficients from the balanced chemical equation are used in the conversion factor.
- ▶ (C) The number of moles you calculate are the number of moles used of that substance. Label that substance **MOLES NEEDED**.

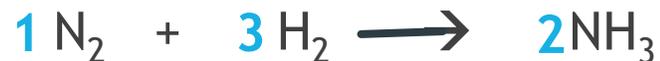
Step 4: Compare “Moles Have” with “Moles Used” to determine limiting/excess reagent.

- ▶ (A) If the calculated **MOLES NEEDED** is greater than the **MOLES HAVE** for a given reactant, then that reactant is the *limiting reagent*. In a given stoichiometry problem, you will use this reactant to determine amount of product formed.
- ▶ (B) If the calculated **MOLES NEEDED** is less than the **MOLES HAVE** for a given reactant, then that reactant is the *excess reagent*.

Example of a Limiting Reagent Problem.

You are given 10.0 grams of N₂ and 10.0 grams of H₂. Given the following reaction, which one is the limiting reagent? How much product will form?

- ▶ Step 1: Begin with a balanced chemical equation and starting amounts for each reactant.



- ▶ Step 2: Convert mass of each starting reactants to moles.

$$10.0 \text{ g N}_2 \times 1 \text{ mole N}_2 / 28.0 \text{ g N}_2 = 0.357 \text{ moles N}_2 \text{ HAVE}$$

$$10.0 \text{ g H}_2 \times 1 \text{ mole H}_2 / 2.02 \text{ g H}_2 = 4.95 \text{ moles H}_2 \text{ HAVE}$$

- ▶ Step 3: Calculate the number of moles used for each reactant.

$$0.357 \text{ moles N}_2 \times (3 \text{ moles H}_2 / 1 \text{ mole N}_2) = 1.07 \text{ moles H}_2 \text{ NEEDED}$$

or

$$4.95 \text{ moles of H}_2 \times (1 \text{ mole N}_2 / 3 \text{ moles H}_2) = 1.65 \text{ moles N}_2 \text{ NEEDED}$$

- ▶ Step 4: Compare “moles have” with “moles needed”

Since “moles needed” of N₂ (1.65 moles) exceeds the “moles have” (0.357 moles),

N₂ is the limiting reagent.

- ▶ Completing the problem, using the “moles have” of the limiting reagent:

$$0.357 \text{ moles N}_2 \times (2 \text{ moles NH}_3 / 1 \text{ mole N}_2) \times (17.0 \text{ g NH}_3 / 1 \text{ mole NH}_3) = 12.1 \text{ g NH}_3$$