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 N_2 and 10.0 grams of H_2. 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.

$$1\,N_2 + 3\,H_2 \longrightarrow 2\,NH_3$$

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

10.0 g N_2 x 1 mole N_2/28.0 g N_2 = 0.357 moles N_2 **HAVE**

10.0 g H_2 x 1 mole H_2/2.02 g H_2 = 4.95 moles H_2 **HAVE**

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

0.357 moles N_2 x (3 moles H_2/1 mole N_2)= 1.07 moles H_2 **NEEDED**

or

4.95 moles of H_2 x (1 mole N_2/3 moles H_2)= 1.65 moles N_2 **NEEDED**

- Step 4: Compare "moles have" with "moles needed"

  Since "moles needed" of N_2 (1.65 moles) exceeds the "moles have" (0.357 moles), N_2 is the limiting reagent.

- Completing the problem, using the "moles have" of the limiting reagent:
- 0.357 moles N_2 X (2 moles NH_3/1 mole N_2) X (17.0 g NH_3/1 mole NH_3) = 12.1 g NH_3