Limiting and Excess Reactants

I. Dimensional Analysis can be used to determine limiting and excess reactants

a. Limiting reactant- The REACTANT that is used up first

b. Excess reactant – The REACTANT that is left over

II.Procedure:

Limiting/Excess Reactants: *27 g of hydrogen gas* react with *15 g of oxygen gas. to form water.*

Typical Problem:

* What *mass of water* will be produced?
* Identify the limiting reactant.
* Identify the excess reactant(s) and determine the amount of excess.
* Determine the mass of water that should be produced.

a. Write and BALANCE the equation

2H2 + O2 🡪 2H2O

b. Do two separate dimensional analysis problems with each reactant as the known and the product as the unknown.

# g H2O = 27g H2 X 1mole H2 X 2mole H2O X 18g H2O = 243g H2O

2.0 g H2  2mole H2 1 mole H2O

# g H2O = 15g O2 X 1 mole O2 X 2 mole H2O X 18 g H2O = **16.8 g H2O**

32 g O2 1 mole O2 1 mole H2O

**THE LIMITING REACTANT IS THE ONE PRODUCES THE LEAST AMOUNT OF PRODUCT.**

**THE EXCESS REACTANT IS THE ONE THAT IS NOT USED UP. PRODUCES THE MOST AMOUNT OF PRODUCT.**

d. Excess reactant used- the amount of excess reactant contained in the product that is formed. Find the amount of product made. Use dimensional analysis to find the amount of excess reactant it contains.

#g H2  = 16.8g H2O X 1mole H2O X 2 mole H2 X 2grams H2 = **1.87 g H2**

18.0 g H2O 2 mole H2O 1 mole H2

e. Excess left over = amount of excess reactant before reaction – amount of excess reactant used to make product.

27.0 g H2 – 1.9 gH2 = **25.1 g H2 leftover**.

III. Theoretical Yield-The maximum amount of PRODUCT THAT COULD BE FORMED BY A PERFECT CHEMIST UNDER PERFECT CONDITIONS IN A PERFECT WORLD. It is a calculated amount using the limiting reactant.

Actual Yield – The amount of PRODUCT actually formed. It is a measured amount. Always less than or equal to the theoretical yield.

IV. Percent Yield

% yield = actual yield (from experiment) x 100

theoretical yield (from calculations)

V. Practice Problems

1. P4 (s) + O2 (g) 🡪 P4O10 (s)

a. Determine the mass of P4O10 formed if 25.0 grams of phosphorus and 50.0 grams of oxygen are combined.

b. What is the limiting reactant?

c. How much of the excess reactant remains after the reaction stops?

**Exercise 3.18 Stoichiometry: Limiting Reactant**

Nitrogen gas can be prepared by passing gaseous ammonia over solid copper(II) oxide at high temperatures. The other products of the reaction are solid copper and water vapor. If a sample containing 18.1 g of NH3 is reacted with 90.4 g of CuO, which is the limiting reactant ? How many grams of N2 will be formed?

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Given/unknown |  |  |  |  |  |  |  |  |  |
| Equation – balance |  | + |  | 🡪 |  | + |  | + |  |
| Mole ratio  (Same as coefficient) |  |  |  |  |  |  |  |  |  |
| Mass ratio  (Coefficient x m. mass) |  |  |  |  |  |  |  |  |  |
| Liter ratio  Coefficient x 22.4 L |  |  |  |  |  |  |  |  |  |