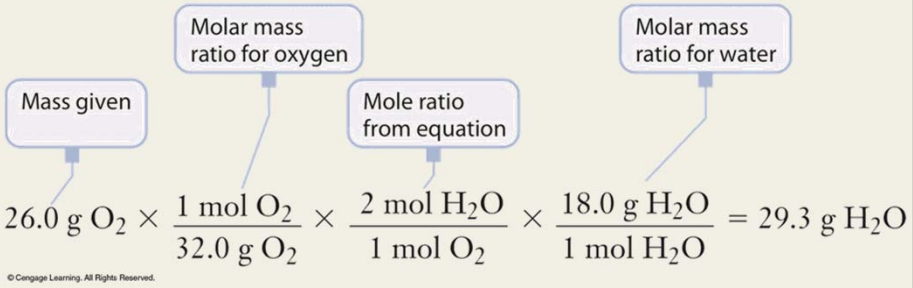
Example Problem

2) How many grams of water can be produced if sufficient hydrogen reacts with 26.0 g of oxygen? (molar mass of oxygen is 32.0 g/mol and molar mass of water is 18.0 g/mol)

$$2\,H_2(g) + O_2(g) \rightarrow 2\,H_2O(g)$$



Example Problem

3) If we have 153 g of S_8 and an excess of phosphorus, what mass of P_4S_3 can be produced in the reaction shown? (The molar mass of S_8 is 256.5 g/mol and that of P_4S_3 is 220.1 g/mol)

$$8P_4 + 3S_8 \rightarrow 8P_4S_3$$

$$153\ g\ S_8 \times \frac{1\ mol\ S_8}{256.5\ g\ S_8} \times \frac{8\ mol\ P_4S_3}{3\ mol\ S_8} \times \frac{220.1\ g\ P_4S_3}{1\ mol\ P_4S_3} = 3.50 \times 10^2\ g\ P_4S_3$$

4) In the reaction arsenic with bromine, $AsBr_5$ will form only when excess bromine is present. Write a balanced chemical equation for this reaction. Determine the minimum number of moles of bromine that are needed if 9.6 moles of arsenic is present.

5) a) Calculate the mass of Carbon required to react with 7.83 g of Fe_2O_3 according to the following equation.

$2\ Fe_2O_3 + 3\ C \longrightarrow 3\ CO2 + 4\ Fe$

(b) Calculate the mass of Iron produced?

Limiting Reactant Concept

- Say you're making grilled cheese sandwiches. You need one slice of cheese and two slices of bread to make one sandwich.

  1 Cheese + 2 Bread → 1 Whole Sandwich

- If you have five slices of cheese and eight slices of bread, how many sandwiches you can make?
- You have enough bread for four sandwiches and enough cheese for five sandwiches.
- You can only make four sandwiches; you will run out of bread before you use all the cheese.

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Limiting Reactant Concept

- Since you run out of bread first, bread is the ingredient that *limits* the number of sandwiches that you can make.
- In a chemical reaction, the ***limiting reactant/limiting reagent*** is the reactant that controls the amount of product you can make.
  - It is used up before the other reactants
- The other reactants are present in excess.
  - Known as the ***excess reactant* or *excess reagent*.**
- Note: A product can NEVER be a limiting or excess reagent!

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Determining the Limiting Reactant

If you heat 2.50 mol of Fe and 3.00 mol of S, how many moles of FeS are formed?

$$Fe(s) + S(s) \longrightarrow FeS(s)$$

- According to the balanced equation, 1 mol of Fe reacts with 1 mol of S to give 1 mol of FeS.
- So 2.50 mol of Fe will react with 2.50 mol of S to produce 2.50 mol of FeS.
- Therefore, iron is the limiting reactant and sulfur is the excess reactant.

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Example Problem

4) A solution of hydrochloric acid contains 5.22 g of HCl. When it is allowed to react with 3.25 g of solid K_2CO_3, the products are KCl, CO_2, and H_2O. Which reactant is in excess?

Skeleton equation, $HCl + K_2CO_3 \rightarrow KCl + CO_2 + H_2O$

Balanced equation: $2\ HCl + K_2CO_3 \rightarrow 2\ KCl + CO_2 + H_2O$

By using the amount of HCl given, calculate the amount of K_2CO_3 needed to completely react with HCl: (MM of HCl = 36.46 g/mol and MM of K_2CO_3 = 138.2 g/mol)

$$5.22\ g\ HCl \times \frac{1\ mol\ HCl}{36.46\ g\ HCl} \times \frac{1\ mol\ K_2CO_3}{2\ mol\ HCl} \times \frac{138.2\ g\ K_2CO_3}{1\ mol\ K_2CO_3} = 9.89\ g\ K_2CO_3$$

- So 5. 22 g HCl reacts 9.89 g K_2CO_3. But we only have 3.25 g K_2CO_3.
- K_2CO_3 limiting reactant while HCl is in excess.

Example Problem

5) If 28.2 g of P_4 is allowed to react with 18.3 g of S_8, which is the limiting reactant?

$$8P_4 + 3S_8 \rightarrow 8P_4S_3$$

You can choose either reactant and determine how much of other reactant is required to complete the reaction

Amount of S_8 needed,

$$28.2\ \text{g}\ P_4 \times \frac{1\ \text{mol}\ P_4}{123.9\ \text{g}\ P_4} \times \frac{3\ \text{mol}\ S_8}{8\ \text{mol}\ P_4} \times \frac{256.5\ \text{g}\ S_8}{1\ \text{mol}\ S_8} = 21.9\ \text{g}\ S_8$$

- So, 28. 2 g P_4 requires 21.9 g S_8 to react completely. But we have 18.3 g of S_8.
- Therefore, S_8 is the limiting reactant

6. If you mix 10.0 g of carbon with 20.0 g of sulfur, S_8, and the reaction $4C + S_8 \rightarrow 4CS_2$ occurs, what is the limiting reactant?

1) Carbon
2) Sulfur
3) Air

Answer: Sulfur