

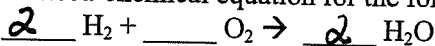
KEY

Chemistry I (1) Review Chapter 9

Name:

Ideal Stoichiometry (No limiting reactants) & Percent Yield

1. The *unbalanced* chemical equation for the formation of water is:



a. If 3.3 mol O₂ are used, how many liters of H₂ are needed?

$$3.3 \text{ mol O}_2 \left| \frac{2 \text{ H}_2}{1 \text{ O}_2} \right| \left| \frac{22.4 \text{ L H}_2}{1 \text{ mol H}_2} \right| = 147.84 \text{ L} \rightarrow 150 \text{ L H}_2 \text{ or } 1.5 \times 10^2 \text{ L H}_2$$

b. How many grams O₂ must react with excess H₂ to form 6.72 grams H₂O?

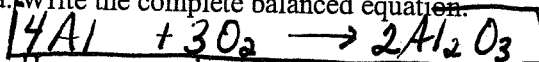
$$6.72 \text{ g H}_2\text{O} \left| \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \right| \left| \frac{1 \text{ O}_2}{2 \text{ H}_2\text{O}} \right| \left| \frac{32.00 \text{ g O}_2}{1 \text{ mol O}_2} \right| = 5.96 \text{ g O}_2$$

c. If you wanted to make 8.12 grams H₂O, how many molecules of H₂ would you need?

$$8.12 \text{ g H}_2\text{O} \left| \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \right| \left| \frac{2 \text{ H}_2}{2 \text{ H}_2\text{O}} \right| \left| \frac{6.02 \times 10^{23} \text{ molec H}_2}{1 \text{ mol H}_2} \right| = 2.71 \times 10^{23} \text{ molec H}_2$$

2. Aluminum reacts with oxygen to form aluminum oxide.

a. Write the complete balanced equation.



b. How many moles of O₂ are needed to react with 1.44 mol of aluminum?

$$1.44 \text{ mol Al} \left| \frac{3 \text{ O}_2}{4 \text{ Al}} \right| = 1.08 \text{ mol O}_2$$

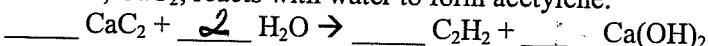
c. How many grams of aluminum oxide can be made if 5.23 grams Al completely react?

$$5.23 \text{ g Al} \left| \frac{1 \text{ mol Al}}{26.98 \text{ g Al}} \right| \left| \frac{2 \text{ Al}_2\text{O}_3}{4 \text{ Al}} \right| \left| \frac{101.96 \text{ g Al}_2\text{O}_3}{1 \text{ mol Al}_2\text{O}_3} \right| = 9.88 \text{ g Al}_2\text{O}_3$$

d. How many grams of aluminum oxide can be formed by the reaction of 38.8 L of oxygen gas?

$$38.8 \text{ L O}_2 \left| \frac{1 \text{ mol O}_2}{22.4 \text{ L O}_2} \right| \left| \frac{2 \text{ Al}_2\text{O}_3}{3 \text{ O}_2} \right| \left| \frac{101.96 \text{ g Al}_2\text{O}_3}{1 \text{ mol Al}_2\text{O}_3} \right| = 117.74 \text{ g} \rightarrow 118 \text{ g Al}_2\text{O}_3$$

3. Calcium carbide, CaC₂, reacts with water to form acetylene.



a. How many grams of water are needed to react with 485 g of calcium carbide?

$$485 \text{ g CaC}_2 \left| \frac{1 \text{ mol CaC}_2}{64.10 \text{ g CaC}_2} \right| \left| \frac{2 \text{ H}_2\text{O}}{1 \text{ CaC}_2} \right| \left| \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} \right| = 272.69 \text{ g} \rightarrow 273 \text{ g H}_2\text{O}$$

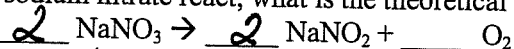
b. How many grams of CaC₂ could make 23.6 g C₂H₂?

$$23.6 \text{ g C}_2\text{H}_2 \left| \frac{1 \text{ mol C}_2\text{H}_2}{26.02 \text{ g C}_2\text{H}_2} \right| \left| \frac{1 \text{ CaC}_2}{1 \text{ C}_2\text{H}_2} \right| \left| \frac{64.10 \text{ g CaC}_2}{1 \text{ mol CaC}_2} \right| = 58.14 \text{ g} \rightarrow 58.1 \text{ g CaC}_2$$

c. If 55.3 g Ca(OH)₂ are formed, how many grams of water reacted?

$$55.3 \text{ g Ca(OH)}_2 \left| \frac{1 \text{ mol Ca(OH)}_2}{74.02 \text{ g Ca(OH)}_2} \right| \left| \frac{2 \text{ H}_2\text{O}}{1 \text{ Ca(OH)}_2} \right| \left| \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} \right| = 26.93 \text{ g} \rightarrow 26.9 \text{ g H}_2\text{O}$$

4. If 156 g of sodium nitrate react, what is the theoretical yield of sodium nitrite?



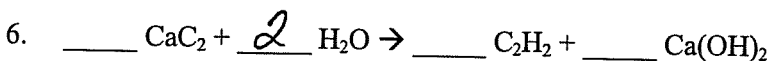
$$156 \text{ g NaNO}_3 \left| \frac{1 \text{ mol NaNO}_3}{85 \text{ g NaNO}_3} \right| \left| \frac{2 \text{ NaNO}_2}{2 \text{ NaNO}_3} \right| \left| \frac{69.01 \text{ g NaNO}_2}{1 \text{ mol NaNO}_2} \right| = 126.65 \text{ g} \rightarrow 127 \text{ g NaNO}_2$$

5. If the actual yield of sodium nitrite from problem number 5 is 112 g, what is the percent yield?

$$\frac{112}{127} \times 100 = 88.2\%$$

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Limiting Reactant/Excess Reactant/ Theoretical Yield



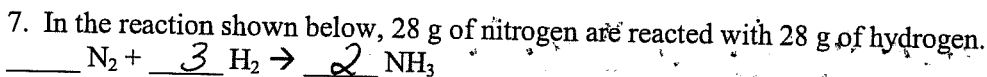
If 64 g CaC_2 is reacted with 64 g H_2O ,

What is the limiting reactant? What is the excess reactant? — H_2O

CaC_2	H_2O
$\frac{64 \text{ g CaC}_2}{1 \text{ mol CaC}_2} \cdot \frac{1 \text{ mol C}_2\text{H}_2}{1 \text{ mol CaC}_2} = 26.04 \text{ g C}_2\text{H}_2$	$\frac{64 \text{ g H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \cdot \frac{1 \text{ mol C}_2\text{H}_2}{2 \text{ mol H}_2\text{O}} = 1.78 \text{ mol C}_2\text{H}_2 = 46.2 \text{ g C}_2\text{H}_2$
$\frac{64 \text{ g CaC}_2}{64.1 \text{ g CaC}_2} \cdot \frac{1 \text{ mol C}_2\text{H}_2}{1 \text{ mol CaC}_2} = 25.99 \rightarrow 26 \text{ g C}_2\text{H}_2$	

How many grams of C_2H_2 is formed?

\downarrow
 $26 \text{ g C}_2\text{H}_2$



What is the limiting reactant? What is the excess reactant? — H_2

N_2	H_2
$\frac{28 \text{ g N}_2}{28.02 \text{ g N}_2} \cdot \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} = 17.04 \text{ g NH}_3$	$\frac{28 \text{ g H}_2}{2.02 \text{ g H}_2} \cdot \frac{2 \text{ mol NH}_3}{3 \text{ mol H}_2} = 18.74 \text{ g NH}_3$
$\frac{28 \text{ g N}_2}{28.02 \text{ g N}_2} \cdot \frac{1 \text{ mol NH}_3}{1 \text{ mol N}_2} = 34.06 \text{ g NH}_3$	$\frac{28 \text{ g H}_2}{2.02 \text{ g H}_2} \cdot \frac{1 \text{ mol NH}_3}{3 \text{ mol H}_2} = 157.4 \rightarrow 160 \text{ g NH}_3$

How many grams of NH_3 can be produced?

\downarrow
 34 g NH_3

How much excess reactant remains?

$\frac{28 \text{ g N}_2}{28.02 \text{ g N}_2} \cdot \frac{3 \text{ mol H}_2}{1 \text{ mol N}_2} = 6.06 \text{ g H}_2$	\leftarrow used	$28 \text{ g} - 6.06 \text{ g} = 21.94 \text{ g}$	\rightarrow excess
$\frac{28 \text{ g H}_2}{2.02 \text{ g H}_2} \cdot \frac{1 \text{ mol H}_2}{1 \text{ mol H}_2} = 13.86 \text{ g H}_2$	have - used =	21.94 g	excess

Do you know:

- The difference between the limiting reactant and the excess reactant? Why is it important to know which is which for a reaction?
- The difference between the theoretical yield and actual yield? Is the TY usually = to the AY? Why or why not? If not how do they usually compare?
- Where do mole ratios come from? What do we use them for?