SCH 3UI Unit 7 Outline
Stoichiometry

Lesson	Topics Covered	Handouts to Print	Homework Questions and Assignments
1	**Note: Stoichiometry** • definition • the meaning of the coefficients in balanced chemical reactions • mole – mole calculations	Stoichiometry 1: Mole – Mole Problems	• complete handout: Stoichiometry 1: Mole – Mole Problems
2	**Note: Stoichiometry using Mass and Volume** • mole – mass calculations • mole – volume calculations • mass – volume calculations	Stoichiometry II: Mass Problems Stoichiometry III: Volume of Gas Problems	• do (at least) questions 1, 2, 4 and 6 on handout: Stoichiometry II: Mass Problems • do (at least) questions 1, 3 and 6 on handout: Stoichiometry III: Volume of Gas Problems
3	**Lab #7** • prelab and begin Lab #7 • theoretical yield and percentage yield	Lab #7 (handed out in class)	• begin lab report for Lab #7 • continue practicing stoichiometry problems from handouts
4	**Note: "Harder" Stoichiometry Problems** • example calculations	Stoichiometry IV: "Harder" Mass and Volume Problems	• complete handout: Stoichiometry IV: "Harder" Mass and Volume Problems
5	**Note: Limiting Factors** • definition and significance of limiting factor • determining the limiting factor, sample calculations	Stoichiometry V: Introduction to Limiting Factor Problems	• complete handout: Stoichiometry V: Introduction to Limiting Factor Problems
6	**Note: Limiting Factors (cont) examples and practice**	Stoichiometry VI: Limiting Factor Problems with Gases Stoichiometry: Final Review Problems	• do (at least) questions 4 and 5 on Stoichiometry VI: Limiting Factor Problems with Gases • begin Unit 07 Review: Stoichiometry
7	**Unit Test**		

Stoichiometry I: Mole-Mole Problems

1. For the reaction: $Cu_{(s)} + 2\ AgNO_{3\ (aq)} \longrightarrow Cu(NO_3)_{2\ (aq)} + 2\ Ag_{(s)}$

a) How many moles of silver are formed when 1 mole of copper is reacted?
b) How many moles of copper (II) nitrate are formed if 4 moles of $AgNO_3$ are reacted?
c) How many moles of copper are reacted when 10 moles of silver are formed?

2. For the reaction: $4\ Fe_{(s)} + 3\ O_{2\ (g)} \longrightarrow 2\ Fe_2O_{3\ (s)}$

a) How many moles of Fe are required to produce 6.0 moles of Fe_2O_3?
b) How many moles of O_2 are used up when 1.0 mole of Fe_2O_3 is produced?
c) How many moles of O_2 are needed to react with 3.00 moles of Fe?
d) How many moles of Fe_2O_3 will form if 0.80 mole of iron are reacted?

3. For the reaction: $3\ Cu_{(s)} + 8\ HNO_{3\ (aq)} \longrightarrow 3\ Cu(NO_3)_{2\ (aq)} + 2\ NO_{(g)} + 4\ H_2O_{(v)}$

a) How many moles of NO are produced from 4.00 moles of copper metal reacting?
b) How many moles of nitric acid are required to react completely with 2.00 moles of copper metal?
c) How many moles of nitric acid are required to react if 2 moles of water are formed?

4. For the reaction: $C_3H_{8\ (l)} + 5\ O_{2\ (g)} \longrightarrow 3\ CO_{2\ (g)} + 4\ H_2O_{(v)}$

a) How many moles of oxygen gas are required to react with 3.55 moles of C_3H_8 (l)?
b) If 1.78 moles of CO_2 are formed, how many moles of C_3H_8 (l) were burned?
c) How many moles of water are formed when 14.22 moles of oxygen gas react with C_3H_8 (l)?
d) If 0.0034 moles of carbon dioxide are formed, how many moles of water vapour are also produced?

Answers:
1a) 2 mol Ag form
b) 2 mol $Cu(NO_3)_2$ form
c) 5 mol Cu react

2a) 12 mol Fe required
b) 1.5 mol O_2 used up
c) 2.25 mol of O_2 required
d) 0.40 mol of Fe_2O_3 will form

3a) 2.67 mol NO produced
b) 5.33 mol HNO_3 reacted
c) 4 mol HNO_3 required

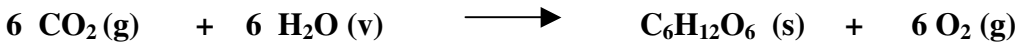
4a) 17.75 moles O_2 required
b) 0.593 moles C_3H_8 burned
c) 11.38 moles H_2O formed
d) 0.0045 moles of H_20 formed

Stoichiometry II: Mass Problems

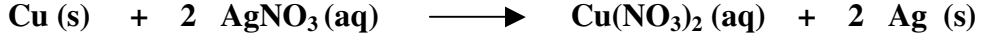
1. How many grams of carbon dioxide are produced when 48.0 grams of carbon are burned?

2. For the reaction 

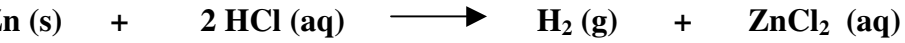
a) What mass of oxygen is formed by the reaction of 102 grams of $KClO_3$?
b) How many grams of $KClO_3$ must be used in order to produce 25 grams of KCl?

3. 

a) What mass of water is needed to produce 50.0 g of $C_6H_{12}O_6$?
b) How many grams of carbon dioxide are needed to react with 18.0 g of water?

4. For the reaction: 

a) How many grams of copper can react with 10.0 g of silver nitrate?
b) What mass of silver is formed when 5.0 g of copper react with silver nitrate?
c) Calculate the mass of copper (II) nitrate produced by the reaction of 1.0 g of silver nitrate with copper.

5. For the reaction: 

What mass of zinc chloride is produced by the reaction of 2.3 g of zinc?

6. For the reaction 

a) How much sulfur can react with 1.0 g of lead?
b) If 1.00 g of lead and 3.00 g of sulfur are mixed and reacted, how much of the sulfur will not react? (Use your answer from part "a" to help determine your answer.)

Answers:
1. 176 g of CO_2
2a) 39.9510 g = 40.0 g of O_2
2b) 41 g of $KClO_3$
3a) 30.0 g of water
3b) 44.0 g of carbon dioxide
4a) 1.87 g of copper
4b) 17 g of silver
4c) 0.55 g of copper (II) nitrate
5. 4.8 g of zinc chloride
6a) 0.15 g of sulfur
6b) 2.85 g of sulfur will not react

Stoichiometry III: Volume of Gas Problems

1. For the reaction: $\mathbf{2\ NH_3\ (g) \longrightarrow 3\ H_2\ (g) + N_2\ (g)}$

   What volume of nitrogen gas will be produced when 48.4 L of ammonia (NH_3) are broken down? (all gases are at STP)

2. For the reaction:

   $\mathbf{3\ Cu\ (s) + 8\ HNO_3\ (aq) \longrightarrow 3\ Cu(NO_3)_2\ (aq) + 2\ NO\ (g) + 4\ H_2O\ (l)}$

   How many litres of NO gas at STP will be produced when 12.0 g of copper react with excess HNO_3?

3. For the reaction: $\mathbf{C_3H_8\ (g) + 5\ O_2\ (g) \longrightarrow 4\ H_2O\ (v) + 3\ CO_2\ (g)}$

a) What mass of water is produced if 60.0 L of propane gas (C_3H_8) at STP are reacted with excess oxygen?
b) What volume of O_2 gas, at STP, is required to produce 250.0 g of CO_2?

4. For the reaction: $\mathbf{Mg\ (s) + 2\ HCl\ (aq) \longrightarrow H_2\ (g) + MgCl_2\ (aq)}$

   What volume of H_2 gas will be produced when 200.0 g of Mg react with excess HCl?

5. For the reaction: $\mathbf{2\ C_8H_{18}\ (l) + 25\ O_2\ (g) \longrightarrow 18\ H_2O\ (v) + 16\ CO_2\ (g)}$

What volume of O_2 gas must be present at STP in order for 120.0 g of octane (C_8H_{18}) to completely react?

6. For the reaction: $\mathbf{XeF_6\ (s) + 3\ H_2O\ (l) \longrightarrow XeO_3\ (g) + 6\ HF\ (g)}$

a) How many moles of water are needed to produce 20.0 L of XeO_3 at STP?
b) How many litres of HF gas are formed by the reaction of 20.0 g XeF_6 with excess H_2O?

7. For the reaction:

   $\mathbf{3\ Ag\ (s) + 4\ HNO_3\ (aq) \longrightarrow 3\ AgNO_3\ (aq) + NO\ (g) + 2\ H_2O\ (l)}$

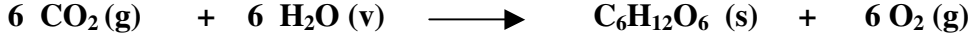
   What is the volume at STP of the NO (gas) produced when 5.0 g of silver are reacted?

Answers:
1. 24.2 L of N_2 produced
2. 2.82 L of NO produced
3a) 193 g of water produced
3b) 212 L of O_2 required
4. 184 L of H_2 produced
5. 294 L of O_2 required
6a) 2.68 moles of H_2O required
6b) 11.0 L of HF produced (3 sig digs, round up from 10.96 L)
7. 0.35 L of NO produced

Stoichiometry IV: "Harder" Mass and Volume Problems

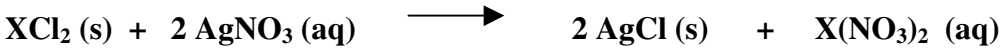
1. Consider the combustion of octane with excess oxygen:

a) What volume of oxygen is needed to completely burn 100.0 g of octane?
b) Given that air is 20.9 % oxygen, what volume of **air** is needed to completely burn 100.0 g of octane?

2. For the reaction 

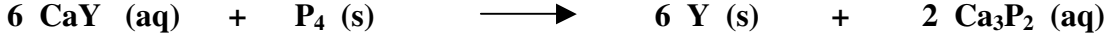
a) What volume of carbon dioxide gas is needed to produce 250.0 g of $C_6H_{12}O_6$?
b) Given that air is 0.035% carbon dioxide, what volume of air is required to supply this amount of carbon dioxide?

3. "X" is an unknown element that reacts with silver nitrate according to the equation:



When 11.10 g of compound XCl_2 are reacted with excess silver nitrate, 28.66 g of silver chloride are produced.
a) What is the molar mass of element "X" ?
b) What is the probable identity of element "X" ?

4. "Y" , an unknown non-metal, is displaced by phosphorus according to the following equation:



When 97.40 g of compound CaY are reacted with excess phosphorus, 81.98 g of calcium phosphide are formed.
a) What is the molar mass of element "Y" ?
b) What is the probable identity of element "Y" ?

5. X is an unknown element. For the reaction:

When 50.0 g of XH_3 are reacted, 79.3 g of water are produced. What is the molar mass and probable identity of X?

Answers:

1a) 245 L of O_2
1b) 1.17×10^3 L of air
2a) 186 L of CO_2
2b) 5.3×10^5 L of air (2 sig digs)
3a) MM of XCl_2 is 111.02 g/mol, MM of X is 40.1 g/mol
3b) X is probably calcium
4a) MM of CaY is 72.15 g/mol, MM of Y is 32.07 g/mol
4b) Y is probably sulfur
5) MM of XH_3 is 17.04 g/mol, MM of X is 14.01 g/mol
X is probably nitrogen, N

Stoichiometry V: Introduction to Limiting Factor Problems

1. For the reaction: **2 Mg (s) + O_2 (g) ⟶ 2 MgO (s)**

   Which element is the limiting factor when 3.00 g of magnesium are reacted with 2.20 g of oxygen gas? What mass of magnesium oxide is formed?

2. For the reaction: **2 Al (s) + 3 S (s) ⟶ Al_2S_3 (s)**

   If 10.0 g of sulfur and 5.00 g of aluminum are reacted, which element will determine the amount of aluminum sulfide that is produced? What mass of aluminum sulfide is formed?

3. For the reaction: **3 Zn (s) + 2 MoO_3 (aq) ⟶ Mo_2O_3 (aq) + 3 ZnO (s)**

   What mass of ZnO is formed when 20.0 g of molybdenum (VI) oxide are reacted with 10.0 g zinc?

4. When 13.7 g of bismuth metal and 9.11 g of chlorine gas are combined in a reaction vessel, a synthesis reaction occurs. What mass of bismuth (III) chloride is formed?

Answers:

1. Magnesium is the limiting factor: 4.97 g of MgO will form.
2. Al is the limiting factor, so the amount of Al will determine how much Al_2S_3 is produced. The mass of Al_2S_3 produced is 13.9 g.
3. Zn is the limiting factor: 12.4 g of ZnO are produced.
4. The reaction is 2 Bi (s) + 3 Cl_2 (g) → 2 $BiCl_3$ (s).
   Bismuth is the limiting factor: 20.7 g of $BiCl_3$ (s) is produced.

Stoichiometry Questions VI: Limiting Factor Problems with Gases

1. For the reaction: **$2\ Na\ (s) + Cl_2\ (g) \longrightarrow 2\ NaCl\ (s)$**

   What mass of NaCl is formed when 0.948 L of chlorine gas react with 2.0 g of sodium?

2. Pentane, a fuel, reacts with oxygen to form carbon dioxide and water according to the equation:

   $C_5H_{12}\ (l) + 8\ O_2\ (g) \longrightarrow 5\ CO_2\ (g) + 6\ H_2O\ (v)$

   How many litres of CO_2 will form when 60.0 g of pentane react with 300.0 L of O_2 gas at STP?

3. For the reaction: **$CS_2\ (g) + 3\ O_2\ (g) \longrightarrow CO_2\ (g) + 2\ SO_2\ (g)$**

   How many grams of sulfur dioxide will form when 63.0 L of carbon disulfide react with 142.0 L of oxygen gas, at STP?

4. For the reaction of boron nitride and fluorine gas, what volume of boron trifluoride will form when 24.0 g of BN react with 22.0 L of F_2?

   $2\ BN\ (g) + 3\ F_2\ (g) \longrightarrow 2\ BF_3\ (g) + N_2\ (g)$

5. An unknown element "X" completely reacts with exactly 24.73 L of oxygen gas, at STP, to form 75.04 g of X_2O_3 according to the equation:

   $4\ X\ (s) + 3\ O_2\ (g) \longrightarrow 2\ X_2O_3\ (s)$

   What is the molar mass of X? What is its likely identity?

Answers:

1. Sodium is in excess, chlorine gas is the limiting factor. 4.95 g of sodium chloride is produced.
2. Oxygen is in excess, pentane is the limiting factor. 93.1 L of CO_2 will form.
3. CS_2 is in excess, oxygen is the limiting factor. 271 g of SO_2 will form.
4. BN is in excess, fluorine is the limiting factor. 14.7 L of BF_3 gas will form.
5. Molar mass of X is 26.98 g/mole. (27.0 g/mol, with sig digs). X is likely aluminum.