Chemistry 11 Stoichiometry Review Assignment

Name: _____ **Date:**_____ **Block:** _____

Answer the following practice questions on a separate page

Define the following terms:

1. Stoichiometry: quantitative relationships among substances as they participate in chemical reactions
2. Stoichiometric ratio: the molar ratio of substances in a chemical reaction (coefficients in a balanced chemical equation)
3. Limiting reactant the reactant in a chemical reaction is the substance that is totally consumed when the chemical reaction is complete. The amount of product formed is limited by this **reagent**, since the reaction cannot continue without it.
4. Excess reactant In a chemical reaction, reactants that are not use up when the reaction is finished are called excess reagents.
5. Percent yield is calculated to be the experimental **yield** divided by theoretical **yield** multiplied by 100%.

(Mole-Mole Conversions)

6. The combustion of the organic fuel, decane, is outlined in the chemical equation below. You must balance the equation in order to answer the subsequent questions a-c.

a. How many moles of CO_2 are produced if 5.0 moles of $C_{10}H_{22}$ react with an excess of O_2?

b. How many moles of O_2 react with 0.75 moles of $C_{10}H_{22}$?

c. How many moles of O_2 would be required to produce 4.0 moles of H_2O?

a) $5.0 \text{ mol } C_{10}H_{22} \left| \frac{20 \text{ mol } CO_2}{2 \text{ mol } C_{10}H_{22}} \right. = \boxed{5.0 \times 10^1 \text{ mol } CO_2}$

b) $0.75 \text{ mol } C_{10}H_{22} \left| \frac{31 \text{ mol } O_2}{2 \text{ mol } C_{10}H_{22}} \right. = \boxed{12 \text{ mol } O_2}$

c) $4.0 \text{ mol } H_2O \left| \frac{31 \text{ mol } O_2}{22 \text{ mol } H_2O} \right. = \boxed{5.6 \text{ mol } O_2}$

7. Use the following equation to solve the problems below:

$$3\ SiO_2 + 4\ Al \longrightarrow 3\ Si + 2\ Al_2O_3$$

a. If 6.0 moles of SiO_2 react, how many moles of:

i. Al react?

ii. Si are produced?

iii. Al_2O_3 are produced?

b. If 2.5 moles of Al_2O_3 are produced, how many moles of:

i. Al react?

ii. SiO_2 react?

a) i) $\frac{6.0\ mol\ SiO_2 \mid 4\ mol\ Al}{3\ mol\ SiO_2} = 8.0\ mol\ Al$

ii) $\frac{6.0\ mol\ SiO_2 \mid 3\ mol\ Si}{3\ mol\ SiO_2} = 6.0\ mol\ Si$

iii) $\frac{6.0\ mol\ SiO_2 \mid 2\ mol\ Al_2O_3}{3\ mol\ SiO_2} = 4.0\ mol\ Al_2O_3$

b) i) $\frac{2.5\ mol\ Al_2O_3 \mid 4\ mol\ Al}{2\ mol\ Al_2O_3} = 5.0\ mol\ Al$

ii) $\frac{2.5\ mol\ Al_2O_3 \mid 3\ mol\ SiO_2}{2\ mol\ Al_2O_3} = 3.8\ mol\ SiO_2$

(Mole-Mass / Mass-Mole Conversions)

8. $N_2 + 2O_2 \rightarrow N_2O_4$

a) If 15.0g of N_2O_4 was produced, how many moles of O_2 were required?

$$\frac{15.0g\ N_2O_4 \mid 1\ mol\ N_2O_4 \mid 2\ mol\ O_2}{92.0g\ N_2O_4 \mid 1\ mol\ N_2O_4} = 0.326\ mol\ O_2$$

b) If 4.0×10^{-3} moles of oxygen reacted, how many grams of N_2 were needed?

$$\frac{4.0 \times 10^{-3}\ mol\ O_2 \mid 1\ mol\ N_2 \mid 28.0g\ N_2}{2\ mol\ O_2 \mid 1\ mol\ N_2} = 5.6 \times 10^{-2}\ g\ N_2$$

9. $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$ How many moles of Cu are needed to react with 3.50g of $AgNO_3$?

$$\frac{3.50g\ AgNO_3 \mid 1\ mol\ AgNO_3 \mid 1\ mol\ Cu}{169.9g\ AgNO_3 \mid 2\ mol\ AgNO_3} = 1.03 \times 10^{-2}\ mol\ Cu$$

10. Mercury (II) oxide decomposes into mercury and oxygen gas.

a) Write and balance the equation.

$2HgO \rightarrow 2Hg + O_2$

b) How many moles of mercury (II) oxide are needed to produce 125g of oxygen?

$$125g\ O_2 \left| \frac{1\ mol\ O_2}{32.0\ g\ O_2} \right| \frac{2\ mol\ HgO}{1\ mol\ O_2} = 7.81\ mol\ HgO$$

c) How many grams of mercury are produced if 24.5 moles of mercury (II) oxide decomposes?

$$24.5\ mol\ HgO \left| \frac{2\ mol\ Hg}{2\ mol\ HgO} \right| \frac{200.6g\ Hg}{1\ mol\ Hg} = 4.91 \times 10^3\ g\ Hg$$

(Mass-Mass Conversions)

11. $Li_3N_{(s)} + 3H_2O_{(l)} \rightarrow NH_{3(g)} + 3LiOH_{(aq)}$

a. What mass of lithium hydroxide are produced when 0.38g of lithium nitride react?

$$0.38g\ Li_3N \left| \frac{1\ mol\ Li_3N}{34.7g\ Li_3N} \right| \frac{3\ mol\ LiOH}{1\ mol\ Li_3N} \left| \frac{23.9\ g\ LiOH}{1\ mol\ LiOH} \right. = 0.79g\ LiOH$$

b. How many grams of lithium nitride would react with 4.05g of H_2O?

$$4.05g\ H_2O \left| \frac{1\ mol\ H_2O}{18.0g\ H_2O} \right| \frac{1\ mol\ Li_3N}{3\ mol\ H_2O} \left| \frac{34.7g\ Li_3N}{1\ mol\ Li_3N} \right. = 2.60g\ Li_3N$$

12. In the combustion of 54.50g of butane (C_4H_6), how many grams of CO_2 are produced? Write and balance the equation before solving.

$2C_4H_6 + 11O_2 \rightarrow 8CO_2 + 6H_2O$

$$54.50g\ C_4H_6 \left| \frac{1\ mol\ C_4H_6}{54.0g\ C_4H_6} \right| \frac{8\ mol\ CO_2}{2\ mol\ C_4H_6} \left| \frac{44.0g\ CO_2}{1\ mol\ CO_2} \right. = 178g\ CO_2$$

13. In the following **unbalanced** equation,

$4\ FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$

a) How many grams of iron (IV) sulphide are used when 9.0g of O_2 react?

$$9.0g\ O_2 \left| \frac{1\ mol\ O_2}{32.0g\ O_2} \right| \frac{4\ mol\ FeS_2}{11\ mol\ O_2} \left| \frac{120.0g\ FeS_2}{1\ mol\ FeS_2} \right. = 12g\ FeS_2$$

b) What is the mass of iron (III) oxide produced when 25.0g of iron (IV) sulphide are used?

$$25.0g\ FeS_2 \left| \frac{1\ mol\ FeS_2}{120.0g\ FeS_2} \right| \frac{2\ mol\ Fe_2O_3}{4\ mol\ FeS_2} \left| \frac{159.6g\ Fe_2O_3}{1\ mol\ Fe_2O_3} \right. = 16.6g\ Fe_2O_3$$

14. $Cu + 2AgNO_3 \rightarrow 2Ag + Cu(NO_3)_2$

How many grams of silver are produced when 36.92g of copper react?

36.92g Cu	1 mol Cu	2 mol Ag	107.9g Ag	= 125g Ag
	63.5g Cu	1 mol Cu	1 mol Ag	

15. ___$Al_2(SO_4)_3$ + ___$Ca(OH)_2 \rightarrow$ ___$Al(OH)_3$ + ___$CaSO_4$

Balance and answer the following questions.

$Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow 2Al(OH)_3 + 3CaSO_4$

a. What mass of aluminum (III) hydroxide are produced if 165.7g of aluminum (III) sulfate react?

165.7g $Al_2(SO_4)_3$	1 mol $Al_2(SO_4)_3$	2 mol $Al(OH)_3$	78.0g $Al(OH)_3$	= 75.5g $Al(OH)_3$
	342.3g $Al_2(SO_4)_3$	1 mol $Al_2(SO_4)_3$		

b. How many grams of calcium hydroxide are needed to form 6.35g of calcium sulphate?

6.35g $CaSO_4$	1 mol $CaSO_4$	3 mol $Ca(OH)_2$	74.1g $Ca(OH)_2$	= 3.45g $Ca(OH)_2$
	136.2g $CaSO_4$	3 mol $CaSO_4$	1 mol $Ca(OH)_2$	

(Mass- Volume/ Volume-Volume Conversions)

16. Given the following equation:

$3\ NO_{2\ (g)} + H_2O_{(l)} \longrightarrow 2\ HNO_{3\ (aq)} + NO_{(g)}$ Assume STP

a. What mass of water is required to react with 15.5 L of Nitrogen dioxide?

b. What volume of Nitrogen monoxide would be produced from 100.0 g of water?

c. If 42.0 L of $NO_{(g)}$ is produced, what volume of $NO_{2\ (g)}$ reacted?

a. $15.5\ L\ NO_2 \left| \frac{1\ mol\ NO_2}{22.4\ L\ NO_2} \right| \frac{1\ mol\ H_2O}{3\ mol\ NO_2} \left| \frac{18.0\ g\ H_2O}{1\ mol\ H_2O} \right| = 4.15\ g\ H_2O$

b. $100.0\ g\ H_2O \left| \frac{1\ mol\ H_2O}{18.0\ g\ H_2O} \right| \frac{1\ mol\ NO}{1\ mol\ H_2O} \left| \frac{22.4\ L\ NO}{1\ mol\ NO} \right| = 124\ L\ NO$

c. $42.0\ L\ NO \left| \frac{1\ mol\ NO}{22.4\ L\ NO} \right| \frac{3\ mol\ NO_2}{1\ mol\ NO} \left| \frac{22.4\ L\ NO_2}{1\ mol\ NO_2} \right| = 126\ L\ NO_2$

17. When Magnesium reacts with Nitric Acid, Hydrogen gas and aqueous Magnesium nitrate are formed. What volume of Hydrogen gas will be produced if 40.0 g of Magnesium is reacted with an excess of Nitric Acid?

$$Mg_{(s)} + 2HNO_{3(aq)} \longrightarrow Mg(NO_3)_{2(aq)} + H_{2(g)}$$

$$40.0\text{ g Mg} \left| \frac{1\text{ mol Mg}}{24.3\text{ g Mg}} \right| \frac{1\text{ mol H}_2}{1\text{ mol Mg}} \left| \frac{22.4\text{ L H}_2}{1\text{ mol H}_2} \right| = \boxed{36.9\text{ L H}_2}$$

18. The corrosion (rusting) of iron is represented as follows: (at STP)

$$3\ O_{2\,(g)} + 4\ Fe_{(s)} \longrightarrow 2\ Fe_2O_{3\,(s)}$$

a. What volume of Oxygen gas would be required to produce 16.0 g of Fe_2O_3?

b. What mass of Iron would be required to react with 10.0 L of O_2 gas?

$$16.0\text{ g } Fe_2O_3 \left| \frac{1\text{ mol } Fe_2O_3}{159.6\text{ g } Fe_2O_3} \right| \frac{3\text{ mol } O_2}{2\text{ mol } Fe_2O_3} \left| \frac{22.4\text{ L } O_2}{1\text{ mol } O_2} \right| = \boxed{3.37\text{ L } O_2}$$

b. $$10.0\text{ L } O_2 \left| \frac{1\text{ mol } O_2}{22.4\text{ L } O_2} \right| \frac{4\text{ mol Fe}}{3\text{ mol } O_2} \left| \frac{55.8\text{ g Fe}}{1\text{ mol Fe}} \right| = \boxed{33.2\text{ g Fe}}$$

19. Mercury (II) oxide decomposes when heated to produce liquid Mercury and Oxygen gas. What mass of Mercury (II) oxide would be required to produce 30.5 L of Oxygen gas? (Assume STP)

$$2HgO \longrightarrow 2Hg_{(l)} + O_{2(g)}$$

i) $$30.5\text{ L } O_2 \left| \frac{1\text{ mol } O_2}{22.4\text{ L } O_2} \right| \frac{2\text{ mol HgO}}{1\text{ mol } O_2} \left| \frac{216.6\text{ g HgO}}{1\text{ mol HgO}} \right| = \boxed{5.90 \times 10^2\text{ g HgO}}$$

ii) $$295\text{ g HgO} \left| \frac{1\text{ mol HgO}}{216.6\text{ g HgO}} \right| \frac{2\text{ mol Hg}}{2\text{ mol HgO}} \left| \frac{200.6\text{ g Hg}}{1\text{ mol Hg}} \right| \frac{1\text{ cm}^3\text{ Hg}}{13.6\text{ g Hg}} = \boxed{20.1\text{ cm}^3\text{ Hg}}$$

20. How many mL of 2.00M HNO3 is needed to consume 5.4g of aluminum?

$2Al + 6HNO_3 \rightarrow 2Al(HNO_3)_3 + 3H_2$

$$5.4\text{g Al} \left| \frac{1\text{mol Al}}{27.0\text{g Al}} \right| \frac{6\text{ mol HNO}_3}{2\text{ mol Al}} = 0.60\text{ mols HNO}_3$$

$[HNO_3]$ = # mols ÷ volume So, Volume = mols ÷ $[HNO_3]$ =0.60mol ÷2M = 0.3 L (x 1000)= **3.0×10^2 mL HNO_3**

21. 20mL of HCl is needed to consume 2.8g Fe. What is the concentration of HCl?

__2Fe + _6_HCl → _2_$FeCl_3$ + _3_H_2

2.8g Fe	1mol Fe	6 mol HCl	
	55.8g Fe	2 mol Fe	=0.15 mol HCl

[HCl] = n ÷V = 0.15mol HCl ÷0.02L = 7.5M HCl

22. What mass of copper will react with 10.0mL of 12.0M nitric acid?

Cu + _4_HNO_3 → __$Cu(NO_3)_2$ + _2_NO_2 + _2_H_2O

[HNO_3] = # mols ÷ volume So mols HNO_3 = 12.0 M x 0.01 L = 0.12 mol HNO_3

0.12 mol HNO_3	1 mol Cu	63.5 g Cu	
	4 mol HNO_3	1 mol Cu	= 1.91 g Cu

Name:_____ Block:_____ Date:_____

Chemistry 11 **Limiting Reagents and Percent Yield Key** Assignment

1. O_2 is limiting.
2. $Mg(OH)_2$ is limiting.
3. H_2SO_4 is limiting.
4. NaCl is in excess.
5. 12g of $CrCl_3$
6. 15.5g SO_3
7. 44.2g Fe
8. 27.3g N_2
9. 22.9g NaCl
10. a) $Pb(NO_3)_2 + 2NaI \rightarrow 2NaNO_3 + PbI_2$
    b) 8.51g $NaNO_3$
    c) NaI
    d) 8.4g $Pb(NO_3)_2$ would be left over.
11. 42% yield
12. 49.1% yield
13. 81.6% yield
14. a) 20.00g $FeCl_2$
    b) 20.0% yield
15. a) 22.2g CS_2
    b) 2.1g SO_2 left over.
16. 0.279g $BaBr_2$
17. a) 21.1g SiF_4
    b) 8.03g left unused.
    c) 34.2% yield