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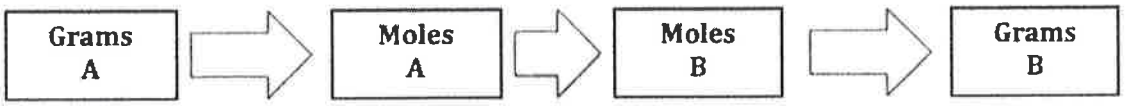
Tutorials, Notes, & Answer Keys

Test Thurs 1/28 Friday 1/29

Stoichiometry Test Review

Vocabulary

- Actual Yield
- Coefficient
- Excess reactant
- Limiting reactant
- Mole ratio
- Percent Yield
- Stoichiometry
- Theoretical Yield



1) In the following reaction, $4C_3H_5(NO_3)_3$ -----> $12CO_2 + 10H_2O + 6N_2 + O_2$, what is the mole ratio between: *(reduce when appropriate)*
   a. Carbon dioxide & water _____
   b. Water & oxygen _____
   c. Carbon dioxide & nitrogen _____

2) **$2\ C_7H_6O_2 + 15\ O_2 \rightarrow 14\ CO_2 + 6\ H_2O$**
   a. If 10 moles of $C_7H_6O_2$ react, how many moles of water will form?

   b. How many moles of CO_2 will form if 244 grams of $C_7H_6O_2$ react?

   c. If 488 grams of $C_7H_6O_2$ react with 480 grams of O_2, how many grams of water will form? (Find the limiting reactant)

   d. If 480 grams of O_2 react and 100 grams of water form, what is my percent yield?

3) **$Fe_2(SO_4)_3 + 6\ KOH \rightarrow 3K_2SO_4 + 2Fe(OH)_3$**

a. How many moles of K_2SO_4 will form if 10 moles of $Fe_2(SO_4)_3$ react?

b. How many grams of KOH are needed to form 10 moles of K_2SO_4?

c. If 10 moles of KOH react with 10 moles of $Fe(SO_4)_3$, what is the limiting reactant?

d. If 90 grams of KOH react with 400 grams of $Fe_2(SO_4)_3$, how many grams of can $Fe(OH)_3$ form? (Hint: Find the limiting reactatant)

4) **$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$**

a) If 10 **moles** of Aluminum react in the equation above, how many **moles** of hydrogen gas will form?

b) If 10 **grams** of Aluminum react, how many **moles** of hydrogen will form?

c) If 15 **moles** of HCl react, how many **grams** of aluminum are needed to completely react?

d) If 55 **grams** of aluminum react, how many **grams** of hydrogen gas will form?

e) If 55 **grams** of aluminum react and only 5 **grams** of hydrogen gas was produced, what is my percent yield?

f) If 55 grams of aluminum reacted and my percent yield was 90%, how much hydrogen gas did I produce?

g) I have 15 moles of aluminum and 20 moles of HCl, what is my limiting reactant?

5) $4KClO_3 \rightarrow 3KClO_4 + KCl$

a. If 20 moles of KClO3 react, how many moles of KCl will form?

b. If 245 grams of $KClO_3$ react, how many moles of $KClO_4$ will form?

6) $4\ Sb + 3O_2 \rightarrow Sb_4O_6$
   a. If 100 grams of Sb react with excess O_2, how many grams of Sb_4O_6 will be formed?

   b. If 100 grams of Sb and 100 grams of O_2 react, what would be the limiting reactant?

7) $2\ N_2 + O_2 \rightarrow 2N_2O$
   a. If 50 grams of N_2 react, how many grams of N_2O would form?

   b. If 50 grams of O_2 react, how many grams of N_2O would form?

8) What would be the limiting reactant in the equation below if 85.3 grams of aluminum and 68 grams of O_2 reacted?

   $4Al + 3O_2 \rightarrow 2Al_2O_3$

9) Consider the following reaction, $\mathbf{P_4 + 5O_2 \rightarrow 2\ P_2O_5}$
   Arlene combines 86 grams of phosphorous with excess oxygen and obtains an 83% yield of P_2O_5. What mass of P_2O_5 did she produce?

10) Consider the following reaction, $2HgO \rightarrow 2Hg + O_2$
Carlos decomposed 90 grams of HgO and produced 6 grams of oxygen. What was his percent yield?

11) In a reaction a student predicts based on his calculations that when he runs a certain chemical reaction he should be able to produce 37.4 grams of H_2O. When the student performs the reaction in a lab the amount of H_2O produced was 30.8 grams. What was the student's percent yield for this experiment?

12) During an experiment, 83.0 grams of potassium hydroxide are produced in a reaction between potassium oxide and water. The theoretical yield of potassium hydroxide is 88.3 grams. What is the percent yield? (Hint: You do not need a chemical equation to solve this problem.)

13) A scientist stated that he had gotten a 98.0% yield of iron in a reaction between iron (III) oxide and carbon monoxide. How many grams of iron did he get during his experiment if the theoretical yield was 210 grams? (Hint: You can do this without writing the balanced equation.)

14) $K_2O + H_2O \rightarrow 2KOH$

a. If 10 grams of potassium oxide and 10 grams of water react, what would be the limiting reactant?

b. How much potassium hydroxide (KOH) (in grams) could be formed.

c. A student runs this reaction and produces 11 grams of potassium hydroxide. What is his percent yield?

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Key

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Vocabulary (matching on test)

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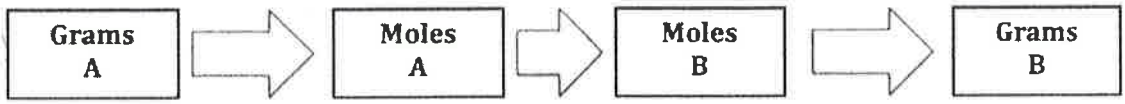

1) In the following reaction, $4C_3H_5(NO_3)_3$ -----> $12CO_2 + 10H_2O + 6N_2 + O_2$, what is the mole ratio between: *(reduce when appropriate)*

a. Carbon dioxide & water — 6:5 (reduced)

b. Water & oxygen — 10:1

c. Carbon dioxide & nitrogen — 2:1 (reduced)

2) **$2\ C_7H_6O_2 + 15\ O_2 \rightarrow 14\ CO_2 + 6\ H_2O$**

a. If 10 moles of $C_7H_6O_2$ react, how many moles of water will form?

Mole → Mole one step

$$10\ mol\ C_7H_6O_2 \left| \frac{6\ H_2O}{2\ C_7H_6O_2} \right. = \boxed{30\ mol\ H_2O}$$

b. How many moles of CO_2 will form if 244 grams of $C_7H_6O_2$ react?

gram → mole → mole two step

$$244\ g\ C_7H_6O_2 \left| \frac{mol}{122\ g} \right. = 2\ mol\ C_7H_6O_2 \left| \frac{14\ CO_2}{2\ C_7H_6O_2} \right. = \boxed{14\ mol\ CO_2}$$

c. If 488 grams of $C_7H_6O_2$ react with 480 grams of O_2, how many grams of water will form? (Find the limiting reactant)

$$488\ g\ C_7H_6O_2 \left| \frac{1\ mol}{122\ g} \right. = 4\ mol\ C_7H_6O_2 \left| \frac{6\ H_2O}{2\ C_7H_6O_2} \right. = 12\ mol\ H_2O \left| \frac{18\ g}{mol} \right. = 216\ g\ H_2O$$

oxygen is limiting reactant

$$480\ g\ O_2 \left| \frac{mol}{32\ g} \right. = 15\ mol\ O_2 \left| \frac{6\ H_2O}{15\ O_2} \right. = 6\ mol\ H_2O \left| \frac{18\ g\ H_2O}{mol} \right. = \boxed{108\ g\ H_2O}$$

d. If 480 grams of O_2 react and 100 grams of water form, what is my percent yield?

Actual yield given → 100 g

Theoretical yield calculated from #2C → 108 g

$$\frac{100\ g}{108\ g} * 100 = \boxed{92.5\%}$$

3) **$Fe_2(SO_4)_3 + 6\ KOH \rightarrow 3K_2SO_4 + 2Fe(OH)_3$**

a. How many moles of K_2SO_4 will form if 10 moles of $Fe_2(SO_4)_3$ react?

Mole → Mole 1 step

$$10\ mol\ Fe_2(SO_4)_3 \left| \frac{3\ mol\ K_2SO_4}{1\ mol\ Fe_2(SO_4)_3} \right. = 30\ mol\ K_2SO_4$$

b. How many grams of KOH are needed to form 10 moles of K_2SO_4?

Mole → Gram 2 step

$$10\ mol\ K_2SO_4 \left| \frac{6\ KOH}{3\ K_2SO_4} \right. = 20\ mol\ KOH \left| \frac{56\ g\ KOH}{1\ mol} \right. = 1120\ g\ KOH$$

c. If 10 moles of KOH react with 10 moles of $Fe(SO_4)_3$, what is the limiting reactant?

$$10\ mol\ KOH \left| \frac{3\ K_2SO_4}{6\ KOH} \right. = 10\ mol\ K_2SO_4$$

KOH is limiting

$$10\ mol\ Fe(SO_4)_3 \left| \frac{3\ K_2SO_4}{1\ Fe(SO_4)_3} \right. = 30\ mol\ K_2SO_4$$

d. If 90 grams of KOH react with 400 grams of $Fe_2(SO_4)_3$, how many grams of can $Fe(OH)_3$ form? (Hint: Find the limiting reactatant)

KOH is Limiting

$$90\ g\ KOH \left| \frac{1\ mol}{56\ g} \right. = 1.6\ mol\ KOH \left| \frac{2\ Fe(OH)_3}{6\ KOH} \right. = .54\ mol\ Fe(OH)_3 \left| \frac{107\ g}{mol} \right. = 57.78\ g\ Fe(OH)_3$$

$$400\ g\ Fe_2(SO_4)_3 \left| \frac{mol}{400\ g} \right. = 1\ mol\ Fe_2(SO_4)_3 \left| \frac{2\ Fe(OH)_3}{1\ Fe_2(SO_4)_3} \right. = 2\ mol\ Fe(OH)_3 \left| \frac{107\ g}{mol} \right. = 214\ g\ Fe_2(SO_4)_3$$

4) **$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$**

a) If 10 **moles** of Aluminum react in the equation above, how many **moles** of hydrogen gas will form?

Mole → Mole one step

$$10\ mol\ Al \left| \frac{3\ H_2}{2\ Al} \right. = 15\ mol\ H_2$$

b) If 10 **grams** of Aluminum react, how many **moles** of hydrogen will form?

Gram → Mole 2 step

$$10\ g\ Al \left| \frac{mole\ Al}{27\ g\ Al} \right. = .37\ mol\ Al \left| \frac{3\ H_2}{2\ Al} \right. = .56\ mol\ H_2$$

c) If 15 **moles** of HCl react, how many **grams** of aluminum are needed to completely react?

$$\frac{15 \text{ mol HCl}}{6 \text{ HCl}} \left| \frac{2 \text{ Al}}{} \right. = \frac{5 \text{ mol Al}}{\text{mol}} \left| \frac{27 \text{ g}}{} \right. = \boxed{135 \text{ g Al}}$$

d) If 55 **grams** of aluminum react, how many **grams** of hydrogen gas will form?

$$\frac{55 \text{ g Al}}{27 \text{ g}} \left| \frac{\text{mol}}{} \right. = \frac{2.04 \text{ mol Al}}{2 \text{ Al}} \left| \frac{3 \text{ H}_2}{} \right. = \frac{3.06 \text{ mol H}_2}{\text{mol}} \left| \frac{2 \text{ g H}_2}{} \right. = \boxed{6.1 \text{ g H}_2}$$

e) If 55 **grams** of aluminum react and only 5 **grams** of hydrogen gas was produced, what is my percent yield?

Actual → 5 g
Theoretical from 4d → 6.1 g

$$\frac{5 \text{ g}}{6.1 \text{ g}} * 100 = \boxed{82\%}$$

f) If 55 grams of aluminum reacted and my percent yield was 90%, how much hydrogen gas did I produce?

$$\underbrace{6.1 \text{ g}}_{\text{Theoretical}} * \underbrace{90\%}_{\% \text{ yield}} = \underbrace{5.49 \text{ g}}_{\text{Actual yield}}$$

g) I have 15 moles of aluminum and 20 moles of HCl, what is my limiting reactant?

$$\frac{15 \text{ mol Al}}{2 \text{ Al}} \left| \frac{3 \text{ H}_2}{} \right. = 15 \text{ mol H}_2$$

$$\frac{20 \text{ mol HCl}}{6 \text{ HCl}} \left| \frac{3 \text{ H}_2}{} \right. = \boxed{10 \text{ mol H}_2}$$

* HCl limiting *

5) $4KClO_3 \rightarrow 3KClO_4 + KCl$

a. If 20 moles of KClO3 react, how many moles of KCl will form?

$$\frac{20 \text{ mol } KClO_3}{4 \text{ } KClO_3} \left| \frac{1 \text{ KCl}}{} \right. = \boxed{5 \text{ mol KCl}}$$

b. If 245 grams of $KClO_3$ react, how many moles of $KClO_4$ will form?

$$\frac{245 \text{ g } KClO_3}{122 \text{ g } KClO_3} \left| \frac{\text{mole}}{} \right. = \frac{2.0 \text{ mol KCl}}{4 \text{ } KClO_3} \left| \frac{3 \text{ } KClO_4}{} \right. = 1.5 \text{ mole } KClO_4$$

6) $4\ Sb + 3O_2 \rightarrow Sb_4O_6$

a. If 100 grams of Sb react with excess O_2, how many grams of Sb_4O_6 will be formed?

$100\ g\ Sb \left| \frac{mol\ Sb}{122\ g} \right. = .82\ mol\ Sb \left| \frac{1\ Sb_4O_6}{4\ Sb} \right. = .21\ mol\ Sb_4O_6 \left| \frac{583\ g}{mol} \right. = 119.7\ g\ Sb_4O_6$

lower amount

b. If 100 grams of Sb and 100 grams of O_2 react, what would be the limiting reactant?

$100\ g\ O_2 \left| \frac{mole}{32\ g} \right. = 3.125\ mol\ O_2 \left| \frac{1\ Sb_4O_6}{3\ O_2} \right. = 1.04\ mol\ Sb_4O_6 \left| \frac{583\ g}{mole} \right. = 606.3\ g\ Sb_4O_6$

* Sb is limiting *

7) $2\ N_2 + O_2 \rightarrow 2N_2O$

a. If 50 grams of N_2 react, how many grams of N_2O would form?

$50\ g\ N_2 \left| \frac{1\ mole}{28\ g} \right. = 1.79\ mol\ N_2 \left| \frac{2\ N_2O}{2\ N_2} \right. = 1.79\ mol\ N_2O \left| \frac{44\ g}{mole} \right. = 78.6\ g\ N_2O$

b. If 50 grams of O_2 react, how many grams of N_2O would form?

$50\ g\ O_2 \left| \frac{mole}{32\ g\ O_2} \right. = 1.56\ mole\ O_2 \left| \frac{2\ N_2O}{1\ O_2} \right. = 3.125\ mole\ N_2O \left| \frac{44\ g}{mol} \right. = 137.5\ g\ N_2O$

8) What would be the limiting reactant in the equation below if 85.3 grams of aluminum and 68 grams of O_2 reacted?

$4Al + 3O_2 \rightarrow 2Al_2O_3$

$85.3\ g\ Al \left| \frac{mole}{27\ g} \right. = 3.16\ mol\ Al \left| \frac{2\ Al_2O_3}{4\ Al} \right. = 1.58\ mol\ Al_2O_3$

$68\ g\ O_2 \left| \frac{mole}{32\ g} \right. = 2.125\ mole\ O_2 \left| \frac{2\ Al_2O_3}{3\ O_2} \right. = 1.42\ mol\ Al_2O_3$

* oxygen limiting *

9) Consider the following reaction, $\mathbf{P_4 + 5O_2 \rightarrow 2\ P_2O_5}$

Arlene combines 86 grams of phosphorous with excess oxygen and obtains an 83% yield of P_2O_5. What mass of P_2O_5 did she produce?

find theoretical first

$86\ g\ P_4 \left| \frac{1\ mole}{124\ g\ P_4} \right. = .69\ mol\ P_4 \left| \frac{2\ P_2O_5}{1\ P_4} \right. = 1.38\ mol\ P_2O_5 \left| \frac{142\ g\ P_2O_5}{mole} \right. =$

$(195.96\ g) * (83\%) = 162.6\ g\ P_2O_5$

Actual yield

Theoretical yield → 195.96 g P_2O_5

10) Consider the following reaction, $2HgO \rightarrow 2Hg + O_2$
Carlos decomposed 90 grams of HgO and produced 6 grams of oxygen. What was his percent yield?

$\frac{90\text{ g } HgO}{217\text{ g}} \times \frac{1\text{ mole}}{1} = .41\text{ mol } HgO \times \frac{1\ O_2}{2\ HgO} = .21\text{ mol } O_2 \times \frac{32\text{ g}}{\text{mole}} = 6.72\text{ g } O_2$ (Theoretical yield)

Actual → 6 g
Theoretical → 6.72

$\frac{6}{6.72} = 89\%$

11) In a reaction a student predicts based on his calculations that when he runs a certain chemical reaction he should be able to produce 37.4 grams of H_2O. When the student performs the reaction in a lab the amount of H_2O produced was 30.8 grams. What was the student's percent yield for this experiment?

$\frac{30.8}{37.4} * 100 = 82\%$

12) During an experiment, 83.0 grams of potassium hydroxide are produced in a reaction between potassium oxide and water. The theoretical yield of potassium hydroxide is 88.3 grams. What is the percent yield? (Hint: You do not need a chemical equation to solve this problem.)

$\frac{83}{88.3} = 94\%$

13) A scientist stated that he had gotten a 98.0% yield of iron in a reaction between iron (III) oxide and carbon monoxide. How many grams of iron did he get during his experiment if the theoretical yield was 210 grams? (Hint: You can do this without writing the balanced equation.)

$210 * 98\% = 205.8\text{ g}$

14) $K_2O + H_2O \rightarrow 2KOH$

a. If 10 grams of potassium oxide and 10 grams of water react, what would be the limiting reactant?

K_2O Limiting: $10\ g\ K_2O \left| \frac{mol\ K_2O}{94\ g} \right. = .106\ mol\ K_2O \left| \frac{2\ KOH}{1\ K_2O} \right. = .212\ mol\ KOH \left| \frac{56\ g}{mol} \right. = \boxed{11.87\ g\ KOH}$

H_2O excess: $10\ g\ H_2O \left| \frac{1\ mol}{18\ g} \right. = .56\ mol\ H_2O \left| \frac{2\ KOH}{1\ H_2O} \right. = 1.11\ mol\ KOH \left| \frac{56\ g\ KOH}{mol} \right. = 62.16\ g\ KOH$

b. How much potassium hydroxide (KOH) (in grams) could be formed.

11.87 g (theoretical yield)

c. A student runs this reaction and produces 11 grams of potassium hydroxide. What is his percent yield?

Actual → 11 g
Theoretical → 11.87

$\frac{11\ g}{11.87} * 100 = \boxed{92.7\%}$