Chem 1024C 27-Nov-2007 Ch 8-9 Homework with Answers

Being an Synthetic Organic Chemist, I spent the past weeks synthesizing several compounds and here's the a

A. Determine the Empirical Formulae:

1.

H	2.055%	2.055 g / 1.008 g/M = 2.039 M	2.039 M/ 1.020 M = 1.999	= 2
S	32.70%	32.70 g / 32.07 g/M = 1.020 M	1.020 M/ 1.020 M = 1	= 1
O	65.25%	65.25 g / 16.00 g/M = 4.078 M	4.078 M/ 1.020 M = 3.998	= 4

H_2SO_4

2.

C	59.96%	59.96 g / 12.01 g/M = 4.993 M	4.993 M / 1.664 M = 3.001	= 3
H	13.42%	13.42 g / 1.008 g/M = 13.31 M	13.31 M / 1.664 M = 7.999	= 8
O	26.62%	26.62 g / 16.00 g/M = 1.664 M	1.664 M / 1.664 M = 1	= 1

Isopropyl Alcohol / Rubbing Alcohol = $H_3C\text{-}CH_2OH$ = **C_3H_8O**

3. A 3.450 g of a sample of nitrogen reacts with 1.970 g of Oxygen.

3.450 g N	3.450 g / 14.01 g/M = 0.2463 M	0.2463 M / 0.1231 M = 2.001
1.970 g O	1.970 g / 16.00 g/M = 0.1231 M	0.1231 M / 0.1231 M = 1

N_2O

4. An organic chemical gives the following analysis:

5.667 g Carbon	5.667 g / 12.01 g/M = 0.4719 M	0.4719 M / 0.1570 M = 3.006
0.3165 g Hydrogen	0.3165 g / 1.008 g/M = 0.3140 M	0.3140 M / 0.1570 M = 2
5.566 g Chlorine	5.566 g / 35.45 g/M = 0.1570 M	0.1570 M / 0.1570 M = 1

Ethyl Chloride $H_3C\text{-}CH_2\text{-}CH_2Cl$ **C_3H_2Cl**

5.

Cu	66.75%	66.75 g / 63.55 g/M = 1.050 M	1.050 M / 0.3500 M = 3	
P	10.84%	10.84 g / 30.97 g/M = 0.3500 M	0.3500 M / 0.3500 M = 1	
O	22.41%	22.41 g / 16.00 g/M = 1.401 M	1.401 M / 0.3500 M = 4.003	

Cu_3PO_4

6. A compound containing only Carbon, Hydrogen and Oxygen gives the following analysis:

C	40.00%	40.00 g / 12.01 g/M = 3.331 M	3.331 M / 3.331 M = 1
H	6.700%	6.700 g / 1.008 g/M = 6.647 M	6.647 M / 3.331 M = 1.995
O	100 % - 40.00% - 6.700% = 59.33 % O		
		53.30 g / 16.00 g/M = 3.331 M	3.331 M / 3.331 M = 1
			C_1H_2O

$C_1H_2O_1$ = 12.01 + 2 * 1.008 + 16.00 = 30.03 g / M

The Molar Mass is between 115 and 125 g/mole. What is the Empirical and Molecular formulae.

2 * 30.03 = 30.06 3 * 30.03 = 90.09 **4 * 30.03 = 120.12** **4 * $C_1H_2O_1$ = $C_4H_8O_4$**

7. An organic compound containing only C, H, N and O has the following analysis

C	49.47%	49.47 g / 12.01 g/M = 4.119 M	4.119 M / 1.03 M = 3.999
H	5.191%	5.191 g / 1.008 g/M = 5.149 M	5.149 M / 1.03 M = 4.999
N	28.86%	28.86 g / 14.01 g/M = 2.060 M	2.060 M / 1.03 M = 2
O	100% - 49.47% - 5.191% - 28.86% = 16.48% O		
		16.48 g / 16.00 g/M = 1.03 M	1.03 M / 1.03 M = 1
			$C_4H_5N_2O$

$C_4H_5N_2O$ = 4 * 12.01 + 5 * 1.008 + 2 * 14.01 + 16.00 = 90.09

The approximate molar mass is 194. What is the Empirical and Molecular formulae.

2 * 90.09 = 192.18 **2 $C_4H_5N_2O$ = $C_8H_{10}N_4O$**

B. Determine the following [Show all math with canceled units and balanced equations]:

1. From the hood experiment, we learned that natural gas, Methane, will burn form carbon dioxide and wate formed from burning 50 g of Methane?

CH_4 + $2O_2$ -> CO_2 + $2H_2O$

50 g |----------> |

1 C = 1 * 12.01 = 12.01 g/M	4 H = 4 * 1.008 = 4.032 g/M
4 H = 4 * 1.008 = 4.032 g/M	2 O = 2 * 16.00 = 32.00 g/M
Mw CH_4 = 16.04 g/M	Mw $2H_2O$ = 36.032 = 36.03 g/M

$\frac{\text{50 g Methane}}{\text{16.04 g/M}} = \frac{\text{X}}{\text{36.03 g/M}}$ = 112.312 g H_2O = **110 g H_2O [2 sign digits]**

2. Sodium Hydroxide is used in rebreathers units to absorb carbon dioxide. The reaction of sodium hydroxi produces sodium carbonate and water. As we all know, since water is produced, the reaction will go to comp of sodium hydroxide is needed to react with 1 pound of carbon dioxide? How much Sodium Carbonate is f

A. $CO_2 + H_2O \rightarrow H_2CO_3$ [Carbonic Acid]

	Strong Base	Weak Acid	Sodium Carbonate	Forms water - a driving force
B.	$2\ NaOH$ +	H_2CO_3 ->	Na_2CO_3 +	$2\ H_2O$

Replace the H_2CO_3 in **B** with the Carbonic Acid in **A** above:

$2\ NaOH + CO_2 + H_2O \rightarrow Na_2CO_3 + 2\ H_2O$

X 1 lb ---------->|

Na 2 * 22.99 = 45.98 g/M
O 1 * 16.00 = 16.00 g/M
H 1 * 1.008 = 1.008 g/M
Mw NaOH = 62.99 g/M

C 1 * 12.01 = 12.01 g/M
O 2 * 16.00 = 32.00 g/M
Mw CO_2 = 44.01 g/M

Na 2 * 22.99 = 45.98 g/M
C 1 * 12.01 = 12.01 g/M
O 3 * 16.00 = 48.00 g/M
Mw Na_2CO_3 = 195.99 g/

1 lb = 453.6 g of carbon dioxide

$$\frac{453.4\ g\ CO_2}{44.01\ g/M} = \frac{X}{62.99\ g/M}$$

X = 648.9 g NaOH = 600 g NaOH [1 sign digit]

$$\frac{453.4\ g\ CO_2}{44.01\ g/M} = \frac{X}{195.99\ g/M}$$

X = 2019.12 g Na_2CO_3 = 2000 g [1 sign digit]

3. Baking Soda will is slightly basic and will react with vinegar to form sodium acetate, water and carbon di complete balanced reaction. How many grams of vinegar is needed to react with a one pound box of baking

Baking Soda = Sodium Bicarbonate = $NaHCO_3$ Vinegar = acetic acid = $H_3C\text{-}COOH = C_2H_4O_2$
Sodium Acetate = $H_3C\text{-}COO^-\ Na^+ = NaC_2H_3O_2$

Baking Soda Vinegar Sodium Acetate
$NaHCO_3 + C_2H_4O_2 \rightarrow NaC_2H_3O_2 + CO_2 + H_2O$
1 Lb ? |----------->

Na 1 * 22.99 = 45.98 g/M
H 1 * 1.008 = 1.008 g/M
C 1 * 12.01 = 12.01 g/M
O 3 * 16.00 = 48.00 g/M
Mw $NaHCO_3$ = 106.998 g/M = 107.0 g/M

C 2 * 12.01 = 24.01 g/M
H 4 * 1.008 = 4.032 g/M
O 2 * 16.00 = 32.00 g/M
Mw $C_2H_4O_2$ = 60.015 g/M

$\frac{453.6\text{ g } NaHCO_3}{107.0\text{ g/M}} = \frac{x}{60.015\text{ g/M}}$ **X = 254.56 g Vinegar = 300g [1 Sign Figure]**

4. 1.00 g of Hydrogen reacts with Oxygen to form water. 1.00 g of Hydrogen also can react with Nitrogen t Calculate the amounts of water and ammonia formed in each reaction?

$2\ H_2 + O_2 \rightarrow 2\ H_2O$
1 g ?
| H 4 * 1.008 = 4.032 g/M
| O 2 * 16.00 = 32..00 g/M
| Mw 2 H_2O = **36.032 g/M**
H 4 * 1.008 = **4.032 g/M**

$\frac{1\text{ g}}{4.032\text{ g/M}} = \frac{X}{36.032\text{ g/M}}$ **X = 8.94 g Water [3 Sign Digits]**

$3\ H_2 + N_2 \rightarrow 2\ NH_3$
1 g ?
| H 6 * 1.008 = 6.048 g/M
| N 2 * 14.01 = 28.02 g/M
| Mw 2 NH_3 = **34.07 g/M**
H 6 * 1.008 = **6.048 g/M**

$\frac{1\ g}{6.048\ g/M} = \frac{X\ .}{34.07\ g/M}$ **X = 5.63 G Ammonia [3 Sign Digits]**

5. From the above equations, 1.00 g of Hydrogen is reacted with 1.00 g of Oxygen. What reactant is in exce

$2\ H_2 + O_2 \rightarrow 2\ H_2O$
1 g 1g
| O 2 * 16.00 = **32.00 g/M**
|
H 4 * 1.008 = **4.032 g/M**

H = $\frac{1\ g}{4.032\ g/M}$ = **0.248 M [3 Sign Digits]** O = $\frac{1\ g}{32.00\ g/M}$ = **0.0313 M [3 Si**

There is more Molar Ratios of Hydrogen then Oxygen, so Hydrogen is in xcs.

0.248 M H - 0.0313 M O = **0.217 M H in xcs.**

6. Aluminum reacts with Chlorine to form Aluminum Chloride. How much Aluminum Chloride is produce Aluminum assuming a 75% reaction yield?

75%
$2\ Al + 3\ Cl_2 \text{ -----> } 2\ AlCl_3$
1.000g Al 2 * 26.98 g/M = 53.96 g/M
| Cl 6 * 35.45 g/M = 212.7 g/M
| Mw 2 $AlCl_3$ = 266.7 g/M
$\frac{1.000\ g}{2 * 26.98\ g/M} = \frac{X\ .}{266.7\ g/M}$ = 4.94 g $AlCl_3$ at 100% Yield

4.94 g $AlCl_3$ at 75% Yield = 4.94 g * 0.75 = **3.707 g AlC**l_3 **[4 Sign Digits]**

7. Phosphorous Tri Chloride will react with water to produce Phosphorous Acid. What is the Theoretical Yi Phosphorous Tri Chloride?

PCl_3 + 3 H_2O ------> H_3PO_3 + 3 HCl
5.000 g ? ----------|
P 1 * 30.97 g/M = 30.97 g/M H 3 * 1.008 g/M = 3.024 g/M
Cl 3 * 35.45 g/M = 106.35 g/M P 1 * 30.97 g/M = 30.97 g/M
Mw PCl_3 = 137.32 g/M O 3 * 16.00 g/M = 48.00 g/M
Mw H_3PO_3 = 81.99 g/M

$\frac{5.000g}{137.32\ g/M} = \frac{X}{81.99\ g/M}$ **X = 2.985 g H_3PO_3 at 100% Yield**
[4 sign digits]