

Chemistry 1054 Exam 2, October 11, 2006

(A1)

Name Key

By submitting this exam, I affirm that I have neither given nor received unauthorized aid. Remember, you must show work for credit.

Useful information: N_A , Avagadro's # = 6.022×10^{23} things/mole, $M = \frac{\text{moles}}{L}$

(1)(4 points) Convert the masses of the following compounds into moles.

(a) 5.88 g of $\text{Fe}(\text{NO}_3)_3$

$$\begin{array}{r}
 \text{Fe } 55.85 \text{ g/mol} \\
 3 \text{ N } 3 (14.01 \text{ g/mol}) \\
 9 \text{ O } 9 (16.00 \text{ g/mol}) \\
 \hline
 241.88 \text{ g/mol}
 \end{array}$$

$$5.88 \text{ g} \div 241.88 \frac{\text{g}}{\text{mol}} = 2.43 \times 10^{-2} \text{ moles}$$

(b) 2.56 g of LiBr

$$\begin{array}{r}
 \text{Li } 6.941 \text{ g/mol} \\
 + \text{ Br } 79.90 \text{ g/mol} \\
 \hline
 86.85 \text{ g/mol}
 \end{array}$$

$$2.56 \text{ g} \div 86.85 \frac{\text{g}}{\text{mol}} = 2.95 \times 10^{-2} \text{ moles}$$

(2)(4 points) Fill in the following table

Formula	Name
HClO_2	chlorous acid
Na_2SO_3	sodium sulfite
NaNO_2	sodium nitrite
SBr_6	sulfur hexabromide

(3)(4 points) Classify the following as either element, compound, heterogeneous mixture, or homogeneous mixture.

(a) apple pie *heterogeneous mixture*

(b) ammonia *compound*

(c) window *solution*

(d) sandpaper *heterogeneous mixture*

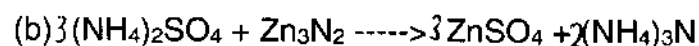
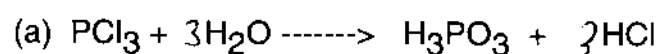
(4)(4 points) Assume that chromium only consisted of two isomers in nature. If the following information represents the abundance and mass of the two isomers, what is the average molecular weight that should go on the periodic table (this will not be the actual mass on the periodic table).

$^{50}_{24}\text{Cr}$ mass = 49.9461, abundance = 17.25%

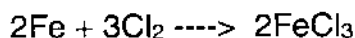
$^{53}_{24}\text{Cr}$ mass = 52.9407, abundance = 82.75%

$$0.1725(49.9461) + 0.8275(52.9407) = 52.42 \text{ amu}$$

(5)(4 points) Balance the following equations



(6)(6 points) Iron (6.00 g) is reacted with chlorine (11.0 g) according to the reaction below.



(a) Which reagent is the limiting reagent?

$$\text{Fe: } 6.00\text{g} \div 55.85 \frac{\text{g}}{\text{mole}} = 0.107 \text{ moles Fe}$$

$$\therefore 0.107 \text{ moles Fe} \times \frac{3 \text{ moles Cl}_2}{2 \text{ moles Fe}} = 0.161 \text{ moles Cl}_2 \text{ needed to react with Fe}$$

$$\text{Cl}_2: 11.00\text{g} \div 70.90 \frac{\text{g}}{\text{mole}} = 0.155 \text{ moles Cl}_2 \text{ present}$$

$\therefore \text{Cl}_2 \text{ is limiting}$

(b) How much FeCl₃ should form?

$$0.155 \text{ moles Cl}_2 \times \frac{2 \text{ moles FeCl}_3}{3 \text{ moles Cl}_2} = 0.103 \text{ moles FeCl}_3$$

(c) If the amount of FeCl₃ that formed was 8.22 g, what is the % yield?

$$0.103 \text{ moles FeCl}_3 \times 162.2 \frac{\text{g}}{\text{mole}} = 16.7 \text{ g}$$

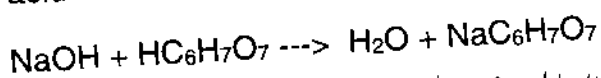
$$\frac{8.22 \text{ g}}{16.7 \text{ g}} \times 100\% = 49.0\%$$

(7)(2 points) If 0.355 g of KCl is dissolved in a 500.0 mL solution, what is the molarity?

$$0.355 \text{ g} \div 74.55 \frac{\text{g}}{\text{mole}} = 4.76 \times 10^{-3} \text{ moles}$$

$$\frac{4.76 \times 10^{-3} \text{ moles}}{0.500 \text{ L}} = 9.52 \times 10^{-3} \text{ M}$$

(8)(4 points) A can of citrus soda was titrated with 0.0100 M NaOH. If it took 12.54 mL of 0.0100 M NaOH to neutralize the acid in 25.00 mL of the citrus soda, what was the concentration of the acid in the can?



$$\left(\frac{0.0100 \text{ mol/L}}{L}\right)(0.01254 \text{ L}) = 1.254 \times 10^{-4} \text{ mol NaOH}$$

$$1.254 \times 10^{-4} \text{ mol NaOH} \times \frac{1 \text{ mol HC}_6\text{H}_7\text{O}_7}{1 \text{ mol NaOH}} = 1.254 \times 10^{-4} \text{ mol HC}_6\text{H}_7\text{O}_7$$

$$\frac{1.254 \times 10^{-4} \text{ mol HC}_6\text{H}_7\text{O}_7}{0.02500 \text{ L}} = \boxed{5.01 \times 10^{-3} \text{ M}}$$

(9)(4 points) Vanillin ($\text{C}_8\text{H}_8\text{O}_3$) is the molecule responsible for the familiar vanilla flavor. What is the elemental composition (in %) of vanillin ($\text{C}_8\text{H}_8\text{O}_3$)?

$$\begin{array}{r} \text{C } 8(12.01 \text{ g/mol}) = 96.08 \text{ g/mol} \\ \text{H } 8(1.01 \text{ g/mol}) = 8.08 \text{ g/mol} \\ \text{O } 3(16.00 \text{ g/mol}) = 48.00 \text{ g/mol} \\ \hline 152.16 \text{ g/mol} \end{array}$$

$$\% \text{C} = \frac{96.08 \text{ g/mol}}{152.16 \text{ g/mol}} \times 100 = 63.14\%$$

$$\% \text{H} = \frac{8.08 \text{ g/mol}}{152.16 \text{ g/mol}} = 5.31\%$$

$$\% \text{O} = \frac{48.00 \text{ g/mol}}{152.16 \text{ g/mol}} = 31.54\%$$

(10)(5 points) Police accuse a person of possession of a large amount of steroids (testosterone). The person states that it is only sugar. If the elemental analysis of the compound comes back as 84.5% C, 11.3% H, and 4.17% O, what is the formula of the compound? Are the police right?

$$C \quad 84.5g \div 12.01g_{/mole} = 7.04 \text{ mol C}$$

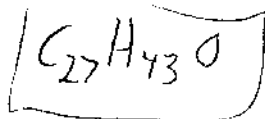
$$H \quad 11.3g \div 1.01g_{/mole} = 11.19 \text{ mol H}$$

$$O \quad 4.17g \div 16.00g_{/mole} = 0.261 \text{ mol O}$$

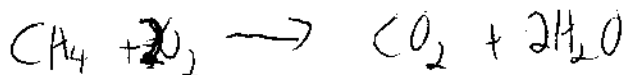
$$7.04 \text{ mol C} \div 0.261 \text{ mol} = 26.97 \approx 27$$

$$11.19 \text{ mol H} \div 0.261 \text{ mol} = 42.9 \approx 43$$

$$0.261 \text{ mol O} \div 0.261 \text{ mol} = 1 \approx 1$$



Extra Credit: (3 points) If 20.0 g of CH_4 and 69.0 g of O_2 are mixed and burned, what compounds remain at the end of the reaction? Write each of the compounds with the amount of the compound present (in moles) when the reaction is complete.



$$20.0g \div 16.05g_{/mole} = 1.25 \text{ mol } CH_4$$

$$69.0g \div 32.0g_{/mole} = 2.16 \text{ mol } O_2$$

$$1.25 \text{ mol } CH_4 \times \frac{2 \text{ mol } O_2}{1 \text{ mol } CH_4} = 2.50 \text{ mol } O_2 \text{ needed} \quad \left. \begin{array}{l} \\ \end{array} \right\} O_2 \text{ limiting}$$

at the end O_2 left

$$2.16 \text{ mol } O_2 \times \frac{1 \text{ mol } CH_4}{2 \text{ mol } O_2} = 1.08 \text{ mol } CH_4 \text{ burned}$$

$$\frac{1.25 \text{ mol } CH_4 - 1.08 \text{ mol } CH_4 \text{ burned}}{=} = 0.23 \text{ mol } CH_4$$

$$2.16 \text{ mol } O_2 \times \frac{2 \text{ mol } H_2O}{2 \text{ mol } O_2} = 2.16 \text{ mol } H_2O \text{ formed}$$

$$2.16 \text{ mol } O_2 \times \frac{1 \text{ mol } CO_2}{2 \text{ mol } O_2} = 1.08 \text{ mol } CO_2 \text{ formed}$$

$$2.16 \text{ mol } H_2O$$

$$1.08 \text{ mol } CO_2$$