Chemistry 1054 Exam 2, October 11, 2006

(41)

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 x 10^{23}things/mole, $M = \frac{moles}{L}$

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

(a) 5.88 g of $Fe(NO_3)_3$

Fe 55.85 g/mol
3 N 3(14.01 g/mol)
9 O 9(16.00 g/mol)
241.88 g/mole

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

(b) 2.56 g of LiBr

Li 6.941 g/mol
Br 79.90 g/mol
86.85 g/mole

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

(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) windex 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).

$^{50}_{24}Cr$ mass = 49.9461, abundance = 17.25%
$^{53}_{24}Cr$ mass = 52.9407, abundance = 82.75%

$0.1725(49.9461\,amu) + 0.8275(52.9407\,amu) = 52.42\,amu$

(5)(4 points) Balance the following equations

(a) $PCl_3 + 3H_2O$ -------> $H_3PO_3 + 3HCl$

(b) $3(NH_4)_2SO_4 + Zn_3N_2$ -----> $3ZnSO_4 + 2(NH_4)_3N$

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

$2Fe + 3Cl_2 \longrightarrow 2FeCl_3$

(a) Which reagent is the limiting reagent?

Fe: $6.00\,g \div 55.85\,g/mole = 0.107$ moles Fe

$\therefore 0.107$ moles Fe $\times \frac{3\ Cl_2}{2\ Fe} = \frac{0.322}{2}$ moles Cl_2 needed to react with Fe

0.161 moles

Cl_2: $11.00\,g \div 70.90\,g/mole = 0.155$ moles Cl_2 present

Cl_2 is limiting

(b) How much $FeCl_3$ should form?

0.155 moles $Cl_2 \times \frac{2\ FeCl_3}{3\ Cl_2}$

$= 0.103$ moles $FeCl_3$

(c) If the amount of $FeCl_3$ that formed was 8.22 g, what is the % yield?

0.103 moles $FeCl_3 \times 162.2\,g/mole = 16.7\,g$

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

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

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

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

(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?

$$NaOH + HC_6H_7O_7 \rightarrow H_2O + NaC_6H_7O_7$$

$\left(\frac{0.0100\ mols}{L}\right)(0.01254L) = 1.254\times10^{-4}\ mols\ NaOH$

$1.254\times10^{-4}\ mols\ NaOH \times \frac{1\ mole\ HC_6H_7O_7}{1\ mole\ NaOH} = 1.25\times10^{-4}\ mols\ HC_6H_7O_7$

$\frac{1.25\times10^{-4}\ mols\ HC_6H_7O_7}{0.02500L} = 5.01\times10^{-3}\ M$

(9)(4 points) Vanillin ($C_8H_8O_3$) is the molecule responsible for the familiar vanilla flavor What is the elemental composition (in %) of vanillin ($C_8H_8O_3$)?

C $8(12.01\ g/mol) = 96.08\ g/mol$

H $8(1.01\ g/mol) = 8.08\ g/mol$

O $3(16.00\ g/mol) = 48.00\ g/mol$

$+$

$152.16\ g/mol$

$\%C = \frac{96.08\ g/mol}{152.16\ g/mol}\times100\% = 63.14\%$

$\%H = \frac{8.08\ g/mol}{152.1\ g/mol} = 5.31\%$

$\%O = \frac{48.00\ g/mol}{152.1\ g/mol} = 31.54\%$

(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 $84.5\,g \div 12.01\,g/mol = 7.04\,mol\ C$

H $11.3\,g \div 1.01\,g/mol = 11.19\,mol\ H$

O $4.17\,g \div 16.00\,g/mol = 0.261\,mol\ O$

$7.04\,mol\ C \div 0.261\,mol = 26.97 = 27$

$11.19\,mol\ H \div 0.261\,mol = 42.9 = 43$

$0.261\,mol\ O \div 0.261\,mol = 1 = 1$

$C_{27}H_{43}O$

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.

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

$20.0\,g \div 16.05\,g/mol = 1.25\,mol\ CH_4$

$69.0\,g \div 32.0\,g/mol = 2.16\,mol\ O_2$

$1.25\,mol\ CH_4 \times \frac{2\,mol\ O_2}{1\,mol\ CH_4} = 2.50\,mol\ O_2$ needed ∴ O_2 limiting

at the end O_2 left

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

$1.25\,mol\ CH_4 - 1.08\,mol\ burned = 0.23\,mol\ CH_4$

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

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

$0.23\,mol\ CH_4$

$2.16\,mol\ H_2O$

$1.08\,mol\ CO_2$