CHEM 1104 Exam 2. October 10, 2007

Name Key **Note: You must show all work for credit.**

I certify that I have neither given nor received unauthorized aid on this assignment.

Useful information: $M = \frac{moles}{L}$ **, LEO says GER**

(1)(6 points) A flask containing 5.00 g of C and 14.1 g of Fe_2O_3 were reacted according to the following equation.

$4Fe^{3+} + 3C^0 \rightarrow 3C^{4+} + 4Fe^0$

$$Fe_2O_3 + 3C \rightarrow 3CO_2 + 2Fe$$

(a) Which reagent is the limiting reagent?

$5.00\,g \times \frac{1\,mole}{12.01\,g} = 0.416\,moles$

$14.1\,g \times \frac{1\,mole}{159.7\,g} = 0.0902\,moles\,Fe_2O_3$

$0.0902\,mol\,Fe_2O_3 \times \frac{3\,moles\,C}{1\,mole\,Fe_2O_3} = 0.271\,moles\,C\,needed$

$\therefore Fe_2O_3$ limiting

(b) How much Fe should form?

$0.0902\,moles\,Fe_2O_3 \times \frac{2\,moles\,Fe}{1\,mole\,Fe_2O_3} = 0.180\,moles\,Fe$

$= 0.180\,moles\,Fe \times 55.85\,\frac{g}{mole}$

$= 10.07\,g\,Fe = 10.1\,g\,Fe$

(c) If the amount of ~~Al_2O_3~~ Fe formed was 3.62 g, what is the % yield?

~~0.064~~

$\frac{3.62\,g}{10.1\,g}(100) = 35.9\%$

(2)(2 points) How would you make a 500.0 mL, 0.100 M solution of NaClO from a 7.80 M stock solution?

$M_1V_1 = 0.500\,L\,(0.100\,M) = 0.0500\,moles\,NaClO\,needed$

$M_2V_2 = 7.80\,M\,V_2 = 0.0500\,moles\,NaClO$

$V_2 = 6.41 \times 10^{-3}\,L$

0.5 pts for units

6.41 mL of 7.80 M stock solution was dilated to 500.0 mL.

(3)(4 points) If it takes 22.1 mL of 0.98 M H_2SO_4 to fully react with the $NaHCO_3$ (according to the unbalanced reaction below) in a 15.00 mL sample of water. How much $NaHCO_3$ was present (in grams)?

+1 for balanced

$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2$

$(0.0221\,L)(0.98\,\frac{mol}{L}) = 2.2\times10^{-2}\,mol\,H_2SO_4$

$2.2\times10^{-2}\,mol\,H_2SO_4 \times \frac{2\,mol\,NaHCO_3}{1\,mol\,H_2SO_4} = 0.0433\,mol\,NaHCO_3$

$0.0433\,mol \times 84.01\,g/mol = 3.64\,g = \boxed{3.6\,g\,NaHCO_3}$

(4)(4 points) Aspirin is acetylsalicylic acid. It is derived from salicylic acid which is found in willow tree bark. The elemental composition of aspirin (in mass %) is 60.00% C, 4.49% H, and 35.52% O. What is the empirical formula for aspirin?

$60.0\%\,C \div 12.01\,g/mol = 5.00\,mol\,C$ $\quad 5\,mol \div 2.22\,mol = 2.25$

$4.41\%\,H \div 1.01\,g/mol = 4.44\,mol\,H$ $\quad 4.44\,mol \div 2.22\,mol = 2$

$35.52\%\,O \div 16.00\,g/mol = 2.22\,mol\,O$ $\quad 2.22\,mol \div 2.22\,mol = 1$

$4(C_{2.25}H_2O) = \boxed{C_9H_8O_4}$

(5)(4 points) Write the net acid-base reactions for the following neutralizations

(a) $HBr(aq) + Ca(OH)_2(aq)$ ---->

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

(b) $HCl(aq) + NH_3(aq)$ ----->

$H^+_{(aq)} + NH_{3(aq)} \rightarrow NH_4^+{}_{(aq)}$

(6)(4 points) Write the balanced molecular, ionic and net ionic equations for the following reactions

molecular (a) $MnCl_{2(aq)} + K_2CO_{3(aq)} \text{ ----> } 2KCl_{(aq)} + MnCO_{3(s)}$

ionic: $2K^+_{(aq)} + 2Cl^-_{(aq)} + Mn^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow MnCO_{3(s)} + 2K^+_{(aq)} + 2Cl^-_{(aq)}$

net ionic $Mn^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow MnCO_{3(s)}$

molecular (b) $NaOH_{(aq)} + FeSO_{4(aq)} \text{ ----> } Na_2SO_{4(aq)} + Fe(OH)_{2(s)}$

ionic $2Na^+_{(aq)} + 2OH^-_{(aq)} + Fe^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow Fe(OH)_{2(s)} + 2Na^+_{(aq)} + 2OH^-_{(aq)}$

net ionic $Fe^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Fe(OH)_{2(s)}$

(7)(4 points) Complete the following neutralization reactions and balance them for complete neutralization (all acidic protons neutralized, all basic units neutralized).

(a) $H_2SO_{3(aq)} + NaOH_{(aq)} \text{ ----> } 2H_2O_{(l)} + Na_2SO_{3(aq)}$

(b) $H_2SO_4(aq) + NH_{3(aq)} \text{ ----> } 2NH_4^+{}_{(aq)} + SO_4^{2-}{}_{(aq)}$

(8)(2 points) Label the following strong electrolytes, weak electrolytes, or nonelectrolytes

(a) PCl_3 nonelectrolyte

(b) HF weak electrolyte

(c) NaOH strong

(d) $MgCl_2$ strong

(9)(2 points) Name the following compounds

(a) $Mg(OH)_2$ magnesium hydroxide

(b) $HClO_2$ hypochlorous acid

(c) HCl hydrochloric acid

(d) NH_3 ammonia

(10)(4 points) Break the following reaction into an oxidation and a reduction 1/2 reaction. Show all work and the oxidation states of the species being oxidized and reduced. You don't have to balance the 1/2 reactions.

$2(5) + 3(-2) = -2$

$25 - 6 = +19$

$25 = +12$

$S_2O_3^{2-} + H_2O_2 \rightarrow H_2O + SO_4^{2-}$

$S_2O_3^{2-} \rightarrow SO_4^{2-}$ oxidation $S^{+2} \rightarrow S^{+6}$

$H_2O_2 \rightarrow H_2O$ reduction $O^{-} \rightarrow O^{2-}$

(11)(6 points) Balance the following half-reactions in base

(a) $NO_3^- \rightarrow NO_2^-$

NO_3^- NO_2^-

$NH_3(g) : -1$ $N : +3$

$N - 5 = -1$

$N : +5$

$NO_3^- + 2e^- \rightarrow NO_2^-$

$NO_3^- + 2e^- \rightarrow NO_2^- + 2OH^-$

$H_2O + NO_3^- + 2e^- \rightarrow NO_2^- + 2OH^-$

(b) $Na \rightarrow Na^+$

$Na \rightarrow Na^+ + e^-$

Nobel Prizes (3pts) Gerhard Ertl

Chem Surface Chemistry

Physics Albert Fert & Peter Gruenberg

Giant magnetoresistance

(11)(6 points) Balance the following half-reactions in base

(a) $NO_3^- \rightarrow NO_2^-$

NO_3^- NO_2^-

$N: +3$

$NH_3(g): -1$

$N - 5 = -1$

$N: +5$

$NO_3^- + 2e^- \rightarrow NO_2^-$

$NO_3^- + 2e^- \rightarrow NO_2^- + 2OH^-$

$H_2O + NO_3^- + 2e^- \rightarrow NO_2^- + 2OH^-$

(b) $Na \rightarrow Na^+$

$Na \rightarrow Na^+ + e^-$

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