Chemistry 105 Exam 3

Name Key

By submitting this exam, I certify that I have neither given nor received unauthorized aid.

Useful information:

(1) Name the following acids and bases.

(a) HNO_3 nitric acid

(b) NH_3 ammonia

(c) H_2SO_3 sulfurous acid

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

(2) Write an equation for the reaction of H_2SO_4 with an equal number of moles of NH_3. Write the molecular equation with phase labels as well as the net acid-base reaction.

$H_2SO_{4(aq)} + NH_{3(aq)} \longrightarrow NH_4(HSO_4)_{(aq)}$

$H_3O^+_{(aq)} + NH_{3(g)} \longrightarrow NH_4^+_{(aq)} + H_2O_{(l)}$

(3) Write the net acid-base reaction for the following neutralizations

(a) $HNO_{2(aq)} + NaOH_{(aq)}$ -------> weak acid strong base

$HNO_{2(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)} + NO_2^-{}_{(aq)}$

(b) $HBr_{(aq)} + Ca(OH)_{2(aq)}$ ----> strong acid - strong base

$H_3O^+_{(aq)} + OH^-_{(aq)} \rightarrow 2H_2O_{(l)}$

(4) Classify the following as weak or strong acids or bases

(a) H_2SO_4 strong acid

(b) $NaHCO_3$ weak base

(c) HBr strong acid

(d) HCH_3COO weak acid

(5) Complete the following neutalization reactions and balance them for a complete neutralization (all acidic protons neutralized, all basic units neutralized).

(a) $2H_3PO_{4(aq)} + 3Ca(OH)_{2(aq)}$ -------> $Ca_3(PO_4)_2 + 6H_2O_{(l)}$

$3H^+ + PO_4^{3-}$ $Ca^{2+} + 2OH^-$

(b) $HF_{(aq)} + LiOH_{(aq)}$ ------> $H_2O_{(l)} + LiF_{(aq)}$

(6) List the oxidation state for each element in the following compounds

(a) $KMnO_4$ $K^+ + MnO_4^{-1}$ $O = -2$

K^{+1}

O^{-2}

Mn^{+7}

$\therefore 4(-2) + Mn = -1$

$Mn = +7$

(b) H_2ClO_3 $HClO_3$ $H^+ + ClO_3^-$ $O = -2$

H^{+1}

Cl^{+5}

O^{-2}

$\therefore 3(-2) + Cl = -1$

$-6 + Cl = -1$

$Cl = +5$

(7) Predict which of the following reactions will occur and which will not based on the activity series. Indicate which metal is the more reactive metal.

(a) $Cu^{2+}_{(aq)} + Sn_{(s)} \text{-----> } Sn^{2+}_{(aq)} + Cu_{(s)}$ Sn is the more reactive metal, ∴ this reaction will occur.

(b) $Cr^{3+}_{(aq)} + 3Ag_{(s)} \text{------> } 3Ag^{+}_{(aq)} + Cr_{(s)}$ Cr is the more reactive metal, ∴ this reaction will not occur

(8) Break the following reaction into it's half reactions. Label the half reactions as oxidations or reduction. Include the electrons. Show all work.

$Bi(OH)_3(s) + Sn(OH)_3^-{}_{(aq)} \text{----> } Bi(s) + Sn(OH)_6^{2-}$

$Bi(OH)_3 + 3e^- \longrightarrow Bi_{(s)}$ reduction

Bi^{+3} Bi^0

$Sn(OH)_3^-{}_{(aq)} \longrightarrow Sn(OH)_6^{-2} + 2e^-$ oxidation

Sn^{+2} Sn^{+4}

$Bi(OH)_3$ $[Bi^{+3} + 3OH^-\ (O^{-2}, H^{+1})]$

$Sn(OH)_3^-$ $[3OH^-\ (O^{-2}, H^{+1}) + Sn^{+2}]$

$3(-2) + 3(+1) + Sn = -1$

$-3 + Sn = -1$

$Sn = +2$

$Bi_{(s)}$ Bi^0

$Sn(OH)_6^{-2}$ $[O = -2, H = +1\ Sn^{+4}]$

$\therefore 6(-2) + 6(+1) + Sn = -2$

$Sn = +4$

(9) Balance the following equation by the half-reaction method.

$CrCl_{6(aq)} + Fe_{(s)} \text{--------> } CrCl_{3(aq)} + FeCl_{2(aq)}$

Cr^{+6} Fe^0 Cr^{+3} Fe^{+2}

Cl^- not changed

$CrCl_6$ $[Cl^{-1}]$ $\therefore 6(-1) + Cr = 0$

$Cr = +6$

Fe^0

$2(Cr^{+6} + 3e^- \longrightarrow Cr^{+3})$ reduction

$3(Fe^0 \longrightarrow 2e^- + Fe^{+2})$ oxidation

$2Cr^{+6} + 3Fe^0 + 6e^- \longrightarrow 2Cr^{+3} + 3Fe^{+2} + 6e^-$

$2Cr^{+6} + 3Fe^0 \longrightarrow 2Cr^{+3} + 3Fe^{+2}$ (putting Cl^-'s)

$2CrCl_{6(aq)} + 3Fe^0_{(s)} \longrightarrow 2CrCl_{3(aq)} + 3FeCl_{2(aq)}$

$CrCl_3$ Cl^{-1} $\therefore 3(-1) + Cr = 0$

Cr^{+3} $-3 + Cr = 0$

$Cr = +3$

$FeCl_2$ Cl^{-1} $\therefore 2(-1) + Fe = 0$

Fe^{+2} $-2 + Fe = 0$

$Fe = +2$

(10) Answer the following questions concerning molarity.

(a) How many moles of HCl are present in 25.50 mL of a 0.263 M solution of HCl?

$25.50\,mL = 0.0255\,L$

$0.0255\,L \times \frac{0.263\,moles}{L} = 6.71 \times 10^{-3}\,moles\ HCl$

(b) How many mL of 3.57 M NaCl is needed to deliver 0.821 moles of NaCl?

$0.821\,moles \div \frac{3.57\,moles}{L} = 0.230\,L = 230\,mL\ NaCl\ solution$

(11) If 35.87 mL of 0.100 M HCl was needed to neutralize 30.0 mL of a Na_2CO_3 solution. How many moles of Na_2CO_3 were present initially? What was the concentration of the Na_2CO_3 solution?

$Na_2CO_{3(aq)} + 2\,HCl \dashrightarrow 2H_2O_{(l)} + CO_{2(g)} + CaCl_{2(aq)}$

$35.87\,mL = 0.03587\,L$

$(0.03587\,L\ HCl)\left(\frac{0.100\,moles}{L}\right) = 3.59 \times 10^{-3}\,moles\ HCl$

$3.59 \times 10^{-3}\,moles\ HCl \times \frac{1\,mole\ Na_2CO_3}{2\,moles\ HCl} = 1.79 \times 10^{-3}\,moles\ Na_2CO_3$

$volume = 30.0\,mL = 0.0300\,L$

$M = \frac{moles}{L}$ ∴ $\frac{1.79 \times 10^{-3}\,moles}{0.0300\,L} = 5.98 \times 10^{-2}\,M\ Na_2CO_3$

(12) A 125 mL solution of $Cu(NO_3)_2$ was treated with sodium carbonate to precipitate copper carbonate. If 0.735 g of $CuCO_3$ was recovered, what was the concentration of the $Cu(NO_3)_2$ solution?

$Na_2CO_{3(aq)} + Cu(NO_3)_{2(aq)} \text{---------} > CuCO_{3(s)} + 2NaNO_{3(aq)}$ $CuCO_3$ FW = 123.6 g/mole

$0.753\,g \div \frac{123.6\,g}{mole} = 6.09 \times 10^{-3}$ moles $CuCO_3$

6.09×10^{-3} moles $CuCO_3 \times \frac{1\,mole\ Cu(NO_3)_2}{1\,mole\ CuCO_3} = 6.09 \times 10^{-3}$ moles $Cu(NO_3)_2$

$M = \frac{moles}{L}$ $\therefore$ $\frac{6.09 \times 10^{-3}\ moles\ Cu(NO_3)_2}{0.125\,L} = 0.0487\,M\ Cu(NO_3)_2$

Extra Credit: When Na is added to water, what reaction occurs (write it out). What type of reaction is this?

$2\,Na_{(s)} + 2H_2O_{(l)} \longrightarrow H_{2(g)} + 2NaOH_{(aq)}$

this is a redox reaction

$Na^0 \rightarrow Na^{+1} + e^-$

$2H^+ + 2e^- \rightarrow H_2^0$