Chem 1314 Section 3
InClass Exercise #2
Fall 2000

Name___________________________

TA Name _______________________

Lab Section #______

ALL work must be shown to receive full credit. **Due at the end of laboratory.**

ICE3.1. What volume of 0.778 M sodium carbonate solution must be diluted to 150.0 mLs with water to reduce its concentration to 0.0234 M Na_2CO_3?

$$\mathbf{M_C \cdot V_C = M_D \cdot V_D}$$

$$\mathbf{0.778\ M \cdot V_C = 0.0234\ M \cdot 150.0\ mL}$$

$$\mathbf{V_C = \frac{0.0234\ M \cdot 150.0\ mL}{0.778\ M} = 4.51\ mL}$$

ICE3.2. A 0.0945 g sample of $CuSO_4 \cdot 5H_2O$ is dissolved and diluted to the mark in a 500.0 mL volumetric flask. A 2.00 mL sample of this solution is transferred to a second 5000.0 mL volumetric flask and diluted.

a) What is the molarity of the $CuSO_4$ in the final solution?

$$\mathbf{0.0945\ g\ CuSO_4 \cdot 5H_2O \left(\frac{1\ mol\ CuSO_4 \cdot 5H_2O}{250.\ g}\right) = 3.78 \times 10^{-4}\ mol\ CuSO_4 \cdot 5H_2O}$$

$$\mathbf{\frac{3.78 \times 10^{-4}\ mol\ CuSO_4 \cdot 5H_2O}{0.500\ L} = 7.56 \times 10^{-4}\ M\ CuSO_4}$$

$$\mathbf{M_C \cdot V_C = M_D \cdot V_D}$$

$$\mathbf{7.56 \times 10^{-4}\ M\ CuSO_4 \cdot 2.00\ mLs = M_D \cdot 5000.0\ mL}$$

$$\mathbf{M_D = \frac{7.56 \times 10^{-4}\ M\ CuSO_4 \cdot 2.00\ mLs}{5000.0\ mLs} = 3.02 \times 10^{-7}\ M\ CuSO_4}$$

I meant to a second 500.0 mL volumetric flask

$$\mathbf{M_C \cdot V_C = M_D \cdot V_D}$$

$$\mathbf{7.56 \times 10^{-4}\ M\ CuSO_4 \cdot 2.00\ mLs = M_D \cdot 500.0\ mL}$$

$$\mathbf{M_D = \frac{7.56 \times 10^{-4}\ M\ CuSO_4 \cdot 2.00\ mLs}{500.0\ mLs} = 3.02 \times 10^{-6}\ M\ CuSO_4}$$

b) To prepare the solution directly what mass of $CuSO_4 \cdot 5H_2O$ must be weighed out?

$$\mathbf{5.000\ L \left(\frac{3.02 \times 10^{-7}\ M\ CuSO_4}{1\ L}\right) = 1.51 \times 10^{-6}\ mol\ CuSO_4 \cdot 5H_2O}$$

$$\mathbf{1.51 \times 10^{-6}\ mol\ CuSO_4 \cdot 5H_2O \left(\frac{250.\ g}{1\ mol\ CuSO_4 \cdot 5H_2O}\right) = 3.78 \times 10^{-4}\ g\ CuSO_4 \cdot 5H_2O}$$

ICE3.3. Describe how you would prepare 250.0 mLs of a 0.0100 M solution of $KMnO_4$.

$$.250\ L\left(\frac{0.0100\ mol\ KMnO_4}{1\ L}\right) = 2.50 \times 10^{-3}\ mol\ KMnO_4$$

$$2.50 \times 10^{-3}\ mol\ KMnO_4\left(\frac{158\ g\ KMnO_4}{1\ mol}\right) = 0.395\ g\ KMnO_4$$

Weigh 0.395 g $KMnO_4$ on a balance. Measure out about 200 mL of water and add the 0.395 g of $KMnO_4$ to the 200 mL of water. After the $KMnO_4$ dissolves, add enough water so the final volume is 250 mL.

ICE3.4. Given the reaction

$$PbO_2(s) + HNO_3(aq) \rightarrow Pb(NO_3)_2(aq) + H_2O(l) + 2O_2(g)$$

a) Balance the chemical equation.

$$2PbO_2(s) + 4HNO_3(aq) \rightarrow 2Pb(NO_3)_2(aq) + 2H_2O(l) + O_2(g)$$

b) What volume of 1.23 M nitric acid is required to react with 15.0 g of lead(IV) oxide according to the equation?

$$15.0\ g\ PbO_2\left(\frac{1\ mol\ PbO_2}{239\ g\ PbO_2}\right) = 6.28 \times 10^{-2}\ mol\ PbO_2$$

$$6.28 \times 10^{-2}\ mol\ PbO_2\left(\frac{4\ mol\ HNO_3}{2\ mol\ PbO_2}\right) = 1.26 \times 10^{-1}\ mol\ HNO_3$$

$$1.26 \times 10^{-1}\ mol\ HNO_3\left(\frac{1\ L}{1.23\ mol\ HNO_3}\right) = 0.102\ L$$

ICE3.5. Phosphoric aciid can be produced according to the reaction

$$Ca_5(PO_4)_3F(s) + 5H_2SO_4(aq) + 10H_2O(l) \rightarrow 3H_3PO_4(aq) + 5(CaSO_4 \cdot 2H_2O)(s) + HF(aq)$$

a) What volume of 2.50 M phosphoric acid is generated by the reaction of 500. g of $Ca_5(PO_4)_3F$ with excess sulfuric acid?

$$500.0\ g\ Ca_5(PO_4)_3F\left(\frac{1\ mol\ Ca_5(PO_4)_3F}{504\ g\ Ca_5(PO_4)_3F}\right) = 0.992\ mol\ Ca_5(PO_4)_3F$$

$$0.992\ mol\ Ca_5(PO_4)_3F\left(\frac{3\ mol\ H_3PO_4}{1\ mol\ Ca_5(PO_4)_3F}\right) = 2.98\ mol\ H_3PO_4$$

$$2.98\ mol\ H_3PO_4\left(\frac{1\ L}{2.50\ mol\ H_3PO_4}\right) = 1.19\ L\ of\ 2.50\ M\ H_3PO_4$$

b) What volume of 3.00 M sulfuric acid is required to react with amount of $Ca_5(PO_4)_3F$ in part a?

$$0.992\ mol\ Ca_5(PO_4)_3F\left(\frac{5\ mol\ H_2SO_4}{1\ mol\ Ca_5(PO_4)_3F}\right) = 4.96\ mol\ H_3PO_4$$

$$4.96\ mol\ H_2SO_4\left(\frac{1\ L}{3.00\ mol\ H_2SO_4}\right) = 1.65\ L\ of\ 3.00\ M\ H_2SO_4$$

ICE3.6. Given the reaction

$$K_2Cr_2O_7(aq) + 6Fe(NO_3)_2(aq) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 6Fe^{3+}(aq) + 7H_2O(l) + 2KNO_3(aq)$$

a) A solution of $Cr_2O_7^{2-}$ is prepared by dissolving 9.34 g of $K_2Cr_2O_7$ in 400.0 mL of water. (Assume no significant change in volume when the solution is prepared.) A total 14.75 mL of this solution is required to reach the end-point in a titration of a 250.0 mL sample containing Fe(II). Determine the concentration of Fe(II) in the solution.

$$\mathbf{9.34\ g\ of\ K_2Cr_2O_7\left(\frac{1\ mol\ K_2Cr_2O_7}{294.2\ g}\right) = 3.17 \times 10^{-2}\ mol\ K_2Cr_2O_7}$$

$$\mathbf{\frac{3.17 \times 10^{-2}\ mol}{0.400\ L} = 7.94 \times 10^{-2}\ M\ K_2Cr_2O_7}$$

$$\mathbf{0.01475\ L\left(\frac{7.94 \times 10^{-2}\ mol}{1\ L}\right) = 1.17 \times 10^{-3}\ mol\ K_2Cr_2O_7}$$

$$\mathbf{1.17 \times 10^{-3}\ mol\ K_2Cr_2O_7\left(\frac{6\ mol\ Fe^{2+}}{1\ mol\ K_2Cr_2O_7}\right) = 7.02 \times 10^{-3}\ mol\ Fe^{2+}}$$

$$\mathbf{\frac{7.02 \times 10^{-3}\ mol\ Fe^{2+}}{0.250\ L} = 2.81 \times 10^{-2}\ M\ Fe^{2+}}$$

b) Calculate the mols of H^+ required to react with the amount of $K_2Cr_2O_7(aq)$ and $Fe(NO_3)_2(aq)$ used in part a.

$$\mathbf{1.17 \times 10^{-3}\ mol\ K_2Cr_2O_7\left(\frac{14\ mol\ H^+}{1\ mol\ K_2Cr_2O_7}\right) = 0.0164\ mol\ H^+}$$

c) If this number of mols of H^+ are dissolved in 300. mLs, calcualte the concentration of H^+.

$$\mathbf{\frac{0.0164\ mol\ H^+}{0.300\ L} = 5.46 \times 10^{-2}\ M\ H^+}$$

ICE3.7. Write the chemical formula(s) of the product(s) and balance the following reactions. Identify all products phases as either (g)as, (l)iquid, (s)olid or (aq)ueous. If no reaction occurs write NR.

a) $2Al(s) + Fe_2O_3(s) \rightarrow \mathbf{Al_2O_3(s) + 2Fe(l)}$

b) $Na_2SO_4(aq) + 2NH_4Cl(aq) \rightarrow \mathbf{(NH_4)_2SO_4(aq) + 2NaCl(aq)}$

c) $Mg(s) + Cu^{2+}(aq) \rightarrow \mathbf{Mg^{2+}(aq) + Cu(s)}$

d) $3Na_2CO_3(aq) + 2Fe(NO_3)_3(aq) \rightarrow \mathbf{6NaNO_3(aq) + Fe_2(CO_3)_3(s)}$

ICE3.8. Write the ionic and net ionic chemical equations for 1b) and 1d).

1b)

Ionic equation:

$$2NH_4^+(aq) + SO_4^{2-}(aq) + 2Na^+(aq) + 2Cl^-(aq) \rightarrow 2NH_4^+(aq) + SO_4^{2-}(aq) + 2Na^+(aq) + 2Cl^-(aq)$$

Net Ionic equation:

$$\cancel{2NH_4^+(aq)} + \cancel{SO_4^{2-}(aq)} + \cancel{2Na^+(aq)} + \cancel{2Cl^-(aq)} \rightarrow \cancel{2NH_4^+(aq)} + \cancel{SO_4^{2-}(aq)} + \cancel{2Na^+(aq)} + \cancel{2Cl^-(aq)}$$

All ions cancel..no net ionic equation....no reaction.

1d)

Ionic equation:

$$6Na^+(aq) + 3CO_3^{2-}(aq) + 2Fe^{3+}(aq) + 6NO_3^-(aq) \rightarrow 6Na^+(aq) + Fe_2(CO_3)_3(s) + 6NO_3^-(aq)$$

Net Ionic equation:

$$\cancel{6Na^+(aq)} + 3CO_3^{2-}(aq) + 2Fe^{3+}(aq) + \cancel{6NO_3^-(aq)} \rightarrow \cancel{6Na^+(aq)} + Fe_2(CO_3)_3(s) + \cancel{6NO_3^-(aq)}$$

$$2Fe^{3+}(aq) + 3CO_3^{2-}(aq) \rightarrow Fe_2(CO_3)_3(s)$$

ICE3.9. Calculate the mass of manganese(II) sulfate that forms with 0.680 mLs of 2.44×10^{-3} M $KMnO_4$ react with 1.25 g of potassium permanganate in excess sulfuric acid. The equation which describes the reaction between oxalic acid, potassium permanganate and sulfuric acid is,

$$2KMnO_4(aq) + 5H_2C_2O_4(aq) + 3H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2MnSO_4(aq) + 10CO_2(g) + 8H_2O(l)$$

$(\text{moles } KMnO_4)_o$	$(\text{moles } H_2C_2O_4)_{required}$	$(\text{moles } H_2C_2O_4)_o$	Conclusion
1.66×10^{-6}	4.15×10^{-6}	1.39×10^{-2}	$KMnO_4$ limiting, $H_2C_2O_4$ excess

$$0.680 \text{ mLs} \left(\frac{1 \text{ L}}{1000 \text{ mLs}}\right)\left(\frac{2.44 \times 10^{-3} \text{ mol } KMnO_4}{1 \text{ L}}\right) = 1.66 \times 10^{-6} \text{ mol } KMnO_4$$

$$1.25 \text{ g } H_2C_2O_4 \left(\frac{1 \text{ mol } H_2C_2O_4}{90.0 \text{ g } H_2C_2O_4}\right) = 1.39 \times 10^{-2} \text{ mol } H_2C_2O_4$$

$$1.66 \times 10^{-6} \text{ mol } KMnO_4 \left(\frac{5 \text{ mol } H_2C_2O_4}{2 \text{ mol } KMnO_4}\right) = 4.15 \times 10^{-6} \text{ mol } H_2C_2O_4 \text{ required}$$

So $KMnO_4$ is the limiting reagent

$$1.66 \times 10^{-6} \text{ mol } KMnO_4 \left(\frac{2 \text{ mol } MnSO_4}{2 \text{ mol } KMnO_4}\right)\left(\frac{151 \text{ g}}{1 \text{ mol } MnSO_4}\right) = 2.51 \times 10^{-4} \text{ g of } MnSO_4$$