Chemistry 60 - Exam II ***Name _____***
24 January 2018

Show all work for credit. State any assumptions made to solve a problem. Give all numerical answers with the correct number of significant figures. All answers in scientific notation must be in correct scientific notation (i.e., 6.022×10^{23} not 6.022E23 or 6.022e23). All instances of incorrect scientific notation will result in the loss of 3 points each. All numbers that require units should have the units written. All instances of numbers without units will result in the loss of 3 points each.

1. (4 points) ***Balance*** the following chemical equations:

   a. $2\ H_3PO_4 \rightarrow \_\_\_\_\_ H_4P_2O_7 + \_\_\_\_\_ H_2O$

   b. $4\ Si_2H_3 + 11\ O_2 \rightarrow 8\ SiO_2 + 6\ H_2O$

2. (18 points) 254.33 g of chromium(II) acetate reacts with sodium sulfide to produce chromium(II) sulfide and sodium acetate. Write ***the chemical, ionic and net ionic equation*** for the reaction including phase labels. Calculate the number of ***grams of chromium(II) sulfide*** produced if there is a 85.23 % yield.

$$Cr(C_2H_3O_2)_2(aq) + Na_2S(aq) \rightarrow CrS(s) + 2\ NaC_2H_3O_2(aq)$$

$$?\ g\ CrS = 254.33\ g\ Cr(C_2H_3O_2)_2 \times \frac{1\ mol\ Cr(C_2H_3O_2)_2}{170.084\ g\ Cr(C_2H_3O_2)_2} \times \frac{1\ mol\ CrS}{1\ mol\ Cr(C_2H_3O_2)_2} \times \frac{84.06\ g\ CrS,\ theor.}{1\ mol\ CrS} \times \frac{85.23\ g\ CrS,\ act.}{100.00\ g\ CrS,\ theor.}$$

$$= 107.1\ g\ CrS,\ actual$$

3. (13 points) Calculate the ***mass of carbon dioxide produced*** when 41.327 g of pentanoic acid ($C_5H_{10}COOH$) reacts with 36.873 g of oxygen gas.

$$4\ C_5H_{10}COOH + 31\ O_2 \rightarrow 24\ CO_2 + 22\ H_2O$$

$$?\ g\ CO_2 = 41.327\ g\ C_5H_{10}COOH \times \frac{1\ mol\ C_5H_{10}COOH}{115.152\ g\ C_5H_{10}COOH} \times \frac{24\ mol\ CO_2}{4\ mol\ C_5H_{10}COOH} \times \frac{44.010\ g\ CO_2}{1\ mol\ CO_2} = 94.769\ g\ CO_2$$

$$?\ g\ CO_2 = 36.873\ g\ O_2 \times \frac{1\ mol\ O_2}{31.998\ g\ O_2} \times \frac{24\ mol\ CO_2}{31\ mol\ O_2} \times \frac{44.010\ g\ CO_2}{1\ mol\ CO_2} = 39.263\ g\ CO_2$$

39.263 g of carbon dioxide are produced.

4. (15 points) 135.2 mL of a 0.436 M solution of tungsten(II) chloride reacts with an excess of a potassium permanganate solution. The balanced chemical equation is:

$$24\ HNO_3 + 3\ KMnO_4 + 5\ WCl_2 \rightarrow 3\ Mn(NO_3)_2 + 3\ KNO_3 + 3\ W(NO_3)_5 + 2\ WCl_5 + 12\ H_2O$$

Calculate the ***number of grams of the tungsten(V) chloride*** produced.

$$?\ g\ WCl_5 = 135.2\ mL\ WCl_2\ sol'n \times \frac{0.436\ mol\ WCl_2}{1000\ mL\ WCl_5\ sol'n} \times \frac{2\ mol\ WCl_5}{5\ mol\ WCl_2} \times \frac{361.11\ g\ WCl_5}{1\ mol\ WCl_5} = 8.51\ g\ WCl_5$$

5. (12 points) Calculate the ***molarity of a sodium carbonate solution*** that is 32.6%(m/m) and has a density of 1.457 g/mL.

$$? \ \frac{\text{mol } Na_2CO_3}{\text{L } Na_2CO_3 \text{ sol'n}} = \frac{36.2 \text{ g } Na_2CO_3}{100.0 \text{ g } Na_2CO_3 \text{ sol'n}} \times \frac{1 \text{ mol } Na_2CO_3}{105.988 \text{ g } Na_2CO_3} \times \frac{1.457 \text{ g } Na_2CO_3 \text{ sol'n}}{1 \text{ mL } Na_2CO_3 \text{ sol'n}} \times \frac{1 \text{ mL } Na_2CO_3 \text{ sol'n}}{10^{-3} \text{ L } Na_2CO_3 \text{ sol'n}}$$

$$= 4.98 \text{ M } Na_2CO_3$$

6. (12 points) How many ***mL of a 0.563 M solution*** are needed to make 500.0 mL of a 0.100 M solution?

$$M_1V_1 = M_2V_2$$

$$V_1 = \frac{M_2V_2}{M_1} = \frac{(0.100 \text{ M})(500.0 \text{ mL})}{(0.563 \text{ M})} = 88.8 \text{ mL}$$

7. (12 points) 254.3 mL of water are added to 436.2 mL of a 0.853 M solution. What is the ***new molarity***?

$$M_1V_1 = M_2V_2$$

$$M_2 = \frac{M_1V_1}{V_2} = \frac{(0.853 \text{ M})(436.2 \text{ mL})}{(690.5 \text{ mL})} = 0.539 \text{ M}$$

8. (14 points) 25.00 mL of a potassium hydroxide solution is titrated with 35.23 mL of a 0.1532 M sulfuric acid solution. What is the ***molarity of the potassium hydroxide solution***?

$$2\ KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\ H_2O$$

$$?\ \frac{\text{mol KOH}}{\text{L KOH sol'n}} = \frac{35.23\ \text{mL } H_2SO_4\ \text{sol'n}}{25.00\ \text{mL KOH sol'n}} \times \frac{0.1532\ \text{mol } H_2SO_4}{1\ \text{L } H_2SO_4\ \text{sol'n}} \times \frac{2\ \text{mol KOH}}{1\ \text{mol } H_2SO_4} = 0.4318\ \text{M KOH}$$