CHEM 101 EXAM III 12-JUN-00

NAME (please print) _____
last first

1. a. Write a balanced net ionic equation for the reaction of hydroiodic acid (HI, a strong acid) with potassium hydroxide (KOH, a strong base).
   b. A volume of 37.49 mL of a 0.0931 M hydroiodic acid solution is added to 28.16 mL of a 0.121 M potassium hydroxide solution.
      i. Which reactant, hydroiodic acid or potassium hydroxide, is the limiting reagent?
      ii. Which of the two ions, hydrogen ion, or hydroxide ion, is present in an excess amount, and what is its final concentration?

2. a. Write a balanced net ionic equation for the reaction of aqueous solutions of lead(II) nitrate, $Pb(NO_3)_2$, and lithium chloride, LiCl.
   b. What mass of solid lithium chloride is necessary to completely react with 75 mL of a 0.105 M solution of lead(II) nitrate?

3. a. Write a balanced net ionic equation for the reaction that occurs when a solution containing antimony(III), $Sb^{3+}_{(aq)}$, is added to a solution containing periodate anion, $IO_4^{1-}_{(aq)}$, to form antimony(V), $Sb^{5+}_{(aq)}$, and iodide anion, $I^{1-}_{(aq)}$, in an acidic media.
   b. Assume that the antimony(III) solution is prepared by dissolving antimony trichloride, $SbCl_3$, and that the iodide formed can be isolated as potassium iodide, KI. What mass of potassium iodide can be obtained from 2.283 grams of antimony(III) chloride, if the reaction has 78 % yield?

4. a. Write a balanced net ionic equation for the reaction of ammonia (NH_3, a weak base) with sulfuric acid (H_2SO_4, a strong dibasic acid, i.e., it furnishes two hydrogen ions).
   b. When 31.20 mL of 0.0727 M sulfuric acid is titrated against an ammonia solution of unknown concentration, it is found that 19.45 mL of the ammonia solution are required for complete neutralization. What is the concentration of the ammonia solution?

5. a. Write a balanced net ionic equation for the reaction of aqueous solutions of iron(III) nitrate, $Fe(NO_3)_3$, and sodium carbonate, Na_2CO_3.
   b. What mass of iron(III) carbonate will be formed from reaction of 50.00 mL of a 0.0538 M iron(III) nitrate solution with 40.00 mL of a 0.0927 M sodium carbonate solution?

6. a. Write a balanced net ionic equation for the reaction of a solution containing hypochlorite anion, $ClO^{1-}_{(aq)}$, with elemental bismuth metal (Bi), to form chloride anion and bismuth(III) oxide, in alkaline media.
   b. What mass of product bismuth(III) oxide would be formed from reaction of 0.581 grams bismuth with 35.00 mL of a solution that is 0.109 M in hypochlorite anion?

7. a. Write a balanced net ionic equation for the reaction that occurs when a solution of copper(II) nitrate, $Cu(NO_3)_2$, is added to a solution of potassium hydroxide, KOH.
   b. What volume of a 0.0803 M potassium hydroxide solution is needed to form 0.200 grams of precipitate if the reaction is 80 % efficient?

8. a. Write a balanced net ionic equation for the reaction of phosphoric acid (H_3PO_4, a weak tribasic acid, i.e., it furnishes three hydrogen ions) with barium hydroxide ($Ba(OH)_2$, a strong dibasic base, i.e., it furnishes two hydroxyl ions).
   b. What volume of a 0.104 M phosphoric acid solution is needed to completely neutralize 50.00 mL of a 0.0853 M solution of barium hydroxide?

1. a. $H^{1+}_{(aq)} + OH^{1-}_{(aq)} = HOH$

b. ? millimoles $H^{1+}_{(aq)}$ from HI = (37.49 mL)(0.0931M) = 3.49030

? millimoles $OH^{1-}_{(aq)}$ from KOH = (28.16 mL)(0.121M) = 3.40736

KOH, i.e., $H^{1+}_{(aq)}$ is limiting reagent, $H^{1+}_{(aq)}$ is present in an excess amount.

c. 3.40736 mmoles $OH^{1-}_{(aq)}$ reacts with the same amount (mmoles) of $H^{1+}_{(aq)}$, leaving 3.49030 – 3.40736 mmoles $H^{1+}_{(aq)}$ present in an excess amount.

total vol. solution = 65.65 mL

$[H^{1+}_{(aq)}]$ = mmoles / mL = 0.08394 / 65.65 = 1.278 E – 3 M

2. a. $Pb^{2+}_{(aq)} + 2\ Cl^{1-}_{(aq)} = PbCl_{2\ (solid)}$

b. moles LiCl = moles $Pb(NO_3)_2$ [C.F.]

$$\frac{?\,grams(LiCl)}{42.5(Std.Wt.)} = (0.075\text{ L})(0.105\text{ M})\left[\frac{1mole(Pb^{2+})}{1mole(Pb(NO_3)_2}\right]\left[\frac{2mole(Cl^{1-})}{1mole(Pb^{2+})}\right]\left[\frac{1mole(LiCl)}{1mole(Cl^{1-})}\right]$$

? grams LiCl = 0.6694 grams

3. a. answer not provided

b. moles KI = moles $SbCl_3$ [C.F.]

$$\frac{?\,grams(KI)}{166(Std.Wt.)} = \{2.283g / 228.3(Std.W.)\}\left[\frac{1mole(Sb^{3+})}{1mole(SbCl_3)}\right]\left[\frac{1mole(I^{1-})}{4mole(Sb^{3+})}\right]\left[\frac{1mole(KI)}{1mole(I^{1-})}\right]$$

? grams KI = 0.475 (IF 100 % YIELD)

becomes 0.3237 grams at 78 % yield

4. a. $NH_{3\ (aq)} + H^{1+}_{(aq)} = NH_4{}^{1+}{}_{(aq)}$

b. moles NH_3 = moles H_2SO_4 [C.F.]

$$(?\text{ M})(0.01945\text{ L}) = (0.727\text{ M})(0.312\text{ L})\left[\frac{2mole(H^{1+})}{1mole(H_2SO_4)}\right]\left[\frac{1mole(NH_3)}{1mole(H^{1+})}\right]$$

? M = 0.233 molar ammonia

5. a. $2\ Fe^{3+}_{(aq)} + 3\ CO_3^{2-}{}_{(aq)} = Fe_2(CO_3)_{3\,(solid)}$

b. Quantities of both reactants are given. This is a limiting reagent type of a problem.

moles ppt = moles $Fe(NO_3)_3$ [C.F.]

$$\text{? mole ppt} = (0.050\ L)(0.0538\ M)\left[\frac{1mole(Fe^{3+})}{1mole(Fe(NO_3)_3}\right]\left[\frac{1mole(Fe_2(CO_3)_3}{2mole(Fe^{3+})}\right]$$

mole ppt via iron(III) nitrate = 0.001345

$$\text{? mole ppt} = (0.040\ L)(0.0927\ M)\left[\frac{1mole(CO_3^{2-})}{1mole(Na_2CO_3)}\right]\left[\frac{1mole(Fe_2(CO_3)_3}{3mole(CO_3^{2-})}\right]$$

mole ppt via sodium carbonate = 0.001236

Sodium carbonate is the limiting reagent, and only 0.001236 moles of ppt will form.

$$\text{? grams ppt} = 0.001236\ \text{moles ppt}\left[\frac{291.6g(ppt)}{1mole(ppt)}\right] = 0.3604\ \text{grams ppt}$$

6. a. answer not provided

b. Quantities of both reactants are given. This is a limiting reagent type of a problem.

moles Bi_2O_3 = moles Bi [C.F.]

$$\text{? mole } Bi_2O_3 = \{0.581\ g / 209\ (\text{Std.Wt.})\}\left[\frac{1mole(Bi_2O_3)}{2mole(Bi)}\right]$$

moles Bi_2O_3 via Bi metal = 0.00139

moles Bi_2O_3 = moles hypochlorite [C.F.]

$$\text{? mole } Bi_2O_3 = (0.035\ L)(0.109\ M)\left[\frac{1mole(Bi_2O_3)}{3mole(ClO^{1-})}\right]$$

moles Bi_2O_3 via hypochlorite anion = 0.00127

Hypochlorite anion is the limiting reagent, and only 0.00127 moles of Bi_2O_3 will form.

$$\text{? g } Bi_2O_3 = 0.00127\ \text{moles } Bi_2O_3\left[\frac{466g}{1mole(Bi_2O_3)}\right] = 0.5926\ \text{grams } Bi_2O_3$$

7. a. $Cu^{2+}_{(aq)} + 2\ OH^{1-}_{(aq)} = Cu(OH)_{2\ (solid)}$

b. moles KOH = moles ppt [C.F.]

$$(?\ Vol.)(0.0803\ M) = \left(\frac{0.200\,g\,(ppt)}{97.5(Std.Wt.)}\right)\left[\frac{2mole(OH^{1-})}{1mole(Cu(OH)_2}\right]$$

Vol. KOH = 0.5109 L (IF 100 % YIELD),

but for 80 % yield, more of the reactant KOH will be needed...

Vol. KOH needed (@ 80 % yield) = 0.5109 / 0.80 = 63.86 mL

8. a. $H_3PO_{4\ (aq)} + 3\ OH^{1-}_{(aq)} = 3\ HOH + PO_4^{3-}{}_{(aq)}$

b. moles $H_3PO_{4\ (aq)}$ = moles $Ba(OH)_2$ [C.F.]

$$(?\ Vol.)\ (0.104\ M) = (0.050\ L)(0.0853\ M)\left[\frac{2mole(OH^{1-})}{1mole(Ba(OH)_2}\right]\left[\frac{1mole(H_3PO_4)}{3mole(OH^{1-})}\right]$$

? Vol. = 27.34 mL of 0.104 M phosphoric acid