Name ______________________ Test 2
PHYS 0109 Fall 2003

Simple Rules for the Solubility of Salts in Water (From Zumdahl, Chemistry, 3e)

1. Most nitrate (NO_3^-) salts are soluble.
2. Most salts containing the alkali metal ions (Li^+, Na^+, K^+, Cs^+, Rb^+) and the ammonium ion (NH_4^+) are soluble.
3. Most chloride, bromide and iodide salts are soluble. Notable exceptions are salts containing the ions Ag^+, Pb^{2+}, and Hg_2^{2+}.
4. Most sulfate salts are soluble. Notable exceptions are $BaSO_4$, $PbSO_4$, $HgSO_4$, and $CaSO_4$.
5. Most hydroxide salts are only slightly soluble. The important soluble hydroxides are NaOH and KOH. The compounds $Ba(OH)_2$, $Sr(OH)_2$, and $Ca(OH)_2$ are marginally soluble.
6. Most sulfide (S^{-2}), carbonate (CO_3^{2-}), chromate (CrO_4^{2-}), and phosphate (PO_4^{-3}) are only slightly soluble (insoluble).

1. Complete the balanced chemical equations for the reactions that occur when the following materials dissolve in water.

a.

$Na_2SO_4(s) \xrightarrow{H_2O}$ $2\ Na^+(aq) + SO_4^{2-}(aq)$

b.

$HBr\ (g) \xrightarrow{H_2O}$ $H^+(aq) + Br^-(aq)$

c.

$C_{12}H_{22}O_{11}(s) \xrightarrow{H_2O}$ $C_{12}H_{22}O_{11}(aq)$

d.

$CaCl_2(s) \xrightarrow{H_2O}$ $Ca^{2+}(aq) + 2\ Cl^-(aq)$

2. Identify the following compounds as an acid, a base, a neutral ionic compound, or a neutral molecular compound. If the compound is an acid, identify whether it is a week or strong acid

a.	HNO_3	strong acid	b.	$BaCl_2$	ionic compound
c.	CH_3OH	neutral molecular	d.	KOH	strong base
e.	NH_3	weak base	f.	KI	neutral ionic
g.	HNO_2	weak acid	h.	$HC_2H_3O_2$	weak acid

3. HCl is a strong acid, HF is a week acid. Write balanced chemical equations for the ionization of the two acids that account for the fact that one acid is a strong acid and the other is a week acid.

$$HF\ (aq) \rightleftharpoons H^+\ (aq) + F^-\ (aq)$$

$$HCl\ (aq) \longrightarrow H^+\ (aq) + Cl^-\ (aq)$$

4. Determine the mass of $Ba(NO_3)_2$ needed to prepare 300.0 mL of a 0.0100 M $Ba(NO_3)_2$ solution.

MM $Ba(NO_3)_2$ = 137.327 + 2(14.006) + 6(15.9994) = 261.34 g

$$0.3000\ \text{L}\ Ba(NO_3)_2\ \text{soln} \times \frac{0.0100\ \text{mol}\ Ba(NO_3)_2}{1\ \text{L}\ Na(NO_3)_2\ \text{soln}} \times \frac{261.34\ \text{g}\ Ba(NO_3)_2}{1\ \text{mol}\ Ba(NO_3)_2} = 0.7840\ \text{g}\ Ba(NO_3)_2$$

5. Determine the mass, in grams, of $AgNO_3$ required to precipitate the chloride, as AgCl, from a 25.0-mL sample of a 0.100 M $FeCl_2$ solution. (Remember to write balanced chemical equations if necessary.)

$2\ AgNO_3\ (aq) + FeCl_2\ (aq) \text{-->} 2\ AgCl\ (s) + Fe(NO_3)_2\ (aq)$

MM of $AgNO_3$ = 107.868 + 14.007 + 3(15.9994) = 169.87 g

$$0.0250\ \text{L}\ FeCl_2\ \text{soln} \times \frac{0.100\ \text{mol}\ FeCl_2}{1\ \text{L}\ FeCl_2\ \text{soln}} \times \frac{2\ \text{mol}\ AgNO_3}{1\ \text{mol}\ FeCl_2} \times \frac{169.87\ \text{g}\ AgNO_3}{1\ \text{mol}\ AgNO_3} = 0.84935 \Rightarrow 0.849\ \text{g}\ AgNO_3$$

6. 0.336 mol of BH_3 was combined with 1.000 mol of CH_2CH_2. 0.250 mol of $B(CH_2CH_3)_3$ was collected. Using the following chemical equation determine

$$BH_3 + 3\ CH_2CH_2 \longrightarrow B(CH_2CH_3)_3$$

a. the theoretical yield for the reaction.

$$0.336 \text{ mol } BH_3 \times \frac{1 \text{ mol } B(CH_2CH_3)_3}{1 \text{ mol } BH_3} = 0.336 \text{ mol } B(CH_2CH_3)_3 \text{ possible from } BH_3$$

$$1.000 \text{ mol } CH_2CH_2 \times \frac{1 \text{ mol } B(CH_2CH_3)_3}{3 \text{ mol } CH_2CH_2} = 0.333 \text{ mol } B(CH_2CH_3)_3 \text{ possible from } CH_2CH_2$$

theoretical yield is 0.333 mol $B(CH_2CH_3)_3$

b. the percent yield.

$$\frac{0.250 \text{ mol } B(CH_2CH_3)_3}{0.333 \text{ mol } B(CH_2CH_3)_3} \times 100 = 75.8\ \%\text{ yield}$$

7. Write balanced chemical equations for the net reaction that occurs when the following solutions are mixed together. If no reaction occurs, write NR where the products would normally be written.

a. NaI and $Pb(NO_3)_2$

2 NaI (aq) + $Pb(NO_3)_2$ (aq) --> 2 $NaNO_3$ (aq) + PbI_2 (s)

b. HNO_3 and NaOH

HNO_3 (aq) + NaOH (aq) --> $NaNO_3$ (aq) + H_2O (l)

c. K_2SO_4 and $MgCl_2$

NR

d. LiOH and H_2SO_4

H_2SO_4 (aq) + 2 LiOH (aq) --> 2 H_2O (l) + Li_2SO_4 (aq)

8. 33.4 mL of a 0.101 M KOH solution were required to neutralized 0.3827 g of an unknown diprotic acid

a. Determine the number of moles of KOH required to neutralize the acid.

$$0.0334 \text{ L KOH soln} \times \frac{0.101 \text{ mol KOH}}{1 \text{ L KOH soln}} = 0.0033734 \Rightarrow 0.00337 \text{ mol KOH}$$

b. Determine the number of moles of acid present.

Diprotic means that there are two protons on each acid molecule (like H_2SO_4), so two moles of KOH are required for each mole of acid.

$$0.0033734 \text{ mol KOH} \times \frac{1 \text{ mol acid}}{2 \text{ mol KOH}} = 0.0016867 \Rightarrow 0.00169 \text{ mol acid}$$

c. Determine the molar mass of the unknown acid.

$$\frac{0.3827 \text{ g acid}}{0.0016867 \text{ mol acid}} = 226.893$$