Worksheet 6 – Displacement Reactions and Acid/Base reactions

Displacement reactions are those in which **ions recombine** in solution. If the products of this recombination are **insoluble** in water, a solid **precipitate** will form.

The **solubility rules** for common salts are summarized below:

1. Most nitrate salts are soluble.
2. Most salts of sodium, potassium and ammonium cations are soluble.
3. Most chloride salts are soluble.
   Exceptions: silver, lead (II), and mercury (I) chloride (Hg_2Cl_2)
4. Most sulfate salts are soluble.
   Exceptions: calcium, barium and lead (II) sulfate
5. Most hydroxides are only slightly soluble
   Exceptions: sodium, potassium, calcium and barium hydroxides
6. Most sulfide, carbonate and phosphate salts are only slightly soluble.

Based on these rules, decide if each of the following compounds is soluble (s), or insoluble (i),and which rule this is based on:

compound	solubility	rule
silver chloride		
manganese (II) hydroxide		
calcium nitrate		
sodium carbonate		
nickel (II) sulfate		
magnesium sulfide		
calcium carbonate		
potassium hydroxide		
ammonium nitrate		
potassium chloride		
aluminum hydroxide		

Each of the compounds in the grid below is water soluble. However, when they are mixed, insoluble compounds may be formed. First, write out the ions that form when the compounds dissolve in water. Then, in each cell of the grid, decide whether or not an insoluble precipitate will form. If a precipitate will form, write out its formula.

	K_3PO_4	$(NH_4)_2S$	$AgNO_3$	$CaCl_2$
Ag_2SO_4				
$Pb(NO_3)_2$				
KOH				
$MgCl_2$				

1.   100.0 mL of 1.0 M iron (III) nitrate is mixed with 100.0 mL of 1.0 M sodium hydroxide. A precipitate forms. Write the molecular equation, ionic equation and net ionic equation for this reaction.

    a.   Balanced molecular equation (leave ionic species as molecules)

    b.   Ionic equation (allow soluble species to appear as ions)

    c.   Net ionic equation (eliminate "spectator" ions)

d. Determine the mass of the precipitate. Use the **net ionic** equation to make these calculations.

   i.   How many moles of the cation are present?

   ii.   How many moles of the anion are present?

   iii. Based on stoichiometry, is there a limiting reagent?

   iv.   How many moles of precipitate will form?

   v.   How many grams of precipitate is this?

   vi.   What is the concentration of the excess ion?

Acid/Base reactions

Strong acids (HA) dissociate completely in water to produce H^+ and A^-. They are called "proton donors" since they give off a proton, H^+. Strong bases (BOH) dissociate completely in water to form B^+ and OH^-. They are called "proton acceptors" since the OH^- will react with H^+. In a neutralization reaction, the H^+ and OH^- combine to form water (H_2O), leaving the components of salt, A^- and B^+ in solution.

1. What volume of 0.200 M HCl is needed to neutralize 20.0 mL of 0.350 M NaOH? HCl is a strong acid and NaOH is a strong base.

    a. How many moles of OH^- are present?

    b. How many moles of H^+ are needed to neutralize the OH^-?

    c. What volume of 0.200 M HCl is needed?

2. When titrating 0.150 M HCl with a calcium hydroxide solution of unknown concentration, 35.0 mL of acid are required to neutralize 25.0 mL of the base. Calculate the molarity of the base.

    a. Write the balanced molecular equation.

    b. Write the balanced net ionic equation.

    c. How many moles of H^+ are present?

    d. How many moles of OH^- are required to neutralize the acid?

    e. What is the molarity of the base?

3.   A chemist dissolves 0.300 g of an unknown monoprotic (one acidic H) acid
        in water. She finds that 14.60 mL of 0.426 M NaOH are required to
        neutralize the acid. What is the molar mass of the acid?

        a.   Units of molar mass are g/mol. How many grams of acid are
                present?

        b.   How many moles of base are required to reach the equivalence
                point?

        c.   How many moles of acid are present?

        d.   What is the molar mass of the acid?