Name: _____

Period: ____ Subject: AP Chem

Date: _____

Stoich: Precipitation Reactions

Please make sure that you ***show all work!*** (italics, bold and underlined – get it?) Some problems include points for intermediate steps as well as the final answer. If the intermediate step isn't shown, the points aren't given! Be sure to write your name and period above.

1. Show the balanced reaction, ionic reaction, and net ionic reaction for a mixture of aqueous barium nitrate and aqueous potassium chromate (include indications of state - ex: (aq))?

$Ba(NO_3)_2$ (*aq*) + K_2CrO_4 (*aq*) => $BaCrO_4$ (*s*) + $2KNO_3$ (*aq*)
Ba^{2+} (*aq*) + $2NO_3^-$ (*aq*) + $2K^+$ (*aq*) + CrO_4^{2-} (*aq*) => $BaCrO_4$ (*s*) + $2K^+$ (*aq*) + $2NO_3^-$ (*aq*)
Ba^{2+} (*aq*) + CrO_4^{2-} (*aq*) => $BaCrO_4$ (*s*)

If 300.0 ml of 2.0 M barium nitrate mixes with 200.0 ml of 2.5 M potassium chromate, how many grams of precipitate will form?

2.0 M · 0.3000 L = 0.60 mol $Ba(NO_3)_2$ (excess)
2.5 M · 0.2000 L = 0.50 mol K_2CrO_4 (limiting)

$$0.50 \text{ mol } K_2CrO_4 \cdot \frac{1 \text{ mol } BaCrO_4}{1 \text{ mol } K_2CrO_4} = 0.50 \text{ mol } BaCrO_4$$

$$0.50 \text{ mol } BaCrO_4 \cdot \frac{253.33 \text{ g } BaCrO_4}{1 \text{ mol } BaCrO_4} = 126.665 \text{ g } BaCrO_4 = \boxed{130 \text{ g } BaCrO_4}$$

What ions are left in solution and at what concentrations?

200.0 mL + 300.0 mL = 500.0 mL (total vol of solution after mixing)

$[K^+]$ = 1.0 mol/0.5000 L = 2.0 M K^+
$[NO_3^-]$ = 1.2 mol/0.5000 L = 2.4 M NO_3^-
$[Ba^{2+}]$ = 0.10 mol/0.5000 L = 0.20 M Ba^{2+}

2. How many grams of potassium chloride must be added to 1.50 L of a 0.250 M silver nitrate solution to precipitate all the silver out of the solution? What is the precipitate formed?

$KCl\ (aq) + AgNO_3\ (aq) \Rightarrow AgCl\ (s) + KNO_3\ (aq)$

$0.250\ M\ AgNO_3 \cdot 1.50\ L = 0.375\ mol\ AgNO_3$

$$0.375\ mol\ AgNO_3 \cdot \frac{1\ mol\ KCl}{1\ mol\ AgNO_3} = 0.375\ mol\ KCl$$

$$0.375\ mol\ KCl \cdot \frac{74.553\ g\ KCl}{1\ mol\ KCl} = 27.9574\ g\ KCl = \boxed{28.0\ g\ KCl}$$

3. How many grams of calcium chloride would be required to make 2.50 L of 1.5 M solution?

$2.50\ L \cdot 1.5\ M\ CaCl_2 = 3.75\ mol\ CaCl_2$

$$3.75\ mol\ CaCl_2 \cdot \frac{110.986\ g\ CaCl_2}{1\ mol\ CaCl_2} = 416.1975\ g\ CaCl_2 = \boxed{420\ g\ CaCl_2}$$

How much of this solution would you need to precipitate out all of the sulfate ions in 750.0 ml of a 3.0 molar solution of sodium sulfate?

$CaCl_2 + Na_2SO_4 \Rightarrow 2NaCl + CaSO_4$

$3.0\ M\ Na_2SO_4 \cdot 0.7500\ L = 2.25\ mol\ Na_2SO_4$

$$2.25\ mol\ Na_2SO_4 \cdot \frac{1\ mol\ CaCl_2}{1\ mol\ Na_2SO_4} = 2.25\ mol\ CaCl_2$$

$M = mol/V \qquad V = mol/M = 2.25\ mol\ CaCl_2/1.5\ M\ CaCl_2 = \boxed{1.5\ L\ CaCl_2\ solution}$

4. 70.5 mg of potassium phosphate is added to 15.0 mL of 0.050 M silver nitrate and forms a precipitate. Write the molecular equation (balanced reaction) for this reaction.

$K_3PO_4 + 3AgNO_3 \Rightarrow 3KNO_3 + Ag_3PO_4$

What is the limiting reactant?

$0.0705\ g\ K_3PO_4 \cdot \frac{1\ mol\ K_3PO_4}{212.274\ g\ K_3PO_4} = 3.32118 \times 10^{-4}\ mol\ K_3PO_4$

$0.015\ L \cdot 0.050\ M\ AgNO_3 = 7.5 \times 10^{-4}\ mol\ AgNO_3$

$3.32118 \times 10^{-4}\ mol\ K_3PO_4 \cdot \frac{3\ mol\ AgNO_3}{1\ mol\ K_3PO_4} = 9.96356 \times 10^{-4}\ mol\ AgNO_3$

$AgNO_3$ is limiting

What is the theoretical yield of the precipitate that forms?

$7.5 \times 10^{-4}\ mol\ AgNO_3 \cdot \frac{1\ mol\ Ag_3PO_4}{3\ mol\ AgNO_3} = 2.5 \times 10^{-4}\ mol\ Ag_3PO_4$

5. Write balanced net ionic reactions for each of the following ***aqueous*** mixtures and list who the spectator ions are for each reaction:
a) chromium(III) sulfate and ammonium carbonate
b) barium nitrate and potassium sulfate
c) iron(II) nitrate and potassium hydroxide

a) $2Cr^{3+}(aq) + 3CO_3^{2-}(aq) \Rightarrow Cr_2(CO_3)_3(s)$
b) $Ba^{2+}(aq) + SO_4^{2-}(aq) \Rightarrow BaSO_4(s)$
c) $Fe^{2+}(aq) + 2OH^-(aq) \Rightarrow Fe(OH)_2(s)$