LABORATORY 8: Chemical Detective & Mystery Powders (Week 1)

PRELAB

Read the following procedure completely in order to prepare for lab.

Answer the following questions in your laboratory notebook:

1. In your own words, write the purpose of this experiment.
2. Create a table of the solubility rules* to use during lab the next two weeks.
3. Write balanced chemical equations for the following reactions. Use the solubility rules to identify the states of matter of the products and circle any precipitates.
   a. $KBr\ (aq) + AgNO_3\ (aq) \rightarrow$
   b. $K_2SO_4\ (aq) + Ca(NO_3)_2\ (aq) \rightarrow$
   c. $KCl\ (aq) + Pb(NO_3)_2\ (aq) \rightarrow$
4. How could you identify unknown cation X^+ as either H^+ or K^+ in the compound XCl (aq)?

**Note: If you have not yet discussed solubility in lecture, the information can be found in Chapter 4 of your textbook, beginning on pp. 157.*

Before beginning in lab, update the Table of Contents with the title of the experiment and corresponding page number. Two of the procedures today deal with hazardous material, so read the procedures below with care and be aware of your peers while working.

PURPOSE

Most ionic compounds, known as salts, dissolve in water, but many are relatively insoluble. You can determine which are soluble and which are not by referring to a solubility table. In this laboratory procedure, you will identify unknown aqueous ions by precipitating insoluble ionic compounds. You will also identify the solubility of a compound at room temperature.

INTRODUCTION

The general chemical equation for precipitation reactions involve ions that rearrange to either create soluble products or insoluble products, where a precipitate (XY) is observed.

$$XNO_3\ (aq) + KY\ (aq) \rightarrow XY\ (s) + KNO_3\ (aq)$$

A solubility table can also be used to identify the negative ion in strong acids, such as HCl, HBr, H_2SO_4, and HNO_3.

All ionic compounds are solids at room temperature, as are many molecular compounds. For a solid to be considered soluble, a minimum of 0.1 g should be able to dissolve in 40 g of water. The solubility of a compound increases with temperature, and a solution is considered saturated when the solubility limit is reached.

EXPERIMENTAL PROCEDURE: PART 1

1. Create larger versions of the following tables in your lab notebook with the cations labeling the rows and anions heading the columns:

Well Plate 1	Cl^-	SO_4^{-2}	CO_3^{-2}
Ca^{+2}			
Ba^{+2}			
Ag^+			

Well Plate 2	Cl^-	SO_4^{-2}	CO_3^{-2}	Color & pH
K^+				
H^+				

2. In the upper left corner of each box in the tables (except pH) predict whether the combinations of cations and anions would create a precipitate (ppt).

3. Obtain two well plates and place them on the white piece of paper provided. Label the rows and columns so that the wells correspond to your data table.

4. Obtain dropper bottles of various aqueous solutions containing the cations and anions listed above. Add three drops of the calcium solution to each well in the row labeled Ca^{+2}, barium solution to each well in the row labeled Ba^{+2}, and so on for all five cations. Record the chemical formulas in your data tables.

5. Add three drops of the chloride solution to each well in the columns labeled Cl^-, sulfate solution to each well in the columns labeled SO_4^{-2}, and so on for the remaining anion. Record the chemical formulas in your data table.

6. Record your observations of any precipitates that formed in your data tables and write the chemical formula if one formed. Write N/R for "no reaction" if no precipitate was formed.

7. Using universal indicator, test the K^+ and H^+ solutions. Record the color and the pH. Use the chart provided to convert the color to pH.

8. Thoroughly clean the well plates carefully following the instructor's directions. Then obtain two separate unknown solutions. Record the labels (for example 1A and 1B). Develop and record a procedure to identify the unknown cation in solution A and both ions in solution B.

9. Write balanced net ionic equations showing the unknowns reacting to form precipitates.

Cleaning Well Plates

When well plates contain hazardous metal ions such as barium Ba^{+2}, silver Ag^+ or lead Pb^{+2}, they must be thoroughly cleaned and the waste properly managed.

Procedure

1. Pour the well plate contents into to the waste bucket provided.
2. Using a squirt bottle, rinse out the wells above the waste bucket for 5 to 10 seconds. Do not rinse twice.
3. With a slightly damp paper towel, rub out each well to remove any remaining precipitate. Be thorough.
4. Using the ceiling lights as background, examine the wells to be sure they are all as clean as possible.

EXPERIMENTAL PROCEDURE: PART 2

1. Create a data table in your lab notebook. For each of the following trials, record the chemical formula, physical appearance, melting point, solubility, and pH of the following compounds in solution.

2. Measure 0.1 g of sucrose / table sugar / $C_{12}H_{22}O_{11}$ and add it to an aluminum dish. Hold the dish above the flame of a Bunsen burner for less than 1 minute. Record any observations, including whether the solid melts, and the appearance/odor of the liquid.

3. Measure an additional 0.1 g of sucrose, and add it to a 100 mL Erlenmeyer flask. Measure 40.0 mL of distilled water in a large graduated cylinder and pour into the flask. Swirl the

solution for one minute; a stir rod is not necessary. Record whether the solid dissolved or not in your lab notebook.

4. Test the pH of the solution by adding three drops of universal indicator. Record the color and pH in your lab notebook. Red is pH < 4, green is pH = 7, blue = 8.5, and purple is pH > 10. (If the solution is pH = 7, confirm that it is neutral using pH paper; if the pH paper turns blue or purple, record the pH = 8.5 or > 10, respectively)

6. Repeat steps 2 – 4 for each of the following compounds (not all will dissolve):

   a. Acetaminophen / Tylenol / $C_8H_9NO_2$
   b. Acetylsalicylic acid / Aspirin / $HC_9H_7O_4$
   c. Ascorbic acid / Vitamin C / $HC_6H_7O_6$
   d. Calcium carbonate / Tums / $CaCO_3$
   e. Citric acid / Citrus fruit / $H_3C_6H_5O_7$
   f. Magnesium hydroxide / Milk of magnesia / $Mg(OH)_2$
   g. Magnesium sulfate / Bath salts / $MgSO_4$
   h. Potassium nitrate / Gunpowder / KNO_3
   i. Sodium bicarbonate / Baking soda / $NaHCO_3$
   j. Sodium carbonate / Washing soda / Na_2CO_3
   k. Sodium chloride / Table salt / NaCl
   l. Sodium nitrate / Gunpowder / $NaNO_3$

WASTE MANAGEMENT

Once you have completed the experimental procedure and calculations, dispose of your solids and/or solutions in the designated waste container(s). Do not add excess materials back into their original containers. Do not dump the solutions down the drain. Thoroughly rinse the well plates and beakers once emptied in the sink. Return all glassware to your drawer. Thoroughly wipe down the bench top with a wet paper towel.