Honors Chemistry Hour\_\_\_\_\_ Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
Dr. Wexler  
Lab: Solutions and Precipitates  
Date\_\_\_\_\_

**Brief Background:**   
Aqueous solutions of ionic compounds contain dissolved positive and negative ions. When two such solutions are mixed, the ions may take part in a double-replacement reaction. One type of product of a double-replacement reaction is a precipitate. This drives the reaction forward since the precipitate is unable to participate in the reverse reaction.  
Other types of products that drive the reaction forward are gases (such as CO2 or H2) and liquid covalent molecules (such as water).

By writing balanced molecular equations and knowing the solubility of specific ionic compounds, you can predict whether or not a precipitate will be formed.

**Objectives:**Write balanced molecular equations for mixtures of aqueous solutions  
Predict which mixtures will form precipitates  
Observe which mixtures actually do form precipitates  
Write net ionic equations where precipitates form  
Understand that spectator ions do not participate in ionic reactions

**Special Materials:**1.0M BaCl2  
1.0M CuSO4  
1.0M FeCl3  
1.0M KI  
1.0M NaCl  
1.0M Na2CO3  
1.0M NaOH  
1.0M Na2SO4  
1.0M Pb(NO3)2  
Microwell plate  
Transfer pipette

**Pre-Lab:**1. What is a double-replacement reaction?

2. What are the three physical types of products able to drive a double-replacement reaction forward?  
A.   
B.  
C.

3. What is a spectator ion?

4. Illustrate the difference between a molecular equation, a complete ionic equation, and a net ionic equation using the mixture of **sodium phosphate and calcium chloride**. Use prior knowledge to predict which of the two products in the balanced molecular equation will be insoluble (form a precipitate).

Note: To write a net ionic equation:

1. Write the balanced molecular equation.
2. Write the balanced complete ionic equation.
3. Cross out the spectator ions that are present.
4. Write the "leftovers" as the net ionic equation.

A. Balanced molecular equation

B. Complete ionic equation

C. Net ionic equation

**Given:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Table of Solubilities of Ionic Compounds in Water | | | | | | |
| **Cation** | **Anion** | | | | | |
| **Cl-** | **CO3-** | **I-** | **NO3-** | **OH-** | **SO42-** |
| **Ba2+** | Aq | S | S | Aq | Aq | S |
| **Cu2+** | Aq | S | Aq | Aq | S | Aq |
| **Fe3+** | Aq | S | Aq | Aq | S | Aq |
| **K+** | Aq | Aq | Aq | Aq | Aq | Aq |
| **Na+** | Aq | Aq | Aq | Aq | Aq | Aq |
| **Pb2+** | S | S | S | Aq | S | S |
| **Ag+** | S | S | S | Aq | S | S |
| **Mg+2** | Aq | S | Aq | Aq | S | Aq |
| **Key** Aq – soluble (forms aqueous solution)(Aq) – partially solubleS – insoluble (solid) | | | | | | |

**Predict:**   
Based on the table of solubilities above, predict which mixtures will form a precipitate. Write your predictions in the data table.

**Procedure:**   
Combine about 5 drops of each reactant according to the table below (no need to stir). Rinse pipet between each solution to prevent contamination of your stock solutions. Observe for precipitation.

**Results:** Record results in a data table below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tube #** | **Reactants (formulas)** | **Products (formulas)** | **Prediction based on Table of Solubilities (P = precipitate)  (NP = no precipitate)** | **Formula of predicted to be insoluble product (where applicable)** | **Test result  (P = precipitate)  (NP = no precipitate)** |
| **1** | CuSO4 + NaOH |  |  |  |  |
| **2** | FeCl3 + NaOH |  |  |  |  |
| **3** | KI and NaOH |  |  |  |  |
| **4** | KI and NaCl |  |  |  |  |
| **5** | KI and Pb(NO3)2 |  |  |  |  |
| **6** | Na2SO4 and Pb(NO3)2 |  |  |  |  |
| **7** | Na2SO4 and BaCl2 |  |  |  |  |
| **8** | Na2CO3 and BaCl2 |  |  |  |  |
| **9** | Na2CO3 and KI |  |  |  |  |
| **10** | Na2CO3 and CuSO4 |  |  |  |  |
| **11** | NaCl and CuSO4 |  |  |  |  |

**Analysis:**1. Write the balanced molecular equation, complete ionic equation and net ionic equation for the following reactions from your list that occurred, including physical states (aq, l, g, s) for all products (assume reactants are always aqueous here). Make sure you correctly figure out the charge-balanced chemical formula for each reactant and product.

Use the following format:  
Reaction 1  
A. Balanced molecular  
CuSO4(aq) + 2NaOH(aq) 🡪Cu(OH)2(s) + Na2SO4(aq)

B. Complete ionic  
Cu+2(aq) + SO4-2(aq) + 2Na+(aq) + 2OH-(aq) 🡪 Cu(OH)2(s) + 2Na+(aq) + SO4-2(aq)

C. Net ionic  
Cu+2(aq) + 2OH-(aq) 🡪 Cu(OH)2(s)

Reaction 2

A. Balanced molecular

B. Complete ionic

C. Net ionic

Reaction 5

A. Balanced molecular

B. Complete ionic

C. Net ionic

2. For mixtures that do not form a precipitate, is it possible to write a net ionic equation? Why or why not? Relate this to the concept of “spectator ions”:

Give an example of a mixture from this experiment that does not have a net ionic equation (compare the balanced molecular, complete ionic and net ionic equations)

A. Balanced molecular equation

B. Balanced complete ionic equation

C. Balanced net ionic equation

**Questions:**1. Seawater is a dilute solution of several ionic compounds, the major one of which is sodium chloride (NaCl). One way to measure the amount of NaCl in a sample of seawater is to mix the sample with a solution of silver nitrate (AgNO3). Write the balanced molecular equation, the balanced complete ionic equation, and the balanced net ionic equation for this reaction. Indicate the physical states of the reactants and products (aq, s, l, or g) in all three equations.

A. Balanced molecular equation

B. Balanced complete ionic equation

C. Balanced net ionic equation

2. Cells that line your stomach secrete hydrochloric acid (HCl), which helps you digest food and kills many bacteria found in food. When these cells secrete too much HCl, and upset stomach may result. One way to relieve an upset stomach is to take an antacid such as magnesium hydroxide [Mg(OH)2]. Magnesium hydroxide, otherwise known as “Milk of Magnesia”, reacts with HCl in a double-replacement reaction. Write the complete and net ionic equations for this reaction.

A. Balanced molecular equation

B. Balanced complete ionic equation

C. Balanced net ionic equation