Precipitation Reactions and Solubility Rules

**A Discovery Lab**

**The purpose of this lab is to discover rules for solubility of various categories of ionic compounds through experimenting with different precipitation reactions. In this lab, you will run a large number of potential precipitation reactions that will allow you to determine the solubility of the products, analyze the patterns in the data, and formulate the solubility rules.**

**Background**

 **An ionic salt is a compound composed of two parts – cations and anions. When an ionic salt is dissolved in water, the salt crystal will dissociate into its corresponding cations and anions. For example, sodium chloride dissociates into sodium ions, Na1+, and chloride ions, Cl1-. The process can be represented using an equation:**

$$NaCl \left(s\right) \rightarrow Na^{1+} \left(aq\right)+ Cl^{1-} (aq)$$

**When two aqueous ionic salt solutions are mixed together, the mixture of cations and anions have the potential to form new compounds. If the cation from one salt and the anion from the other salt combine to form an insoluble solid product, that insoluble solid product is called a precipitate. The reaction is called a precipitation reaction and is a type of double displacement reaction. If aqueous sodium chloride is mixed with aqueous barium nitrate, a precipitate, barium chloride, is formed:**

$$2Na^{1+}\left(aq\right)+ 2Cl^{1-}\left(aq\right)+ Ba^{2+}+ 2NO\_{3}^{1-} \rightarrow BaCl\_{2} \left(s\right)+ 2Na^{1+}\left(aq\right)+ 2NO\_{3}^{1-}(aq)$$

**Notice that the sodium ions and the nitrate ions stayed dissociated in solution. They don’t combine to form a precipitate and are called spectator ions. They are called spectator ions because they are present in the reaction mixture, but don’t participate in the reaction.**

**If two aqueous ionic salt solutions are mixed together, and a visible precipitate does not form, then an appropriate conclusion would be that the two salts did not react with each other.**

**It is important to note that every salt has some degree of solubility, however slight. Some salts dissolve easily in water while others do not. Even if a salt is considered insoluble, a few ions will be pulled off the crystal lattice to dissolve in water. Tables of solubilities can help predict whether or not a precipitate will form when two aqueous salt solutions are mixed together.**

**Materials:**

***Part I Chemicals – All salt solutions listed below have a concentration of 0.1 M.***

**AgNO3 BaCl2 Na2CO3 K3PO4**

**Ca(NO3)2 (NH4)2SO4 Pb(NO3)2**

***Part II Chemicals – All salt solutions listed below have a concentration of 0.1 M.***

**FeCl3 MgBr2 K2CO3 NaOH**

**Pb(NO3)2 Na2SO4 Na2CrO4**

***Equipment***

**48 well reaction plate waterproof ink or pencil**

**Beral-type pipets – 14 black table top or black piece of paper**

**Labels for pipets – 14 Pipet (cassette) holders**

**Procedure:**

**In this lab experiment, you will combine fourteen salt solutions, two at a time, in two parts. Seven solutions will be combined in Part I, and seven other solutions will be combined in Part II. Observations will be recorded as to which combinations form precipitates and which do not. From these results, a list of soluble substances and a list of insoluble substances will be generated. This list will be analyzed to develop general rules of solubility.**

**You will develop a step-wise procedure that strategically combines the seven solutions for Part I and a step-wise procedure that strategically combines the seven solutions for Part II. Be explicit in terms of quantities of salt solutions, where to put the different salt solutions, and what to do with the chemicals when you are finished with them. (HINT: Your instructor will provide waste containers.)**

**Once you have developed and written your procedure, show your procedure to your instructor for approval, then begin testing your salt solutions!**