Lab: Precipitation in Double Replacement Reactions

In meteorology the term precipitation refers to meteorological phenomena such as rain or snow. Precipitation is chemical solutions occurs when two chemicals react to form a product that is insoluble in water and falls out of solution like rain or snow. A precipitate is a solid substance that separates from solution during a chemical reaction. A precipitate can be identified by the cloudy, milky, gelatinous, or grainy appearance it gives to the mixture.

A barium sulfate precipitate can be produced by the reaction of barium chloride and sodium sulfate. A chemical equation to describe the reaction is written and balanced like this:

$$BaCl_2\ (aq)\ +\ Na_2SO_4\ (aq)\ \rightarrow\ 2\ NaCl\ (aq)\ +\ BaSO_4(s)$$

Barium sulfate, $BaSO_4$ (s), is a common precipitate used as an X-ray contrast medium because it is insoluble in water an opaque to x-rays. Typically a patient drinks an aqueous slurry of barium sulfate just before he is x-rayed. The precipitate coats his stomach and intestines. These organs then show up on the x-ray film in vivid contrast, aiding the doctor's diagnosis.

Notice the reaction that forms $BaSO_4$ is a double-replacement reaction in which the cations and anions of the reactants trade partners to form the products. Also notice that the ratios in which cations and anions combine to form reacts are different from the ratios for the products. For example, Na^+ combines with SO_4^{2-} in a ratio of 2:1 in sodium sulfate, Na_2SO_4; whereas Na^+ combines with Cl^- in a ration of 1:1 in sodium chloride, NaCl.

To write a total ionic equation, rewrite all aqueous substances as their component ions and keep all solid substances unchanged. $BaCl_2\ (aq)\ +\ Na_2SO_4\ (aq)\ \rightarrow\ 2\ NaCl\ (aq)\ +\ BaSO_4(s)$

$$Ba^{+2}(aq)\ +\ 2Cl^{-}(aq)\ +\ 2Na^{+}(aq)\ +\ SO_4^{-2}(aq)\ \rightarrow\ 2Na^{+}(aq)\ +\ 2Cl^{-}\ (aq)\ +\ BaSO_4(s)$$

Cancel all components of the reaction that are identical on both the reactant and product side of the reaction. These are called spectator ions.

$$\cancel{Ba^{+2}(aq)}\ +\ \cancel{2Cl^{-}(aq)}\ +\ 2Na^{+}(aq)\ +\ \cancel{SO_4^{-2}(aq)}\ \rightarrow\ \cancel{2Na^{+}(aq)}\ +\ 2Cl^{-}\ (aq)\ +\ BaSO_4(s)$$

Write the net ionic equation by rewriting the reaction equation including only those reactants and products that change in the reaction. $Ba^{+2}(aq)\ +\ SO_4^{-2}(aq)\ \rightarrow\ BaSO_4(s)$

Always check to see that your net ionic equation is balanced.

In this lab you will observe precipitation reactions by mixing aqueous solutions of various ionic compounds. You will then write balanced complete chemical equations, total ionic equations, net ionic equations and name the compounds formed. Lead, silver and calcium compounds commonly undergo reactions that form precipitates. Silver bromide, AgBr, for example, is a light-sensitive precipitate used to coat photographic papers. In this lab you will mix solutions of lead, silver and calcium compounds with other compounds in solutions. You will observe and describe the precipitates that are formed.

Purpose

The purpose of this lab is to observe double replacement reactions and to practice writing balanced chemical equations, total ionic equations and net ionic equations.

Pre-Lab Questions

Answer all the questions completely and neatly in your lab book.

Read the introduction before you answer the following questions.

1. How is the term precipitate used in describing weather conditions?
2. How is the term precipitate used in describing chemical reactions?
3. What are some ways of identifying a precipitate in a reaction?
4. Describe what happens in a double replacement reaction.

5. Why is Barium sulfate used to X-ray the stomach and intestines?
6. How is the precipitate Silver I bromide used?

Procedure

1. Place the experimental grid in a sheet protector.
2. Clean the sheet protector and rinse with distilled water.
3. Put 1 drop of $AgNO_3$ on each X in the top row.
4. Add 1 drop of the solution at the top of each column.
5. Repeat with $Pb(NO_3)_2$ on the second row and $CaCl_2$ on the third row.
6. Record qualitative observation on the data table in your lab book..

Safety

- Wear your safety glasses!
- Rinse your hands before leaving the lab area.

Data Table: Double Replacement Reactions

	KI	NaCl	NaOH	$FeCl_3$	Na_2SO_4	Na_3PO_4	Na_2CO_3	$CuSO_4$
$AgNO_3$								
$Pb(NO_3)_2$								
$CaCl_2$								

Questions for Analysis

Answer the following questions based on your lab data. Each answer should be a complete sentence that makes it obvious what the question was.

1. Which solutions formed a precipitate when combined with $AgNO_3$?
2. Which solutions formed a precipitate when combined with $Pb(NO_3)_2$?
3. Which solutions formed a precipitate when combined with $CaCl_2$?
4. Verify the precipitates you observed with the expected solubility from a reference sheet. Did you observe any precipitates for reactions that should not have had a precipitate? Explain your results.
5. Did you fail to see a precipitate for any reaction that should have formed a precipitate? Even if you did not, explain how this could have occurred?
6. Why is there no precipitate formed when $CaCl_2$ combines with NaCl ?
7. Write a 1) balanced chemical equation, 2) a total ionic equation, 3) a net ionic equation and 4) name the solid products formed for the precipitation reactions of $AgNO_3$ with KI
8. Write a 1) balanced chemical equation, 2) a total ionic equation, 3) a net ionic equation and 4) name the solid products formed for the precipitation reactions of $Pb(NO_3)_2$ with Na_2SO_4
9. Write a 1) balanced chemical equation, 2) a total ionic equation, 3) a net ionic equation and 4) name the solid products formed for the precipitation reactions of $CaCl_2$ with Na_3PO_4
10. How would your results have been affected if you did not clean off the sheet protector with distilled water prior to beginning this experiment?

Conclusion: Write a complete sentence that refers back to your stated purpose.