

Ionic Reactions in Aqueous Solutions

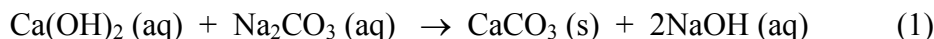
In this experiment you will have the opportunity to examine precipitation reactions and test the solubility rules.

Introduction

Reactions in aqueous solutions are important in many ways. These reactions occur in our homes as well as in lakes, rivers and oceans, in biological systems such as our bodies, and in many industrial applications. Many reactions that occur in aqueous solution involve ions. Precipitation is only one way in which ions can be removed from solution.

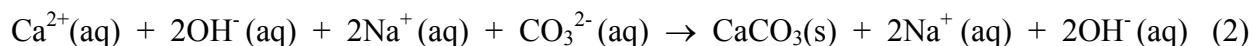
Precipitation reactions in aqueous solution depend on the fact that one product does not dissolve readily in water. Substances vary considerably in their ability to dissolve in water. Some compounds dissolve readily and are said to be soluble. Others have very limited solubilities and are said to be insoluble. There are rules for predicting the solubilities of certain ionic compounds that will form as products to a specific reaction. These rules can be found in your general chemistry textbook.

You will be asked at the end of the experiment to write the net ionic reactions for reactions which form a precipitate. In order to do this, you must understand the difference between a molecular equation and an ionic equation. We will use the example involving the reaction of calcium hydroxide with sodium carbonate. We can write the equation as follows:

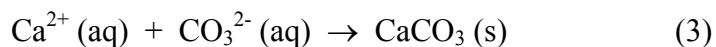


This is called a molecular equation, an equation in which the substances are written as if they were molecular substances, even though they may actually exist in solution as ions. The molecular equation is useful because it indicates which solutions have been added and what products have been produced. However, this does not tell us that the reaction actually involves ions in solution. When solid calcium hydroxide dissolves in water, it goes into solution as Ca^{2+} and OH^- ions. Each formula unit of calcium hydroxide when dissolved in water yields one Ca^{2+} and two OH^- ions. It is much more descriptive to write $\text{Ca}^{2+} (\text{aq}) + 2\text{OH}^- (\text{aq})$ in place of $\text{Ca(OH)}_2 (\text{aq})$ in equation 1.

If we write replacements for all of the compounds that are in solution in equation 1 the result is the following equation



This is an example of an ionic equation, an equation for a reaction involving ions in solution in which soluble substances are represented by the formulas of the predominant species in that solution. Ionic substances that are insoluble are represented by formulas of the compounds. You will note that in equation 2, some ions appear on both sides of the arrow. These are called spectator ions; they are ions in an ionic equation that do not take part in the reaction. We can cancel them from both sides of the equation. The resulting equation is



This is the net ionic equation, an ionic equation from which spectator ions have been canceled. It is this equation, along with the molecular equation that you will be required to write for all successful precipitation reactions in this laboratory experiment.

Procedure

1. Using your well plate, fill the first row of wells (fill only four wells if there happen to be more than four wells available in a row) approximately one-fourth of the way with 0.1M ammonium nitrate.
2. To each of these wells containing the ammonium nitrate, add the same amount of 0.1M sodium bromide to the first well, 0.2M sodium sulphate to the second, 0.1M sodium hydroxide to the third, and 0.1M of sodium carbonate to the fourth. Record your observations, noting the colours of all precipitates.
3. Repeat steps 1 and 2 with 0.1M barium nitrate the second row of wells, 0.1M silver nitrate in the third row, 0.1M calcium nitrate in the fourth , and 0.1M copper (II) nitrate in the fifth. Remember to record your observations.
4. Obtain an unknown solution from your instructor. Be sure to record the letter or number of your unknown before starting your tests on the solution.
5. Repeat steps 1 and 2 using your unknown and record your results. From your results, you should be able to determine the identity of your unknown.
6. Properly dispose of the solutions in the well plates and rinse.

Results

1. Examining precipitation reactions.

	NaBr	Na ₂ SO ₄	NaOH	Na ₂ CO ₃
NH ₄ NO ₃				
Ba(NO ₃) ₂				
AgNO ₃				
Ca(NO ₃) ₂				
Cu(NO ₃) ₂				

Unknown Letter _____

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Identity of Unknown _____

Questions

1. Write balanced molecular and net ionic equations for each successful precipitation reaction that you observed.