

Observing Chemical Reactions

Introduction

An integral part of any experimental science is observing how the world behaves and drawing conclusions from the observed behavior. In this laboratory exercise you will mix chemicals and make observations about the resulting solutions. Your observations of these attempts will tell you whether or not the reactions actually occur, and from this data you will be able to plan a procedure for identifying and separating the salts in an unknown.

How do you know that mixing two chemicals results in a chemical reaction? Look for as many physical indications as possible. Does the color of the solution change? Does it heat up? Does it cool down? Does the smell change? Is gas evolved? Use all of your senses- except taste; remember, don't eat the chemicals! It cannot be emphasized enough that making good observations, and writing them down, is critical to successful investigations in science. Think about how often you have said to yourself, "I'll remember the phone number until I get home," and then promptly forgotten it. It is much easier to forget something you have noted about a new chemical reaction, especially something you did not realize was significant at the time, than something you considered important in the first place. If you note a change or a lack of change, write it down!

After determining which chemicals react, you will need to develop a scheme for the separation of a mixture of salts. Check with you TA to ensure that your scheme will work. Once you have an acceptable scheme, you will identify which two of the salts you have worked with are in an unknown solution.

Safety: Use care when handling acids and bases. Silver nitrate will stain clothing and skin; wear gloves. Dispose of solutions containing silver in the waste jars in the hood. Wear your goggles.

Procedure

Work in pairs on this experiment. The actual data analyses and the written reports must be done entirely independently of your lab partner or other students. Make sure that you avoid unauthorized collaboration and plagiarism. All suspected violations of the Code of Academic Conduct will be referred to Student Judicial Affairs.

Part I. Reactions of the Salt Solutions

1. In this part of the experiment you will experiment with four metal salts and five other reagents. The metal salts you will use are silver nitrate, strontium nitrate, magnesium nitrate and aluminum nitrate. The other reagents you will work with are 6 M hydrochloric acid, 3 M sulfuric acid, 6 M ammonium hydroxide, 6 M sodium hydroxide and 6 M nitric acid. The salt solutions will be found on the chemical shelves, and the acids and bases will be found on the trays by your lab station. If the reagent present in the laboratory is more concentrated than this, dilute it.

Find out what happens when you try to react each reagent with the individual metal salts. Add a couple of drops of one of the reagents to one of the metal salts. What happened? Add a couple more drops and record your observations. Add several drops. Continue until you are sure that you have added an excess of the reagent. It will not take more than a milliliter or two to reach an excess of the reagents. There are twenty possible combinations of salts with reagents. Try them all. You may also want to see what happens if you add more than one reagent to the salt solution.

As you do these reactions, there are some important things you should keep in mind:

Scale: Be sure you do reactions on a reasonable scale. You do not want to be working with such small amounts of material that you have trouble determining results, but at the same time you do not want to be working on such a large scale that you use up an inordinate amount of materials. It is suggested that you do your experiments with volumes that will easily fit in one of your test tubes.

Waste: Silver solutions should not go down the drain; it must be disposed of in the waste jars in the fumehood. Disposal of this waste is very expensive. Plan your

experiment so that you generate as little silver waste as possible. The dispensary will only accept a certain amount of waste from this experiment. If you and your fellow students generate more than this amount, the stockroom will not allow you to complete the parts of this lab that require the use of silver.

Solutions that do not contain silver may be disposed of by pouring them down the drain. Nonetheless, be aware of the amounts of material that you are using. Use enough to get the results you need, but do not be wasteful.

Time: You only have three hours to complete this exercise. Decide which reactions are the most important for you to complete, and which provide ancillary information or satisfy curiosity.

As you work on this portion of the experiment, do your own work, and collaborate with your neighbors. If you seem to get disparate results, talk about why your results are different. Did one of you make an error, or are you just going about things differently?

Question A: In performing these reactions and any required dilutions, should you use tap water or deionized water? Why?

Question B: For each observed reaction between a reagent and a metal salt write a balanced chemical equation that shows what is occurring.

Part II. Analyzing an Unknown

In this part of the experiment you will use the data you have accumulated to tell which of the salts are present in an unknown. Your unknown contains two of the four metal salts you have worked with. Develop a procedure that will distinguish between these four compounds and use it to identify the composition of your unknown. You may need to be able to separate a solid precipitate from a solution. Instructions for separation follow.

1. Transfer the solution and the precipitate to a centrifuge test tube. Fill a second test tube with water until the volumes in the two test tubes are approximately the same.
2. Place the two test tubes in the centrifuge. The test tubes should be placed opposite each other so that their weight is balanced as the centrifuge spins. As there are likely to be more people using the centrifuge, make sure that your test tubes are labeled so that you can identify them when the centrifuge stops.
3. Turn on the centrifuge and allow it to spin for a minute. When the centrifuge stops spinning remove your test tube carefully- you do not want to disturb the solid at the bottom of the tube.
4. If you are trying to completely remove a salt from a solution, add a little more of the reagent that caused the precipitation. If more solid forms in the solution, recentrifuge and repeat this step.

5. Decant the supernatant solution from the solid and reserve. Avoid disturbing the precipitate when pouring off the solution.
6. Add a few milliliters of deionized water to the precipitate and stir. This washes any excess reagent away from the precipitate. Recentrifuge. Decant the supernatant and combine with the reserved solution from Step 5. You have now completed the separation of your precipitate from solution. Separate tests may be performed (as needed) on the precipitate or the supernatant solution.

Question C Why do you test for complete precipitation in Step 4 if you are going to do any further chemical tests on the supernatant?

Write-up Include in your write-up complete observations, answers to the questions and the composition of your unknown. Remember to record your unknown number in your report.

Clean up Pour any solutions or solids containing silver into the silver waste jar in the fume hood. Pour any other solutions down the drain.