The Chemistry of Some Household Products

Performance Goals

- **2–1** Perform tests to confirm the presence of known ions in certain solids.
- **2–2** Perform tests to confirm the presence of these ions in household products.
- 2–3 Analyze and identify an unknown solid.

CHEMICAL OVERVIEW

In everyday life we encounter a large number of chemicals. In fact, everything that surrounds us is a chemical. The air we breathe is a mixture of gaseous elements, oxygen, and nitrogen. The food we eat contains carbohydrates, proteins, large molecular mass vitamins, etc. You may not think about it, but you handle all kinds of chemicals every day.

Qualitative analysis is used to identify components of a solution or solid. A reagent that causes an easily recognized reaction with a particular ion present is added to a sample of the unknown. If the reaction occurs, the ion is present; if the reaction does not occur, the ion is absent.

In this experiment you will perform tests on known compounds that show the presence of certain ions. Once you have become familiar with these specific reactions, you will perform the same tests on some common household products. Finally, you will be given an unknown compound. By performing a series of tests, you will determine which of the following ions is present in your unknown: Cl^- , NH_4^+ , SO_4^{2-} , HCO_3^- , PO_4^{3-} .

SAFETY PRECAUTIONS AND DISPOSAL METHODS

Acids and bases are corrosive and contact with your skin should be avoided. Any spilled acid or base should be washed off promptly. Be sure to wear goggles or safety glasses while performing this experiment.

Dispose of excess solids as directed by your instructor. Solutions containing precipitates should be collected in a waste container.

PROCEDURE

1. Table Salt, NaCl

The presence of chloride ions, Cl^- , can be detected by reacting the dissolved substance with silver nitrate, $AgNO_3$. A white precipitate of silver chloride, AgCl, will form. This reaction is typical of all solutions that contain the Cl^- ion.

Place a few crystals of table salt in a small test tube. Dissolve the solid in about 10 drops of deionized water. Add 2 drops of 1 M nitric acid, HNO₃. Then add 2 or 3 drops of 0.1 M silver nitrate, AgNO₃. Record your observations.

2. Garden Fertilizers

Some of the active ingredients of ordinary garden fertilizers are ammonium salts. These compounds are the source of nitrogen, an element essential for the growth of plants. When a strong base, such as sodium hydroxide, NaOH, is added to a compound containing the $\mathrm{NH_4}^+$ ion, gaseous ammonia, $\mathrm{NH_3}$, is liberated. This can be detected by a piece of red litmus paper that has been moistened with deionized water. The paper will turn blue if $\mathrm{NH_3}$ is present.

- A. Pour about 10 drops of 1 M ammonium chloride, NH₄Cl, into a small test tube. Add about 10 drops of 3 M sodium hydroxide, NaOH. Hold a piece of moist red litmus paper in the mouth of the test tube. Do not allow the paper to come into contact with the side of the test tube, since it may have NaOH on it. Record your observations. If you notice no change, gently warm the test tube in a hot-water bath and check with litmus paper again.
- **B.** Place a small amount of garden fertilizer into a test tube. Add about 10 drops of 3 M NaOH to the solid. Hold a moist strip of red litmus paper in the mouth of the test tube. Record your observations.

3. Epsom Salt, MgSO₄ · 7H₂O

Epsom salt can be purchased in any drugstore. It is commonly used to prepare soothing baths, and it is sometimes used as a purgative. If a solution of barium chloride, BaCl₂, is added to a solution of Epsom salt, a finely divided white precipitate of barium sulfate, BaSO₄, will form.

- **A.** Pour about 10 drops of 1 M sodium sulfate, Na₂SO₄, into a small test tube. Add 3 drops of 1 M hydrochloric acid, HCl, and 2 or 3 drops of 1 M BaCl₂. Record your observations.
- **B.** Place a small amount of Epsom salt into a test tube. Dissolve the solid in about 10 drops of deionized water. Add 3 drops of 1 M HCl and 2 or 3 drops of 1 M BaCl₂. Record your observations.

4. Baking Soda, NaHCO₃

Baking soda and baking powder both contain sodium hydrogen carbonate, NaHCO₃. When this compound reacts with an acid, gaseous carbon dioxide is produced. This makes bread or cakes "rise." Carbon dioxide is produced whenever compounds containing HCO_3^- or CO_3^{2-} ions react with acids. The formation of bubbles indicates that at least one of these ions is present in a sample.

A. Using a spot plate, dissolve a small amount of baking soda in about 10 drops of deionized water. Add about 6 to 8 drops of 1 M hydrochloric acid, HCl. Record your observations. Repeat the test by

- dissolving a small amount of baking soda directly in HCl. Again record your observations, noting any difference between the two reactions.
- **B.** Take another small amount of solid baking soda and add 10 drops of commercial vinegar to it. Record your observations, noting any difference between this reaction and the ones in Step 4A.

5. Detergents

One of the common ingredients of laundry detergents and wall-washing compounds is sodium phosphate, Na₃PO₄. The PO₄³⁻ ion can be detected by adding ammonium molybdate, (NH₄)₂MoO₄, to a dissolved sample. A yellow, powdery precipitate will form. Sometimes gentle heating in a water bath is necessary to hasten the reaction.

- **A.** Pour about 10 drops of 1 M sodium phosphate, Na₃PO₄, into a small test tube and add 3 M HNO₃ until the solution is acidic. (Test by dipping a stirring rod into the solution and touching the wet rod to a strip of blue litmus paper. The solution is acidic if the color changes to red.) Then add 6 to 8 drops of 0.5 M (NH₄)₂MoO₄ and place the test tube in a hot-water bath for a few minutes. Record your observations.
- **B.** Repeat the procedure with a small amount of laundry detergent. Dissolve the solid in about 10 drops of deionized water, acidify it, and add the molybdate reagent. Record your observations. Heat the solution in a water bath and note any change, if there is one.

6. Identification of an Unknown

Obtain a solid unknown and record its number on your work page. Place small portions of the unknown in five separate test tubes. Keep enough unknown to make three additional tests, in case you wish to repeat one or more of the procedures. Dissolve each solid portion in about 10 drops of deionized water and perform the five tests on the separate portions. Your unknown will contain only one ion. Identify the ion and record it on your work page. Remember, you have not identified the cation, so you cannot record your result as "Epsom salt," you have only identified the $\mathrm{SO_4}^{2-}$ ion! Record it as such.

Vam	е	Date	Section
E	xperiment 2		
A	lvance Study Assignment		
1.	What would happen if you used tap water instead	of deionized water in this	experiment?
2.	You have a piece of chalk. How would you determine	ine if it contains CaCO ₃ ?	
3.	If you have a white powder that could be either Epso one it is?	m salt or table salt, how co	uld you decide which
4.	Why is it dangerous to mix household chemicals in	discriminately?	

Name	Date	Section
Experiment 2 Work Page		
Substance Tested		
Table salt		
NH ₄ Cl	_	
Fertilizer	_	
Na ₂ SO ₄		
Epsom salt		
Baking soda solution + HCl		
Baking soda solid + HCl		
Baking soda solid + vinegar		
Na ₃ PO ₄		
Detergent		

Ion present ___

Describe the experimental observation on which your result is based:

Unknown number _____

Name	Date	Section
Experiment 2 Report Sheet		
Substance Tested		
Table salt		
NH ₄ Cl		
Fertilizer		
Na ₂ SO ₄		
Epsom salt		
Baking soda solution + HCl		
Baking soda solid + HCl		
Baking soda solid + vinegar		
Na ₃ PO ₄		
Detergent		

Describe the experimental observation on which your result is based:

Unknown number _____ Ion present ___