LAB 8.1 LABORATORY MANUAL

Properties of Ionic Compounds

Use with Section 8.2

What parts of your body are ionic compounds? Those that compose your skin? Your hair? Actually, most of the human body is composed of nonionic compounds. But, you could not live without sodium chloride and other ionic compounds found inside you. How can you distinguish ionic compounds from other types of compounds? By investigating sodium chloride, you will explore some of the common properties of ionic compounds.

Problem

What are some of the properties of ionic compounds?

Objectives

- **Observe** the crystal shape of NaCl.
- **Compare and contrast** ionic compounds with a nonionic compound.
- **Explain** the differences in the conductivity of ionic compounds in different forms.

Materials

NaCl, coarse grain
NaCl, fine grain
LiCl
sugar (sucrose)
hammer
stereoscope, microscope, or hand lens
crucible
Bunsen burner
ring stand and clamp
wire gauze
conductivity indicator
100-mL beaker
crucible
clay triangle
distilled water

Safety Precautions

- **Always wear safety goggles and a lab apron.**
- **Hot objects will not appear to be hot. Be careful when handling any material that has been heated.**
- **Do not touch or taste any chemicals used or formed in the laboratory.**
- **Do not touch both electrodes on the conductivity indicator at the same time—a small electrical jolt could result.**

Pre-Lab

1. Define crystal lattice energy.
2. Explain what forces must be overcome for a substance to melt.
3. Describe what is necessary for a substance to be a conductor of electricity.
4. Read the entire laboratory activity. Form a hypothesis as to whether distilled water is a conductor of electricity. Record your hypothesis on page 58.
5. Define and give an example of an electrolyte.

Procedure

Part A: Crystal Lattice Structure

1. Use a stereoscope, a microscope, or a hand lens to observe both coarse and fine salt. Record your observations in the data table.
2. With a hammer, gently tap on a coarse grain until it breaks. Note the shapes of the broken pieces and record your observations.

Part B: Melting Point

1. Set up the apparatus as shown in **Figure A**.

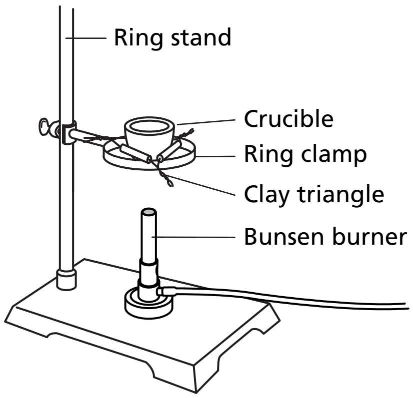

Figure A

2. Sprinkle a pea-sized pile of NaCl in the crucible and heat it with a low flame until the NaCl melts, or for 2 minutes, whichever comes first. If the salt melts within the 2-minute period, record the melting point as low. If the salt does not melt within 2 minutes, record the melting point as high.
3. In the fume hood, and using the same apparatus shown in **Figure A,** repeat step 2 for sugar. (Note: Like most compounds in living organisms, sugar is nonionic.) Make sure the flame is the same setting as your burner in step 2.

Part C: Conductivity

Solid

1. On a piece of paper, make a small pile of NaCl, about the size of three peas. Place the contacts of the conductivity indicator in the pile. Record the results.

Solution

2. Pour about 50 mL of distilled water into a clean 100-mL beaker. Notice that like most ionic substances, NaCl dissolves easily in water.
3. Making sure that you have wiped off the contact wires, place the conductivity indicator in the distilled water. Record the results in the data table.
4. Transfer and dissolve the pile of NaCl into the distilled water. Dissolving in water is another property shown by many ionic compounds. Place the conductivity indicator in the salt solution. Record the results.
5. Repeat step 3 with an equal amount of sugar. (Note: Some nonionic compounds dissolve in water, but many do not.)

Molten

6. Set up the apparatus as shown in **Figure A.**
7. In a clean, dry crucible, mass out approximately 1 g of lithium chloride, LiCl, another typical ionic compound. (The melting point of sodium chloride, NaCl, is too high to observe using classroom laboratory equipment.)
8. Before heating it, place the conductivity indicator in the solid LiCl. Record the results.
9. Place the crucible in the clay triangle and heat the crucible until the LiCl melts. This may take several minutes.
10. Quickly turn off the burner and plunge the clean contact wires of the conductivity indicator into the molten LiCl. Record your observations.
11. Remove the conductivity indicator, allow the wires to cool, and then carefully clean the contact wires.
12. **CAUTION: Do NOT touch the crucible until after it has cooled for about 10 minutes.**

Hypothesis

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Cleanup and Disposal

1. Follow your teacher's directions for disposing of the LiCl.
2. Make sure your balance is left in the same condition as you found it.
3. Be careful that your burner and clamp are cooled before putting them away.
4. Carefully return all laboratory equipment to the proper place and dispose of all waste in the designated containers.

Data and Observations

Part A: Crystal Lattice

Observations about the coarse and fine NaCl	
Observations about the pieces of NaCl after breaking the coarse salt	

Part B: Melting Point

Observations about the melting point of NaCl (high or low melting point)	
Observations about the melting of sugar (high or low melting point)	

Part C: Conductivity

Test Substance	**Conductivity Indicator (Record light as off, dull, bright, or blinking)**	**Conductor Rating (good, poor, or none)**
Solid NaCl		
Distilled water		
NaCl dissolved in distilled water		
Sugar dissolved in distilled water		
Solid LiCl		
Molten LiCl		

1. From the results of Part A, and using words like *soft*, *ductile*, *malleable*, *brittle*, *hard*, or *pliable*, how would you describe sodium chloride?

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2. Sodium chloride and lithium chloride are typical ionic compounds, while sugar represents a typical nonionic compound. In general, how do these two types of compounds compare in their melting points?

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3. In Part C, why was it important to use distilled water instead of tap water for the conductivity measure?

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Analyze and Conclude

1. **Recognizing Cause and Effect** In a crystal lattice structure, the electrons are held tightly by the ions, which are rigidly held in place by electrostatic attraction. Discuss how this characteristic explains why ionic compounds generally (a) have high melting points and (b) do not conduct electricity in the solid state.

2. **Comparing and Contrasting** Nonionic compounds do not exist in crystal lattice structures but rather as individual particles, which are affected by other particles. In other words, nonionic compounds experience forces between particles. Based on what you learned in Part B about the melting points of ionic versus nonionic compounds, how do you think the attractive energy between particles compares with the energy of the crystal lattice?

3. **Thinking Critically** Explain how ionic compounds, which do not conduct electricity in the solid form, can conduct electricity when they are in the molten state or dissolved in water.

4. **Drawing a Conclusion** All ionic compounds exist in only one state at room temperature. From what you learned in this investigation, what is that state and why do you think they do not exist in the other states at room temperature?

5. **Error Analysis** What could be done to improve the precision and accuracy of your investigation?

Real-World Chemistry

1. The human body is mainly composed of nonionic compounds, such as water, carbohydrates, lipids, and proteins. Why then are people such good conductors of electricity?
2. Magnesium carbonate, an ionic compound, is sometimes used as a thermal insulator in buildings. Why would you expect ionic compounds to be good thermal insulators?
3. Ionic compounds often have higher melting points than metals. Using at least two properties of ionic compounds, explain why cookware is not made from ionic compounds.