Comparing Ionic and Molecular Compounds

Background Information

Ions in an ionic compound and molecules in a molecular compound are held together by forces of attraction called **chemical bonds.** An **ionic bond** is the force that holds positively charged cations and negatively charged anions together in a crystal lattice. Each cation is attracted to all the neighboring anions in the lattice. Each anion is attracted to all the neighboring cations in the lattice.

In molecules, atoms are held together by covalent bonds. In a **covalent bond,** two atoms share a pair of valence electrons. The atoms are held together by the attractions between the protons in each nucleus and the shared electrons. If one atom in a covalent bond has a greater attraction for electrons than the other atom does, the electrons are not shared equally between the atoms. The atom with the greater attraction has a partial negative charge, while the other atom has a partial positive charge. This type of covalent bond is called a **polar covalent bond.** When the electrons are shared equally between the atoms, the bond is called a **nonpolar covalent bond.** Whether a molecule is polar or nonpolar depends on the type of covalent bonds and the shape of the molecule.

In this investigation, you will use ease of melting to compare the strength of the ionic bonds in sodium chloride to the strength of intermolecular attractions in paraffin. Paraffin is a mixture of hydrocarbons, which are molecular compounds that contain only hydrogen and carbon. Then, you will compare the ability of the molecules in sugar and the molecules in paraffin to dissolve in water.

Problem

How do different forces of attraction affect the behavior of ionic compounds and molecular compounds?

Pre-Lab Discussion

Read the entire investigation. Then, work with a partner to answer the following questions.

1. **Inferring** How would you expect the strength of the forces that hold a solid together to affect the melting point of the solid?

_____

_____

_____

Name _____ Class _____ Date _____

2. **Predicting** A solid can dissolve in water if the particles in the solid are attracted to water molecules. Would you expect an ionic compound to dissolve easily in water? A compound with polar molecules? A compound with nonpolar molecules? Explain your answers. (*Hint:* Water molecules are strongly polar.)

3. **Controlling Variables** Identify the manipulated and responding variables in this investigation.

4. **Formulating Hypotheses** Record your hypothesis of whether the bonds that hold ions together in a crystal are stronger than the intermolecular attractions that hold molecules together in a solid.

5. **Evaluating** What results in this investigation would support your hypothesis?

Materials *(per group)*

sodium chloride	clay triangle	sugar
paraffin	Bunsen burner	test-tube rack
3 spatulas	tongs	clock or watch
2 crucibles	2 test tubes with stoppers	
ring stand with iron ring	glass-marking pencil	

Safety

Put on safety goggles and a lab apron. Be careful to avoid breakage when working with glassware. Tie back loose hair and clothing when working with flames. Do not reach over an open flame. Use extreme care when working with heated equipment or materials to avoid burns. Note all safety alert symbols next to the steps in the Procedure and review the meaning of each symbol by referring to the Safety Symbols on page xiii.

Name _____ Class _____ Date _____

Procedure

1. Use a spatula to place a pea-sized quantity of sodium chloride in a crucible. Use a second spatula to place a pea-sized quantity of paraffin in a second crucible.
2. Use the ring stand, iron ring, and clay triangle to support the crucible of sodium chloride above a burner.
3. Light the burner and observe the contents of the crucible for 1 minute. Keep the flame away from the contents of the crucible. Record your observations in the data table. **CAUTION:** *Be careful when working with flames. Tie back loose hair and clothing.*
4. Use tongs to carefully remove the crucible from the flame. Gently place the crucible in a safe place on the lab table where you will not accidentally touch it as it cools. **CAUTION:** *Use extreme care when working with heated equipment or materials to avoid burns. Do not touch objects after they have been heated. Allow them to cool completely first.*

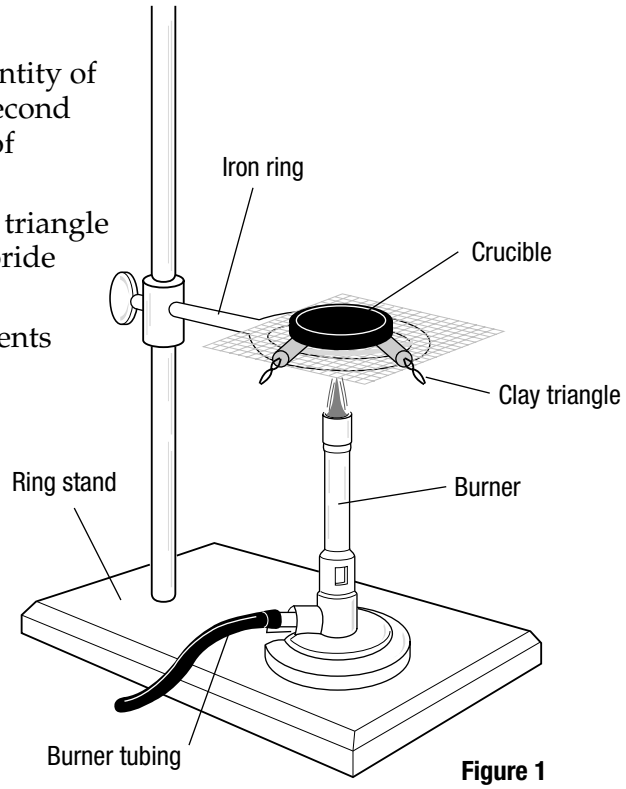

Figure 1

5. Repeat Steps 2 through 4 with the crucible of paraffin. Turn off the gas supply to the burner when you are done.
6. Label two test tubes *1* and *2* with the glass-marking pencil. Fill the test tubes halfway with water.
7. Use a new spatula to place a pea-sized quantity of sugar in test tube 1. Use the spatula that you used for paraffin in Step 1 to place a pea-sized quantity of paraffin in test tube 2.
8. Stopper the test tubes. Holding the stoppers firmly in place, shake each test tube to speed up the dissolving of the salt and paraffin.
9. Observe the contents of the test tubes and record your observations.

Observations

DATA TABLE

Solid Material	Melting	Dissolving in Water
Sodium chloride		_____
Paraffin		
Sugar	_____	

Name _____ Class _____ Date _____

Analysis and Conclusions

1. **Inferring** Based on your data on melting, which forces are stronger—the ionic bonds in sodium chloride or the attractions between molecules in paraffin? Explain your answer.

2. **Inferring** Based on your data on dissolving in water, which material is more likely to contain polar molecules—sugar or paraffin? Explain your answer.

3. **Evaluating and Revising** Did your data support or contradict your hypothesis?

4. **Predicting** Which type of compound—ionic or molecular—would you expect to have a higher boiling point? Explain your answer.

Go Further

Suppose you had a sample of sodium chloride and paraffin mixed together. How could you separate the sodium chloride from the paraffin?