Differences Between Ionic and Covalent Compounds

A compound is defined as the chemical combination of two or more elements. A chemical bond is the "glue" that holds atoms of different elements together. Bonds can be classified into two general types: *ionic* and *covalent.* Ionic bonds generally occur between a metallic atom and a nonmetallic atom. The ionic bond involves the transfer of electrons from the metallic atom to the nonmetallic atom, resulting in a charge difference. The positively charged metal ion is then attracted to the negatively charged nonmetal ion. Covalent bonding generally occurs between atoms that are nonmetallic and it involves the sharing of electrons.

Properties such as melting point, boiling point, solubility, electrical conductivity, color, and odor are some of the properties that can help you distinguish ionic from covalent compounds. In this experiment, you will observe several properties of some ionic and covalent compounds and attempt to recognize some patterns among the properties. It is important to understand that the patterns are generalizations that do not necessarily apply to all ionic and covalent compounds.

OBJECTIVES

1. to identify compounds as either primarily ionic or primarily covalent from the name and formula
2. to observe and record the solubility, melting time, and electrical conductivity of several ionic and covalent compounds
3. to recognize patterns among some of the properties that will help to distinguish ionic compounds from covalent compounds

MATERIALS

Apparatus

centigram balance
glazed paper
6 test tubes (18- x 150-mm)
test-tube rack
6 stoppers, for test tubes
hot plate
beaker (250-mL)
graduated cylinder
safety goggles
lab apron

Reagents

benzoic acid, C_6H_5COOH
magnesium chloride, $MgCl_2$
paradichlorobenzene, $C_6H_4Cl_2$
potassium iodide, KI
sodium nitrate, $NaNO_3$
sucrose, $C_{12}H_{22}O_{11}$
methanol

PRELAB

Answer questions 1-5 on the Report Sheet.

PROCEDURE

1. Put on your laboratory apron and safety goggles.
2. Obtain six pieces of glazed paper and label each piece with the name of one of the six solids that you will test. (Methanol is a liquid.) Using the balance, put two grams of each substance on the appropriate piece of paper and divide the two grams into two equal piles.

3. Obtain six test tubes, six stoppers, and a test-tube rack. Label the test tubes 1-6 to correspond to the numbers in the tables on the Report Sheet.
4. Begin heating approximately 150 mL of water in a 250-mL beaker on a hot plate. This will be used to determine the solubility of each substance (Step 6) in hot water.
5. Place 5 mL of room-temperature water in each of the test tubes. Then put 1 gram of each of the solids into the appropriate test tube. Stopper the tubes and shake them to dissolve the solids as much as possible. Shake for one to two minutes. If the substance dissolves, it is soluble, if not, it is insoluble. Record the results on the Report Sheet as soluble or insoluble.
6. Put any test tubes containing substances that did not dissolve in room-temperature water into the beaker of hot water for two or three minutes. Again, shake the contents. Record the solubilities on the Report Sheet.
7. Rinse the test tubes and stoppers. Check with your teacher for the proper disposal of the solutions and the undissolved solids.
8. Place 5 mL of methanol in each of the test tubes. Dispose of any leftover methanol carefully, following your teacher's guidelines. Then put 1 gram of each of the solids into the appropriate test tube. Stopper the test tubes and shake them for one to two minutes. Record the solubilities on the Report Sheet.

CAUTION: Methanol is very poisonous. Do not get it in your mouth or eyes; do not swallow any.

9. Rinse the test tubes and stoppers. Check with your teacher for the proper disposal of the solutions and the undissolved solids.
10. Clean up all of the materials and wash your hands thoroughly with soap and water; use a fingernail brush to clean under your fingernails. The remainder of the lab will be done as a demonstration by your teacher.
11. Watch as your teacher demonstrates the "melting time" of the solids. Melting time is the amount of time necessary to melt a certain quantity of a solid. This does not give an accurate value for the melting point, but will enable you to see differences among the compounds. Record the melting times on the Report Sheet.

CAUTION: Methanol is flammable. Before using it, be sure all burners and other flames in the laboratory are extinguished, and that all hot plates are turned off.

12. Again, watch as your teacher demonstrates the electrical conductivity of solutions of the solids. Electrical conductivity can be tested by using a conductivity tester. Electrodes are placed into a solution and the tester is turned on. If the solution conducts electricity, the light bulb will light. If the solution does not conduct electricity, the light will not go on. If the light bulb is dim, the solution is considered to be a poor conductor. Record the results on the Report Sheet.

POST LAB DISCUSSION

You have just recorded several properties of some ionic and covalent compounds. Up until now, you have not identified the substances as ionic or covalent. Ionic compounds are generally made up of metallic and nonmetallic elements, with the metal giving up electrons to the nonmetals. Covalent compounds are generally made up of atoms that are nonmetallic, with the atoms sharing electrons. In addition, the differences in electronegativity between the atoms involved can help to determine the ionic or covalent character of the bonds. Sodium chloride is an ionic compound because sodium is a metal that gives up an electron to chlorine, a nonmetal. The electronegativities of sodium and chlorine, respectively, are 0.96 and 3.00, having a difference of 2.04. Carbon dioxide is a covalent compound, because the elements carbon and oxygen share electrons in bonding. The electronegativities of carbon and oxygen are 2.56 and 3.37, having a much smaller difference of 0.81.

You will need to refer to your textbook or another reference to help you in determining whether the compounds used in this experiment are ionic or covalent. It is important to emphasize that some of the results of the experiment may not reflect particular patterns.

Differences Between Ionic and Covalent Compounds

Name_____

Class _____ Date _____

EXPERIMENT 12A REPORT SHEET

PRELAB QUESTIONS

1. Ionic compounds are generally made up of what kind of elements? _____

_____

2. Covalent compounds are generally made up of what kind of elements? _____

3. How is "melting time" related to the melting point of substances? _____

_____

4. How can the electrical conductivity of a solution be tested? _____

_____

_____

5. Predict whether each of the following compounds is primarily ionic or primarily covalent:

   a. sodium iodide (NaI) _____

   b. methane (CH_4) _____

   c. calcium chloride ($CaCl_2$) _____

   d. ammonia (NH_3) _____

RESULTS

SUBSTANCE	SOLUBILITY IN			MELTING TIME	ELECTRICAL CONDUCTIVITY OF SOLUTION
	ROOM TEMP. WATER	HOT WATER	METH-ANOL		
1					
2					
3					
4					
5					
6					

CONCLUSIONS

1. Determine whether each of the compounds is ionic or covalent. Refer to your textbook or another reference to check your prediction. Summarize the answers in the table on the next page.

NAME	FORMULA	IONIC OR COVALENT
1		
2		
3		
4		
5		
6		

2. Look at the results carefully. Are there any patterns that you have observed in the property of solubility? Explain._____

_____

_____

3. Similarly, look at the other properties. What can you say about each of the other properties in relation to the ionic or covalent character of the compounds?

melting time _____

electrical conductivity_____

SYNTHESIS

1. Predict the following:
   a. solubility of sodium iodide in water _____
   b. melting time of sodium iodide _____
   c. electrical conductivity of a glucose solution _____
2. Using the information in your textbook or another reference, draw a sketch of the bonding in:
   a. paradichlorobenzene

   b. methanol

   c. sucrose