Name _____ Date _____ Period _____

IONIC AND COVALENT COMPOUNDS Chemistry

Objectives

1. Analyze six chemical compounds as to their solubility and electrical conductivity
2. Determine the electronegativity differences of six chemical compounds
3. Predict patterns of solubility and electrical conductivity for polar, nonpolar and ionic compounds

Introduction

Compounds are made of two or more elements that are held together by chemical bonds. In general, there are two types of chemical bonds: ionic and covalent. **Ionic bonds** are electrostatic forces that exist between oppositely charged ions. Atoms that lose electrons become positively charged ions (cation); atoms that gain electrons become negatively charged ions (anion). The attractive force between a cation and an anion is referred to as an ionic bond. Compounds that are held together by ionic attractions are classified as ionic compounds. Solutions of ionic compounds are referred to as electrolytes because they conduct electricity. **Covalent bonds** are formed when two atoms share electrons in a compound, but the sharing of electrons is not always equal. **Electronegativity** is the ability of an atom to attract electrons. To classify the bonds in a compound as ionic, polar covalent or nonpolar covalent, the difference in electronegativity values between the atoms must be calculated.

Electronegativity Differences and Bond Types

Electronegativity difference range	*Type of bond*	*Example*
0.0 – 0.4	Nonpolar covalent (NPC)	H – H (0.0)
0.4 – 1.0	Moderately polar covalent (PC)	H – Cl (0.96)
1.0 – 2.0	Very polar covalent (PC)	H – F (1.78)
≥ 2.0	Ionic (I)	K – Cl (2.34)

Electronegativity calculations are one way to determine if a compound is ionic, polar covalent or nonpolar covalent. It is fairly simple if there are only two types of atoms in the compound; but what if there are three or more types of atoms? Compounds that contain only nonmetals are covalent. Compounds that contain both metals and nonmetals are usually ionic. For example, Na_2SO_4 contains a metal (Na) and nonmetals (sulfur and oxygen), and so is expected to be ionic. The rule works because metals give up electrons very easily to form cations, and nonmetals gain electrons easily to form anions resulting in an ionic bond.

<u>Safety Notice:</u> Eating or drinking is not permitted during labs! Goggles and aprons are required throughout the entire laboratory procedure.

Materials

hot plate
conductivity apparatus
13 mm x 150 mm test tubes
test tube rack
10 mL graduated cylinder
benzoic acid
sodium chloride
paradichlorobenzene
stirring rods
sucrose
sodium nitrate
calcium chloride
250 mL beaker

Methods

I. Prepare a hot water bath by pouring about 150 mL of tap water into a 250 mL beaker. Put the beaker on a hot plate and heat @ setting '3'. Do not boil the water!

2. Clean the 10 mL graduated cylinder and the 6 test tubes, number them from 1 – 6, and place them in a test tube rack.

3. Using the 10 mL graduated cylinder, measure 5 mL of tap water and pour into test tube #1. Repeat this procedure for test tubes #2 - #6.

4. Using the laboratory balance and a weighing boat/paper, mass 1.0 g samples of the following solids and place into the correctly numbered test tube:
   Tube 1 Benzoic acid (C_6H_5COOH)
   Tube 2 Sodium chloride (NaCl)
   Tube 3 Paradichlorobenzene ($C_6H_4Cl_2$)
   Tube 4 Calcium Chloride ($CaCl_2$)
   Tube 5 Sodium nitrate ($NaNO_3$)
   Tube 6 Sucrose ($C_{12}H_{22}O_{11}$)

5. Examine the six tubes containing the solids and pick out the tubes in which the solid did not dissolve. Place these tubes in the hot water bath and stir.

6. Record the solubility data using (+) for soluble and (–) for insoluble on the data table.

7. Using a battery type conductivity apparatus, test the conductivity of the six solutions. If the solution conducts electricity, record as a (+) in the data table. If it does not, then record a (–). Rinse the probes in a beaker of tap water & dry before each test.

8. Pour all the solutions down the drain using plenty of water. Wash the test tubes. Use caution in handling the tubes from the hot water bath.

9. Add water for the hot water bath if needed, and leave it on setting '3'.

10. Using an electronegativity chart, e.g. ptable.com, find and record the electronegativity differences for water, sodium chloride, calcium chloride, and sodium nitrate; use the C – H bond in benzoic acid and paradichlorobenzene; and the C – O bond for sucrose.

11. CLEAN ALL GLASSWARE AND EQUIPMENT/WASH OFF YOUR LABORATORY TABLE. PLEASE RETURN MATERIALS AS DIRECTED BY THE TEACHER. WASH YOUR HANDS THOROUGHLY WITH SOAP AND WATER BEFORE LEAVING THE LAB ROOM.

OBSERVATIONS/DATA TABLE

	Compound name	Compound formula	Solubility in water	Solubility in ethanol	Conductivity	Electronegativity difference	Compound type
1				+			
2				+			
3				+			
4				+			
5				+			
6				+			

CALCULATIONS – electronegativity differences as instructed in procedural step #10

Questions

1. Identify each substance as polar covalent, nonpolar covalent, or ionic. Show answers in the last column of your data table using I = ionic, NPC = nonpolar covalent, PC = polar covalent.

2. Are ionic substances soluble in polar substances?

3. Why is ethanol able to dissolve nonpolar substances?

4. Are nonpolar substances soluble in polar or ionic substances?

5. From your data, which of the compounds containing carbon is soluble in water?

6. When are ionic bonds formed?

7. What is the difference between polar and nonpolar covalent bonds?

8. What attracts polar and ionic substances?

9. Why are electronegativity differences important?

10. What does electronegativity refer to?