Name _____ Class _____ Date _____

Inquiry Lab

Using Scientific Methods

Ionic and Covalent Conductivity

The structural nature of ionic and covalent compounds causes their physical properties to differ dramatically. For instance, ionic compounds separate into their individually charged ions when combined with water. Covalently bonded molecules, depending on their shape and thus the distribution of charge on them, may not dissolve in water at all. Even if they do, this is often due to breaking of weak bonds between the molecules, rather than dissociation of the molecule itself. The degree of separation of a substance into ions or uncharged molecules in solution can be determined by how well the solution conducts electricity. As charge carriers, ions can move easily though a solution, and so conduct electricity well, whereas uncharged molecules do not. In this lab, you will determine whether various compounds are ionic or covalent according to how well they conduct electricity.

OBJECTIVES

Using Scientific Methods **Test** how electrical conductivity varies with chemical composition.

Compare and contrast the electrical conductivities of different solutions.

Infer which solutions are ionic or covalent based on how well they conduct electricity.

MATERIALS

- baking soda, 35 g
- beakers, 250 mL, 7
- distilled water, 750 mL
- flashlight bulb, 6 V
- grain alcohol (ethanol), 150 mL
- granulated sugar, 150 g
- insulated copper wire, 20 cm long, 3
- lantern battery, 6 V
- silica gel, 25 g
- socket for 6 V bulb
- table salt, 25 g
- vinegar, 150 mL

SAFETY

ASK A QUESTION

1. How might electrical conductivity indicate the presence or absence of ions in a solution?

FORM A HYPOTHESIS

2. Form a hypothesis that answers your question. Explain your reasoning.

_____

_____

_____

_____

TEST THE HYPOTHESIS

3. Strip off 1 cm of the insulation from both ends of each piece of copper wire. Construct the conductivity tester by connecting one length of copper wire between the socket and the battery, another wire to the other battery terminal, and the third wire to the other socket terminal. Screw the bulb into the socket, and test the device by touching the two loose ends of copper wire to each other and noting if the bulb lights up. **CAUTION:** Do not touch the exposed ends of the copper wire. Handle the wire only using the insulated portion. Use care when handling copper wire. It can scratch or puncture the skin.

4. Pour 150 mL of distilled water into each of five beakers.

5. Prepare four solutions by dissolving the table salt, baking soda, sugar, and silica gel into four of the five beakers of water. Label each beaker with a number and a description of its contents.

6. Pour 150 mL of alcohol into a sixth beaker, and 150 mL of vinegar into a seventh beaker. Label each beaker with a number and a description of its contents. **CAUTION:** Do not use alcohol near an open flame.

7. Place the ends of the conductivity tester's wires into each of the seven beakers. Note whether the lamp burns brightly, dimly, or not at all. Record your observations in the table.

TABLE: IONIC AND COVALENT CONDUCTIVITY

Solution	Lamp Burns Brightly	Lamp Burns Dimly	Lamp Does Not Burn
Distilled Water			
Distilled Water and Table Salt			
Distilled Water and Baking Soda			
Distilled Water and Sugar			
Distilled Water and Silica Gel			
150 mL Alcohol			
150 mL Vinegar			

8. When you've completed your observations, dispose of the liquids according to your teacher's instructions, and thoroughly rinse out each of the beakers. Disconnect the wires of the conductivity tester from the battery. Wash your hands thoroughly with soap or detergent when the lab is completed.

ANALYZE THE RESULTS

1. **Making Comparisons** Which solutions conducted electricity well? Which solutions were weak conductors of electricity? What observations led to these conclusions? Explain your answer.

2. **Analyzing Results** Which solutions contained ionic compounds? Which solutions appeared to contain covalent compounds? Explain your answer.

DRAW CONCLUSIONS

3. **Evaluating Methods** What do you think may have limited your ability to determine the conductivity of a solution?

4. **Drawing Conclusions** How does the chemical composition of the solutions tested relate to electrical conductivity?

5. **Evaluating Results** Vinegar is a solution containing acetic acid, which is a covalently bonded (molecular) substance. How did the observed conductivity of this solution fit in with your conclusions?

6. **Making Predictions** Tap water conducts electricity, which is why it is dangerous to operate electrical appliances near sinks or tubs filled with water, or to operate such appliances with wet hands. Why does tap water behave differently from distilled water?

EXTENSION

1. **Research and Communication** Research the molecular or ionic structure of the various substances that you tested, and find out why they do or do not separate into charged components at the atomic level. Use this to explain why they are strong, weak, or nonconductors of electricity.