PROPERTIES OF IONIC AND COVALENT COMPOUNDS

Can you predict the way atoms are held together even though individual particles cannot be seen?

Objectives

- Determine differences in physical properties for ionic, polar covalent, and non-polar covalent compounds.
- Identify bond types for unknown substances based on physical properties.

Materials and Equipment

- Data collection system
- Conductivity sensor
- Hot plate
- Graduated cylinder, 100-mL
- Beakers (4), 100-mL
- Stirring rod
- Spatula or scoopula
- Tongs
- Aluminum foil square (6), 5-cm × 5-cm
- Masking tape
- Wash bottle filled with distilled water
- Distilled water
- Table salt
- Table sugar
- Paraffin wax
- Unknown A
- Unknown B
- Unknown C

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- The hot plate gets extremely hot. Avoid contact with the hot plate until it has completely cooled.
- Keep all materials, especially electrical cords and paper, away from the hot plate while it is hot.
- Wear safety goggles at all times.

Procedure

1. Plug in the hot plate. Turn it on to the highest setting.

2. Label the beakers *salt*, *sugar*, *wax*, and *distilled water*.

3. Fold three pieces of aluminum foil into small dishes. Use tape to label the dishes *salt*, *sugar*, and *wax* as shown in Figure 1. Position the label as shown so that it will not directly touch the heating surface when the dish is placed on the hot plate.

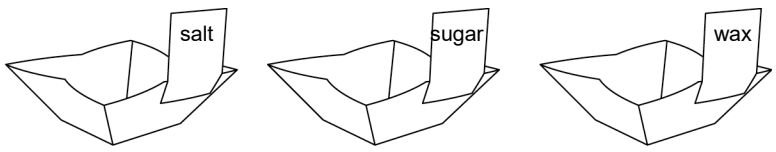

Figure 1: Use tape to create labels for three foil dishes

4. Use a spatula to place a pea-sized sample of each substance in the appropriately labeled dish. Add another pea-sized sample of each substance to the appropriately labeled beaker.

5. Test the hardness of each compound by rubbing a small sample from each dish between your fingers. Record results for hardness as either soft and waxy, or brittle and granular in Table 1. Return each sample to the appropriate dish and wash your hands after testing.

6. Heat the dishes on the hot plate for up to 3 minutes. If a substance begins to melt, use tongs to carefully remove the dish from the hot plate and record its melting point as *low* in Table 1. If a substance is still solid after heating for 3 minutes, record its melting point as *high*. After 3 minutes, remove all dishes from the hot plate.

7. Add 60 mL of distilled water to each beaker.

8. Use the stirring rod to stir the *salt* beaker for exactly two minutes. If a substance dissolves in water after two minutes of stirring, it is soluble. Record the solubility in Table 1.

9. Rinse the stirring rod thoroughly with distilled water.

10. Repeat Steps 8 and 9 for the *sugar* and *wax* beakers.

11. Select Sensor Data in SPARKvue and connect the conductivity sensor to your device.

12. Make sure only the conductivity measurement is checked and choose the Digits template.

13. Start collecting data.

14. Rinse the probe with distilled water over a sink or waste container. Be sure to rinse between the metal electrodes at the base of the probe. Gently shake excess water from the probe after rinsing.

15. Test the conductivity of distilled water by placing the sensor probe in the *distilled water* beaker. When the reading stabilizes, record the value for Conductivity in the space provided between Table 1 and Table 2.

16. Repeat Steps 14 and 15 to test the electrical conductivity of salt, sugar, and wax. If the conductivity reading is similar to distilled water, the is sample not a conductor of electricity. If conductivity is much greater (100 times or more) than distilled water, the sample is a conductor. Record results for Conductor in Table 1.

17. Dispose of the solutions in the beakers according to your teacher's instructions.

18. Rinse the beakers thoroughly with distilled water. Label three clean beakers *A*, *B*, and *C*.

19. Fold three new foil dishes and label as *A*, *B*, and *C*.

20. Obtain pea-sized samples of unknown substances A, B, and C and place in the appropriate dish and beaker.

21. Repeat the procedure to test the physical properties of unknown substances A, B, and C. Record results in Table 2.

22. Stop collecting data.

23. Turn off the hot plate and allow the dishes to cool.

24. Clean the lab station according to your teacher's instructions.

Data Collection

Table 1: Observed physical properties of ionic, polar covalent, and non-polar covalent substances

Physical property	Table salt: Ionic bonds	Table sugar: Polar covalent bonds	Wax: Non-polar covalent bonds
Hardness Soft and waxy, or brittle and granular?			
Melting point High or low?			
Solubility Does it dissolve in water? Yes or no.			
Conductivity (μS/cm)			
Conductor Will it conduct electricity? Yes or no.			

Conductivity reading for distilled water: _____ μS/cm

Table 2: Observed physical properties of unknown substances A, B and C

Physical property	Substance A	Substance B	Substance C
Hardness Soft and waxy, or brittle and granular?			
Melting point High or low?			
Solubility Does it dissolve in water? Yes or no.			
Conductivity (μS/cm)			
Conductor Will it conduct electricity? Yes or no.			

Questions and Analysis

1. Draw pictures that illustrate how particles are arranged for each bond type at the atomic scale.

Ionic solids: **Molecular solids: Polar covalent** **Molecular solids: Non-polar covalent**

2. Compare the bond types shown in Table 1 headings with your observations. Which bonds are associated with soft substances, and bonds are associated with brittle or granular substances?

3. Based on your results, which bond types allow a substance to melt at low temperatures? Which bond types are associated with melting at high temperatures?

4. According to your results, which bond types allow a substance to dissolve in water? Which bond types prevent a substance from dissolving in water?

5. Which bond types allow a substance to conduct electricity when dissolved in water?

6. Identify the bond type (ionic, polar covalent, or non-polar covalent) for each unknown substance. Support your answers with evidence from this investigation.

Unknown	Type of bond	Evidence
A		
B		
C		