Chemistry I-Standard

Characteristics of Bonds Lab

**ESSENTIAL QUESTION:**

How do melting points, solubility, and detection of an odor relate to types of bonds?

**PURPOSE:**

In this lab you will examine the properties of ionic compounds and covalent compounds. The properties studied are: **volatility, melting point, and solubility in water.**  You will use these properties to classify substances as ionic or covalent.

**BACKGROUND INFORMATION:**

Compounds have either covalent or ionic bonds depending upon the nature of the forces that hold them together. In ionic compounds, the force of attraction is between oppositely charged ions. This attraction is called an ionic bond. Compounds with ionic bonds form crystals with a regular pattern of positive and negative ions held together by the electrical force of attraction. In covalent compounds, the atoms are held together by an interaction between adjacent nuclei and shared electrons called covalent bonds. Covalent compounds exist in the form of distinct particles called molecules. The molecules of covalent compounds are held together in clusters by weak forces generally referred to as intermolecular forces. Intermolecular forces are much weaker forces than the covalent bonds that hold the elements together within the molecules or ionic bonds that hold the positive and negative ions together in crystals. These different forces account for the many properties of ionic and covalent compounds such as solubility, melting point, and the degree of volatility,

* **Melting:** In order to melt an ionic compound, it is necessary to break ionic bonds. Therefore, ionic compounds usually have high melting points. To melt a covalent compound, it isn’t necessary to break bonds. It is only necessary to overcome the much weaker intermolecular forces that hold the particles together.
* **Volatility --** The particles in a volatile compound must be held together by weaker forces so that some can break away and travel through the air to our noses.
* **Solubility –** Ionic compounds tend to be soluble (or dissolve in) water because water is a polar compound that can exert enough force to overcome the ionic bond and cause the ions to go into solution. In general covalent compounds are less soluble in water. The tendency of compounds to dissociate or ionize in water tells a great deal about the way in which bonds hold the compound itself together.

**PRE-LAB QUESTIONS: Answers to these questions may be found from the *Background Information*:**

1. Write the chemical formulas for the five substances listed in the materials section.
2. Per the introduction, what are intermolecular forces and in what kind of compounds do they exist?
3. Why do ionic compounds have such high melting points?
4. How will you classify a compound as having a high volatility?
5. Are ionic compounds or covalent compounds more soluble in water? Why?

-2-

**MATERIALS:**

* Medium test tubes (7)
* Test tube rack
* Stirring rod
* Hot plate
* Solids: calcium chloride, potassium chloride, sugar, 3 unknown solid sample
* Liquids: deionized water, acetone, oil

**SAFETY:**

Safety goggles should be worn at all times. Acetone is incredibly flammable. It should NEVER be in near a heat source. When working with acetone make sure it is being tested at the conductivity station. The conductivity meter is composed of two probed which test for electrical properties. Never touch the probes

**Procedure: Part One**

1. **Record the physical appearance, texture, hardness and luster:**
   1. is it solid, liquid, or gas at room temperature?
   2. is the texture powdered, chalky, crystalline, sandy/gritty or something else?
   3. How hard is it? Can you dent it with a fingernail or is it hard enough to scratch other surfaces?
   4. Is it shiny or dull? What kind of color does it have?
2. Using the wafting method, observe the smell of each substance in the stock beakers. If you **can smell** the substance, then write **yes** in the column under **volatility**. If you **cannot smell** the substance, then write **no** in the column under volatility.
3. In the data table **record the phase** at room temperature.
4. Place a tiny amount (less than 1 gram) of each of the solid substances (A, B, C, D, G, H, and I) into the micro-wells or test tubes provided. Put one substance per test tube only!
5. Add several milliliters of distilled water into the wells with the solid sample. **Do not put water into the liquid samples.** Mix the samples so that each has a chance to dissolve in water. Rinse your stirring rod in between samples.
6. **Determine which substance is soluble in water.** The substance dissolves if the original substance is no longer visible. The water solution may have a color but should be transparent.
7. **Clean up!** Clean all materials and return equipment to the correct location.
8. Test each substance **that dissolved** for **electrical conductivity** using the large tester provided. Be sure to rinse your electrodes after each substance and dry with paper towel. Record your results in the data table.

**Procedure: Part Two**

**Test Only Solid Substances**

1. Make small foil boats by wrapping a piece of aluminum foil around the bottom of a small beaker (~50 mL). Your boats should be about the size of the end of your thumb.
2. Put a small amount of one solid (enough that you can see) into a small foil boat.
3. Place the all the boats on the hot plate on medium-high. Heat for a maximum of 3 minutes. Record in the data table which substance melts, or in which nothing happens at all. **Recheck for volatility.**

-3-

**POST-LAB QUESTIONS:**

1. Ionic compounds must be composed of 2 ions, one cation and one anion. How are cations and anions formed? Where on the periodic table are elements that form cations? anions?
2. A covalent bond is created between which types of elements? Where on the periodic table are these elements?
3. Were ionic compounds or covalent molecules generally solids at room temperature?
4. Did ionic compounds or covalent molecules generally have high melting points?
5. Were ionic compounds or covalent molecules generally soluble in water?
6. Did ionic compounds or covalent molecules generally conduct electricity when dissolved?
7. Using your data, which property is most useful in categorizing a substance as ionic?
8. Using your data, which property is most useful in categorizing a substance as covalent?
9. Clearly identify the three unknowns as either ionic or covalent in the space below. Support your answer with evidence from the lab.
10. Explain how the type of bond could determine the volatility of a substance.
11. Does the strength of the bond have anything to do with the melting point? Explain why.
12. Water molecules are polar which means one side of the molecule is positively charged and the other side of the molecule is negatively charged. Which substances tend to dissolve easier in water, ionic or covalent? Why?

-4-

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| Substance | Physical Property | Volatility (yes or no) | Phase at Room temp. (solid or liquid) | Melting Point (high or low) | Solubility: does it **dissolve in water** (yes or no) | Electrical Conduct. **with** **H2O** (yes or no) | Ionic or Covalent? |
| A. Distilled water  (control) |  |  |  | X | X | X | X |
| B. CaCl2 |  |  |  |  |  |  |  |
| C. KCl |  |  |  |  |  |  |  |
| D. Sugar |  |  |  |  |  |  |  |
| E. Oil  **Test at Conductivity Station** |  |  |  | Low |  | Test without water |  |
| F. Acetone  **Test at Conductivity Station** |  |  |  | Low |  | Test without water |  |
| G. Unknown #1 |  |  |  |  |  |  |  |
| H. Unknown #2 |  |  |  |  |  |  |  |
| I. Unknown #3 |  |  |  |  |  |  |  |