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Investigation into Chemical Bonds

  

**Introduction**

 Chemical compounds are combinations of atoms held together by chemical bonds. These chemical bonds are of two basic types – **ionic and covalent**. An ionic compound always contains ionic bonds and a covalent compound always contains covalent bonds. Ionic bonds result when one or more valence electrons from a **metal atom** are transferred to a **nonmetal atom** or group of atoms. In this case positive and negative ions are created. An ionic compound will nearly always include a metal and a nonmetal. Some examples of ionic compounds would be NaCl, CuSO4, or AgNO3. Covalent compounds occur when valence electrons are shared by two or more **nonmetal atoms**. Therefore, a covalent compound never contains a metal. Some examples of covalent compounds would be CO2, PCl3, or C6H12O6. Metallic bonds are the attraction between **metal cations** and a free-flowing “sea of electrons”. Metal bonds occur in all pure metals and alloys.

 The type of bonding in a substance is a significant factor in determining the properties of that substance. Properties such as solubility in water, melting point, conductivity in an aqueous solution, or conductivity in a solid are largely dependent on the type of bonds between atoms. Determining the properties of a substance allows a scientist to predict the type of bond present, or, knowing the type of bond allows a scientist to predict the properties a substance will exhibit.

 In this experiment you will conduct tests on several substances to determine how the properties suggested above: melting point, solubility in water, conductivity in an aqueous solution, and conductivity in a solid vary according to bond type. After compiling the data on these properties, you will predict properties for solids with ionic bonds, covalent bonds, and metallic bonds.

 **Pre-Lab Questions:**

1. Describe two differences and two similarities between ionic *bonds* and covalent *bonds*.
2. Explain how you can identify substances as having covalent bonds, ionic bonds, or metallic bonds based on the chemical formula. ie. NaCl
3. Which electrons in an atom do you think are most likely to be involved in bonding? Why?
4. Identify each substance used in this experiment as an ionic compound, a covalent compound or a metal based on the chemical formula.

|  |  |  |  |
| --- | --- | --- | --- |
| **Substance** | **Classification** | **Substance** | **Classification** |
| Sucrose (C12H22O11) |  | Calcium chloride (CaCl2) |  |
| Potassium iodide (KI) |  | Napthalene (C10H8) |  |
| Sodium sulfate (Na2SO4) |  | Copper (Cu) |  |
| Paraffin (C20H42) |  | Sodium chloride (NaCl) |  |
| Steel wool (Fe) |  | Water (H2O) |  |

**Materials**

aluminum foil thin stem pipettes well plate micro-stirrer

conductivity apparatus hot plate metal spatula tongs

sucrose calcium chloride paraffin

potassium iodide naphthalene sodium chloride

sodium sulfate copper steel wool

**Safety**

* Be careful with HOT hot plates. Assume they are hot for a long time after being turned on and keep all classroom materials away from the hot plate.
* The heating of solids should take place for 2 to 3 minutes ONLY.
* Do not touch any of the chemicals being used with your hands.

**Procedure**

1. Make a data table that includes 10 substances (9 that are known and 1 unknown) being observed for 5 characteristics.
2. Examine the appearance of each substance. Record a brief description in the data table.
3. Warm the hot plate at your station on **low - medium**. While the hot plate is heating, obtain a square of aluminum foil. Label the foil with the names of the 7 solid substances that will be placed on it (omit copper and steel wool). Place a **FEW** crystals of each substance on the foil. Carefully place the foil on the hot plate. After 2 or 3 minutes turn off the hot plate and remove the foil with tongs. Dispose of the foil and the crystals in the trash. Record relative melting point as “melted very quickly” or “melted eventually” or “did not melt.”
4. Wash the well plate with deionized water and shake out excess water.
5. Place the well plate over a piece of paper. Place a **FEW** crystals of each substance (omit copper and steel wool) into separate wells in the well plate. Label the paper with the name of the substance next to the corresponding well. Add 10 drops of deionized water to the crystals in each well. Stir with a toothpick. If the substance has not dissolved, add a few more drops of water and stir. Record the solubility of the substance in water in your data table. Write S for “soluble” if the substance dissolves and I for “insoluble” if the substance does not dissolve. Many solids do not dissolve immediately. Allow a few minutes before making your observation. It might be helpful to view the mixture against a dark background.
6. Test the conductivity of **the compounds that dissolved in water** (omit testing substances that did not dissolve) by dipping both electrodes of the micro-conductivity apparatus into each mixture of crystals and water in the well plate. Be sure to rinse and dry the electrodes after testing **each** sample. If the bulb lights up, the solution conducts electricity. Indicate conductivity by recording “bulb lights” when electricity is conducted and “no light” when electricity is not conducted, in your data table.
7. Test the conductivity of the copper and steel wool as solids by placing both electrodes of the micro-conductivity tester on the sample. Record the conductivity in your data table.
8. Thoroughly wash the well plate with tap water and wipe with a paper towel. Place the well plate upside down on a paper towel to dry.

**Data:** Make a preliminary data table below. After the lab, word-process the data table with results included.

Analyze your data:

1. Use the results in your data table to describe the properties that were investigated for ionic compounds, covalent compounds, and metals, in the following table.

Properties of Substances with Different Types of Bonds

|  |  |  |  |
| --- | --- | --- | --- |
| **Property** | **Ionic Compounds** | **Covalent Compounds** | **Metals** |
| Relative melting point(high, low or varies) |  |  | Varies |
| Solubility in water |  |  |  |
| Conductivity in aqueous solution |  |  |  |
| Conductivity of Solid |  |  |  |

1. Identify the unknown substance as ionic, covalent or metal. Include the number of the unknown that your group tested. Explain your justification.

**Conclusion:**

Type a 1 paragraph conclusion that includes:

* Restatement of purpose
* Relationship between the type of bond and related properties.

This should be a summary of ***general*** properties for substances with ionic bonds, covalent bonds, and metallic bonds. Include specific examples *with each type of bond* that you tested.

* Explanation of why you classified your unknown the way you did
* Verify your lab results (general properties) with a published source. Make sure it is reliable and be sure to cite it with a parenthetic reference at the end of the quote and an APA-formatted works cited.