

Ms. Randall

Regents Chemistry

Lab activity: Ionic or Covalent

Background: Compounds are formed when electrons are shared or transferred between atoms. Ionic compounds are formed when two or more atoms of very different electronegativities combine. Metals combine with nonmetals to form ionic compounds. The metal which has a low electronegativity loses an electron to a nonmetal, which has a high electronegativity. The metal becomes positively charged (cation) and the nonmetal becomes negatively charged (anion). The positive and negative ions now have strong electrostatic attraction for each other; thus an ionic bond is formed. Many ionic compounds are crystalline and composed of a collection of ions in a 3-dimensional array. The smallest ratio between the ions is referred to as a formula unit. For example, sodium chloride crystals have 6 Na^+ ions to every 6 Cl^- ions but the formula unit for sodium chloride is NaCl since the smallest ratio between ions is one sodium ion to one chloride ion.

Covalent compounds on the other hand are formed when atoms of similar electronegativities combine. When atoms have similar electronegativities neither atom is strong enough to pull an electron from the other atom; therefore the atoms share the electrons in a very strong and stable bond. Covalently bonded compounds form discrete units called molecules; therefore a covalent compound is also called a molecular compound.

Some properties may be used to predict the type of bonding in a substance. These properties are phase at room temperature, melting point, solubility in water and electrical conductivity. Several physical properties of different compounds will be demonstrated. In this experiment you will find how these properties vary in ionic and covalently bonded substances.

Objective: Properties such as phase, melting points, and conductivity will be tested in order to discover the types of bonds household chemicals have.

Pre-Lab:

1. Complete the sentences:
 - a. Ionic bonds involve the _____ of electrons.
 - b. Ionic bonds contain elements that are _____ and _____.
 - c. Covalent bonds involve the _____ of electrons.
 - d. Covalent bonds contain elements that are _____ only.

Safety: Lab goggles and aprons must be worn at all times.

Materials: conductivity meter, NaCl , dH_2O , Al , NH_3 , $\text{C}_6\text{H}_{12}\text{O}_6$ (sugar), CaCl_2

Procedure: Record all results in the data table below.

1. Determine the phase of each substance.
2. Using the conductivity tester determine if the substance conducts electricity in its current phase.
3. Then observe the mixture of the substance in the beaker and determine:
 - a. if it *soluble* (dissolves)
 - b. if it conducts electricity in aqueous form.
4. Based upon your results determine the identity and melting point of each substance from the list below:

Table 1:

| List of Substances | Type of Substance | Melting Point (Celsius) |
|--|-------------------|-------------------------|
| a. NaCl (table salt) | | 801 |
| b. H ₂ O (pure water) | | 0 |
| c. Al (aluminum) | | 933 |
| d. C ₆ H ₁₂ O ₆ (glucose) | | 186 |
| e. NH ₃ (ammonia) | | -77.8 |
| f. CaCl ₂ (calcium chloride) | | 772 |

Data:

| Chemical | Phase (S, L, or G?) | Melting point (°C) | Conductivity (Y or N?) | Solubility in water (Y or N?) | Aqueous conductivity (Y or N?) |
|----------|------------------------|-----------------------|---------------------------|-------------------------------------|-----------------------------------|
| 1 | | -77.8 | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | 772 | | | |
| 6 | | | | | |

Analysis:

1. What substance(s) tested were ionic? Explain why in terms of their properties.
2. What substance(s) tested were covalent? Explain why in terms of their properties.
3. What substance(s) tested were metallic? Explain why in terms of their properties.
4. The melting points of the ionic compounds are much higher than those of the covalent compounds. What does this imply about the strength of ionic and covalent bonds?
5. Explain in terms of particles why ionic compounds can conduct electricity while covalent compounds cannot.

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Lab Conclusion: Ionic or Covalent

1. Write a paragraph summarizing what you have learned about the scientific concept of the lab from doing the lab. Back up your statement with details from your lab experience.
2. Which formula represents an ionic compound?
 - a. NaCl
 - b. N₂O
 - c. HCl
 - d. H₂O
3. Which statement best describes the substance that results when electrons are transferred from a metal to a nonmetal?
 - a. It contains ionic bonds and has a low melting point.
 - b. It contains ionic bonds and has a high melting point.
 - c. It contains covalent bonds and has a low melting point.
 - d. It contains covalent bonds and has a high melting point.
4. Which atoms are most likely to form covalent bonds?
 - a. metal atoms that share electrons
 - b. metal atoms that share protons
 - c. nonmetal atoms that share electrons
 - d. nonmetal atoms that share protons
5. A chemist performs the same tests on two homogeneous white crystalline solids, *A* and *B*. The results are shown in the table below.

| | Solid A | Solid B |
|--|----------------|--------------------------|
| Melting Point | High, 801°C | Low, decomposes at 186°C |
| Solubility in H ₂ O (grams per 100.0 g H ₂ O at 0°C) | 35.7 | 3.2 |
| Electrical Conductivity (in aqueous solution) | Good conductor | Nonconductor |

The results of these tests suggest that

- A) both solids contain only ionic bonds
- B) both solids contain only covalent bonds
- C) solid *A* contains only covalent bonds and solid *B* contains only ionic bonds
- D) solid *A* contains only ionic bonds and solid *B* contains only covalent bonds