Lab

11

# Sugar or Salt?
# Ionic and Covalent Bonds

*TN Standard* **2.1:** *The student will investigate chemical bonding.*

## *Have you ever accidentally used salt instead of sugar?*

Drinking tea that has been sweetened with salt or eating vegetables that have been salted with sugar tastes awful! Salt and sugar may look the same, but they obviously taste very different. They are also very different chemically. Salt is made up of sodium and chloride and is ionically bonded. Sugar, on the other hand, is composed of carbon, oxygen, and hydrogen and has covalent bonds.

## Introduction

A salt molecule is made up of one sodium atom and one chlorine atom. For salt to be made, the sodium atom must lose an electron and become a sodium ion. When sodium loses an electron it becomes a $Na^+$ and is called a **cation.**

$$Na \rightarrow Na^+ + e^-$$

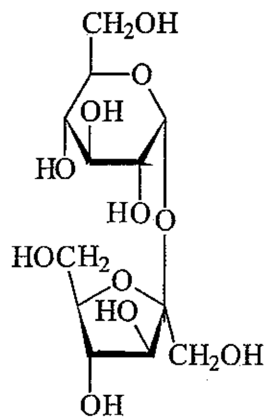
The chlorine atom must add the sodium's electron and become a chloride ion. When it adds the sodium's lost electron it becomes $Cl^-$ and is called an **anion.**

$$Cl + e^- \rightarrow Cl^-$$

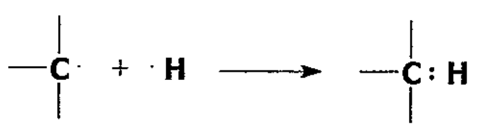
The sodium ion is then attracted to the chloride ion and a bond is formed from the attraction between a positive and negative ion. This type of bond is called an **ionic bond**. Ionic bonds usually form between metals and non-metals.

$$Na^+ + Cl^- \rightarrow Na^+Cl^-$$

Table sugar or sucrose differs from salt in the bonding between its atoms. The atoms in sugar do not form ions; instead, they share their electrons. The type of bond that forms from the sharing of electrons between the atoms of the table sugar is a **covalent bond.** Table sugar has a much more complex chemical structure than salt. It looks like this:




A bond forms between one of the carbon atoms and one of the hydrogen atoms when one of the valence electrons of the carbon atom combines with one of the valence electrons of the hydrogen atom. This forms an electron pair.




(This is normally written C-H.)

Ionically bonded compounds behave very differently from covalently bonded compounds. When an ionically bonded compound is dissolved in water it will conduct electricity. A covalently bonded compound dissolved in water will not conduct electricity. Another difference is that ionically bonded compounds generally melt and boil at much higher temperatures than covalently bonded compounds.

In the first part of this lab you will investigate how ionically bonded and covalently bonded substances behave differently in their conduction of electricity. You will do this by using a simple anodizing apparatus. A stainless steel screw and an iron nail will be used for the electrodes. In an anodizing apparatus, the water must contain enough ions to conduct electricity. Then the water will react to form hydrogen and oxygen gases.

$$2H_2O \rightarrow 2H_2 + O_2$$

Since the stainless steel screw is not very reactive, bubbles can be seen coming off of it. The iron nail will react with the oxygen to form iron oxide which is commonly called rust. This can be seen on the nail after the reaction proceeds for several minutes.

In the second part of this lab you will explore the differences in melting points between ionically bonded and covalently bonded compounds. You will do this by placing a small amount of sugar in one small test tube and heating it at different heights over a Bunsen burner. You will then repeat this procedure using salt instead of sugar.

## Objectives

- To understand the difference between ionic and covalent bonding.
- To link ionic and covalent bonding with their physical properties.

Space for lab Notes:

Hypothesis:

## Part 1: Nail Test for Ionic Bonding

1. Rinse a clean 250 mL beaker several times with distilled water to prevent contamination from ions that may be on the beaker. Fill the beaker about ¾ full with distilled water.
2. Pour a packet of sugar (about 3 g) into the 250 mL beaker. Stir the solution with a clean stirring rod until the sugar is dissolved and the solution is well mixed.
3. Stretch two rubber bands around the 250 mL beaker. Be careful not to spill any of the solution. The rubber bands should loop from the top to the bottom of the beaker. Position the 2 rubber bands next to each other (Figure 4). **HINT**: Do not position the bands around the circumference of the beaker.
4. Attach the first wire lead to just underneath the flat head of an iron nail (using the alligator clip). Place the iron nail between the 2 rubber bands on one side of the 250 mL beaker so that it is suspended in the water. The end of the nail should be in the solution while the head with clip is resting on the rubber bands. (See Figure 4).
5. Attach the second wire to just below the head of the stainless steel screw. Place the screw between the 2 rubber bands on the opposite side of the 250 mL beaker, next to the nail. Make sure the end of the screw is in the solution and the head with the clip is resting on the rubber bands.
6. Connect the wire coming from the iron nail to the positive (+) terminal of the 9-volt battery (usually the circular terminal). **CAUTION: Be careful when using energy sources such as batteries around water.**
7. Connect the wire coming from the steel screw to the negative (-) terminal of the battery (usually the hexagonal terminal). **CAUTION: Be careful when using energy such as batteries around water.**
8. Allow the apparatus to stand for two minutes and make observations. Record your observations in Part 1 of the Data section.
9. Thoroughly clean the glassware, nail and screw with distilled water.
10. Repeat the procedure using a salt packet (approximately 0.65 g) instead of a sugar packet.

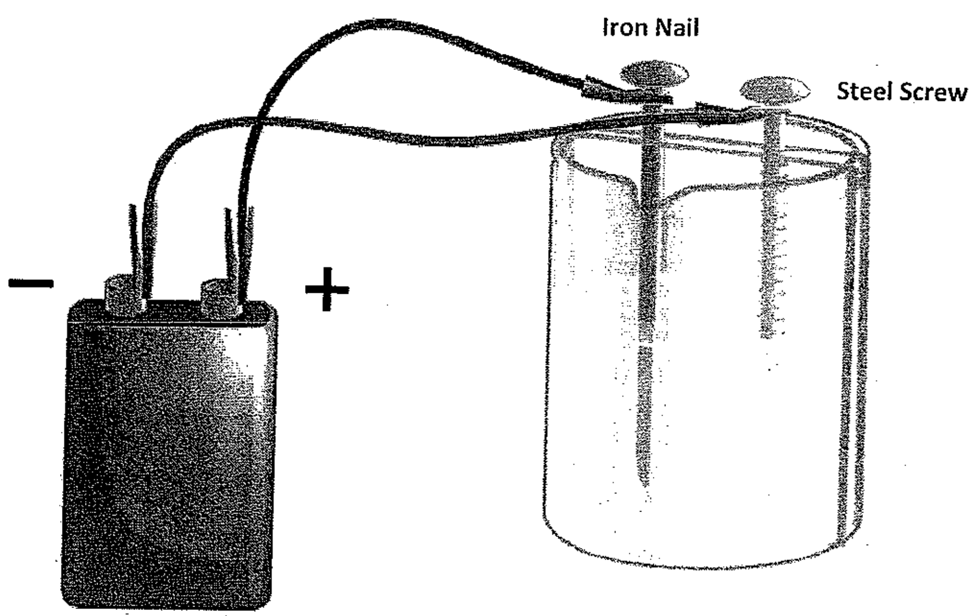



Figure 4: Apparatus for Procedure Part 1

**Procedure Part 2**

1. Put on safety goggles and a lab apron.
2. Fold the piece of aluminum into a small rectangle (somewhat like a boat).

Place a few crystals of salt and sugar in separate locations on the square of aluminum foil. Do not allow the samples of crystals to touch.

3. Write a brief description of each of the 2 substances.
4. Place the foil on the hot plate.
5. Turn on the hot plate. Note the substance that melts first. Turn off and allow cooling.

**Procedure Part 3**

1. Put a *few* crystals of each of the white solids on the microplate and add 10 drops of water. Record the whether it dissolved in **Table 1 (Solubility).**
2. Clean the microplate by rinsing it with water. Wash your hands thoroughly before you leave the lab and after all work is finished.

**Data**

**Part 1:** **Observations**

| **salt** | **sugar** |
|---|---|
| | |

**Part 2:**

| **Compound** | **Description** | **Melting point (first or last to melt)** | **Solubility in $H_2O$** |
|---|---|---|---|
| salt | | | |
| sugar | | | |

**Conclusion**

*Write a formal conclusion. All of the criteria below must be in the conclusion.*

| | |
|---|---|
| Purpose restated | |
| Major findings stated, refers to graph, data table, notes, etc.<br>- state finding and data that supports the finding (some explanation may be necessary.<br>- findings should be able to answer the question:<br>What are three characteristics of ionic vs covalent compounds? (don't forget to indicate how you know which substance was ionic or covalent) | |
| Revisits hypothesis (supported or not supported) | |
| Suggests extension to lab | |

**Please type on a separate sheet of paper if you can not fit your answer in the space provided.**