Sample Lab Manual
Green Introductory Chemistry

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Lab Safety Rules

Always follow the instructions in your laboratory manual and follow these general rules:

- **Please thoroughly read the lab exercise before starting!**
- If you have any doubt as to what you are supposed to be doing and how to do it safely:
    - ◊ STOP!
    - ◊ Double-check the manual
    - ◊ Check the website www.eScienceLabs.com
    - ◊ Email: Help@eScienceLabs.com
    - ◊ Call for help 1-888-Esl-Kits (1-888-375-5487)
- Safety glasses or goggles should be worn at all times.
- When handling chemicals, always wear the protective gloves and apron provided in your kit.
- Long hair should be pulled back and secured.
- All jewelry (rings, watches, necklaces, earrings, bracelets, etc.) should be removed.
- All loose clothing (jackets, sweatshirts, etc.) should be removed.
- Read and understand all labels on chemicals.
- Do not eat, drink, chew gum, apply cosmetics or smoke while conducting an experiment.
- Do not use any part of the lab kit as a container for food.
- Consult your physician if you are pregnant, allergic to chemicals, or have other medical conditions that may require additional protective measures.
- Wearing soft contact lenses while conducting experiments is discouraged, as they can absorb potentially harmful chemicals.
- Never leave a heat source unattended.
- If there is a fire, evacuate the room immediately and dial 911.
- Work in a well ventilated area.
- Monitor experiments at all times, unless instructed otherwise.
- Never return unused chemicals to their original container.
- Always wear closed toe shoes.

Lab Safety

- Never ingest chemicals. If this occurs, seek immediate help.
- Call 911 or “Poison Help” 1-800-222-1222
- Never pipette anything by mouth.
- If you have ANY questions or concerns, read the “Material Safety Data Sheet” (MSDS) for that chemical. The MSDS lists the dangers, storage requirements, exposure treatment and disposal instructions for every chemical.
- The MSDS for any chemical supplied by eScience Labs Inc., can be found at www.eScienceLabs.com
- If a spill occurs, consult the MSDS to determine how to clean it up.
- Never pick up broken glassware with your hands. Use a broom a dustpan to discard in a safe area.
- Always put lids back onto chemicals immediately after use.
- Never put chemicals in an unmarked container.
- Safely dispose of chemicals. If there are any special requirements for disposal, it will be noted in the lab manual.
- When finished, wash hands and lab equipment thoroughly with soap and water.

Above all, **USE COMMON SENSE!**

Green Chemistry

Lab 11:

Ionic and Covalent Bonds

Lab 11: Ionic and Covalent Bonds

Objectives

- To understand the differences between ionic and covalent bonding
- To link ionic and covalent bonding with the physical properties of matter

Introduction

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.

A salt (sodium-chloride) molecule is made up of one sodium atom and one chlorine atom. In order for the atoms to combine, the sodium atom must lose an electron, while the chlorine atom must gain an electron; the resulting **ions** have opposite charges and attract one another.

When sodium loses an electron it becomes a positively charged ion (Na^+), called a **cation**.

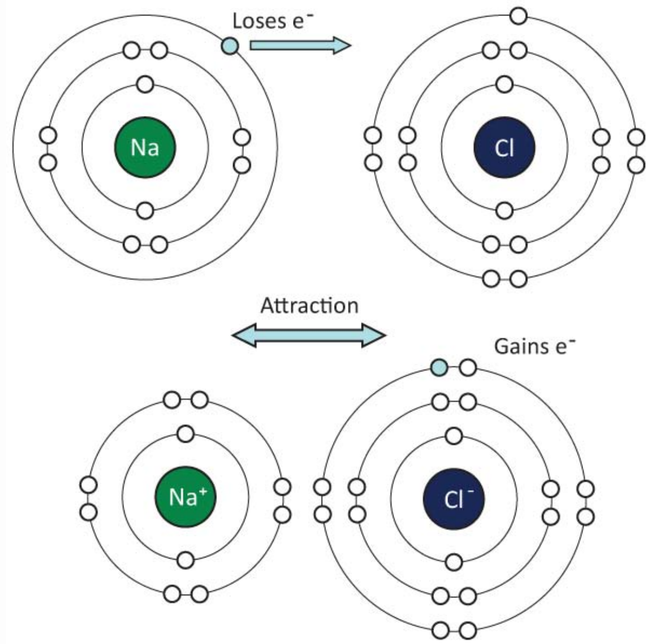


Figure 1: In order to undergo ionic bonding, an electron must transfer between the Na and Cl atoms. This gives each atom an opposite charge, resulting in attraction.

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

The chlorine atom adds this free electron, becoming a negatively charged **anion**.

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

A bond can now form between the negatively-charged Cl^- and the positively-charged Na^+. This type of bond is called an **ionic bond**. Ionic bonds typically form between one metal and one non-metal ion. The above reaction can be written as:

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

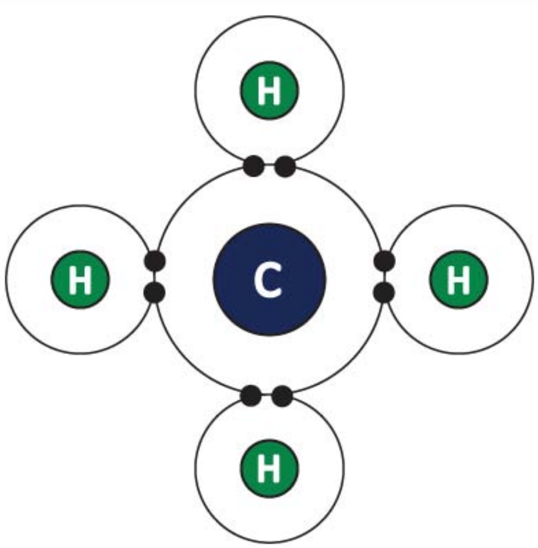
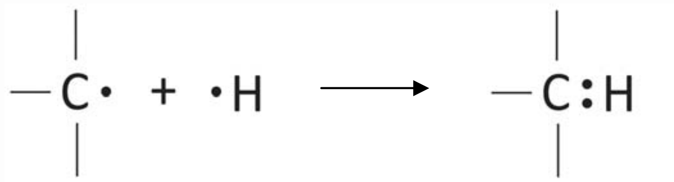


Figure 2: Covalent bonding diagram for a methane molecule (CH_4). Note that both the central carbon and outer hydrogen atoms have full outer shells.

Table sugar or sucrose differs from salt in the bonding between its atoms. The atoms in sugar do not form ions; instead, they are held together because of *shared* 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 (see Figure 3). A covalent bond between one carbon atom and one hydrogen atom forms when one of the valence electrons of the carbon atom groups with one of the valence electrons of the hydrogen atom, forming an electron pair.



Note: 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.

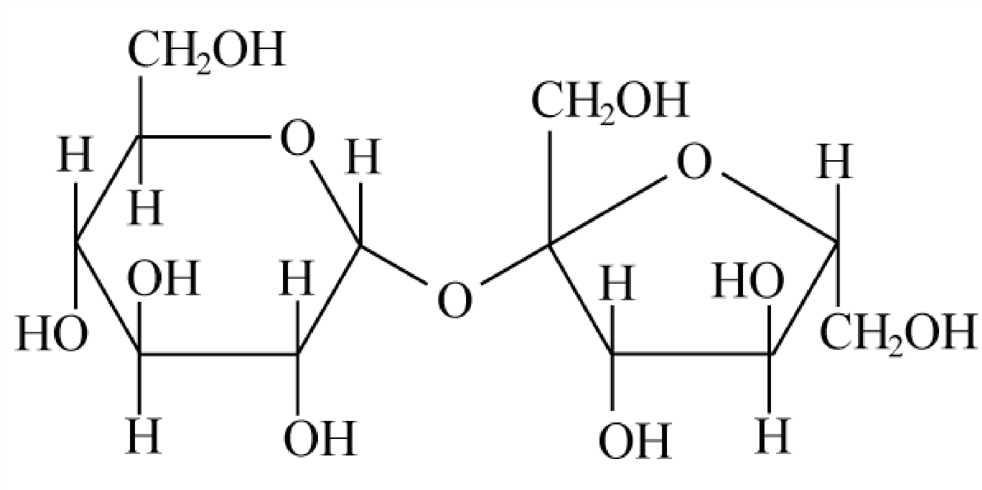


Figure 3: Chemical structure for table sugar (sucrose). Here, different atoms combine via covalent bonding, as opposed to ionic bonding. Notice the complexity of this molecule compared to NaCl.

Pre-lab Questions

1. What is an ionic bond?

2. What is a covalent bond?

3. Do you think sugar or salt will melt at a higher temperature? Explain your answer.

Lab 11: Ionic and Covalent Bonds

Experiment: Sugar or Salt?

Materials

- 2 Sugar packets
- 2 Salt packets
- 9-Volt battery
- 2 Rubber bands
- Deionized water
- 1 Iron nail
- 2 Wire leads with alligator clips on each end
- 1 Stainless steel screw
- 150 mL beaker
- Stirring rod
- 2 Small test tubes
- Spatula
- Test tube holder
- Alcohol Burner
- Permanent marker
- Ruler

Procedure

Part 1: Nail Test for Ionic Bonding

1. Rinse a clean 150 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 deionized water.
2. Pour a packet of sugar (about 3 g) into the 150 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 150 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 150 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 150 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 deionized water.
10. Repeat the procedure using a salt solution (~0.65 g) instead of the sugar.

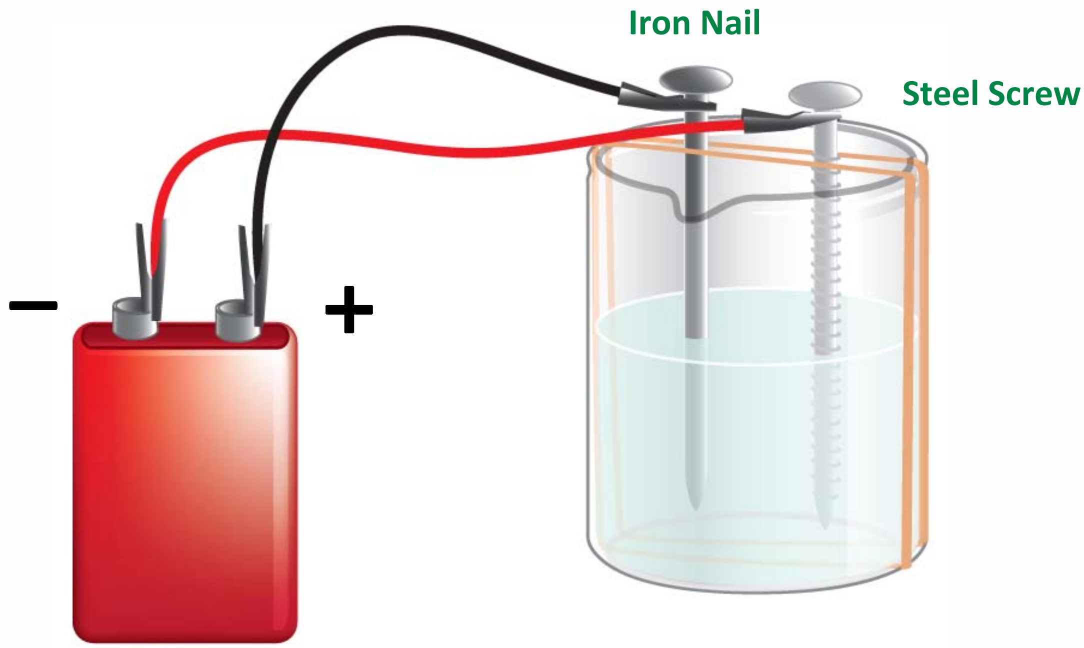


Figure 4: **Apparatus for Procedure Part 1**

Part 2: Melting Points

1. Place a spatula tip full of sugar into a small test tube. The sugar should just coat the bottom of the test tube. **CAUTION**: **Be sure the test tube does not have any small cracks or chips in it.**
2. Light the alcohol burner and notice the blue inner cone. When placing the butane lighter next to the test tube, the blue inner cone should be positioned on the tube. **CAUTION**: **Long hair should be tied up and loose clothing restrained when around an open flame to prevent fire and burns**. **Be sure you are wearing your safety goggles.**
3. Place the test tube containing the sugar in a test tube holder. Hold the test tube at a slight angle over the burner flame. Continue to hold the test tube in the flame until the sugar just begins to melt. **HINT:** If you keep the sugar in the flame until it turns dark brown or black, you will not be able to clean the test tube. Stop heating test tube **as soon** as it begins to melt.
4. Allow the test tube to cool to room temperature before touching it. **CAUTION**: **The test tube will be very hot and can burn your skin if touched before it cools. Hint:** After the test tube has cooled for a few seconds, place it in a beaker or wire test tube rack to finish cooling and continue with the procedure.
5. Record your observations in the data section.
6. Repeat the procedure using salt instead of the sugar.
7. Extinguish the alcohol burner. Make sure the test tubes have cooled to room temperature before touching them. **CAUTION**: **The test tube will be very hot and can burn your skin if touched before it cools.**
8. Record your observations in the data section.
9. Clean-up: The sugar and salt solutions can be poured down the drain. Rinse the beaker, screw, nail, and stirring rod several times with deionized water. Clean the test tubes with water first and then rinse them with deionized water. They may need to soak for a few minutes in hot water in order to remove the melted substances.

Lab 11: Ionic and Covalent Bonds

Data

Part 1

Observations for the sugar solution:

Observations for the salt solution:

Part 2

Observations for the melting of sugar:

Observations for the melting of salt:

Post-lab Questions

1. Why is deionized water instead of tap water used in Part 1?

2. In Part 1, why did you not observe a stream of bubbles coming off the stainless steel screw in the sugar solution?

3. Did any bubbles form off the screw in the sugar solution at all? Why might this happen, despite your answer to Question 2?

4. In Part 1, why did you observe a stream of bubbles coming off the steel screw in the salt solution? Explain any changes that took place on the nail.

5. In Part 2, which of the substances has the lower melting point? Was this what you expected? Explain your results.

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