Lab: The Behavior of Liquids and Solids

FOR THE TEACHER

Summary
In this lab, students will be able to explore and explain behaviors of liquids and solids based on the individual particles in the states of matter.

Grade Level
High School

NGSS Alignment
This lab will help prepare your students to meet the performance expectations in the following standards:

- **HS-PS1-3**: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
- **Scientific and Engineering Practices**:
  - Analyzing and Interpreting Data
  - Obtaining, Evaluating, and Communicating Information

Objectives
By the end of this lab, students should be able to

- Explain the difference in behaviors between liquids and solids using the changes in the forces of attraction between the particles in the substances as reasoning.
- Describe how the temperature difference between substances can change the forces of attraction between the particles in the substances.

Chemistry Topics
This lab supports students' understanding of

- States of Matter
- Intermolecular Forces
- Phases of Matter

Time
**Teacher Preparation**: 25 minutes  
**Lesson**: 45 minutes

Materials (per group)

- 1 Petri dish
- 50 mL beaker with medicine dropper
- Tap water
- 2 pieces of ice
- Forceps
- 70% or 91% Isopropyl alcohol in dropper bottle or with medicine dropper
- Graph paper
- 4-6 pieces of anhydrous calcium chloride
- Magnifying glass

Safety
- Always wear safety goggles when handling chemicals in the lab.
- Students should wash their hands thoroughly before leaving the lab.
• When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.

Teacher Notes
• Students should have an understanding of the behaviors of liquids and solids. Discussion of intermolecular forces and bonds should have been previously completed.
• Ensure the students are looking carefully at the substances and concentrating on the individual particles of the substances. They want to look at it on the macro level and not the micro level.
• In my experience, during some of the experiments, sometimes students don’t see that when there is water on the top of the dish it will cause a cloud formation on underneath side of the drop inside of the dish. Emphasize that student’s look carefully in order to collect these observations.
• It is helpful for the teacher to continuously move throughout the room and check student’s results as they are working. Instruct students to repeat a step if they say that nothing happens and remind them to look very closely to see the changes on all levels.

For the Student
Lesson

The Behavior of Liquids and Solids

Background
Why does the outside of a glass filled with water and ice get wet on a humid day? Why does table salt clump together on a humid day? Well, it is because of the way that liquids and solids interact on a particle level. After completing this activity, you should be able to explain some behaviors of liquid and solids on the particle level.

Prelab Questions
1. What are the different types of intermolecular forces that cause attractions between particles in substances?
2. How do substances change between states of matter based on intermolecular forces?
3. What conditions allow substances to change between states of matter?

Materials (per group)
• 1 Petri dish
• 50 mL beaker with medicine dropper
• Tap water
• 2 pieces of ice
• Forceps
• 70% or 91% Isopropyl alcohol in dropper bottle or with medicine dropper
• Graph paper
• 4-6 pieces of anhydrous calcium chloride
• Magnifying glass

Safety
• Always wear safety goggles when handling chemicals in the lab.
• Wash your hands thoroughly before leaving the lab.
• Follow the teacher’s instructions for cleanup of materials and disposal of chemicals.
**Procedure**

1. You will use the combination of substances outlined in the data table below for each of the 5 experiments.
2. In each of the 5 experiments, substances used will be indicated as “Substance A”, “Substance B” and “Substance C”. Place any substance indicated as “A” or “B” **INSIDE** the petri dishes and any substance indicated as “C” **ON THE COVER** of the petri dish. If the “N/A” is indicated in the data table, nothing needs to be added for that particular substance.
3. For each experiment place the petri dish on a piece of graph paper.
4. **Experiment 1 example:**
   a. According to the data table, Substance A is indicated as water. Place one drop of water in the dish.
   b. Substance B indicates N/A. Nothing needs to be done.
   c. Cover the petri dish with the lid.
   d. Substance C indicates ice. Place a small piece of ice on the top of the dish.
5. After 2-3 minutes, remove the ice and place in sink. Take the lid off and observe the interior surface of the petri dish and the contents of the dish. Record all observations in the data table. Clean and dry the petri dish.
6. Using Experiment 1 as an example, Repeat steps 4 and 5 for the remaining experiments using the materials listed in the data table. In experiment 4, place the water and calcium chloride about 3 centimeters apart using the graph paper as your guide.

<table>
<thead>
<tr>
<th>Experiment</th>
<th><strong>Substance A</strong> (placed in dish)</th>
<th><strong>Substance B</strong> (placed in dish)</th>
<th><strong>Substance C</strong> (placed on top of dish)</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drop of water</td>
<td>N/A</td>
<td>Ice Cube</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Drop of water</td>
<td>N/A</td>
<td>Drop of water</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Drop of alcohol</td>
<td>N/A</td>
<td>Drop of water</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Drop of water</td>
<td>2-3 pieces of CaCl₂</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>2-3 pieces of CaCl₂</td>
<td>Ice Cube</td>
<td></td>
</tr>
</tbody>
</table>

**Analysis**

1. Explain the observations in Experiment 1 with respect to the behavior of liquids and solids. Be specific including pressure and temperature changes and the forces of attraction changes that occur with the particles in the substances. What evidence was seen in and on the petri dish?
2. Did a cloud form on the inside of the dish in Experiment 2? Explain why or why not using temperature and the forces of attractions in your explanation.

3. Describe what changes occurred with the solid calcium chloride in Experiments 4 and 5. Use temperature, pressure and forces of attraction changes in the description.

4. Explain how the alcohol drop and the water drop looked similar and/or different before, during and after the experiment.

**Conclusion**
Describe how the purpose of the lab was met using observations. Explain how this concept relates to why a person will sweat when exercising or on a humid day. Infer what may happen if you place a drop of water and a drop of alcohol about 3 centimeters apart in the petri dish.