Differentiating Liquids

Purpose:
Discover how to use physical and chemical properties to differentiate liquids.

Introduction:
Liquids, similar to solids, have distinct properties that can be used to identify them. Some of these properties are the same as for solids, others are specific to liquids. Important properties of liquids include density, viscosity, and the ability to dissolve other materials.

Materials:
- electronic balance or other device (capable of massing a 10 mL graduated cylinder)
- 3 - 50 mL beakers containing approximately 3 mL of each of the following reagents: water, isopropyl alcohol and glycerine
- 3 droppers or 3 Pasteur pipets and bulbs (one for each beaker and reagent above)
- test tubes and test tube rack
- 1 - 10 mL graduated cylinder
- 1 stirring stick
- 1 salt packet
- 1 sugar packet
- 1 tablet of Alka Seltzer® or effervescent tablet broken into pieces.

Procedure:
Prepare a Data Table as suggested below.
Work with your partner, but share the materials with the other team of two as you perform the following tests. Record all results in a Data Table.

1. **Viscosity:**
Viscosity is a property of liquids which describes a liquid's ability to flow. For example, honey, which flows relatively slowly, has a high viscosity. While determining the density of each liquid during the next step, characterize the viscosity of each liquid as low, medium or high and record this in the Data Table.

2. **Density:**
Density is calculated using the formula:
\[
\text{Density} = \frac{\text{mass}}{\text{volume}}
\]
To easily find the mass of any liquid you must first find the mass of a clean, dry 10 mL graduated cylinder. This lab ware is utilized because it is small enough to take the mass on an electronic balance as well as measure the volume of a liquid. Add 10 mL of the liquid to the cylinder then find the combined mass of the cylinder and the liquid. The mass of the liquid is equal to the mass of the cylinder and the liquid minus the mass of the graduated cylinder. The density of the liquid is calculated by taking the mass of the liquid and dividing it by the volume of the liquid measured.

For this experiment use 10 mL of each liquid, use the glycerin last, and pour each liquid back into its original beaker at the lab bench for later use.
3. **Reaction with Alka Seltzer®** (contains sodium bicarbonate)
   Label three test tubes #1, #2 and #3 in your test tube rack.
   Add 20 drops of glycerin to Test tube #1.
   Add 20 drops of isopropyl alcohol to test tube #2
   Add 20 drops of water to test tube #3
   Add a small piece of Alka Seltzer® tablet to each test tube, observe and record your results in the Data Table under “Gas Produced?”

4. **Solubility of sugar:**
   Label three test tubes #4, #5 and #6 for this test.
   Add 20 drops of glycerin to test tube #4
   Add 20 drops of isopropyl alcohol to test tube #5
   Add 20 drops of water to test tube #6
   Using the end of your stirring stick, add a scoopful of sugar to each test tube. Stir each sample vigorously for one minute and record your results in the Data Table.

5. **Solubility of salt:**
   Label three test tubes #7, #8 and #9 for this investigation.
   Add 20 drops of glycerin to test tube #7
   Add 20 drops of isopropyl alcohol to test tube #8
   Add 20 drops of water to test tube #9
   Using the end of your stirring stick, add a scoopful of salt to each test tube. Stir each sample vigorously for one minute and record your results in the Data Table.

6. **Volume addition challenge:** Measure and record the volume of 20 drops of water in the graduated cylinder and retain in a beaker while you measure and record the volume of 20 drops of isopropyl alcohol. Add the two volumes together in the graduated cylinder and record to total volume.

Clean your equipment and your lab bench and follow the instructor’s directions for concluding the experimental portion of this lab activity.

**Data Table: Differentiating liquids**

<table>
<thead>
<tr>
<th>Substance</th>
<th>Viscosity (low-med-high)</th>
<th>Mass of Liquid (g)</th>
<th>Volume of Liquid (mL)</th>
<th>Calculated Density (g/mL)</th>
<th>Gas Produced?</th>
<th>Solubility of sugar: Dissolves?</th>
<th>Solubility of salt: Dissolves?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycerin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isopropyl alcohol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vol of 20 drops water: _____mL</td>
<td>Vol of 20 drops alcohol: _____mL</td>
<td>Total Vol: _____mL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Analysis Questions:

1. **Viscosity**:
   a. What is viscosity? Is this an intrinsic or extrinsic property?
   b. Which liquid is most viscous?

2. **Density**:
   a. How else could you utilize a balance and the graduated cylinder to find the mass of the liquid without having to take two measurements and subtract their values?
   b. Which substance had the greatest density?
   c. If you were able to carefully pour all three substances together (glycerin, isopropyl alcohol and water) what would you see? Use the graduated cylinder provided opposite to draw and label your representation. *(Time permitting, allow students to experiment with these solutions in their graduated cylinder.)*
   d. Is density an intrinsic or an extrinsic property?

3. **Solubility**:
   a. Describe the similarities or differences between the solutions that would or would not dissolve the sugar.
   b. Describe the similarities or differences between the solutions that would or would not dissolve the sugar.
   c. Is solubility an intrinsic or an extrinsic property?

4. **Production of a gas** - If you observed bubbles being produced with the addition of the Alka Seltzer® or effervescent tablet:
   a. What gas do you predict was evolved? Why?
   b. If a gas did evolve is this result a chemical or physical change?
   c. Based on your results, what must be present for a gas to be produced with the Alka Seltzer® or effervescent tablet?

5. **Additive volumes of water and alcohol**: Noting the individual volumes measured for the 20 drops of water and the 20 drops of alcohol, discuss in sentence form, what the expected additive volume would have been compared to the volume measured when the two liquids were put together in the graduated cylinder. Suggest a reason for the difference between the expected total volume and the actual measured total volume.

6. Based on this experiment, and on any other experience you have had with liquids, which one property do you think is the most useful for telling liquids apart? *Explain your answer using examples from lab or life experiences.*
Teacher Notes:

Suggestions:

This lab may be used as an introductory experience for students and analysis questions help lead them into thinking for themselves in the laboratory setting such as the possibility of taring the graduated cylinder on the balance prior to adding the liquids for the mass measurements.

Viscosity tends to be a simple, visible property that helps students more easily understand the difference between intrinsic and extrinsic properties.

Open class discussion on the results of the additive volumes of the water and isopropyl alcohol is suggested allowing students to hypothesize why this occurs and helps to explore the properties of liquids further.

National Science Content Standards addressed:

Content Standard A: As a result of activities all students should develop abilities necessary to do scientific inquiry and understandings about scientific inquiry; design and conduct scientific investigations.

Indiana Science Standards Addressed: Properties of Matter C.1.1, C.1.2, C.1.3

C.1.1 Differentiate between pure substances and mixtures based on physical properties such as density, melting point, boiling point, and solubility.

C.1.2 Determine the properties and quantities of matter such as mass, volume, temperature, density, melting point, boiling point, conductivity, solubility, color, numbers of moles, and pH (calculate pH from the hydrogen-ion concentration), and designate these properties as either extensive or intensive.

C.1.3 Recognize indicators of chemical changes such as temperature change, the production of a gas, the production of a precipitate, or a color change.

C.1.35 Infer and explain physical properties of substances, such as melting points, boiling points, and solubility, based on the strength of molecular attractions.

California Science Standards Addressed: Chemical Bonds 2d,

2 d. in a liquid the inter-molecular forces are weaker than in a solid, so that the molecules can move in a random pattern relative to one-another.