LAD A2 Density of Various Liquids

Name____________________

Introduction:

We will start our investigation by comparing the viscosity of the four liquids that we will be studying. Viscosity is a characteristic property that measures a materials resistance to flowing. A characteristic property is one that can be used to help identify a substance. For instance ketchup has a high viscosity and water has a lower viscosity. Before we start we will qualitatively compare the viscosity of all four liquids and propose a correlation between viscosity and density. After we measure and calculate the density of the liquids we will determine if our proposed correlation is valid.

Density is also characteristic property. Density is a measure of the mass per unit volume. In other words density is a ratio of a substance's mass compared to its corresponding volume. Density can be easily calculated after measuring the mass and volume of some substance and then using the formula: $Density = \frac{mass}{volume}$

Goggles must be worn at all times during the LAD.

A random amount of liquid means to just pour some in not trying to hit any particular line.

(Go to the Honors Chem home page to get a link a Google Sheet with a template of this Lab's data table)

Procedure A: ***This data will be collected together as a class.*** Water in a large beaker

(a) Determine the mass and volume of a <u>random amount</u> of water in a large beaker.
(b) Repeat the process for a total of 4 trials using <u>different random amount</u> of water in a large beaker.

Processing the data A:

(a) Calculate the density of the water in each trial. Round the answer off appropriately and be sure and put a unit label at the head of the column (or row).
(b) We will report the 6 trials on the class data table.

Procedure B: Alcohol ***in a small graduated cylinder***

a Determine the mass and volume of a <u>random small amount</u> of alcohol in a 10 ml graduated cylinder.
b Repeat the process by adding a little bit more alcohol for a total of 4 trials using <u>different random amounts</u> of the liquid in the 10 ml graduated cylinder.
c After returning the alcohol to the appropriate container, no need to wash the cylinder, simply grip it tightly and shake it dry.

Processing the data B:

a Calculate the density of the liquid in each trial. Round the answer off appropriately, be sure and put a unit label at the head of the column (or row).
b Calculate an average of all four values.
c Report the average to the class data table.

Procedure C: Water ***in a small graduated cylinder***

- Repeat the procedure B for water. Use a wash bottle for the water rather than the faucet so that the water doesn't get all over the outside of the graduated cylinder. The wash bottles are much easier to aim than the water coming out of the faucets.

Processing the data C:

- Repeat the calculations in part B for the water trial.

Procedure D & E: Oil and corn syrup ***in small graduated cylinders***

- Repeat procedure B for the last two liquids, oil and corn syrup.
- Use the same graduated cylinder from trial C for one liquid, then use a clean cylinder for the second liquid. No need to clean the cylinders when you are done, just leave them in the soapy water in the tub on the center lab bench.
- Repeat the calculations for both liquids reporting your average value of each to the class data table.

Procedure F: Water ***in a volumetric(or density) flask***

a Determine the mass of the volumetric flask.
b Fill the flask with water to the etched line. The volume of the flask is listed on the flask.
c Determine the mass WITH THE ANALYTICAL BALANCE of the flask with water in it.

Processing the data F:

a Subtract the mass of the flask to determine the mass of the water.
b Calculate the density of the water for the one trial. Round the answer off appropriately.
c Report your density value to the class data table.

Disposal:

If they have NOT been contaminated, alcohol and oil should be returned to their respective containers. The cylinder used for oil should be placed in the appropriate wash tub on the center lab bench. The corn syrup need not be poured back into the container, just put the cylinder into the other appropriately labeled wash tub on the center lab bench.

Post LAD Questions

1. Mass and volume are physical properties. These values will vary with the amount of material. Tolerating the fact that there is error in the density values, the data *should* demonstrate that density is a physical property that does *not* change with the amount of material being measured. How is it that density is an *intensive* property, even though that density is calculated from two *extensive* properties?

2. The theoretical value for the density of water at room temperature is 0.998 g/ml, for our purposes, we'll consider it to 1 g/ml *(Review NS B5 we will work together as a class on this question.)*
   a. Comment on the accuracy and precision of the class data for the density of water using the *small graduated cylinder* and the *volumetric flask* **compared with** the *beaker* used during the class demo, Procedure A. Define these two terms while making your comments.

   b. Does the data indicate which measuring device is least precise and/or least accurate − a beaker or a graduated cylinder / volumetric flask? If one is less precise and/or accurate than the others, suggest why.

3. In class, a correlation between viscosity and density was proposed. State the correlation that was made earlier and then, based on the findings in this lab, is the proposed correlation between viscosity and density valid?

The real story about viscosity.

It is tempting to suggest that density causes viscosity, or viscosity causes density, however, the reality is that viscosity is caused by the ease with which molecules of a liquid can move with respect to one another and this is not always or only affected by density. Viscosity of a *pure* substance (such as oil, water, and alcohol) can *depend* on several different factors:

- the attractive forces between molecules (a topic we will study in chap 14)
- the size and shape of the molecules in a liquid.

In summary, molecules with stronger intermolecular forces, and larger, and longer molecules are all more likely to become entangled with each other. It is this "stickiness and tangled-ness between molecules" that is more important than the density of the substance in causing the material's viscosity.

The viscosity of a *solution* (such as the corn syrup) is associated with the density of that solution

- The number of molecules dissolved will affect how crowded together the particles are which will affect the molecules ability to move around and thus affect the viscosity of the solution.

In summary, in a more crowded solution (which will be a more dense solution), the molecules are more likely to become entangled with each other increasing the material's viscosity.

Error Analysis - review NS A2 for more information on doing Error Analysis

A. After stating the source of the error, (*this has been done for you in the questions below*)
B. state which data and how it would be affected (or unaffected) (higher or lower?).
C. then state how the calculated value(s) would be affected (higher or lower?).

4. Since the corn syrup is so viscous, more time is required for the syrup to run down the sides into the graduated cylinder. If a student did not wait long enough before recording the volume of the corn syrup, would the calculated density of the corn syrup be too large, too small, or unchanged?

5. If the oil got shook up as the oil is poured into the cylinder, bubbles may form. If a student noticed that there were bubbles in their oil, would the calculated density of the oil be too large, too small, or unchanged?

6. It is always important to keep a clean lab, especially around the balances. If there were water on the outside of the cylinder or spilled on the balance pan after taring, would the calculated density of the water be too large, too small, or unchanged??