CHM 2045L
Physical Properties

Purpose: To observe and record some common physical properties.

Background: Physical properties can tell us a lot about an unknown chemical. In this experiment you will look at three physical properties: density, solubility and boiling point.

The density of a substance is the ratio of the mass of the substance to its given volume. The density of both solid and liquid is given in units of g/mL. To determine the density of any substance it is necessary to find both the mass and the volume of a given sample. The formula for density is given below.

Density = mass / volume or d = m/v

Solubility is a measure of how well one substance dissolves in another substance. The general rule of solubility is "like will dissolve like" which means polar substances tend to dissolve in polar substance and non-polar substance tend to dissolve in non-polar substances.

The boiling point of a substance is the temperature at which the liquid substance changes to vapor. The normal boiling point of a liquid is determined at 1 atm of pressure.

Materials:

Apparatus:

10 mL graduated cylinder
Six small test tubes
Test tube rack
250 mL beaker
Bunsen Burner
Utility and Thermometer clamps
Two 15 x 150 mm test tubes
Two capillary tubes
Ring stand
Stirring rod
Rubber Bands

Chemicals:

D.I. water
Salt solution
Sodium chloride
Calcium carbonate
Unknown solid
Ethanol
Soybean oil
Unknown liquid

Procedure:

Part A: Density

1. Determine the density of D.I. water
    a. Weigh a dry 10 mL graduated cylinder
    b. Add between 8-9 mL of DI water to the graduated cylinder
    c. Reweigh the graduated cylinder with the water
    d. Calculate the density it should be very close to 1.00g/mL
2. Determine the density of an unknown salt solution
    a. Obtain around 25 mL of an unknown salt solution
    b. Record the letter of the salt solution you have
    c. Rinse the 10 mL graduated cylinder with 2-3 mL of salt solution
    d. Discard the rinsing solution
    e. Fill the graduated cylinder with between 4-5 mL of salt solution
    f. Reweigh the graduated cylinder with the salt solution
    g. Calculate the density of your salt solution
    h. Add 3-4 mL more of the salt solution to the graduated cylinder, for a total volume of about 7-9 mL
    i. Reweigh the graduated cylinder with the salt solution
    j. Calculate the density of your salt solution
    k. Record your two density determinations and then take an average of your two determinations.
    l. Unknown salt solution can be put down the drain

Part B: Solubility

1. Determining the solubility of known solids
    a. Obtain two test tubes
    b. Place 2 ml of DI water in each
    c. Weigh out 0.2 g of NaCl and add it to one of the two test tubes
    d. Shake, observe and record your results
    e. Weight out 0.2 g of $CaCO_3$ and add it to the other test tube
    f. Shake, observe and record your results
    g. Waste from each of the above can go down the drain
2. Determining the solubility of an unknown solid
    a. Obtain a unknown solid
    b. Record the letter of the unknown solid
    c. Place 2 mL of DI water in a test tube
    d. Weigh out 0.2 g of unknown solid and add it to the test tube
    e. Shake, observe and record your results
    f. Waste from the unknown can go down the drain
3. Determining the solubility of known liquids
    a. Obtain two test tubes
    b. Place 2 ml of DI water in each
    c. Measure out 1 mL of ethanol and add it to one of the two test tubes
    d. Shake, observe and record your results

e. Measure out 1 mL of soybean oil and add it to the other test tube
f. Shake, observe and record your results
g. Waste should go in the solubility/boiling point waste container

4. Determining the solubility of an unknown liquid
    a. Obtain a unknown liquid
    b. Record the letter of the unknown liquid
    c. Place 2 mL of DI water in a test tube
    d. Measure out 1 mL of unknown liquid and add it to the test tube
    e. Shake, observe and record your results
    f. Waste should go in the solubility/boiling point waste container

<u>Part C: Boiling Point</u>

1. Determining the Boiling point of a known liquid
    a. Assemble a boiling point apparatus as shown by instructor
    b. Half fill a 250 mL beaker with DI water
    c. Place the beaker over the Bunsen burner
    d. Use a thermometer clamp to hold the thermometer so that the bulb of the thermometer is right next to the bottle of the test tube (neither the test nor the thermometer should touch the bottom of the beaker. The test tube should be attached to your thermometer with the rubber bands
    e. Place 1 ml of ethanol in the test tube
    f. Put a capillary tube upside down in the test tube, open side down!!
    g. Ignite the Bunsen burner; **stir** the water bath about every 30 seconds for even heating.
    h. When you see a continuous flow of bubbles from the capillary tube extinguish the Bunsen burner and watch the capillary tube.
    i. When the bubbles cease coming from the tube, record the temperature.
    j. Waste should go in the solubility/boiling point waste container
2. Determining the Boiling point of a unknown liquid
    a. Obtain 2 mL of unknown liquid
    b. Record the letter of the unknown you have
    c. Repeat boiling point procedure, remember capillary tube goes open end down!!
    d. Waste should go in the solubility/boiling point waste container

Pre-lab Questions:

1. Define each of the following:
    a. Density:

    b. Solubility:

    c. Boiling point:

2. Determine the density of a 14.765g object that when place in 25.00mL of water rises the level of the water to 27.65ml.

3. Briefly describe how you could easily calibrate a thermometer at 0°C and100°C.

Data Table:

Part A:

	D.I. Water	**Unknown Salt Solution Determination #1**	**Unknown Salt Solution Determination #2**
Weight of dry Cylinder			
Volume of liquid			
Weight of cylinder and liquid			
Weight of liquid			
Density of liquid			

Number of unknown salt solution: _____

Average density of unknown salt solution: _____

Part B:

Solubility of	**Observation**	**Soluble or Insoluble**
NaCl		
$CaCO_3$		
Unknown solid (# _____)		
Ethanol		
Soybean Oil		
Unknown liquid (# _____)		

Part C:

Boiling point of ethanol: _____

Unknown Number: _____

Boiling point of Unknown: _____

Post-lab Questions:

1. Explain why the boiling point procedure in this experiment would not work for a substance that has a boiling point greater than 100°C.

2. Explain what is meant by the phase "likes dissolve likes" when dealing with solubility?

3. Briefly explain why the smaller the density sample the larger the error factor when dealing with the same piece of glassware.