

Experiment 1: Physical Properties of Organic Compounds

Introduction

Physical properties are defined as a property that can be measured without changing the composition of the substance. The physical properties that will be measured during this lab are solubility, density, melting point, boiling point and refractive index. These physical properties can help elucidate the identity of an unknown substance. These same properties can also be used to determine the purity of a particular compound. Let us look at each of these properties individually.

Solubility is defined as the maximum mass of a substance that can be dissolved in a fixed mass of a solvent at a given temperature. A substance will have a different solubility in different solvents depending on polarity of both the substance and the solvent. The old adage is that like dissolves like, hence a polar substance will be more soluble in a polar solvent and vice versa. The solvents used in this experiment will be water, ethanol, acetone and benzene.

Density is defined as the mass of a substance per a unit volume. In this experiment, grams per milliliter will be the density units. A dense liquid such as mercury has a density of 13.546 g/mL. In contrast, hexane has a density of only 0.659 g/mL. Hence, one can use the density in determining the identity of an unknown substance.

The melting point is defined as the temperature at which a substance goes from a solid to a liquid. For example, water (ice) changes from a solid to a liquid at 0° Celsius at STP. Although the melting point is usually listed at a certain temperature, most substances melt over a temperature range. The temperature range is defined as the temperature at which a substance begins to melt to the temperature at which the whole sample is completely a liquid. A smaller temperature range would indicate a purer substance.

The boiling point is defined as the temperature at which a substance goes from a liquid to a gas. For example, water changes to steam at 100° Celsius at STP. However, unlike the melting point, boiling points are significantly affected by atmospheric pressure.

The refractive index can also be used to determine the identity of an unknown substance. Refraction is the changing in the direction of a ray of light passing from one medium to another. You have probably observed this looking down into the water while standing in it. The refraction of light causes your legs to look shorter. As with the other physical properties, a substance has a unique refractive index.

List of possible solids and their solubility in certain solvents

Compound	Water	Ethanol	Acetone	Benzene
Acetamide	soluble	soluble		
Acetanilide		soluble	soluble	soluble
Anthracene			soluble	soluble
Benzoic Acid		soluble	soluble	soluble
Benzoin		soluble	soluble	

List of possible liquids

1-propanol
2-propanol
2-butanol
2-methyl-1-propanol
3-methyl-1-butanol
ethyl acetate
toluene

Procedure

Melting Point

Determine the melting point of your unknown solid

1. Deposit approximately 0.01 grams of your unknown solid into a small pile on a piece of weigh paper.
2. Insert a capillary tube, open end down, into the pile of unknown solid forcing some of the solid into the capillary tube.
3. Tap your capillary tube, closed end down, on the bench top to force the solid to the bottom of the capillary tube.
4. Repeat steps 2 and 3 until approximately 5 mm of sample are at the bottom of the capillary tube.
5. Place your capillary tube, closed end down, into the melting point apparatus.
6. Turn on the melting point apparatus and watch both the temperature display and your solid sample. (Heating your sample too quickly will result in an inaccurate melting point determination.)
7. When your sample begins to melt, record the temperature.
8. As soon as the entire sample is melted, once again record the temperature, this will give you the temperature range.
9. Repeat steps 1 through 8 to confirm your melting point.

Solubility

Determine the solubility of your unknown solid in water.

1. Add a small amount of your unknown solid to one of your test tubes. The amount should be roughly equivalent to the size of grain of rice.
2. Add 10 drops of water to your test tube containing the unknown solid and agitate.

3. Record your observations. Did your solid dissolve? Remember, the degree of solubility is dependant on temperature and is sometimes hard to determine. Therefore, your observations may not correspond exactly to the table of solubility.

Repeat the above three steps with ethanol, acetone and benzene.

With the data you have collected for both the solubility and melting point determine the identity of your solid unknown.

Density

Determine the density of your unknown liquid (**Do this first!**)

1. Place your 25 mL Erlenmeyer on a balance and tare.
2. Pipet 1 mL of your unknown into the tared 25 mL Erlenmeyer flask.
3. Record the mass of your 1 mL of unknown liquid.

Boiling Point

Determine the boiling point of your unknown liquid

1. Obtain a micro test tube from your laboratory instructor.
2. Place 5 drops of your unknown liquid into the test tube.
3. Place a capillary tube, open end down, into the test tube containing your unknown liquid.
4. Attach this assembly to a thermometer with a rubber band. Your laboratory instructor will demonstrate.
5. Clamp a Thiele-Dennis tube onto a ring stand in such a way that the bottom of the tube is over a Bunsen burner.
6. Insert your thermometer assembly into the oil of the Thiele-Dennis tube so that the end of the thermometer is at the junction of the Thiele-Dennis tube. The rubber band should stay above the level of the oil. Your laboratory instructor will demonstrate.
7. Slowly heat the Thiele-Dennis tube until a rapid stream of bubbles flow from the capillary tube.
8. Remove the heat and watch until the bubble stop emerging from the capillary tube.
9. Record the temperature.
10. Repeat steps 10 through 12 to confirm your boiling point.

Refractive Index

Determine the refractive index of your unknown liquid.

Correct use of the refractometer will be demonstrated by your laboratory instructor.

1. Open the two part prism assembly.
2. Place one drop of your unknown liquid on the prism. Be sure not to touch the prism to avoid scratching it.
3. Close the two part prism assembly.
4. Turn on the refractometer.
5. Look through the eyepiece and adjust the coarse adjusting wheel until the cross hairs are at the junction of the light and dark field.
6. Use the drum to sharpen the junction of the light and dark fields if necessary.
7. Push down the on and off switch on the back left side of the instrument.
8. Read the scale to four decimal places while looking through the eye piece.
9. Open the two part prism assembly and clean with a Kim wipe and ethanol.

With the data you have collected for the density, boiling point and refractive index determine the identity of your liquid unknown.

Data

Name _____

Solid Unknown # _____

Solubility

Water observations:

Ethanol observations:

Acetone observations:

Benzene observations:

Melting Point

Temperature where solid begins to melt: _____

Temperature where solid is completed melted: _____

Identity of unknown solid: _____

Liquid Unknown # _____

Density

Mass of 1 mL of unknown liquid: _____

Density of unknown liquid: _____
(Show calculation)

Boiling Point

Temperature of boiling point: _____

Refractive Index: _____

Identity of unknown liquid: _____