Organic Lab Activity
Physical Properties of Petroleum-based Materials

Purpose

To observe the difference in the physical properties of several petroleum-based materials and relate the properties to molecular size.

Procedure

You will be using the following materials -

	Carbon atoms per molecule
Mineral Oil	12-20
Asphalt	More than 34
Kerosene	12-16
Paraffin Wax	More than 19
Motor Oil	15-18
Household Lubricating Oil	14-18

1. Record the physical state (solid, liquid, gas) of the material at room temperature.

2. Determine the density of each of the materials. Record the mass, volume, density, and molecule size of each material in a data table.

3. Determine the relative viscosity of each material using the procedure described below. Viscosity is the measurement of a liquid's resistance to flow. Several factors contribute to viscosity. For example, glycerol has a high viscosity because of its tendency to form many hydrogen bonds. For other molecules, such as oils, viscosity can be related to the length of the of the molecule. The viscosity of a solid should be recorded as "infinite".

   a. Use the pipettes provided by your instructor. Note that each pipette is to be used for only the substance labeled.
   b. Place your finger over the pin hole near the top of the pipette bulb. Squeeze the pipette bulb and draw offthe desired liquid to the top of the tape. Make sure the tip of the pipette is over the container into which it is to drain.

c. Have your partner time how long it takes for the liquid to drain from the tape mark to the bottom of the bulb once you release your finger from the hole.

d. Repeat the above procedure for each of the liquids.

e. Determine the relative viscosity using the following equation and table.

Calculate the relative viscosity of your samples at room temperature by applying the following formula. The values for the absolute viscosity of water are in units of centipoises (cp). A centipoise is equal to 0.01 g/cm·s.

$$\text{relative viscosity}_{oil} = \frac{\text{density}_{oil} \times \text{time elapsed}_{oil} \times \text{viscosity}_{H_2O}}{\text{density}_{H_2O} \times \text{time elapsed}_{H_2O}}$$

2°C 1.671

Temperature (°C)	Absolute Viscosity for H_2O (cp)
18	1.053
20	1.002
22	0.955
24	0.911
25	0.890
26	0.870
28	0.833

52° .5290

f. Make an ice bath in a large beaker. Fill test tubes half full with each of the liquids to be tested and place them in the ice bath for 5-8 minutes so that they reach a temperature of 0° C - 10°C. It is important that the samples are tested at the same temperature.

g. Repeat procedures b through e for the cold samples.

h. Set up a hot water bath. Heat the water so that it reaches a temperature between 35° C and 45° C. Fill test tube half full with each of the liquids to be tested and place them in the hot water bath. When the samples are warm, test their viscosities by repeating steps b through e.

i. Record all viscosity data in a table that includes: name of material, molecule size, time, relative viscosity.

Analysis

1. What is the relationship between density and molecule size for these substances?

2. What is the relationship between physical state at room temperature and molecule size for these substances?

3. What is the relationship between viscosity and molecule size for these substances? Suggest a reason for this relationship.

4. How does temperature affect the viscosity of these liquids? Suggest a reason for this affect.

5. Based on your results which oil would you want to put into your car during the frigid South Dakota winter, SAE10W-30 or SAE10W-40? Explain.

6. You've just made yourself a steaming stack of pancakes for breakfast. You take the syrup bottle out of the refrigerator only to discover there's hardly any left. You turn in upside down and wait and wait and wait. You're going to be late to school. Explain how you could get the last of the syrup out faster.

	Physical State	Density	Size	Room Temp.		Cold Temp.		Warm Temp.	
				Time	Visc.	Time	Visc.	Time	Visc.
Mineral Oil									
Kerosene									
House Oil									
10-30									
10-40									
20-50									
Asphalt		1.3		Inf.	Inf.	Inf.	Inf.	Inf.	Inf.
Wax		1.8		Inf.	Inf.	Inf.	Inf.	Inf.	Inf.