Microdensity of Plastics

Introduction:
Density is defined as the mass per unit volume of a substance. It is one of the most important properties used in the identification of substances. Usually, density is found by massing the object, measuring its volume, and then dividing mass by volume. However, if the sample of material is very small and irregularly shaped, it may be difficult to determine the mass and volume with precision.

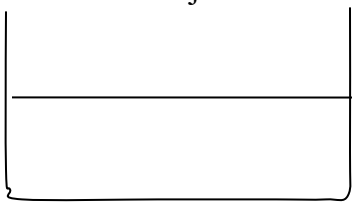
This experiment demonstrates an **indirect** method of determining density. It uses the relative densities of substances and the properties they demonstrate. An object with a low relative density will float on top of a liquid with a high relative density. But if the liquid's density is somehow decreased, a point could be reached where the densities are equal. At this point, the object will be suspended in the liquid, neither sinking nor floating. This same idea is used for a relatively high density object and a low density liquid; only the liquid's density must be increased to suspend the material. Once the object is suspended, the object and the liquid possess exactly the same density. The density of the object can be determined indirectly by measuring the density of the liquid in which the object is suspended.

Practical application:[1]
The most common type of plastics recycling in the United States is *mechanical recycling*. The mechanical recycling process refers to the direct recycling and conversion of plastics from discarded materials into plastic pellets. These recycled pellets are then reintroduced into the plastic production process to form new products.

Usually only PETE and HDPE (These are specific types of plastic.) bottles are collected for recycling. During the mechanical recycling process, these bottles are chopped up into small pieces called “flake”, which are then washed to remove contaminants. The different plastics and contaminants are then separated using a Flotation Tank, which takes advantage of the differences in plastic densities. HDPE is less dense than water and therefore floats in the tank, while dirt and more dense plastic contaminants sink and are removed. The reverse is true for PETE, which is more dense than water. In this case, the less dense contaminants are floated away.

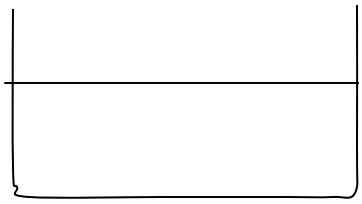
Guiding Questions:
Please answer the following questions before beginning the lab.

1. A block with a density of 0.8 g/mL is placed in water. Water’s density is nearly 1.0 g/mL. Draw a picture of the object in a container of water.



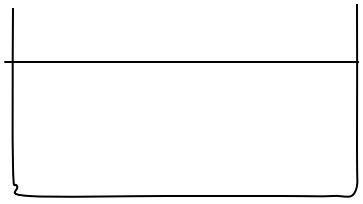
[1] “The Mechanical Recycling Process.” http://www.plasticsresource.com/recycling/index.html (20 May 2002).

2. Now, that same block is placed in a light oil (d = 0.70 g/mL) Draw a picture of this object in the oil.



3. What would happen if we mixed some water with a bunch of the light oil (assuming it would dissolve in water)? What would happen to the density?

4. Imagine that we kept adding water to the oil. Eventually the density of the "oil" would become 0.80 g/mL, the same as the block. Draw a picture of this scenario.



5. An object whose density is to be measured is floating on a liquid. After *methanol* is added to the liquid, the object is suspended. What effect did the *methanol* have on the density of the liquid? Think about the questions above.

6. An object whose density is to be measured has sunk to the bottom of a test tube containing a liquid. After saturated sodium iodide is added to the liquid, the object is suspended. What effect did the saturated sodium iodide have on the density of the liquid?

Materials:
small piece of plastic
forceps
4" test tube
50 mL beaker
methanol
saturated KI (potassium iodide) solution
stirring rod
1 mL micropipette/tips
top loader balance

Safety:
- **Always** wear safety glasses in the chemistry lab.
- **Never** eat or drink in the chemistry lab.

Practice:
1. Tare a small beaker on a balance.
2. Using a micropipette, place 1.000 mL of water into the beaker.
3. Record the mass of the water sample.
4. Calculate the density of the water sample.

	Water
Mass	
Volume	
Density	

Procedure:
1. Fill a test tube 1/4 to 1/3 full with water.

2. Obtain a known plastic given to you by the instructor. Record the type of plastic in the data section as the identity of the plastic.

3. Bubbles can form on the plastic and change its apparent density. In order to reduce the number of bubbles, hold the plastic with forceps and drop methanol on it. *Be careful not to lose the plastic in the bottle.* Then transfer the plastic to the test tube of water.

4. *If the plastic **floats**:*
- Add **methanol** - a few drops at a time - to the test tube, and carefully stir the solution with a stirring rod until the liquid is homogeneous.
- Repeat this step until the plastic is suspended in the solution.

*If the plastic **sinks**:*
- Add the **KI** (saturated sodium iodide)- a few drops at a time - to the test tube, and carefully stir the solution with a stirring rod until the solution is homogeneous.
- Repeat this step until the plastic is suspended in the solution

Note: During the stirring process, be careful not to create tiny air bubbles which can attach to the piece of plastic. If this happens, the plastic will float regardless of the solution's density. To remove air bubbles, tap the test tube.

5. When the plastic is suspended in the solution, the density of the plastic should be equal to that of the solution. Place a small beaker on the balance and tare it.

6. Remove 1.000 mL of the solution with a micropipet, and place it in the beaker. Record the mass of the solution in the data section.

7. Repeat this procedure with for 3 more knowns and one unknown plastic given to you by the instructor.

Data:
The following information contains the accepted values for the densities of plastics. Please note that plastic 3 is not used in this experiment.

Plastic		**Density (g/cm^3)**
1 = PETE	polyethylene terephtalate	1.39
2 = HDPE	high density polyethylene	0.95 - 0.97
3 = PVC	polyvinyl chloride	varies
4 = LDPE	low density polyethylene	0.92 - 0.94
5 = PP	polypropylene	0.90 - 0.91
6 = PS	polystyrene	1.05 - 1.07

Do Not use a calculator to determine the density! The math is easy.

	Known	**Unknown**	**Unknown**	**Unknown**	**Unknown**
Identity of plastic					
Mass of solution					
Volume of solution					
Density of solution					
Density of plastic					

Questions:

1. Based on density, what is the identity of your unknown(s)?

2. Why is this method of determining density referred to as an indirect method?

3. An object whose density is to be measured is floating on a liquid. After methanol is added to the liquid, the object is suspended. What effect did the methanol have on the density of the liquid?

4. An object whose density is to be measured has sunk to the bottom of a test tube containing a liquid. After saturated sodium iodide is added to the liquid, the object is suspended. What effect did the saturated sodium iodide have on the density of the liquid?

5. What is the purpose of dripping methanol on the piece of plastic prior to placing it in the test tube of water?

6. What are some sources of error for this experiment?

7. If you had to make a floatation device from plastics, which types of plastics used in this lab would be most effective in your design? Why?