DENSITY OF DIFFERENT PLASTICS

Objective:

Students will:

- Investigate how different numbered plastics have different densities.

Introduction:

Plastic is a versatile polymeric product. Plastic can be flexible or rigid; transparent or opaque. It can be made to look like leather, wood, or silk. It can be made into toys or heart valves. Altogether there are more than 10,000 different kinds of plastics. The basic raw materials for plastic are small linked monomers made from petroleum or natural gas. These fossil fuel monomers are sometimes combined with other elements, such as oxygen or chlorine, to make difference types of long chain polymeric plastics.

Pro: Plastics are really very energy efficient to make. It takes 20-40 percent less energy to manufacture plastic grocery bags than paper ones. And, since plastics are lightweight and take up so little space, it is much more efficient to transport them. It takes seven trucks to deliver the same number of papers bags as can be carried in one truckload of plastic bags. Many plastics can be reprocessed and made into new products much cheaper that recycling wood or paper.

Con: Plastic bags are a pervasive problem for municipalities looking to control litter because they are prone to catching the wind and floating to where they are not easily retrieved. Also, plastic is a petroleum based product which is a non-renewable resource that we generally purchase from overseas markets. Plastics also have a long natural half-live compared to wood or paper or even some metals. Plastic do not decay easily and make extra fill for trash dumps.

<u>Why can not all plastics be recycled.</u>

If glass and metal can be melted and recast, why can't all plastics be melted and recast? If we can recycle water bottles why not plastic cups? Why can't all #2 plastics be recycled?
It has to do with their internal structure and chemical composition.

Most recycling involves shredding, melting and recasting. Glass and metals and some plastics will do that easily. Other plastics are so highly self attached at the molecular level that they char or burn before they can melt. Even though most plastic molecules started with a central chain of carbon atoms similar to oil itself. The way this monomers were linked together to form the plastic polymers determines if the finished solid material will melt when heated, like butter or will burn when reheated, like popcorn. So even though plastics all have the same initial components which constitute being plastic and relate to the number they are given (i.e. 1-7), however, the individual makeup within each product dictates our ability to recycle it.

Materials:

- Plastic Samples – Three pieces of each plastic number 1-7
- Centigram Balance
- 25 ml graduated cylinder and water
- Container of water for each student group
- Optional - pieces of fabric (fur, flannel, silk, cotton, synthetic fabrics)

Procedure:

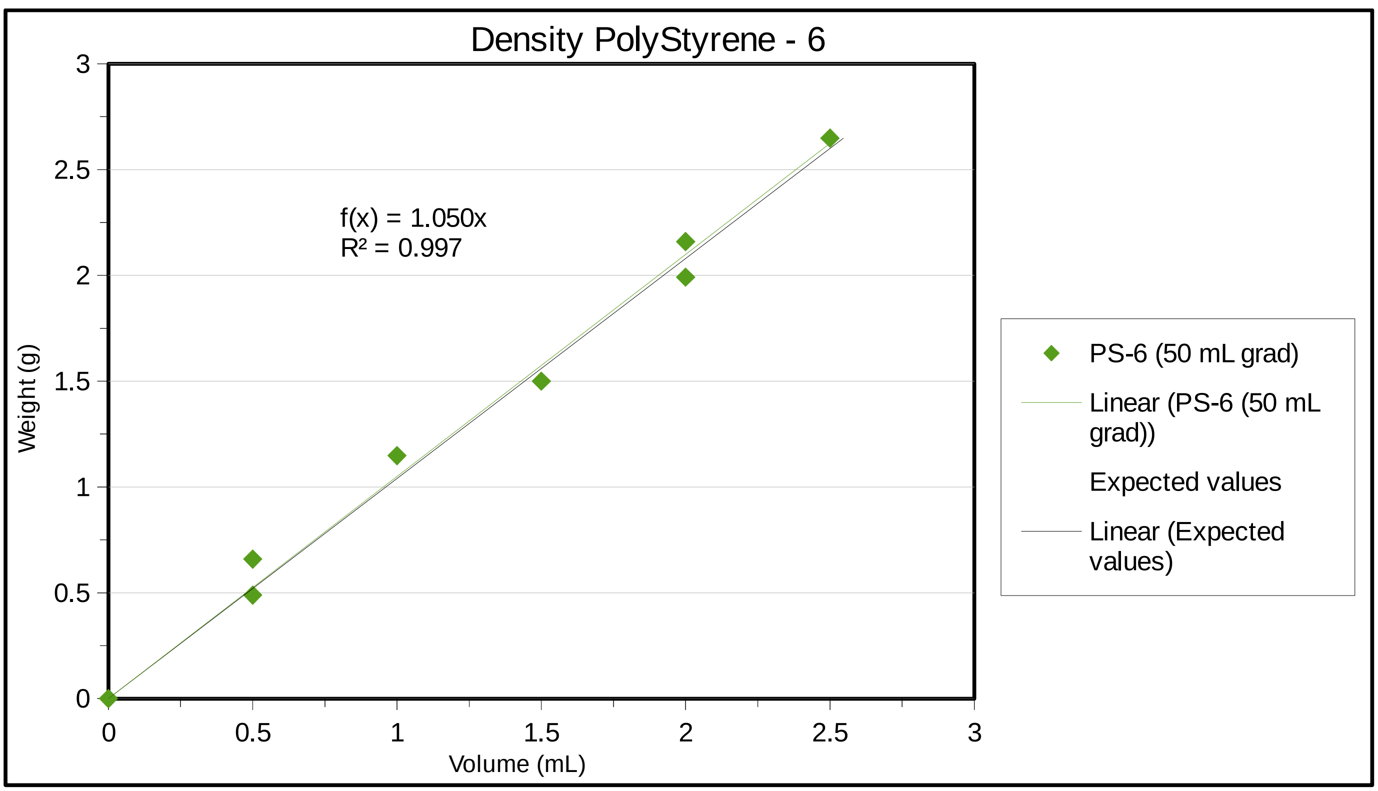
- Cut up different types of plastic products.
- Explain to students that some of these plastics will sink and some will float.
- Allow students to examine the plastic in small groups.
- Note and record the physical characteristic of each plastic group: color and texture,

- Weigh each of the three pieces of plastic for each sample and combinations of pieces
- Record weight of pieces on the worksheet using the centigram balance.

- Fill the 25 ml graduate cylinder to about 15 ml, then add plastic.
- Have students predict which pieces will sink and which will float.
- Put all plastic pieces in the water and record observations.

- Record the volume of the plastic using the method of displacement on the work sheet.
- Repeat the volume measurements for each combination of plastic pieces.
- Graph the results as wt (g) vs vol (mL) for each combination of plastic pieces.
- Calculate the slope of the line, which will be the plastic density in g/mL.

Example of a density graph of polystyrene plastic.



Discussion:

Remember, that Density is the mass, measured in grams, per unit volume, measured in mL, of a substance.

Density = mass (g)/ volume (mL)

Density indicates how "tightly the matter is packed" in that substance. For example, the element Lead (density = 11.3 grams/mL) has about four times more "matter" (and thus more mass) packed into one mL than does the element Aluminum (density = 2.7grams/mL).

Density is an "intensive" physical property of matter, which means that density is independent of the amount of substance being measured. And thus it can be useful for helping to determine the identity of an unknown substance. The concept of density is also quite useful for some very practical and everyday applications.

To determine the density of a substance. You need only to measure the mass and volume of a sample of that substance, and then perform the calculation. However, there is a big advantage to making multiple measurements of a sample, rather than just a single measurement. Making several measurements of the same sample allows you to look at the quality of your measurements, by comparing their precision – how close the measurements are to one another.

This is Why we use the graphic method to calculate the density because the line through the points is like an average of each point.

References

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1) Vanderbuilt Student Volunteers for Science. "Density Column Using Recycled PPlastics".

http://www.nclark.net/Density_Column.pdf (6/13/14)

2) Rob Gardner. "Identifying Plastics by Their Densities". Recycle: Green Science

Projects for a Sustainable Planet. 2001. 24-27.

3) Environmental Protection Agency, Office of Solid Waste. "Methods to Manage and
Control
Plastic
Wastes". February 1990. (EPA/530-SW-89-051)
The American Plastics Council

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Name ____________________________ Date ________________________

Plastics Density

Material	Weight (g)	Floats or Sinks (mL)	Starting Volume (mL)	Ending Volume (mL)	Piece Volume (mL)
#1 plastic container piece #1					
#1 plastic container piece #2					
#1 plastic container piece #3					
#2 plastic bottle piece #1					
#2 plastic bottle piece #2					
#2 plastic bottle piece #3					
#3 plastic siding piece #1					
#3 plastic siding piece #2					
#3 plastic siding piece #3					
#4, 6-pack ring piece #1					
#4, 6-pack ring piece #2					
#4, 6-pack ring piece #3					
#5, soda straw piece #1					
#5, soda straw piece #2					
#5, soda straw piece #3					
#6, plastic pen piece #1					
#6, plastic pen piece #2					
#6, plastic pen piece #3					

Name ______________________________ Date _________________________

Name ___________________________ Date _______________________

Material	Density measured from graph (g/mL)	Density range from table below (g/mL)	In the range (yes/no)
#1 plastic container			
#2 plastic bottle			
#3 plastic siding			
#4 6-pack ring			
#5 soda straw			
#6 plastic pen			

<u>Lab Questions:</u>

1. Which two plastics would be most difficult to separate by density? Why?

2. Why are the samples submerged rather than placed on top of the solutions?

3. Plastics 2 and 4 are both polyethylene. If these materials are made of the same polymer what is different about them?

Green Question(s)

4. Why is it important to recycle plastics?

5. What waste is generated in the experiment?

Plastic Type	Name	Properties	Density Range	Common Uses	Recycled Into
PET	Polyethylene terephthalate	Tough, rigid shatter-resistant, softens if heated	1.38-1.39 g/mL	Soda, water and juice bottles. Some ThermaForms (takeout and produce container).	*Fiberfill for winter coats, sleeping bags and bean bags. Rope, *carpet, parking stops and other plastic bottles.
HDPE	High Density Polyethylene	Semi-rigid, tough, flexible	0.95-0.97 g/mL	Milk and water jugs. Detergent bottles. Margarine tubs. Thinner bags (grocery sack).	*Toys, *piping, plastic lumber, *nursery containers and other plastic bottles.
Vinyl	Polyvinyl Chloride	Strong, semi-rigid, glossy	1.16-1.35 g/mL	Siding and pipes. Shower curtains. Some detergent bottles. Some shrink wrap.	Plastic pipes, shower curtains, medical tubing, and vinyl dashboards.
LDPE	Low Density Polyethylene	Flexible, not crinkly, moisture-proof	0.92-0.94 g/mL	Thicker bags (Garbage, sandwich and dry cleaning). Plastic wrap. 6-pack rings. Lids from tubs.	Plastic lumber, wrapping films, grocery/sandwich bags and *recycling carts.
PP	Polypropylene	Non-glossy, semi- rigid	0.90-0.91 g/mL	Yogurt cups and margarine tubs. Screw-on lids/caps. Souvenir cups. Straws.	*Clothes hangers. Car bumpers.
PS	Polystyrene	Brittle, sometimes glossy, strong chemical reactions	1.05-1.07 g/mL	Expanded Styrofoam egg cartons, packing pellets and take-out containers. Non expanded plastic picnic cups and cutlery.	Baseboards, *CD cases, lightweight concrete and packaging.
Number 7 plastics	Other	Varies	Varies	Plastics mixture - squeezable bottles, biodegradable plastics and Tupperware.	Difficult to recycle

Items with an * are manufactured in North Carolina.