Professional Development Situation: Activity Guide

Skill Focus: Connecting to Prior Knowledge and Experiences

Time Required: 60 minutes

LEARN ABOUT DENSITY WITH PLASTICS

In this activity, youth will investigate how different numbered plastic have different properties.

Activity provided courtesy of the North Carolina Department of Environment and Natural Resources. (http://recycleguy.org/).

Learning Objectives

- Youth will be able to describe how the properties of different plastics affects their density.
- Youth will be able to identify the benefits of recycling plastics.

Key Terms

- Density: *mass per unit of volume. Density is relevant to buoyancy, purity, and packaging.*

Materials

- Examples of plastic number 1-7
  - #1 plastic drink bottle with cap and plastic non-bottle; #2 plastic bottle with cap and plastic bag; #3 PVC pipe and container; #4 6-pack ring and plastic bag; #5 plastic container; #6 expanded Styrofoam coffee cup; #6 non-expanded plastic picnic-style disposable cup; #7 PLA bio-based plastic; paper cup
- Tubs of water for each youth group. Plastic storage bins work well.
- Aluminum Foil
- Salt
- Hot tap water

- 3 thermometers
- Optional – pieces of fabric (fur, flannel, silk, cotton, synthetic fabrics)
- Copies of worksheet and plastic types sheet for each youth.

Advanced Preparation

- Review the activity and practice it on your own, if possible.
    - *Italics words are what you can say to youth.*
- Gather all the materials needed.
- Review the content about plastics below.

Plastic is a versatile product. Plastic can be flexible or rigid; transparent or opaque. It can 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 petroleum and/or natural gas. These fossil fuels are sometimes combined with other elements, such as oxygen or chlorine, to make difference types of plastic.

Pro: Plastics are really very energy efficient. 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.

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.

Using some common objects found in the classroom and a clear container filled with water, demonstrate that some objects sink and some float. Those that have a greater density than water will sink and those that have less density than water will float. Plastics also behave the same way.

Plastic Bottle versus Tub Analogy:

- *Why can't all plastics be recycled? If we can recycle water bottles why not plastic cups? Why can't all #2's be recycled?*

- *Just think about a pancake and a biscuit - although they are made of the same ingredients, (water, eggs, flour and milk) there are different quantities of these ingredients within each item. Pancake batter is runnier than biscuit batter making it easier to pour whereas biscuit batter is more easily molded. Also, once you make the batter for each item, you cook them at similar temperatures but for different lengths of time. Pancakes cook relatively quickly at a high direct heat, while biscuits have to be put in an oven and given time to bake. Plastics are the same way. They 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.*

Activity Instructions

Introduction (5 minutes)

- Organize youth into small groups of 3-5 (depending on the amount of plastic tubs you have).
- Gather the different types of plastic products.
- Explain to youth that some of these plastics will sink and some will float.

Density Predictions and Testing (10 minutes)

- Encourage youth to predict which pieces will sink and which will float. Allow youth to examine the plastic in their small groups.
- Encourage youth to put all plastic pieces in the water and record observations on the worksheet provided.

Density Discussion Questions (10 minutes)

- Discuss with youth how the shape of an item can affect its ability to float or sink. Demonstrate with an empty soda bottle with the cap on.
    - *Why does it float? Now take the cap off and fill it with water? Why does it sink?*
- Have youth use pieces of aluminum foil and make “boats” that will float.
- Discuss why floating litter would be a problem for aquatic animals.
- *How would the plastics behave if the water was very salty (like the ocean)?*
- To test this, add several heaping tablespoons to the water and stir well. Retest plastics.

Material	Floats or Sinks
#1 plastic bottle with cap	Floats

#1 plastic bottle without cap	Sinks
#1 plastic non-bottle	Sinks
#2 plastic bottle with cap	Floats
#2 plastic bottle without cap	Floats
#2 plastic bag	Floats
#3 PVC pipe	Sinks
#3 container (with or without cap)	Sinks
#4, 6-pack ring	Floats
#4 plastic bag	Floats
#5 plastic container	Floats
#6 expanded Styrofoam	Floats
#6 non-expanded Styrofoam	Sinks
#7 PLA bio-based plastic	Varies

Heating and Cooling Procedure (15 minutes)

- Explain to youth that when heat is applied to a substance, they can change its state. For example, when heat is applied to ice (a solid), it will melt into liquid water and will remain a liquid at room temperature. When wax is heated by the wick of a candle, it melts from a solid to a liquid. However, when it is allowed to cool at room temperature, it returns to a solid.
- Plastics behave more like wax when heated. To demonstrate this, pour hot water (as hot as your tap allows) into a #1 clean, empty, drink bottle. Fill ¾ full and cap. Using gloves, demonstrate to the youth that the bottle becomes more flexible when it is heated by gently squeezing the side of the bottle.
- Note that the plastic used in the above step was a # 1 plastic bottle.
- Repeat the same experiment using a plastic milk jug or shampoo bottle, a #2 plastic. Allow youth to predict the results. The milk jug will not become as malleable when hot water is added.
- Continue this line of thinking by providing three other containers for the youth: a paper cup, a Styrofoam (#6 expanded) coffee cup, and a #6 non-expanded plastic picnic-style disposable cup.
- Using hot tap water, fill each container. Record how malleable each container is and the water's temperature using the thermometer.
- Hand out the plastic properties sheet to each youth.

Heating and Cooling Discussion Questions (15 minutes)

- Have the youth predict which container will be the best insulator after 15 minutes. During the 15 minute wait time, discuss with them the transfer of energy that occurs when something cools.
- Discuss with the youth how to increase the insulation value of different plastics. They could wrap material around each one (fur, flannel, silk, cotton, synthetic fabrics) and retest results. Also, they could stack the cups in different ways to increase heat retention. Retest ideas if desired.

Reflection and Discussion

Connections (5 minutes)

Discuss the career connections to the group.

- **Product Engineer:** design, develop, and manage new product ideas for corporations or entrepreneurs. Product engineers have to determine what type of material the product is made of and consider cost, sustainability, environmental impact, and performance when making these decisions.
- **Mechanic, Maintenance Technicians, and Machinery Maintenance Workers:** inspect and repair the automated equipment and trucks in materials recovery facilities. These careers involve knowledge of electricity, electronics, hydraulics, and computer programming. For more information about careers in recycling visit the Bureau of Labor Statistics website http://www.bls.gov/green/recycling/.

Plastics Density

Write down if the material floats or sinks.

Material	Floats or Sinks
#1 plastic bottle with cap	
#1 plastic bottle without cap	
#1 plastic non-bottle	
#2 plastic bottle with cap	
#2 plastic bottle without cap	
#2 plastic bag	
#3 PVC pipe	
#3 container (with or without cap)	
#4, 6-pack ring	
#4 plastic bag	
#5 plastic container	
#6 expaned Styrofoam	
#6 non-expanded Styrofoam	
#7 PLA bio-based plastic	

Plastic Type	Name	Properties	Density Range	Common Uses	Recycled Into
	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.
	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.
	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.
	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.
	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.
	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