

Educator's Guide



Eco 360

Activity 4: Properties of Plastics

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Curriculum Connections

Activity 4: Properties of Plastics

Alberta

- ❖ Science 20 Unit A: Chemical Changes
 - 20-A3.1k identify materials used in daily life that are based upon Alberta's petrochemical industry and that involve changes in energy
- ❖ Grade 9 Unit C: Environmental Chemistry
 - 3 - Analyze and evaluate mechanisms affecting the distribution of potentially harmful substances within an environment

Ontario

- ❖ Grade 9 Chem (C1.1, C1.2, C2.2, C2.3, C3.4)

Activity 4: Properties of Plastics

Overall Objective

Learners will be able to discover various physical and chemical properties of common household plastics through an at home or in-class experiment.

Materials

- Internet-enabled device
- Eco 360 notebook (we recommend asking learners to maintain a notebook for this program to write down reflections as they go through the program)
- [Observation Tables Handout](#)
- [Solutions for Testing Density of Plastics Handout](#)
- [Information of Plastics Handout](#)
- Samples of plastics coded with identifying numbers 1 through 6
- 70% isopropyl rubbing alcohol
- Light corn syrup
- Water
- Metric or standard measuring spoon
- Four small, plastic cups or bowls
- Candle and matches for flame test
- Tongs
- Beaker of water
- Fine-tipped permanent marker
- Scissors
- Plastic bag
- Reusable bag
- Scale

Time Required

60 minutes - 90 minutes

Learning Outcomes

By the end of this activity, learners will:

- understand the physical and chemical properties of different types of plastics
- accurately record observations
- communicate their results and think critically about the potential implications of what they mean within the circular economy process, and the environment

Grade Level

Suitable for Grades 9 to 12

Activity Outline

Step One

Prepping the experiment:

- a. Have learners take a look around their house in a distance learning setting (can ask learners to bring plastics to the school or go check out the recycling bins for in-class learning) to try and find plastics with the identifying numbers 1 through 6.
- b. Have learners take a few minutes to look at what they found. They should notice the differences between the plastics. Some are smooth and malleable, while others are brittle and rigid. Some are clear, while others are opaque.
- c. Allow learners to reference the '[Information of Plastics Handout](#)' as they are finding various plastic products in their house. It gives learners examples of each type of plastic as well as their associated formulas and structures.
- d. Learners will need to cut five sample pieces (four if no flame test is being conducted) of each of the six plastic containers they gathered into one or two inch squares. There should be a total 30 little pieces of plastic divided into each of the six groups.
- e. Learners will need to prepare the solutions linked [here](#), each in its own bowl labelled A, B, C, and D. These solutions will be used to test the physical property of relative density of each of the six different plastics. Note that for example, if type-1 plastic floats in all four solutions, it means that its density is less than the density of all the solutions. If it were to sink in two of the solutions and float in the other two, then its density is somewhere in between.
- f. A beaker of water needs to be prepared within the fume hood prior to the flame test.

Step Two

Conducting the experiment:

- a. Have learners label each of the groups of plastics using the fine-tipped permanent marker with its corresponding number 1 through 6.

- b. Learners should record their observations using the [Observation Table Handout](#), or by using their own created observation table. They should record the various physical properties for each of the groups of plastics including: colour, clarity, hardness, odour, and malleability.
- c. Learners should place one of the five sample pieces of the type 1 plastic in the first solution A. Record whether or not it sinks or floats in the second observation table found [here](#). Continue testing the density for the remaining three solutions for the type 1 plastic. Repeat this process for the other five types of plastic samples. Learners should be able to determine the relative density based on these observations and referring to the density column of the known solutions.
- d. Mechanical strength test: Learners should find a plastic bag at their home for this test. Record the plastic code type of the bag (should be found at the bottom). Start by adding one item to the plastic bag and weighing it on a scale (if the weight of the item is not picked up by the scale then weigh yourself first, add the item to the bag, and weigh yourself again while holding the bag with the item and subtract that new weight from the original weight to find the weight of the item). Continue adding items one by one and recording the total weight (remember your units) that is being held by the plastic bag. Please record when the plastic bag rips, or can't hold anymore items. Repeat this process with a reusable grocery bag. If more items can be held then just extend the third observation table found [here](#).
- i. Compare and contrast the differences and/or similarities of the bags.
 - ii. What are reusable grocery bags made out of or are there different kinds? Did yours have a recycle code on it? What allows it to be used more than once, and how is that better than a plastic bag?
- e. Flame test: Using tongs, hold the last remaining plastic sample from each group individually over a lighted candle. Observe and record the flame and smoke colour in the first observation table found [here](#). This property that learners are testing for is known as combustibility (an object's ability to burst into flames), and it is a chemical property. Chemical properties differ to physical ones because they deal with an object's ability to change or produce a new substance. Learners will be able to see that smoke is being produced when heat is being added to the plastics.

- f. Discard the plastic into the pail of water to ensure all the flames are extinguished. Repeat this process for the remaining samples from each group.



Learner Assessment

Consolidation: Have learners answer or discuss as a class these questions:

- a. Share your findings and compare the differences between the plastics.
- b. Imagine doing this experiment again and not knowing the groups of plastics for each. Do you think you would be able to identify each plastic sample based on only the physical and chemical properties? Why or why not?
- c. How do you think recycling companies test for unknown plastics to determine their identity?

Further, find the learner exemplars below in the associated handouts section for a more formative assessment.



Teaching Tips

Safety note for flame test: Remind learners to be sure to use care when conducting the following part of the experiment. This test should only be done in a fume hood at school (it can be removed from the observation table). Be sure to remind learners to not breathe in the smoke produced by the burning of plastic.

Associated Worksheets



Eco 360

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Observation Tables Worksheet (Properties)

Learner Name: _____

Plastic Sample	Colour	Clarity (transparent/t ranslucent/op aque)	Hardness (hard or soft)	Odour	Malleability (malleable or brittle)	Flame Colour (Combustion)	Smoke Colour
							
							
							
							
							
							

Observation Tables Worksheet (Density)



Learner Name: _____

Plastic Sample	Solution A	Solution B	Solution C	Solution D	Relative Density Estimate

Observation Tables Worksheet (Strength)



Learner Name: _____


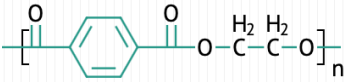

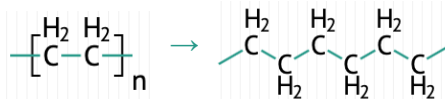

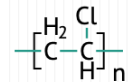



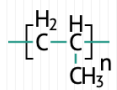

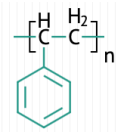
	Plastic Bag	Reusable Bag	Did it tear? (Y/N)
Plastic ID Code			N/A
Total Weight Added (2 Items) (remember units)			
Total Weight Added (2 Items)			
Total Weight Added (3 Items)			
Total Weight Added (4 Items)			
Total Weight Added (5 Items)			
Total Weight Added (6 Items)			

Solutions for Testing Density of Plastics



Solution	Mixture of Isopropyl Rubbing Alcohol, Light Corn Syrup, and Water	Density (g/mL)
A	5 mL 70% isopropyl alcohol + 2 mL of water	0.91
B	4 mL 70% isopropyl alcohol + 2 mL water	0.93
C	water	1.00
D	1 mL light corn syrup + 1 mL water	1.16







Information of Plastics Worksheet

Plastic Type & Symbol	Plastic Examples	Chemical Formula	Chemical Structure
 PET (Polyethylene Terephthalate)	Beverage bottles, plastic cans, fabric fibres and carpets, some bottles for hygiene products	$(C_{10}H_8O_4)_n$	
 HDPE (High-Density Polyethylene)	Bottles for household chemicals, milk jugs, juice containers, medicine bottles	$(C_2H_4)_n$	More linear compared to LDPE: 
 PVC (Polyvinyl Chloride)	Toys, blister wrap, cling wrap, detergent bottles, loose-leaf binders, blood bags, medical tubing	$(C_2H_3Cl)_n$	
 LDPE (Low-Density Polyethylene)	Bags (grocery, dry cleaning, bread, frozen food bags, newspapers, garbage), plastic wraps; coatings for paper milk cartons and hot & cold beverage cups; some squeezable bottles (honey, mustard), food storage containers	$(C_2H_4)_n$	More "branches" compared to HDPE: 
 PP (Polypropylene)	Thermal vests, car parts (bumpers), disposable diapers, sanitary pad liners, furniture	$(C_3H_6)_n$	
 PS (Polystyrene)	Food containers, egg cartons, disposable cups and bowls, packaging, cosmetic bags	$(C_8H_8)_n$	

Learner Exemplar (Properties)



Learner Name:

Plastic Sample	Colour	Clarity (transparent/translucent/opaque)	Hardness (hard or soft)	Odour	Malleability (malleable or brittle)	Flame Colour (Combustion)	Smoke Colour
 Plastic Honey Container	Clear	Transparent	Fairly hard	No scent - honey	Not very malleable Not brittle	Blue/yellow	Black
 Plastic Baking Powder Container	White	Opaque	Hard	No scent - baking powder	Not very malleable Not brittle	Blue/yellow	White
 Milk Pitcher Holder	White	Opaque	Very hard	No scent	Not very malleable Not brittle	Blue/yellow	No smoke - just melts
 Plastic wrap	Clear	Transparent	Soft	Plastic smell	Very malleable Not brittle	Blue/yellow	White
 Ice Cream Container	Plastic is white Labels have various colours	Translucent	Hard	Mild plastic smell - vanilla ice cream	Fairly malleable Not brittle	Yellow/orange	White
 Yogurt Container	Plastic is white Label have various colours	Opaque	Fairly hard	Smells like yogurt	More malleable than the ice cream container Not brittle	Yellow	Black

Learner Exemplar (Density)



Learner Name:

Plastic Sample	Solution A	Solution B	Solution C	Solution D	Relative Density Estimate
	sinks	sinks	sinks	sinks	greater than 1.16 g/mL
	sinks	sinks	floats	floats	between 0.93-1.00 g/mL
	sinks	sinks	sinks	sinks	greater than 1.16 g/mL
	sinks	floats	floats	floats	Between 0.91-0.93 g/mL
	floats	floats	floats	floats	lesser than 0.91 g/mL
	sinks	sinks	sinks	floats	between 1.00-1.16 g/mL