Plastics: Reduce Use or Recycle?

Topic
Plastics

Grades
6-8

Site
Indoors, Outdoors

Duration
45 minutes

Materials
see page 2

Vocabulary
disposable, fossil fuels, monomer, plastic, polymer, recycle, upcycle

Next Generation Science Standards

Practices
Asking questions and defining problems

Core Ideas
PS1.A Structure and properties of matter
ESS3.C Human impacts on Earth systems

Crosscutting Concepts
Structure and function

Performance Expectations
See page 4

Focus Question

How do we use plastics? Are there better or worse uses of plastics?

Overview

From contact lenses to medical tubing to single-use disposable yogurt containers, plastics are ubiquitous in our daily lives. But how wisely are we using these durable, versatile materials produced from fossil fuels - a nonrenewable resource? In this activity, students examine different kinds of plastics and investigate what happens after plastic objects are thrown in the recycling bin. They are also challenged to think about whether some of the ways we use plastics are better than others.

Objectives

Students will be able to:

- Observe and describe the physical and chemical properties that can be used to identify different types of plastics.
- Differentiate single-use plastics from other plastics.
- Examine society's use of plastics and recognize that plastic is made from a nonrenewable resource.

Background

In 2012, the United States generated almost 14 million tons of plastics as containers and packaging, about 11 million tons as durable goods such as appliances, and almost 7 million tons as nondurable goods, such as plates and cups. Only 9 percent of the total plastic waste generated in 2012 was recovered for recycling (www.epa.gov/osw/conserve/materials/plastics). Plastic is ubiquitous in our modern world. Plastic is used to make durable items like contact lenses, vehicle parts and electronics. It is also used to make items that are used just once like water bottles, plastic bags, straws and food containers. Plastic is lightweight, durable and relatively economical to manufacture. However, it does not biodegrade; instead it photodegrades into smaller and smaller pieces so it remains in the environment indefinitely. There is a high environmental cost to single-use, disposable plastic; wildlife ingestion and entanglement and habitat alteration are some of the side effects of discarded plastic. In addition, harmful human health effects have been linked to additives in plastics (phthalates and bisphenol A among others).

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VOCABULARY

Disposable: a product designed for single use after which it is recycled or disposed of in a landfill

Fossil fuels: the remains of plants and animals buried in the Earth's crust and heated and pressurized into crude oil, natural gas, coal and heavy oils

Monomer: a molecule that chemically binds to other molecules creating polymers

Plastic: an easily-shaped substance made from fossils fuels through chemical reactions

Polymer: a large molecule made up of monomers

Recycle: processing an existing material or product into a different material or product; uses energy and additional raw materials

Upcycle: processing an existing material or product into a higher quality material or product

Plastics are primarily synthetic polymers made with chemicals that are derived from nonrenewable fossil fuels, specifically petroleum or natural gas. There are thousands of different kinds of plastics. Plastics can be differentiated by certain chemical and physical properties. These properties are surface appearance, transparency, rigidity, density and flammability. The Society of the Plastics Industry developed identification codes for six of the most common types and a seventh that includes a number of different plastic types. These are the numbers located in what has come to be called the "recycling symbol" on plastic objects. It is a misconception that this identification code means the object can be recycled. The codes were developed to help recyclers differentiate between various kinds of plastic. Some plastics are cheaper and less energy intensive to recycle (numbers 1 and 2) while others often don't get recycled at all (number seven). Regardless, recycling is costly in terms of energy and other resources. It is much less costly, both economically and environmentally, to reduce the amount of plastic used. Every municipality and/or county is different in what it may or may not recycle. Contact your local waste management company for details on recycling in your community.

Materials

- Computer and projector
- Variety of clean plastic packaging and objects (enough for each student group to have 4-5 pieces)
- **Plastics: Reduce Use or Recycle** prezi (see link in procedure)
- **How We Use Plastics** cards (one set per student group)
- **Plastics: Reduce Use or Recycle** student sheet (one per student)
- **Types of Plastics** student sheet (one per student)

Teacher Preparation

1. A week before the lesson, ask students to bring in a variety of rinsed out plastic objects. Make sure you get a variety of resin identification codes (numbers on each object). Ideally, have five pieces per student group.
2. Make a set of **How We Use Plastics** cards (page 9 and 10) for each student group. You may want to laminate them for reuse with different classes.
3. Decide if you want copies of the **Types of Plastics** student sheet and **Plastics: Reduce Use or Recycle** student sheets or if you'll have them use their science notebooks.
4. Check the prezi link to make sure it works. Use the presentation notes on page 7 to run through the presentation before class.

Procedure

1. **IN SMALL GROUPS, STUDENTS WRITE DOWN EVERYTHING IN THE ROOM MADE OF PLASTIC.** Give students 30 seconds to write down everything in the room made of plastics. What kinds of objects are made of plastic? How are they used? Are they used multiple times or only once? Does the plastic all look the same? Feel the same? How many of the items in the room are made of plastic compared to other materials (wood, metal, glass)?

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2. **Introduce the focus question to the class.**
Share the question: *How do we use plastics? Are there better or worse uses of plastics?* You may write it up on the whiteboard or have students add it to their science notebook. Give students time to write their initial thoughts down or discuss with a partner.

3. **Students categorize illustrations of a variety of plastic items according to how we use them.**
Pass out a set of **How We Use Plastics** cards to every student group. Have them sort the cards into categories depending on how they are used. Depending on the level of the students, you may have them sort into "single-use" versus "multiple-use" or if they have more prior knowledge, "wise uses of plastics" versus "unwise uses of plastics." In their science notebooks, ask them to record the item, what category they placed it in and their reasoning. You may want to model creating a three-column table with "item," "single-use"/"multiple-use" or "wise"/"unwise" and "why."

4. **Students examine and differentiate a variety of plastic packaging.**
Pass out a variety of rinsed plastic packaging with different resin identification codes (RIC). Pose the question: how do we tell different kinds of plastics apart? Give students time to sort them into categories of different plastics. Then solicit ideas from the class on how to tell plastics apart (may range between use, color, number, etc.). Discuss the resin identification codes and how they are an industry code for differentiating plastics but that doesn't always mean the plastic objects are recycled.

5. **As a whole group, discuss the observable properties of different plastics.**
Pass out **Types of Plastics** student sheet. Have students examine the plastic objects and record the observable properties of different plastics. If time, you may challenge them to plan an investigation(s) to distinguish between plastic types. The physical and chemical differences can be found by examining surface appearance (smooth, glossy, rough), how light travels through the plastic (transparent, translucent, opaque), rigidity (or flexibility), density and flammability. If you have time, you may choose to do Plastics in the Water Column activity which explores density of plastics. (See **Resources**.)

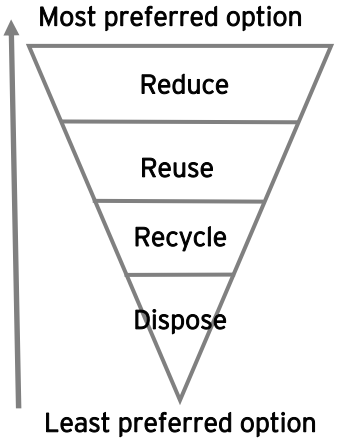
6. **Share the Plastics: Reduce Use or Recycle presentation.**
Challenge students to think about where plastics come from and how efficiently (in terms of energy and the environment) they are used while sharing the presentation at: http://prezi.com/dsxiusp6vh9a/plastics-reduce-use-or-recycle-2014. See page 8 for the presentation talking points.

7. **Students reassign illustrations of plastics into "wise" and "unwise" uses.**
Now that students understand that plastics are versatile yet also ultimately nonrenewable and resource-intensive to recycle, ask them to go back and reorganize illustrations of plastics into "wise" and "unwise" uses. Have them explain what they mean by "wise" and why they categorized each illustration as they did. Be sure they understand the difference between single-use disposable plastic and durable uses of plastics.

ONLY WE HUMANS MAKE WASTE NATURE CAN'T DIGEST.

CHARLES MOORE
ALGALITA MARINE RESEARCH FOUNDATION

Hierarchy of Waste Pyramid



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If you think you are too small to make a difference, try going to bed in a room with a mosquito.

African proverb

8. **As a class, discuss reducing and reusing versus recycling.**
   Ask your students about the "3Rs." Make sure they understand that there is an intentional order to them (reduce, reuse, and then recycle). Ask them to come up with ways to reduce and reuse plastic products that they typically recycle. Discuss which plastics their municipality recycles or if they don't know, brainstorm how to find out. You may even come up with sample questions to ask the local materials recovery facility (MRF) or waste management district.

9. **Return to the focus question.**
   Now that students have examined what plastic is and how we use plastic, have them revisit the question: *How do we use plastics? Are there better or worse uses of plastics?* Students may think on their own or discuss with a partner. Then in their science notebook, you may have them draw a line of learning and under it add to their original thoughts about the question.

Extensions

Have students investigate which plastic types are more commonly recycled where they live and develop tips about how to better assist the recycling process (compacting plastics, rinsing them, putting all plastic bags and film in a plastic bag, etc.). Then develop a communications campaign to educate your school, community or city.

Resources

Websites

California's Department of Resources Recycling and Recovery (Cal Recycle)
http://www.calrecycle.ca.gov/

5 Gyres Project
http://5gyres.org

Monterey Bay Aquarium's Plastics in the Water Column activity
http://www.montereybayaquarium.org/PDF_files/teaching_activities/Plastics_in_theWater_Column6-8.pdf

Society of the Plastics Industry
http://www.plasticsindustry.org

Story of Stuff: The Story of Bottled Water
http://storyofstuff.org/movies/story-of-bottled-water/

Recommended Books

Plastic: A Toxic Love Story. Freinkel, Susan. Houghton Mifflin Harcourt, 2011.
Plastic-Free: How I Kicked the Plastic Habit and You Can Too. Terry, Beth. Skyhorse Publishing Inc., 2012.

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References

Andrady, A.L. & Neal, M.A. 2009 *Applications and societal benefits of plastics*. Phil.Trans. R. Soc. B 364, 1977-1984

Plastics Recycling Primer. Moore Recycling Associates Inc: Recycling Implementation Specialists. June 2011. Prepared for the Maine State Planning Office. http://www.maine.gov/spo/recycle/docs/Plastics/PlasticsRecyclingPrimer.pdf

Standards

Next Generation Science Standards www.nextgenscience.org

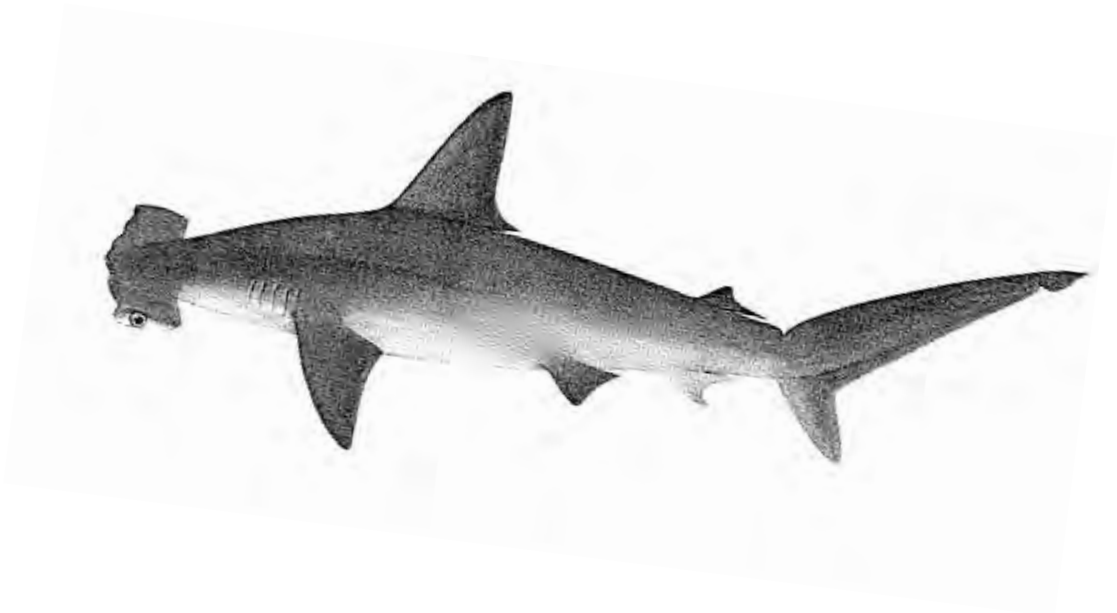
Performance Expectation

Supports MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Common Core State Standards www.corestandards.org

Language Arts, SL.6-8.1
Speaking and Listening: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly

THE MISSION OF THE MONTEREY BAY AQUARIUM IS TO INSPIRE CONSERVATION OF THE OCEANS.



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Name:

Plastics: Reduce Use or Recycle?

1. List as many objects made of plastic in this room as possible.

Item	Is it used multiple times?	Is it used once?	What alternative materials could it be made out of?

Discuss:

- What did you notice?
- How did the number of objects made of plastics compare to objects made with other materials (wood, glass, metal, etc.)?
- What is plastic?

2. Sort the illustrated cards into categories of how plastics are used. Explain the criteria you used.

3. After the plastics presentation, answer these questions in your science notebook or on a separate piece of paper.

- Is plastic a renewable or nonrenewable resource? Explain.
- Explain what the number on each piece of plastics means.
- How might you figure out what plastics your community recycles (or if they do at all)?
- How could you personally reduce the amount of plastic you use?
- Explain what you consider wise and unwise uses of plastic. What criteria are you using?

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Types of Plastics

Name:

Resin ID Code and Name	Types of Products	Properties: Surface Appearance (glossy, rough, smooth)	Properties: Rigidity (rigid, semi-rigid, flexible)	Properties: Transparency (transparent, translucent, opaque)	Properties: Density (sinks, floats, neutrally buoyant in fresh water)	Ways to Reduce Use
1 **PETE** Polyethylene terephthalate						
2 **HDPE** High-density polyethylene						
3 **PVC** Polyvinyl chloride						
4 **LDPE** Low-density polyethylene						
5 **PP** Polypropylene						
6 **PS** Polystyrene (two kinds)						
7 **Other** Many kinds						

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Plastics: Reduce Use or Recycle?
Presentation Notes, Part One

Frame 2: Think-pair-share: What is plastic? Where does it come from?

Frame 3: Plastics are made using fossil fuels. Some are made using liquid petroleum and some are made using liquid natural gas. These fuels are what we use to power our cars and houses. Fossil fuels are a nonrenewable resource.

Frame 5: Plastics don't biodegrade because during the manufacturing process, extreme temperatures in the presence of a catalyst link smaller molecules together to create strong bonds within large chainlike molecules called polymers. Organisms in nature don't recognize the bonds created (not in all polymers, just in petroleum-derived plastics) and thus can't break them down. See http://www.livescience.com/33085-petroleum-derived-plastic-non-biodegradable.html These chainlike molecules also make plastics strong and versatile.

Frame 6: Show the educreations animations depicting how monomers link to make polymers. Note: Students may not recognize molecular models yet.

Frame 7: There are thousands of different resins, or plastics. The plastics industry stamped the number on the bottom (a resin ID code) to quickly be able to distinguish broad groups. If you didn't have those numbers, you can tell plastics apart using the physical and chemical properties that students observed earlier: surface appearance (smooth, glossy, rough), how light travels through the plastic (transparent, translucent, opaque), rigidity (or flexibility), density and flammability. You may want to hold up plastic objects to point out these characteristics.

Frame 8: *Show the resin codes - ask which code they think soda bottles have (1) or iPhone cases (7) Show real examples of plastics with different resin codes.*
These are the resin identification codes (#1-7). Certain numbers are more often recovered for recycling than others. For examples, #1 and #2 are more often recovered. This has to do with infrastructure (factories and processing plants) as well as the chemical/physical properties of the plastic. And even though water bottles are often #1s and are more often recycled, additional materials/resources need to be added during the recycling process to make a new water bottle. Some plastics like the mix of #7 are often never recycled. In the U.S., only 8% of plastics used are actually recycled. *Think-Pair-Share: If only 8% gets recycled where does the rest go?*

Frame 9: The cost of disposable plastic to environmental health is enormous. Have you ever seen plastic waste on the beach? *Note to teacher: you may want to Google image search ocean plastic entanglement to show the breadth of the issue*. Animals may become entangled in the debris or even ingest it. They may also use it as unnatural habitat. This waterway is down near Los Angeles.

Frame 10: This video shows how turtles can mistake plastics for food.

Continued on next page...

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Plastics: Reduce Use or Recycle?
Presentation Notes, Part Two

Frame 11: Ask students: When you recycle something, what do you think it comes back as? Recycling plastics are better than not recycling. But it's best to REDUCE our use of plastics by using less. Recycling has quite an economic cost. Many material recovery facilities (landfills, waste management agencies, etc.) in the U.S. ship our plastics to other places like China where they process the plastics and turn them into other items (like plastic yarn used in astro turf, lawn furniture and/or many other objects. Where is your waste management facility? Does your city use single-stream recycling or multiple-stream recycling? Single stream means you put all glass, plastics, paper, aluminum into one bin and it's sorted at the facility. Multiple stream means families and businesses sort the recycling into different bins before it's picked up.

Frame 12: *Think-Pair-Share: How do you think plastic is recycled? What process might it go through?* Show the video of the plastic bag recycling center. It takes a lot of energy to recycle. Again a good idea to use less especially when it comes to single-use disposable plastics.

Frame 13: So to recap, plastics are made from nonrenewable resources (fossil fuels), they cannot biodegrade and thus remain in the environment indefinitely, they are strong and versatile, they can be recycled but recycling uses a lot of energy and often additional plastic needs to be added to the process, only 8% of plastics in the U.S. are recycled and some of the rest ends up in the ocean and waterways. *Think-pair-share: so how can we use plastic more wisely*? Pack reusable utensils and containers for snacks, ask for no straw, reusable bags and water bottles, etc. It's important to use less disposable plastic. Why use something made to last forever, only once?

Frame 14: There are many people, including youth/students raising awareness about the amount of single-use plastic we use. This is Milo Cress speaking at the Monterey Bay Aquarium (photo on left) about his Be Straw Free campaign. He has asked restaurant staff to ask people if they want a straw, before automatically putting one in a drink. The photo on the right is a school group who educated their school about single-use plastics and actually reduced the amount of disposable water bottles used at their school. *Think-Pair-Share: What is one thing you could do to use less plastic?*

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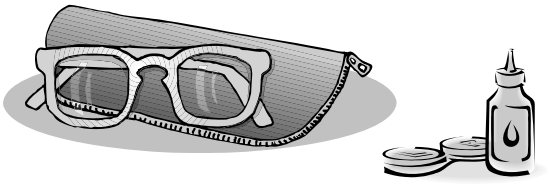
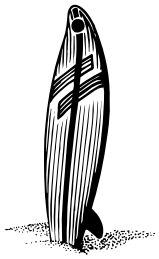
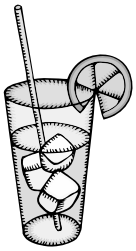
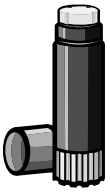
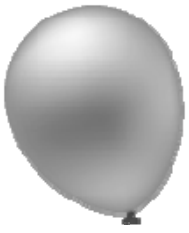
How Do We Use Plastics?

Glasses/Contact Lenses 	Fleece Sweatshirt/Jacket 
Surfboard 	Grocery Bag 
Straw 	Cell Phone 
Pen 	Lip Balm/Lip Gloss 
Toy 	Balloon 

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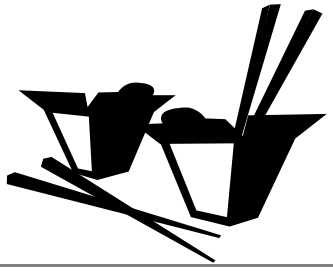
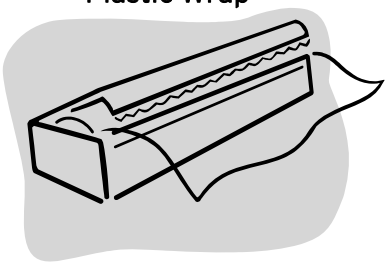
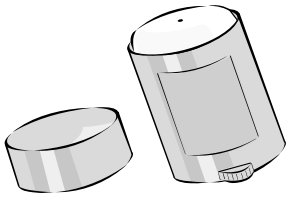
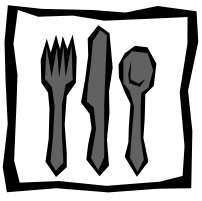
How Do We Use Plastics?

Vehicles 	Take Out/Left Over Containers 
Plastic Wrap 	Yogurt Cup 
Cleaning Products 	Pacifier 
Child Car Seat 	Single-serving Chip Bag 
Deodorant/Body Spray 	Plastic Dinnerware 

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