Tires Shouldn't Retire

GRADES 9-12

ISRI
Voice of the Recycling Industry

JASON Learning

PREPARE:

Time Required: 2 class periods (90 minutes) without extensions

- Gather materials (see activity pages).
- Divide students into groups of 3-4.
- Make copies of Tires Shouldn't Retire student data sheet.
- Provide a wide rubber band and ruler for each group.
- Confirm no students have latex allergies.
- Review safety precautions.
- Dilute liquid latex (add 400 mL H2O to 600 mL latex and mix well).
- Confirm students will have access to computers and internet.

Note: Liquid Latex is used for special effects make up and can be purchased at party stores.

MOTIVATE:

- Give each group of students a large rubber band that has been cut so it can lay flat.
- Ask them to make qualitative and quantitative observations as they examine the rubber band.
- As a class, discuss the following questions: How far can the rubber band stretch? Does it stretch in both directions, down its length and across its width? (primarily along the length)
- Ask one student in each group to hold the rubber band to their lips and stretch it. Do you feel a temperature change? (stretching is exothermic so it should feel slightly warm)
- What do your observations suggest about the molecular structure of rubber? (maybe the molecules are long and parallel)
- Show images of rubber trees and the molecular structure of natural vs. synthetic rubber.

TEACH:

- Natural rubber is an organic elastomer, with many properties that seem counterintuitive upon first examination. As students explore and model the molecular structure of rubber, they will begin to understand how important the product is to industry and everyday life. In this activity, students move from qualitative observations of the properties of rubber to the creation of a rubber product. They will then extend their understanding of the importance of rubber by reading a passage on the history of rubber and the production of rubber tires.
- Conduct activity with students (see activity pages) to make a rubber product from liquid latex.

- After students have done the bounce test, have them place the rubber ball back in the baggy to be put in the trash can. Balls should not leave the room in case other students in the school have latex allergies.
- Have students read the passage Rubber Now and Then, and discuss questions

REFLECT/ASSESS

Students should be able to:

1. Compare and contrast the properties of natural and vulcanized rubber.
2. Describe what characteristics of rubber molecules are related to its unique properties.
3. Evaluate the importance of recycling tires in an environmentally responsible way (making sure they do not end in landfills).

EXTEND

It's likely that an area close to the school site uses recycled tires for paving, track surfaces or a surface for recreation. Have students find such a surface and create a poster on the theme: "Do you know where this surface came from?" Students should trace the rubber from its origin in the rainforest to its final recycled use.

JOURNAL QUESTION

Manufacturers are enthusiastic about the potential for even greater and better uses for the scrap rubber from tires. Have students imagine what some of those new uses might be, and describe the properties that make it rubber ideal for those purposes.

WEBLINKS

Hevea brasiliensis (rubber tree) images	https://commons.wikimedia.org/wiki/Category:Hevea_brasiliensis
Molecular structure of natural vs. synthetic rubber	https://en.wikipedia.org/wiki/File:RubberSyn%26Natural.png

Tires Shouldn't Retire

Background

The special properties of latex rubber make it ideal for many purposes, including automobile tires. Natural rubber (sometimes called caoutchouc) is an elastic hydrocarbon polymer. Its long polymer molecules are much like "loose pieces of rope." They stretch and fold. When rubber is stretched the long molecules can no longer vibrate, so their extra energy is released as heat. Stretching rubber is therefore exothermic while contraction is endothermic. Chemists often compare the molecular model of rubber to the model of a gas, considering it a one-dimensional gas.

Natural rubber (latex) comes from the sap of tropical trees. Even though synthetic rubber can now be produced, the natural form still comprises about 45 percent of the rubber we use and some of the raw material for automobile tires. Growing rubber trees places strains on tropical environments. The tree lives for about 32 years, using a great deal of water and nutrients especially during the seasons when water is scarce. In many regions of the world where rubber trees are grown they are suffering droughts due to climate change. Re-using the rubber we harvest takes on added importance.

When rubber first became available to upper class Europeans in the 18th Century it was an instant fad. But rubber boots tended to become hopelessly soft in the summer sun and brittle in winter heat. To make natural rubber more durable and less sensitive to temperature changes, it is vulcanized—a process invented by Charles Goodyear in 1839. This process changes the sulfur bonds between rubber's long molecules and improves its resistance and elasticity in lower temperatures. It then becomes a thermoset material. Carbon black is often added to improve its strength in tires.

About 21 percent of today's passenger tires are made from natural rubber. Synthetic rubber represents 27 percent and carbon black 28 percent. Because tires are not only rubber but contain steel belts, they must be processed for recycling. There are two main ways to do this. The tires can be frozen (cryogenics) to separate out the rubber. Another method is called ambient grinding. The difference in the two processes is that cryogenics produces a rubber particle that has a smooth surface area and ambient grinding produces a rough surface area. Each process has specific uses in the industry, although ambient grinding is used more often.

Answers to Reflect and Apply

1. How are the properties of natural and vulcanized rubber different? **Natural rubber is thermoplastic; Vulcanized rubber is thermoset.**
2. What characteristics of rubber molecules are related to its unique properties? **Long organic molecules can slide past one another unless set by sulfur bonds.**
3. Why is it important to make sure that tires do not end in landfills? **The material is valuable, resilient and comes from fragile natural environments.**

Tires Shouldn't Retire

Think for a moment about all of the things we use that contain rubber, from balloons to toys, to the tires on our cars. Where does rubber come from and what are its unique properties? In this activity, you will move from qualitative observations of the properties of rubber to the creation of a rubber product. Finally, you will explore the history of rubber and the production of rubber tires, from rainforest to road, and consider the value of recycling.

Materials

- 15 mL of dilute liquid latex
- Graduated cylinder
- Paper coffee cup for each group
- Paper towels
- Eye protection for each student
- Vinyl or latex gloves
- Lab coats
- Stirring spoon
- Dropper bottle of dilute HCl or vinegar for each group
- Sandwich baggie for each group
- Meter stick for each group

Part 1: Make Rubber

1. Put on your eye protection, gloves, and lab coats. Caution: Liquid latex contains ammonia, a base. It is caustic. Do not handle it.
2. Put 15 mL of dilute latex in your cup.
3. Add a few drops of acid to the latex and stir. Observe the mixture and try to shape it into a ball. If it does not appear firm enough, add a few more drops of acid and continue to stir.
4. When the latex is malleable, like dough, put it into a plastic bag and squeeze out excess water.
5. When the ball has become firm, wipe and dry the outside with paper towel.
6. Test the "bounciness" or elasticity
   A. Drop it from a height of one meter (Don't throw it; just let it fall).
   B. Record the height of the ball's first bounce.
   C. Repeat the drop several times. Does the height of the bounce change? Can you explain why or why not?
7. Dispose of the rubber according to the teacher's instructions.

Part 2: The History, Chemistry and Future of Rubber

Read the passage *Rubber Then and Now*

Reflect and Apply

- How are the properties of natural and vulcanized rubber different?
- What characteristics of rubber molecules are related to its unique properties?
- Why is it important to make sure that tires do not end in landfills?

Extensions

Find out more about how tires are recycled and re-used. What kinds of products are made from recycled tires?

It's likely that an area close to the school site uses recycled tires for paving, track surfaces or a surface for recreation. Find such a surface and create a poster on the theme: "Do you know where this surface came from?" Be sure to trace the rubber from its origin in the rainforest to its final recycled use..

JOURNAL QUESTION

Manufacturers are enthusiastic about the potential for even greater and better uses for the scrap rubber from tires. Describe what some of those potential uses for rubber might be and how its properties make it ideal for those purposes.

Rubber Then and Now

When rubber was first brought from the Amazon to Spain in the 1520s there was no word for “bounce.” Balls and ball-players from the Amazon toured Europe to the amazement of their audiences. They, of course, had been using rubber for centuries. They slashed the trunks of trees, boiled the milky sap and stretched it over the fire. Native Americans used it for tobacco pipes and dishes, waterproofed their clothing and played with the elastic substance.

In 1825, some hundred pairs of rubber boots were imported to Massachusetts. A decade later, hundreds of thousands had been sold. But the rubber wasn’t very practical; it melted in the heat and cracked in the cold. In 1839, Charles Goodyear in- vented the process of vulcanization—a chemical change in rubber’s long polymer molecules caused by heating—which set the rubber and made it durable enough for use in long-lasting products and inevitably, in car tires. This process changes the sulfur bonds between rubber’s long molecules and improves its resistance and elasticity in lower temperatures. Goodyear never made any money from his invention, but an Englishman, Thomas Hancock, patented it in 1944 and the rest is history.

Once native only to the Amazon, rubber trees are now found in many tropical Asian countries. They occupy environments that were once rainforests, using a great deal of water and nutrients. The industry needed to cultivate, harvest and process the rubber creates challenges to the fragile environments that surround the rubber plantations.

While synthetic rubber is now available for many purposes that once required natural rubber, it isn’t ideal for automobile tires. Of the natural rubber produced in the world about 45 percent is used for vehicle tires. A tire is carefully engineered, not only of rubber, but with steel or nylon belts and chains. Each year, Americans alone generate about 100 million scrap tires, with more than 90 percent being recycled or reused. Some still end up in fields, lakes, and landfills. Scrap rubber from tires is invaluable. Once shredded and ground under very cold conditions, it is used for creating the surfaces on which vehicles and people move, like roads, tracks and playgrounds. It takes almost 1,000 tires per lane/mile to make a road of rubberized asphalt. The metal in old tires is also recyclable.

Manufacturers are enthusiastic about the potential for even more and better uses for scrap rubber from tires. The biggest challenge is to help people appreciate the value of natural vulcanized rubber and to make sure that once harvested, tires never “retire.”