Polymer Activity from the:

Latex Balls

Grades: 6-8 and 9-12

Subtitles:

Making a Latex Ball
Making Three Latex Balls with Additives
Bounce Testing the Balls
3-2-1 Blast Off!
Be Cool to Your School!
Hot Latex Balls!

Science Standards: Content Standard A: Science as Inquiry; Content Standard B: Physical Science; Content Standard G: History and Nature of Science;

Concept and History: Latex is a milky-white sap of the rubber tree. The name rubber is attributed to the English chemist, Joseph Priestly, who discovered in 1770 that the material could rub out pencil marks and thus the name rubber was coined. Originally the rubber tree was known only in the Amazon Valley of Brazil, but an amateur British botanist introduced seeds of the tree to Malaysian plantations in the late 1870's. In total there are about 18,000 species of latex-producing plants, but only a few species are actually being used. Today over 85% of all natural rubber comes from the Far East and over 99% of all the world's natural rubber supply comes from a single species and it is known as the rubber tree (*Hevea brasiliensis*). The consistency of latex is around 35% pure rubber, over 60% water, with the remainder being proteins.

Prior to 1839 rubber products were not widely used because it was hard to process. Latex needed to be processed within hours of obtaining it from the tree as, once the rubber congealed, there was no means to return it to the liquid state. In addition, it became sticky in hot weather and stiff in cold weather. However Charles Goodyear changed that with an accidental discovery. By spilling a sulfur-rubber mixture on a hot stove, the compound was "cured" as a result of the heat. The process was called vulcanization in honor of Vulcan, the god of fire.

This activity called "Latex Balls" is designed to investigate how elastic materials store energy and how that energy can be converted from the potential (stored state) to the kinetic (active state). Manufacturers place additives in polymer formulations to change the physical properties of the polymer. Students will investigate how the following additives change the physical properties of latex: calcium carbonate, talc, and polyacrylamide. Also to be investigated is the relationship that temperature has upon the bounce of the ball. Historically, the relationship between the bounce of a ball and temperature is legendary. In its infancy professional baseball managers would alter the bounce effect of baseballs by either freezing them or placing them in the oven several hours before the visiting team arrived. Depending upon which team had the greater amount of home-run hitters, the manager would either heat or freeze the baseballs to give his team a decided advantage. We can test how temperature affects the physical characteristics of our latex balls and by doing these tests and we can see what the manager would have done if the 1926 New York Yankees came to town.

Safety:

Liquid latex is packaged in ammonia which acts as a preservative, Neutralization with vinegar (acetic acid) will cause the latex to solidify into rubber very quickly. Latex may be purchased from Flinn Scientific (800-452-1261) with catalog # L0004 for 500 mL. The ammonia and vinegar have irritating fumes. Latex is not considered hazardous. People with a latex allergy should not do this laboratory. Goggles must be worn at all times.

Note: "Mold Builder" from Michael's may also be used for these balls. It is $11 for 473 mL. This is thicker so one must make sure the vinegar penetrates all the latex to make the ball the maximum size possible.

Materials for making four latex balls: (per group)

20 mL liquid latex x 4 = 80 mL
20 mL vinegar x 4 = 80 mL
three 3 oz Solo plastic cups
3 Popsicle sticks
goggles
ruler and permanent marker
2 teaspoons of calcium carbonate
2 teaspoons of talc
1 teaspoon of Soil Moist or
polyacrylamide crystals

Procedure for making plain a latex ball:

1. Using a ruler and marker, make a mark on the side of the plastic cup at the 1.4 cm mark and one at the 2.7 cm mark. These are measurements from the bottom of the cup. These are equivalent to 20 mL of liquid and 40 mL of liquid.
2. Add 20 mL of latex to the cup.
3. Add 20 mL of vinegar to the same cup. Stir with the Popsicle stick.
4. Quickly remove the congealed latex blob with your fingers and mold it into a ball.
5. It will be necessary to wash the ball in a sink with the water running or in a tub of water. While you wash the ball, squeeze out any excess water from the latex ball and any bubbles of trapped vinegar inside the ball. Make sure you are wearing the chemical splash goggles to avoid the possibility of vinegar coming into contact with the eye.
6. After drying the ball with a paper towel, test its bounce (or conversion from potential to kinetic energy) by dropping your ball from the heights. See the next procedure.

Procedure for making latex balls with additives:

1. Use the same marked cup and stick as used to make the plain latex ball.
2. Rinse the cup with water.
3. Add 20 mL of latex and add 2 teaspoons of calcium carbonate.
4. Stir with the stick.
5. Add 20 mL of vinegar to the same cup. Stir with the stick.
6. Quickly remove the congealed latex blob with your fingers and mold it into a ball.
7. It will be necessary to wash the ball in a sink with the water running or in a tub of water. While you wash the ball, squeeze out any excess water from the latex ball and any bubbles of trapped vinegar inside the ball. Make sure you are wearing the chemical splash goggles to avoid the possibility of vinegar coming into contact with the eye.
8. After drying the ball with a paper towel, test its bounce (or conversion from potential to kinetic energy) by dropping your ball from the heights. See the next procedure.
9. For the Talc additive, repeat steps 1-8.
10. For the Soil Moist (polyacrylamide) - Put 1 teaspoon into a clean cup. Add 40 mL of vinegar. Wait for 5 min for the crystals to swell. In another clean cup, add 20 mL of latex. Add the vinegar and crystals to the latex. Stir with the stick and mold with your hands.
11. Using a permanent marker, label the four balls with your initials and kind of ball.

Materials for testing the balls:

Latex balls made in the above procedures
Meter stick

Procedure for testing the latex balls:

1. After drying a ball with a paper towel, test its bounce (or conversion from potential to kinetic energy) by dropping your ball from the heights recorded in Data Table 1.
2. Tape a meter stick to a wall, table, or other object so that it is perpendicular to the floor. The "zero" end of the meter stick should be in contact with the floor.
3. Working in pairs, one student should hold their ball so that the bottom of the ball is 30 cm. above the floor. The second student should be on the floor so that he/she is able to measure how high the ball bounces back up, or rebounds, after it is dropped. The measurement should be made from the bottom of the ball.
4. Drop (DO NOT throw) the ball from the 30 cm height. Record the height of the rebound in the data table. Since it is hard to judge exactly how high the ball bounces, repeat this test three times and take an average of your measurements.
5. Repeat the drop tests at 60 and 90 cm drop tests on a soft surface such as foam rubber and record your results. Note: The meter stick should be adjusted so that the "zero" end is resting against the top of the foam surface.

6. Drop the ball from shoulder height again. This time count the number of times the ball bounces. Note whether the ball returns to the same height after each bounce.
7. Repeat these steps for the other three balls.

Data Table 1:

Type of Ball	Bounce Height from 30 cm	Bounce Height from 60 cm	Bounce Height from 90 cm	Number of times ball bounces from shoulder height
Pure Latex Ball	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.
Latex + calcium carbonate	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.
Latex + Talc	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.
Latex + Soil Moist	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.

Teacher Notes:

When a ball like a tennis ball strikes the floor, the force of the impact flattens the ball slightly and then bounces off the floor because of its elastic force. The ball is literally pushing itself up from the floor. The energy produced from this collision of the floor and the ball is a direct result of the ball returning to its original shape. This ball because of its consistent roundness tends to bounce very straight and flattens evenly.

With the student made latex balls, the results are very much different. The student made ball does not flatten evenly because of its irregular and somewhat bumpy shape. Because of the inconsistency of the shape it is more likely to bounce irregularly and will not be anything close to a straight bounce. Because it is more likely to bounce at an angle, it might be better dubbed as a "Crazy Ball".

Materials for 3-2-1 Blast Off!

Latex balls made in the above procedure
Basketball or soccer ball
Chemical splash goggles

Procedure for 3-2-1 Blast Off!:

1. Launch your latex ball by bouncing it against a basketball or soccer ball. Because this activity can cause your latex ball to literally blast off, it is recommended that chemical splash goggles are worn and that the activity be done outdoors.
2. Hold the basketball in your throwing hand and the latex rubber ball in the other hand.
3. Toss your latex rubber ball up several feet into the air.
4. When your latex rubber ball is on its way down, toss the basketball up so that it hits the latex ball on its descent. What happens?
5. Reverse the process by throwing the basketball up first and the latex ball second. What happens?

Teacher Notes:

When one tosses the basketball at the latex ball, the latex ball literally blasts off into the air. This is because the basketball has more mass than the latex ball. It is actually easier to move objects of less mass than objects of greater mass. What happens in the reverse process? Well, the latex rubber ball is again affected, but with a downward flight. The flight of the basketball is barely affected by collision from the latex ball.

Materials for Be Cool to Your School!:

Latex balls
Freezer or ice chest full of ice
Meter stick

Procedure for Be Cool to Your School!:

1. Place latex balls in either the freezer compartment of a school or home refrigerator. If a freezer is not available, a Styrofoam ice chest with ice could also be used.
2. Tape a meter stick to a wall, table, or other object so that it is perpendicular to the floor. The "zero" end of the meter stick should be in contact with the floor.
3. Working in pairs, one student should hold their ball so that the bottom of the ball is 30 cm. above the floor. The second student should be on the floor so that he/she is able to measure how high the ball bounces back up, or rebounds, after it is dropped. The measurement should be made from the bottom of the ball.
4. Drop (DO NOT throw) the ball from the 30 cm height. Record the height of the rebound in the Data Table 2. Since it is hard to judge exactly how high the ball bounces, repeat this test three times and take an average of your measurements.
5. Repeat the drop tests at 60 and 90 cm drop tests on a soft surface such as foam rubber and record your results. Note: the meter stick should be adjusted so that the "zero" end is resting against the top of the foam surface.
6. Drop the ball from shoulder height again. This time count the number of times the ball bounces. Note whether the ball returns to the same height after each bounce.

Data Table 2 Be Cool To Your School!:

Type of Ball	Bounce Height from 30 cm	Bounce Height from 60 cm	Bounce Height from 90 cm	Number of times ball bounces from shoulder height
Pure Latex Ball	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.
Latex + calcium carbonate	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.
Latex + Talc	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.
Latex + Soil Moist	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.

Materials for Hot Latex Balls!:

Latex balls
Pan or Pyrex® glassware
Hotplate
Tongs

Procedure for Hot Latex Balls!:

1. Place latex balls made in a pan of water and allow to simmer for 10 minutes.
2. Using the tongs, extract one latex ball from the boiling water.
2. Tape a meter stick to a wall, table, or other object so that it is perpendicular to the floor. The "zero" end of the meter stick should be in contact with the floor.
3. Working in pairs, one student should hold their ball with the tongs so that the bottom of the ball is 30 cm above the floor. The second student should be on the floor so that he/she is able to measure how high the ball bounces back up, or rebounds, after it is dropped. The measurement should be made from the bottom of the ball.

4. Drop (DO NOT throw) the ball from the 30 cm height. Record the height of the rebound in the Data Table 3. Since it is hard to judge exactly how high the ball bounces, repeat this test three times and take an average of your measurements.
5. Repeat the drop tests at 60 and 90 cm drop tests on a soft surface such as foam rubber and record your results. Note: the meter stick should be adjusted so that the "zero" end is resting against the top of the foam surface.
6. Drop the ball from shoulder height again. This time count the number of times the ball bounces. Note whether the ball returns to the same height after each bounce.

Data Table 3 Hot Latex Balls!:

Type of Ball	**Bounce Height from 30 cm**	**Bounce Height from 60 cm**	**Bounce Height from 90 cm**	**Number of times ball bounces from shoulder height**
Pure Latex Ball	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.
Latex + calcium carbonate	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.
Latex + Talc	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.
Latex + Soil Moist	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	AVE.	AVE.	AVE.	AVE.

Written by Wayne Goates, Kansas Polymer Ambassador, and Mary Harris, Missouri Polymer Ambassador.
Contributed ideas from Lynn Higgins, Illinois Polymer Ambassador