WONDERS OF POLYMER SCIENCE

Patch Requirements

(Daisies, Brownies, Juniors)

SPE FOUNDATION

PLASTICS ARE *EVERYWHERE*

SPE INSPIRING PLASTICS PROFESSIONALS

OUTCOME:

Participants will understand that plastics are everywhere—in most facets of life, that plastics are moldable, and the difference between natural and synthetic plastic.

SUPPLIES: Paper, pencil

ACTIVITY:

- Watch *Plastics Are Everywhere* video.
- Find 10 different plastic things in your home, school, or troop meeting location that you use every day.
- Discuss with your troop whether these products could be reused in a different way or recycled at the end of their life.

FOR THE TROOP LEADER:

Natural polymers are bio-degradable, meaning they naturally decompose over time. Most synthetic polymers do not decompose, so recycling these polymers is important. Recycling uses mechanical processes to separate plastic types, grind the plastic, and eventually remelt and remold it into a new shape. For hard to recycle plastics, modern technology can also use chemical processes to break the polymer bonds, creating high value monomers which can then be reused. Although some types of plastic products present challenges to the environment, many plastic products are essential to modern society in food packaging, medical applications, and consumer products.

ROY G BIV

OUTCOME:

Participants will understand basic color theory with primary and secondary colors, and the role of color in the manufacturing of plastic.

SUPPLIES: Color paddles*, color wheel*, paint, paint brushes, construction paper, scissors, glue

ACTIVITY:

- Watch the ROY G BIV video
- Color mixing: Red + yellow = orange; blue + red = purple; yellow + blue = green. Use a color wheel to help you with your choices.
- Combine colors with color paddles*.
- Make a color wheel with paint or construction paper. If using construction paper cut triangles to fit this color wheel template and create your own color wheel.
- Make color equations with paint or construction paper.

* These items are in the *Color Your World with Polymer Science* kit that can be obtained through your council.

POLYMER *STRUCTURES*

INSPIRING PLASTICS PROFESSIONALS

OUTCOME:
Participants will understand the structure of polymers.

SUPPLIES: construction paper in strips, scissors, stapler, glue

ACTIVITY:

- Watch *Polymeric Structures* video (Lower levels watch video until 2.20 minutes).
- Create models of polymer structures (paper or human chains).

PROCEDURE:

Human Polymer chain model: Each participant represents a monomer. Hold hands to form a single straight polymer. Have the girls move around the room as a polymer. Now create two parallel polymer lines. Crosslink the polymer by asking 2-3 girls to connect the two lines by holding hands (think of an "H" formation). Have the girls move around the room again. Is it easier to move around the room as a single polymer or as a crosslinked polymer?

Paper Chain Polymer model: Each paper loop is a monomer. Connect them in a single chain to make a polymer. Move the polymer chain around and notice how easily it moves. Crosslink the polymer by taking two single lines and attaching one or two links between the lines (think of an "H" formation). Move it around. Notice how it is more difficult to move the crosslinked polymer.

FOR THE TROOP LEADER:

The smaller molecules that come together to form polymers are called monomers. Think of monomers like paper clips that link together to form a polymer chain. Polymers are many monomers linked together in chains of 50k to 500k monomers long.

FIRST
PLASTICS

INSPIRING PLASTICS PROFESSIONALS

OUTCOME:

Participants will synthesize an example of a first plastic (casein) and understand the role plastics play in society today.

SUPPLIES: Milk, vinegar, food coloring*, popsicle stick, heat resistance cup, slotted spoon, large container (or sink) that will fit the strainer, paper towels, examples of colorful plastics (toys, buttons, kitchen items, colorful packaging e.g., laundry detergent bottles).

ACTIVITY:

- Watch *The First Plastics* video to 5:32 minutes.
- Make casein (Milk Plastic). Color the casein with food coloring. Use the color wheel for making choices.

PROCEDURE:

- Add 1-3 drops of food coloring to a mug.
- Add 1 cup of hot milk (not boiling) in a heat resistance cup.
- Add 4 teaspoons of white vinegar to the cup.
- Mix slowly with a spoon for a few seconds.
- Stack layers of paper towels on a hard surface that will not be damaged if it gets damp.
- Allow the milk and vinegar mixture to cool then use a slotted spoon to scoop out the curds.

PROCEDURE (cont.):

- Fold the edges of the paper towel stack over the curds and press down on them to absorb excess liquid. Use extra paper towels if needed to soak up the remaining moisture.
- Knead all the curds together into a ball, as if it were dough. What you have in your hands is a casein plastic.
- If you want to use the casein plastic to make something, shape or mold it by hand or use cookie cutters within an hour of making the plastic dough then leave it to dry on paper towels for at least 48 hours. Once it has dried, the casein plastic will be hard.

FIRST *PLASTICS*

FOR THE TROOP LEADER:

The word plastic is used to describe a material that can be molded into many shapes. Plastics do not all look or feel the same. Think of a plastic grocery bag, a plastic doll or action figure, a plastic lunch box, or a disposable plastic water bottle. They are all made of plastic, but they look and feel different. Why? Their similarities and differences come from the different molecules that they are made of.

Plastics are similar because they are all made up of molecules, called monomers, which are repeated in a chain. The chain-like structures of monomers linked together are called polymers and all plastics are made from polymers. Sometimes polymers are chains of just one type of molecule. In other cases, polymers are chains of different types of molecules that link together in a regular pattern.

Milk contains molecules of a protein called casein (pronounced "kay-seen"). When you heat milk and add an acid (in our case vinegar), the casein molecules unfold and reorganize into a long chain. Each casein molecule is a monomer and the polymer you make is made up of many casein monomers hooked together in a repeating pattern. The polymer can be scooped up and molded, which is why it is a plastic.
The plastic you make will be crumblier and more fragile than Erinoid plastic. That is because the companies that made those casein plastics included a second step. They washed the plastic in a harsh chemical called formaldehyde. The formaldehyde helped harden the plastic. Although you will not use formaldehyde because it is too dangerous to work with at home, you will still be able to mold the unwashed casein plastic you make. Try shaping it, molding it, or dyeing it to make beads, figures, or ornaments. Casein is an example of a biodegradable plastic.

* These items are in the *Color Your World with Polymer Science* kit that can be obtained through your council.

SLIME!

OUTCOME:

Participants will understand that slime is a crosslinked polymer and the properties of a non-Newtonian fluid.

SUPPLIES: Elmer's clear glue (diluted 50:50 with water), powdered Borax for cross linking (find it at the grocery store in the laundry aisle), measuring spoons, plastic cups, water, food coloring*, small plastic "snack" bags

ACTIVITY:

- Watch the *Slime* video to:
  - 2:43 to make the traditional slime
  - 3:58 to make a slime variation
  - 5:19 for the viscosity race
- Make Slime

PROCEDURE:

- To make 4% Sodium Borate solution: Dissolve 1 Tbsp of *20 Mule Team* borax powder into 2 ⅔ cups warm water.
- To make 50% Elmer's glue solution: Combine 3 cups Elmer's glue with 3 cups water. Stir until mixed.
- Color the diluted clear or white glue with food coloring making red, blue, and yellow.
- Condiment bottles work very well to squeeze the liquids into Ziploc bags. **The ratio of glue to borax solution is 2:1.** You can eye-ball the amounts needed or mark the corner of the bag for pre-measuring. Mix the glue and food coloring first to create the desired colors, then mix (crosslink) it with borax solution, in the bag, to make slime. Using the color wheel, you can figure out how to make any color.

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SLIME!

INSPIRING PLASTICS PROFESSIONALS

FOR THE TROOP LEADER:

When "stirring" the slime, ask participants if it feels cool or warm. (cool). Discuss that this is an example of an endothermic reaction—one that takes 'in' heat. An endothermic reaction absorbs energy (heat) instead of giving off energy (heat). An endothermic reaction feels cool because the reaction pulls heat from your finger into the slime. An exothermic reaction would feel warm/hot to the touch.

WHAT IS A NON-NEWTONIAN FLUID?

Pressure-sensitive substances, like slime (and silly putty and quicksand) are non-Newtonian fluids. In a non-Newtonian fluid, viscosity can change when under force to either more liquid or more solid.

Often a substance changes its state because of a change of temperature—like freezing water to make a solid ice cube or boiling water to make steam which is a gas. But this simple mixture shows how changes in force, and the rate it's applied, can also change the properties of some substances.

The slime will behave differently depending on the amount and speed of force applied. Let it sit on a surface or in a cup or bag and observe how it slowly moves like a super thick fluid. Roll the slime into a ball and drop it from about 20 inches on a hard surface and observe how it behaves like a bouncy solid.

When pressure is applied quickly to a non-Newtonian fluid (like when you hit it or drop it) it increases the thickness (or viscosity). A fast tap on the top of the slime and it feels hard, but if you press your finger in slowly the mixture is fluid. Moving quickly forces the molecules together, without giving them time to move apart. Moving slowly allows time for the molecules to move out of the way.

Explain force to younger participants with this activity: Have each person make a small sign that says "BIG" and another sign that says "LITTLE". Then play "Big or Little Force?" with them. The troop leader asks if slamming a door is a big or little force? What about quietly closing a door? Are hiccups big or little? A galloping horse? An explosion? Riding a roller coaster? Rolling a marble or throwing a ball? To answer, they hold up the appropriate sign. Have everyone think of their own big and little force examples.

CAREER EXPLORATION

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CHOOSE ONE OPTION:

- Find 3 careers in plastics that interest you. Choose one and click to complete this career card. You can start with the websites below or do an internet search using the keywords below.
- The Texas universities listed have student Society of Plastics Engineers chapters. Explore their academic degrees to find out more about their programs which support the plastics industry.
  - Baylor University, Waco
  - Lamar University, Beaumont
  - Texas A&M, Kingsville
  - Texas State University, San Marcos
  - Texas Tech University
  - University of North Texas
  - University of Houston

KEYWORD SEARCH FOR CAREERS:

- Appliance Design, Applications Engineer, Automotive Engineer
- Business Analyst, Chemical Engineer, Chemist
- Economic Analyst, Electrical Engineer, Industrial Engineer
- Injection Molding, Material Engineer, Material Scientist, Mechanical Engineer
- Packaging Engineer, Polymer Engineer, Polymer Scientist, Process Engineer
- Plastics Engineer, Supply Chain Manager, Toy Designer, Transportation Management

Schools with programs in Polymer Science and Plastics Engineering:

- University of Southern Mississippi: USM-polymer science
- University of Akron
- Pennsylvania State University: PSU-Materials Science and Engineering
- Ferris State University
- University of Massachusetts–Lowell
- Shawnee State University: Shawnee State Plastics Engineering Tech
- University of Wisconsin-Stout
- Western Washington University

Career Websites:

- Women in Plastics on Careers, Challenges, and the Future
- Indeed - 12 Plastics Industry Jobs (With Duties and Salaries)