Wonders of Polymer Science Patch Requirements

(Daisies, Brownies, Juniors)

Plastics are Everywhere!

Goal: Scouts will understand that plastics are everywhere—in most facets of life, that plastics are moldable, and the difference between natural and synthetic polymers and plastics.

Supplies: paper, pencil

Activity:

- Watch *Plastics Are Everywhere* video.
- Find 10 different plastic things in your home, school, or troop meeting location.
- Identify Natural and Synthetic Polymers: The troop leader calls out the name of an object (see examples below) and the girls yell out if it is a synthetic or natural polymer. Or an alternative approach: troop leader yells synthetic or natural and the girls yell out a name of an object or item they see.
    - Synthetic polymer examples: eye glass frames, back packs, shoe soles, polyester clothes, pens, phone cases, water bottle, plastic cups, straws, food packaging.
    - Natural polymer examples: hair, fingernails, DNA, silk, latex.

For the troop leader: Natural polymers are bio-degradable, meaning they naturally decompose over time. Most synthetic polymers do not decompose so recycling 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.

Outcome: Students understand that a plastic-free world is impossible, and that responsible use, recycling, and disposal of plastics is especially important.

ROY G BIV

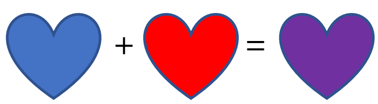
Red, Orange, Yellow, Green, Blue, Indigo, Violet

Goal: Scouts 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:

- Combine color paddles from the kit to mix secondary colors.
- Do 1 of these activities:
    - Make a color wheel with paint or construction paper. If using construction paper cut triangles to fit the color wheel found at www.4spe.org/scoutpatch
    - Make color equations with paint or construction paper.
      Red + Yellow = ?; Blue + Yellow = ?; Red + Blue = ?



Outcome: Students will apply color theory when they add color in upcoming polymer activities. Students will understand how color is added to plastics to make vibrant colors.

*These items are in the Wonders of Polymer Science kit found at the scout store.

Polymer Structures

Goal: Scouts 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 scout 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 chain 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—**small units that link together to form a large polymer**. Think of monomers like paper clips that link together to form a chain, and that chain is a polymer. Polymers are made of many monomers linked together. Another model to consider: one Lego brick is a monomer and the structures you build with the Lego bricks are polymers.

Outcome: Students will understand that all plastic things are made of polymers, and polymers are different based on the configuration of the molecules.

First Plastics (Juniors)

Goal: Scouts will synthesize an example of a first plastic (casein) and understand the role plastics play in today's society.

Activities:

- 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.

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).

Casein recipe: watch to 5:32 minutes

- 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.
- 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.

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 over and over again 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.

Outcome: Students will understand how first plastics were used commercially.

Slime

Goal: Scouts 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 (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 traditional slime
  - 3:58 to make slime variation
  - 5.19 for a viscosity race
- Make slime

Procedure:

- To make 4% Sodium Borate solution: Dissolve 1/3 cup of *20 Mule Team* borax powder into 8 1/2 cups warm water.
- Color the clear 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. The scouts mix the glue first to create secondary colors, then mix it with the borax solution in the bag to make slime. This is an example of a chemical reaction called crosslinking. The girls can figure out how to make any color using their color wheel.

For the troop leader: When the scouts are "stirring" the slime ask them 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 as it gives off heat.

What is a non-Newtonian fluid? Pressure-dependent substances, like slime (and silly putty and quicksand) are non-Newtonian fluids. In a non-Newtonian fluid, viscosity changes depending on the force applied and it behaves either more like a liquid or more like a 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* can also change the properties of some substances.

The slime will behave differently depending on the amount 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 twenty (20) inches on a hard surface and observe how it behaves like a bouncy solid.

When pressure is applied to a non-Newtonian fluid (like when you squeeze) it increases the resistance to the force (or viscosity). A fast tap on the top of the slime and it feels hard, but if you dip your finger in slowly the mixture doesn't resist the force and behaves more like a fluid.

Explain force to younger scouts with this activity: Have the scouts each make a small sign that says BIG and another sign that says LITTLE. Then play "Big or Little Force?" with scouts. 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, the girls hold up the appropriate sign. Have scouts think of their own BIG and LITTLE force examples.

Outcome: Students will understand that forces can be big or little and slime behaves differently depending on the force applied because it is a non-Newtonian fluid.