Polymers and You

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The word polymer originates from two Greek words. The prefix "poly" means many; the suffix "mer" comes from the Greek "meros" which means part. Polymer then literally means "many parts." A polymer is produced by connecting many separate individual units, called monomers, together into a long chain. The number and type of monomers as well as the amount of cross-linking between monomers results in different properties in the polymers that are produced. For example the monomer glucose, a very simple sugar, makes the polymer starch if put together one way, yet makes cellulose if put together a different way. Polymers can be either synthetic or natural.

Activity 1: Spot the Polymer

In this activity, students examine various materials and guess if they are polymers or not. They will then take their knowledge and make some polymers from paper clips and/or people.

Materials:

- Examples of various polymers (CD, plastic bag, soda bottle, wood, corn starch, uncooked macaroni, etc)
- Examples of non-polymers (sugar, salt, glass, aluminum foil, water)
- Paper clips

Procedure:

1. Examine all the materials and guess/ discuss the differences and try to determine what are polymers and what are not polymers.
2. Use paper clips to demonstrate what a polymer is. Link paper clips together to form long chains; add in some cross-links; make it crazy.
3. Ask for volunteers from class to make a people polymer. Discuss how you could make the people polymer stronger.

Activity 2: "Silly Putty"

In this activity, students will use Elmer's glue, borax, and water to make a silly putty-like polymer.

Materials:

- Borax (found in the laundry detergent aisle in the grocery store, 20-Mule Team)
- Elmer's glue (regular, not the washable kind or glitter kind)
- Water
- Plastic cups (6 to 8 ounce size is good)
- Plastic spoons or other stirring utensils
- Food coloring, if desired

Procedure:

1. Pour equal amounts of Elmer's glue and water into one of the plastic cups. Add a few drops of food coloring, if desired. Stir well.
2. Fill another plastic cup about one-third full with water. Add about 1 or 2 tsp of Borax to this water and stir until most of the Borax is dissolved
3. Pour the Borax solution into the glue-water solution and slowly stir with a plastic spoon so that all the glue solution comes into contact with the Borax solution.
4. Take the silly putty out of the cup and continue to play with it in your hands. Do not attempt to "dry" it with paper towels because it will stick. The putty will dry

naturally in your hands and become the "correct" consistency the more you play with it.
5. Store in plastic zip lock bags.

What happened?
Glue contains polyvinyl acetate (PVA). These polymers are "normally" long chained and will slide past one another so they do not interact with each other. Borax contains the borate ion, $B(OH)_4$, that forms a cross-link between the PVA polymers in the glue and causes them to stick together.

Activity 3: Oobleck

Students will mix cornstarch (already a polymer) and water and form another non-Newtonian fluid! Non-Newtonian fluids sometimes act like solids and sometimes act like liquids.

Materials:
- Cornstarch
- Small plastic cups (6 to 8 ounces works well)
- Plastic spoons or other stirring utensils
- Water

Procedure:
1. Add about _ cup of cornstarch to a plastic cup.
2. Add about half as much water (only a few tablespoons) to the cornstarch.
3. Mix well with a spoon.

What happened?
Anytime a polymer is added to a liquid, it slows down the reaction time of the liquid and makes it harder for the liquid to move. Cornstarch is a polymer. The cornstarch slows down the movement of water very much. If pressure is applied quickly, the cornstarch polymer gets tangled up and resists movement; it will act like a solid. If pressure is applied slowly, there is time for the polymer to react and they don't get as tangled; it will act more like a liquid.

Activity 4: Fuzzy Fibers

Students will examine both cotton and wool and observe the difference between these fibers. They will then attempt to make felt from both wool and cotton and discuss their results in relation to their observations of the fibers.

Materials:
- Wool (fleece, carded or combed)
- Rolled cotton
- Magnifying lens or simple microscopes
- Dishpan with hot water and liquid soap
- Small (2-3 inch diameter) one per student

Procedure:
1. Take a small clump of wool and cotton. Compare how they feel. Use a magnifying glass or microscope and observe differences.
2. With a medicine dropper, place three drops of water on each clump of fiber and observe what happens.
3. Fill the dishpan with hot water and add some soap to make a sudsy bath.
4. Dip your stone into the water.
5. Wrap a **thin** layer of wool around the stone.
6. Wrap a second layer of wool around the stone, crosswise to the first.
7. Repeat the above steps until the stone has 6 or 7 thin layers around it and is evenly covered.

8. Wrap a piece of yarn several times around the stone and tie it to keep the fibers in place.
9. Dip the fiber-covered stone in the hot soapy water and wet it completely. As you do this, squeeze and roll the stone through your fingers until the outside is smooth. Do this approximately 5 minutes.
10. Rub and press all sides of the stone on a washboard or some other rough surface.
11. Dip the stone occasionally in the soapy water and continue rubbing and pressing until the wool is snug around the stone.
12. Rinse out the soap in warm water
13. Blot the felted stone with a towel and let it air dry (this make take a day or two).
14. When dry, remove the stone by cutting through one side of the felt.
15. Repeat using cotton fibers and observe any difference.