Bay Area Scientists in Schools Presentation Plan

Lesson Name: Polymer Possibilities
Presenter(s): Kevin Lance, Jennifer Soto, Shea Thompson

Grade Level: 5th Grade
Standards Connection(s): All matter is made of atoms, which combine to form molecules. Separate mixtures and identify compounds using physical properties.

Abstract: We will be introducing kids to the world of polymers. Examples of polymers are all around us whose properties and uses are largely determined by their chemical structure. We will explain how polymers are large molecules consisting of long chains of repeating units. Through activities we will look together at the structure of polymers and their possible properties.

Vocabulary/Definitions:

- *Monomer - A single unit that is used to make polymers*
- *Polymer - Very large molecules composed of repeating units*
- *Polymerization reaction - A chemical reaction that links monomers together to form a polymer*
- *Viscosity - A measure of how easily the material flows*
- *Elasticity- How easily a material returns to its original shape after being stretched*
- *Viscoelasticity - A material that has both viscous and elastic properties*

Materials:

What you'll bring with you:

- Glue,
- Borax,
- Corn starch,
- water,
- Measuring cup,
- Spoons,
- Worksheets,
- Rulers,
- Ziploc bags,
- labels,
- food coloring,
- gloves,
- paper towels,
- newspapers

What students should have ready (pencils, paper, scissors)

- **Pencils**

Classroom Set-up:

Before starting, cover tables with newspaper. Prepare Borax solution for Shea (2 T water, ½ t Borax) and corn starch solution for Jenn (1/2T starch into 1 cup of water) in advance.

Students will be divided into 3 groups for the hands-on part of the lesson

Classroom Visit

1. **Personal Introduction:** **3 Minutes**
   Who are you? What do you want to share with students and why? How will you connect this with students' interests?
   Introduce ourselves as UC Berkeley graduate students. Each mention 1 hobby and 1 real-life connection of our lab interests.

Topic Introduction: **10 Minutes**

Big Idea(s), vocabulary, assessing prior knowledge. What questions will you ask to learn from students?

In a polymerization reaction, small molecules called "monomers" react to form "polymers," which are very large molecules composed of repeating units. Discuss some common polymers (e.g., erasers, silly putty, Teflon, Kevlar, tires, etc.).

Real life analogies:

1. A train, which is composed of boxcars.
2. A wall, which is composed of bricks.

Ask for 4 volunteers and have them come to the front of the classroom. Explain that each of the students represents a monomer. As individual monomer units the students may easily move about. Now, ask the students to hold hands, which represent polymerization. The three presenters will also 'polymerize' to represent another polymer chain. As they polymerize they begin to solidify, yet chains of students can still slide past each other. This is why many polymers can be described as stretchy. When you stretch a polymer by pulling it, chains of the polymer are sliding past each other.

Note that in a real polymer, the monomers are often the same – like if you cloned one student and made a circle of his clones!

2. **Learning Experience(s):** **30 Minutes**
   Important: Don't eat the materials used to make the ball or the ball itself. Wash your work area, utensils, and hands when you have completed this activity. Use gloves to handle the mixtures.

   Students first break into three groups and go to three stations. There, they all make the Magic Recipe (2T water, 1T glue, 1T borax) to take with them around to other stations.

I. Viscosity (Gak- Kevin)

Compares the Magic Recipe to pre-made styrofoam-like (borax/glue only) and pre-made goopy recipe (3T water, 1T glue, 1T borax). Compare ability to flow - flow out of cups onto surface?

Recipe:

- 3T water
- 1T glue
- 2T Borax

Mix water and glue, then add borax. [Recipe Variations: **2:1:1** for magic recipe that is viscoelastic and a little bouncy; and **3:1:2** makes sticky snot]

Experiment: To learn about cross-linking in a polymer network. Make analogy to meatballs in a plate of spaghetti.

One group: mix glue and borax only.

Second group: mix glue, water (glue and water first, then mix, then borax), and borax. Adding water lets everyone space out (think about watering down a plate of spaghetti) and move around. Describe the effects in your notebook. (Borax/glue group can add water at the end if they want - it'll take a little while to mix)

II. Viscoelasticity (Time-related stretch - Shea)

Compare the more viscoelastic (stretches faster over time) Magic Recipe with the less viscoelastic play-doh recipe.

Play-doh recipe:

1. Pour 1 T glue into bag
2. Add 1 T corn starch
3. Add ½ t Borax solution (2 T water, ½ t Borax)

Pull both polymers apart quickly. What do you observe? Now, pull them both apart slowly. What happened?

III. Elasticity (Bouncy ball- Jennifer)

Compare the Magic Recipe to the bouncy ball recipe.

Bouncy ball recipe:

1. 2 T glue
2. 1 T corn starch solution (1/2T starch into 1 cup of water)
3. 1 T Borax

3. **Wrap-up: Sharing Experiences and Building Connections** **10 Minutes**
   Putting the pieces together – how will students share learning, interpret experience, build vocabulary?

   Who can explain what a polymer is? (with analogy or not)
   What are some examples of real-life polymers? (plastics)
   What is viscosity? Can you think of any liquids in real life that have different viscosities?

TOTAL 50 – 60 Minutes

Follow-up – After Presentation

To explore more polymers, check out: http://pslc.ws/macrog/kidsmac/kfloor4.htm

Here are some questions for students to complete after the presentation to review what they learned.

• What is a polymer?
• What are some examples of a polymer that are found in your classroom?
• What are some properties of polymers?
• Why would someone want different properties for different polymers?
• Learn more about plastics and recycling - what do those numbers in the triangles on the bottom of plastics mean?
• Experiment with cooking gelatin - make different concentrations of gelatin/water mixes and test flow or mechanical properties
• Find out how plastics are made! Why are some stiff (like tupperware) and others flexible (like polyester clothes)

Green Polymers (*BASIS Lesson Developed by Sarpong Lab*) - Polymers are an important part of our day to day lives. The presentation explores the construction of polymers from monomers, the properties of polymers, and the degradation of polymers, connecting to green chemistry ideas. This lesson explores polymers from the how they are made, properties of polymers, and how they break down. http://www.crscience.org/lessonplans/5_greenpolymers_sarpong_09-10.pdf

Gum Drop Chains and Shrinky Necklaces (*Polymer Science Learning Foundation*) - In this activity, learners thread gumdrops together to make a model of a polymer. Then they thread the chains together to mimic crosslinks, and discover how crosslinked polymers act differently than uncrosslinked ones. Use this activity to illustrate about the various structures of polymers. http://pslc.ws/macrog/kidsmac/activity/gumdrop.htm

Reading Connections:

- Janice VanCleave's Molecules by Janice VanCleave – (Children ages 8-12) Includes 20 simple and fun experiments that allow you to discover the answers to these and other fascinating questions about molecules, plus dozens of additional suggestions for developing your own science fair projects. Learn about the structure of molecules with a simple experiment using gum drops and toothpicks; about molecular motion with a glass, a cup, and food coloring; about crystals using Epsom salts, a soap dish, and a paint brush; and much more. All experiments use inexpensive household materials and involve a minimum of preparation and clean up. http://www.amazon.com/Janice-VanCleaves-Molecules-VanCleave/dp/047155054X/