Bay Area Scientists in Schools Presentation Plan

Lesson Name____Green Polymers_____
Presenter(s)_____The Sarpong Group_____
Grade Level__5th_____ **Standards Connection(s)**_ chemical reactions to make molecules

Abstract: Polymers are an important part of our day-to-day lives. This lesson explores the construction and cross-linking of polymers, some properties of polymers, and the degradation of polymers, with connections to green chemistry and recycling.

Vocabulary/Definitions:

- polymer – a very large molecule composed of repeating units
- monomer – a single unit that is used to make polymers
- polymerization – a chemical reaction that links monomers together to form a polymer
- cross-linking – making chemical bonds between two polymer chains
- degrade – break down

Materials

A. Making Polymers
- Plastic Cups
- Elmer's Glue
- Borax
- Water
- Food Coloring
- Pipettes
- Plastic Spoons
- Ziploc Bags

B. Properties of Polymers
- Plastic Cups
- Coffee Filters
- Rubber Bands
- Water
- Pipettes
- Distilled Water
- Sodium Polyacrylate
- Gloves
- Brine Solution

C. Degrading Polymers
- Legos
- Magic Nuudles
- Styrofoam Packing Peanuts
- Degradable Packing Peanuts
- 3 Beakers
- Water
- Ethyl Acetate

We will bring everything with us, but access to water would be helpful.

Classroom Set-up:

We will start and end in a large group; we will talk to the teacher in advance to learn about the classroom setup and the best way to divide the class into three groups for the stations segment of the lesson.

Classroom Visit

1. Introduction

Personal Introduction: 2 Minutes

We are students and researchers (can calculate "grade level" for the students) from UC Berkeley studying organic chemistry! We are originally from all over the world, but we all share a passion for science!

Topic Introduction: 12 Minutes

Poll the class to see if anyone has heard of the word polymer before, or knows any examples of polymers. Define the five key terms for this lesson and write them on the board: **polymer**, **monomer**, **polymerization**, **cross-linking**, and **degradation**. Discuss some common polymers, both synthetic and natural (e.g., Teflon, Kevlar, plastics, rubber, DNA, etc.).

Can discus two real-life analogies:

1. A train (**polymer**), which is composed of boxcars (**monomers**).
2. A wall (**polymer**), which is composed of bricks (**monomers**).

Make a "human polymer" with the class. Explain that each student is currently a **monomer**, a single unit with freedom of movement. Have everyone join hands in a **polymerization reaction** to form a large **polymer**. Have a couple volunteers come in and **cross-link** the polymer, making connections between sections of the polymer. This polymer has limited movement but is also much stronger than the individual monomers. Finally, **degrade** the polymer by having the students let go of each other's hands, reforming the student monomers.

Break the students into three groups, where they will get to perform experiments on making polymers, testing properties of polymers, and degrading polymers.

2. Learning Experience(s): 36 Minutes

For the bulk of the lesson, the students will be divided up into three groups to visit stations (~12 minutes/station)

A. Making Polymers Station

Concepts: polymerization, cross-linking

Instructions: *(Have the students work in pairs or small groups)*

1) Fill the base of a cup up to the line with glue, ~1 inch. Explain that glue is a polymer.

2) Add about 3 pipettes of water to the glue and stir

3) Add 1 drop of food coloring and stir until well mixed

4) Add about 3 pipettes of saturated borax solution and stir well. You may need to add more of the borax solution if the slime is still watery. Explain that the borax is cross-linking the glue together, changing its properties.

5) After the slime is fully formed, knead it well to remove any excess water.

6) Divide the slime up so each student has a piece, put it in a sealable Ziploc bag, have the students write their name on their bag, and set the bags of slime aside to give to the teacher for distribution later in the school day.

B. Properties of Polymers Station

Concepts: control experiment, variable

Instructions:

1) Place a coffee filter over the top of a plastic cup and secure it with a rubber band. It is important to pull it tight so that it fits like a drumhead.

2) Using a pipette, slowly drop water on the center of the coffee filter and have the students count how many drops it takes for the water to reach the edge of the cup. Explain that this is a *control experiment*.

3) Give a cup, coffee filter, and rubber band to each group of 2 students and have them attach the filter to the cup.

4) Place a small amount of polymer (the *variable*) on each coffee filter and have the students make observations about the polymer. DO NOT LET THE STUDENTS TOUCH THE POLYMER. If a student touches the polymer, they should wash their hands.

5) Have the students SLOWLY drop water on top of the polymer, keeping track of the number of drops it now takes to saturate the filter paper. Ask the students to make observations of what is happening to the polymer.

6) Once all groups are done, discuss the observations the students made and the properties of the polymer. Discuss why the students would not want to touch this polymer. Discuss where you might encounter this type of polymer in daily life (diapers, potting soil, heat packs, toys that expand in water, etc.)

7) Take one student's polymer and add a few drops of a saturated salt water solution and have the students make observations about what is happening.

8) To clean up, remove the coffee filter with polymer from each cup and collect the cups and rubber bands. Reminder: DO NOT ALLOW THE STUDENTS TO TOUCH THE POLYMER, AS IT WILL DRY OUT THEIR SKIN/EYES. IF A STUDENT TOUCHED THE POLYMER, THEY SHOULD WASH THEIR HANDS BEFORE MOVING ON TO THE NEXT STATION.

C. Degrading Polymers Station

Concepts: degradation, recycling, green chemistry

Instructions:

1) Discuss what happens to materials we no longer need or are able to use? Instead of throwing everything in the garbage to wind up in a landfill, what if we could break down, or **degrade**, materials made of polymers?

2) Pass around a few Styrofoam packing peanuts and have the students describe them. Do the same thing with the magic nuudles and the biodegradable packing peanuts.

3) Place one of each packing peanut in its own beaker of water and set it aside.

4) Give each student a few Legos and ask them to build something with the pieces they were given.

5) Have each student give their structure to the person next to them, who should then take it apart and build something different with those bricks, simulating degradation and recycling of materials. This can be repeated a couple of times, then collect all the Legos.

6) Return to the beakers of packing peanuts. Examine each material and have the students make a new set of observations. Discuss the benefits of degradable materials.

7) Add a couple drops of ethyl acetate to a piece of Styrofoam and have the students make observations of what they see.

8) Dump the magic nuudle and degradable polymer waters into a waste container for disposal back in lab.

3. Wrap-up: Sharing Experiences and Building Connections 10 Minutes

We will bring everyone back to one group to review the things learned that day. Each station leader will review the experiments, main observations, and key words learned at each station. Encourage the students to think about the many different polymers they encounter every day and the cycle of materials being broken apart and rebuilt. Ask the students if they have any questions about the experiments we performed or about being a scientist in general!

TOTAL 60 Minutes

Follow-up – After Presentation

Suggest students write a letter explaining "How we learned about polymers and recycling plastics…"

Gak! (*BASIS Lesson developed by Chemical Engineering Graduate Students***) -** You are given the task of making the best gak. The head scientists have come up with three recipes but they need your help to find the best one. Using concepts of engineering and science, together we will explore the new materials and learn methods to test for which one has the best properties. (**Does not include recipe)** http://www.crscience.org/lessonplans/5_Gak_ChemE_10-11.pdf

Polymer Possibilities (*BASIS Lesson Developed by Bioengineering Graduate Students*) - 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. (**Includes recipes of various polymers)** http://www.crscience.org/lessonplans/5_PS_Polymer_Possibilities_11-12.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/