Polymer Properties Classroom Kit Student Guide

What are Polymers?

The word polymer comes from the Greek words polys (many) and meros (parts). Polymers are molecules made up of many repeating units, like a chain. Each link of the chain can exist as a small molecule, or monomer. When a chemical reaction causes hundreds or thousands of them to join together, they become one large molecule. The process of creating the chain from monomers is called polymerization. GobbledyGoop, Slippery Spheres, Silly Squares and JellyStones are all copolymers. Copolymer chains are made up of two different monomers, which alternate.

GobbledyGoop Experiments

Divide students into three groups.

1. Add 4 ounces of water to a cup. Slowly stir in 1 teaspoon of GobbledyGoop powder with the stirring spoon. What happens?
2. Put regular soil into two cups of water. Stir to make the water muddy. Sprinkle a small amount of GobbledyGoop powder in one of the cups. What happens?
3. GobbledyGoop Water Temperatures
   - Put ½ teaspoon of GobbledyGoop powder into a cup. Now add 2 ounces of cold water to the cup and stir.
   - Put ½ teaspoon of GobbledyGoop powder into a cup. Now add 2 ounces of hot water to the cup and stir.
   - Which water makes the slime the fastest? How does the slime react to the different temperatures of water?
4. Viscosity of GobbledyGoop
   - Add 2 ounces of water to a cup. Now slowly stir in 2 teaspoons of the GobbledyGoop powder.
   - Add 2 ounces of water to a cup. Now slowly stir in 1 teaspoon of the GobbledyGoop powder.
   - Add 2 ounces of water to a cup. Now slowly stir in ½ teaspoon of the GobbledyGoop powder. Add 2 more ounces of water.
   - Viscosity is a measure of a liquid's thickness or resistance to flow. For example, syrup is more viscous than water. Is one slime more viscous than the others? What causes the slime to be either thick or thin?

Discussion Questions

1. How does GobbledyGoop work? What is a polymer? Why is GobbledyGoop so slimy and stringy?
2. What other uses could GobbledyGoop have?
3. What other liquids can you think of that are more viscous than water?

Slippery Spheres, Silly Squares & JellyStone Experiments

All three of these polymers are crosslinked polymers. Crosslinking is a process that introduces chemical bonds between the polymer chains. The result is a network of chains. The crosslinking allows the polymers to retain a distinct shape. The greater the number of crosslinks, the more rigid the shape will be. Crosslinking also reduces the capacity the polymer has to expand and absorb water. So, the less crosslinking, the bigger the polymers can grow with water. The polymers expand with water due to electrostatic repulsions.

Experiments 1-4 require observing after 1 hour and overnight. Experiments 5, 6 and 7 are more flexible; they can be set up or done during another experiment and left overnight.

1. Hydrate Polymers in Hot and Cold Water

Each group uses a single color. Make sure the hot water is less than boiling or the corn cups will melt.

Group 1: Add ⅛ teaspoon or about 50 Slippery Spheres to 1 cup of cold water.
Add ⅛ teaspoon or about 50 Slippery Spheres to 1 cup of hot water.

Group 2: Add ½ teaspoon or about 10 Silly Squares to 1 cup of cold water.
Add ½ teaspoon or about 10 Silly Squares to 1 cup of hot water.

Group 3: Add ⅛ teaspoon or about 20 JellyStones to 1 cup of cold water.
Add ⅛ teaspoon or about 20 JellyStones to 1 cup of hot water.

All Groups: Compare your polymers after 10 minutes, 1 hour and overnight. Are the ones in the cold water or hot water bigger? Compare them to the unhydrated polymers. How much have they grown? Can you think of a good way to measure this? Are they fully grown after leaving them overnight? If they have expanded above the water level, transfer some into a new cup to see if they get bigger. What color is the water? Do the polymers retain their color? Look at the other groups' polymers. Did they behave differently?

2. Polymer Color

Group 1: Add ⅛ teaspoon each of two colors of Slippery Spheres to 1 cup of hot water.

Group 2: Add ½ teaspoon each of two colors of Silly Squares to 1 cup of hot water.

Group 3: Add ⅛ teaspoon each of two colors of JellyStones to 1 cup of hot water.

All Groups: What do you think will happen? Compare your polymers right after adding the water, after 1 hour, and the next day. What color is the water? Did the polymers retain their color? Look at the other groups' polymers. Did the colors of the Slippery Spheres, Silly Squares or JellyStones mix more? How do the polymers compare to the single color cups from the last experiment?

3. Saltwater

Group 1: Add 2 teaspoons salt to 1 cup of water. Fill another cup with 1 cup of water. Add a few of each of the non-hydrated polymers (JellyStones, Silly Squares and Slippery Spheres) to each cup. Compare size and color over 1 hour and the next day.

Group 2: Hydrate a few of each polymer for 20 minutes in hot water. Add 2 teaspoons salt to 1 cup of water. After the 20 minutes in hot water, pick out pairs of polymers with the same size, shape and color. Add one of each pair of polymers to the saltwater and the other to an empty cup, so you have a way to compare to the original (pre-salt) size. You should have 1-3 JellyStones, Silly Squares and Slippery Spheres in each cup. Do they float or sink in salt water? Watch for 30 minutes. Compare the size of each polymer to its twin in the empty cup. What happens to the color? Check again tomorrow.

4. Acid

Hydrate a few of each polymer for about 25 minutes in hot water. Find pairs of partially hydrated polymers with the same size, shape and color. Add one of each pair of polymers to ½ cup lemon juice or something acidic. Leave the other in an empty cup, so you have a way to compare to the original (pre-acid) size. Observe up to 1 hour and then leave overnight. Did anything happen? Pour off the lemon juice and put the polymers back in water. Do they rehydrate?

5. Polarity and Hydration

Group 1: Add ⅛ teaspoon or less of Slippery Spheres to ¼ cup oil.

Group 2: Add ½ teaspoon or less of Silly Squares to ¼ cup oil.

Group 3: Add ⅛ teaspoon or less of JellyStones to ¼ cup oil.

All Groups: What effect does cooking oil have on JellyStones, Silly Squares and Slippery Spheres?

6. Freeze and Melt Polymers

Put a few of each of the fully hydrated polymers in a freezer for a few hours or overnight. Add a few of each of the polymers to boiling water or microwave the polymers. Water must be boiling, so do not do this in the corn cups; the cups will melt! Do the polymers freeze? Do they melt?

7. Absorption and Evaporation

Put a few hydrated polymers on one or more paper towels. The paper towel will absorb water from the polymers. How long does it take the polymers to lose water and change back into a small pebble?

Discussion Questions

1. Do you know any other materials that are polymers?
2. What are some other special uses for JellyStones?
3. What causes a molecule to be polar or non-polar? What is an example of polar molecule? A non-polar molecule?
4. What is the difference between an anionic and a polar polymer?
5. What do you think causes these three polymers to have different properties?

Notes

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