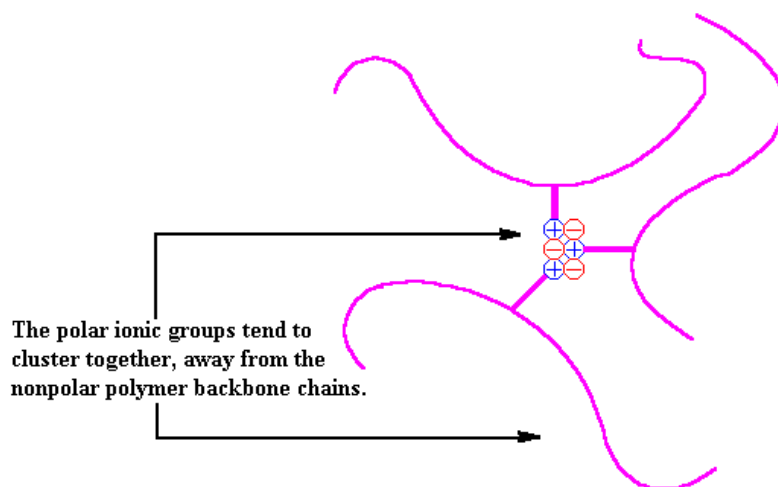


## Silly Putty – Understanding materials and properties.

Concept: Plastics and many biological molecules are polymers, very large molecules made by connecting many small molecules, monomers, together. A good way to visualize this concept is a paper clip chain. An individual paper clip is a monomer, one unit. Connecting hundreds of the clips together in a chain makes the polymer, many units. In this exercise, glue contains polyvinyl acetate, a polymer that is soluble in water creating a viscous solution. Adding sodium tetraborate, Borax, induces cross-linking, a process where different polymer chains are connected together from the sides. Initially, the polymer chains could slide past one another, but after cross-linking, they stick together making a silly putty-like material.

### Instructions:

1. Add 30 mL (1/3 cup, 2cm depth in 3 oz cup) of glue (Elmer's) into a small cup.
2. Add 1-2 drops of food color if desired and stir the mixture with a wood stick or plastic spoon.
3. Assign different volumes of water to add ranging from 5-15 mL. Stir the mixture.
4. Assign different volumes of 4% borate solution to add, ranging from 5-15 mL so that total volume of water and borate solution equals 20 mL. It may be beneficial to have students work in pairs, so one student can pour in the borate solution while the other stirs the mixture.
5. Once the mixture becomes too thick to stir, have the students knead the silly putty to ensure complete mixing.
6. Report differences in the nature of the mixing process and properties of the final products.
7. Depending on equipment and class time, observe the time it requires for the silly putty samples to flow from a funnel, stretch to the desk top while the student holds one end, etc. (be creative)



# Slime

Concept: Plastics and many biological molecules are polymers, very large molecules made by connecting many small molecules, monomers, together. A good way to visualize this concept is a paper clip chain. An individual paper clip is a monomer, one unit. Connecting hundreds of the clips together in a chain makes the polymer, many units. In this exercise, polyvinyl alcohol, PVA, is a polymer that is soluble in water creating a viscous solution. Adding sodium tetraborate, Borax, induces cross-linking, a process where different polymer chains are connected together from the sides. Initially, the PVA chains could slide past one another, but after cross-linking, they stick together making slime.

## Instructions:

1. Add 30 mL (1/3 cup, 2cm depth in 3 oz cup) of 4% PVA solution into a small cup.
2. Add 1-2 drops of food color if desired and stir the mixture with a wood stick or plastic spoon.
3. Assign different volumes of 4% borate solution to add, ranging from 5-15 mL. It may be beneficial to have students work in pairs, so one student can pour in the borate solution while the other stirs the mixture.
4. Once the mixture becomes too thick to stir, have the students knead the slime to ensure complete mixing.
5. Report differences in the nature of the mixing process and properties of the final products.
6. Depending on equipment and class time, observe the time it requires for the slime samples to flow from a funnel, stretch to the desk top while the student holds one end, etc. (be creative)

