Objective

Students will make slime to explore the idea that matter has mass, which is always conserved.

National Science Education Standard

Physical Science Standards, K-4 and 5-8: Properties and changes of properties in matter.

Missouri Grade Level Expectations

Properties of Matter; Mass and Temperature; Properties of and Changes in Matter; Physical and Chemical Properties and Changes of Matter

Background information

Matter and mass

There are three states of matter: gas, liquid and solid.

- A solid has a certain size and shape.
- A liquid takes the shape of its container.
- A gas is matter that has no shape or size of its own.

You can convert one form of matter to another typically by adding or removing heat. For example water can exist as a solid (ice), liquid, or gas (steam) by adding heat. A key concept is that when any of these react, there is conservation of matter. When you mix solutes (like corn starch, or sugar) in a solvent (like water) there are many things that can happen. You can get mixtures, solutions or colloidal suspension. Mixing these two forms of matters does not result in a loss of matter. The mass remains constant. How are weight and mass different?

1. Mass is a measurement of the amount of matter something contains, while weight is the measurement of the pull of gravity on an object.
2. Mass is measured by using a balance comparing a known amount of matter to an unknown amount of matter. Weight is measured on a scale.
3. The mass of an object doesn't change when an object's location changes. Weight, on the other hand, does change with location.

What is slime?

Slime is a highly viscous polymer. What is a polymer? A polymer is a long chain of small chemical units called monomers. When the monomers are chemically cross-linked together to form a polymer, the properties change. Typically they become more viscous and more flexible. The properties of a polymer can change dramatically depending upon the chemical composition of the monomer. Plastics are the most notable example of a polymer. Polymers are either natural or synthetic. Natural polymers such as proteins, DNA, starch, and cellulose occur in nature. Synthetic polymers are chemically prepared. The physical properties of polymers can vary tremendously. For example, some polymers are extremely flexible and fluid, whereas others are very hard and stress-resistant. One way to classify polymers is based on differences in elasticity. Elasticity refers to the ability of a polymer to stretch and return to its original shape. Elastomers are highly flexible and very elastic. One factor that affects the elasticity is the type of monomer group. Rubber, for example, is very elastic and is made from isoprene monomers. (from http://icn2.umeche.maine.edu/newnav/Homepage/Highschool/Slime/lecpolymers2.htm)

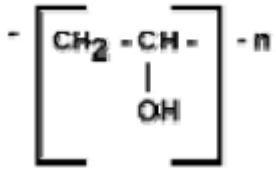
SLIME!

Slime forms when you add borax solution (borate) to polyvinyl alcohol (PVA) solution. PVA is a polymer that is soluble in water. It is a thick solution. Borax then reacts to cross link the PVA forming a net-like structure. The slime is very thick because the water in the solution becomes trapped in the net. Other polymers such as starch and gelatin also form very thick solutions but these occur upon heating.

What is PVA?

Polyvinyl alcohol is a polymer. PVA is a non-toxic, water-soluble polymer. It is produced by DuPont and sold for applications including adhesives, paper coatings, cosmetics, textiles, ceramics, and emulsion paints. (http://www.dupont.com/industrial-polymers/elvanol/E-7130/E-7130A.html).

The chemical structure for the monomer is shown below. The number of monomers in the polymer is on the order of hundreds.

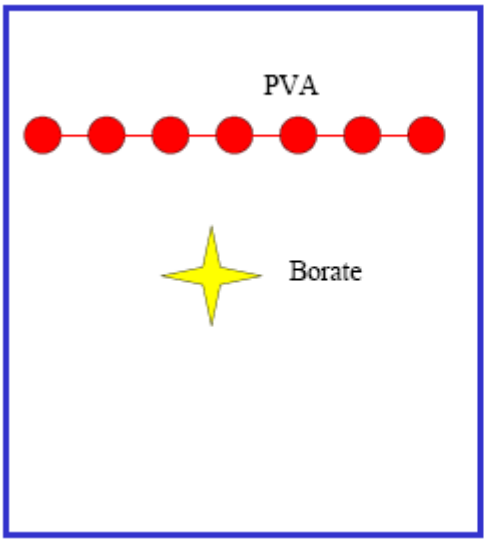


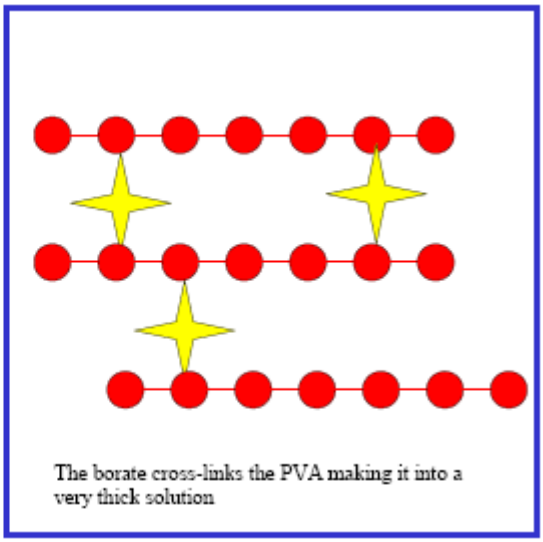
What is borax?

Borax, short for sodium borate, is a chemical that is found in some common household materials like laundry detergent. It is a mineral that is mined from lake deposits.

What happens when you mix PVA and borax?

The chemical reaction is as follows:





The borate cross-links the PVA making it into a very thick solution. The borate cross-links two or more PVA chains forming a complex network. Think about a mesh and how if you have a very fine mesh it can entrap water. The PVA chain is hooked together at various points and forms a network that entraps and holds water.

Materials

2% Borate
3% PVA
ziplock bags (snack or sandwich size)
food coloring
falcon tubes
test tube holders
transfer pipettes
glitter (optional)
thermometers (optional)
graduated cylinders (optional)
balances (optional)

Preparation for teacher:

1. Prepare a 3% solution of polyvinyl alcohol (PVA obtained from www.chemistrystore.com) by mixing 3 grams of PVA with 100 ml of water and heat to approximately 80C (do not allow it to boil!).
2. Prepare a 2% solution of borax by mixing 2 grams of borax (from the grocery store) in 100 ml of water.
3. Fill falcon tubes with borax solution. Add 10 drops of food coloring to each falcon tube.

Engage

Mix up a batch of slime and place it on each table. Ask students to describe the slime without touching it. What does it look like? What do you think it feels like? What do you think it smells like? Students record thoughts in science notebook.

Explore

Procedure for students:

1. Add approximately 20 ml of PVA into a zip lock plastic bag (sandwich size).
2. Add approximately 2 ml of borax (~ 2-3 full pipette squirts).
3. Add a pinch of glitter (optional).
4. Squish/massage the two liquids together in the bag and watch/feel as it thickens.

Students observe the contents of the bag before mixing and after mixing and record observations in science notebooks. Questions to encourage thinking: Is it a liquid or a solid? What do they feel? How have the properties of the materials changed? (It becomes thicker and it should feel slightly cool.) What changes are seen in the slime? How do these changes occur? What properties have not changed? Mass? Temperature? Students measure the mass and temperature of the solutions and the products to determine if there are any changes.

Explain

Teacher may use 'background' section for visual representations of the chemical reaction. Students explain what happened when the two chemicals were mixed together to form slime. Students explain how the properties of the materials changed and the effects on mass and temperature of the materials.

Elaborate/Extend

Students offer real life examples of chemical changes they have observed in other things. Example: Jell-O. You may also vary the amounts of each solution to change the properties of the slime.

Evaluate

Students gather as a group and discuss what they discovered through their explorations. Did the mass change? Did the temperature change? What are the reasons behind these results? Students also may make graphs to show the changes.

Activity adapted from http://www.nbtc.cornell.edu and http://projects.actua.ca/html/pdfs/Gak.pdf.