Station 5

Lumpy Liquids and Squishy Solids + Make a bouncy Ball

Have you ever turned a liquid into a solid just by tapping on it? In this experiment you make just such a liquid.

For this experiment you will need:

- corn starch (about ¼ cup, or 60 cm^3)
- water (about ¼ cup, or 60 cm3)
- a bowl for mixing
- newspaper

Place a sheet of newspaper flat on a table. Put the mixing bowl in the middle of the newspaper. Add ¼ cup of dry cornstarch to the bowl. Add about 1/8 cup (2 tablespoons, or 30 cm^3) of water to the corn starch and stir slowly. Add water slowly to the mixture, with stirring, until all of the powder is wet.

Continue to add water until the cornstarch acts like a liquid when you stir it slowly. When you tap on the liquid with your finger, it shouldn't splash, but rather will become hard. If your mixture is too liquid, add more cornstarch. Your goal is to create a mixture that feels like a stiff liquid when you stir it *slowly*, but feels like a solid when you tap on it with your finger or a spoon.

Scoop the cornstarch mixture into the palm of your hand, then slowly work it into a ball. As long as you keep pressure on it by rubbing it between your hands, it stays solid. Stop rubbing, and it “melts” into a puddle in your palm. Can you think of other tests you can do with it?

Why does the cornstarch mixture behave like this?

Think of a busy sidewalk. The easiest way to get through a crowd of people is to move slowly and find a path between people. If you just took a running start and headed straight for the crowd of people, you would quickly slam into someone and you wouldn't get very far. This is similar to what happens in the cornstarch mixture. The solid cornstarch acts like a crowd of people. Pressing your finger slowly into the mixture allows the cornstarch to move out of the way, but tapping the mixture quickly doesn't allow the solid cornstarch particles to slide past each other and out of the way of your finger.

We use the term “viscosity” to describe the resistance of a liquid to flow. Water, which has a low viscosity, flows easily. Honey, at room temperature, has a higher viscosity and flows more slowly than water. But if you warm honey up, its viscosity drops, and it flows more easily. Most fluids behave like water and honey, in that their viscosity depends only on temperature. We call such fluids “Newtonian,” since their behavior was first described by Isaac Newton (when he wasn’t discovering the laws of gravity or developing the calculus). The cornstarch mixture you made is called “non-Newtonian” since its viscosity also depends on the force applied to the liquid or how fast an object is moving through the liquid.

Other examples of non-Newtonian fluids include ketchup, silly putty, and quicksand. Quicksand is like the cornstarch mixture: if you struggle to escape quicksand, you apply pressure to it and it becomes hard, making it more difficult to escape. The recommended way to escape quicksand is to slowly move toward solid ground; you might also lie down on it, thus distributing your weight over a wider area and reducing the pressure. Ketchup is the opposite: its viscosity decreases under pressure. That’s why shaking a bottle of ketchup makes it easier to pour.

Disposal: First dilute the cornstarch mixture with plenty of water before pouring it down the drain. Why? What do think would happen to the semi-solid, semi-liquid form that you prepared if pressure were applied to it by other water in the drain? Yes – a plugged drain.

Make Bouncing Ball

What You Need:

- Elmer's glue gel or 4% polyvinyl alcohol solution
- 4% (saturated) borax solution
- phosphorescent zinc sulfide (ZnS) or glowing paint
- measuring cups/spoons
- bowl or ziploc baggie
- spoon (optional)

Introduction

Balls have been toys practically forever, but the bouncing ball is a more recent innovation. Bouncing balls were originally made of natural rubber, though now bouncing balls can be made of plastics and other polymers or even treated leather. You can use chemistry to make your own bouncing ball. Once you understand the basic technique, you can alter the recipe for the ball to see how the chemical composition affects the bounciness of the ball, as well as other characteristics.

The bouncing ball in this activity is made from a polymer. Polymers are molecules made up of repeating chemical units. Glue contains the polymer polyvinyl acetate (PVA), which cross-links to itself when reacted with borax.

Bouncing Polymer Ball Materials

Here's a list of materials you need to gather to make bouncing polymer balls:

- borax (found in the laundry section of the store)
- cornstarch (found in the baking section of the store)
- white glue (e.g., Elmer's glue - makes an opaque ball) or blue or clear school glue (makes a translucent ball)
- warm water
- food coloring (optional)
- measuring spoons
- spoon or craft stick to stir the mixture
- 2 small plastic cups or other containers for mixing
- marking pen
- watch with a second hand
- metric ruler
- zip-lock plastic baggie