Cloverbud Investigators: STEM for Every Season

Non-Newtonian Fluids "Flubber"

August

Background:

Non-Newtonian…What? We know that there are three states of matter: liquid, solid and gas but did you know that there are substances that can be both a liquid and a solid at the same time?

Famous scientist Sir Isaac Newton described how liquids or fluids normally behave. He observed that they have a constant viscosity or flow. This means that their flow behavior or viscosity only changes with fluctuations in temperature or pressure. Take water for example, water freezes and turns into ice at 32˚F and turns into a gas at 212˚F, with the effects of boiling. Between these temperatures, water performs like a "normal liquid" with a constant viscosity. It's the nature of liquids to take the form of the dish they are poured into; we call these "normal liquids" or Newtonian fluids. However, some fluids don't follow the rules, we call these "strange liquids" or Non-Newtonian fluids.

In this experiment we will attempt to answer the age old question, is it a solid or a liquid? This answer may not be obvious with Non-Newtonian fluids because it could depend on stress or force that the fluid is under at the time of testing. Non-Newtonian fluids can change their viscosity or flow behavior when under stress. If you apply a force to the fluid, like shaking it, the sudden stress will cause them to act like a solid, or in some cases it may result in the opposite behavior and make them more liquefied. If you remove the stress, they will return to their earlier state.

Have you ever heard the saying, "you're as slow as molasses"? Have you had trouble getting honey to pour out of its container? Molasses and honey have a high viscosity, so they flow at a slow rate. What if we applied a higher temperature to these substances? Remembering that temperature plays a role in the viscosity of a liquid, what do you think would happen if we placed the molasses or honey in the microwave for 30 seconds? Would it flow faster or slower? Let's look at another pair of liquids, water and rubbing alcohol for example; these liquids are considered to have a low viscosity. The low viscosity means that water and rubbing alcohol will pour out of its container quite fast. What would happen if we increased the temperature of these two liquids? Would they pour faster, slower or remain the same? Why?

In this investigation, we are going to examine a mixture of corn starch, food coloring, and water that we will call "flubber." We will test the stress limits of our "flubber" by determining what is needed for it to become a solid and what will keep it in liquid form. In what ways could we apply stress to test it? Let's make a list of possible stressors that could change its viscosity.

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Warning: the cornstarch will not stay mixed with the water forever. Over time, the grains of corn starch will detached from the water and form a solid cluster at the bottom of the container, so you must not pour this mixture down the drain, it could clog your pipes or plug up the drain.

Proper disposal: Pour the mixture into a zipper-lock baggie and dispose of it in the trash bin.

August's Mystery: "Flubber" is it liquid or solid?

***Supplies*:**

- Box of Cornstarch
- Plastic Container with lid
- Water
- Spoon
- Food Coloring
- Paper towels
- Sandwich baggie
- Table covering

Science Behind Non-Newtonian Flubber:

In this experiment we will make a Non-Newtonian Fluid we will call "flubber," to study the science behind the viscosity of liquids. **Viscosity** is a fluid's measurable thickness or resistance to flow. Honey, ketchup, and molasses are examples of liquids that have a high resistance to flow or a high viscosity level. Sir Isaac Newton stated that the viscosity of a fluid can be changed only by altering the fluid's temperature, for example motor oil or honey flows more easily when it warms up and becomes thicker when it gets cold. A Non-Newtonian fluid reacts the same with temperature increases or decreases, but its viscosity can also be changed by applying pressure or stress. In our experiment you will see that if you squeeze a handful of "Flubber" its viscosity will increase and it will act like a solid until pressure is released. When you release pressure, the "flubber" returns to its liquid form.

Flow for Each	Room Temperature	Refrigerated	Warmed Up	Best Results?
Honey				
Syrup				
Ketchup				

Depending on age, the chart can be collected in Seconds or Fast & Slow.

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What to Do:

Step 1: Measure 1 cup of cornstarch and pour into plastic container.

Step 2: Add 1/2 cup water to the cornstarch.

Step 3: Pick a color and add 2 drops of food coloring to the mixture.

Step 4: Mix the water, corn starch and coloring with a spoon. Add more water or cornstarch as needed. The mixture should be "liquid like" but not too watery or have clumps remaining.

Step 5: Test the Flubber… What makes it act like a liquid? What makes it act like a solid?

Step 6: Place Flubber in a baggie to take home or to throw away see disposal method on previous page.

Go Over Findings:

Give examples of a liquid, a solid and a gas.

Ask "Can you have a solid and a liquid at the same time?" "Is there a name for this?"

Ask "What is the resistance of flow called?" Answer: Viscosity.

Ask "Who is the scientist who studied the viscosity of liquids?"

Can you think of a career where you might work with liquids, solids and gases?

Investigate, Create, & Take: Investigators can take with them:

- ✓ The Flubber

Sources:

Science Learning Hub by The University of Waikato, Non-Newtonian fluids: http://sciencelearn.org.nz/Science-Stories/Strange-Liquids/Non-Newtonian-fluids

Steve Spangler, Non-Newtonian Cornstarch Recipe: http://www.stevespanglerscience.com/lab/experiments/non-newtonian-fluid/

Additional Links:

Cornstarch Walk on Water - Cool Science Experiment by Sick Science and Steve Spangler: https://www.youtube.com/watch?v=GkY2nT-3Glo

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