Name:_____
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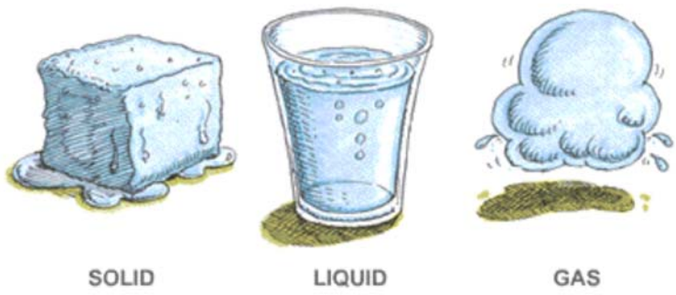
Making OOBLECK!

The everyday materials around us generally fit into one of three categories: solid, liquid, and gas. Along with plasma, these three categories represent the different possible states of matter. A table is solid, while the air we breathe is a gas. Some materials can even transition between the different states. For example, water can exist as a solid (ice), a liquid (water), or a gas (steam or vapor) as shown here:



In this lesson, we will explore the properties of “oobleck” – a simple mixture of cornstarch and water. Oobleck is unique because it can behave as both a solid *and* a liquid. Many centuries ago, Sir Isaac Newton proposed that fluids should flow at a predictable, constant rate. Many fluids do indeed behave this way and are called “Newtonian” fluids. Water is a perfect example of a Newtonian fluid: when you are in a swimming pool, water flows around you whether you are moving around quickly or slowly.

However, as you will soon discover for yourself, oobleck does not behave as a typical Newtonian fluid. Oobleck belongs to a class of materials known as “non-Newtonian” fluids. Unlike water and other Newtonian fluids, non-Newtonian fluids respond differently depending on how quickly you try to move them around (the “strain rate”). If you could go swimming in a pool of oobleck, the oobleck would feel like a liquid when you moved slowly, but would act like a solid if you tried to swim around quickly.

There are many examples of non-Newtonian fluids, and understanding the behavior of non-Newtonian fluids is important for many areas of scientific research. For example, the food industry deals with many non-Newtonian fluids including ketchup, mayonnaise, jelly, and cranberry sauce. Understanding how these materials behave helps food scientists make more tasty food products. Biologists studying cells are also interested in non-Newtonian fluids because the goopy insides of cells behave as non-Newtonian fluids and this influences many cellular processes. Engineers are even finding ways of putting non-Newtonian fluids to good use in our everyday lives by using them to fill potholes!

1. In the space below, write down the different properties of **liquids and solids**. Write down your ideas. *Some examples: liquids flow, splash, take the shape of the container they are in; solids hold their shape, resist forces like pushing or hitting* etc…

2. At each of your desks you will see the following items:

Measuring spoons	Individual 80 mL beakers
A beaker of water	Stirring rods
A beaker of corn starch	Food colouring

Together with your partner you will make a small beaker of oobleck:

a. Put 3 tbsp (45mL) of cornstarch in a bowl and add a small drop of food coloring (optional).

b. Slowly add up to 2 tbsp (~30 mL) of water while mixing, until all the cornstarch is wet.

c. Keep adding water until the oobleck feels like a liquid when mixed slowly.

d. Oobleck is done when it is no longer powdery (needs more water) but doesn't splash when hit with a spoon (needs more corn starch).

3. Use the list you made in step one to systematically test whether oobleck behaves like a solid or a liquid. It may be helpful to also test a bowl of pure water for comparison with a "true" liquid. *Does the oobleck flow? What happens when you squeeze it in your hand? Hit it with a spoon? What happens to the water when you do the same?*

4. After establishing that oobleck can act like a solid *and* a liquid, explore how these behaviors relate to the "strain rate" – how fast you try to move or perturb the oobleck.

a. Try stirring the oobleck with your finger. If you stir quickly, the oobleck should resist. If you stir slowly, the oobleck should give way.

b. Try modeling quicksand (another non-Newtonian fluid) by letting your fingers sink to the bottom of the bowl and trying to remove them quickly. What happens?

c. Try your hand at levitation! Put the oobleck into a lightweight bowl or cup. Dip your fingers or a spoon into the oobleck and then quickly lift upward. You should be able to momentarily bring the entire container up in the air before it starts falling down.

5. Be sure to completely clean up all equipment and wipe off your desktops when complete!