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Name of this activity: Solid, Liquid, Both or Neither?

Synopsis of the Activity: Participants will make a mixture of cornstarch and water, commonly called oobleck. The mixture behaves as a solid when pressure is applied to it, and as a liquid otherwise. The participants are asked to determine whether the mixture is a solid or a liquid. Through exploration and guided questions participants should determine that sometimes it is a liquid and other times it is a solid, and under what conditions these two states of matter occur.

Audience: 4th grade and up

Activity (Learning) Goals: Students will think critically about what it means to be a solid or a liquid through attempting to characterize a substance that is not clearly one or the other. At the end of the activity the students should understand that the substance can be either under different conditions that affect its state of matter.

Concepts Addressed: states of matter, forming and testing hypotheses

Materials: 3 cups plus $\sim 1/4$ cup cornstarch/participant, ~ 1 L of water, 1 small bowl/participant, 1 metal L-joint with lengths of sides about 2", one container 1 L in volume that can fit the L-joint, $1/8$ or $1/4$ cup measuring container, 1 roll paper towels, a solid (e.g. small rock) for comparison, a bowl of water for comparison

Preparation and Set-up: Mix 2 cups cornstarch and about three quarters of a cup of water in the 1 L container. It should be fairly thick but still look like a liquid, and you should be able to pick it up with your hands, i.e. it should be thick enough to become a solid when pressure is applied. If the mixture is thin and watery add cornstarch. If the mixture is so thick that it doesn't melt like a liquid when you stop squeezing the part you pick up then add a bit of water. The L-joint should sink freely in the mixture, check this and remove the L-joint. Set out a bowl of liquid and a solid for comparison.

Guiding Questions:

1. Is this a solid or a liquid?

2. Can you pick up a liquid?
3. Can you stir a solid?
4. What happens if you stir it fast (with finger)?
5. When you pick it up you are squeezing it. What happens if you continue or stop squeezing it?
6. Does it sometimes seem like a solid and other times seem like a liquid, does it always seem like both a solid and a liquid, or something else?
7. Do you know of anything that can be a solid or a liquid? What about water?
8. What makes water change from a solid to a liquid?
9. What is making the oobleck change from a solid to a liquid?

Activity Description and Teaching Strategies:

1. **Engage** Show a video of people running across a pool of oobleck

<https://www.youtube.com/watch?v=yHlAcASsf6U>

Talk about how you were trying to figure out whether this was a liquid or a solid, they can run across it so it seems like a solid but they make waves so it seems like a liquid. Audience should try to help you figure it out. Then say you are going to make some of the stuff. Each audience gets a bowl. Pass around cornstarch telling each person to measure out 1/4 cup, then pass around water telling each to measure 1/8 cup and mix the two with their fingers.

2. **Explore** Ask them if it is a solid or a liquid. Compare with the bowl of water and solid that have been placed out.
3. **Explain** Ask guiding questions to try to have students reach the conclusion that it is either a solid or a liquid under different conditions, i.e. when pressure is applied or not.
4. **Elaborate** Tell the students that sound consists of pressure waves, and that when we speak our mouths are sending pressure waves through the air that vibrate in our ears and allow us to hear. Say that this is how speakers

work, they vibrate which sends pressure waves through the air. Show a video of oobleck on a speaker

<https://www.youtube.com/watch?v=3zoTKXXNQIU>

Explain how the vibrations send pressure waves through the oobleck, causing it have properties of a solid and that this allows it to do strange things like “stand up” on the speaker.

5. **Evaluate** Ask the question “How would you escape from a pool of oobleck if you sunk into one?” If you would like you can show a video of people getting stuck in oobleck on youtube

<https://www.youtube.com/watch?v=KoJWX2gGZKE>

“Would you want to move fast or slow, and why?” “What do you think will happen if you move fast or slow?” Here you can lightly drop the L-joint into the large pool of oobleck prepared previously. Say “This is a model foot, we are going to try to get it out of a pool of oobleck.” Perform their suggestions or have them experiment with the foot. Some people will want to just pull really hard on the L-joint to get it out. You could say “Well you might pull a muscle if you were doing that, this is just a small model foot, a large foot would be much more difficult to move, just like its easier to lift your finger out of this pool than the larger model foot. How could you get out without risking hurting yourself?” They should come to the conclusion that the best way to get out is to move slowly so that the oobleck remains in the liquid state, it is a lot easier to move in a liquid than in a solid!

Vocabulary solid, liquid

Miscellaneous Information The oobleck is safe to eat although it doesn’t taste very good. It won’t stain clothes. Hands are best cleaned in a sink.

Scientific Content Background and Additional Resources

(a) http://en.wikipedia.org/wiki/Non-Newtonian_fluid

(b) <http://www.wired.com/2012/07/oobleck-explained/>

(c) <http://imaginationstationtoledo.org/content/2010/12/oobleck-a-non-newtonian-substance/>