Oobleck: A Program about States of Matter
Presented by the Sciencenter in Ithaca, NY

Program Overview

Oobleck introduces students to states of matter and scientific observation. The program is designed for classes or home-school groups of up to 24 students in grades K-3. Each program runs approximately 50 minutes, and is held in the Sciencenter's classroom.

Students begin by sharing and activating prior knowledge the processes of observation and description and also about states of matter. The students break into groups and use their senses to observe and describe the properties of a solid, liquid and gas. They are then given a third substance called oobleck, which behaves sometimes like a liquid and other times like a solid depending on the force applied. After observing and describing the properties of oobleck, students are encouraged to determine whether the substance is solid or liquid and explain why. *(For background information about oobleck and states of matter, see page 2.)*

Although there are a number of learning objectives, students may not grasp them all during the program. Post-program activities will reinforce their learning and help broaden their understanding.

Learning Objectives:

Students will be able to:

- Define matter as anything that has mass and takes up space.
- Explain that almost all matter on Earth is in one of three states: solid, liquid, or gas
- Define solids, liquids and gases in terms of some of their properties and give examples of each.
- Explain that scientific observation consists of using five senses to obtain information.

Students practice the following process skills:

- Scientific observation, description, and classification
- Interpreting data, and drawing conclusions.

New York State Math, Science and Technology Curriculum Standards:

Standard 1 Analysis, Inquiry and Design

Scientific Inquiry

1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing creative process.
2. Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

Standard 4 Science

The Physical Setting

3. Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
5. Energy and matter interact through forces that result in changes in motion.

Background Information

How do scientists know what they know? Scientists use their five senses to explore the natural world. In this program students become aware of how they gain knowledge and get to become scientists by systematically observing and describing things from a scientific perspective.

"Oobleck," named for the mysterious green substance described in the Dr. Seuss classic *Bartholomew and the Oobleck*, is a non-newtonian fluid meaning it doesn't follow Newton's laws of motion. A non-newtonian fluid (like oobleck or silly putty) has a different viscosity depending on the force applied. By contrast, newtonian fluids (like water) have a constant viscosity at a given temperature. No matter how fast you stir them they never get thicker or thinner.

Oobleck is a mixture of cornstarch and water. As a mixture of a solid and a liquid, it takes on properties of both, and behaves in unpredictable ways. In liquids, the bonding or attraction between molecules is weak, allowing the molecules to easily flow past one another and rearrange, giving liquids their characteristic properties. In solids, the bonding between molecules is much stronger. The molecules cannot be easily rearranged, so the solid keeps its shape.

In oobleck, the relatively large solid cornstarch molecules form long chains. The smaller water molecules flow past each other and between cornstarch molecules allowing the chains to slide and flow around each other. This is why oobleck behaves like a liquid when it is not under pressure. When you squeeze or press on oobleck, the water is temporarily forced out of the mixture and the starch molecules are pressing against each other, causing the mixture to behave like a solid.

Resources

Websites

Answer from a Cornell scientist about why Oobleck behaves as it does:

http://www.ccmr.cornell.edu/education/ask/?quid=14

Sites for kids about matter, phase change, and energy:

http://www.chem4kids.com/files/matter_intro.html
http://www.nyu.edu/pages/mathmol/textbook/statesofmatter.html
http://www.school-for-champions.com/science/matterstates.htm
http://www.edinformatics.com/math_science/states_of_matter.htm
http://www.abpischools.org.uk/resources/solids-liquids-gases/index.asp

Books

Bayrock, Fiona. *States of Matter: A Question and Answer Book*. Mankato, MN: Capstone Press, 2006.

Seuss, Theodor Geisel. *Bartholomew and the Oobleck*. New York: Random House, 1949.

VanCleave, Janice. *Chemistry for Every Kid: 101 Easy Experiments that Really Work*. New York: John Wiley & Sons, 1989.

Weidner Zoehfeld, Kathleen. *What is the World Made of? All About Solids, Liquids, and Gases.* New York: Harper Collins, 1998.

Classroom Activities

States of Matter!!!

Familiarize students with three states of matter and some of their properties.

Procedure

1. Assemble a collection of small solid objects such as pennies or marbles and containers of various shapes and sizes. Measure the objects (weight, size, volume), transfer them between containers, and describe their observations.
2. Distribute containers of water or juice. Measure the liquids, transfer them between containers, even pour on the ground or in the sink then record their observations.
3. "Catch" air in a plastic bag and tie it to prevent the air from escaping. Compress the sides and change the shape. Use straws to blow bubbles into a glass of water. Observe and record.

Literature Connection

Read the classic Dr. Seuss book, *Bartholomew and the Oobleck* (Random House, 1949) and see where our non-newtonian fluid got its name. Compare the substance in the story to the substance handled in the program.

Oobleck Recipe

Spend some more time exploring non-newtonian fluid at home.

Materials for 1 student

- ½ cup cornstarch
- ¼ cup water
- 1 drop of green food coloring

Procedure

1. Put the water and food coloring in a large bowl and begin adding the cornstarch while you stir or knead. Continue adding cornstarch until you have oobleck.
2. Students can take oobleck home in Ziploc bags.
3. Do not put oobleck down the drain or it will clog pipes. You can allow the cornstarch to settle, pour off the water and discard the solids in the trash.
4. Oobleck will get moldy if left out, but may be kept in the refrigerator for several days.

Glurch Recipe

Check out another non-newtonian fluid and compare this homemade silly putty to oobleck.

Materials for 1 student

- ¾ cup liquid laundry starch
- ½ cup white glue
- pinch of salt

Procedure

1. Stir together ingredients until they combine, then turn out the mixture and knead until firm. If it seems too runny, add a little more salt.
2. Have students try rolling the glurch into a ball. Let it rest in the palms of their hands. Stretch it out slowly. Pull it apart suddenly. How is it similar to oobleck? How is it different?

Glurch vs. Oobleck

Practice scientific process skills by developing questions and testing hypotheses when you compare to unfamiliar substances.

- Make a batch of oobleck and a batch of glurch and have students compare the properties of theses two non-newtonian fluids by designing "competitions" between them.
    - Which fluid spreads farther when equal amounts are placed on a desk?
    - Which can be poured faster from one container to another?
    - Which can hold a Popsicle stick upright for longest?

Oobleck Planet

Practice problem-solving skills with this assignment as the basis for a creative writing, art, or presentation project.

Procedure

1. Explain to students that they will be taking a trip to a planet that is covered in an ocean of oobleck.
2. Ask them to describe what they would expect that planet to be like? What would the inhabitants be like? How would the structures look? Write a short story.
3. Design a space ship that could land and take off on Planet Oobleck. Design space gear to keep yourself safe during their visit.
4. Draw pictures or build a model spaceship from recycled materials and present your design to the class.

Funny Fluids

Reinforce knowledge of the properties of different states of matter. Apply scientific learning to real-world questions.

Ask students to consider other substances that don't fit neatly into our definitions of solid, liquid and gas. Come up with a list of ordinary substances that students encounter regularly like toothpaste, yogurt, foam, and gelatin. Discuss their properties and decide whether they're solids, liquids, or gasses.

All Three States in One!

Challenge yourself to explain an interesting state of matter. Reinforce knowledge, practice observation skills and hypothesis testing.

Materials

- Can of shaving cream
- Paper towels

- Penny
- Magnifying lenses

Procedure

1. Squirt some shaving cream onto a piece of paper towel and observe it. If possible, examine it with a magnifying lens.
2. Try blowing gently on the shaving cream.
3. Try rubbing some between your fingers.
4. Carefully place a penny on top of the shaving cream and observe what happens.
5. Leave the shaving cream overnight and observe again in the morning. Leave it for several more days. How has it changed?
6. For clean science fun put some shaving cream directly on the students' desks. After they have observed it, they can use the soapy foam and wet paper towels to clean their desktops.

Explanation: Students have learned the properties of different states of matter, but some matter doesn't seem to fit well into any category. For example, what is shaving cream? Shaving cream is a mixture of solid, liquid and gas! The solid soap mixed with liquid water traps tiny air bubbles forming foam.

Melting Water, Drinking Steam

Observe the relationship between temperature and state change.

Materials

- Hot plate or electric kettle
- Oven mitts
- Mug or dish with a handle
- Ice

Procedure

1. Talk to students about the relationship between temperature and state change. Use the words melt, freeze, evaporate, condense. Explain that at the right temperature most substances will change state. Water is a great familiar example, but you can also talk about other familiar substances that can be found in more than one state such as molten metals, liquid butter, and melted sugar.
2. Ask students to predict what will happen to ice when left out over time. Hand students pieces of ice and have them describe the changes that occur.
3. Use an electric kettle or heat a pot of water over a hot plate until steam rises visibly. Ask students what is happening when water boils and what is the substance rising from the kettle. Using an oven mitt, hold a mug of ice or cool water over the steam and watch the droplets of steam collect on the bottom.

Measuring the Freezing Point

Observe the relationship between temperature and state.

Materials

- Three plastic containers
- Cooking oil

- Rubbing alcohol
- Water
- Thermometers

Procedure

1. Put some of each liquid in a container and measure the temperature. Place all three containers in a freezer.
2. Periodically check and record the temperature and the phase of all three substances.
3. Determine the freezing point by recording the temperature at which the liquid becomes a solid.

Tasty State Change

Show a state change from liquid to solid by making ice cream.

Materials

- Half and half
- Sugar
- Vanilla
- Chocolate syrup
- Ice
- Salt
- Pint-sized Ziploc bags
- Quart-sized Ziploc bags
- Thermometers

Recipe for 1 students

- ½ cup half and half
- 1 Tablespoon of sugar
- 1 squirt of chocolate syrup or a few drops vanilla

Procedure

1. Place ice in two cups. Add salt to one of the cups. Measure the temperatures in each of the cups and record them.
2. To make the ice cream, put the liquid ingredients for each student in a pint sized bag and seal carefully.
3. Place the pint bag inside a quart bag and fill on both sides with ice and salt. Seal the outer bag carefully.
4. Shake until the liquid ingredients turn into ice cream.
5. Discard salt and ice. Rinse the pint bag before opening. Students can eat ice cream directly from pint bags.