El Paso Water & SCIENCE

Phases of Matter Part 1: The Rules of Being a Solid

Grade 5th

Vocabulary

balance
centimeters
displacement
force
graduated cylinder
grams
LxWxH
mass
milliliters
millimeters
solid
tape measure
volume

Booklet Print/Fold

Activity Overview

In this activity students will investigate rules that determine if matter is a solid

TEKS Alignment

5.5 (A) Classify matter based on measurable, testable, and observable physical properties, mass magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating using water as a reference point), solubility in water, and the ability to conduct or insulate thermal energy or electric energy.

Materials

For the teacher for demonstration:

- Tracings of several objects on paper including: a hand, a shoe, a book and then an example of a chalk outline of a body in a crime scene.
- (1) clear plastic tumbler
- a hammer
- safety goggles
- (1) plastic sandwich bag
- 500 ml graduated cylinder

Per Group:

- measurement tools to measure mass (digital or triple beam balance)
- measurement tools to measure length (tape measure or ruler)
- measurement tools to measure volume of the rock and the ice cube (graduated cylinder and water, tape measure)

Per Student:

- a plastic straw for each student
- a small rock (1 inch in length) for each student
- an ice cube (appx. 1 inch ice cubes) for each student
- Rules of Solids Foldable or paper to create a foldable graphic organizer
- scissors
- pencil

Managing Materials

*This activity can be done with a student-made folded organizer or the Booklet Print/Fold available on the webpage. The student made folded organizer includes a step where students decide which rule goes to the

investigation. The booklet print/fold already provides the rule in order to save time on the activity.

*Working with ice cubes: This set of foldables investigates water in its liquid, gas and solid states. To avoid having ice cubes melt during the activity, you may want to keep the ice cubes in a freezer and set aside until ready to be used.

THE HISTORY BEHIND IT

Many communities prepare for the winter by insulating and draining pipes to avoid water freeze damages. In El Paso Texas, we are used to warmer winters and many people do not winterize their pipes. On February 1, 2011, an unexpected winter storm followed by several days of sub-freezing temperatures caused a lot of damage to homes pipes and the city infrastructure. Water and gas lines burst, and power generators failed to protect main lines. Electricity was brought into the area from elsewhere on the grid, but the city experienced rolling blackouts to help with peak demand. By the end of the winter storm, El Paso recorded freezing temperatures for 78 consecutive hours.

The freeze of 2011 taught many El Pasoans one important property of water, that water expands when freezes. In its liquid state, water molecules are loosely packed than in the crystal structure of ice. This means the ice is less dense and so takes up more space than the liquid.

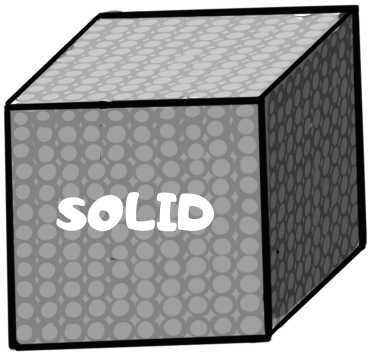
THE SCIENCE BEHIND IT: What Matters When Teaching Matter?

"Hey, how hard could this be? I know the difference between solids, liquids and gases and I'm pretty sure that my students can point them out as well."

Many teachers make the mistake of spending little time on the concept of categorizing matter, especially in the upper grades when kids seem to be able to tell the difference between the states of matter and many students even know how the structure of the matter is comprised. However, spending a couple of days learning about the states of matter will actually give your students a deeper knowledge of the characteristics of physical states while, at the same time, introduce or review Science tools and measurement for future investigations. Some teachers have classes go on a treasure

hunt to find everyday things to put into categories of the 3 states, only to realize that there are objects that may seem like a solid but behave like a liquid or seem like a liquid but behave like a solid. This teacher resource explains the 3 basic states of matter and will elaborate on some of the things that kids often have problems classifying.

The first state of matter that we will address and the easiest of the 3 to show examples of are solids. Solid objects are easy to point out and find in a classroom. In most science books you will see solids portrayed in a molecular sense in which you may have a bunch of particles tightly bound together with little or no movement (which gives them the behavior of acting solid). Usually, the model illustration looks something like this:



What many classrooms and school curriculums will do is ask the kids to create models of these particles so that they can tell the difference between solids, liquids and gases. We've seen everything from hole punched confetti to pinto beans glued down to illustrate a model of the particles of the states of matter. In fact, before doing these activities, we would suggest building such models to give your students some background information about what the particles look like so that they can relate the information back to these activities. These models also provide explanations for conductors and insulators later in the curriculum.

Even though many teachers have their students build these models, teachers don't necessarily go into the characteristics that determine how a state of matter behaves. These characteristics are the deciding factors for determining when matter is at a particular phase. In some cases in the classification process, some objects can seem to behave differently than they are supposed to, and your students may ask some tricky questions that may stump you.

Here are some basic rules of what makes a solid a solid:

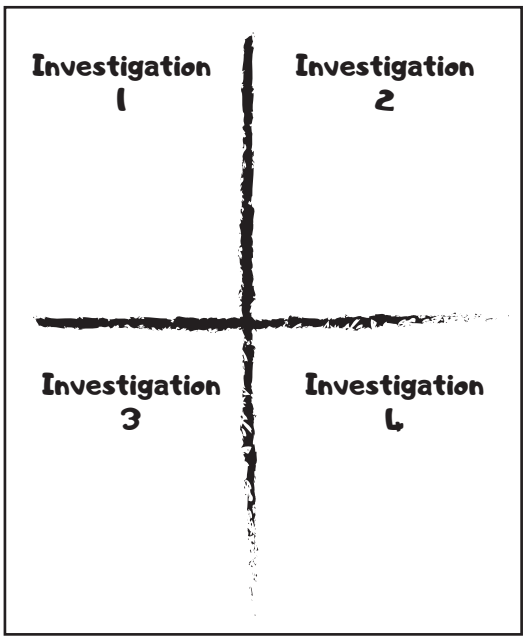
- Solid objects have a definite shape, mass, density and volume.
- Solid objects will not allow another object to pass through easily.
- Solid objects will hold their shape unless a force is applied.
- Solid objects can be measured for mass, volume and linear measurement.

Procedure: Rules of Being a Solid Foldable

Guiding Questions: How can I determine if something is a solid? Can I design a test to find out if my object is a solid?

Booklet Print/Fold

To investigate and demonstrate these rules, the students use the Booklet Print/Fold organizer provided. As the students investigate or the teacher demonstrates, the students will be responding inside the doors of the organizer. If students create it from scratch, do not have the students label each rule on the front of doors until the organizer is complete. The students will determine which rule belongs with which investigation after it is completed. At the beginning of this first day of investigations, the organizer should look like this:



ENGAGE: INVESTIGATION DOOR #1
Solid Objects Have a Definite Shape

1. **Show the students tracings of random objects (For example: a hand, a shoe, a footprint)**
Teacher: *Can we guess what these objects are, that were traced on the paper?*

Teacher: *What do all of these things have in common?*
If students cannot arrive to the conclusion that all are solid objects, guide them into the conclusion.

Teacher: *What state of matter are all of these things?*
Students should arrive to the conclusion that all the objects must be solid in order to trace around them.

Teacher: *What can we say about solid objects?*
Students should arrive to the statement that solid objects can be traced.

Teacher: *Today I am going to give you two solid objects, and you are going to prove to me and the class that these solid objects are considered solids because they follow certain rules of solids. Knowing what we just inferred about solid objects, how can you prove that this rock and this ice cube are actually solids?*

2. Students will prove that their two objects (a rock and the ice cube) are solids by tracing around the objects onto the inside of investigation door #1 in the folding organizer. Have the students respond to the question “How are you able to prove that your solid has a definite shape?”

Students should answer that their objects are solid because they can trace around them

EXPLORE: INVESTIGATION DOOR #2

Solid Objects Will Not Allow Another Object to Pass Through Easily.

1. Each student is given a plastic straw.
Teacher: *How are straws used in the real world?*
Possible answers may include that a straw is used to drink liquid. When you put the straw in the liquid the straw passes through the liquid easily.

Teacher: *Can you pass the straw through your objects as easily as you would a liquid drink?*

2. The students will investigate their rock and cube by trying to get a straw to pass through these objects as easily as it might a liquid. Inside Investigation Door #2, have them draw and label a picture of what happened and write a short description of what happened and if they were successful.

*Students should respond that they couldn't get the straw to pass through easily and you may find that some of your students strike the rock and cubes quite hard to prove that it might be able to. The straw may break a part of the rock, but it won't pass through it easily.

EXPLORE: INVESTIGATION DOOR #3

Solid Objects Hold Their Shape Unless a Force is Applied

Unless you have enough hammers and tumblers for everyone to try this demonstration individually, this activity is probably best done by the teacher.

1. **Teacher:** *Based on our last two investigations, what phase of matter is this plastic cup?*

Students should arrive at the conclusion that it is a solid because it has a definite traceable shape and that the object will not allow the straw to pass through it easily.

2. Have the students draw the cup on the inside of Investigation Door #3 and have them label it as "Before". Place the plastic tumbler into a sandwich bag and seal it.

Teacher: *What do you think will happen if we were to hit the tumbler with the hammer?*

Teacher puts on the safety goggles and proceeds to smash the cup with the hammer.

3. Have the students draw the shape of the cup afterwards as an “after” drawing. Then have them respond to the following questions.

Teacher: *Describe how the solid cup was able to change its shape. Describe a force that might be able to change the shape of your rock or your ice cube.*
Have the students write their responses in their illustrated foldable .

EXPLORE: INVESTIGATION DOOR #4:
Solid Objects Can Be Measured

Teacher: *We have been able to test our objects through 3 different investigations, but can our object be described as a solid in another way? Is it possible to take measurements of solids?*

Students should answer that solids can be massed, solids can be measured through linear measurement (length, width and height), and solids can be measured for volume.

1. Using measurement tools, the students will take the mass of the rock and ice cube. They will take the length, width and height of the cube to get linear measurement. Using the formula for volume (LxWxH), have the students calculate the amount of volume or space that the ice cube takes up. Have the students then take measurements of the rock. Because of the irregular sides of the rock, they will not be able to calculate the volume of the rock without using displacement.

So what is displacement?
Displacement is a way of calculating the amount of volume or space that an object takes up by measuring the rise of water within a graduated container.

How do you do displacement?
Teacher: *Using a graduated cylinder or small beaker that the rock can easily fit into without getting wedged into the container, fill the cylinder or beaker with water to a point it can still be measured (usually half full is fine as long as the water level will still be able to cover the rock completely when the rock is dropped into the beaker or cylinder.) Measure the amount of water in milliliters before you drop in the rock and after you drop in the rock. The difference between the two measurements is the volume of the rock, the amount of space that the rock took up in the container.*

2. *Using displacement to measure volume is how scientists can calculate the volume of irregular shaped solid objects. Larger objects are just measured in larger measuring containers.*

Have the students record all of their measurements of the rock and ice cube in the inside of Investigation Door #4.

EXPLAIN: RULES OF SOLIDS

Pulling it All Together Activity

1. Write the following rules on the board/whiteboard in this order so that students can choose which statement went with which activity:
   a. Solid objects can be measured.
   b. Solid objects will change shape when a force is applied.
   c. Solid objects have a definite shape.
   d. Solid objects will not allow another object to pass through easily.

2. **Teacher:** *Can you tell which one of these rules of solid matter applied to the investigations that we did in class? Work with your group (or partners) to match up the right rule with the investigation in your foldable.*
   a. Solid objects can be measured. (Investigation 4)
   b. Solid objects will change shape when a force is applied. (Investigation 3)
   c. Solid objects have a definite shape. (Investigation 1)
   d. Solid objects will not allow another object to pass through easily. (Investigation 2)

3. Go to each group and verify the right answers, then have them write the rules on the appropriate doors on the outside of the foldables.

ELABORATE: INDEPENDENT RESEARCH

1. Students will find a solid object either at home or at school and will use the four rules of solids to prove that their solid object is actually a solid. They will draw and label the object in their science journal and write a paragraph describing how they could test their object to prove that it was a solid using all four rules. Some questions that they may answer in their paragraph might be:

   - How can I prove it has a definite shape?
   - Could another object pass through my object easily?
   - What kind of force could be applied in order to get my object to change its shape?
   - How could I measure my object so that I could find its mass, length, width, height and volume?

VOCABULARY

balance	An even distribution of weight enabling someone or something to remain upright and steady.
centimeters	A metric unit of length, equal to one hundredth of a meter.
displacement	The moving of something from its place or position.
force	Strength or energy as an attribute of physical action or movement.
graduated cylinder	A tall narrow container with a volume scale used especially for measuring liquids.
grams	A metric unit of mass equal to one thousandth of a kilogram.
LxWxH	Length x width x height
mass	A coherent, typically large body of matter with no definit shape.
milliliters	One thousandth of a liter (0.002 pint).
millimeters	One thousandth of a meter (0.039 in.).
solid	Firm and stable in shape; not liquid or fluid.
tape measure	A length of tape or thin flexible metal, marked at intervals for measuring.