

CT Science Standard 2.1- States of Matter

Materials can be classified as solid, liquid or gas based on their observable properties.

2.1 States of Matter



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Summary

Matter changes state---from solid to liquid to gas and back again, right before our eyes, but sometimes we don't even notice this wonder of science. Your students will explore the states of matter, learning to categorize different materials using the properties that distinguish them as solids, liquids or gases. While visiting the CT Science Center, your students may deepen their experiences and knowledge about the properties of matter and the 2.1 Science Standard as they use the Trail Guide questions and visit the Galleries.

This unit has been developed to complement some of the core themes, content standards and expected performances of the CT Core Science Frameworks, as well as the National Science Education Standards. It is a supplemental series of "hands-on" investigations that are inquiry-based and designed to engage students as well as to enhance and build upon their prior content knowledge. It may be integrated with other subjects or it may be taught in its entirety within the science classroom.

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CT State Frameworks for “Properties of Matter”

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The complete CT Core Science Curriculum Frameworks is available at the website <http://www.state.ct.us/sde/curriculum/>. See also: American Association for the Advancement of Science, *Atlas of Science Literacy*, Project 2061. In addition, Grade Level Expectations (GLEs) were released in June, 2007, to “unpack” the science content for grades K-5. Content standard 2.1 examines some of the basic properties of matter.

Following are the specific sections from the CT Core Science Curriculum Framework that are addressed in this unit. The A INQ information reflects the process skills intended for grades PreK-2 specifically representing the content standards of scientific inquiry, literacy, and numeracy.

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Content Standards	Expected Performances
<p>SCIENTIFIC INQUIRY</p> <ul style="list-style-type: none">Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena. <p>SCIENTIFIC LITERACY</p> <ul style="list-style-type: none">Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science. <p>SCIENTIFIC NUMERACY</p> <ul style="list-style-type: none">Mathematics provides useful tools for the description, analysis and presentation of scientific data and ideas.	<p>A INQ.1 Make observations and ask questions about objects, organisms and the environment.</p> <p>A INQ.2 Use senses and simple measuring tools to collect data.</p> <p>A INQ.3 Make predictions based on observed patterns.</p> <p>A INQ.4 Read, write, listen and speak about observations of the natural world.</p> <p>A INQ.5 Seek information in books, magazines and pictures.</p> <p>A INQ.6 Present information in words and drawings.</p> <p>A INQ.7 Use standard tools to measure and describe physical properties such as weight, length and temperature.</p> <p>A INQ.8 Use nonstandard measures to estimate and compare the sizes of objects.</p> <p>A INQ.9 Count, order and sort objects by their properties.</p> <p>A INQ.10 Represent information in bar graphs.</p>

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Grade 2	
Core Themes, Content Standards and Expected Performances	
State Framework	CMT Correlation
<p><i>Properties of Matter - How does the structure of matter affect the properties and uses of materials?</i></p> <p>2.1 – Materials can be classified as solid, liquid or gas based on their observable properties.</p> <p>◆ Solids tend to maintain their own shapes, while liquids tend to assume the shapes of their containers, and gases fill their containers fully.</p>	<p>A 18. Describe differences in the physical properties of solids and liquids.</p>

SCIENCE CONTENT STANDARD 2.1

GRADE-LEVEL CONCEPT: ◆ Solids tend to maintain their own shapes, while liquids tend to assume the shapes of their containers, and gases fill their containers fully.

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Unpacked Content Standards:

1. All materials (matter) take up space. Matter can be classified by whether it is in solid, liquid or gas form. Each state of matter has unique properties.
2. Solids are the only state of matter that keep their own shape. A solid's shape can only be changed if a force is applied to it, such as hammering, slicing or twisting. Solids can be hard, soft, bouncy or stretchy.
3. Solids take up a certain amount of space (volume); the volume does not change if the solid is placed in different containers.
4. Liquids do not have their own shape; they go to the bottom of a container and take on the shape of the part of the container they occupy. Liquids pour and flow from a higher point to a lower point; some liquids flow faster than others.
5. Liquids have a definite volume. When a liquid is poured into different containers, the shape of the liquid may change, but the volume does not.
6. Gases do not have a definite shape; they take on the shape of whatever container they occupy. For example, the air in an inflated balloon can be squeezed and reshaped.
7. Gases do not have a definite volume; they spread out in all directions to fill any size container, or they keep spreading in all directions if there is no container. For example, blowing even a small amount of air into a balloon immediately fills the entire balloon; the smell of baking bread eventually fills the entire house and even outside.

KEY SCIENCE VOCABULARY: property, classify, matter, state of matter, solid, liquid, gas, volume

Grade Level Expectations

1. Compare and contrast the properties that distinguish solids, liquids and gases.
2. Classify objects and materials according to their state of matter.
3. Measure and compare the sizes of different solids.
4. Measure and compare the volume of a liquid poured into different containers.
5. Design a simple test to compare the flow rates of different liquids and granular solids.

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Massachusetts Learning Standards

Physical Science

PreK-2

1. Sort objects by observable properties such as size, shape, color, weight, and texture.
2. Identify objects and materials as solid, liquid, or gas. Recognize that solids have a definite shape and that liquids and gases take the shape of their container.

Grades 3-5

2. Compare and contrast solids, liquids, and gases based on the basic properties of each of these states of matter.

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Safety Standards

1. Be aware of food and latex allergies among your students---do not use foods that are know allergies, and substitute non-latex materials for the gloves and balloons used if needed.
2. Goggles should be worn if any object being used may splash, break, or be tossed.
3. When smelling odors in science, students should be shown the “wafting” method, whereby using their hand, they gently waft the fumes toward their nose.
4. Review expectations for appropriate behavior, handling of materials and cooperative group procedures to be sure that activities are accessible and safe for all students prior to beginning these investigations.
5. Make any necessary student modifications.
6. Monitor students to be sure they are acting appropriately, handling materials accordingly, and working cooperatively.
7. For more comprehensive information on science safety, consult the following guidelines:

American Chemical Society - http://membership.acs.org/c/ccs/pubs/K-6_art_2.pdf

Council of State Science Supervisors –

http://www.cssscience.org/downloads/sciaf_cal.pdf

http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/science/safety/scisaf_cal.pdf



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Misconceptions and Facts

According to Benchmarks for Science Literacy, "Students should examine and use a wide variety of objects, categorizing them according to their various observable properties. They should subject materials to such treatments as mixing, heating, freezing, cutting, wetting, dissolving, bending, and exposing to light to see how they change. Even though it is too early to expect precise reports or even consistent results from the students, they should be encouraged to describe what they did and how materials responded.

Students should also get a lot of experience in constructing things from a few kinds of small parts ("Tinkertoys" and "Legos"), then taking them apart and rearranging them. They should begin to consider how the properties of objects may differ from properties of the materials they are made of. And they should begin to inspect things with a magnifying glass to discover features not visible without it."

<http://www.project2061.org/publications/bsl/online/index.php?chapter=4#C1>

Misconception ¹	Fact
<p><u>General</u></p> <p>Materials can only exhibit properties of one state of matter.</p> <p>There are only 3 states of matter- solid, liquid and gas.</p>	<p>Materials may be in transition or may show multiple characteristics.</p> <p><u>A solid</u> holds its shape and has a fixed volume.</p> <p><u>A liquid</u> has the shape of its container, has a free surface, and a fixed volume.</p> <p><u>A gas</u> takes the shape of its container, and the volume of its container.</p> <p>There are actually 5 states of matter—solid, liquid, gas, plasma, and Bose-Einstein condensates. Plasma is sort of like gas, but made up of free electrons and ions of the element. You may have seen plasma—it makes up the Northern Lights and the stars. It also is seen as the glowing inside a fluorescent light bulb!</p> <p>Bose-Einstein Condensates were first predicted in 1920, but not demonstrated until 1995. They occur in only a few elements, and at very, very low</p>

¹ From <http://homepage.mac.com/vtalsma/syllabi/2943/handouts/misconcept.html#physical> credited to Hapkiewicz, A. (1999). Naïve Ideas in Earth Science. MSTA Journal, 44(2) (Fall'99), pp.26-30. <http://www.msta-mich.org> and Hapkiewicz, A. (1992). Finding a List of Science Misconceptions. MSTA Newsletter, 38(Winter'92), pp.11-14.

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	temperatures (just above absolute zero.) For more about these states see the footnote ²
<u>Changing States</u> When things dissolve or evaporate they “disappear.” Dew formed on the outside of glass comes from the inside of the glass. Mass and volume, which both describe an “amount of matter,” are the same property. Melting/freezing and boiling/condensation are often understood only in terms of water.	<p>The law of conservation of matter tells us that nothing really disappears. Even if we cannot see something, (such as a gas) doesn't mean it is not there.</p> <p>Condensation occurs when water vapor in the air turns into liquid water. Dew is a form of condensation.</p> <p>Mass is the measure of how much matter is in an object. Volume is the measure of how much space it takes up. Mass is often used in the context of weight, but in reality “weight” is based on what gravitational field the mass is being measured in. You can be “weightless” if you were in outer space, but you won't be “massless.” When changing states, the mass of a material will stay the same, although its volume may not.³</p> <p>Any material will change states, given the correct temperature and pressure conditions.</p>
<u>Gases</u> “Steam” is the visible cloud of water vapor over boiling water. Steam is visible water gas molecules.	<p>“Molecules at the surface of a volume of water will gradually evaporate as they gain enough energy to “jump” into the air. This can happen at an air temperature of around 15°C and above. Evaporation takes place slowly at these temperatures, although it is would be faster on a hot, dry summer's day.</p> <p>When water is heated to 100°C then all of the molecules quickly gain energy. At boiling point the molecules turn into steam and move into the air. It</p>

² *Two States of Matter they Didn't Teach You About in School (Until Now)* Thomas Oberst, 2005. A power point about states of matter developed under the Cornell Science Inquiry Partnership program.

csip.cornell.edu/curriculum_resources/CSIP/Oberst/Plasma_%20&_%20Bose.ppt

³ For more about this topic, see *Your Weight on Other Worlds* Exploratorium

<http://www.exploratorium.edu/ronh/weight/> Where you can input your weight on earth and see what you'd weigh on other stars, moons or planets.

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<p>Gases do not have mass.</p> <p>Air and oxygen are the same gas.</p> <p>Helium and hot air are the same gas.</p>	<p>does not take long for all of the water to change into steam.⁴ ”</p> <p>Gas does have mass and with the right equipment can be measured. Because gas molecules fill the volume of their container, they are harder to measure than a solid.</p> <p>All gases that are invisible, odorless, and colorless are not the same!</p> <p>"Air" is a mixture of many gases, including nitrogen (78%), oxygen (21%), argon (about 1%) and trace gases (far less than 1% each) of carbon dioxide, neon, helium, methane, krypton, hydrogen, and xenon.</p>
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⁴ <http://www.saburchill.com/chemistry/chapters/chap033.html>

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Pre-Visit Activities

ACTIVITIES SUMMARY

The visit to the CT Science Center begins in your classroom with pre-visit activities. It is suggested that you complete these activities as a prerequisite to prepare your students for the actual visit. It is also suggested that teachers complete the post activities and follow up assessment to integrate your visit into a meaningful unit of study.

Activity: Classifying and Observing the Properties of Materials

In this activity students will make observations about the properties and characteristics of materials that help us to classify them as solids, liquids, or gases.

The emphasis in these activities is on building the vocabulary to describe observations made, to create a definition for each classification and to apply those definitions to materials. Students will also be encouraged to refine their definitions as new observations and discoveries are made.

Science Concept

- ❖ **2.1 – Materials can be classified as solid, liquid or gas based on their observable properties.**

ENGAGING ACTIVITY

Pre-Assessment and Post-Assessment

Have students write to the following prompt in their science notebooks:

Materials can be grouped in 3 ways—as a solid, a liquid, or a gas. Give an example of each classification, and describe why that material is either a solid, a liquid or a gas.

At the completion of the activity, have students revisit the writing prompt, and then reflect on how they would answer now. Add to the prompt the following:

Materials have different properties. List some of the different properties for a solid, a liquid and a gas.

Descriptions should be more complete, with more information given by the students after completing the activity.

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Materials for the classroom

Note: Be aware of food and latex allergies among your students---do not use foods that are known to cause allergic reactions, and substitute non-latex materials for the gloves and balloons used if needed.

Make up stations to place around the classroom containing the following : (Each material may be duplicated to allow for distribution to the stations for the activity)

- Examples of solids, such as a rock, a powder (sugar or salt) in a small dish.
- Examples of liquids, such as juice in a small glass, milk, water in a clear bottle.
- Examples of gas a glass of fizzy soda, a fish tank pump with tubing run through water, a water plant such as elodea which will produce gas bubbles on the leaves when in the light, a spoonful of baking soda in a glass with a mixture of water and vinegar (discuss with students that they are observing the gas in these examples, not the liquids or solid containers)
- Pencil and science notebook for notes

Discussion

Discuss “rules” with the class. Why do we have rules?—to know how to act and what to do in a situation? Your class probably made some of their rules in the beginning of the year---have any been changed or added to? Human beings make up rules to help us understand what is going on in nature. We sometimes need to make changes in our rules with new situations. In this activity, the students will be writing their own set of rules about materials.

Look up the scientific definitions of solid, liquid, and gas in your science text book, dictionary or online. From <http://www.grc.nasa.gov/WWW/K-12/airplane/state.html>

A solid holds its shape and has a fixed volume.

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A liquid has the shape of its container, has a free surface, and a fixed volume.

A gas takes the shape of its container, and the volume of its container.

Did the class list of the rules agree with the definitions that you found? Look up “volume” and “mass” in your science dictionary, too. Discuss your rules. Which ones would the class agree to change, eliminate, or accept? Make a final list of “Our Rules about Solids, Liquids, and Gases” and put them in your science notebooks.

Discussion: You used your senses with your rules. How can you tell if something is a solid, liquid or gas? As a writing prompt, have students discuss the following questions in their science notebook:

“ Do you know that an objects is a solid, liquid or gas---

- When you see it?
- When your feel it?
- When you hear it?
- When you smell it?”

We do not taste things in Science Class! We also use the “wafting” method of smelling!

Activity: Can the state of matter change?

Materials needed

- One small ice cube for each student
- A paper towel (write the student’s name on the towel)
- The classroom rules for solids, liquids and gases
- Pencil and science notebook

1. Give each student an ice cube to place on their paper towel.
2. Make a drawing of your ice cube in your science notebook. Explain the state of matter of the ice, using the classroom definitions and properties.



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3. Observe your ice cube for 15 minutes. Make drawings of your ice cube. Explain what you are observing using your classroom definitions.
4. Discuss your observations with the class. What happened to the ice cubes? Does the state of matter change? (They gradually changed from solid ice to liquid water).
5. Place the paper towels in a sunny location or near a heater for part of the day or overnight. Ask students to notice if there is any ice left or water on the towel when you first put your towels away.
6. Later, ask the students to take out their ice cubes---when they say they have disappeared, ask where the ice went. This discussion will lead to the fact that it has evaporated---turned into a gas! Discuss if they have noticed other liquids that evaporate.



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2.1 States of Matter

Science Center Classroom Activity

2.1 Materials can be classified as solid, liquid or gas based on their observable properties.

GLEs

1. Compare and contrast properties that distinguish solids, liquids, and gases.
2. Classify objects and materials according to their state of matter.

Materials Needed:

Introduction- 2 sets of balloons –one ice balloon, one with water, and one with air. (balloons are the same color and size)

Activity A- a block of wood (#1), a squishy ball (#2), and a bag of water (#3) (one set for each group) *Note- freezer bags are used for all stations due to their strength and everything should be double bagged so that items do not leak out of their respective bags.

Activity B- a balloon (#1), a marble (#2) and a cube (#3) (one set for each group)

Activity C- a room temperature sponge (#1), a room temperature bag of corn syrup (#2) and an ice cube in a container (#3) (one set for each group)

Activity D- a wiffle ball (#1), a ping-pong ball (#2), and a water balloon (blown up to the size of the ping-pong ball (#3) (one set for each group)

Activity E- test tube of sand and water (#1), a bag of beads and sand (#2) a cup of seltzer water (#3) (one set for each group)



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Introduction: (10 minutes)

We have 3 balloons on the demonstration table: one filled with frozen water, one with water, and one with air. We will investigate the contents of the three balloons. Are they all the same? They are the same size and the same color. They are all balloons but are they different? We pass a balloon filled with air around throughout the classroom for the students to touch. We investigate the balloons by demonstration. You try to squeeze the frozen water balloon. Show it is rigid underneath and does not change its shape. Now open the frozen water balloon with scissors. You can see the large ball of ice. Place it in a container. We will then investigate the balloon with water in it. Squeeze it and show we can change its shape. We will then open the water balloon (by poking with a pin) and let the water drain out into a large container. There was water inside that balloon but was there anything inside the other balloon? You can see the water that came out of the water balloon but could not see the air that came out of the first balloon. Take the water from the balloon and put it in different shaped containers. Show that the water can change its shape. We will investigate the balloon with air. Squeeze it and show that we can change its shape. We will open the balloon with air and let the air out (our balloon is tied closed so we poke a hole in it with a pin). Combine the information on all three balloons into large chart. Show this on the Starboard (interactive whiteboard). If you do not have a starboard you can list them on a standard whiteboard in front of the classroom. Students will have an observation sheet where they will be able to write Yes or No for their choices.

Material	Does the Volume Change?	Does the Shape Change?
Balloon #1		
Balloon #2		
Balloon #3		

Balloon #1 = Ice Balloon #2 = Water Balloon #3 = Air



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States of Matter- Which is a solid, which is a liquid, which is a gas? Why? Assign a name to each balloon- solid, liquid or gas based on the characteristics above.

Material	Does the Volume Change?	Does the Shape Change?	Solid?	Liquid?	Gas?
Balloon #1					
Balloon #2					
Balloon #3					

Teacher's notes:

- 8. Solids tend to maintain their own shapes. Solids take up a certain amount of space (volume); the volume does not change if the solid is placed in different containers.
- 9. Liquids tend to assume the shapes of their containers, Liquids have a definite volume. When a liquid is poured into different containers, the shape of the liquid may change, but the volume does not.
- 10. Gases do not have a definite shape; they take on the shape of whatever container they occupy. For example, the air in an inflated balloon can be squeezed and reshaped. Gases do not have a definite volume; they spread out in all directions to fill any size container, or they keep spreading in all directions if there is no container. For example, blowing even a small amount of air into a balloon immediately fills the entire balloon; the smell of baking bread eventually fills the entire house and even outside.

We will now experience six different activities where we will investigate different questions. We will observe different objects. We will ask specific questions about these objects and include them in our chart. Are they a solid, a liquid, or a gas? Ask them to write YES or NO for each object and to think about why they are choosing that category.

Activities: (25 minutes)

Activity A- Does it Feel Hard or Soft? We provide a block of wood (#1), a squishy ball (#2), and a bag of water (#3). Ask the students if it feels hard or soft. Ask them to record the answer in their observation sheet and whether they think it is a solid,

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liquid or gas based on the characteristics they have learned so far.

Activity B- What is the shape? We provide a balloon (#1), a marble (#2) and a cube (#3). Ask the students to record the shape of the object (circle or square) in their observation sheet and whether they think it is a solid, liquid, or a gas.

Activity C- What is its temperature? We provide a room temperature sponge (#1), a room temperature bag of corn syrup (#2) and an ice cube in a container (#3). Ask the students to record whether it is warm or cold and whether they think it is a solid, liquid or a gas.

Activity D- What size is it? We provide a wiffle ball (#1), a ping-pong ball (#2), and a water balloon (blown up to the size of the ping-pong ball (#3). We ask the students to record what size it is (small or large) and whether they think it is solid, liquid or a gas.

Activity F- What is in there? It's a mystery. We provide test tube of sand and water (#1), a bag of beads and sand(#2) a cup of seltzer water (#3). We ask the students to record what they think is inside the test tubes and the bag. Encourage them to draw a picture in the space provided as many may not be able to write at this level. Is there more than one state of matter inside? You may write yes for more than one category if you think your object fits two or more but be ready to explain why.

Wrap-Up (10 minutes)

Discuss the chart they created for all the activities. What were their choices? Have the chart from the observation sheet on the Starboard. If you do not have a Starboard available write them on your standard whiteboard in front of the classroom. Check off their choices as a group. Review each activity. Activity A- Does the hardness matter? The wood may be hard or the sand may be soft but they are both solids. Activity B- Does shape matter? The marble and the cube are different shapes but they are both solids. The balloon can change its shape as there is air in inside (a gas). Activity C- Does the temperature matter? The sponge and the ice cube are both different temperatures but are still both solids. Activity D- Does size matter? The wiffle ball and marble are different sizes but still both solids. The balloon might be as large as the ping-pong ball but the balloon contains a gas and the ping-pong ball is a solid. Activity E- Are there two states of matter in the test tubes and bag? What are they? These are mixtures. We have solids and liquids together, solids and solids together, and liquid and gas together. Show pictures that represent solid, liquid and gas on the Starboard at the end of the class. We have investigated shape and volume differences. A material can be a solid, liquid or gas based on these characteristics. There are many other differences between materials but they do not necessarily determine whether a material is a solid, liquid, or gas.

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Introduction- List of Rules

Please answer YES or NO

Material	Does the Volume Change?	Does the Shape Change?	Is it a Solid?	Is it a Liquid?	Is it a Gas?
Balloon #1					
Balloon #2					
Balloon #3					

Introduction- List of Rules

Please answer YES or NO

Material	Does the Volume Change?	Does the Shape Change?	Is it a Solid?	Is it a Liquid?	Is it a Gas?
Balloon #1					
Balloon #2					
Balloon #3					

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States of Matter Student Observation Sheet

Activity A –Does It Feel Hard or Soft?

Material	Is it hard or soft?	Does the volume change?	Does the shape change?	What is it? Solid, Liquid or Gas?
#1				
#2				
#3				

Activity B- What Is It's Shape?

Material	Is it a circle or a square? (a sphere or a cube)	Does the volume change?	Does the shape change?	What is it? Solid, Liquid or Gas?
#1				
#2				
#3				

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Activity C- What Is It's Temperature?

Material	Is it cold?	Does the volume change?	Does the shape change?	What is it? Solid, Liquid or Gas?
#1				
#2				
#3				

Activity D- What Size Is It?

Material	Is it smaller or larger?	Does the volume change?	Does the shape change?	What is it? Solid, Liquid or Gas?
#1				
#2				
#3				

Activity E- What's In There?

Material	What is inside?	Does the volume change?	Does the shape change?	What is it? Solid, Liquid or Gas?
#1				
#2				
#3				

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Teacher Trail Guides

Trail Guide 6th Floor Overlook Balcony: 2.1 States of Matter

Visit the Planet Earth Gallery

Go to the 6th floor overlook balcony

Look outside over the Connecticut River. How is the water moving? Is water always a liquid?

Look behind you at the stream table exhibit. Watch the movement of the water within the water table. How is that water moving?

How does it compare to the water outside in the Connecticut River?

Teacher notes:

The changing state of water influences weather!

The precipitation that falls is part of the water cycle. Water evaporates (changes into water vapor) and then condenses as the temperature drops, changing back into liquid water. If it is cold enough, that water will become ice or snow---frozen water. Once the precipitation falls to the Earth, it will evaporate, sink into the ground, or run off into larger bodies of water. There it will evaporate into water vapor to start all over again.

Note: Second grade students have not been exposed to the water cycle yet, but see weather and the changing states of water every day.

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Trail Guide Biomechanics: 2.1 States of Matter

Visit the Sports Lab Gallery

Go to Biomechanics

Complete the three stations. Compare your results. When athletes do hard physical activities they sweat.

Did you start sweating during that activity?

Where did that water come from?

Teacher notes:

Where does the moisture come from? Sweat is transpired water and chemicals from our bodies. It comes through our skin. It started as the foods and liquids that we ate. So where does that sweat go once it comes through our skin? Not all of it will drip off of us--Sweat's job is to cool us. It does this through evaporation---changing that water from liquid to vapor as it evaporated, taking some of our heat away when it changes state!

CT Science Standard 2.1- States of Matter

Materials can be classified as solid, liquid or gas based on their observable properties.

Trail Guide Earth Observatory: 2.1 States of Matter

Visit the Planet Earth Gallery

Go to the Earth Observatory

The weather events that occur in one geographic area may not have originated in that same area. Choose an Earth event on touch screen related to storms. Watch it play out on the globe.

Watch your world at work. What type of weather do you see? Can you spot storm clouds?

Are there solids, liquids or gases on and around the earth?

What are the storm clouds? Are they solids? Is there liquid in them? Is there gas?

Teacher notes:

Weather is all about the changing state of water!

The precipitation that falls is part of the water cycle. Water evaporates (changes into water vapor) and then condenses as the temperature drops, changing back into liquid water. If it is cold enough, that water will become ice or snow---frozen water. Once the precipitation falls to the Earth, it will evaporate or run off into larger bodies of water. There it will evaporate into water vapor to start all over again.

CT Science Standard 2.1- States of Matter

Materials can be classified as solid, liquid or gas based on their observable properties.

Trail Guide Different Types of Clouds: 2.1 States of Matter

Visit the Planet Earth Gallery

Go to the Weather Station

View Different Types of Clouds

Check out the Weather Station. Most days we see some clouds in the sky. Do all of them mean that rain or snow is on the way?

Why or why not?

Spin the dial and view the different types of clouds. You can turn the dial either direction. Watch clouds form and disappear.

What type of weather is associated with each type of cloud?

How are they created?

Teacher notes: Cirrus (fair weather), Nimbostratus (produce rain or snow), cumulus (puffy-fair weather), cumulus congestus (towering cumulus- reaches higher in the sky), stratus (grey sheet-may produce drizzle-at ground level “fog”), stratocumulus (low-lying cloud formation), altostratus (made from ice crystals-form ahead of storm clouds), altocirrus (made of ice crystals- mid level atmosphere), and cirrostratus (made of ice crystals-“whitish veils”, very thin can hardly see at all).

CT Science Standard 2.1- States of Matter

Materials can be classified as solid, liquid or gas based on their observable properties.

Trail Guide Moon Projection Globe: 2.1 States of Matter

Visit the Exploring Space

Go to the Moon Projection Globe

What is on the moon?

Are there solids, liquids, and gases?

There is no oxygen. If you visit the Climate Change Theater our friend the sheep on the moon will show you that. He turns blue because he has no oxygen.

Are there other gases on the moon?

Is there liquid?

Teacher notes: In 2008 water was discovered in volcanic pearls brought back by the 1971 Apollo 15 mission.

CT Science Standard 2.1- States of Matter

Materials can be classified as solid, liquid or gas based on their observable properties.

Trail Guide KidSpace: 2.1 States of Matter

Visit the KidSpace Gallery

Explore the lego block building area within the water tables.

Can you contain a lot of water in one area?

What type of creations can you make?

Where do you see the water flowing within your own creation?

What are some of the rules you may have discovered about a liquid such as water?

Is the water changing its shape to flow over the blocks?

Are there solids, liquids, and gases in this gallery?

As you go through the other galleries think about that question. Are solids, liquids and gases present in all the galleries you will visit or have visited?

Teacher notes: This experience will get students thinking about properties of matter. Does the shape change? Does the volume change? (space it takes up). You can make connections from this gallery with the other galleries they will experience.

CT Science Standard 2.1- States of Matter

Materials can be classified as solid, liquid or gas based on their observable properties.

Student Trail Guides

Trail Guide 6th Floor Overlook Balcony: 2.1 States of Matter

Visit the Planet Earth Gallery

Go to the 6th floor overlook balcony

Look outside over the Connecticut River. How is the water moving? Is water always a liquid?

Look behind you at the stream table exhibit. Watch the movement of the water within the water table. How is that water moving?

How does it compare to the water outside in the Connecticut River?

CT Science Standard 2.1- States of Matter

Materials can be classified as solid, liquid or gas based on their observable properties.

Trail Guide Biomechanics: 2.1 States of Matter

Visit the Sports Lab Gallery

Go to Biomechanics

Complete the three stations. Compare your results. When athletes do hard physical activities they sweat.

Did you start sweating during that activity?

Where did that water come from?

CT Science Standard 2.1- States of Matter

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Trail Guide Earth Observatory: 2.1 States of Matter

Visit the Planet Earth Gallery

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Trail Guide Moon Projection Globe: 2.1 States of Matter

Visit the Exploring Space

Go to the Moon Projection Globe

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Are there solids, liquids, and gases?

There is no oxygen. If you visit the Climate Change Theater our friend the sheep on the moon will show you that. He turns blue because he has no oxygen.

Are there other gases on the moon?

Is there liquid?

CT Science Standard 2.1- States of Matter

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Trail Guide KidSpace: 2.1 States of Matter

Visit the KidSpace Gallery

Explore the lego block building area within the water tables.

Can you contain a lot of water in one area?

What type of creations can you make?

Where do you see the water flowing within your own creation?

What are some of the rules you may have discovered about a liquid such as water?

Is the water changing its shape to flow over the blocks?

Are there solids, liquids, and gases in this gallery?

As you go through the other galleries think about that question. Are solids, liquids and gases present in all the galleries you will visit or have visited?

Post-Visit Activity

This follow up activity will allow students to explore what they have learned about the characteristics of solids, liquids and gases in a fun way.

Oobleck—Just what state of matter is that stuff?

Engaging Activity

Read *Bartholomew and the Oobleck* by Dr. Seuss. Make your own “oobleck” and use your rules of solids, liquids, and gases to define what state of matter it is.

Materials for the classroom (For each 6 students):

- 1 1/2 C. Corn Starch
 - 1 C. Water
 - Food Color (optional)
 - 4 oz. cups for each student, or small zip lock baggies to hold oobleck
 - A variety of trays and containers for testing the oobleck
 - The classroom rules for solids, liquids, and gases from earlier activities
 - Pencils and science notebook
1. Have students record the recipe for oobleck in their notebooks.
 2. Mix the ingredients and allow children to experiment with the mixture. When "pushed" together, the mixture will appear dry and solid; as children let go of the mixture, it flows like a smooth liquid.
 3. Have students record their observations and decide what characteristics and properties of a solid, liquid or gas they can demonstrate with their oobleck.
 4. Have the students choose which state of matter they think the oobleck is and justify why they think their answer is the correct one. Teams of students making the same statement (oobleck is a solid) or (oobleck is a liquid) should work together to make the case for their beliefs by using evidence they have collected through their observations of the properties of oobleck.

Notes on Oobleck:

From <http://www.science-house.org/CO2/activities/polymer/oobleck.html>

When does the oobleck act like a liquid and when does it act like a solid? It acted like a solid when you rolled it, pushed it, or hit it. It acted like a liquid when you moved slowly through it, held it or set your hand on top. Oobleck acts like a solid when enough pressure is applied and acts like a liquid when little or no pressure is applied.

Why do you think it acts this way? What do polymers look like? They look like long chains. Are they big or small? It's small to us but it is big to atoms. It's big if you are standing inside of the oobleck. So there are these long chains trying to move. If I press them hard and fast what happens? They get tangled up and in the way so the oobleck can't move. If I press on the chains slowly, they have time to move.

Can you think of anything else that acts like oobleck? Quicksand does! So how do you think you should move through quicksand?

From <http://chemistry.about.com/od/chemistryhowtoguide/ht/oobleck.htm>

Oobleck is a type of non-Newtonian fluid called a dilatant.

If you slowly lower your hand into oobleck, it will sink, but it is difficult to quickly remove your hand (without taking all the oobleck and its container with you).

If you squeeze or punch the oobleck, the starch particles will not move out of the way quickly, so the oobleck will feel solid.

Oobleck can be molded in a container, but when the mold is removed, the oobleck will lose its shape.

Performance Task

Mystery Matter Detectives

Materials for the classroom

- The classroom rules for solids, liquids and gases
- Pencil and Mystery Matter Detectives worksheet
- Stations set up with “mystery matter” hidden in sealed rubber or vinyl gloves (preferably colored gloves that are opaque)
 - Mystery materials should include examples of solids, liquids, and gases.
 - Seal all gloves well and instruct student to test gently!
 - Choose some materials that are not easily identified.
 - As students will have to rely on senses other than sight, things that crunch, are lumpy or squishy are especially good in this activity. Possible materials (use what is available and your imagination!):
 - Water
 - Jello or pudding
 - A powder like flour, sugar or salt (partially or fully fill the glove—maybe one of each?)
 - Small candies—round, or maybe gummy bears or worms
 - Crunch cereal
 - Coins
 - A small helium balloon
 - Air
 - Ice cubes

1. Group students in pairs. (this activity might also be completed by individuals)
2. Place mystery gloves, marked with a letter, at each station.
3. Students will circulate to each station and judge each mystery glove using the classroom rules for solids, liquids and gases. They will determine if the material is a solid, a liquid or a gas according to the rules and properties using the Mystery Matter Detectives worksheet on page 34.
4. Students may also write down a guess of what is in the mystery glove.
5. You might request that students complete the activity in silence to discourage “sharing” of answers and to keep the sense of “mystery”.

Curriculum Embedded Guided Investigation

Elementary School Science

Content Standard 2.1

What's the Matter?



Teacher Manual

Connecticut Science Center

Sandra M. Justin, Ph D

Introduction to "What's the Matter?"

This is a guided exploration about the properties of matter. Matter may exist as solids, liquids and gases, each with identifiable characteristics. States of matter may be described by sight, by touch, by sound or by smell or taste. When young students carefully observe, describe and measure the properties of objects, a foundation is being set to allow for the development of more complicated procedures and ideas in the upper grades.

In this guided exploration, students will explore and classify objects based on their observable properties.

SAFETY NOTES:

- Review appropriate behavior expectations and cooperative peer or group work standards.
- Review the appropriate use of materials (i.e. scales, glassware, thermometers, etc) to make sure they are accessible and safe for all students.
- Monitor students to make sure they are following directions, handling materials with care and working cooperatively.
- Water spills on tile floors can make the floors slippery. Provide each group with a damp sponge so that any water spills can be immediately mopped up.

For more comprehensive information on science safety, consult the following guidelines from the American Chemical Society-

http://membership.acs.org/c/ccs/pug/K-6_art_2.pdf and the Council of State Science supervisors:

http://www.csss-scoemce.org/downloads/scisaf_cal.pdf

The Curriculum Embedded Guided Exploration "What's the Matter?" can relate conceptually to the following:

Properties of Matter: How does the structure of matter affect the properties and uses of materials?

2.1 Materials can be classified as solid, liquid or gas based on their observable properties.

- Solids tend to maintain their own shape, while liquids tend to assume the shape of the container and gasses fill the entire container.

A1. Describe differences in the physical properties of liquids.

Unpacked Content Standards

1. All materials (matter) take up space. Matter can be classified by whether it is a solid, liquid or gas. Each state of matter has unique properties.

- Solids are the only state of matter that keep their own shape. A solid's shape can only be changed if a force is applied to it, such as hammering, slicing, or twisting. Solids can be hard, soft, bouncy, or stretchy.
- Solids take up a certain amount of space (volume); the volume does not change if the solid is placed in different containers.
- Liquids do not have their own shape; they go to the bottom of a container and take the shape of part of the container they occupy. Liquids pour and flow into different containers, the shape of the liquid may change, but the volume does not.
- Liquids have a definite volume. When a liquid is poured into different containers, the shape of the liquid may change, but the volume does not.
- Gases do not have a definite shape; they take the shape of whatever they occupy. For example, the air in an inflated balloon can be squeezed and reshaped.
- Gases do not have a definite volume; they spread out in all directions to fill any size container, or they keep spreading in all directions if there is no container. For example, blowing even a small amount of air into a balloon immediately fills the entire balloon; the smell of baking bread eventually fills the entire house and even travels outside.

Underlying Science Concepts

- Objects have observable physical properties that can be described in terms such as, color, size, texture, temperature and shape.
- Objects may be measured using tools; including rulers, balances and thermometers or by using non-standard tools such as a hand or a pencil.
- Objects may be made of one or more materials that can be used to describe the object, such as wood, metal or paper.
- Some materials exist in different states: solid, liquid and gas.
- Objects can be classified or grouped into categories using observable properties.

Key Inquiry Skills

- Make observations and ask questions about objects, organisms and environment.
- Use senses and simple measuring tools to collect data.
- Make predictions based on observed patterns.
- Read, write, listen and speak about the observable world.
- Present information in words and drawings.
- Use standard tools to measure and describe physical properties such as weight, length and temperature.

- Use non-standard measures to estimate and compare the size of objects.
- Represent information in bar graphs.

Student Misconceptions

Misconception	Fact
Air and oxygen are the same thing.	Air surrounds us and is composed of a mixture of gasses. Oxygen comprises 21% of our 'air.'
Objects that cannot be seen do not exist.	Scientists use tools to observe objects that are too small to be seen with the naked eye.
When things dissolve, they disappear.	When things dissolve, they pass into solution.
Materials can only exhibit properties of one state of matter.	Materials may exhibit properties of more than one state. Some solid materials can act as a liquid (Salt takes the shape of a container. Water commonly exists in 3 states.)
Mass and volume are the same.	Volume is the amount of space an object takes up, while mass is the amount of matter in an object.

ADVANCE PREPARATION FOR THE TEACHER

1. Carefully read through all teacher and student materials. Modify the Student materials based on the needs of your students. Then print and photocopy Student materials.
2. Obtain appropriate quantities of materials requested by students and/or that you feel would be appropriate.

MATERIALS DISTRIBUTION

Get students involved in distributing and returning materials. This saves time for the teacher and also teaches students collaborative skills and self-reliance. One way to distribute materials is through a “cafeteria style” distribution center. All materials are laid out on a table or counter and each group sends a representative to pick up the required materials. Trays or plastic shoeboxes work well for transporting materials from the center to the lab groups.

ESTIMATED COMPLETION TIME AND PACING SUGGESTIONS

Class	Activity	Homework
1	Engage	As needed
2	Explore	As needed
3	Conduct Exploration and collect data	As needed
4	Conduct Exploration and collect data	As needed
5	Explain, Communicate results	As needed
6	Apply	As needed
7	Extend	As needed

PEDAGOGY: Consult the teacher notes accompanying each step of the guided investigation for suggestions related to classroom implementation, differentiation, assessment and extensions strategies. Each Teacher note is followed by a reference to the Framework inquiry skill featured in that task component. For example, the notation “**AINQ.12**” indicates an inquiry skill related to using senses and simple measuring tools to collect data.

What's the Matter?

Objectives: Students will;

1. Explore and describe various objects.
2. Classify objects based upon common properties.

Engage

This is where you 'set the hook!' Give the students something to observe or to think about, but no tools. Ask them to raise a question or to make a statement about the object(s). This is an anticipatory set to introduce them to the exercise and to set the context. This also provides an opportunity for a pretest. This is where an interdisciplinary lesson on the use of adjectives or words used to describe is valuable. Listen carefully and note any misconceptions that might arise.

This activity starts with a discussion of the word 'property.' Ask the students if they have heard the word and if they know its meaning. Discuss that the properties or characteristics of an object can describe the object, not the materials from which it is made. Hold up an object, such as an apple or a book, and ask the students to list its properties. Answers should be charted for use on a word wall. Students can do this individually or in small groups using different objects.

AINQ.14

Language Arts Connection: *This is a logical juncture to reinforce the importance of 'descriptive' words, such as pronouns, adjectives, adverbs, and prepositions, with the students. Examples of words that the students can add to a word wall are:*

hot & cold	texture	soft
shapes	moveable	hard
size	smell	colors
small	medium	large
rough	smooth	bumpy
property	characteristic	group

sort

classify

identify

Explore

Note: Investigation #1 engaged the students to use descriptive words to identify an object. This activity can be done more than once, using different items that allow the students the opportunity to become familiar with the vocabulary of adjectives and synonyms.

Investigation #2 - Guided exploration

Materials:

Plain paper bags - any size

An assortment of objects - balls, wooden blocks, stuffed animals, packing peanuts, rolls of tape, marbles, crayons or pencils, small books

Tape/stapler

Observation Sheet #1

Preparation:

This activity may be done in centers or as a full class activity. Without showing the students, put one object into a bag. Label the bag, A, B, C, D, etc and seal the bag with tape or with staples. Prepare 5 or more bags in this manner.

To model the activity, the teacher might consider a 'talk aloud' with the class to explain how an object may be described. The teacher might also do a full class activity with an object so that the students clearly understand the process.

Procedure for Centers

The sealed bags should be at the center with the accompanying worksheet.

Directions:

- 1. Shake the bag.*
- 2. Describe the sounds you hear as the object moves in the bag.*

3. Write the words that best describes the object. It is not necessary to guess the name of the object.

4. Gently squeeze the bag. Add to your list of descriptive words.

Optional: Students may take turns placing an object inside the paper bag for a partner, and the partner may examine the objects and describe what might be inside

Procedure for full class or group activity.

Directions:

1. The teacher explains that there is an object in the bag. By shaking the bag and listening to the sounds the students will be able to list the properties they hear.

2. The teacher shakes the bag. The students write down the type of sound they hear and the characteristics of the object that made the sound.

3. The students break into groups of 4. Each group is given a bag or bags to examine further. The bags are rotated thorough each group.

**Hint: Prepare one more bag than is needed to allow for groups that finish quickly. If there are 5 groups, have 6 bags prepared.*

Identical bags for each group can also be prepared and distributed.

At the conclusion of the activity, the teacher opens the bag and reveals what is inside. The students check their lists and correct or add to them as necessary.

Closure:

*Students may add to the word wall. If available, students can use a thesaurus. Students can also include other sensory words that describe objects, such as smell, touch, texture, surface temperature, and other characteristics. **AINQ.14***

Moving as Molecules

This activity may be used at any time throughout this guided investigation. There are many variations to this activity, any would be suitable. This activity was adapted from, <http://www.canteach.ca/elementary/physical15.html>.

Purpose: The students will imitate the movement of molecules to assist them in visualizing and understanding the concept that molecules are in constant motion.

Directions

1. Have the whole class stand up and explain that they are now going to "become" molecules. Explain that warm molecules move around a lot and they like to spread away from each other. Ask students to do this by walking, bouncing, or dancing. The hotter the molecules are, the faster they move. Ask students to act like hot molecules.
2. Next the students become cold molecules. Cold molecules like to huddle together and bounce slowly. The colder the molecules are, the slower they bounce, and when they freeze they bounce or shake very slowly, but they don't stop moving. Ask students to act like frozen molecules.
3. Say "hot molecules," "cold molecules," and "warm molecules," and students should act accordingly. Start slowly but then faster, see if the class can respond right away.
4. Instruct the students to act like a solid (huddle very close), a liquid (spread out a bit, but stay in a confined area), and as gas molecules (spread out everywhere). Make it more complicated by asking them to act like hot or cold solid molecules, hot or cold liquid molecules or hot or cold gas molecules.
5. Students can draw the moving molecules in their science notebooks. **AINQ.16**

Experiment

In this activity, students will be able to collect data and make observations as water goes through changes of state. **AINQ.12, AINQ.17**

Note: You may need to define the word "mass." Mass can be defined as the amount of matter an object contains. Weight is the result of the effect of gravity on mass. On Earth, people use mass and weight interchangeably. A method to measure mass is to weigh an object.

Materials: per group or per child

Small containers with lids, such as film canisters, small jars, or plastic containers.

Crushed ice

Balance scales

Thermometers

Notebook or Observation Sheets 3A & 3B

Procedure:

- 1. Give the students the container filled with ice. The students should mass the container with the ice and the lid*
- 2. Students will collect data and make observations of the properties of the ice.*
- 3. The students will take temperature readings and make observations as the ice melts.*
- 4. When the ice has melted, the students will take a temperature reading, the mass of the container with lid and compare the mass of the ice to the mass of the water.*
- 5. The students will place the sealed container on a shelf or counter and observe changes. (This part of the activity may last a day or two.)*
- 6. Have the students re-mass the container. Remove the lid. Ask the students to mass the container with the water and the lid. Take a temperature reading. (The students should realize that the mass is the same.)*
- 7. The students will put the container without the lid, back on the shelf. Observations should be gathered everyday until there is no water visible. (Students may mass the container every day to gather data.)*
- 8. Mass the container and lid.*
- 9. Students should make final observations and hypothesize about where the water went.*

Expected outcomes: Students should collect data that indicate that the mass of the ice and the mass of the water (melted ice) is the same. This is an indication of conservation of mass. The students need not know the terminology, but should be able to understand the concept.

As the water evaporates, discussion regarding "Where did the water go?" is appropriate. Connections to previous knowledge, such as wet bathing suits drying in the sun, puddles on the playground or drying clothes may reinforce the concept of evaporation.

*Mathematics connections: Taking the temperature of the melting ice is an authentic use of data for graph making. A line graph is appropriate. The students may make their own graph or participate in constructing a class graph. **AINQ.20***

Closure: Ask the students to recall the activity, Moving as Molecules. In small groups ask the students to act as molecules to show what happened to the ice.

1. Gather the following materials to use in planning and conducting your investigation:

Materials (Requested to be listed later....but possible ideas)	
Various types of materials and varied colors	
various size containers	
Various colored cloth	graduated cylinders
Various colored papers	various types of soils (sand vs wet soil)

*Teacher notes: Depending on the materials you are using, allow students to use their creative problem-solving skills to design their apparatus so they can collect the data they think is important for their research. Instruct each group to draw how they would set up their investigation. As a class select one plan to follow. **C INQ.5***

2. Design a procedure that will help you answer your research question. List the steps you will follow in your science notebook. Include enough detail so that anyone could repeat your experiment.

Teacher notes: Allow students ample time to talk with their lab partners about their experimental design. They need to be clear on their research question (e.g., “How does color affect its ability to gain heat?”) and how they can control all the variables to collect reliable data related to the question. C INQ.3

3. In your science notebook, record the **independent** variable you will investigate, the **dependent** variable and the variables that must be kept constant in your experiment.

Teacher notes: ▲ If your students are not experienced designing controlled experiments, you may lead a class discussion about the dependent variable (the one thing that will change) and the independent variable (the outcome to be measured). C INQ.4

4. Design a **data table** to record your findings in your science notebook.

Teacher notes: Remind students that the data table is useful for recording all quantities used in the procedure. For those students who are not yet proficient at designing their own data tables, you may want to provide them with part or all of a table (a sample is provided below): C INQ.5

	Temperature Recorded During Heating			
Surface Type	2 min	4 min	6min	8min
Sand				
Water				
Student choice				
Student choice				

5. Conduct your **experiment** and record your findings. Does the data seem reasonable? Do you need to repeat trials?

Teacher notes: This is a good opportunity to hold a class discussion about the need to do multiple trials in an experiment. Ask students what might be different if they did multiple trials. Ask them if they think there will be any difference in the results. Remind them to modify their data tables to incorporate the multiple trials. C INQ.5

6. **Calculate** the temperature of each of the samples

Teacher notes: Now is the time to use mathematics to process the raw scientific data. If students conducted multiple trials, guide them to recognize the need to find the average temperature. C INQ.6

7. **Interpret** the data. Use your calculations to help you reach a conclusion about what properties affect heat absorption.

Teacher notes: C INQ.8

Some students may choose to graph their data for analysis

EXPLAIN

Share your procedures and conclusions with others in your class. How are they alike? How are they different? What changes could be made to the procedures to make the results more similar?

Teacher notes: Lead a post-lab discussion in which data is displayed from lab groups who investigated the same independent variable. This is a great opportunity to discuss reasons for possible differences in results among lab groups. When students share their methods, others should comment about whether variables were properly controlled. Good time to talk about “experimental errors” that might affect student confidence in their results. C INQ.8

Extend

In this activity, students will develop their own system of sorting, grouping or classifying, developed by observation and manipulation of similar objects. AINQ.19

Materials:

Similar objects, such as buttons, dried peas & beans, pasta, writing instruments

Observation Sheet #2

Hint: *Each group of students should have about 20 objects to observe. Each group can have different objects with which to work.*

In this activity, the students will classify the group by a common property that they have identified. Then, they will split the group into two new sub-groups or sets using another property. In other words, the students are making a dichotomous key to sort the objects.

Procedure:

Part A

- 1. Model the activity using classroom objects that have been gathered and displayed on a table in front of the room. The items should be labeled, A, B, C, etc. Use objects such as fruit, containers (with/without lids, plastic glass, labels/no labels) or various writing objects.*
- 2. The class should name the group.*
- 3. Divide the entire group into two groups or sets, based on a common property. Name the new groups. Use chart paper or the board to identify the groups during the activity.*
- 4. Divide each new group into two new subsets, groups using the same criteria. Name the subsets or groups.*
- 5. As an option, the groups may continue to be split. A group must have at least 2 members and be named.*

Part B

- 1. Divide the class into groups of 2 or 3, depending upon materials available.*
- 2. Give each group objects to observe.*
- 3. Using the same procedure as demonstrated, the students will sort/group/classify their objects. (Emphasize that the words are synonyms.)*
- 4. The teacher should visit each student group and discuss their sorting system.*

Extension: Ask the students to re-organize their items based upon one or two characteristics. Each group will visit the other groups and try to identify which characteristics the group used to sort their items.

Applying Your Findings to Solving a Problem

In this activity, the students will use what they have learned to describe an object. They are asked to design a favor bag containing a prize for a party. The object must be a solid. Once the object has been selected, the student must design and construct a 'bag' to hold the object. The recipient of the bag must use touch or sound to identify the contents. The container could be a bag or something pliable, allowing for the sense of touch, or hard (box or plastic) so that the recipient must use their sense of hearing as

they manipulate the bag to describe the contents. Explain that the guests must identify the contents of the bags before they are allowed to open it to see what is inside.

AINQ.11, AINQ.12, AINQ.13

Materials: Small objects such as stuffed animals, markers, pieces of fruit, or candy. The students are encouraged to use an object of their own choosing.

Materials for the construction of 'favor bags.' (construction paper, plastic or foil wrap, wrapping paper, tissue boxes, plastic and cardboard containers, such as from yogurt or juice boxes.

Observation Sheet #4A - Designing the Bag

Observation Sheet #4B - What's In My Bag?

Overview of task

The students have been asked to make favor bags for parties. Explain that the guests must describe the contents of the bags before they are allowed to open the bags. The students should follow these guidelines.

- *Choose the favors or prize that will be described.*
- *Decide what type of container will hold the prize. (bag, plastic box, tissue paper)*
- *Design, draw and construct a model favor bag.*
- *The students will present their 'model' and explain why it is an appropriate favor bag.*

- Students will exchange favor bags and identify the contents.

Observation sheet #1

What's In the Bag?

Don't open the bag!

Shake the bag. What sounds do you hear?

Touch the object through the bag. How does it feel?

Bag	What I hear & Feel	Properties of object
Example (rock)	loud, moves around bag, hard, small	hard, small, round, does not weigh much
A		
B		

C		
Bag	What I hear & Feel	Properties of object
D		
E		
F		
G		

Observation Sheet #2

Can You Find My group?

Directions:

1. Name your group of items.
2. Divide the large group into 2 groups using one thing (property) that one group has that the other does not.
Name your new groups.
3. Can you divide new groups into 2 new groups? Look at the items carefully.





Name of Group

Name of Group



Name of Group

Name of Group

Observation Sheet #3A

Melting Ice

Which is heavier, a container of ice or a container of water?

What is your *prediction*? _____

Mass of Materials	
Mass of container, lid and ice	
Mass of container, lid and melted ice	
Mass of (empty) container and lid	
Was there a difference in mass? Why or why not?	

What do you *notice* as the ice melts?

Observations
Container, lid and ice
Container, lid and melted ice
Container and lid

Observation Sheet #3B

What's the Temperature?

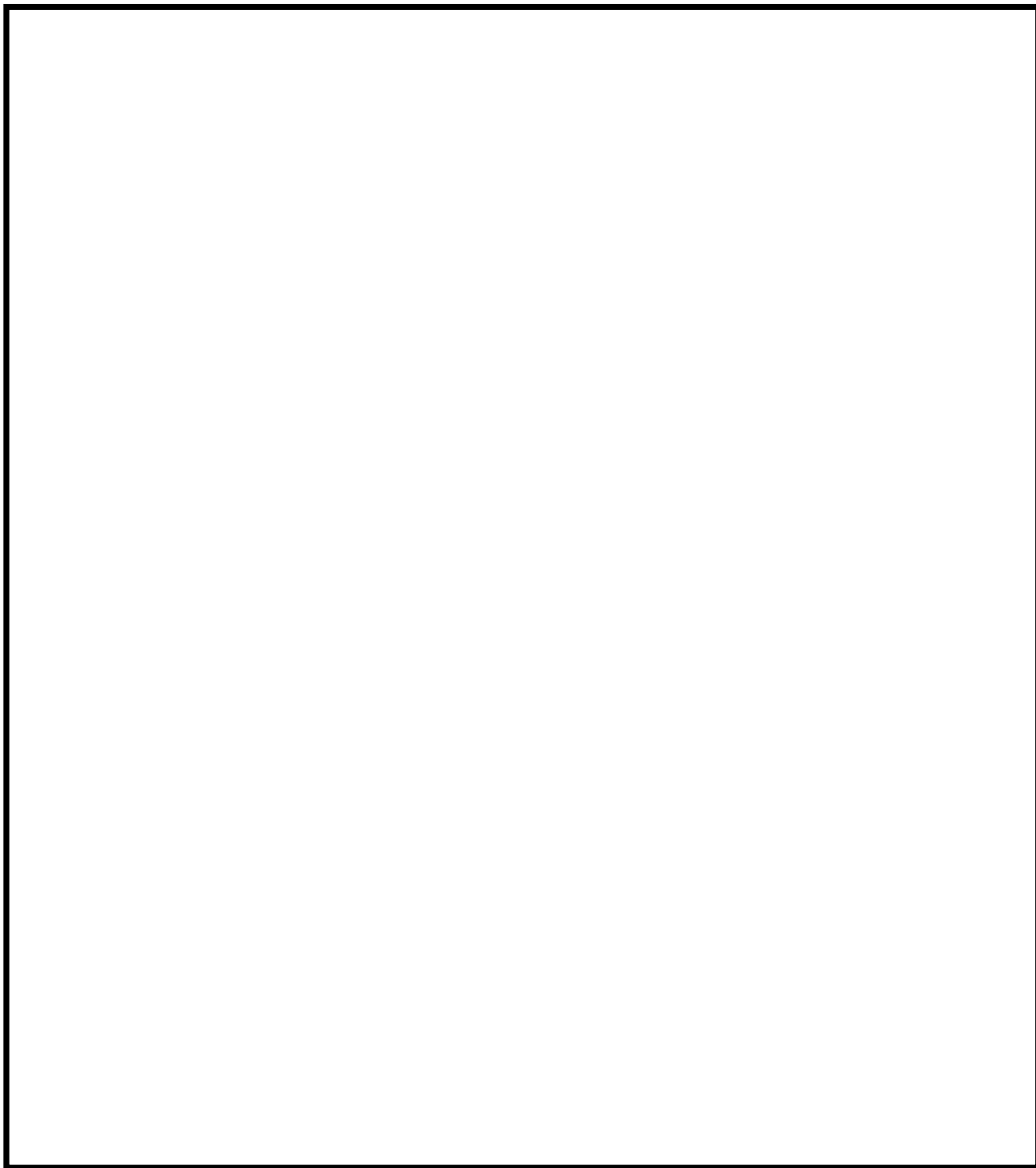
Using a thermometer, record the temperature of the ice in the container. With your class or group, decide how often to take the temperature; for example, every 2 minutes, 5 minutes or every 10 minutes.

Temperature	
Time	Temperature

Observation Sheet #4A

Designing the Bag

Your job is to design a bag for your prize.

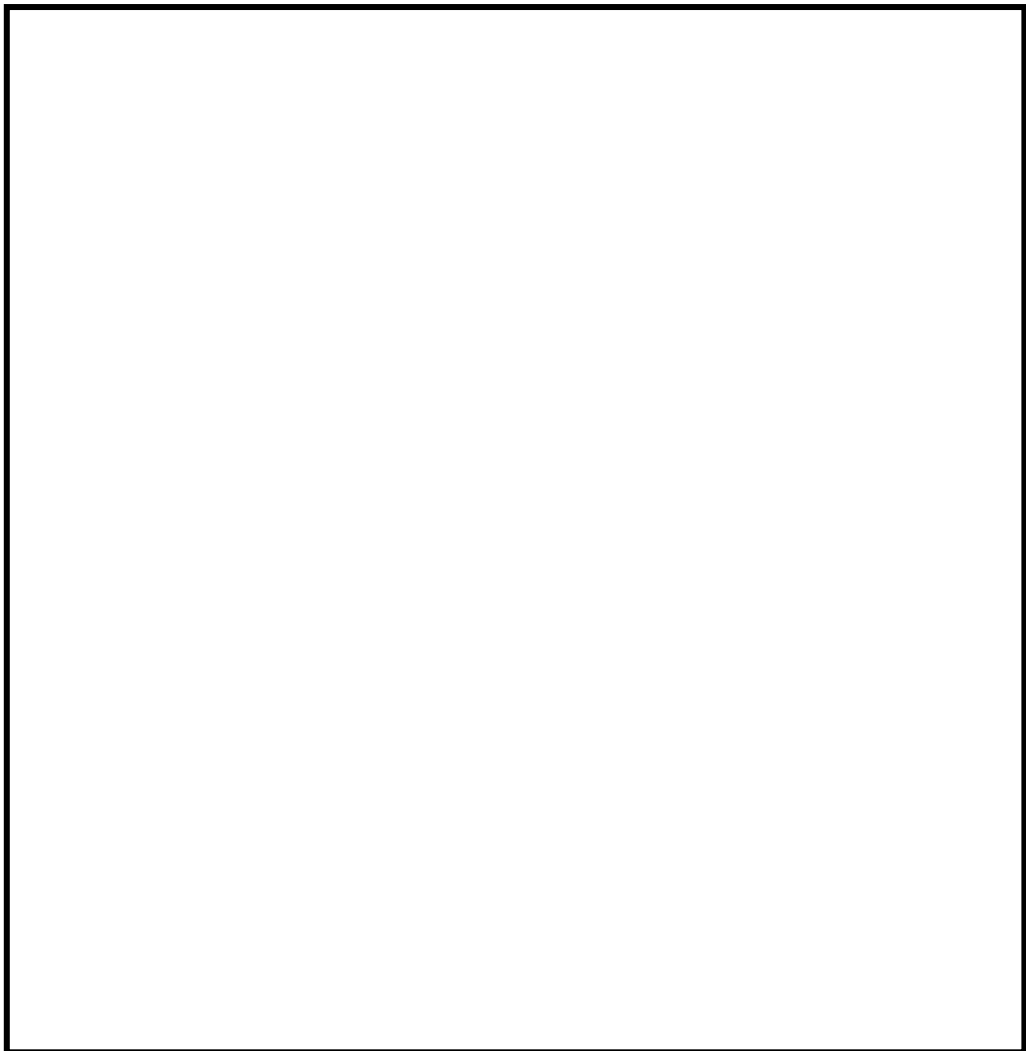


1. Draw the object.
2. Draw a bag to hold the object.
3. List the properties of the object.
4. Why did you choose the bag?
5. Why is the bag a good choice to hold the object?

Observation Sheet #4B

What's In My Bag?

Use your senses to discover what is in the bag.



1. Draw the bag.

2. Draw the shape and size of the object you think is inside the bag.

3. What do you feel?

4. What do you hear?

5. What do you think is inside? Why?

Mystery Matter Detectives Worksheet

Name: _____

Mystery Glove	Solid, Liquid or Gas?	What do you think it is?
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		

Teacher Resources

Safety Disclaimer:

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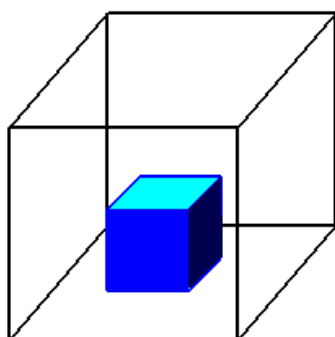
Teacher Background Information

From NASA's Glenn Research Center <http://www.grc.nasa.gov/WWW/K-12/airplane/state.html>



States of Matter

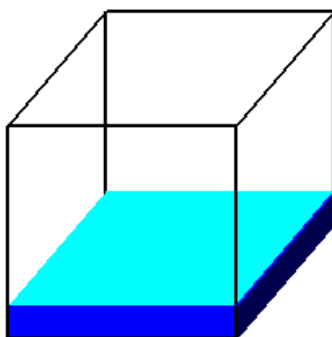
Glenn
Research
Center



Solid

Holds Shape

Fixed Volume

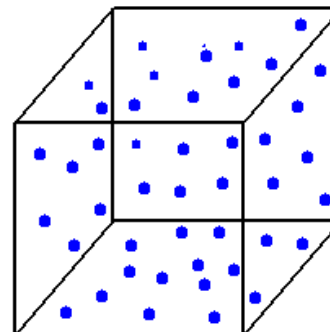


Liquid

Shape of Container

Free Surface

Fixed Volume



Gas

Shape of Container

Volume of Container

All matter is made from atoms with the configuration of the atom, the number of protons, neutrons, and electrons, determining the kind of matter present (oxygen, lead, silver, neon ...). Every substance has a unique number of protons, neutrons, and electrons. Oxygen, for example, has 8 protons, 8 neutrons, and 8 electrons. Individual atoms can combine with other atoms to form molecules. Water molecules contain two atoms of hydrogen **H** and one atom of oxygen **O** and is chemically called **H₂O**. Oxygen and nitrogen, which are the major components of air, occur in nature as **diatomic** (two atom) molecules. Regardless of the type of molecule, matter normally exists as either a **solid**, a **liquid**, or a **gas**. We call this property of matter the **state** of the matter. The three normal states of matter have unique characteristics which are listed on the slide.

Solid In a **solid** the molecules are closely bound to one another by molecular forces. A solid holds its shape and the volume of a solid is fixed by the shape of the solid. **Liquid** In a **liquid** the molecular forces are weaker than in a solid. A liquid will take the shape of its container with a free surface in a gravitational field. In microgravity, a liquid forms a ball inside a free surface. Regardless of gravity, a liquid has a fixed volume.

Gas In a **gas** the molecular forces are very weak. A gas fills its container, taking both the shape and the volume of the container.

Fluids (Liquids and Gases) Liquids and gases are called **fluids** because they can be made to flow, or move. In any fluid, the molecules themselves are in constant, random motion, colliding with each other and with the walls of any container. The motion of fluids and the reaction to external forces are described by the Navier-Stokes Equations, which express a conservation of mass, momentum, and energy. The motion of solids and the reaction to external forces are described by Newton's Laws of Motion.

Any substance can occur in any state. Under standard atmospheric conditions, water exists as a liquid. But if we lower the temperature below 0 degrees Celsius, or 32 degrees Fahrenheit, water changes its state into a solid called ice. Similarly, if we heat a volume of water above 100 degrees Celsius, or 212 degrees Fahrenheit, water changes its state into a gas called water vapor. Changes in the state of matter are **physical changes**, not chemical changes. A molecule of water vapor has the same chemical composition, **H₂O**, as a molecule of liquid water or a molecule of ice.

When studying gases, we can investigate the motions and interactions of individual molecules, or we can investigate the large scale action of the gas as a whole. Scientists refer to the large scale motion of the gas as the **macro scale** and the individual molecular motions as the **micro scale**. Some phenomena are easier to understand and explain based on the macro scale, while other phenomenon are more easily explained on the micro scale. Macro scale investigations are based on things that we can easily observe and measure. But micro scale investigations are based on rather simple theories because we cannot actually observe an individual gas molecule in motion. Macro scale and micro scale investigations are just two views of the same thing.

Plasma - the "fourth state" The three normal states of matter listed on the slide have been known for many years and studied in physics and chemistry classes. In recent times, we have begun to study matter at the very high temperatures and pressures which typically occur on the Sun, or during re-entry from space. Under these conditions, the atoms themselves begin to break down; electrons are stripped from their orbit around the nucleus leaving a positively charged **ion** behind. The resulting mixture of neutral atoms, free electrons, and charged ions is called a **plasma**. A plasma has some unique qualities that causes scientists to label it a "fourth state" of matter. A plasma is a fluid, like a liquid or gas, but because of the charged particles present in a plasma, it responds to and generates electro-magnetic forces. There are fluid dynamic equations, called the Boltzman equations, which include the electro-magnetic forces with the normal fluid forces of the Navier-Stokes equations. NASA is currently doing research into the use of plasmas for an ion propulsion system.

* Some solids, such as salt or sand, may act as a liquid, and take the shape of a container. However, it should be noted that each particle retains its own shape.

Professional Development



Come be a student for two days. Prior to bringing your class to the CT Science Center, you are encouraged to spend time at the Center and explore the exhibits and programs available to you and your students by participating in our two day Field Trip Professional Development Workshop.

During these two days, you will have an opportunity to explore the Exploring Space and Planet Earth Galleries, the Picture of Health Gallery and the Sports Lab and other relevant galleries using our standards based Trail Guides. These guides will lead you and your students on the pathway toward enjoying the museum while maintaining focus on your grade level or content standard.

You will also have the opportunity to participate as a learner in the pre visit, visit and post visit activities provided by the CT Science Center. In addition, you will participate in an Embedded Task aligned with content standard 2.1. Afterward, you will process the various activities and discuss their applications in your classroom and in your students' learning.

Interdisciplinary Connections/Extensions

Language Arts

After reading *Bartholomew and the Ooblek*, have the students write a follow-up story of what might have happened next. Include states of matter (solids, liquids, and gases) in the narrative.

Art

Different materials have different characteristics, even in the same state---sand and paper are both solids, but you can create very different things with each. Give the students 2 pieces of paper and a small cup of sand and about 3 tablespoons of white glue in a small cup. Ask them to create a desk top artwork using the materials. Have students draw their project in their science notebooks and list the properties of each of the materials they used and 6 ways that paper and sand are similar.

Mathematics

The mass of materials stays the same when they change states. Weigh ice cubes on a gram scale or balance while the water is frozen. Wait until the ice melts, and then reweigh the containers. Is the weight the same?

Social Studies

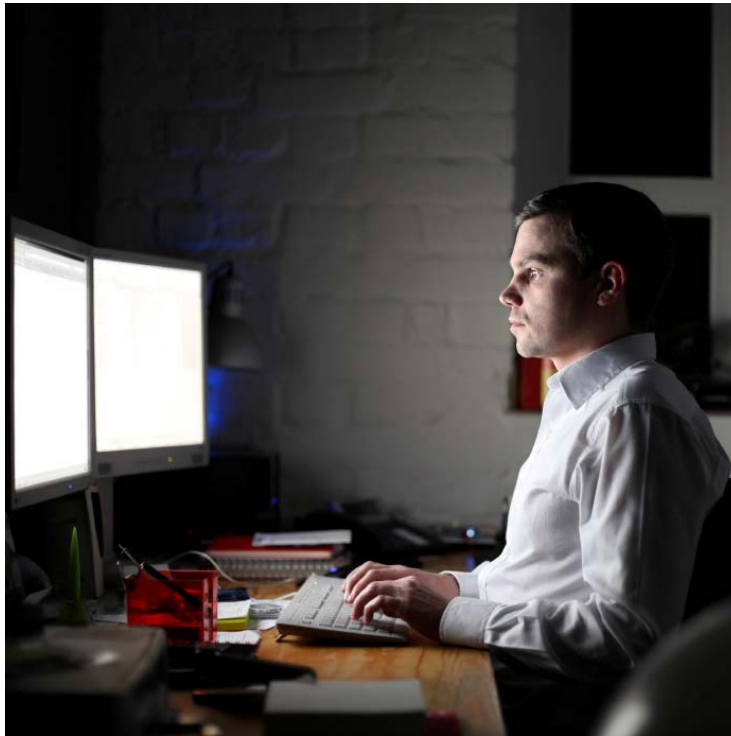
Investigate how people live when the water around them is often frozen such as native Alaskans or always liquid in tropical island cultures. How would your life be different if the temperature was quite a bit warmer or colder than it is where you live?

Websites for Teachers

Teacher Sites

Visit the Foss site for a fun interactive where kids can play “Change It,” a drag and drop game to see how heating or freezing different materials will change them. Also at this site are an Ask the Scientist features, and Home/School Connection ideas supported in both English and Spanish. <http://www.fossweb.com/modulesK-2/SolidsandLiquids/index.html>

Still want to know a bit more about solids and liquids? Have you heard that glass is really a liquid and the panes in old windows show that glass is flowing very slowly? Is it true? Check out this article by Philip Gibbs that will tell you all you ever wanted to know! <http://math.ucr.edu/home/baez/physics/General/Glass/glass.html>



Literature Links

From NSTA Recommends:

Ontario Science Centre *Starting With Science Series: Solids, Liquids and Gases* Kids Can Press Ltd., Tonawanda, NY 2000 ISBN: 1-55074-401-1 Grade Level: K-4. Primary level explorations using common household materials.

From the National Science Digital Library (NSDL) *Water, Snow, and Ice: Virtual Bookshelf* by Angela Grandstaff and Jessica Fries-Gaither at http://onramp.nsd.org/eserv/onramp:911/aug08_sl_vb.html

Water Dance. Thomas Locker. 1997. Picture book. Recommended ages: Grades K-5. Although this book is written in poetic language, the author-illustrator's precise word choices and beautiful paintings will engage students in scientific concepts. The book's back matter gives facts about each of the 13 water scenes depicted. For ideas on using the book, please refer to "*Water Dance: Integrating Science, Literacy, Art, and Movement*" in the Across the Curriculum department of this issue.

Water Series. Helen Frost. 2000. Nonfiction books. Recommended ages: Grades K-1. Four books in this series use simple text and color photographs to illustrate the water cycle and the behavior and the properties of water in its different states of matter. The book titles are *Water As a Gas*, *Water As a Liquid*, *Water As a Solid*, and *The Water Cycle*.

Water, Water Everywhere: A Book about the Water Cycle. Melvin and Gilda Berger. 1995. Nonfiction book. Recommended ages: Grades 2-4. This beginning reader examines the water cycle, phase changes of water, and how people in cities and small towns get clean water.

Looking at Solids, Liquids, and Gases: How Does Matter Change? Jackie Gaff. 2008. Nonfiction book. Recommended ages: Grades 2-4. Divided into chapters, this book explains the states of matter and how matter can change from one state to another. Each section is headed with a question, making this book perfect for use with a comprehension strategy such as [SQ3R](#)

Water. Christin Ditchfield. 2002. Nonfiction book. Recommended ages: Grades 2-4. This book is divided into five chapters, such as "What Is Water?" and "The Water Cycle," a list of further reading and web sites, and a glossary. Best for independent reading or sharing with small groups.

The Water Cycle. Therese Greenaway. 2001. Nonfiction book. Recommended ages: Grades 3-5. In this book, readers can find out about how our planet's water is recycled and reused through a series of natural phenomena called the water cycle. Other topics include water for life, water purification, and human consumption and pollution of

water. Each chapter is devoted to a separate topic and could be the basis of a series of hands-on science lessons.

Water Science. Deborah Seed. 1992. Nonfiction book. Recommended ages: Grades 2-5. This book is overflowing with facts, stories, and 40 water projects! Readers will be enticed by the fascinating facts and be amazed by the many explorations. This book could be used by a teacher to create a series of science centers, or as the basis for independent inquiry and exploration.

Videos

From Teachers Domain

www.teachersdomain.org is a rich resource for science lessons, videos and other resources. You need to register to use this free resource.

Check out some of the following related to properties of matter:

Pouring Air into Water

<http://www.teachersdomain.org/resource/phy03.sci.phys.matter.zbubble/>

Mystery Mud: Exploring Changes in States of Matter

<http://www.teachersdomain.org/resource/phy03.sci.phys.matter.mud/> includes a visit to the lab at MIT.

Observe Water in Winter and Summer

<http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.wintersummer/>

Observe Precipitation

<http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.precipitation/>

There is a very fun 4 minute video on You Tube about running on a pool of oobleck. The video background conversation is in Spanish, so I am not at all sure if it is child-appropriate if you understand the language. To use it in a classroom beware of the sidebar information that shows on You Tube. It is often not classroom appropriate!

<http://www.youtube.com/watch?v=yHIAcASsf6U>



Classroom Kits

Delta Education supplies the Solids and Liquids Foss Kit for \$774 Complete. You can also purchase pieces. According to Delta, the Solids and Liquids module provides experiences that heighten students' awareness of the physical world. Matter with which we interact exists in three fundamental states: solid, liquid, and gas. In this module first and second graders have introductory experiences with two of these states of matter, solid and liquid.

<http://www.delta-education.com/productdetail.aspx?Collection=Y&prodID=1072>

Lawrence Hall of Science GEMS book Matter: Solids, Liquids, Gases with lessons for grades 1-3. 128 pg. \$16.00 For more information visit

<http://lawrencehallofscience.stores.yahoo.net/masoliandga.html>

LHS's book Liquid Explorations (\$13.50) can be found at

<http://lawrencehallofscience.stores.yahoo.net/liqex.html> while a complete kit is available from Carolina for \$270 at <http://www.carolina.com/product/k-8+curriculum+programs/gems/gems+physical+science/gems-+liquid+explorations+kit.do?sortby=ourPicks>

Home/School Connection

Celebrate the changing states of matter with a Winter Festival. Make snow cones, find some ice cream machines and make some ice cream (see recipe on page 22), pop some popcorn (it is the steam inside the corn that expands and makes the kernels pop) and have some fun. Make a big batch of Oobleck (recipe pg 30) and read *Bartholomew and the Oobleck*. Students could also make homemade play dough and set up evaporation cups of salt or sugar solutions that could be taken home for the evaporation phase.

Students could learn about popcorn, and create a play about how we see the water cycle and changing states of matter in the planting, growth, harvest and cooking of the popcorn.

Evaporation Experiment

The volume you make of this solution depends on how much you will need. A good amount might be an ounce per person to fill a clear plastic film container with lid (which might be available at a local store that develops film.) An alternative is small sauce cups for food service use that have tight fitting covers

Make a supersaturated solution of salt and water or sugar and water.

- To each 1 cup of very warm water, stir in salt or sugar one spoon at a time until no more will dissolve. This should be about a cup of salt or sugar for each cup of hot water.
- Label the container.
- Pour about 1 ounce in the container.(2 Tablespoons)
- Mark a line in black marker at the top of the level of solution in the container.
- Instruct the student to take it home and to open the container and leave it on a sunny window sill where it won't be disturbed.
- Observe the container each day or two and see what happens. Do not shake or stir the solution!

Career Information

Rocks melt! Volcanologist need to know when they will and why. Visit http://www.pbs.org/safarchive/5_cool/53_career.html for a profile of a scientist who studies Volcanoes.

(Higher Reading Level Sites)

Learn about being a Agriculture and Food Scientist <http://www.bls.gov/k12/nature05.htm>; a Chemist <http://www.bls.gov/k12/science01.htm> , or even a Firefighter <http://www.bls.gov/k12/help03.htm> All of these jobs work with the properties of different materials, and need to understand how heat and cold affect materials, plants, animals, and people.

Other possibilities in this area include Material Scientists who study the properties of materials and design packaging and making of objects, Meteorologists who study weather and the changing states of water in our atmosphere, and Chemists who study and work with different materials, understand their properties, and how the materials work together. Another kind of chemist is a chef or baker, who mixes different materials, changes temperatures and pressures, and turns it all into something good to eat.





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Websites for Students

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<http://www.fossweb.com/modulesK-2/SolidsandLiquids/activities/changeit.html>

Check out BBC’s kid site for a game to sort solids, liquids and gases. There is also an interactive activity (reading level age9/10) for kids to heat and cool a liquid to see what happens. http://www.bbc.co.uk/schools/scienceclips/ages/9_10/science_9_10.shtml

Check out BBC’s kid site for an interactive game to heat solids to see what happens.

http://www.bbc.co.uk/schools/scienceclips/ages/8_9/solid_liquids.shtml