Standard

CT - 3.1 – Properties of Matter - Heating and cooling cause changes in some of the properties of materials.
MA - Physical Gr. PreK-2 #1 – Gr. 3-5 #1 and #3

MELTING AWAY

Connecticut Science Center

Created by:

Kathie Moskovitz, Saugatuck Elementary School, Westport Public Schools

Bryan P. Baker, Program Educator, Connecticut Science Center

UPDATED: February 2011

Connecticut Science Center | 250 Columbus Blvd, Hartford, CT 06103

Connecticut Science Center

Table of Contents

Summary

This program has been developed to provide you and your students with pre visit, visit and post visit materials related to the study of the properties of matter. During your visit, your students will enjoy opportunities to make observations, raise questions, and learn more about some of the properties of matter in one of our Education Classrooms.

In addition, your class will tour the **Health Gallery**, the **Sports Gallery**, the **Invention Dimension Gallery**, and the **Planet Earth Gallery**. Your students will be provided with Trail Guides that will help them make observations, predictions, and raise further questions about specific exhibits within the galleries that are related to the properties of matter. Also included in this program are lessons that provide interdisciplinary connections, as well as additional resources such as websites, literature links, career information, home and school connections, and related videos.

This package has been developed as a unit 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.

The complete CT Core Science Curriculum Frameworks is available at the website http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/science/PK8_sciencecurriculumstandards2009.pdf . See also: American Association for the Advancement of Science, *Atlas of Science Literacy*, Project 2061. In addition, Grade Level Expectations (GLEs) were released in Spring 2009, to "unpack" the science content for grades K-5. Content standard 3.1 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 B INQ information reflects the process skills intended for grades 3-5 specifically representing the content standards of scientific inquiry, literacy, and numeracy.

Inquiry Standards

Grades 3-5 Core Scientific Inquiry, Literacy and Numeracy	
Content Standards	**Expected Performances**
SCIENTIFIC INQUIRY ♦ Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena. SCIENTIFIC LITERACY ♦ Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science. SCIENTIFIC NUMERACY ♦ Mathematics provides useful tools for the description, analysis and presentation of scientific data and ideas.	B INQ.1 Make observations and ask questions about objects, organisms and the environment. B INQ.2 Seek relevant information in books, magazines and electronic media. B INQ.3 Design and conduct simple investigations. B INQ.4 Employ simple equipment and measuring tools to gather data and extend the senses. B INQ.5 Use data to construct reasonable explanations. B INQ.6 Analyze, critique and communicate investigations using words, graphs and drawings. B INQ.7 Read and write a variety of science-related fiction and nonfiction texts. B INQ.8 Search the Web and locate relevant science information. B INQ.9 Use measurement tools and standard units (e.g., centimeters, meters, grams, kilograms) to describe objects and materials. B INQ.10 Use mathematics to analyze, interpret and present data.

CT Science Standards, Grade Level Concepts & Expectations, & CMT Correlation

Properties of Matter - How does the structure of matter affect the properties and uses of materials? GRADE 3			
3.1 Materials have properties that can be identified and described through the use of simple tests.			
Core Science Curriculum Framework	**Underlying Concepts** *Students should understand that…*	**Grade-Level Expectations** *Students should be able to…*	**CMT Expected Performances**
3.1.a. Heating and cooling cause changes in some of the properties of materials.	1. Materials have properties that are directly observable; examples include its state of matter, or its size, shape, color or texture. Other properties can only be observed by doing something to the material (simple tests). Materials can be sorted and classified based on their testable properties. 2. Some materials dissolve (disappear) when mixed in water; others accumulate on the top or the bottom of the container. The temperature of water can affect whether, and at what rate, materials dissolve in it. 3. Some materials, such as sponges, papers and fabrics, absorb water better than others. 4. Some materials float when placed in water (or other liquids such as cooking oil or maple syrup); others sink to the bottom of the container. 5. Some materials conduct heat better than others. Materials that are poor heat conductors are useful for keeping things cold or hot. 6. Some materials are attracted to magnets. Magnetic materials contain iron. 7. The physical properties of a material can be changed, but the material remains the same. For example, a block of wood can be cut, sanded or painted, but it is still wood. 8. Heating and cooling cause materials to change from one state of matter to another and back again. Adding heat can cause solids to melt into liquids (for example, chocolate, ice cream, butter or wax); removing heat (cooling) can cause liquids to harden into solids (for example, hot candle wax hardens as it cools). 9. Adding heat can cause water to boil and evaporate into a gas in the air (for example, steam rises from heated water); removing heat (cooling) can cause water vapor to condense into liquid water (for example, warm steam hitting a cold mirror). Water outdoors or in an open container evaporates without boiling (for example, puddles, ponds, fish tanks, etc.) 10. Water may exist as a solid, liquid or gas, depending on its temperature. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing. 11. Liquid water becomes solid water (ice) when its temperature cools to 0 degrees Celsius (32 degrees Fahrenheit). Warming ice to a temperature above 0 degrees Celsius causes it to melt into liquid water. **SCIENTIFIC LITERACY TERMINOLOGY:** physical property, state of matter, solid, liquid, gas, dissolve, absorb, conduct, attract, melt, freeze, boil, evaporate, condense	1. Compare and contrast the properties of solids, liquids and gases. 2. Demonstrate that solids, liquids and gases are all forms of matter that take up space and have weight. 3. Carry out simple tests to determine if materials dissolve, sink or float in water, conduct heat or attract to magnets. 4. Classify materials based on their observable properties, including state of matter. 5. Design and conduct fair tests to investigate the absorbency of different materials, write conclusions based on evidence, and analyze why similar investigations might produce different results. 6. Explain the role of heating and cooling in changing matter from one state to another during freezing, melting, evaporation and condensation.	**B1**. Sort and classify materials based on properties such as dissolving in water, sinking and floating, conducting heat, and attracting to magnets. **B2**. Describe the effect of heating on the melting, evaporation, condensation and freezing of water.

Massachusetts Science Standards

Physical Science
Grades PreK-2
Standard #1

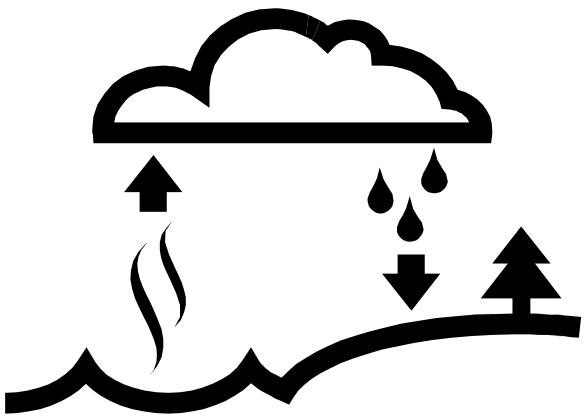
Sort objects by observable properties such as size, shape, color, weight, and texture.

Physical Science
Grades 3-5
Standard #1

Differentiate between properties of objects (e.g., size, shape, weight) and properties of materials (e.g., color, texture, hardness).

Physical Science
Grades 3-5
Standard #3

Describe how water can be changed from one state to another by adding or taking away heat.



Safety Standards

1. Discuss safety concerns and appropriate behavior expectations with students prior to each science activity.
2. Make any necessary individual student modifications.
3. Help students keep spaces where science activities are conducted uncluttered.
4. Limit size of student working groups to a number that can safely perform the activity without causing confusion and accidents.
5. Make certain that students understand they are not to drink from glasses or plastic containers used for science experiments.
6. Do not allow eating or drinking in any space where science investigations are conducted.
7. Have a whiskbroom, dust pan, and disposal container for broken glass when using glassware of any type.
8. Do not use mercury thermometers with students. Any mercury thermometers still present should be disposed of properly.

For more comprehensive information on science safety, consult the following websites from:
American Chemical Society –

http://portal.acs.org/portal/PublicWebSite/about/governance/committees/chemicalsafety/publications/WPCP_012300

Council of State Science Supervisors;

Connecticut Department of Education–

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

The Connecticut Science Supervisors Association – Science Safety White Paper –

http://cssaonline.net/cssapositionpapers.html

Misconceptions and Facts

Misconceptions	Facts
Elementary and middle-school students may think everything that exists is matter, including heat, light, and electricity (Stavy, 1991;Lee et al., 1993).	Matter is anything that has mass and takes up space. Heat, light, and electricity are forms of energy. Energy is not matter.
Elementary and middle-school students may believe that matter does not include liquids and gases, or that they are weightless materials. (Stavy, 1991; Mas, Perez, & Harris, 1987).	Matter can exist as a solid, liquid, or a gas. The mass of a given amount of a substance does not change when it changes state or phase.
Although some 3rd graders may start seeing weight as a fundamental property of all matter, many students in 6th and 7th grade still appear to think of weight simply as "felt weight"—something whose weight they can't feel is considered to have no weight at all. (Carey, 1991; Smith et al., 1985; Smith, Snir, & Grosslight, 1987).	Even invisible forms of matter – air and other gases – take up space and have weight.
Students seem to understand evaporation. Before they understand that water is converted to an invisible form, they may initially believe that when water evaporates it ceases to exist, or that is changes location but remains a liquid, or that it is changed into some other perceptible form (fog, steam, water droplets, etc.) (Bar, 1989; Russell, Harlen, & Watt, 1989; Russel, Watt, 1990).	Air is the final location of water when it evaporates and becomes water vapor. Students have difficulty with this idea until they come to accept air as a permanent substance. Water can be removed from the air through condensation. Condensation occurs when water vapor is cooled to a point where it turns back into liquid water.

From *Benchmarks for Science Literacy,* and From *Science for All Americans*, and From *the Atlas of Science Literacy*

www.project2061.org/publications/rsl/online/SFAA/CHAP4.HTM

Pre-Visit Activities

The visit to the CT Science Center begins in your classroom with the pre-visit activities. It is suggested that you complete these activities or others like them to prepare your students for their visit. It is also suggested that teachers engage students in the post visit activities to integrate your visit into a meaningful unit of study.

The following highlighted GLE's and GLC's are covered in this section:

Properties of Matter - How does the structure of matter affect the properties and uses of materials? GRADE 3			
3.1 Materials have properties that can be identified and described through the use of simple tests.			
Core Science Curriculum Framework	Underlying Concepts *Students should understand that…*	Grade-Level Expectations *Students should be able to…*	CMT Expected Performances
3.1.a. Heating and cooling cause changes in some of the properties of materials.	1. Materials have properties that are directly observable; examples include its state of matter, or its size, shape, color or texture. Other properties can only be observed by doing something to the material (simple tests). Materials can be sorted and classified based on their testable properties. 2. Some materials dissolve (disappear) when mixed in water; others accumulate on the top or the bottom of the container. The temperature of water can affect whether, and at what rate, materials dissolve in it. 3. Some materials, such as sponges, papers and fabrics, absorb water better than others. 4. Some materials float when placed in water (or other liquids such as cooking oil or maple syrup); others sink to the bottom of the container. 5. Some materials conduct heat better than others. Materials that are poor heat conductors are useful for keeping things cold or hot. 6. Some materials are attracted to magnets. Magnetic materials contain iron. 7. The physical properties of a material can be changed, but the material remains the same. For example, a block of wood can be cut, sanded or painted, but it is still wood. 8. Heating and cooling cause materials to change from one state of matter to another and back again. Adding heat can cause solids to melt into liquids (for example, chocolate, ice cream, butter or wax); removing heat (cooling) can cause liquids to harden	1. Compare and contrast the properties of solids, liquids and gases. 2. Demonstrate that solids, liquids and gases are all forms of matter that take up space and have weight. 3. Carry out simple tests to determine if materials dissolve, sink or float in water, conduct heat or attract to magnets. 4. Classify materials based on their observable properties, including state of matter. 5. Design and conduct fair tests to investigate the absorbency of different materials, write	B1. Sort and classify materials based on properties such as dissolving in water, sinking and floating, conducting heat, and attracting to magnets. B2. Describe the effect of heating on the melting, evaporation, condensation and freezing of water.

	into solids (for example, hot candle wax hardens as it cools). 9. Adding heat can cause water to boil and evaporate into a gas in the air (for example, steam rises from heated water); removing heat (cooling) can cause water vapor to condense into liquid water (for example, warm steam hitting a cold mirror). Water outdoors or in an open container evaporates without boiling (for example, puddles, ponds, fish tanks, etc.) 10. Water may exist as a solid, liquid or gas, depending on its temperature. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing. 11. Liquid water becomes solid water (ice) when its temperature cools to 0 degrees Celsius (32 degrees Fahrenheit). Warming ice to a temperature above 0 degrees Celsius causes it to melt into liquid water. SCIENTIFIC LITERACY TERMINOLOGY: physical property, state of matter, solid, liquid, gas, dissolve, absorb, conduct, attract, melt, freeze, boil, evaporate, condense	conclusions based on evidence, and analyze why similar investigations might produce different results. 6. Explain the role of heating and cooling in changing matter from one state to another during freezing, melting, evaporation and condensation.	

Pre-assessment

Have the children write a response to the following prompt:

How do you think an inventor decides what materials to use when designing a new invention?

Provide specific examples for students if necessary. For example, an inventor might want to design a new type of ball, a new kind of shoe, or a bicycle helmet.

Assess students on their knowledge of the properties of materials; both observable and testable.

Following your pre-visit activities, classroom activities, and post-visit activities, have the students answer the same prompt to assess their learning.

Pre-visit Lesson #1 - What's in the bag?

Purpose: To introduce students to the concept of physical properties

Materials:
Paper bags
A different bag for each group of 2 or 3 students containing:
napkin or paper towel
metal cube, rod, or ball
brown, wooden Cuisenaire rod
glass or ceramic figurine
a rock, preferably unusual
small foam or rubber ball
sock or mitten
a ball of foil
crayon
small plastic bag

Have students reach into their bag and describe what they feel. The idea is not to identify the object, but to identify the properties that can be felt. Have each group begin a list in their science notebooks of properties or characteristics that they can feel. Have students share their ideas, creating a list of properties or characteristics that can be *felt.*

"I think there is a stick in my bag, and it feels smooth and long and thin and not very heavy."

Have the students take the object out of their bag and begin a second list of properties that can be *seen.*

"I see now that it is brown and rather shiny."

Point out that these properties or characteristics of the objects can be determined by simply observing: size, shape, color, texture, transparency, and relative weight.

Ask students to list the materials that make up the objects in the bags.

Let students know that the materials from which the objects are made have additional properties, some of which can be determined by doing something to the material. These properties are important because they help people consider which material to use when making something.

Have students begin a 3-column chart in their notebooks listing: a material, a use of that material, and the property or properties that make it a good choice.

Share some of these, charting materials and properties, as a way to help students begin thinking and speaking about observable and testable properties.

Pre-visit Lesson #2 – What if...?

Purpose: To engage students in a discussion about materials that are commonly used to make everyday objects. They will begin to consider how the properties of each material determine its uses.

This lesson also serves as an additional pre-assessment to determine what students already know about the properties of materials, as well as allowing misconceptions to begin to surface.

Procedure: Gather a collection of objects that are made of a variety of single materials such as a paperclip, a plastic spoon, a plain wooden clothespin, a sheet of paper, a small cardboard box, a cotton ball, an eraser, a crayon, a rack of staples or a nail, a sock or glove, a mug, etc. Include an ice cube as one of the objects to pull the concept of state or phase into the discussion.

Have students name each material, then engage them in a discussion by asking why they think the manufacturer of each object decided to make it out of that particular material. Allow students to talk and respond to one another without commenting or correcting their ideas. Make note of the properties of materials that they mention – strength, flexibility, toughness, texture, durability, color, absorbency, thermal conductivity, weight, state, etc. Students may note that some of the objects are sometimes made out of other materials. Spoons, for example, are often made of metal or wood.

When the discussion is finished, have them make observations about their shoes. What materials were used to make them? Why were those materials used?

Most students are likely to be familiar with the story of Cinderella and her glass slippers. *(You might read a version of the story to them at this point.)* Lead them to a

consideration of the idea of glass slippers. What would it be like to wear glass slippers? How did Cinderella manage to wear them? Why would only her foot fit the missing slipper?

Let this discussion lead to a writing assignment:
What if _____ were made of _____?

Offer students a few possibilities for consideration: What if shoes *were* made of glass? What if blankets were made of straw? What if baseballs were made of stone? Let students suggest a few more object/material combinations. Ask them to write about and illustrate the advantages and disadvantages they image would be encountered by making their object out of a different material.

To close the lesson, have students brainstorm a list of properties that need to be considered when making decisions about which material to use. This is a good time to introduce some of the terms used to describe physical properties that have not yet come up in discussion. For example, after listing 'how much a material bends', offer the term 'flexibility'.

Pre-visit Lesson #3 – Adventures of an Ice Cube

Purpose: To observe changes of state and identify some of the properties of water

Materials:

water	small squares of aluminum foil for lids
medicine cups	permanent marker
balance scale and gram weights	quart size sealable plastic bags

Day 1

1. Engage the students in a discussion about the properties of water. What properties can be observed directly? What else might be determined by testing it?
2. Have each student measure 25 ml of water into their medicine cup.
3. Weigh *(find the mass of)* one of the student's cups using a balance scale and gram weights.
4. Ask the students if they think all of the cups of water will weigh the same amount.
5. Let them weigh others as needed to convince them that equal amounts of water weigh the same amount.
   You can weigh the cup separately and subtract to determine the weight of the water alone, or simply record the weight of the cup and water together. Since the metric scale is based on water, 50 ml of water = 50 cc = 50 grams.
6. Have students write their names or initials on the foil then use it to cover the cups.
7. Freeze the water in the cups overnight.

Day 2

1. Observe changes. Students may notice that the cup seems to be fuller *(water expands when frozen)*.
2. Ask students if they think the ice will weigh the same as the water.
3. Have them weigh the water *(ice)* again so they can discover that the weight is the same.
4. Have each student carefully settle his or her cup of ice into a bottom corner of a sealable plastic bag. If the ice has started to melt, ask students do their best to keep all of the water in the cup.
5. Seal the bags and tape them by the diagonally opposite corner in sunny window where students will be able to observe them easily. Be sure the cup of ice is in an upright position.
   You may want to have students name their ice cube. It personifies the "Adventure" and gives students the chance to come up with appropriately chilly names for their ice cubes.
6. Have students diagram the set up in their science notebooks.
7. Ask them to predict changes that they might see over the course of the week.

Days 3 - 7

1. Observe the bags daily.
2. Have students record what they notice and wonder at various times of day.

Over the course of the Adventure, they will get to see their water in many different 'states' (*pun intended!)* The ice will melt into water, turn into water vapor, condense into droplets on the side of the bag, and rain down into the bottom corner beneath the cup. It is important that the students leave their bags sealed and hanging in the window during these observations.

Provide appropriate terms for students as they observe the water changing state. They are likely to know 'melting', but may be unfamiliar with 'evaporating' and 'condensing'. Guide them to understand how the water evaporates out of the cup into the air in the bag, condenses on the sides of the bag as it cools, and ends up in a puddle beneath the cup. Have students design a way to diagram this cycle.

Then share a diagram of the water cycle or visit
http://www.epa.gov/safewater/kids/flash/flash_watercycle.html

At the end of the week, have students consider whether any of the water that made the original ice cube has been lost or disappeared. Work with them to determine the weight of the original set-up by adding the weight of the plastic bag to that of the water and cup. Then have them weigh some of the still-sealed bags. It is important that the bags be kept sealed so the trapped water vapor will be included in the total weight. This will help them begin to understand that although water vapor is invisible, it is there and it does have weight.

Students may then enjoy releasing the water into the world by opening the bag and allowing the water to evaporate. How long would it take for the water to evaporate if the bag were simply left open? Would the water evaporate more quickly if the cup were taken out of the bag and left on the counter? Suppose it was poured onto a plate? Encourage students' questions along these lines help them design evaporation investigations.

Discovery Center Activity

The following highlighted GLE's and GLC's are covered in this section:

Properties of Matter - How does the structure of matter affect the properties and uses of materials? GRADE 3			
3.1 Materials have properties that can be identified and described through the use of simple tests.			
Core Science Curriculum Framework	**Underlying Concepts** *Students should understand that…*	**Grade-Level Expectations** *Students should be able to…*	**CMT Expected Performances**
3.1.a. Heating and cooling cause changes in some of the properties of materials.	1. Materials have properties that are directly observable; examples include its state of matter, or its size, shape, color or texture. Other properties can only be observed by doing something to the material (simple tests). Materials can be sorted and classified based on their testable properties. 2. Some materials dissolve (disappear) when mixed in water; others accumulate on the top or the bottom of the container. The temperature of water can affect whether, and at what rate, materials dissolve in it. 3. Some materials, such as sponges, papers and fabrics, absorb water better than others. 4. Some materials float when placed in water (or other liquids such as cooking oil or maple syrup); others sink to the bottom of the container. 5. Some materials conduct heat better than others. Materials that are poor heat conductors are useful for keeping things cold or hot. 6. Some materials are attracted to magnets. Magnetic materials contain iron. 7. The physical properties of a material can be changed, but the material remains the same. For example, a block of wood can be cut, sanded or painted, but it is still wood. 8. Heating and cooling cause materials to change from one state of matter to another and back again. Adding heat can cause solids to melt into liquids (for example, chocolate, ice cream, butter or wax); removing heat (cooling) can cause liquids to harden into solids (for example, hot candle wax hardens as it cools). 9. Adding heat can cause water to boil and evaporate into a gas in the air (for example, steam rises from heated water); removing heat (cooling) can cause water vapor to condense into liquid water (for example, warm steam hitting a cold mirror). Water outdoors or in an open container evaporates without boiling (for example, puddles, ponds, fish tanks, etc.) 10. Water may exist as a solid, liquid or gas, depending on its temperature. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing. 11. Liquid water becomes solid water (ice) when its temperature cools to 0 degrees Celsius (32 degrees Fahrenheit). Warming ice to a temperature above 0 degrees Celsius causes it to melt into liquid water. **SCIENTIFIC LITERACY TERMINOLOGY:** physical property, state of matter, solid, liquid, gas, dissolve, absorb, conduct, attract, melt, freeze, boil, evaporate, condense	1. Compare and contrast the properties of solids, liquids and gases. 2. Demonstrate that solids, liquids and gases are all forms of matter that take up space and have weight. 3. Carry out simple tests to determine if materials dissolve, sink or float in water, conduct heat or attract to magnets. 4. Classify materials based on their observable properties, including state of matter. 5. Design and conduct fair tests to investigate the absorbency of different materials, write conclusions based on evidence, and analyze why similar investigations might produce different results. 6. Explain the role of heating and cooling in changing matter from one state to another during freezing, melting, evaporation and condensation.	**B1**. Sort and classify materials based on properties such as dissolving in water, sinking and floating, conducting heat, and attracting to magnets. **B2**. Describe the effect of heating on the melting, evaporation, condensation and freezing of water.

Classroom Activity: Melting Blocks (45 minutes)

Introduction:

The students will be shown a plastic two layered mug. Ask them to name some of the properties that this mug has such as color, composition, function, size, weight, shape, etc. Write these on the board. Student will now be shown a set of Ice Melting Blocks *(available in most science catalogues)*. Ask them what are some of the properties that these two blocks have? Lead them to the fact that they look essentially the same. Mention that all matter has physical properties that we can observe, but matter also has properties which we can't observe. In order to determine these we need to other types of test. In this case, we will put an ice cube on each of the blocks. Ask them to predict what will happen to ice cubes when they are placed on each block. *(As the two blocks appear to be identical, students will probably not expect them to have different properties.)* Students will be asked to explain their answers. After the students have finished predicting what will happen, the teacher will place one ice cube on each block. The students will observe that one ice cube melts considerably faster than the other.

Materials *(for each group of 3-4 students)*

- Ice Melting Block Set
- 8 Blocks (3" x 3")
  - 1 Plastic (1/4" thick)
  - 1 Wood (1/4" thick)
  - 1 Insulated Aluminum (1/4" thick)
  - 1 Aluminum **(1/2" thick)**
  - 3 Aluminum **(1/4" thick)**
  - 1 Aluminum **(1/8" thick)**
- 8 ice cubes of approximately equal size *(in bowls for easy distribution and clean up)*

- 8 liquid crystal thermometers (http://www.coleparmer.com/catalog/product_view.asp?sku=9030825)
- 1 Roll of paper towels

For the instructor:

- Cooking pot or small pan
- Insulated Travel Mug

Procedure:

(Determining Pre-existing Conditions and Creating Hypotheses)

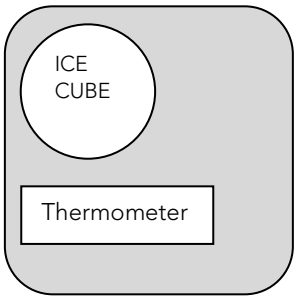
1. Distribute the Plastic, wood, and one of the 1/4" thick aluminum blocks to the students.
2. Have the students place the blocks on the desk, and instruct the students to leave the blocks on the desk.
3. Ask them to describe any properties they associate with the materials.
   - *Record their ideas on the board.*
4. Next, ask them to feel each of the materials with their fingertips, and identify the materials as either feeling cool or cold, feeling fairly neutral, or feeling warm.
5. Have the students' measure and record the temperature of each block.
   (The thermometers on the blocks show three possible results. A blue rectangle means the actual

temperature higher than the blue rectangle, a brown rectangle means the actual temperature is lower than the brown rectangel, and a green rectangle is closest to the actual temperature.)

6. Let groups briefly explain a few of their observations.
7. Ask students what would happen if ice cubes were placed on the blocks.
8. Ask each group to decide how they will record their observations.

(Heat transfer as a function of material.)

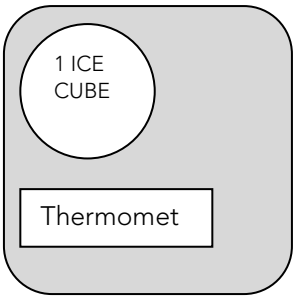
9. Pass out the ice cubes and have the students place one ice cube on each of the blocks.
10. Tell the students not to touch the blocks after the ice has been placed.
11. Give them 5 minutes to observe and record results.
    - *The unexpected results are sure to generate lots of questions.*
        - *Why would the ice cube on the aluminum melt so quickly?*
        - *What happens to the temperature of the blocks?*
        - *Is the aluminum, which feels cool, actually hot?*
12. Ask the groups to put any remaining ice back into the bowls and dry off the blocks.
    - *This gets clean up started and gives the materials a moment to get back to room temperature.*
13. Ask the students to explain their results.
14. Ask the students if the experiment has raised any new questions, and record their responses.



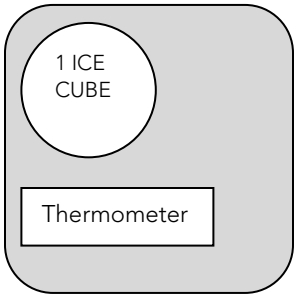
15. Show students the Styrofoam cup and cooking pot. Both of these containers are designed to hold hot liquids, but in different circumstances. For example, when we put hot cocoa into the foam cup, do we want the heat from inside to get outside? No, it would burn our hands. Ask the students to figure out what properties of the cup allow the heat to stay in. The cup is made out of a type of material that is called an INSULATOR. Temperature does not easily flow through insulators. However, with the pot, do we want the heat to get into it from the stove to warm our soup? Yes, ask the students how it is constructed in order to do that. The pot is made of metal which is a good thermal CONDUCTOR, which they discovered from their experiments. If the outside of the pot is hot, then what does it have to help us pick it up? A handle. . . .But shouldn't the handle be hot too? No it is coated in plastic which is an insulator. By going through this process the students will see how their experiments apply directly to everyday items.

    Students may be familiar with the term 'insulate', but may not know insulator, conductor, or thermal conductivity. Introduce these terms and relate them to the materials and the activity that students have just experienced. Guide the students to every day examples of materials people use to control heat transfer: plastic handles on cooking utensils, rugs on tiled bathroom floors, Styrofoam coffee cups. Allow time for students to ask questions and make suggestions for other ways to investigate the thermal conductivity of materials.

(Heat transfer as a result of insulation)



16. Distribute the 1/4" thick insulated aluminum block and the third 1/4" thick plain aluminum blocks to the students.
17. Have the students place the blocks on the desk, and instruct the students to leave the blocks on the desk.
18. Ask them to describe any properties they associate with the materials.
    - *Record their ideas on chart paper or the board.*
19. Have the students' measure and record the temperature of each block.
20. Let groups briefly explain a few of their observations.
21. Ask students what would happen if ice cubes were placed on the blocks.
    - *Would there be any difference in speed at which they melted?*
    - *Give students time to debate and make predictions.*
    - *Be sure the students explain the reasoning behind their predictions.*
22. Have the students record their predictions.
23. Pass out the ice cubes and have the students place one ice cube on each of the blocks.
24. Give the students 5 minutes to observe and record results.
25. Ask the groups to put any remaining ice back into the bowls and dry off the blocks.
    - *This again gets clean up started and gives the materials a moment to get back to room temperature.*
26. Ask the students to explain their results.
27. Ask the students if the experiment has raised any new questions, and record their responses.



(Heat transfer as a function of thickness)

28. Distribute the 1/8" thick, 1/2" thick, and the second 1/4" thick aluminum blocks to the students.
29. Have the students place the blocks on the desk, and instruct the students to leave the blocks on the desk.
30. Ask them to describe any properties they associate with the materials.
    - *Record their ideas on chart paper or the board.*
31. Have the students' measure and record the temperature of each wall plate.
32. Let groups briefly explain a few of their observations.
33. Ask students what would happen if ice cubes were placed on the blocks.
    - *Would there be any difference in speed at which they melted?*
    - *Give students time to debate and make predictions.*
    - *Be sure the students explain the reasoning behind their predictions.*
34. Have the students record their predictions.
35. Pass out the ice cubes and have the students place one ice cube on each of the blocks.
36. Give the students 5 minutes to observe and record results.
37. Ask the groups to put any remaining ice back into the bowls and dry off the blocks.
    - *This again gets clean up started and gives the materials a moment to get back to room temperature.*
38. Ask the students to explain their results.
39. Ask the students if the experiment has raised any new questions, and record their responses.

This might be a good time to draw the three blocks on the board, and record the estimated pre-test temperature, and then post-test temperature. In order to make a visual representation of it, draw a thick line to "fill" each block with coldness. They will see it takes more lines to fill the larger block and therefore the larger block stays warm longer and melts the ice cube faster. The thinnest block only takes a line or two, therefore cools down quicker and the ice cube takes longer to melt.

40. Use the final five minutes of the lesson time for students to respond in writing to one of the following invitations:
    - *What did you learn from this lesson?*
    - *What are you still wondering about the way that heat travels through materials?*
    - *What investigation would you like to do next?*

Trail Guides

We have created a set of "Trail Guides" for use by you and your students. The first section consists of the trail guides with teacher notes; the second section has the exact same Trail Guides without the teacher notes. You may copy these directly as handouts.

The following highlighted GLE's and GLC's are covered in this section:

Properties of Matter - How does the structure of matter affect the properties and uses of materials? GRADE 3			
3.1 Materials have properties that can be identified and described through the use of simple tests.			
Core Science Curriculum Framework	**Underlying Concepts** *Students should understand that…*	**Grade-Level Expectations** *Students should be able to…*	**CMT Expected Performances**
3.1.a. Heating and cooling cause changes in some of the properties of materials.	1. Materials have properties that are directly observable; examples include its state of matter, or its size, shape, color or texture. Other properties can only be observed by doing something to the material (simple tests). Materials can be sorted and classified based on their testable properties. 2. Some materials dissolve (disappear) when mixed in water; others accumulate on the top or the bottom of the container. The temperature of water can affect whether, and at what rate, materials dissolve in it. 3. Some materials, such as sponges, papers and fabrics, absorb water better than others. 4. Some materials float when placed in water (or other liquids such as cooking oil or maple syrup); others sink to the bottom of the container. 5. Some materials conduct heat better than others. Materials that are poor heat conductors are useful for keeping things cold or hot. 6. Some materials are attracted to magnets. Magnetic materials contain iron. 7. The physical properties of a material can be changed, but the material remains the same. For example, a block of wood can be cut, sanded or painted, but it is still wood. 8. Heating and cooling cause materials to change from one state of matter to another and back again. Adding heat can cause solids to melt into liquids (for example, chocolate, ice cream, butter or wax); removing heat (cooling) can cause liquids to harden into solids (for example, hot candle wax hardens as it cools).	7. Compare and contrast the properties of solids, liquids and gases. 8. Demonstrate that solids, liquids and gases are all forms of matter that take up space and have weight. 9. Carry out simple tests to determine if materials dissolve, sink or float in water, conduct heat or attract to magnets. 10. Classify materials based on their observable properties, including state of matter. 11. Design and conduct fair tests to investigate the absorbency of different materials, write conclusions based on evidence, and	**B1**. Sort and classify materials based on properties such as dissolving in water, sinking and floating, conducting heat, and attracting to magnets. **B2**. Describe the effect of heating on the melting, evaporation, condensation and freezing of water.

	9. Adding heat can cause water to boil and evaporate into a gas in the air (for example, steam rises from heated water); removing heat (cooling) can cause water vapor to condense into liquid water (for example, warm steam hitting a cold mirror). Water outdoors or in an open container evaporates without boiling (for example, puddles, ponds, fish tanks, etc.) 10. Water may exist as a solid, liquid or gas, depending on its temperature. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing. 11. Liquid water becomes solid water (ice) when its temperature cools to 0 degrees Celsius (32 degrees Fahrenheit). Warming ice to a temperature above 0 degrees Celsius causes it to melt into liquid water. SCIENTIFIC LITERACY TERMINOLOGY: physical property, state of matter, solid, liquid, gas, dissolve, absorb, conduct, attract, melt, freeze, boil, evaporate, condense	analyze why similar investigations might produce different results. 12. Explain the role of heating and cooling in changing matter from one state to another during freezing, melting, evaporation and condensation.	

Teacher Trail Guides

Trail Guide *Build-a-Bike*: 3.1 Properties of Matter

Visit the **Sports Gallery - 5th Floor South**

Build-a-Bike

Design a bike. What materials did you use as you built the bike?

Why did you choose these materials?

Teacher notes:
Student responses should consider the size of each part, as well as the materials' strength, flexibility, weight, its ability to be formed into the required shape (malleability).
Standard 3.1a GLC#1

Trail Guide *Build-a-Bike*: 3.1 Properties of Matter

Visit the **Sports Gallery – 5th Floor South.**

Build-a-Bike

Examine two versions of the same bicycle part.

How are the materials used for these parts the same?

How are they different?

Teacher Notes:
Student responses should consider the materials' strength, flexibility, weight, its ability to be formed into the required shape (malleability).
Standard 3.1a GLC#1

Trail Guide *Helmet Crash Test*: 3.1 Properties of Matter

Visit the Sports Gallery – 5th Floor South

Helmet Crash Test

Choose either helmet type or hammer height. Design an investigation that shows; A) How the height of the hammer affects force, ***or*** B) Which helmet gives the best protection.

Make a prediction and give a reason.

Show your data to prove or disprove your prediction.

What did you use as a control in this investigation?

Teachers Notes:
The investigation should have a testable question, a procedure and a data table. A prediction should be based on observation and be directly related to the testable question. An example of a control could be a trial without a helmet.
Standard 3.1a GLC#1

Trail Guide *Apollo Mission Spacesuit*: 3.1 Properties of Matter

Visit the **Exploring Space Gallery – 5th Floor South**

Apollo Mission Spacesuit

Look at the replica spacesuit from the Apollo missions.

Do you think the material used to make the spacesuits is different than your clothes?

Why?

Was the weight (mass) of the suit an important factor in its design?

Would this suit be useful on Earth, why or why not?

Teacher Notes:
Student responses should focus on the differences in temperature and gravity on the moon. Because the moon is so much colder then Earth, insulation was vital to the Astronauts survival on these missions. Because the gravity on the moon is 1/6th the gravity on Earth, the suits mass wasn't as important a factor. On Earth the mass of the suit would cause it to be too heavy for any practical use.
Standard 3.1a GLC#1

Trail Guide *What Is Insulation*: 3.1 Properties of Matter

Visit the **Energy City Gallery – 6th Floor South**

What Is Insulation?

Study the different types of insulation that are displayed.

Which type of insulation would be best for your house?

Why is it important to have proper insulation?

How would your energy costs be affected without insulation?

Teacher Notes:
Students should notice that without insulation it would be much more difficult to stay warm in the winter. It would also cause the families energy costs to rise, as more energy would be needed for heating the house and the hot water tank. Student responses for the best choice will depend on the cost of the different insulations.
Standard 3.1a GLC#1,5

Trail Guide *Weather Station*: 3.1 Properties of Matter

Visit the **Planet Earth Gallery – 6th Floor South**

Go to the Weather Station
Find the exhibit on clouds

Use the knob to scroll through the different types of clouds and read the description associated with each of them. Do the different clouds indicate different weather patterns?

What might a cirrus cloud indicate?

Nimbostratus?

Cumulus?

Stratus?

Now go to the Overlook Balcony and observe the clouds in the sky today. Do any of them look familiar? Can you make a small forecast for the rest of the day's weather based on the type of cloud you see? Write your forecast in your science notebook and provide the reasoning behind your prediction.

Teacher Notes:
Based on the type of cloud coverage and what they learn about them using the exhibit on clouds at the weather station, students can attempt to identify the different clouds in the sky from the overlook balcony. Upon successful identification, students should be able to make a prediction for today's weather.
Standard 3.1a GLC#9, GLE#6

Student Trail Guides

Trail Guide *Build-a-Bike*: 3.1 Properties of Matter

Visit the Sports Gallery - 5th Floor South

Build-a-Bike

Design a bike. What materials did you use as you built the bike?

Why did you choose these materials?

Trail Guide *Build-a-Bike*: 3.1 Properties of Matter

Visit the **Sports Gallery – 5th Floor South.**

Build-a-Bike

Examine two versions of the same bicycle part.

How are the materials used for these parts the same?

How are they different?

Trail Guide *Helmet Crash Test*: 3.1 Properties of Matter

Visit the **Sports Gallery – 5th Floor South**

Helmet Crash Test

Choose either helmet type or hammer height. Design an investigation that shows; A) How the height of the hammer affects force, ***or*** B) Which helmet gives the best protection.

Make a prediction and give a reason.

Show your data to prove or disprove your prediction.

What did you use as a control in this investigation?

Trail Guide *Apollo Mission Spacesuit*: 3.1 Properties of Matter

Visit the **Exploring Space Gallery – 5th Floor South**

Apollo Mission Spacesuit

Look at the replica spacesuit from the Apollo missions.

Do you think the material used to make the spacesuits is different than your clothes?

Why?

Was the weight (mass) of the suit an important factor in its design?

Would this suit be useful on Earth, why or why not?

Trail Guide *What Is Insulation?*: 3.1 Properties of Matter

Visit the **Energy City Gallery – 6th Floor South**

What Is Insulation?

Study the different types of insulation that are displayed.

Which type of insulation would be best for your house?

Why is it important to have proper insulation?

How would your energy costs be affected without insulation?

Trail Guide *Weather Station*: 3.1 Properties of Matter

Visit the **Planet Earth Gallery – 6th Floor South**

Go to the Weather Station
Find the exhibit on clouds

Use the knob to scroll through the different types of clouds and read the description associated with each of them. Do the different clouds indicate different weather patterns?

What might a cirrus cloud indicate?

Nimbostratus?

Cumulus?

Stratus?

Now go to the Overlook Balcony and observe the clouds in the sky today. Do any of them look familiar? Can you make a small forecast for the rest of the day's weather based on the type of cloud you see? Write your forecast in your science notebook and provide the reasoning behind your prediction.

Post-Visit Lessons

The following highlighted GLE's and GLC's are covered in this section:

Properties of Matter - How does the structure of matter affect the properties and uses of materials? GRADE 3			
3.1 Materials have properties that can be identified and described through the use of simple tests.			
Core Science Curriculum Framework	**Underlying Concepts** *Students should understand that…*	**Grade-Level Expectations** *Students should be able to…*	**CMT Expected Performances**
3.1.a. Heating and cooling cause changes in some of the properties of materials.	1. Materials have properties that are directly observable; examples include its state of matter, or its size, shape, color or texture. Other properties can only be observed by doing something to the material (simple tests). Materials can be sorted and classified based on their testable properties. 2. Some materials dissolve (disappear) when mixed in water; others accumulate on the top or the bottom of the container. The temperature of water can affect whether, and at what rate, materials dissolve in it. 3. Some materials, such as sponges, papers and fabrics, absorb water better than others. 4. Some materials float when placed in water (or other liquids such as cooking oil or maple syrup); others sink to the bottom of the container. 5. Some materials conduct heat better than others. Materials that are poor heat conductors are useful for keeping things cold or hot. 6. Some materials are attracted to magnets. Magnetic materials contain iron. 7. The physical properties of a material can be changed, but the material remains the same. For example, a block of wood can be cut, sanded or painted, but it is still wood. 8. Heating and cooling cause materials to change from one state of matter to another and back again. Adding heat can cause solids to melt into liquids (for example, chocolate, ice cream, butter or wax); removing heat (cooling) can cause liquids to harden into solids (for example, hot candle wax hardens as it cools). 9. Adding heat can cause water to boil and evaporate into a gas in the air (for example, steam rises from heated water); removing heat (cooling) can cause water vapor to condense into liquid water (for example, warm steam hitting a cold mirror). Water outdoors or in an open container evaporates without boiling (for example, puddles, ponds, fish tanks, etc.) 10. Water may exist as a solid, liquid or gas, depending on its temperature. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing. 11. Liquid water becomes solid water (ice) when its temperature cools to 0 degrees Celsius (32 degrees Fahrenheit). Warming ice to a temperature above 0 degrees Celsius causes it to melt into liquid water. **SCIENTIFIC LITERACY TERMINOLOGY:** physical property, state of matter, solid, liquid, gas, dissolve, absorb, conduct, attract, melt, freeze, boil, evaporate, condense	1. Compare and contrast the properties of solids, liquids and gases. 2. Demonstrate that solids, liquids and gases are all forms of matter that take up space and have weight. 3. Carry out simple tests to determine if materials dissolve, sink or float in water, conduct heat or attract to magnets. 4. Classify materials based on their observable properties, including state of matter. 5. Design and conduct fair tests to investigate the absorbency of different materials, write conclusions based on evidence, and analyze why similar investigations might produce different results. 6. Explain the role of heating and cooling in changing matter from one state to another during freezing, melting, evaporation and condensation.	**B1**. Sort and classify materials based on properties such as dissolving in water, sinking and floating, conducting heat, and attracting to magnets. **B2**. Describe the effect of heating on the melting, evaporation, condensation and freezing of water.

Post-visit Lesson #1 – Cocoa Cups

Purpose: to allow students to apply their thinking about thermal conductivity in an everyday situation.

Materials for each group of 3-4 students:
- hot drink cups or mugs made of three different materials: ceramic, Styrofoam, cardboard, glass, or enamel
- 3-4 plastic drink lids
- hot tap water, approximately 1 quart,
- 3 – 4 thermometers
- Paper or notebooks for recording observations and conclusions

Procedure:

Day 1
Have students recall what they discovered about thermal conductivity during the classroom lesson at the Science Center.

Let students examine the different types of hot cups and ask them to predict which would keep a hot drink warm for the longest time. Be sure to ask students to explain the thinking behind their prediction.

Show the students the materials that are available to them, and have them work in teams to design an investigation that would demonstrate which material actually does the best job of keeping a drink warm.

Assist students as necessary in designing their investigations. In order to have a fair test, they will need to keep the amount of water and the starting temperature of the water the same for each cup. They can decide as a team whether they want to use covers. They will also need to decide on a method and schedule for data collection.

Day 2
Have students gather materials and conduct their investigations. It is not necessary for all of the water to cool down completely to reach a conclusion; 20-30 minutes of data collection should be long enough.
Have students analyze the data they collect, and write their conclusions in their science journals. Then have each team report their findings to the class.

Guide students to connect their findings into general statements about the thermal conductivity of the materials. Conclusions may include:
- ✓ Styrofoam does not conduct heat well. It makes an excellent insulator.
- ✓ Thick ceramic mugs insulate better than thin china cups.

- ✓ Enamel coated metal cups do not keep drinks warm for long. Metal is a good thermal conductor, so does not insulate well.
- ✓ Covering the cup keeps the drink warmer longer regardless of the material from which the cup is made. (This is because the cover lowers the evaporation rate. Evaporation is a cooling process. As the water evaporates, it takes some of the heat with it.)

If one material does the best job of keeping the drink warm, why isn't it used for ***all*** hot cups? Have students identify other properties of the materials that need to be considered when deciding on their use. For example:

- Ceramics are fragile, but they are durable if handled carefully, and do a good job of keeping drinks warm.
- Enameled metal cups don't break easily, but they are not as good at keeping drinks warm.
- Styrofoam insulates well, but cracks easily, and it is not bio-degradable.
- Cardboard cups are inexpensive and disposable, and generally keep drinks warm long enough to be consumed.

Post-visit Lesson #2: Cloud observations

Purpose: This lesson and the one that follows are designed to help students extend their thinking about the states of water by having them consider the water in our atmosphere. In this lesson, students learn that condensation often occurs high in the atmosphere, and they begin to identify clouds that are likely to produce rain.

Materials
Science notebooks or Cloud Observation booklets (two 18x4" strips, folded into fourths and taped together forms an 8-page accordion booklet that can be stretched out to show day-to-day changes)
Cloud chart - optional

Procedure:
Remind students of the clouds they observed in displays at the Science Center. Let them describe what they remember about the clouds as seen from above.
Over the course of a week or two, have students observe clouds once or twice a day for a few minutes. Allow students to sketch and write descriptions of the clouds they see. Students should be encouraged to notice their shape, color or darkness, size, the portion of the sky they occupy, and their motion across the sky. Different heights can sometimes be noted on days when there is more than one type of cloud formation or when the wind speed at the surface is different than in the upper atmosphere.

Provide students with a compass or help them determine the cardinal points by noting the motion of the sun so they can record the wind direction. By observing the motion of branches or a flag, students can begin to develop a scale for the wind speed. They should also record any precipitation coming from the clouds.

Remind them that the clouds are made of water vapor that has condensed in the cool upper layers of the atmosphere. In Connecticut, southerly winds often carry moisture from the Gulf of Mexico, and

winds from the east or northeast are likely to produce clouds and rain as they blow in air carrying water vapor from the Atlantic Ocean creating a Nor'easter.

Once students have become fairly familiar with cloud types, and are able to recognize clouds likely to produce rain, post a cloud chart in the room, if one is available, to offer students the names of some of the basic cloud types. The maps at www.weather.com will allow students to see satellite views of current cloud cover and water vapor, as well as the motion of the clouds over a three hour period.

You might also provide them with a copy of the Beaufort Wind Force Scale so they can compare their observations with this standard. Information about Admiral Beaufort and a copy of the scale can be found at
http://www.islandnet.com/~see/weather/history/beaufort.htm

Post-visit Lesson #3: Puddle observations

Purpose: To extend students' experiences with evaporation in a naturalistic setting: puddles.

Advanced preparation:
Take a walk around your school shortly after a rainstorm and locate places where puddles naturally form. It is nice to locate some in potentially sunny areas and some in shady spots, but this is not required.

Materials:
Puddles of water – naturally occurring or teacher/student made
Chalk
Science notebooks for recording
Measuring tapes, string, and/or meter sticks
Pails or gallon milk jugs for measuring and transporting water

If possible, do this lesson on a day when puddles have been left after a rain and rain is unlikely for the next couple of days. Allow students to find puddles and decide on two or three to study.

If natural puddles are not available, plan to carry enough water outside to make puddles in two of the hollows in which puddles naturally form.

Procedure:
Let students know that this lesson will focused on the evaporation of rainwater. Have them consider where they have noticed puddles in the schoolyard. Are there puddles that lie in their paths as they move in and out of the building? Can they estimate how long the puddles remain after a storm?

Head outside to a puddle spot. *(You can have all of the students carry their science notebooks or designate a few students to record observations and measurements to share when everyone gets back inside.)* Have students form a circle around one puddle and share observations. Lead them into a discussion of how the puddle might be measured. They may think of measuring the length and width, the distance around, and perhaps the depth. They may also want to measure the amount of

water in the puddle. One way to do this is to outline the puddle with chalk *(or a line in the dirt)*, wait until all of the water evaporates, then measure the amount of water it takes to refill the puddle.

Have students work in teams to make and record measurements of this puddle and one or two others.

Back inside, have students map out the locations of the puddles and make predictions about how long it will take the water in each puddle to evaporate. Factors they might consider are the size of each puddle, its location, the air temperature, and the amount of wind. They might simply predict which puddle will be the first to disappear.

Make plans to observe the puddles three or four times as the water evaporates. The frequency of the observations will depend on the students' estimates of the evaporation rate.

After each observation, allow students to change their predictions if they wish. This should be done by writing a new prediction rather than erasing an earlier one. Discuss the ideas behind each new prediction, and have students include a brief written explanation for the reasons behind any new estimates.

When the puddles finally disappear, have students write what they have learned about evaporation in their journals. Make note of students' use of terms that indicate their developing understanding of the factors that affect evaporation.

Performance Task: Cool Lemonade

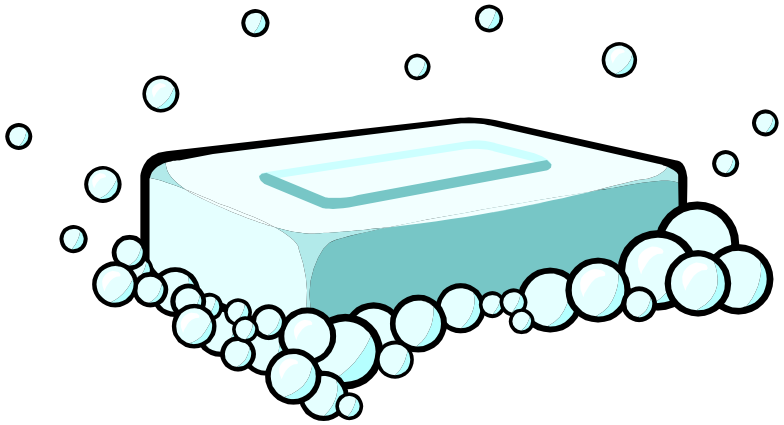
Purpose: To assess students understanding of thermal conductivity.

Students can take the role of designer or advertiser to describe a cup that will keep a serving of lemonade cool for an extended time. Each will need to write a description of his or her cup, an explanation for the elements of design, and a picture or diagram of the container, including its dimensions. Students are also welcome to discuss the convenience and practicality of their designs, and compare them to other types of cups.

An effective design would be made of an insulating material such as Styrofoam or plastic, and may include considerations of the thickness and weight of the material used, the dimensions of the container and the surface area, and the use of a cover. Students can also be assessed on their ability to explain the reasons for their designs, and their use of important terms associated with thermal conductivity (heat, insulate, conduct).

Guided Investigation

Content Standard 3.1



Will It Float?

Teacher Manual

Rachael Manzer, K-8 Science Supervisor
Suffield Public Schools

Will It Float?
A Guided Exploration of Sorting and Classifying Materials Based Upon Properties

ENGAGE:

1. Drop an unpeeled orange in the water. Did it sink or float?
2. Peel the orange. Drop the peeled orange in the water. Did it sink or float?
3. Drop one of the peels in water. Did it sink or float?
4. In your science journals, explain why some objects sink and others float.

Teacher Notes: This discrepant event paired with the students science notebook entry will help reveal the students misconceptions about floating and sinking. Some of the common misconceptions to look for are:

- *Water is pushing up on the object.*
- *Weight determines if an object will sink or float.*
- *Heavy objects always sink and light objects always float.*
- *The amount of water will cause objects to float or sink better.*
- *Objects with holes will always sink.*
- *Objects with air float.*
- *Objects float on top of a liquid.*
- *A larger heavier object will not float as well as a smaller lighter object made out of the same material.*
- *Weight of the water must be more then the weight of the object.*
- *Objects float in water because they are lighter then water. They sink in water because they are heavier then water.*
- *Wood floats and metal sinks.*

When you know the student's misconceptions, you can correct them by providing learning opportunities that examine and test these misunderstandings.

EXPLORE:

In this activity, you will explore some of the properties of objects you use every day.

1. **Gather** these materials for your group:

   - 12 objects that are made of a variety of materials such as metal, wood, plastic, paper, and edible objects.
   - Balance scale
   - Fabric measuring tape
   - Hand lens

Teacher Notes: Students can gather objects from around the classroom or bring in objects from home. You will want to make sure the objects are made of a variety of materials. Possibilities could be paperclip, sponge, aluminum foil, lemon, eraser, marble, pencil, and plastic eating utensil.

2. **Observe** the properties of the different objects both with and without the hand lens. Record your observations on the table.

3. With your group, use your observations to name 5 properties that you could use to **sort** your groups of objects. Record your rules for sorting on the table below.

4. Try your first sorting rule on the set of objects. Was it a good rule for sorting? Why or why not?

5. Put all your objects back together in one group and then repeat step 4 with another sorting rule. Continue until you have tested all of the rules for sorting.

Teacher Notes: This should be a fun way for students to begin thinking about the properties of various materials. Have the students' share how they sorted and classified their objects with their classmates. Discuss with the students that objects can be described by several properties like size, shape, color, weight, composition, or even purpose. ***B INQ.1***

My Observations

Properties Observed Without Magnifier	Properties Observed With Magnifier

My Sorting Rules

What were your rules for sorting your objects into groups?

6. **Think** about your rules for sorting. Can we sort objects on whether they sink or float? What descriptive words can be used to describe objects that sink or float?

_____
_____
_____
_____

Teacher Notes: Use the list of descriptive words the students generate to help the students predict whether objects sink or float.

7. **Predict** which of your 12 objects will sink and float. Use the table to record your data.

Object	Weight	Length	Prediction	Reason

8. **Measure** the weight and length of each object. Record the data on the table.

Teacher Notes: By including a balance and a measuring tape, students will practice and refine their measurement skills. A balance and measuring tapes can be used to help the students compare objects and after the expert is conducted help address common misconceptions about sinking and floating. ***B INQ.9***

Now you're ready to test your predictions.

EXPERIMENT #1: WHICH OBJECT WILL FLOAT? In this activity, you will further sort your objects by determining which objects will sink of float or float.

1. **Gather** the following materials to use in the planning and conducting of your experiment.

For each lab group:
- 12 objects that you have worked with previously
- Clear bucket or a bowl (testing tank)
- Graduated cylinder
- Permanent marker
- Paper towels
- Water

For each student:
- Data table

2. Re-**sort** your 12 objects based upon your group's prediction about if the objects will sink of float.

Object	Prediction: Will It Sink or Float?	Test Result: Did it Sink or Float?	Test Result: Did the Water Level Rise?	Notes:

3. Prepare your **Data table.** You should write the objects you will be testing in the first column.

Teacher Notes: Have students record their observations in an organized table, similar to the one shown below. If your students are experienced at using observation tables, they may want to design their own table. If so, delete the table shown here and leave space for students' own table designs. B INQ.5

4. Fill the testing tank half full with water.
5. Use the permanent marker to record the water level.
6. Conduct the **experiment**. Place one object above the water so it just touches the top of the water and let go. **Observe** what happens.
7. On your **data table** record whether the object sank or floated.

8. On your **data table** record whether the water level rose, stayed the same, or went down.
9. On your **data table** record anything you found interesting. For example, you notice _____ sank faster then _____.
10. Reach into the test tank and remove the test object.
11. Once the water settles, **observe** the water level. Is the water at the same level as the beginning of the experiment? If not use the graduated cylinder to add a little more water.
12. Repeat steps 6-11 with the other objects.

*Teacher Notes: Step 1-12 directly relate to **B INQ. 3***

13. After you have completed your experiment, **sort** the objects that sank in one pile and the items that floated in another.

EXPLAIN
Think About Your Data:

1. Examine your group of objects that floated. Do they have anything in common?

_____
_____
_____

2. Examine your group of objects that sank. Do they have anything in common?

_____
_____
_____

Teacher Notes: Lead a class discussion to help students drawing conclusions from this experiment. Have the students discuss the similarities and differences about the characteristics of the objects that sank. Have the students notice the weight of various objects they tested. Many children believe that heavy objects sink and lighter objects float. Point out that some heavy objects like boats float, while relatively lighter objects such as coins sink. Encourage them to predict why objects sink and float. Have them draw on prior knowledge and describe observations they have made of sinking and floating objects. Encourage them to make comparisons and connections. They should realize that weight of an object is not the only factor that determines if an object sinks or floats. ***B INQ.3, B INQ.5***

Depending on the objects the students tested, students probably had the opportunity to confront some other common misconception, like;

- *Weight determines if an object will sink or float.*
- *Heavy objects always sink and light objects always float.*
- *Wood floats and metal sinks.*
- *Objects float on top of a liquid.*
- *Objects with holes will always sink.*
-

3. What happened to the water level when you placed objects in the testing tank? Did the water increase, stay the same, or decrease? Why do you think that happened?

_____

_____

_____

Teacher Notes: Continue the class discussion by drawing conclusions about what happened to the water level after they placed an object in the test tank. Did the water level rise, stay the same, or lowered? Are there their differences in your findings? Why were there differences in your findings? If needed, be prepared to replicate some of the testing. Children should begin to see a connection between the displacement of water and why an object sinks or floats. ***B INQ.5***

Some objects, when placed in water will float, while others will sink. Some objects neither float nor sink. The objects ability to float or sink is a function of buoyancy. Objects that float have positive buoyancy. Objects that sink have negative buoyancy. A Greek mathematician named Archimedes defined the principle of buoyancy: "Any object, wholly or partly immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object." The statement is known as Archimedes' principle. Think about what happens when you take a bath. When you fill the bathtub half full with water and then get in the water level rises. The weight of your body displaces the water.

One factor if an object sinks or floats is density. Density equals mass/volume. Salt water has a higher density then freshwater because the salt in the water adds more mass to the water without changing the volume, or amount of water. The increased density if the salt water in comparison to fresh water, allows objects to float much easier. Objects with greater density than the fluid will sink, while objects with less density will float.

Other factors about whether or not an object will float are shape and position. A steel boat when turned on its end will not float; however a steel boat will float when turned horizontally.

4. How did your group decide if something was floating? Did the object have to rise above the top of the water or was it floating if it did not touch the bottom? Why is it important for everyone to have the same definition?

_____

_____

5. Does it matter how much water is in your test tank? Should it be the same amount of water for each item?

_____

_____

Teacher Notes: A Fair Test is an experiment in which one condition (independent variable) affects another (dependent variable). All other conditions are kept constant. It is only by carrying out a fair test

*that you can be sure that what you have changed (independent variable) affected what you measured. **B INQ.3***

6. Share your data and discuss your conclusions with the whole class.

*Teacher Notes: Further exploration of sink and float will certainly help students expand their understanding of this concept. Students may need to do additional experiments with other materials to further test their conclusions. **B INQ. 6***

Learn More about Sinking and Floating

Have you ever wondered why a large steel ship like oil tankers and cruise ships float in the ocean? Read books to gather more information about different types of ships. Compare and contrast ships that were built to for speed and those designed to carry cargo. Use the information to design and build your boat out of recycled materials.

Teacher Notes: Once the students have completed their research have the students design their own ships to compete in a Boat Regatta. All you need to provide is building materials like wood, plastic, cardboard, or foam for the boat and a body of water. A child's wading pools works great. Depending upon the size of your water body set the size limit for your student's boat. (20 cm in length is a good size of a wading pool that is 1 meter in diameter.) Have two types of ships; power boats and cargo boats. (For power boats allow the students only one power source like sails, rubber bands, balloons, etc.) Before building, have the students make detailed drawings of their design. On race day, power boats should be given at least 3 chances to get the fastest time. For cargo boats, have the students load put small weights like pennies on the boat. Which boat will hold the most weight without sinking? Follow up the competition with a discussion questions like; did the boat that held the most weight look like the boat that went the fastest? How does the shape of a boat help determine how much weight it can carry or how fast can it go? Make a real life connection by taking about how most regattas like the America's Cup have very strict rules on the types of boats that can enter. Ask the students why would the America's Cup need rules on the type of boat can be entered.

ELABORATE
EXPERIMENT #2: Will Soap Float?

You have been sorting objects by their properties. What if all the objects look the same? What simple test can you do that would help find out more information about each object? How can you use that new information to sort and classify the objects? In this experiment, you will use what you learned in Experiment #1 to find out more about the properties of similar objects.

Teacher Note: You will need to provide each group of students with 4 white bars of different brands of soap. One of the bars should be Ivory and another should be a store brand. Each group does not need a full bar. All the bars should be the same size.

Inquiry Starter:

1. Gather 4 different brands of bars white soap and hand lens.

2. Use the hand lens to **observe** and **compare** the properties of the 4 different brands of soap.
3. **Measure** the length, width, and weight of each brand of soap. Make a data table in your science notebook and record your observations.
4. Make a **Data Table** in your science notebook and record your **observations** and wonders.

Notice	Wonder	Testable Questions

Teacher Note: Having the bars of soap be the same size and color will really encourage students to investigate other properties. Students may examine the texture of shape of the soap. Or ask questions about the rate it will dissolve or if it will sink or float. B INQ.1

5. Talk to your group about your observations. As a groups come up with a list of **questions** that you would like to investigate. Record the questions on your **Data Table**.

Focused Investigation:

Teachers Note: There is some teacher preparation before this inquiry investigation can begin. Before the students select the question they would like to investigate, you will need review the questions. Only select the questions for the students to investigate that are specifically tied to the Connecticut State Science Framework

Display the questions that will not be tested today in the classroom labeled, "Test Later." Explain to the students that we will not have the opportunity to test these questions today but may test them on another day. Display the questions that the students may chose to investigate around the classroom. B INQ.1

1. Select the **question** you want to investigate.

Teacher Note: Have the students do a gallery walk. Have them walk around the classroom, read the question, and select the question they are most interested investigating. There should be 3 -5 students investigating the same question. Several groups of students could be investigating the same question. B INQ.1

2. With your group, **design** your experiment. What materials will you use? How will you make sure you have **fair test**? How are you going to collect your **data**? Record your experimental **design** in your science notebooks.

Teacher's Note: Decide on the materials the students will have prior to the start on the investigation. Suggested materials:

- *Hot water*
- *Cold water*
- *Beakers*
- *Graduated cylinders*
- *Bucket or bowl (test tank)*
- *Magnets*
- *Stirrers*
- *Salt*
- *Sugar*
- *Thermometer*
- *Stop watches*

Introduce the materials before students begin designing their experiment. If a group needs a material that you have not provided, ask them to come and ask you. You can decided if the additional material(s) will help students discover the answer to their question while still moving toward CT Science Framework Standard 3.1. ***B INQ.4***

3. **Predict** what you think will happen to each brand of soap. Record in your science notebooks.
4. **Conduct** your experiment. Record your findings in a **data table** in your Science Notebooks.

Teacher Note: Monitor their experiments. Look to see if they are conducting a fair test. Look to see if they are recording their information in a data table. ***B INQ.3***

5. **Analyze** the results of the experiment with your group. What **conclusions** can you make based upon your data? Were there any surprises? How would you sort and classify the bar soap? What new **questions** do you have? If you could do the experiment again, what would you **design** differently? **Write** about your findings in your science notebook.

Communicate Your Learning:

Teacher Note: Decide how you want the groups to share the information with other. For example, will they could create a poster or develop a power point or a write journal article? The activity found in the student guide is only one example about how the students could share their findings with others. Decide on how much time each group will have to create their presentation and share with others. ***B INQ.6***

6. **Communicate** and share the results of your experiment by designing an advertisement for a brand of soap. The advertisement should be neat and catch the customer's attention. It should include:

- the brand of the soap
- data you collected
- statements describing the results of your experiment
- and why that information is important to the customer

Teacher Note: It is important in the share out for students to tie results back to the properties of the objects. Sometimes objects may look the same (color, shape, size) but other properties can be found by doing simple tests. ***B INQ.6***

Teacher Note: For more information on Ivory Soap and why it floats see "Pure Fun with Ivory" from Ivory Soap's Homepage http://www.ivory.com/PureFun.htm

Possible Extensions:
How Do Boats Float?

How can a ship weighing hundreds of pounds stay afloat? It all has to do how much water is pushing against you and a scientific principal called buoyancy. When you stretch your body out in a swimming pool, you float. But in the same pool when you curl up in ball you sink. When your body is all curled up in a ball, there is not as much water pushing against you so you sink. But when you lay out flat, there is more water pushing against you so you float.

Try This Experiment:

Who in your class can **design** and **construct** a boat out of aluminum foil that will hold the most pennies without sinking?

*Teacher's Note: You may want to give the students some clay so they can **explore** and **test** different shapes of a boat when placed in water. Then give every group the same amount of aluminum foil. A 10 inch square is usually enough. Explain to the students that is the only piece of aluminum foil they will get. If they rip it they will need to find a way to repair it. B INQ.1*

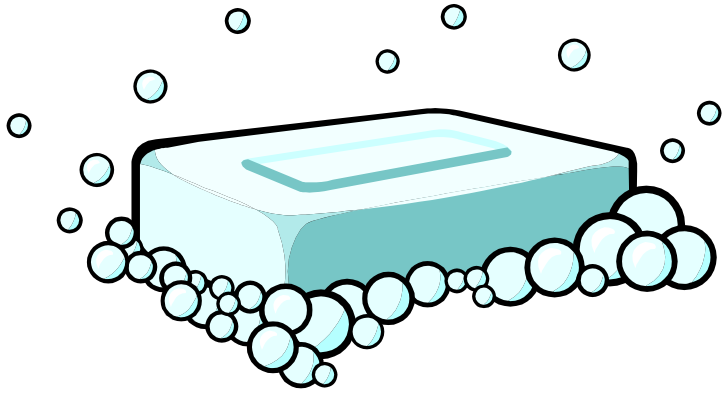
1. **Test** to see how many pennies or paper clips your boat will hold without sinking.
2. Retrieve your objects and dry them
3. Weigh the paperclips and/or pennies to determine how much weight your boat could hold before sinking.
4. **Record** your data in your science notebooks.
5. **Compare** your data with your classmates. What **conclusions** can you make based upon your data?
6. **Compare** your boat design with your classmates. What **conclusions** can you make based upon your observations?
7. **Share** your conclusions with your classmates.

Teacher Notes: the following expected performances are addressed in this extension; B INQ.1, B INQ.3, B INQ.5, B INQ.6

Further Questions to Explore

- Experiment by making your boat out of different materials. What types of materials were more buoyant? Why?
- Experiment by making different shaped boats. What shape of boat was most buoyant? Why?
- What do you think would happen if we add salt to the water?

Guided Investigation
Content Standard 3.1



Will It Float?

Student Materials

Rachael Manzer, K-8 Science Supervisor
Suffield Public Schools

Will It Float?
A Guided Exploration of Sorting and Classifying Materials Based Upon Properties

ENGAGE:

1. Drop an unpeeled orange in the water. Did it sink or float?
2. Peel the orange. Drop the peeled orange in the water. Did it sink or float?
3. Drop one of the peels in water. Did it sink or float?
4. In your science journals, explain why some objects sink and others float.

EXPLORE:

In this activity, you will explore some of the properties of objects you use every day.

1. Gather these materials for your group:
   - 12 objects that are made of a variety of materials such as metal, wood, plastic, paper, and edible objects.
   - Balance scale
   - Fabric measuring tape
   - Hand lens

2. Observe the properties of the different objects both with and without the hand lens. Record your observations on the table.

   My Observations

3. With your group, use your observations to name 5 properties that you could use to **sort** your groups of objects. Record your rules for sorting on the table below.

Properties Observed Without Magnifier	Properties Observed With Magnifier

What were your rules for sorting your objects into groups?

4. Try your first sorting rule on the set of objects. Was it a good rule for sorting? Why or why not?

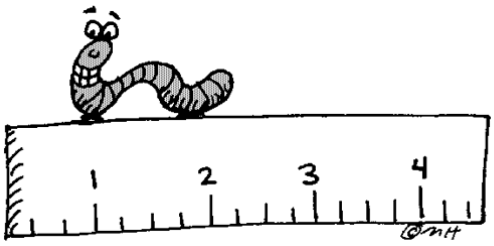
_____
_____
_____
_____
_____

5. Put all your objects back together in one group and then repeat step 4 with another sorting rule. Continue until you have tested all of the rules for sorting.
6. **Think** about your rules for sorting. Can we sort objects on whether they sink or float? What descriptive words can be used to describe objects that sink or float?

_____
_____
_____
_____
_____
_____

7. **Predict** which of your 12 objects will sink and float. Use the data table on the following page to record your data.

8. **Measure** the weight and length of each object. Use the data table on the following page to record your data.



Sink or Float Data Table

Object	Weight	Length	Prediction	Reason

Now you're ready to test your predictions.

EXPERIMENT #1: WHICH OBJECT WILL FLOAT?

In this activity, you will further sort your objects by determining which objects will sink or float.

1. **Gather** the following materials to use in the planning and conducting of your experiment.

For each lab group:

- 12 objects that you have worked with previously
- Clear bucket or a bowl (testing tank)
- Graduated cylinder
- Permanent marker
- Paper towels
- Water

For each student:

- Data table

2. Re-**sort** your 12 objects based upon your group's prediction about if the objects will sink of float.
3. Prepare your **data table.** You should write the objects you will be testing in the first column. See the data table on the next page.

The Experiment: Sink or Float?

Object	Prediction: Will It Sink or Float?	Test Result: Did it Sink or Float?	Test Result: Did the Water Level Rise?	Notes:

4. Fill the testing tank half full with water.
5. Use the permanent marker to record the water level.
6. Use the permanent marker to record the water level.
7. Conduct the **experiment**. Place one object above the water so it just touches the top of the water and let go. **Observe** what happens.
8. On your **data table** record whether the object sank or floated.
9. On your **data table** record whether the water level rose, stayed the same, or went down.
10. On your **data table** record anything you found interesting. For example, you notice _____ sank faster then _____.
11. Reach into the test tank and remove the test object. Once the water settles, **observe** the water level. Is the water at the same level as the beginning of the experiment? If not use the graduated cylinder to add a little more water.
12. Repeat steps 6-11 with the other objects.
13. After you have completed your experiment, **sort** the objects that sank in one pile and the items that floated in another.

EXPLAIN
Think About Your Data:

1. Examine your group of objects that floated. Do they have anything in common?

_____
_____
_____

2. Examine your group of objects that sank. Do they have anything in common?

_____
_____
_____

3. What happened to the water level when you placed objects in the testing tank? Did the water level increase, stay the same, or decrease? Why do you think that happened?

   _____

   _____

   _____

4. How did your group decide if something was floating? Did the object have to rise above the top of the water or was it floating if it did not touch the bottom? Why is it important for everyone to have the same definition?

   _____

   _____

5. Does it matter how much water is in your test tank? Should it be the same amount of water for each item?

   _____

   _____

6. Share your data and discuss your conclusions with the whole class.

Learn More about Sinking and Floating

Have you ever wondered why a large steel ship like oil tankers and cruise ships float in the ocean? Read books to gather more information about different types of ships. Compare and contrast ships that were built to for speed and those designed to carry cargo. Use the information to design and build your boat out of recycled materials.

ELABORATE
EXPERIMENT #2: Will Soap Float?

You have been sorting objects by their properties. What if all the objects look the same? What simple test can you do that would help find out more information about each object? How can you use that new information to sort and classify the objects? In this experiment, you will use what you learned in Experiment #1 to find out more about the properties of similar objects.

Inquiry Starter:

1. **Gather** 4 different brands of bars white soap and hand lens.
2. Use the hand lens to **observe** and **compare** the properties of the 4 different brands of soap.
3. **Measure** the length, width, and weight of each brand of soap. Make a data table in your science notebook and record your observations.
4. Make a **Data Table** in your science notebook and record your **observations** and wonders.

Notice	Wonder	Testable Questions

5. Talk to your group about your observations. As a group come up with a list of **questions** that you would like to investigate. Record the questions on your **Data Table**.

Focused Investigation:

1. Select the **question** you want to investigate.
2. With your group, **design** your experiment. What materials will you use? How will you make sure you have **fair test**? How are you going to collect your **data**? Record your experimental **design** in your science notebooks.
3. **Predict** what you think will happen to each brand of soap. Record in your science notebooks.
4. **Conduct** your experiment. Record your findings in a **data table** in your Science Notebooks.
5. **Analyze** the results of the experiment with your group. What **conclusions** can you make based upon your data? Were there any surprises? How would you sort and classify the bar soap? What new **questions** do you have? If you could do the experiment again, what would you **design** differently? **Write** about your findings in your science notebook.

Communicate Your Learning:

6. **Communicate** and share the results of your experiment by designing an advertisement for a brand of soap. The advertisement should be neat and catch the customer's attention. It should include:

- the brand of the soap,
- data you collected,
- statements describing the results of your experiment,
- And why that information is important to the customer.

Teacher Resources

Safety Disclaimer:

The content of this Teacher's Resource section is intended to serve as an educational resource for teachers and students.

Preparing for the safety of yourself and your students is a critical step in planning for any hands-on science- related activities. Prior to conducting any of the activities included in this resource section, please familiarize yourself and your students with any potential hazards, and take the necessary precautions appropriate for each specific activity.

Connecticut Science Center is not responsible for the contents of any books, videos, websites or other resources to which we provide a reference and does not necessarily endorse the opinions, activities, services, products or information expressed within them.

Teacher Background Information

Content Standard 3.1, *Properties of Matter*, builds upon Standard 2.1, *Solids, Liquids, and Gases*, and is directly related to Standard 3.3, *Rocks and Minerals*, and 3.4 *Conservation of Natural Resources*. The goal of Standard 3.1 is to help children consider some of the unique properties of water, one of our most valuable natural resources, and to begin to recognize some of the properties of other common materials and the ways in which these properties determine how they can be used.

Water is the only substance or material that we regularly encounter in all three states, liquid, solid, and gas. It **evaporates**, **condenses**, and **freezes** at temperatures normally found on Earth.

Water **freezes** and becomes a solid at 0°C. One of the unusual properties of water is that its solid form, ice, is less dense than its liquid form. This is why ice floats.
Adding heat to ice will cause it to **melt** and become liquid again. Although the volume of the ice and water are different, the mass, or weight of the ice and water will be the same.

When water changes from a liquid to a gas, it is **evaporating**. Bringing water to its boiling point, 100°C, will create steam, a cloud of miniature water droplets. The steam will rapidly turn to water vapor which is a gas and is invisible. Evaporation of water also occurs at normal atmospheric temperatures well below its boiling point. Puddles disappear, towels dry, and unwrapped bread can quickly become hard and stale even when the temperature is cool.

Condensation occurs when water vapor is cooled enough to become liquid water. Water vapor in the air on a warm summer day is easily 'captured' as it condenses on the sides of a cool glass of lemonade. Water vapor condenses on bathroom mirrors after a shower and on the grass in the form of dew on a cool morning. Clouds form as water vapor condenses on particles in the cooler

temperatures of the upper atmosphere, and, when conditions are just right, water vapor condenses at ground level to form fog.

Frost and snowflakes form when water vapor changes directly from a gas to a solid. This process is called **sublimation**. Sleet forms when a layer of warm air sits above a layer of freezing air at the surface. Raindrops fall as liquid, then freeze as they fall through cold air near the ground.

Other materials that children are apt to be familiar with in more than one state are chocolate, butter, and candle wax. Heating chocolate or butter will cause it to melt. Cooling will return it to a solid state, but not to its original shape. Candle wax first melts, then burns when heated. While cooling melted wax will cause it to solidify, some of the wax from a burning candle vaporizes to form a gas and cannot be retrieved.

Most of the materials we encounter every day are solid. A few are made of natural materials – rocks and minerals or wood – but most are made of manufactured materials. Manufactured materials include those derived from biological sources, such as paper, rubber, and natural fabrics, and materials derived from the Earth itself, such as metals, glass, ceramics, and nylon and other plastics.

Each of these materials has properties that determine its uses. These properties include **thermal conductivity**, **buoyancy**, **absorbency**, **solubility**, and **magnetic attraction**. (Other properties such as toughness, flexibility, and elasticity, do not come under the scope of this Standard. Hardness of rocks is addressed in Standard 3.3.)

Thermal conductivity is a measure of the ease with which heat can be transferred through a material. Metals conduct heat well, while natural materials and plastics do not. Materials that are poor conductors can be used as **insulators**.

The **buoyancy** of a material is related to its density. Materials with a density lower than water will float on water while those with a density greater than water will sink. Materials with a density very close to that of water will come to rest near the top or bottom of the water column. This is true whether the material is solid or liquid. Cooking oils float to the top of bottles of salad dressings because they are less dense than water and other water-based ingredients such as vinegar. While density is a difficult concept for most students in grade 3 due to the need to understand the relationship between weight and volume, investigating buoyancy will help students begin to discover that weight alone does not determine whether an object will sink or float. Watermelons are certainly heavy, but they do float.

While **absorbency** can refer to the absorption of energy, Standard 3.1 is concerned only with the degree to which a material absorbs or repels water.

Some solid materials are **soluble**, i.e., they can be dissolved in a liquid. Water is an excellent solvent. Sugar, an organic compound, and salt, a mineral, both dissolve in water. When dissolved, the crystals of sugar or salt break down into particles so small they cannot be seen, although they can still be tasted. A mixture of a solute (sugar) and a solvent (water) is called a solution. The solid in a solution can be recovered from the solution by allowing the liquid to evaporate.

There is a limit to how much of each solid will dissolve in a given amount of liquid. The amount of solute that will dissolve may be increased by increasing the temperature. Factors that affect the speed with which dissolving occurs include temperature, particle size, and the ratio of solute to solvent.
Other solid materials like cinnamon or sand are not soluble. Rather than forming a solution, they will become suspended in the water or sink.

Also see *Benchmarks for Science Literacy* (Section 4D)
http://www.project2061.org/publications/bsl/online/ch4/ch4.htm#D_E

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 Health and Sports Gallery, Invention Dimension Gallery and Exploring Space Gallery 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 a Guided Exploration aligned with content standard 3.4. Afterward, you will process the various activities and discuss their applications in your classroom and in your students' learning.

3.1 Content Workshop

Materials have properties that can be identified and described through the use of simple tests.

This is a five day content workshop focused specifically on standard 3.1 which focuses on the concept of properties of matter. Through participating in this inquiry-based workshop, you will deepen your understanding of this standard and more importantly, be better prepared to guide your students to an in depth understanding of this concept as well.

During this workshop, you will have the opportunity to experience multiple inquiries that will guide you to a deeper understanding of the science concept, as well as the opportunity to then process the inquiries as a teacher and discuss their applications in your classroom and in your students' learning.

You will also experience the integration of language arts and science through vocabulary, nonfiction texts and science notebooking.

Come for the week and collaborate with other Grade 3 teachers across the state as you design and develop your own inquiry-based lesson to be used in your classroom with your students.

Go to www.ctsciencecenter.org for details.

Interdisciplinary Connections

Art and Science
You may be able to arrange for students to study techniques and art materials for drawing clouds with the art teacher, or you might find and discuss drawings in art or picture books that include clouds.

Social Studies
The students can investigate how the thermal characteristics of different building materials affected the social structure and interactions of cultures over the ages and around the world.

History
How did the changing ability to live in cold or hot environments affect the course of great events and human history in general?

Websites

www.weather.com
The Weather Channel on line

Third Grade Water Cycle
http://www.epa.gov/safewater/kids/flash/flash_watercycle.html
Animated description of the water cycle covering clouds, rain, water storage and water vapor

Science NetLinks Water 1 Water and Ice http://www.sciencenetlinks.com/lessons.cfm?DocID=4
Water 2: Disappearing Water http://www.sciencenetlinks.com/lessons.cfm?DocID=168
Water 3: Melting and Freezing http://www.sciencenetlinks.com/lessons.cfm?DocID=161
Three lessons in a series designed to address a concept that is central to the understanding of the water cycle—that water is able to take many forms but is still water.

What is Water http://www.nyu.edu/pages/mathmol/textbook/slg.html
Basic information about the states of water appropriate for grade 3

Water http://www.solcomhouse.com/water.htm
An adult resource; all you need to know about water

0BH*Weather Doctor's Weather People and History: Beaufort Wind Speed Scale*
www.islandnet.com/~see/weather/history/beauwscl.htm
Beaufort Wind Speed Scale

BBC - Schools - KS2 Bitesize Revision - Science - Materials
http://www.bbc.co.uk/schools/ks2bitesize/science/materials.shtml
A wonderful site for teachers and students from Great Britain about properties of materials with simulations, facts, and quizzes

Exploratorium Science Snacks http://www.exploratorium.edu/snacks/index.html
Cold Metal, Curie point, Give and Take
These three Snacks for the Exploratorium website connect to a study of some of the ways materials react to heat. They require fairly simple materials, and are appropriate for 3rd grade students.

Connecticut Clean Energy Fund

For programs to increase awareness of clean energy:
http://www.ctcleanenergy.com/EducationalPrograms/tabid/61/Default.aspx

Literature Links

The Really Useful Science Book, A Framework of Knowledge for Primary Teachers
By Steve Farrow
1999, The Falmer Press, London & Philadelphia
ISBN 0 7507 0983 9

An excellent resource written with everyday examples and very accessible language

What If Rain Boots Were Made of Paper?
By Kevin Beals and P. David Pearson
ISBN-10:1-59821-492-6
Delta Education

Develops an understanding of the relationship between a material's physical properties and its uses

Solids, Liquids, And Gases (Rookie Read-About Science)
by Ginger Garrett
ISBN-13: 978-0516246635

Basic, easy-to-read text about states of matter

What Is the World Made Of? All About Solids, Liquids, and Gases
(Let's-Read-and-Find-Out Science, Stage 2)
by Kathleen Zoehfeld and Paul Meisel
ISBN-13: 978-0064451635

An accessible study of solids, liquids, and gases. The book gives examples of each state of matter and some simple activities that demonstrate the attributes of each.

Solid, Liquid, or Gas? (It's Science)
by Sally Hewitt
ISBN-13: 978-0516263939

Presents information about the properties of solids, liquids, and gases, using observation and activities

Solids, Liquids and Gases (Starting with Science)
by Ontario Science Centre
ISBN-13: 978-1550741957

Thirteen science experiments carefully chosen by the Ontario Science Centre. With minimal supervision, children can explore the three states of matter, what makes each state unique and how matter changes from a solid to a liquid to a gas through evaporation, condensation, melting and freezing.

Solids, Liquids, and Gases: From Air to Stone
by Carol Ballard
ISBN: 1403435529

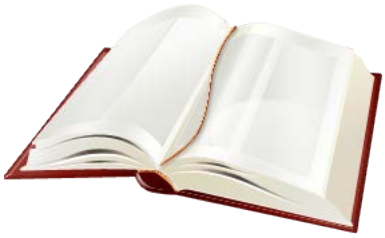
Using a question and answer format the author taps into some of the core principles of the material world. Readers will come away with a solid base of information about topics such as the effect of temperature upon materials, chemical changes, solutions, and freezing points.

How Things Are Made. Washington, D.C.: National Geographic, 1980.
Ajello, Arnold B., ed.
ISBN 0-87044-334-8

Shows a wide variety of common objects—from matches to toothpaste to baseballs—and explains how they are made.

Antoine Lavoisier: Founder of Modern Chemistry
by Yount, Lisa
ISBN 0-89490-785-9 Hillside, N.J.: Enslow, 1997.

A biography of Antoine Lavoisier, suitable for 9- to 12-year-olds



Videos

Solids, Liquids, and Gases: A First Look
Rainbow Educational Media

Melting Glaciers
http://video.nationalgeographic.com/video/player/environment/global-warming-environment/antarctica-ice.html?fs=environment.nationalgeographic.com

Home insulation
http://www.metacafe.com/watch/877242/useful_guide_to_loft_insulation/

Home Insulation
http://www.askthebuilder.com/Home_Insulation_Video.shtml

States of Matter
http://ksnn.larc.nasa.gov/k2/s_statesMatter_v.html

States of Matter
http://videos.howstuffworks.com/hsw/12963-states-of-matter-the-three-types-of-matter-video.htm

Classroom Kits

FOSS (Full Option Science System) Laurence Hall of Science
Grade 1-2 module: Solids and Liquids
Grade 3-4 module: Water

STC (Science and Technology for Children)
Elementary Science Units: Solids and Liquids

Student groups observe or test the objects for a range of properties such as color, shape, hardness, and buoyancy. After these investigations, students sort the solids and have their partners guess the sorting criteria. The investigation of liquids begins with students exploring the look and feel of 2 different liquids. As their investigations broaden to include several liquids, students explore how their liquid samples look and feel, their fluidity, how they mix with water, and their degree of absorption.

Software

Encyclopedia of Science (2.0 C/M&W/Us). New York: DK Publishing, 1997. CD-ROM.
ISBN 0-7894-1230-6

This interactive CD-ROM is a children's science encyclopedia that works in a Macintosh or Windows environment. The encyclopedia includes a Quiz Master feature that students can use to test their knowledge of science and technology.

Home and School Connections

Have students conduct a survey of the types of hot cups used in their homes. Guide students to develop a data collection chart that includes the types of cups or mugs they think are in their homes. They might also include data from family members regarding types of hot cups they recall using outside of the home in the past week. This data could then be graphed to show the types of cups that are in everyday use.

Have students do a survey of their homes/apartments to see what different types of insulation materials and technologies are being used. Also have them suggest additional ways to conserve energy and make the home/apartment more energy efficient.

Career Information

Materials Science and Engineering (MSE)

http://www.crc4mse.org/
Materials Science and Engineering Careers Resource Center
If you are interested in a career in Materials Science & Engineering or just want to learn more about this exciting field you've come to the right place!

http://www.materials-careers.org.uk/discover/index.htm
Information about materials careers, biographies of people who work in the industry, teacher resources, and more.

http://www.asm-hartford.org/career.htm
What do Material Engineers do and where do they work?

Student Resources

Safety Disclaimer:

The content of this Student's Resource section is intended to serve as an educational resource for students.

Preparing for the safety of yourself is a critical step in planning for any hands-on science- related activities. Prior to conducting any of the activities included in this resource section, please familiarize yourself with any potential hazards, and take the necessary precautions appropriate for each specific activity.

Connecticut Science Center is not responsible for the contents of any books, videos, websites or other resources to which we provide a reference and does not necessarily endorse the opinions, activities, services, products or information expressed within them.

Websites for Students

www.weather.com
The Weather Channel on line

Third Grade Water Cycle http://www.epa.gov/safewater/kids/flash/flash_watercycle.html
Animated description of the water cycle covering clouds, rain, water storage and water vapor.

What is Water http://www.nyu.edu/pages/mathmol/textbook/slg.html
Basic information about the states of water appropriate for grade 3.

BBC - Schools - KS2 Bitesize Revision - Science - Materials
http://www.bbc.co.uk/schools/ks2bitesize/science/materials.shtml
A wonderful site for teachers and students from Great Britain about properties of materials with simulations, facts, and quizzes

Connecticut Clean Energy Fund

For programs to increase awareness of clean energy:
http://www.ctcleanenergy.com/EducationalPrograms/tabid/61/Default.aspx