

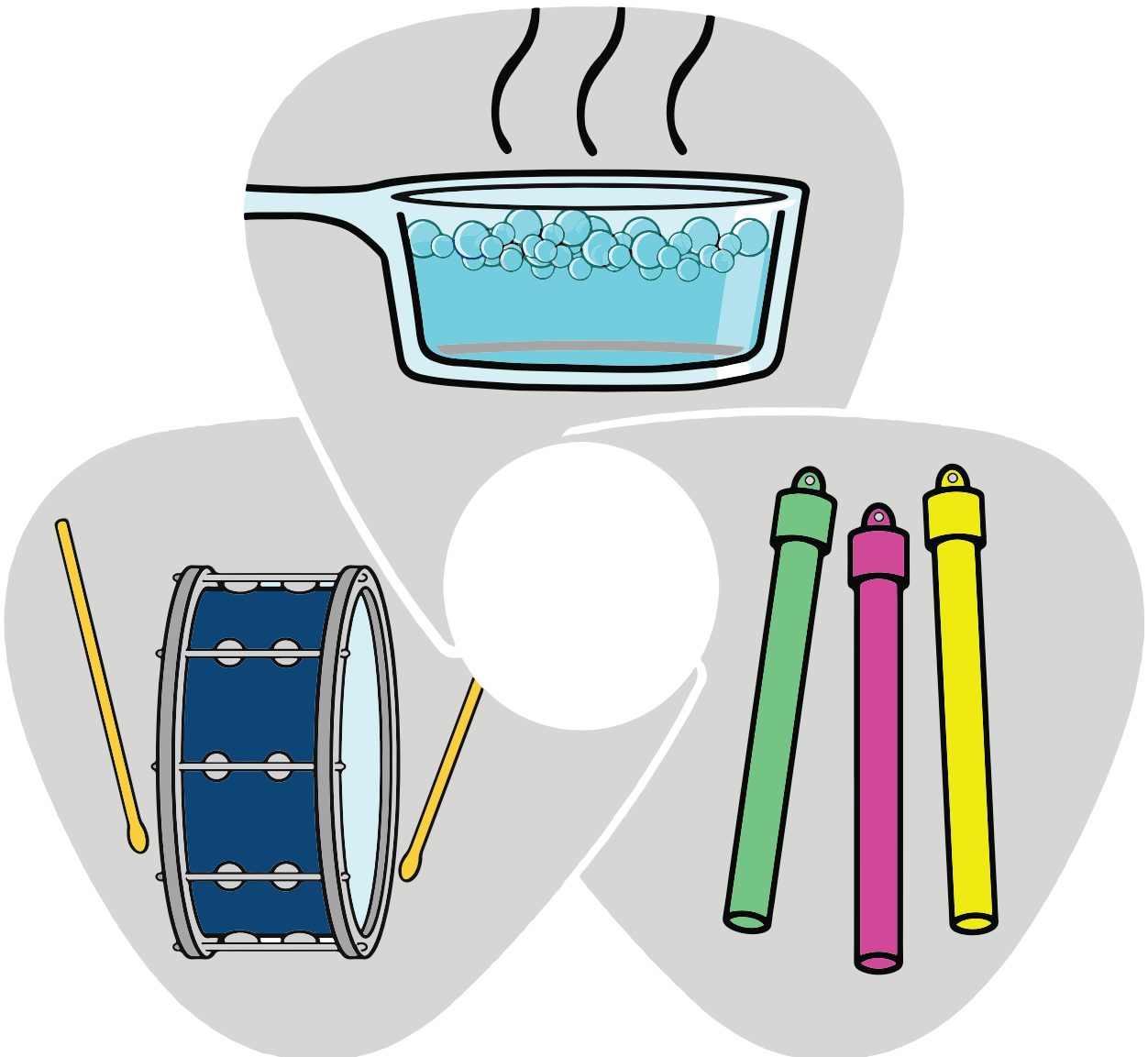


mosaic

an integrated approach to
mathematics, science, technology, & language

Grade 2

Changes in Light, Heat, and Sound Energy



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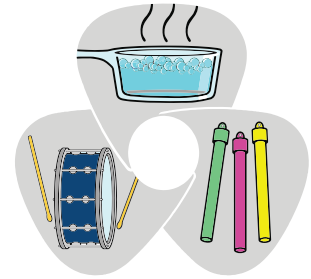
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Contents

Introduction	1
Language Objectives for English Learners	2
The 5E Lesson Cycle	3
Background Knowledge	6
 Lesson Overview	8
Big Ideas	8
Concepts.....	8
Language Support for English Learners	8
 Lesson Procedures	11
Engage	11
Heat and Temperature.....	11
Light and Temperature	12
Discussion: Connecting to Prior Knowledge.....	13
Explore	14
Understanding and Reading a Thermometer	14
General Instructions for Explore Centers.....	16
Light Center 1: Shadows	17
Light Center 2: Sunny Stencils, Part I.....	17
Heat Center: How Does Your Capsule Grow?	18
Sound Center: Dancing Rice.....	18
Explain	20
General Instructions.....	20
Light Center 1: Shadows	20
Light Center 2: Sunny Stencils, Part I.....	20
Heat Center: How Does Your Capsule Grow?	21
Sound Center: Dancing Rice.....	21
Elaborate	23
States of Matter and Mass.....	23
Light Center 2: Sunny Stencils, Part II	24

Evaluate	26
Group Project 1	26
Group Project 2	28
Individual Assessment	29
Assessment Support for English Learners	29
Resources	30
Materials List and Details	30
Frequent English/Spanish Vocabulary Words	34
Handouts	48
Explore Resources	
Figure 1: Horizontal Number Line	48
Figure 2: Vertical Number Line	49
Light Center 1 Instructions	50
Light Center 1 Shadow Mat	51
Light Center 1 Data Sheet	52
Light Center 2 Data Sheet, Part I	53
Heat Center Instructions	54
Heat Center Data Sheet	55
Sound Center Instructions	60
Sound Center Data Sheet	61
Elaborate Resources	
Light Center 2 Data Sheet, Part II	62
Evaluate Resources	
Group Project 1 Rubric	63
Group Project 2 Rubric	64
Energy Assessment Teacher Instructions	65
Energy Assessment	66
Reading Connections	68
Texas Essential Knowledge and Skills (TEKS) Focus	69
References	73



Changes in Light, Heat, and Sound Energy

Introduction

This lesson on energy is one part of a K–5 instructional cross-curriculum program that integrates science, mathematics, and technology applications. The concepts in the lesson support the implementation of the 2010–2011 Texas Essential Knowledge and Skills (TEKS) as well as the Texas English Language Proficiency Standards (ELPS). The ELPS provide guidance for teachers working with English learners in the core content areas.

The cross-curricular integration in this lesson includes inquiry-based activities to engage students with content while teaching higher-order thinking skills and facilitating understanding of the connections among math, science, and technology. *The National Science Education Standards* (National Research Council, 1996) describes inquiry-based instruction as “the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world” (p. 23). Inquiry-based instruction must be carefully structured to ensure that students engage in investigations that deepen and expand their scientific knowledge as well as develop their scientific habits of mind. In *A Framework for K–12 Science Education* (2012), the National Research Council has redefined “inquiry” as “scientific and engineering practices.” To promote such practices, teachers should provide learning experiences that engage students with fundamental questions and guide them in how to find the answers.

In addition to the integration of math, science, and technology, this module provides a list of related reading resources that may be used during reading or storytelling time. The books could also be used as an additional resource during the investigations and group activities. You may want to consult with the school librarian or a local community library to reserve as many of these books as possible for use during this module.

Language Objectives for English Learners

Effective instruction in second language acquisition involves giving ELs opportunities to listen, speak, read, and write at their current levels of English development while gradually increasing the linguistic complexity of the English they read and hear and are expected to speak and write. The ELPS and Texas English Language Proficiency Assessment System (TELPAS) define four English language proficiency levels: beginning, intermediate, advanced, and advanced high. These levels are not grade-specific, although there is a grade band for grades K–1 and a second for grades 2–12. ELs also may exhibit different proficiency levels within the language domains of listening, speaking, reading, and writing. The proficiency level descriptors outlined in the chart below show the progression of second language acquisition from one proficiency level to the next for each language domain. These descriptors serve as a road map to help content-area teachers instruct ELs in ways that are commensurate with students’ linguistic needs.

ELPS-TELPAS Proficiency Descriptors

	Beginning	Intermediate	Advanced	Advanced High
Listening	Beginning English learners (ELs) have little or no ability to understand spoken English used in academic and social settings.	Intermediate ELs have the ability to understand simple, high-frequency spoken English used in routine academic and social settings.	Advanced ELs have the ability to understand, with second language acquisition support, grade-appropriate spoken English used in academic and social settings.	Advanced high ELs have the ability to understand, with minimal second language acquisition support, grade-appropriate spoken English used in academic and social settings.
Speaking	Beginning English learners (ELs) have little or no ability to speak English in academic and social settings.	Intermediate ELs have the ability to speak in a simple manner using English commonly heard in routine academic and social settings.	Advanced ELs have the ability to speak using grade-appropriate English, with second language acquisition support, in academic and social settings.	Advanced high ELs have the ability to speak using grade-appropriate English, with minimal second language acquisition support, in academic and social settings.
Reading	Beginning English learners (ELs) have little or no ability to use the English language to build foundational reading skills.	Intermediate ELs have a limited ability to use the English language to build foundational reading skills.	Advanced ELs have the ability to use the English language, with second language acquisition support, to build foundational reading skills.	Advanced high ELs have the ability to use the English language, with minimal second language acquisition support, to build foundational reading skills.
Writing	Beginning English learners (ELs) have little or no ability to use the English language to build foundational writing skills.	Intermediate ELs have a limited ability to use the English language to build foundational writing skills.	Advanced ELs have the ability to use the English language, with second language acquisition support, to build foundational writing skills.	Advanced high ELs have the ability to use the English language, with minimal second language acquisition support, to build foundational writing skills.

From: *Educator Guide to TELPAS: Grades K–12* (pp. 15, 22, 30, 40, 78, 84) by Texas Education Agency (TEA), Student Assessment Division, 2011, Austin, TX: TEA. Copyright 2011 by TEA. Available from <http://www.tea.state.tx.us/student.assessment/ell/telpas>. Adapted by SEDL with permission.

The 5E Lesson Cycle

The 5E lesson cycle provides a structure for implementing learning activities that elicit and build on students' existing knowledge to expand and deepen their understanding of that knowledge. Each of the 5Es describes a phase of learning: Engage, Explore, Explain, Elaborate, and Evaluate. The lesson cycle should be implemented in its entirety, and educators should avoid pulling selected activities and using them in a piecemeal fashion. The 5Es are designed to introduce and develop deeper conceptual understanding in a carefully constructed sequence.

The ELPS are embedded into the 5E lesson cycle to provide strategies and techniques for teachers to use as they shelter science and mathematics content and academic English.

1

ENGAGE

The introduction to the lesson should capture students' attention and make connections between students' prior knowledge and the new concept they will be learning.

In this module: Students observe the movement of red liquid in a thermometer in different temperatures as well as the differences in the brightness of light sticks when they are placed in ice water, hot water, and room-temperature water.

English learners: English learners (ELs) at the beginning level will require significant facilitation to access prior knowledge, such as materials in their first language and gestures and pictures. ELs at the intermediate level will require opportunities to make associations between the knowledge learned in the two languages, such as working in mixed-language groups with plenty of opportunities to discuss the content in both languages as well as additional time or opportunities to express their understanding orally or in writing. ELs at the advanced and advanced high levels will require practice with the appropriate expression of the content's mastery (oral or written).

2

EXPLORE

Students receive opportunities to interact socially as they acquire a common set of experiences by actively exploring the new concept through investigations or activities. Students should have common experiences before they are asked to explain their understanding of a new concept. After the initial use of the activities, you may find it helpful to leave the Explore materials out in the classroom to allow students to revisit the centers for further reinforcement of the introduced concept.

In this module: Students rotate through centers to observe and measure the effects of changing the amount of light, heat, and sound energy.

English learners: Because they must process both content and academic language, ELs usually need more time to explore at the centers than English-proficient speakers. Grouping ELs with students who speak their first language and have higher levels of English proficiency will help ELs understand content concepts in their native language while learning English. As ELs explore through hands-on experiences at the centers, the teacher should monitor conversations to check for understanding of concepts and engagement.

3

EXPLAIN

Students share information about their observations at the Explore centers and engage in meaningful discussions with one another and the teacher to clarify any misconceptions and deepen their understanding of the concept they are studying. After students have had a direct experience with the concept and the chance to communicate their operational definitions, the teacher uses targeted questioning strategies to connect student experiences and observations with the concept being taught and to introduce correct terminology.

In this module: Students explain the activities at the Explore centers and participate in a teacher-led discussion as a formative assessment of student understanding.

English learners: Beginning and intermediate ELs may have difficulty explaining or sharing their understanding from the Explore activities without prior practice or preparation. To help them prepare, allow ELs to practice sharing out in pairs before sharing with the whole class. One strategy might be to pair students who have different language proficiency levels. Then have the pairs discuss their personal understanding and use language frames (e.g., “Today I learned . . .”) to prepare a response in English to share with the class.

4

ELABORATE

Students have the opportunity to apply the concept in a new context through additional activities, such as reading to learn, or investigations. Providing additional active learning experiences allows students to strengthen and expand their understanding of the concept.

In this module: The teacher reads *Melting and Freezing* (2010) by Lisa Greathouse after a pre-reading activity in which students list materials they commonly see freeze or melt, such as ice cream, water, and chocolate. Students then investigate and measure the effects of changing the amount of light energy applied to construction paper.

English learners: The goal during the Elaborate phase is to minimize the language demands and optimize content understanding. While building content knowledge through activities such as reading *Melting and Freezing*, explicitly share illustrations and vocabulary for ELs. When possible, allow ELs to practice additional investigations and present their findings with an English-proficient partner to help them learn the concepts and demonstrate their understanding.

5

EVALUATE

Students demonstrate their mastery of the concept and process skills, allowing both the teacher and the students to monitor and reflect on the progress made as an outcome of instruction.

In this module: Using technology such as digital cameras and a collaborative storytelling website, students work in groups to develop a presentation about how energy causes change. Teachers may also elect to have each student complete a multiple-choice assessment.

English learners: Evaluations for ELs should use a variety of formats that reflect each students' level of English language proficiency. For example, assessments may include teacher observations and students' alternative expressions of knowledge. For ELs at beginning levels, responses in their first language (when possible), acting out a response, or drawing a response is appropriate. ELs at intermediate levels should be allowed to use oral and written responses using language frames (e.g., "Today I learned that ____ happened because ____."). Advanced and advanced high ELs may be assessed in the same way as their English-speaking peers, but assessment may require linguistic support with academic English terms, such as *define*, *provide evidence for*, and *give an example of*.

Background Knowledge

The study of energy and measurement are abstract and often difficult concepts for second grade students. To help them grasp these concepts, access students' prior knowledge and provide concrete experiences that connect light, heat, and sound to their everyday lives. As your students experience increasingly complex interactions between matter and energy, they will begin to understand that many of the changes they observe occur in predictable patterns. The study of energy also fosters a young child's ability to describe the world in both a qualitative and quantitative manner, and provides many opportunities for using comparative, nonstandard, and standard measurements of time and temperature.

Energy

Because energy is an abstract concept, teachers need to give students opportunities to experience and interact with different forms of energy. The U.S. Department of Energy defines energy as the ability to do work or the ability to move an object. At the start of this unit, access students' prior knowledge to determine their definitions of energy. Then at the end of the unit, revisit the concept to refine students' operational definition of energy.

Light

The concept of light is also abstract for children. When light is present, people can see objects. Light travels away from its source in straight lines through space as waves of energy. Patterns in the behavior of light are very predictable. Light can pass through or bounce off objects, and different materials can block or absorb light. If an object blocks light, a shadow of the object forms. If the intensity or direction of the light source changes, the appearance of an object's shadow can change in size, shape, or darkness. Absorbing light energy can cause changes in matter. A common example includes the color of paper or fabric fading as the matter absorbs light over time.

Heat

Temperature and heat are not the same thing! Temperature is a measurement of how hot or cold a substance is; heat is the amount of energy contained in a substance or material. When heat energy is passed or transferred to a cooler material, it may cause simple changes in matter. For example, a frozen solid ice cube melts in our warm hands and becomes a liquid. In second grade, students should have experiences that help them understand that more heat energy causes the colored fluid in a thermometer to expand and rise, while less heat energy causes the colored fluid in a thermometer to contract and fall.

Sound

Vibrations often cause sounds. We can hear when sound waves travel through the air to our ears and cause our eardrums to vibrate. Sound can also travel through other forms of matter, such as liquids and solids. For example, students may remember hearing sounds underwater while they were swimming.

Number Lines

Many students may not have experience reading thermometers yet. Thus, teachers may find it helpful to introduce this skill before beginning activities that require it. As an instructional aid, teachers can use the analogy of a thermometer as a vertical number line. A related prerequisite is the concept of scale on a number line and the need to determine how much each mark or tick on the line is worth.

Standard Units of Measure

Teachers can also use number lines and thermometers to help students understand the idea of standard units, represented by the equal distances between the marks on both. Ask questions that guide students to connect reading a number line and measuring temperature to the idea of standard units and to the realization that standard units must be the same size.

The analogy between a number line and a thermometer, along with the connection to equal distances and standard units, constitutes a strong math (number line) and science (thermometer) connection. Although using standard units of measurement is not an expectation in the Grade 2 TEKS, students use standard units (degrees) to measure temperature. Teachers can thus use the connections among these concepts to lay the foundation for the idea of estimation of precise measurements (e.g., the scale on a thermometer could be by 2 or 5 degrees, but students could collect data to the nearest whole number).

Technology

Students should receive multiple opportunities to use technology to access, interpret, and share information. Technology enables students to document and present data in ways that are visually interesting and easy to understand. Technology also affords students the opportunity to explore and experiment with science that might otherwise be costly, difficult, or dangerous, such as through the use of simulations. And technology is useful to reteach a concept or to instruct students who were absent during the hands-on learning time. If a student misses a lab experience, many examples of similar labs can often be found on websites such as TeacherTube. This module provides opportunities for students to use technology to create a digital story about different forms of energy and to observe and document the effects of heat energy on plants.

Whenever possible, technology activities should be used to enhance concept development, not replace hands-on experiences. In addition, technology should not be limited to the Internet and computers. Some other forms of technology to integrate into instruction include calculators, digital cameras, and recording devices.

Lesson Overview

This module has been developed so that teachers can adapt it to their schedule and classroom structure. The amount of time required to teach the module and the individual activities will vary depending on how often you teach science and math and for how long. General guidelines for structuring the lessons are provided, but teachers may find that different schedules or structures are more suitable for their classrooms. However, the sequence and order of the individual activities should be followed to achieve the educational goals.

Big Ideas

- Energy comes from a variety of sources and often causes changes.
- Number lines may be oriented in different positions but always use an equal distance between the markings on the line.

Concepts

By the end of this lesson, Grade 2 students should understand the following concepts:

- Light, sound, and heat are forms of energy.
- Energy causes changes.
- Changes in size, mass, and temperature can often be measured.
- There are many ways to gather, view, and analyze information.
- Number lines may be used horizontally or vertically.
- Standard units can be beneficial.
- Safe practices during investigations should be used at all times.
- A variety of tools may be used to collect data.
- Thermometers can be used to measure the amount of heat in an object to the nearest value represented on the scale.
- Technology can be used to record, organize, and explain data through the use of pictures, numbers, and words.
- Observable patterns can be used to make predictions.
- A variety of sources of information should be accessed and used to demonstrate understanding.

Language Support for English Learners

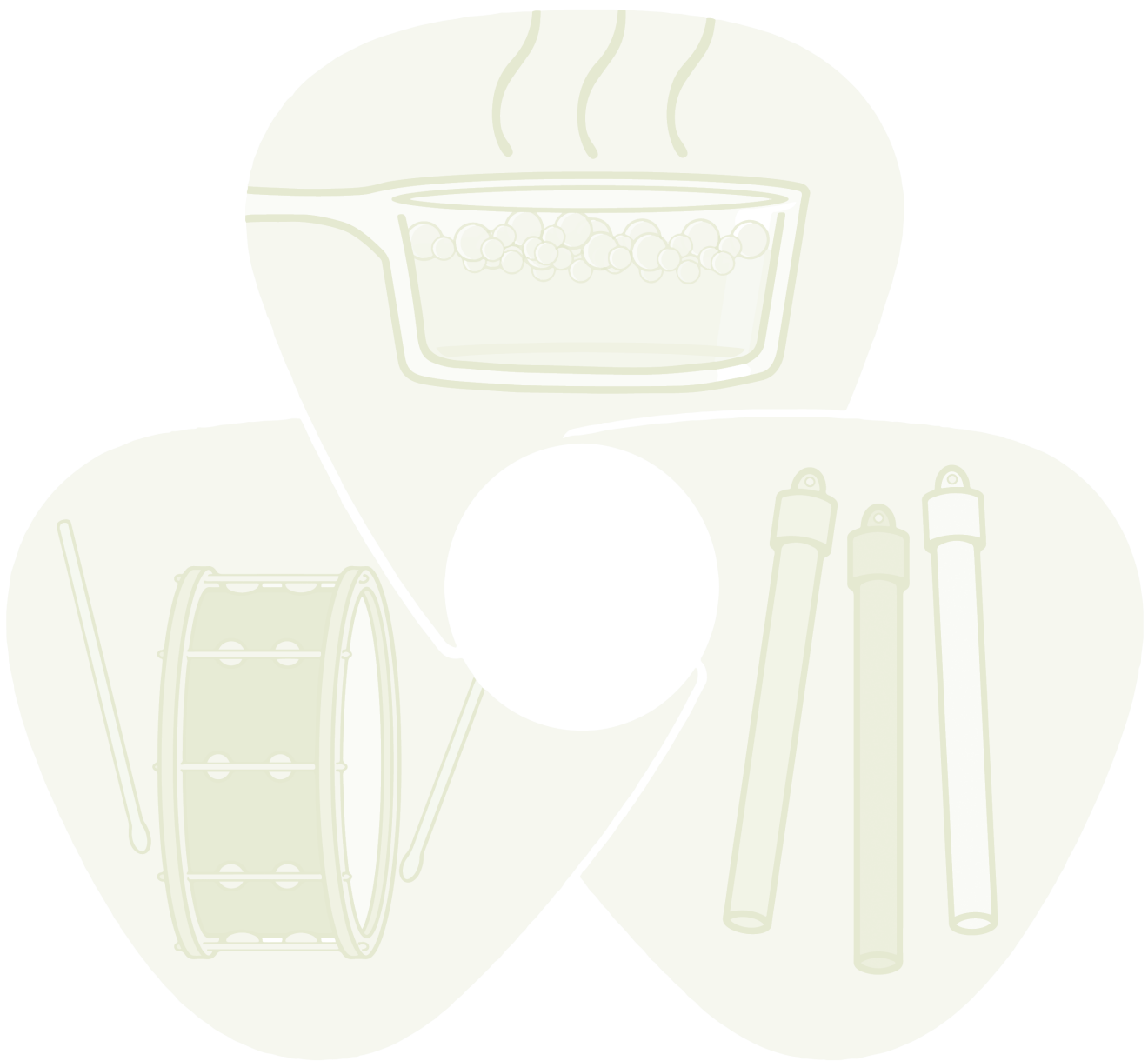
Embedded throughout this lesson are strategies for academic English language support. The following strategies or supports should be used consistently during the instructional process:

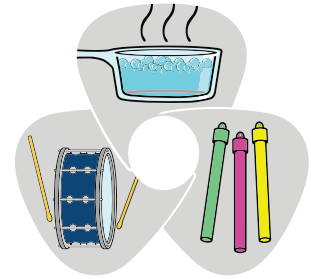
- Consider the language demands of instruction. Find ways to contextualize abstract concepts. For example, to contextualize the concept of energy, show pictures or video clips of machines or people using energy. Another method is to use graphic organizers with content-specific vocabulary.
- Create picture word banks to help beginning ELs with vocabulary.
- Pair beginning and intermediate ELs with more advanced ELs.

- Encourage more advanced ELs to provide linguistic support in their native language to assist beginning ELs.
- Model demonstrations and procedures explicitly. For example, use body gestures while explaining concepts and provide realia (real examples, such as a flashlight or a thermometer), illustrations, pictures, and so on.
- Provide opportunities for students to engage actively in academic conversations and hands-on learning. (ELs may disengage or sit passively if they do not understand or cannot communicate their ideas. They need opportunities to practice academic English.)
- Be cognizant of the amount of wait time you give ELs to allow them more time to process their thinking.
- Beginning and intermediate ELs may not have the academic English necessary to comprehend assessments. Differentiate assessments by limiting the number of questions and allowing students to show their knowledge by creating drawings and demonstrating experiments.
- The following is a list of high-frequency vocabulary in this lesson that teachers may find helpful for supporting beginning ELs. The list addresses English-Spanish translations; teachers may need additional word-to-word translations for other languages. Visuals for selected terms are also provided in the Resources section of this unit for use on a word wall or during instruction.

English Vocabulary	Spanish Vocabulary
balance scale	balanza
Celsius	Celsio
circle	circulo
cold	frío
cold water	agua fría
color	color
compare	compare
degrees	grados
different	diferente
drum	tambor
energy	energía
estimation	estimación
Fahrenheit	Fahrenheit
flashlight	linterna
freeze	congelar
hand lens (magnifying glass)	lupa
heat	calor
hot	caliente
hot water	agua caliente
hypothesis	hipótesis

English Vocabulary	Spanish Vocabulary
ice cube	cubo de hielo
light	luz
light stick	vara reluciente
melt	derretir
number line	línea numérica
observe	observe
opaque	opaco
predict	prediga
shadow	sombra
sound	sonido
square	cuadrado
straight	recto o derecho
sun	sol
temperature	temperatura
thermometer	termómetro
translucent	translúcente
transparent	transparente
unit	unidad
vibrate	vibrar
water	agua
What happens when...	Que sucede cuando...





Lesson Procedures

ENGAGE

Heat and Temperature

Time: Approximately 15 minutes

1. Draw a three-column chart as shown at right for the class to see.
2. Fill one cup with hot water and one with ice water. Leave the third cup empty.
3. Ask students to predict the movement of the red liquid in a thermometer when it is placed in each cup. Write students' predictions in the appropriate columns on the chart.
4. Place a thermometer in each cup and ask students to observe the movement of the red liquid when a thermometer is in hot water, ice water, and room-temperature air. Ask:

- What happened to the red liquid in the thermometer placed in hot water? Why did this result occur? *It moved upward, showing an increase in temperature.*
- What happened to the red liquid in the thermometer placed in ice water? Why did this result occur? *It moved downward, showing a decrease in temperature.*
- What happened to the red liquid in the thermometer placed in the empty cup? Why did this result occur? *The red liquid did not move or change because the thermometer is still in room-temperature air.*

5. Note on the chart the results of placing the thermometers in hot water, ice water, and room-temperature air, indicating whether the temperature increased, decreased, or stayed the same in each case.

Materials

For the class

- ☐ 3 thermometers
- ☐ 3 clear cups
- ☐ Hot water
- ☐ Ice water
- ☐ Chart paper or whiteboard
- ☐ Markers

Hot	Cold	Room

Light and Temperature

Time: Approximately 20 minutes

1. Ask students to observe a light stick before it is activated and to record observations about it in their journals.
2. Ask students if they have used or seen a light stick before. Ask those who have to explain why we call it a light stick and how to make it light up.
3. Demonstrate how you can bend the light stick in the center to activate it and ask students to make observations as the light stick begins to glow.
4. Activate the two remaining light sticks by bending them in the center. Make sure all three sticks are the same color to avoid perceived differences due to color rather than temperature.
5. Hold the three glowing light sticks close to one another and ask students to compare them. Ask:
 - What happens when a light stick is bent in the center? *It glows.*
 - What did you notice about the brightness of the three glowing light sticks? *They are identical.*
6. Draw a three-column chart as shown at right or reuse the chart from the previous activity.
7. Ask students to predict what might happen to a light stick if it is placed in hot water, ice water, or left at room temperature. Write students' predictions in the appropriate columns on the chart.
8. Place one light stick in the cup of hot water, one in the cup of ice water, and one in the empty cup.
9. Take the light sticks out of the cups and observe them for any changes in brightness.
 - What happened to the light stick that was placed in hot water? *It glowed a little brighter.* Record this result on the chart.
 - What happened to the light stick that was placed in ice water? *It became very dim.* Record this result on the chart.
 - What happened to the light stick in the empty cup? *It remained the same.* Record this result on the chart.
10. Discuss whether this test confirmed or denied the students' predictions. Then introduce the term *hypothesis* (Spanish-*hipótesis*). Explain that the predictions students made in this and the previous activity are like the hypotheses that scientists make. Tell students that scientists seldom say a hypothesis is wrong; it was either proved or denied. Scientists learn and discover by testing hypotheses, so students should not fear having a hypothesis denied.

Materials

For the class

- ☐ 3 light sticks (same color)
- ☐ 3 clear cups
- ☐ Hot water
- ☐ Ice water
- ☐ Chart paper/whiteboard
- ☐ Markers

For each student

- ☐ Journal

Hot	Cold	Room

Discussion: Connecting to Prior Knowledge

Time: Approximately 10 minutes

Lead a discussion to connect the previous activities to students' personal experiences. Ask:

- What does it feel like outside in the middle of summer? *Answers will vary depending on your location, but students may state that it feels hotter.*
- Where do you find hotter temperatures on a thermometer? *at the upper (or right) end of the thermometer; at the other end from the bulb*
- What does it feel like outside in the middle of winter? *Answers will vary depending on your location, but students may state that it feels colder.*
- Where do you find colder temperatures on the thermometer? *at the lower (or left) end of the thermometer; at the end near the bulb*
- What happened when a thermometer was put in hot water? *The red liquid moved toward the top end or to the other end from the bulb.*
- What happened when a light stick was put in hot water? *The stick glowed brighter.*
- What happened when a thermometer was put in ice water? *The red liquid moved toward the bottom end or the end closer to the bulb.*
- What happened when a light stick was put in ice water? *The stick became dimmer.*

English Language Support

- For beginning and intermediate ELs, provide visual support of the materials by pointing to each item and stating its name in English (e.g., "This is a light stick.").
- Use word-to-picture translations. Illustrated English-Spanish vocabulary cards for key terms are provided in the Resources section (thermometer-*termómetro*).
- Use body or hand gestures to help support understanding. For example, point to your head to illustrate thinking, point to your ear to illustrate listening, and point to your eye to illustrate looking.
- When asking questions, institute wait time to allow students more time to process information.
- As students are engaged in the inquiry process, provide opportunities for ELs to participate actively.
- Frequently check ELs to ensure they understand the lesson.

EXPLORE

Understanding and Reading a Thermometer

Time: Approximately 30 minutes

Before students can perform the activities at the Explore centers, they need to learn the prerequisite skill of reading a thermometer to the nearest degree and explaining what the reading means. The following activity is provided as one way to develop this skill.

Part I

1. Give each student a copy of Figure 1, which shows a number line positioned horizontally.

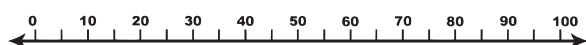


Figure 1

2. Ask students how much each mark on the number line represents. *Students should see that some of the marks represent 10s, but there are other marks that are not labeled.*
3. If students cannot determine that the number line is divided by 10s, ask leading questions such as, Let's read the numbers on this line out loud together. What do we call this kind of counting? *counting by 10s*
4. Ask what the marks between the 10s on the number line represent. *fives*
5. Say to students: Let's count the marks on the number line with our fingers and find out if each one represents 5. Put your finger on the zero. Now, what would the first mark be if we counted by fives? *5, right!* Then the next mark would be 10, so that is right. What about the mark after that? What comes after 10 when we are counting by fives? *15* Let's keep counting together to make sure this pattern works.
6. Once students determine the scale, have them label all the marks on the number line. In addition, lay the foundation for the idea of standard units by pointing out that the marks all represent an equal amount and are all an equal distance apart.

Materials

For each group

- ☐ Thermometer
- ☐ Colored pencil
- ☐ 1 copy Figure 1: Horizontal Number Line (see Resources section)
- ☐ 1 copy Figure 2: Vertical Number Line (see Resources section)

For each student

- ☐ 2 copies Figure 1: Horizontal Number Line (see Resources section)
- ☐ 1 copy Figure 2: Vertical Number Line (see Resources section)

Part II

1. Give each student a second copy of Figure 1. Instruct students to lay the number line horizontally (running side to side) on their desks.
2. Then instruct students to rotate the number line counterclockwise until it is vertical with the zero at the bottom of the desk and the 100 at the top. (The labeled numbers will be facing in the wrong direction, but most students should still be able to read them.)
3. Ask students where the biggest numbers are located on the line. *at the top* Then ask where the smallest numbers are located. *at the bottom*
4. Just as before with the horizontal number line, ask students what each mark on the number line represents and to explain their reasoning. Lead the students to discover again that the vertical number line is labeled by 10s and that the marks in between are in increments of 5.

Part III

1. Hold up a copy of Figure 2, which shows a vertical number line, next to a thermometer for the class to see.
2. Ask students to compare the figure and the thermometer. Ask:
 - How are the number line and the thermometer different, and how are they similar? *The thermometer has different labels, more marks, and a bulb on one end; but it looks very similar to the standing number line.*
3. Ask students to examine the labeling and marks on the thermometer. If appropriate, ask them to determine how much each mark on the thermometer is worth and to explain how they know.
4. Students may notice there are two different scales on the thermometer: Fahrenheit and Celsius. Explain that in the United States, we use the Fahrenheit scale in most cases. The Celsius scale is commonly used in science as well as in other countries, such as our neighbors, Mexico and Canada. So it is a good idea to know about both scales.
5. Remind students that we use thermometers and the Fahrenheit and Celsius scales to measure temperature.
 - How do weather reporters usually state the temperature? (To prompt students, provide the language stem, "It is 75 _____ outside.") *degrees*
 - Degrees are a way of measuring the temperature of objects. Have you ever taken your own temperature or has somebody else taken your temperature? *Students might raise their hands to say that they've had their temperature taken.*
 - When do we take someone's temperature? *When they are sick, and we want to know if they have a fever.*

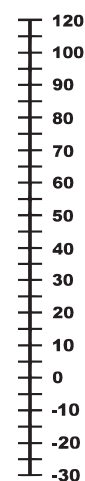


Figure 2

Part IV

1. Give each student a copy of Figure 2. Instruct students to label the marks that do not have numbers (the marks for 5, 15, 25, etc.).
2. Hold up a copy of Figure 2 and point to specific marks, such as 75 degrees, and ask students for the temperature that each mark represents.
3. Lay the foundation for the idea of estimation. Use a colored pencil to draw a short segment that does not fall exactly on a mark on the number line (e.g., at approximately 52 degrees).
4. Ask students what that temperature is. *Students should use words and phrases such as almost, close to, and more or less.*
5. Explain the idea of estimation using those types of phrases, with an emphasis that estimates are guesses and not exact or perfect answers.

English Language Support

The language demands of this part of the lesson are very high. To make the learning more contextualized (concrete), the teacher should consider the following:

- Explicitly model each activity or discussion. For example, carefully model the activities that involve thermometers to familiarize students with the device.
- Position ELs close by when you demonstrate and explain each activity.
- Frequently check for student understanding.
- Have ELs show they understand the activities by demonstrating them.

General Instructions for Explore Centers

Time: Approximately 75 minutes, including about 15 minutes per center (monitor center activity to see if students finish sooner)

This activity consists of four centers. Organize students into groups of two to three members and assign one fourth of the groups to work at each center. Then rotate. A class of 25 students will need approximately two of each center.

1. Prior to class, set up the center materials in areas of the classroom that allow space for students to work together in small groups of two to three. Refer to the Materials List and Details in the Resources section for more information about setting up each center.
2. Instruct students that their job involves making careful observations about the activity at each of the centers they visit with their group. Emphasize the importance of recording detailed information on their data sheets or in their journals.
3. Carefully read aloud the instructions for each center and demonstrate the activities. Ask if students have any questions.

4. While students are at each center, move about the room to monitor their activities. After about 15 minutes, have groups rotate centers.
5. You may want to leave the Explore centers set up for several days, if possible, to allow students to return to the activities and complete them more than once.

Light Center 1: Shadows

Students observe the darkness of a shadow as they cover the lit end of a flashlight with squares made of different materials, such as plastic wrap, tissue paper, wax paper, and so on. The terms *transparent*, *translucent*, and *opaque* are introduced.

Materials

For each center

- ☐ Light Center 1 Instructions (see Resources section)
- ☐ Light Center 1 Shadow Mat (see Resources section)
- ☐ Graph paper
- ☐ Tape
- ☐ Binder clip
- ☐ Pad of sticky notes
- ☐ Flashlight

☐ 9 x 9 cm squares of:

- Clear plastic bag or wrap
- Coffee filter paper
- Copy paper
- Foil
- Gauze fabric
- Milk jug plastic
- Tissue paper
- Wax paper

For each student

- ☐ Light Center 1 Data Sheet (see Resources section)

Light Center 2: Sunny Stencils, Part I

Students examine a sheet of colored construction paper that has a stencil attached and predict what they think might happen if the sheet is left out in the sun for several days. Students record their predictions, which they will discuss and investigate later during the Elaborate phase.

Materials

For each center

- ☐ Stencil pattern (or natural object, such as leaf, flower, shell)
- ☐ Sheet of blue or green construction paper
- ☐ Clear tape

For each student

- ☐ Light Center 2 Data Sheet, Part I (see Resources section)

Heat Center: How Does Your Capsule Grow?

Students measure the temperature of cups of ice water and warm water. Students then conduct investigations using magic animal growing capsules, which are small sponge shapes that are compressed in a capsule that dissolves in warm water. Students measure the area of each capsule before it is placed in water. They then observe what happens when they place a capsule into the water in each cup. You may want to wait to give out the growing capsules until each group completes steps 1–3 on the center instructions.



Water should not be warmer than 54°C for safety.



Safety goggles required

Materials

For each center

- ☐ Heat Center Instructions (see Resources section)
- ☐ 2 clear plastic cups
- ☐ Ice water
- ☐ Warm water
- ☐ 2 thermometers
- ☐ Red pencil or crayon
- ☐ 2 magic animal growing capsules (per group)
- ☐ Timer or clock
- ☐ 5 safety goggles

For each student

- ☐ Heat Center Data Sheet (see Resources section)

Sound Center: Dancing Rice

Students use a model to observe vibrations and sound waves. Students make vibrations by hitting a cookie sheet above rice resting in a shallow foil pan, which causes the rice to bounce.

Materials

For each center

- ☐ Sound Center Instructions (see Resources section)
- ☐ Shallow foil pan
- ☐ Rice (handful bundled in plastic wrap)
- ☐ Plastic wrap
- ☐ Rubber band
- ☐ Cookie sheet
- ☐ Wooden spoon

For each student

- ☐ Sound Center Data Sheet (see Resources section)

English Language Support

- For beginning and intermediate ELs, provide visual support of the materials used at each center by pointing to each item and stating its English name (e.g., “This is rice.”) and/or providing cards with illustrated and labeled terms. (Illustrated English-Spanish vocabulary cards for selected terms are available in the Resources section.)
- Explicitly model each procedure or demonstration and monitor your pacing to ensure that ELs have enough time to process the information.
- Monitor the rate, tone, and enunciation of your speech.
- Make intentional efforts to ask ELs questions when you model a demonstration to check for understanding.
- Make intentional efforts to ask ELs questions as they engage in each center. Ask them to demonstrate what they are learning as a formative assessment.

EXPLAIN

General Instructions

Time: Will vary with the level of discussion

Students explain their observations from the Explore centers and participate in a teacher-led discussion as a formative assessment of student understanding. This portion of the lesson also provides an opportunity to introduce new vocabulary.

Light Center 1: Shadows

Ask students the following questions about their observations at the Shadows light center:

- What was the source of light? *a flashlight*
- What blocked the light? *squares of different materials*
- What is needed for a shadow to form? *light and an object to block the light*
- Did you observe a shadow when the flashlight end was blocked with clear plastic? *Yes, the shadow was dark because light from the flashlight was able to shine through the clear plastic.*
- What is another word for clear? *transparent*
- Did you observe a shadow when the flashlight end was blocked with filter paper or wax paper? *Yes, but the shadow was lighter because light was only partially able to shine through.*
- What is a word for materials that allow only some light to pass through? *translucent*
- Did you observe a shadow when the flashlight end was blocked with paper or foil? *No, because light from the flashlight could not shine through the paper or foil.*
- What is a word for materials that do not allow light to pass through? *opaque*
- What happened to the darkness of the shadow as the amount of light from the flashlight was dimmed by different materials? *The shadow got lighter as the flashlight beam was dimmed.*

Light Center 2: Sunny Stencils, Part I

Ask students the following questions about their predictions at the Sunny Stencils light center:

- What did you predict would happen if the construction paper covered with the stencil was placed outside for several days? *Answers may vary; that the paper would get darker or lighter.*
- What experiences do you have with things that have been left in bright sunlight? *Answers may vary but include seeing fabric, plastic, and paint that had faded.*
- What can we do to test the predictions about the effect of sunlight? *Students should respond that we could do an experiment. Explain that the class will be doing one soon.*

Heat Center: How Does Your Capsule Grow?

Ask students the following questions about their observations at the heat center:

- Which direction did the red liquid in the thermometer move when it was placed in the cup of ice water? *It moved down.*
- Why do you think this happened? *The ice water was colder than the air in the room.*
- What was your recorded temperature of the ice water? *Students should provide the temperatures that they recorded during the activity.*
- Which direction did the red liquid in the thermometer move when it was placed in the cup of warm water? *It moved up.*
- Why do you think this happened? *The water was warmer than the air in the room.*
- What was the temperature of the warm water? *Students should provide the temperatures that they recorded during the activity.*
- Which capsule changed in size the most? *The capsule in the warm water dissolved and revealed a small foam animal.*
- What happened to the capsule in cold water? *It did not change or it changed more slowly.*
- What caused the change in the capsule that revealed an animal? *heat*
- How many squares did each capsule cover before it was put in the water? *Answers will vary.*
- What number of squares did the foam animal cover after it was put in the water? *Answers will vary. This would be a good time to discuss why answers will vary and that small variations are normal and correct. Most of the students' answers should be similar. When there is a wide difference, explore why.*

Sound Center: Dancing Rice

Ask students the following questions about their observations at the sound center:

- What happened to the rice in the pan when you tapped the cookie sheet gently with the spoon? *The rice moved and then settled back on the pan.*
- What happened to the rice in the pan when you tapped the cookie sheet harder with the spoon? *The rice moved higher in the air and then settled back on the pan.*
- Why would tapping the cookie sheet cause the rice to move? *Tapping the cookie sheet caused vibrations, which moved through the air until they reached the rice and caused it to move.*

English Language Support

The language demands of this part of the lesson are very high. To make the learning more contextualized (concrete), the teacher should consider the following:

- During the series of questions, explicitly model each discussion by using objects, body gestures, visuals, and demonstrations. For example, model the actions as you ask a question such as, “What did you predict would happen when the construction paper covered with the stencil was placed outside?”
- Watch your pacing (use a slower rate of delivery) as you ask questions and guide discussion.
- Provide ELs with opportunities to speak and engage by asking recall questions and by using language frames (e.g., “The rice in the pan _____ when I hit the cookie sheet.”).
- Intermediate ELs may need the same support as beginners as both groups are learning new concepts.
- During question and discussion sessions, pair ELs at different English proficiency levels and have the pairs engage in think-pair-share activities (e.g., “Tell your partner what you saw when. . .”).

ELABORATE

States of Matter and Mass

Time: 2 days (Day 1: approximately 40 minutes; Day 2: approximately 20 minutes)

1. This activity involves using a balance scale. If students are not familiar with or have not used a balance scale before, it may be necessary to explain what one is and show students how to use it. Then explain that a balance scale measures the mass of objects, which is a lot like weight.
2. Organize students into lab groups of two to three members.
3. Ask students to think of materials that melt. List students' responses on chart paper or a whiteboard.
4. Distribute to each group the following: one large ice cube, paper towels, one clear plastic cup, a balance scale, and nonstandard objects such as Unifix® cubes for measuring mass.
5. Instruct students to use the balance scale to measure the mass of the ice cube. Students should then record the mass in their journals.
6. Ask each group to place its ice cube in the cup.
7. Read *Melting and Freezing* (2010) by Lisa Greathouse.
8. After the story, ask students to check their ice cubes for any changes that occurred while you were reading. Ask:
 - What happened to your ice cube while you listened to the book? *The ice melted, and it changed from a solid to a liquid.*
 - What caused the ice to melt? *The temperature in the room is warmer than the temperature in the cooler or freezer. Heat caused the ice to melt.*
 - Describe what happened when your ice melted. *The ice cube got smaller, and liquid water was in the cup.*
9. Instruct students to measure the mass of any remaining ice and then the mass of the water in the cup.
 - How do you know the ice got smaller? *It looks smaller, and its mass is less.*
 - Where is the rest of the mass of the ice cube? *When the ice cube melted, part of its mass became liquid water. The mass is not lost; it is now a liquid.*

Materials

For the class

- ☐ *Melting and Freezing* by Lisa Greathouse
- ☐ Chart paper/whiteboard
- ☐ Markers
- ☐ Ice chest (for ice cubes)

For each group

- ☐ Large square ice cube
- ☐ Paper towels
- ☐ Clear plastic cup
- ☐ Balance scale
- ☐ Nonstandard objects for measuring mass (e.g., blocks or Unifix® cubes)

For each student

- ☐ Journal

10. Ask guided questions to discover if students think the liquid water in the cup can turn back into ice if placed in a freezer and what the shape of the new ice cube might be.
 - What could we do to change the liquid water back to ice? *Place the cup in a freezer overnight.*
 - Will the ice cubes look the same if we place the cups in a freezer? *No, because the liquid water will take the shape of the cup, and the ice cubes might be round.*
 - Would the refrozen ice have the same mass as the original ice cube? *Yes, as long as we do not spill any of the water from the melted ice cube.*
 - Why do the ice cubes and refrozen ice have the same mass? *None of the ice cube or water was lost; it just changed form when it melted.*
11. Freeze the water in the cups overnight and allow students to observe and measure the mass of the round cubes the next day.
 - Did the round ice have the same mass as the square ice cube? *Yes, as long as we did not spill any of the water from the melted ice cube.*
 - Have you ever had a freezer pop melt while you were eating it? If you saw liquid on the freezer pop, where did the drops come from? What made the freezer pop melt? When it melted, did the mass change? *Answers will vary but should indicate that students understand that adding heat energy causes ice to melt and change into liquid form and that the mass of water does not change when it melts or freezes.*

Light Center 2: Sunny Stencils, Part II

Time: Approximately 6–7 days

1. This activity includes an experiment that requires a span of at least 5 sunny days (or longer if any of the days are cloudy with little or no sunshine).
2. Remind students of the predictions they made in the Sunny Stencils light center. Explain that they are now going to conduct an investigation to test their predictions. In the investigation, they will be comparing the changes that occur to covered and uncovered areas of construction paper when exposed to different amounts of light energy.
3. Organize students into groups of two to three members.
4. Provide each group with the listed materials (except for the data sheet).
5. Have students tape a stencil to each sheet of construction paper.
6. Ask students to label the back of each sheet. They should label one sheet with a 0, another with a 2, and a third with a 5. In addition, each group should write a group name on the sheets.

Materials

For each group

- ☐ 3 stencil patterns (or natural objects, such as leaves)
- ☐ 3 sheets of blue or green construction paper
- ☐ Clear tape
- ☐ Marker for labeling sheets

For each student

- ☐ Light Center 2 Data Sheet, Part II (see Resources section)

7. Tell students they are not going to put the sheet labeled 0 in the sun. Ask students why they think that is. *to provide one sheet without any sun exposure to compare to the other two sheets placed in the sun; in science, this is called a control*
8. Have students place the sheets labeled 0 in a location that does *not* receive any sunlight. Then have students place the other sheets in a location with full exposure to direct sunlight. After 2 sunny days, move the sheets labeled 2 to the location that does *not* receive any sunlight. After 5 sunny days, collect all the sheets.
9. Instruct students to form their same groups. Distribute the sheets to the groups and then give each student a data sheet.
10. Ask the students to remove the stencils, compare the sheets, and then answer the questions on the data sheet.
11. When the groups have completed the task, lead a whole-group discussion of the responses:
 - Why did we cover parts of two sheets of paper and place a third sheet in an area that does not receive sunlight? *to provide examples of the sheets without any sun exposure as a comparison (control) so we could see how much the areas exposed to sunlight had faded*
 - What happened to the areas of the paper exposed to sunlight? *They lost color, became lighter, faded.*
 - Did the uncovered areas fade more on Sheet 2 or Sheet 5? *Sheet 5*
 - You leave a toy painted blue outside in the sun for 2 weeks. What do you think will happen to the color of the blue toy? *The blue color of the toy will fade and not be as blue.*
 - Based on the experiment, what does *fade* mean? *For colors, fading means that you have less or a lighter shade of that color, such as a light blue instead of a dark blue.*
 - How does the amount of time an object is exposed to sunlight relate to how much the object fades? *The longer something is exposed to sunlight, the more it will fade.*

English Language Support

- While reading *Melting and Freezing*, pace the speed at which you read and explicitly share pictures and ask questions to assist ELs.
- While modeling and discussing the demonstrations, give ELs the opportunity to engage in them by participating, talking about various actions, or asking questions.
- Explicitly share the student data sheet with ELs.
- Support ELs as they are completing the data sheet.
- Frequently check for student understanding and, if needed, clarify key concepts to address misinterpretations or misunderstandings.

EVALUATE

Two group projects for assessing student understanding are provided below. Teachers may want to have students do one or both projects. In addition, teachers may elect to have each student complete the multiple-choice assessment provided.

Group Project 1

Time: Approximately 2–3 weeks

1. In this group project, students investigate the effects of changing the amount of light energy that two plants receive. Each group then creates a presentation of the results.
2. Organize students into groups of two to three members. Distribute the group materials.
3. Instruct each group to examine and record the characteristics of the two plants (color, number of leaves, height, width, etc.) in their journals.
4. Use a digital camera to take a picture of each plant. (You may want to allow students to take the pictures.)
5. Create a situation where one of the plants does not get any light, such as by putting the plant in a dark closet or placing a box over it. Place the second plant where it will get proper sunlight.
6. Ask each group to develop a hypothesis to describe what will happen to each plant. If students need an aid, ask them to complete the following prompt: "If we put this plant in the dark, the plant will _____; if we put the other plant in full light, the plant will _____."
7. Continue to water both plants in the same way as needed.
8. Each day, the groups should observe the plants and record the same list of plant characteristics in their science journals.
9. The teacher or a student should also take a picture with the digital camera of each plant whenever students record observations. Print these photos, label and date them, and post them on a bulletin board or poster to provide a visual chronological record.
10. Students should continue recording daily observations until a noticeable change occurs to the plant not receiving sunlight.

Materials

For the class

- ☐ 2 green, leafy potted plants of the same type (should require direct sunlight)
- ☐ Digital camera

For each group

- ☐ Group Project 1 Rubric (see Resources section)
- ☐ Ruler or measuring tape
- ☐ Paper or electronic science journal to record observations
- ☐ Computer with installed presentation software (or whiteboard)

11. Provide each group with a copy of the picture files and, as a class, review the images in chronological order.
12. Instruct each group to develop a second hypothesis explaining what caused the changes.
13. Then ask each group to create a presentation explaining how the plants changed and how long it took for the changes to be observed. The presentation should include both of the group's hypotheses. Depending on the technology available, the presentation can take various forms (e.g., electronic slide show or video).
14. Provide each group with a copy of the rubric below (also provided in the Resources section), which will be used to grade the presentations. Read the rubric aloud to students row by row. After you read each row, check that students understand what is expected.
15. As students work on their presentations, check in with them regularly to monitor their progress, provide feedback, review expectations, and offer assistance or guidance.
16. Have each group share its presentation with the class.

	1-Needs Improvement	2-Satisfactory	3-Excellent
Hypotheses	No hypothesis is provided.	Only one hypothesis is provided, or the second does not accurately explain how energy was related to the changes observed.	Two hypotheses are provided, and the second accurately explains how energy was related to the changes observed.
Measurement	No measurement is included, or no explanation is given as to why no measurement is included.	The form of measurement included is inappropriate (e.g., time for length).	The unit of measurement included is used correctly, or an explanation is given as to why a measurement is not relevant.
Presentation	The presentation does not include any images or illustrate how energy was related to the changes observed.	The images and text only partially illustrate how energy was related to the changes observed.	The images and text accurately illustrate how energy was related to the changes observed.

Group Project 2

Time: Approximately 1 hour (30 minutes to develop; 30 minutes to present)

1. Organize students into small groups of two to three.
2. Have the groups use a storytelling website such as <http://www.storybird.com> to create a digital story about energy. After registering on the site, students can choose images and enter text to tell their story. You may want to preselect images on the site for students.
3. Tell the groups they will each write a story about the changes caused by three forms of energy.
4. Explain to students that they are going to create either a fiction or nonfiction story that includes a minimum of at least one change caused by the form of energy the group selected and how that change can be measured.
5. In class, model the process for students by going to the website, selecting story art, and adding your own text. You may also want to create a story in advance that meets all the requirements of the project to provide as a model for students.
6. Provide each group with a copy of the rubric below (also provided in the Resources section), which will be used to grade the digital stories. Read the rubric aloud to students row by row. After you read each row, check that students understand what is expected.
7. Monitor the groups while they work to check their progress, provide feedback, review expectations, and offer assistance or guidance.
8. Have each group present its digital story to the class.

Materials

For each group

- ☐ Group Project 2 Rubric (see Resources section)
- ☐ Computer with Internet access
- ☐ Collaborative storytelling website such as <http://www.storybird.com>

	1-Needs Improvement	2-Satisfactory	3-Excellent
Energy	No form of energy is included.	The three forms of energy are included, but an example of how each one causes change is not.	The three forms of energy are included as well as at least one example of how each one causes change.
Measurement	No measurement is included, or no explanation is given as to why no measurement is included.	The form of measurement included is inappropriate (e.g., time for length).	The unit of measurement included is used correctly, or an explanation is given as to why a measurement is not relevant.
Technology	Technology is not used successfully.	Technology is limited to word processing.	Students created and shared their digital book online.

Individual Assessment

Time: 20 minutes

Have each student complete the Energy Assessment, which is similar to STAAR™. See the Resources section for the assessment, instructions, and answer key.

Materials

For each student

- ☐ Energy Assessment (see Resources section)
- ☐ 2 pencils

Assessment Support for English Learners

While developing assessments for English learners, take into consideration each student's English language proficiency level (from TELPAS and teacher observation). Differentiate evaluations by levels of English proficiency. Methods of assessing ELs might include the following:

Beginning and Intermediate:

- Physical demonstrations (repeating the experiment while a teacher checks for understanding)
- Pictorial products (drawings related to what students learned in the centers)

Advanced:

- Oral presentations of what students learned while a teacher provides linguistic support
- Spanish-English word bank with content-specific vocabulary for ELs to use during assessments
- Linguistic support provided by monitoring ELs while they are taking the assessment
- Clarification of test questions if needed to ensure understanding of what is being asked

Advanced High:

- Limited linguistic support with comprehension of test questions as needed
- Consistent monitoring of ELs while they are engaged in the assessment and clarification of concepts as needed

Materials List and Details

ENGAGE

For the class

- ☐ 3 thermometers
- ☐ 3 light sticks of the same color (can be ordered from party goods vendors)
- ☐ 3 clear cups
- ☐ Hot water
- ☐ Ice water
- ☐ Chart paper or whiteboard (with three-column chart prepared as shown at right)
- ☐ Markers

Hot	Cold	Room

EXPLORE

Understanding and Reading a Thermometer

Teacher Preparation: Make the specified number of copies of Figure 1 and Figure 2.

For the class

- ☐ Thermometer
- ☐ Colored pencil
- ☐ 1 copy of Figure 1: Horizontal Number Line
- ☐ 1 copy of Figure 2: Vertical Number Line

For each student

- ☐ 2 copies of Figure 1: Horizontal Number Line
- ☐ 1 copy of Figure 2: Vertical Number Line

Light Center 1: Shadows

Teacher Preparation: Copy and laminate the Light Center 1 Instructions and Shadow Mat, and make a copy of the data sheet for each student. Prepare 9 x 9 cm squares of the listed materials. Prior to class, place a table against a wall. Tape the graph paper to the wall so that the bottom of the paper is even with the table surface. Place the shadow mat on the table so that the top of the mat (page) is against the graph paper. You may want to use tape to hold the mat in place. Ensure that when a lit flashlight is in the correct position on the mat, the light hits the graph paper.

For each center

- ☐ Light Center 1 Instructions (laminate for repeated use)
- ☐ Light Center 1 Shadow Mat (laminate for repeated use)
- ☐ Graph paper
- ☐ Tape

- ☐ Binder clip
- ☐ Pad of sticky notes
- ☐ Flashlight
- ☐ 9 x 9 cm squares of:
 - Clear plastic bag or wrap
 - Coffee filter paper
 - Copy paper
 - Foil
 - Gauze fabric
 - Milk jug plastic
 - Tissue paper
 - Wax paper

For each student

- ☐ Light Center 1 Data Sheet

Light Center 2: Sunny Stencils, Part I

Teacher Preparation: Make a copy of the Light Center 2 Data Sheet, Part I for each student. Tape a stencil to a blue or green sheet of construction paper (or cover the paper with a natural object).

For each center

- ☐ Stencil pattern (or natural object, such as leaf, flower, shell)
- ☐ Sheet of blue or green construction paper
- ☐ Clear tape

For each student

- ☐ Light Center 2 Data Sheet, Part I (see Resources section)

Heat Center: How Does Your Capsule Grow?

Teacher Preparation: Copy and laminate the Heat Center Instructions and make a copy of the Heat Center Data Sheet for each student. Immediately before the activity, fill the cups with ice water and warm water, so the water remains at the correct temperature.

For each center

- ☐ Heat Center Instructions
- ☐ 1 clear plastic cup with ice water
- ☐ 1 clear plastic cup with warm water
- ☐ 2 thermometers
- ☐ Red pencil or crayon
- ☐ Timer or clock
- ☐ 2 magic animal growing capsules (per group; available for purchase online)
- ☐ 5 safety goggles



Warm water should not be warmer than 54°C for safety.



Safety goggles required

For each student

- ☐ Heat Center Data Sheet

Sound Center: Dancing Rice

Teacher Preparation: Copy and laminate the Sound Center Instructions and make a copy of the Sound Center Data Sheet for each student. Wrap a handful of rice in plastic wrap and use a rubber band to seal the bundle. Prior to class, place the rice bundle in the shallow foil pan. Open the bundle and spread out the rice. Stow the rubber band.

For each center

- ☐ Sound Center Instructions (laminate for repeated use)
- ☐ Shallow foil pan
- ☐ Rice (handful bundled in plastic wrap and sealed with a rubber band)
- ☐ Plastic wrap
- ☐ Rubber band
- ☐ Cookie sheet
- ☐ Wooden spoon

For each student

- ☐ Sound Center Data Sheet

ELABORATE

States of Matter and Mass

Teacher Preparation: At least 1 day in advance, prepare large square ice cubes. You may want to add food coloring to the water before pouring it into the ice cube tray and freezing it.

For the class

- ☐ *Melting and Freezing* by Lisa Greathouse
- ☐ Chart paper or whiteboard
- ☐ Markers
- ☐ Ice chest (to store ice cubes)

For each group

- ☐ Large square ice cube
- ☐ Paper towels
- ☐ Clear plastic cup
- ☐ Balance scale
- ☐ Nonstandard objects for measuring mass (e.g., blocks or Unifix® cubes)

For each student

- ☐ Journal

Light Center 2: Sunny Stencils

Teacher Preparation: Plan the activity for a time when you will likely have 5 consecutive days of sunshine. Locate places where you can place the construction paper in direct sunlight for 5 or more days without the paper getting wet or moved. Prior to class, make a copy of the Light Center 2 Data Sheet, Part II for each student.

For each group

- ☐ 3 stencil patterns (or natural objects, such as leaves, flowers, shells)
- ☐ 3 sheets of blue or green construction paper
- ☐ Clear tape
- ☐ Marker for labeling sheets

For each student

- ☐ Light Center 2 Data Sheet, Part II

EVALUATE

Group Project 1

For the class

- ☐ 2 green, leafy potted plants of the same type (should require direct sunlight)
- ☐ Digital camera

For each group

- ☐ Group Project 1 Rubric
- ☐ Ruler or measuring tape
- ☐ Paper or electronic science journal to record observations
- ☐ Computer with presentation software (or whiteboard)

Group Project 2

For each group

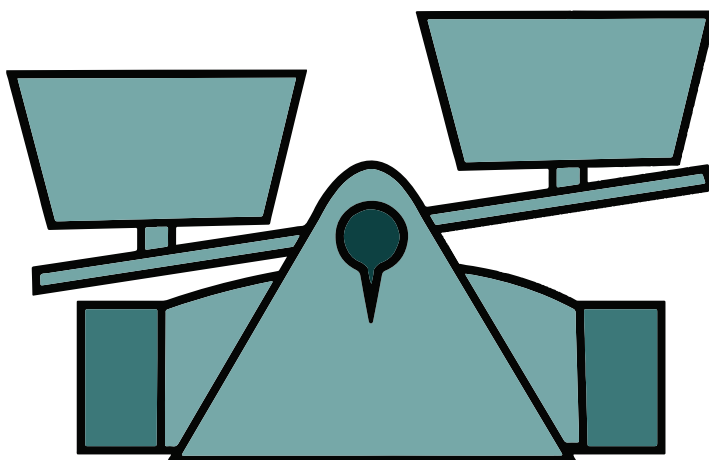
- ☐ Group Project 2 Rubric
- ☐ Computer with Internet access
- ☐ Collaborative storytelling website such as <http://www.storybird.com>

Individual Assessment

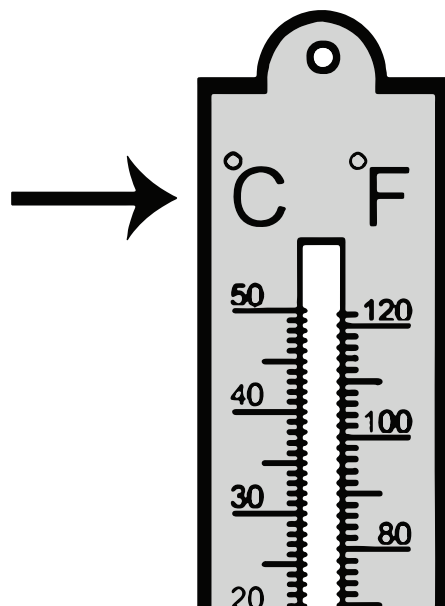
For each student

- ☐ Energy Assessment
- ☐ 2 pencils

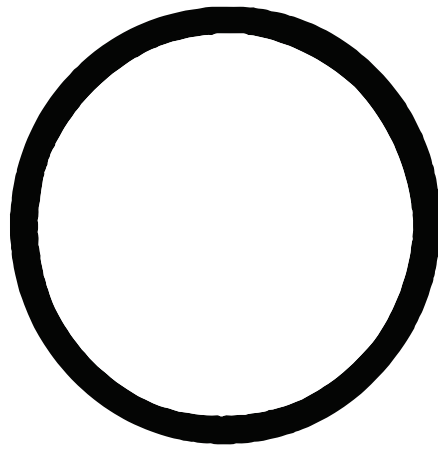
Frequent English/Spanish Vocabulary Words



balance scale / balanza



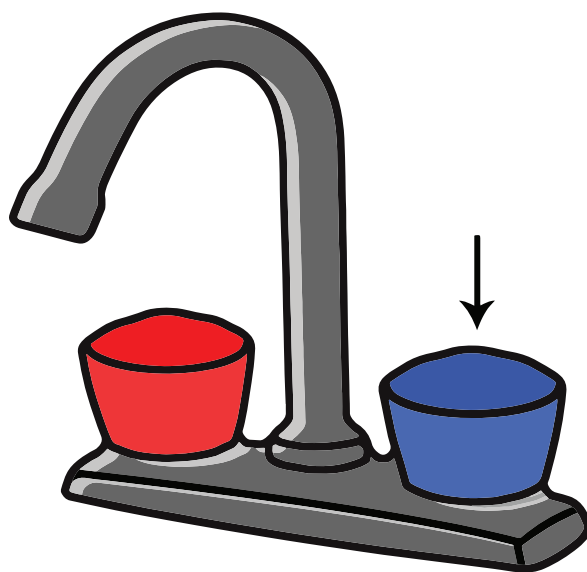
Celsius / Celsio



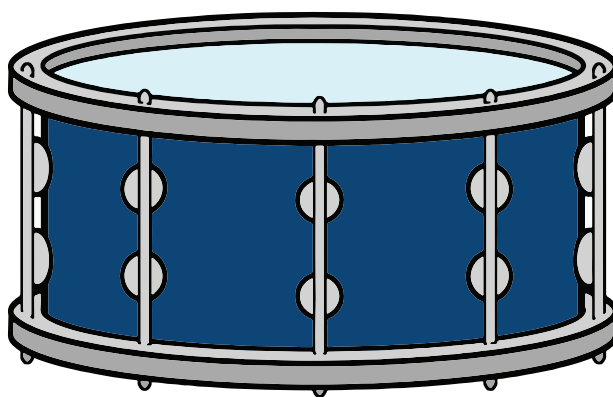
circle / círculo



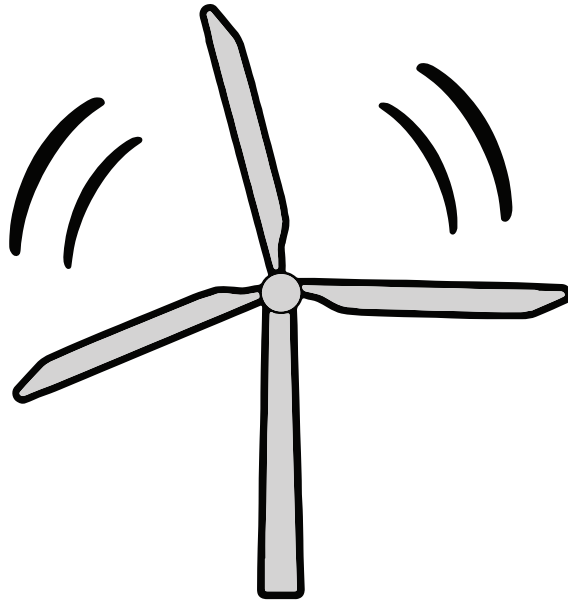
cold / frío



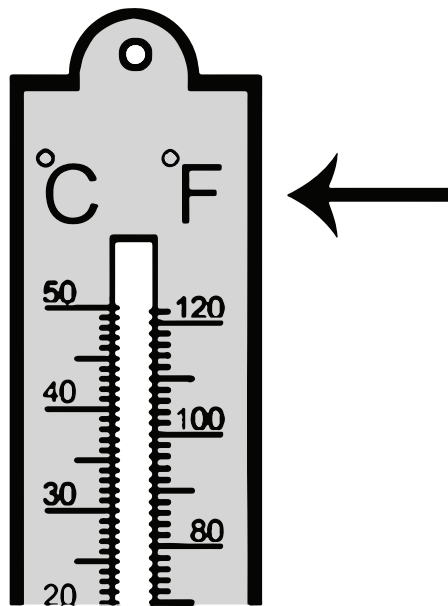
cold water / agua fría



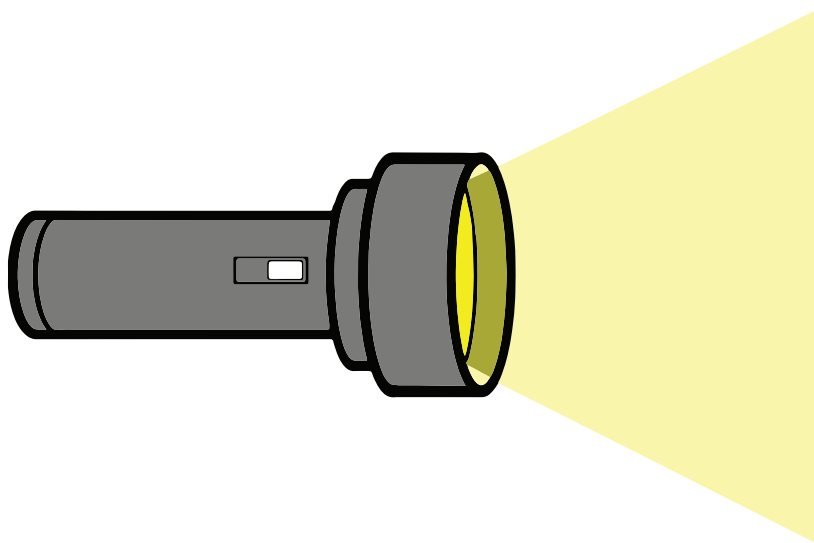
drum / tambor



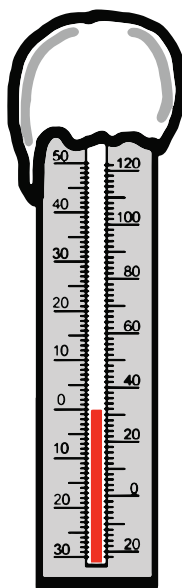
energy / energía



Fahrenheit / Fahrenheit



flashlight / linterna



freeze / congelar



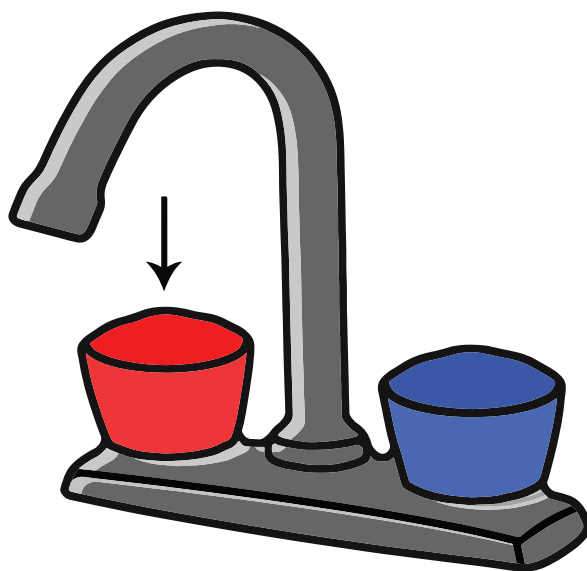
**hand lens (magnifying glass) /
lupa**



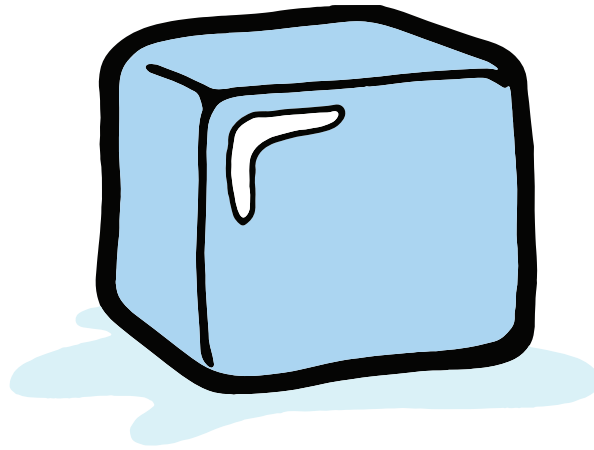
heat / calor



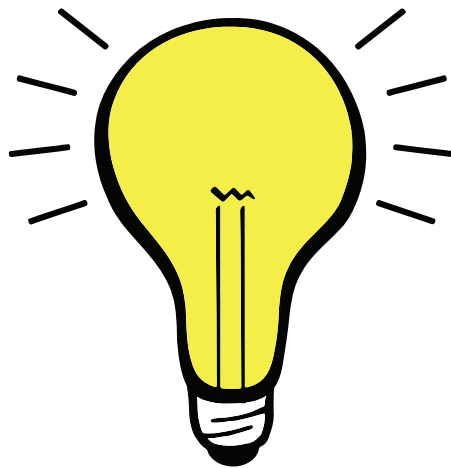
hot / caliente



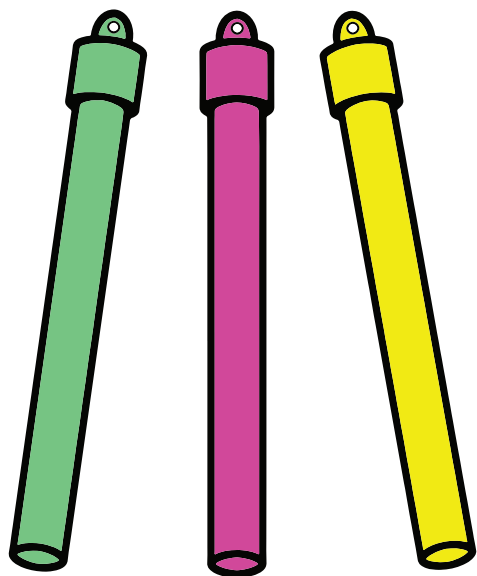
hot water / agua caliente



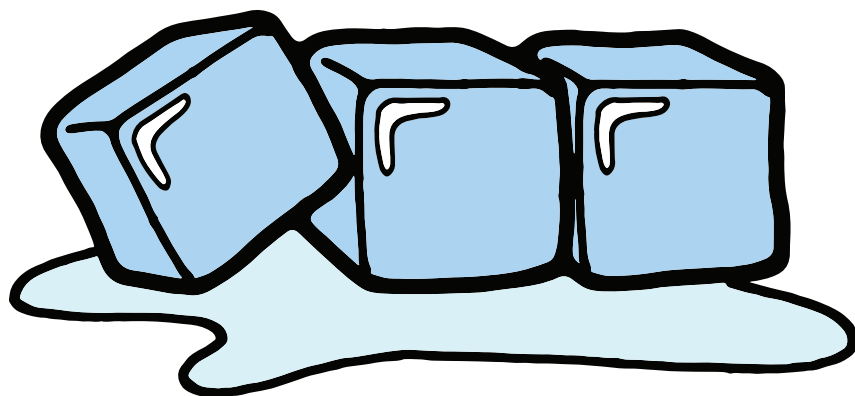
ice cube / cubo de hielo



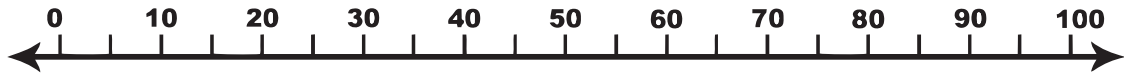
light / luz



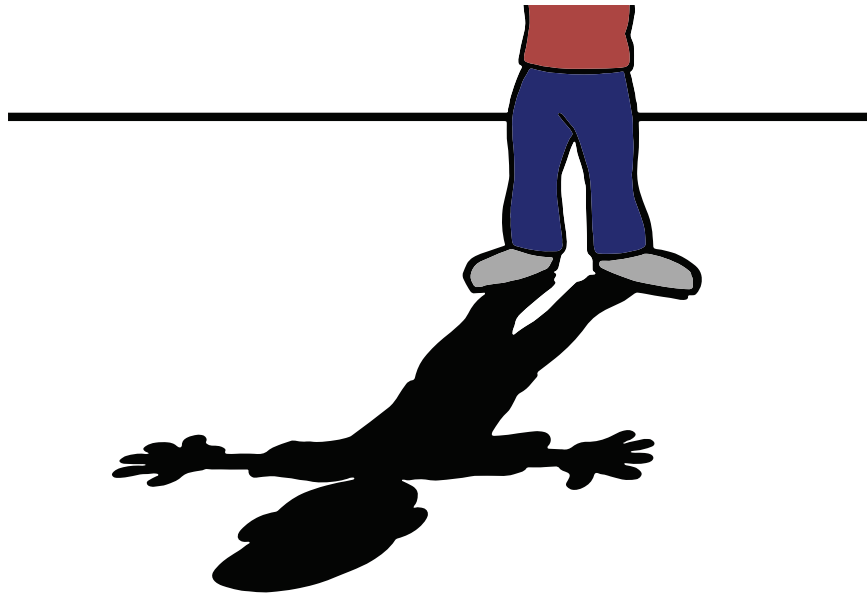
light stick / vara reluciente



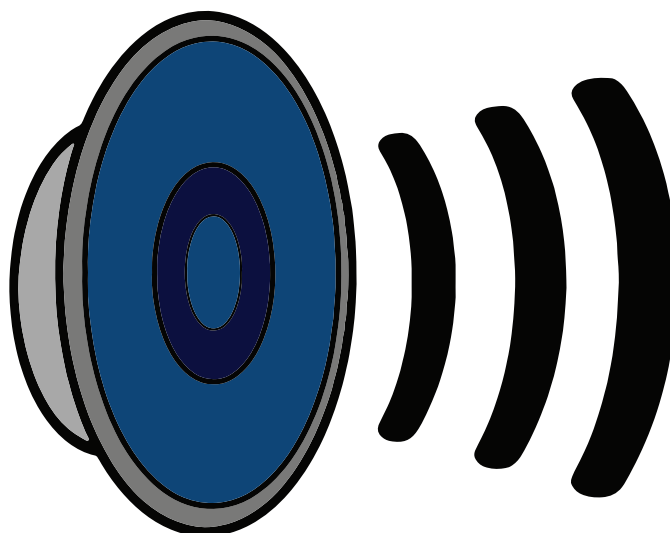
melt / derretir



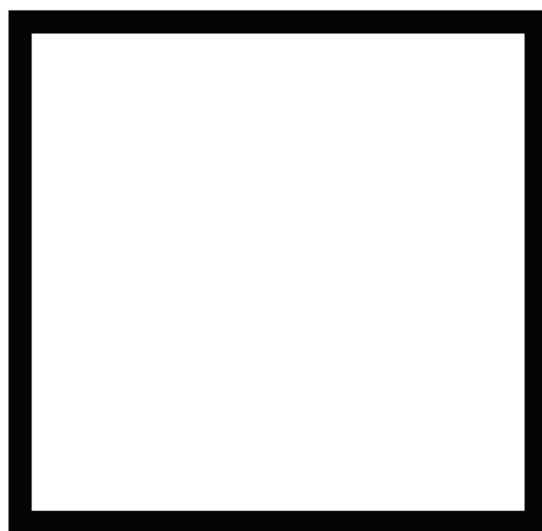
**number line /
línea numérica**



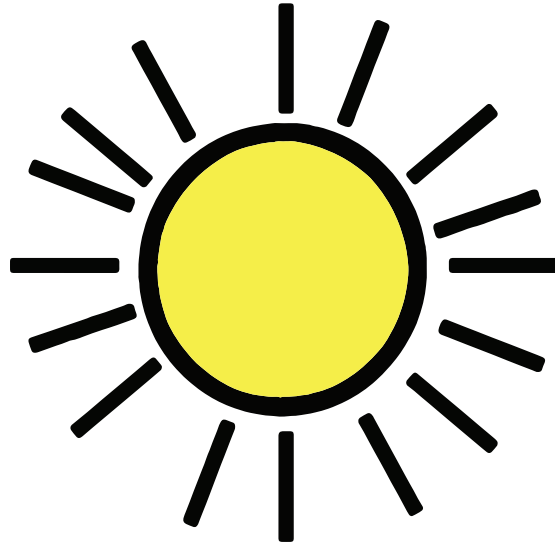
shadow / sombra



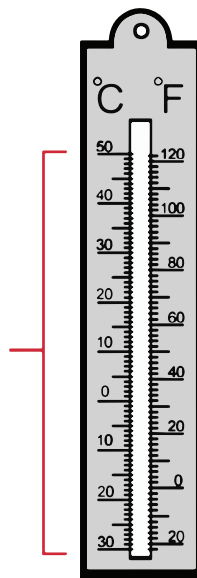
sound / sonido



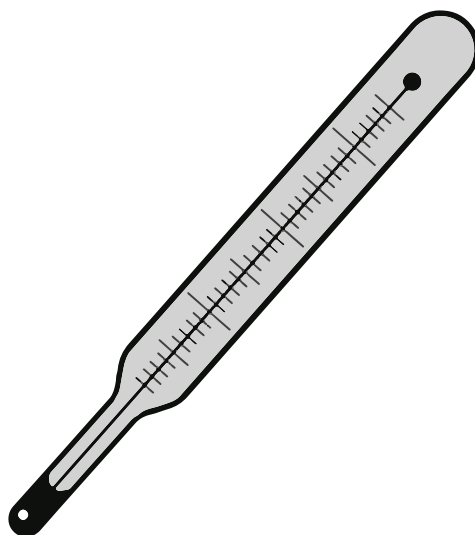
square / cuadrado



sun / sol



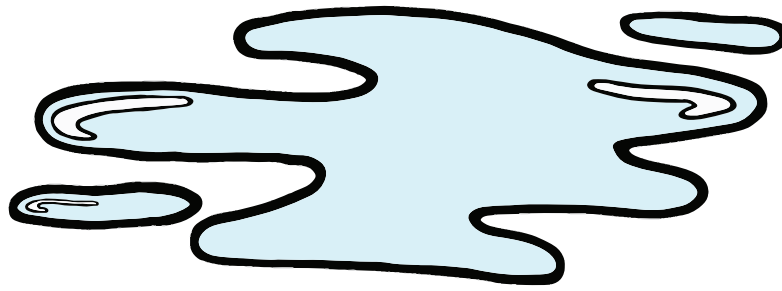
temperature / temperatura



thermometer / termómetro



vibrate / vibrar



water / agua

Figure 1: Horizontal Number Line

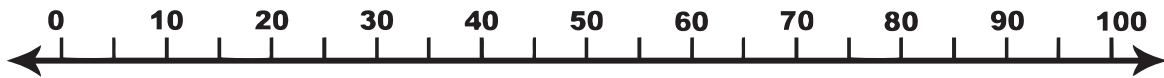
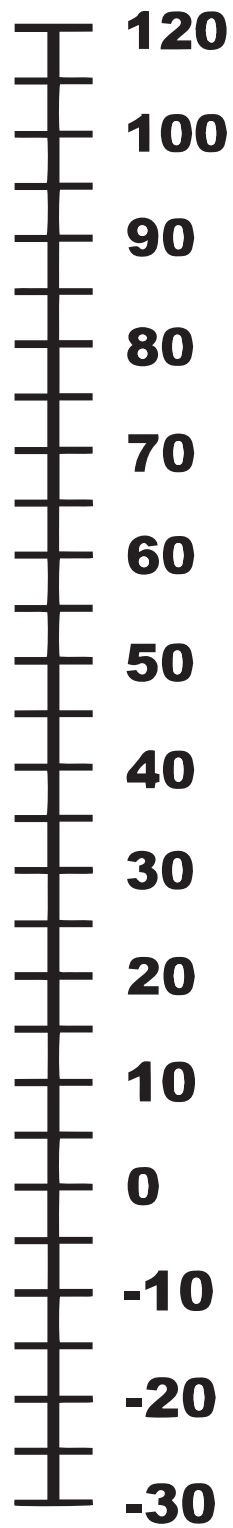


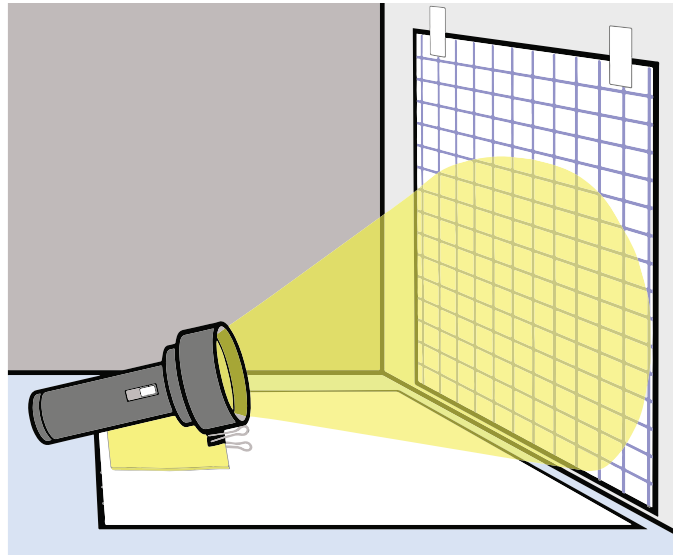
Figure 2: Vertical Number Line



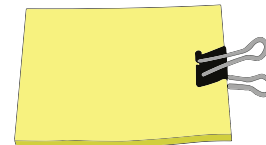
Light Center 1 Instructions

Shadows

Read all the steps before you start.



1. Examine the picture above. Set up the items in the center in the same way. Place the front end of the flashlight on the **X** on the Shadow Mat. The handle of the flashlight will hang off the mat.
2. Place the pad of sticky notes with the clip (as shown at right) under the front of the flashlight.
3. Turn the flashlight on. The flashlight should shine on the graph paper on the wall. What do you notice about the size and brightness of the circle of light?
4. Leave the flashlight in the same place as you test each material.
5. Place each material listed below over the end of the flashlight. Observe the darkness of the shadow that forms on the graph paper on the wall. Record your observation on your data sheet.

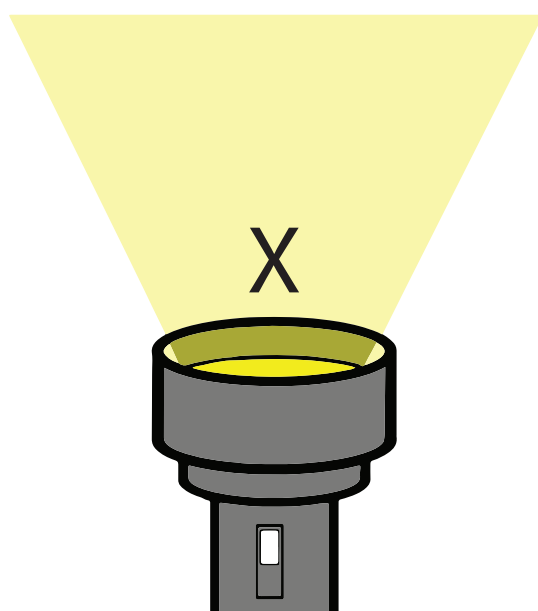


Materials to Cover Flashlight

- | | |
|-----------------------------|--------------------|
| • Clear Plastic Bag or Wrap | • Milk Jug Plastic |
| • Tissue Paper | • Wax Paper |
| • Gauze Fabric | • Copy Paper |
| • Coffee Filter | • Foil |

Light Center 1 Shadow Mat

Wall with graph paper here



Light Center 1 Data Sheet

Name _____ Date _____

Changing the Darkness of Shadows

Question: What will happen to the shadow of an object as the light source gets dimmer?

Prediction: Circle a word or phrase to complete your prediction.

As the light gets dimmer, the shadow will get

darker lighter stay the same

Follow the instructions at the Shadows light center. Place each material in front of the flashlight one at a time. Observe how dark the shadow of the material is. Record your observations below.

Material Covering Flashlight	Shadow
Clear Plastic Bag or Wrap	
Tissue Paper	
Gauze Fabric	
Coffee Filter	
Milk Jug Plastic	
Wax Paper	
Copy Paper	
Foil	

1. Which material produces the darkest shadow?
2. Which material produces no shadow? Why do you think this happens?
3. What is needed for a shadow to form?

Light Center 2 Data Sheet, Part I

Name _____ Date _____

Sunny Stencils

Look at the colored sheet of paper. The item taped to the paper is a **stencil**.

What do you think might happen to the paper if it were left out in the sun for several days?

- Think about what might happen to the uncovered part of the paper.
- Then think about what might happen to the covered part of the paper.

Discuss your thoughts with your group.

Record your prediction below.

Heat Center Instructions

How Does Your Capsule Grow?

Read all the steps before you start.

1. Place a thermometer in each cup of water.
2. Observe the direction of the movement of the red liquid on each thermometer. Note the number where each red line stops.
3. Record your observations on the data sheet by coloring a red line on each thermometer.
4. Place the two capsules on the grid on the data sheet. Count and record how many squares each capsule covers or touches. Write the number below each grid.
5. Place one capsule in each cup of water. Set the timer for 3 minutes.
6. Observe and record on your data sheet any changes in the capsules.
7. Remove the capsules at the end of 3 minutes and place them on paper towels.
8. Place each capsule on the grid on the data sheet. Count and record how many squares each capsule covers or touches. Write the number below each grid.
9. Give the wet capsules to your teacher.
10. Leave your station clean, neat, and dry.

Heat Center Data Sheet

Name _____ Date _____

How Does Your Capsule Grow?

Part I

Question: What will happen to the red liquid in a thermometer when it is placed in cold or warm water?

Prediction: Circle the word or phrase to complete your prediction.

The red liquid will

rise **fall** **stay the same**

in cold water.

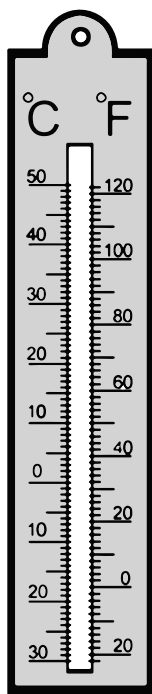
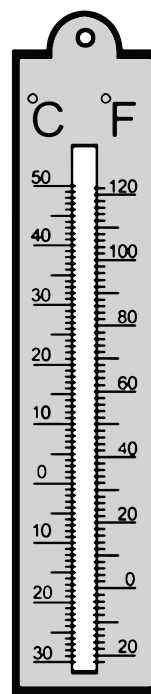
The red liquid will

rise **fall** **stay the same**

in warm water.

Heat Center Data Sheet, continued

Follow steps 1–3 on the instructions at the heat center. Color a red line on each thermometer to show how far the red liquid moved.

**Cold water****Warm water**

1. Which direction did the red liquid move on the thermometer placed in cold water?
2. On what number did the red liquid stop on the thermometer in cold water?
3. Which direction did the red liquid move on the thermometer placed in warm water?
4. On what number did the red liquid stop on the thermometer in warm water.

Heat Center Data Sheet, continued

Part II

Question: What will happen to a capsule placed in cold water? What will happen to a capsule placed in warm water?

Prediction: Circle the word or phrase to complete your predictions.

The capsule in the cold water will

grow faster **grow slower** **grow at the same rate**
as the capsule in the warm water.

The capsule in the warm water will

grow faster **grow slower** **grow at the same rate**
as the capsule in the cold water.

Follow steps 4–10 on the instructions at the heat center.

1. Place one capsule on each side of the grid below. Trace the capsules. Count and record how many squares each capsule covers or touches.

_____ **Squares**

_____ **Squares**

-
-
-
-

- [illegible]

Warm _____

Heat Center Data Sheet, continued

- 4.** Discuss and record in the space below why there was or was not a difference in how quickly the capsules grew in the cold and warm water.

- 5.** Leave your station clean, neat, and dry.

Questions

Discuss in your group.

- 1.** Which capsule showed the most change?

- 2.** What caused the change in the capsule?

- 3.** What happened to the capsule in cold water?

Sound Center Instructions

Dancing Rice

Read all the steps before you start.

1. Sit so that each person in your group can see the pan with the rice.
2. Hold the cookie sheet a few inches above the rice and tap the cookie sheet softly with the wooden spoon.
3. Observe any changes in the position of the rice.
4. Hold the cookie sheet above the rice again and hit the cookie sheet harder with the wooden spoon.
5. Observe any changes in the position of the rice.
6. Answer the questions on the Sound Center Data Sheet.

Sound Center Data Sheet

Name _____ Date _____

Dancing Rice

1. Did you hear a sound when the cookie sheet was tapped with the wooden spoon?

2. What happened to the rice when the cookie sheet was tapped with the wooden spoon?

3. Did you hear a sound when the cookie sheet was hit harder with the wooden spoon? Was the second sound louder or softer than the first sound?

4. What happened to the rice when the cookie sheet was hit harder with the wooden spoon?

Light Center 2 Data Sheet, Part II

Name _____ Date _____

Sunny Stencils

Remove the stencils from the paper. Then answer the following questions.

1. Why did we not put one sheet of paper in the sun? Why did we cover parts of the sheets of paper?
2. What happened to the uncovered areas of the paper?
3. Did the uncovered areas fade more on Sheet 0, Sheet 2, or Sheet 5? Circle your answer.

Sheet 0

Sheet 2

Sheet 5

4. You leave a toy painted blue outside in the sun for 2 weeks. What do you think will happen to the color of the blue toy?
5. Based on the experiment, what does **fade** mean?
6. How does the amount of time an object is exposed to sunlight relate to how much the object fades?

Group Project 1 Rubric

	1-Needs Improvement	2-Satisfactory	3-Excellent
Hypotheses	No hypothesis is provided.	Only one hypothesis is provided, or the second does not accurately explain how energy was related to the changes observed.	Two hypotheses are provided, and the second accurately explains how energy was related to the changes observed.
Measurement	No measurement is included, or no explanation is given as to why no measurement is included.	The form of measurement included is inappropriate (e.g., time for length).	The unit of measurement included is used correctly, or an explanation is given as to why a measurement is not relevant.
Presentation	The presentation does not include any images or illustrate how energy was related to the changes observed.	The images and text only partially illustrate how energy was related to the changes observed.	The images and text accurately illustrate how energy was related to the changes observed.

Group Project 2 Rubric

	1-Needs Improvement	2-Satisfactory	3-Excellent
Energy	No forms of energy are included.	The three forms of energy are included, but an example of how each one causes change is not.	The three forms of energy are included as well as at least one example of how each one causes change.
Measurement	No measurement is included, or no explanation is given as to why no measurement is included.	The form of measurement included is inappropriate (e.g., time for length).	The unit of measurement included is used correctly, or an explanation is given as to why a measurement is not relevant.
Technology	Technology is not used successfully.	Technology is limited to word processing.	Students created and shared their digital book online.

Energy Assessment Teacher Instructions

1. Duplicate the assessment and distribute to each student.
2. Read the following instructions aloud to the class:

“Carefully read each question and the possible answers. Then circle the letter next to the best answer to each question.”

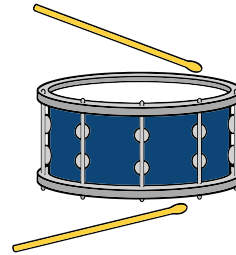
Answer Key

1. D
2. B
3. C
4. A
5. B
6. B
7. D

Energy Assessment

1. Hitting a drum with a drum stick causes it to _____.

A break
B melt
C change color
D vibrate

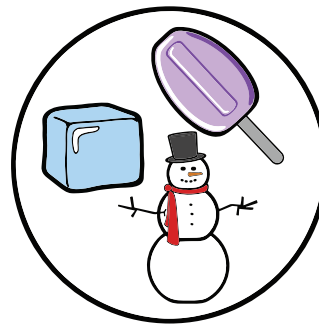


2. Which of these will most likely form a dark shadow on a sunny day?

A air
B tree
C clear cup
D water

3. The pictures inside the circle can be grouped together because they show things that _____.

A vibrate to make sounds
B feel soft to touch
C melt at room temperature
D have the same mass



4. Which of these most likely shows the temperature of a glass of ice water?
(F indicates Fahrenheit, C indicates Celsius)

A 41°F (5°C)
B 86°F (30°C)
C 32°F (0°C)
D 95°F (35°C)

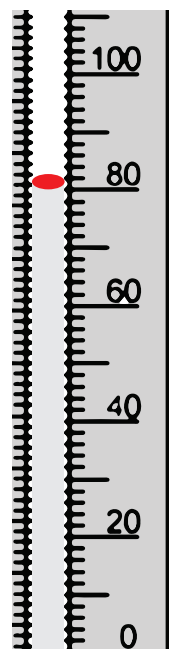
5. Shadows are formed when an object _____.

- A bounces off light
- B blocks light
- C is in a dark room
- D moves quickly



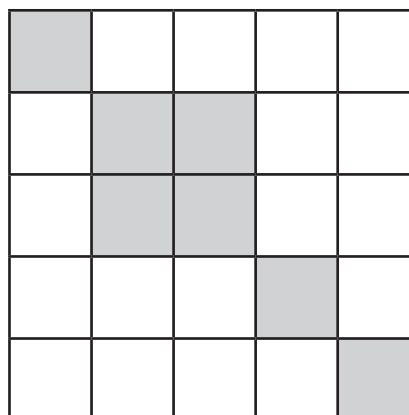
6. On the thermometer below, if the red liquid went up to the red dot, what would the temperature be? (F indicates Fahrenheit)

- A 77°F
- B 82°F
- C 87°F
- D 80°F



7. How much area is shaded in the grid below?

- A 18 square units
- B 5 square units
- C 12 square units
- D 7 square units



Reading Connections

The following books are recommended as literary resources to enhance the study of light, heat, and sound energy for Grade 2 students.

Light

Bradley, K. B. (2002). *Energy Makes Things Happen* (Let's-Read-and-Find-Out Science 2). New York, NY: HarperCollins Publishers.

Light

Asch, F. (2000). *Moonbear's shadow*. New York, NY: Aladdin.

Berge, C. (2006). *Whose shadow is this? A Look at animal shapes—Round, long, and pointy*. North Mankato, MN: Picture Window Books.

Branley, F. M. (1998). *Day light, night light: Where light comes from*. (Let's-Read-and-Find-Out Science 2). New York, NY: HarperCollins Publishers.

Branley, F. M. (2005). *What makes day and night* (Let's-Read-and-Find-Out Science 2). New York, NY: HarperCollins Publishers.

Bulla, C. R. (1994). *What makes a shadow?* (Let's-Read-and-Find-Out Science 1). New York, NY: HarperCollins Publishers.

Cobb, V. (2002). *I see myself*. (Vicki Cobb Science Play). New York, NY: HarperCollins Publishers.

Lee, S. (2010). *Shadow*. San Francisco, CA: Chronicle Books.

Swinburne, S. R. (1999). *Guess whose shadow?* Honesdale, PA: Boyds Mills Press.

Tompert, A. (1988). *Nothing sticks like a shadow*. New York, NY: Sandpiper Houghton Mifflin Company.

Heat

Greathouse, L. (2010). *Melting and freezing*. (Science Readers: A Closer Look). Huntington Beach, CA: Teacher Created Materials. (Available in English and Spanish)

Manolis, K. (2008). *Temperature*. (Blastoff! Readers: First Science). Minneapolis, MN: Bellwether Media.

Sound

Branley, F. M. (2005). *Flash, crash, rumble and roll*. (Let's-Read-and-Find-Out Science 2). New York, NY: HarperCollins Publishers.

Manolis, K. (2008). *Sound* (Blastoff! Readers: First Science). Minneapolis, MN: Bellwether Media.

Pfeffer, W. (1999). *Sounds all around*. (Let's-Read-and-Find-Out Science 1). New York, NY: HarperCollins Publishers.

Wright, L. (2000). *The science of noise*. (Science World). Austin, TX: Raintree Steck-Vaughn Company.

Texas Essential Knowledge and Skills (TEKS) Focus

§112.13. Science, Grade 2, Beginning with School Year 2010–2011.

(b) Knowledge and skills.

- (2) Scientific investigation and reasoning. The student develops abilities necessary to do scientific inquiry in classroom and outdoor investigations. The student is expected to:
 - (A) ask questions about organisms, objects, and events during observations and investigations;
 - (C) collect data from observations using simple equipment such as hand lenses, primary balances, thermometers, and non-standard measurement tools; and
 - (D) record and organize data using pictures, numbers, and words.
- (4) Scientific investigation and reasoning. The student uses age-appropriate tools and models to investigate the natural world. The student is expected to:
 - (A) collect, record, and compare information using tools, including computers, hand lenses, rulers, primary balances, plastic beakers, magnets, collecting nets, notebooks, and safety goggles, timing devices, including clocks and stopwatches, weather instruments such as thermometers, wind vanes, and rain gauges; and materials to support observations of habitats of organisms such as terrariums and aquariums; and
 - (B) measure and compare organisms and objects using non-standard units that approximate metric units.
- (5) Matter and energy. The student knows that matter has physical properties and those properties determine how it is described, classified, changed, and used. The student is expected to:
 - (A) classify matter by physical properties, including shape, relative mass, relative temperature, texture, flexibility, and whether material is a solid or liquid;
 - (B) compare changes in materials caused by heating and cooling; and
 - (C) demonstrate that things can be done to materials to change their physical properties such as cutting, folding, sanding and melting.
- (6) Force, motion, and energy. The student knows that forces cause change and energy exists in many forms. The student is expected to:
 - (A) Investigate the effects on an object by increasing or decreasing amounts of light, heat, and sound energy such as how the color of an object appears different in dimmer light and how heat melts butter.

§111.14. Mathematics, Grade 2.

(b) Knowledge and skills.

- (9) Measurement. The student directly compares the attributes of length, area, weight/mass, and capacity, and uses comparative language to solve problems and answer questions. The student selects and uses nonstandard units to describe length, area, capacity, and weight/mass. The student recognizes and uses models that approximate standard units (from both SI, also known as metric, and customary systems) of length, weight/mass, capacity, and time.

§126.2. Technology Applications, Kindergarten–Grade 2.**(b) Knowledge and skills.**

- (2) Foundations. The student uses data input skills appropriate to the task. The student is expected to:
 - (B) use proper keyboarding techniques such as correct hand and body positions and smooth and rhythmic keystroke patterns as grade-level appropriate.
- (7) Solving problems. The student uses appropriate computer-based productivity tools to create and modify solutions to problems. The student is expected to:
 - (A) use software programs with audio, video, and graphics to enhance learning experiences; and
 - (B) use appropriate software, including the use of word processing and multimedia, to express ideas and solve problems.
- (8) Solving problems. The student uses research skills and electronic communication, with appropriate supervision, to create new knowledge. The student is expected to:
 - (A) use communication tools to participate in group projects; and
 - (B) use electronic tools and research skills to build a knowledge base regarding topic, task, or assignment.
- (11) Communication. The student delivers the product electronically in a variety of media, with appropriate supervision. The student is expected to:
 - (A) publish information in a variety of media including, but not limited to, printed copy or monitor display; and
 - (B) publish information in a variety of media including, but not limited to, stored files or video.
- (12) Communication. The student uses technology applications to facilitate evaluation of communication, both process and product. The student is expected to:
 - (A) select representative products to be collected and stored in an electronic evaluation tool.

§74.4. English Language Proficiency Standards.**(a) Introduction.**

- (1) The English language proficiency standards in this section outline English language proficiency level descriptors and student expectations for English language learners (ELLs). School districts shall implement this section as an integral part of each subject in the required curriculum. The English language proficiency standards are to be published along with the Texas Essential Knowledge and Skills (TEKS) for each subject in the required curriculum.
- (2) In order for ELLs to be successful, they must acquire both social and academic language proficiency in English. Social language proficiency in English consists of the English needed for daily social interactions. Academic language proficiency consists of the English needed to think critically, understand and learn new concepts, process complex academic material, and interact and communicate in English academic settings.

- (3) Classroom instruction that effectively integrates second language acquisition with quality content area instruction ensures that ELLs acquire social and academic language proficiency in English, learn the knowledge and skills in the TEKS, and reach their full academic potential.
 - (4) Effective instruction in second language acquisition involves giving ELLs opportunities to listen, speak, read, and write at their current levels of English development while gradually increasing the linguistic complexity of the English they read and hear, and are expected to speak and write.
 - (5) The cross-curricular second language acquisition skills in subsection (c) of this section apply to ELLs in Kindergarten-Grade 12.
 - (6) The English language proficiency levels of beginning, intermediate, advanced, and advanced high are not grade-specific. ELLs may exhibit different proficiency levels within the language domains of listening, speaking, reading, and writing. The proficiency level descriptors outlined in subsection (d) of this section show the progression of second language acquisition from one proficiency level to the next and serve as a road map to help content area teachers instruct ELLs commensurate with students' linguistic needs.
- (b) School district responsibilities. In fulfilling the requirements of this section, school districts shall:
- (1) identify the student's English language proficiency levels in the domains of listening, speaking, reading, and writing in accordance with the proficiency level descriptors for the beginning, intermediate, advanced, and advanced high levels delineated in subsection (d) of this section;
 - (2) provide instruction in the knowledge and skills of the foundation and enrichment curriculum in a manner that is linguistically accommodated (communicated, sequenced, and scaffolded) commensurate with the student's levels of English language proficiency to ensure that the student learns the knowledge and skills in the required curriculum;
 - (3) provide content-based instruction including the cross-curricular second language acquisition essential knowledge and skills in subsection (c) of this section in a manner that is linguistically accommodated to help the student acquire English language proficiency; and
 - (4) provide intensive and ongoing foundational second language acquisition instruction to ELLs in Grade 3 or higher who are at the beginning or intermediate level of English language proficiency in listening, speaking, reading, and/or writing as determined by the state's English language proficiency assessment system. These ELLs require focused, targeted, and systematic second language acquisition instruction to provide them with the foundation of English language vocabulary, grammar, syntax, and English mechanics necessary to support content-based instruction and accelerated learning of English.
- (c) Cross-curricular second language acquisition essential knowledge and skills.
- (1) Cross-curricular second language acquisition/learning strategies. The ELL uses language learning strategies to develop an awareness of his or her own learning processes in all content areas. In order for the ELL to meet grade-level learning expectations across the foundation and enrichment curriculum, all instruction delivered in English must be linguistically accommodated (communicated, sequenced, and scaffolded) commensurate with the student's level of English language proficiency. The student is expected to:

- (A) use prior knowledge and experiences to understand meanings in English;
- (B) monitor oral and written language production and employ self-corrective techniques or other resources;
- (C) use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary;
- (D) speak using learning strategies such as requesting assistance, employing non-verbal cues, and using synonyms and circumlocution (conveying ideas by defining or describing when exact English words are not known);
- (E) internalize new basic and academic language by using and reusing it in meaningful ways in speaking and writing activities that build concept and language attainment;
- (F) use accessible language and learn new and essential language in the process;
- (G) demonstrate an increasing ability to distinguish between formal and informal English and an increasing knowledge of when to use each one commensurate with grade-level learning expectations; and
- (H) develop and expand repertoire of learning strategies such as reasoning inductively or deductively, looking for patterns in language, and analyzing sayings and expressions commensurate with grade-level learning expectations.

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