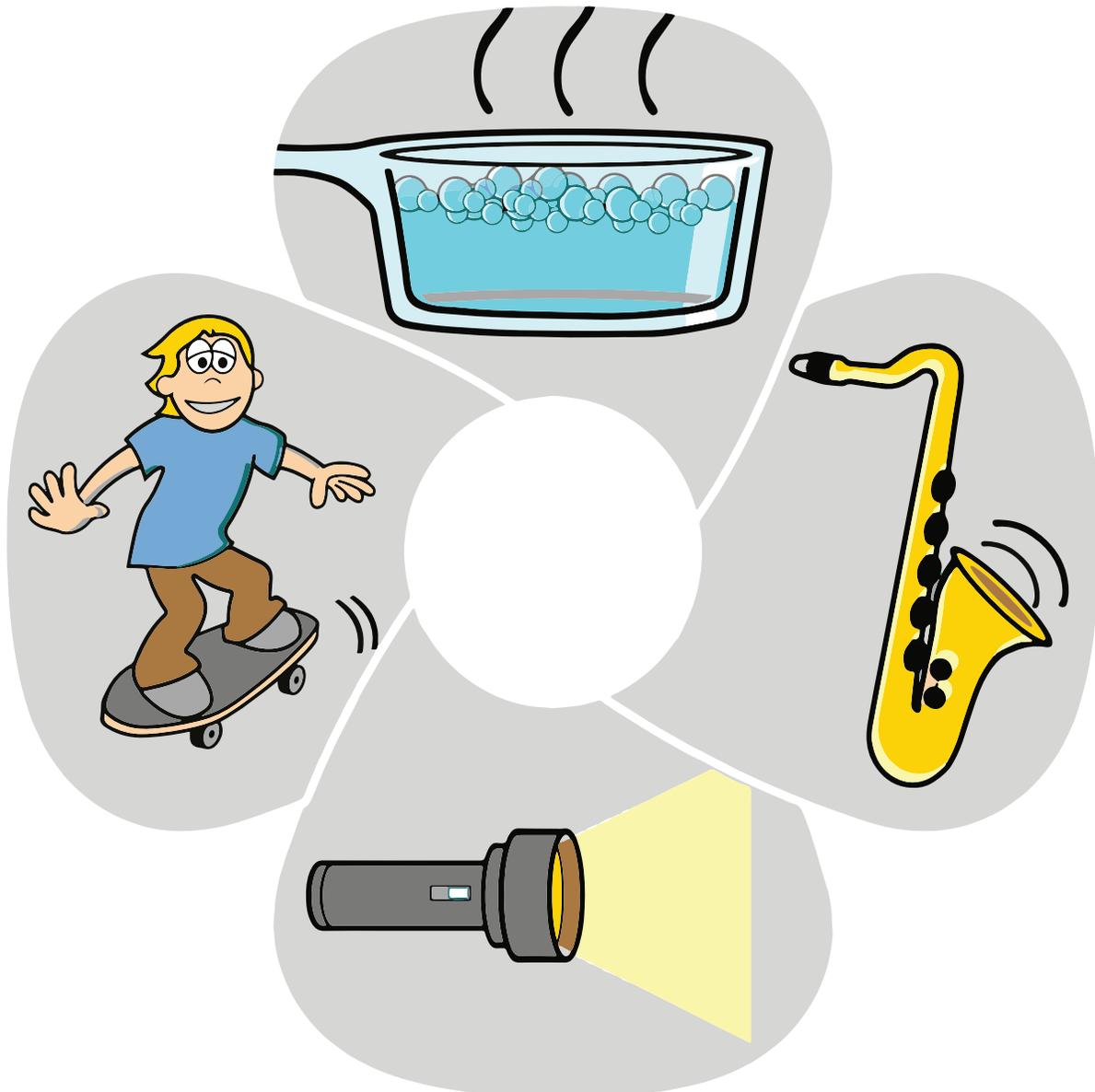


Exploring Light, Thermal, Mechanical, and Sound Energy in Everyday Life



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Exploring Light, Thermal, Mechanical, and Sound Energy in Everyday Life

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 complete an Everyday Energy Anticipation Guide as a preview of energy concepts. Later, during the Elaborate phase, students revisit the anticipation guide to see what they have learned about energy and whether they have changed their minds about any of their previous answers.

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. Intermediate ELs 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 everyday examples of light, heat, sound, and mechanical energy. The centers provide students with common experiences using mirrors, ice, spoons, and pencils to explore different forms of 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 the 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. The teacher more formally introduces the concept of mechanical energy, while carefully monitoring student understanding to avoid misconceptions.

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: Students observe and identify forms of mechanical energy by observing a swing set and an online simulation. Students continue to deepen their understanding of scale and temperature through the use of manipulatives and a website to compare Fahrenheit and Celsius scales on a thermometer.

English learners: The goal during the Elaborate phase is to minimize the language demands and optimize content understanding. While building content knowledge through the activities in this phase, 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: Students work in groups to develop either a digital story about how the four types of energy cause changes or an electronic presentation showing how the four types of energy are used in a playground or resort. Teachers may also elect to have each student complete a multiple-choice assessment to help prepare for the state assessment.

English learners: Evaluations for ELs should use a variety of formats that reflect each student's 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 is abstract for elementary students. To increase their understanding of energy, provide concrete experiences that enable students to connect different types of energy to their everyday lives. As students experience increasingly complex interactions between energy and matter, they will begin to understand that many of the changes they observe occur in predictable patterns for each form of energy. The study of energy also fosters a student's ability to observe, describe, and predict patterns in both a qualitative and quantitative manner.

Energy

Grade 3 students need multiple opportunities to experience 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, check to determine students' definition of energy. Then at the end of the unit, revisit the concept to refine and deepen students' operational definition of energy.

Light

Light travels through air and space as waves of energy. The waves we can detect are called visible light. There are many sources of light, but the initial energy for all light sources comes from the sun. Patterns in the behavior of light are very predictable because light moves away from its source in straight lines in the form of waves until it comes in contact with an object or material that changes its direction. Light can pass through, reflect or bounce off, or be blocked by different materials as it moves in a straight line from its source.

Light rays can reflect or bounce off a surface or an object in much the same way that a thrown rubber ball bounces off a wall. The texture of the surface determines how much light will be reflected or absorbed. Mirrors have smooth, shiny surfaces that absorb very little light, so they reflect light in almost exactly the same pattern as it hits the mirror, which allows us to see a complete reflected image of objects.

Without light, we cannot see. Our eyes are built to detect a portion of the electromagnetic spectrum known as the visible spectrum. Each eye contains a lens that refracts, or bends, the light waves so they travel to the retina at the back of the eyeball. The retina then sends signals to the brain, which interprets them as an image.

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. This heat energy can pass or transfer to other cooler objects. Adding heat energy often causes changes in matter, such as melting chocolate. Taking away heat energy can also lead to changes in matter, such as a freezer changing liquid water to ice.

Mechanical Energy

Mechanical energy is the energy an object or material has because of its motion or position and is the sum of potential energy (stored) and kinetic energy (energy in motion). The movement of a car or the stretching of a spring scale are examples of mechanical energy.

Sound

All sounds are caused by vibrations, or rapid back-and-forth movements. Vibrations can be heard and often felt when they travel through the air to our ears as sound waves. Sounds can also travel through other materials, like liquids and solids.

We hear sounds with our ears. The outer ear collects sound waves and funnels them to the eardrum, causing it to vibrate. The three tiny bones in our middle ear pick up the vibrations, which then pass on to the cochlea in the inner ear. The vibrations cause the little hairs on the cochlea to vibrate, and these vibrations in turn are sent to the brain. This process is why you cannot hear well when you have an ear infection—fluid in the middle ear prevents the eardrum and cochlea from vibrating properly.

Musical instruments produce specific sounds by making air vibrate at different rates called frequencies. Frequency can be measured by how many times one part of the sound wave moves back and forth in a second.

Different notes are produced on a guitar or violin by increasing the tension on the strings, causing them to vibrate faster, or with a greater frequency. For example, a guitar player turns the tuning pegs at the end of the fingerboard to increase the tension on the strings. Likewise, a guitar player presses a string on the fingerboard to raise the pitch of a note by allowing only a section of the string to vibrate.

Measurement

The Elaborate phase of the lesson will establish several key ideas related to measurement. First, this phase will reinforce the idea of subtraction as a means of finding the distance between two points. Students will also learn that the starting point for counting a distance between two points is not always zero. This activity further lays the foundation for the fractional benchmark of $\frac{1}{2}$ or halfway.

Students in third grade are beginning to use standard units of measurement. Additional concepts they must master are the ideas of volume and cubic units. A good way to connect volume to science is by exploring the conservation of matter. Students use a specific volume of water and pour it into different-shaped containers. Even though the different shapes of the containers can make the volume of water appear to be more or less, the volume stays constant.

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. For example, by using simulations, students can see how different situations can affect a scientific experiment. And technology is useful to reteach a concept or to instruct students who were absent during the hands-on learning time. This module provides opportunities for students to use technology to experiment with simulations, document and report findings, and create electronic presentations about different forms of energy.

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 is important in everyday life and may cause changes in objects around us.
- Mechanical energy is the sum of potential energy and kinetic energy.
- Comparisons can be made mathematically every day.

Concepts

By the end of this lesson, Grade 3 students should understand the following concepts:

- Energy exists in many forms, including light, heat, sound, and mechanical energy.
- Energy can move from one object or material to another object or material.
- Light travels in straight lines from its source, and may be absorbed, blocked, or reflected.
- Mechanical energy can be described as physical movement and the potential for more action.
- Light, heat, and sound energy can cause changes in matter.
- Changes in the size, mass, and temperature of matter can be measured.
- Descriptive investigations should be planned and conducted safely.
- A variety of tools, such as rulers, spring scales, and thermometers, can be used to observe and measure the results of investigations and to collect data.
- Patterns based on evidence from investigations can be analyzed and interpreted to construct reasonable explanations.
- We can use writing, diagrams, and discussion to communicate valid conclusions supported by data.
- Models can be used to represent the natural world.

Language Support for English Learners

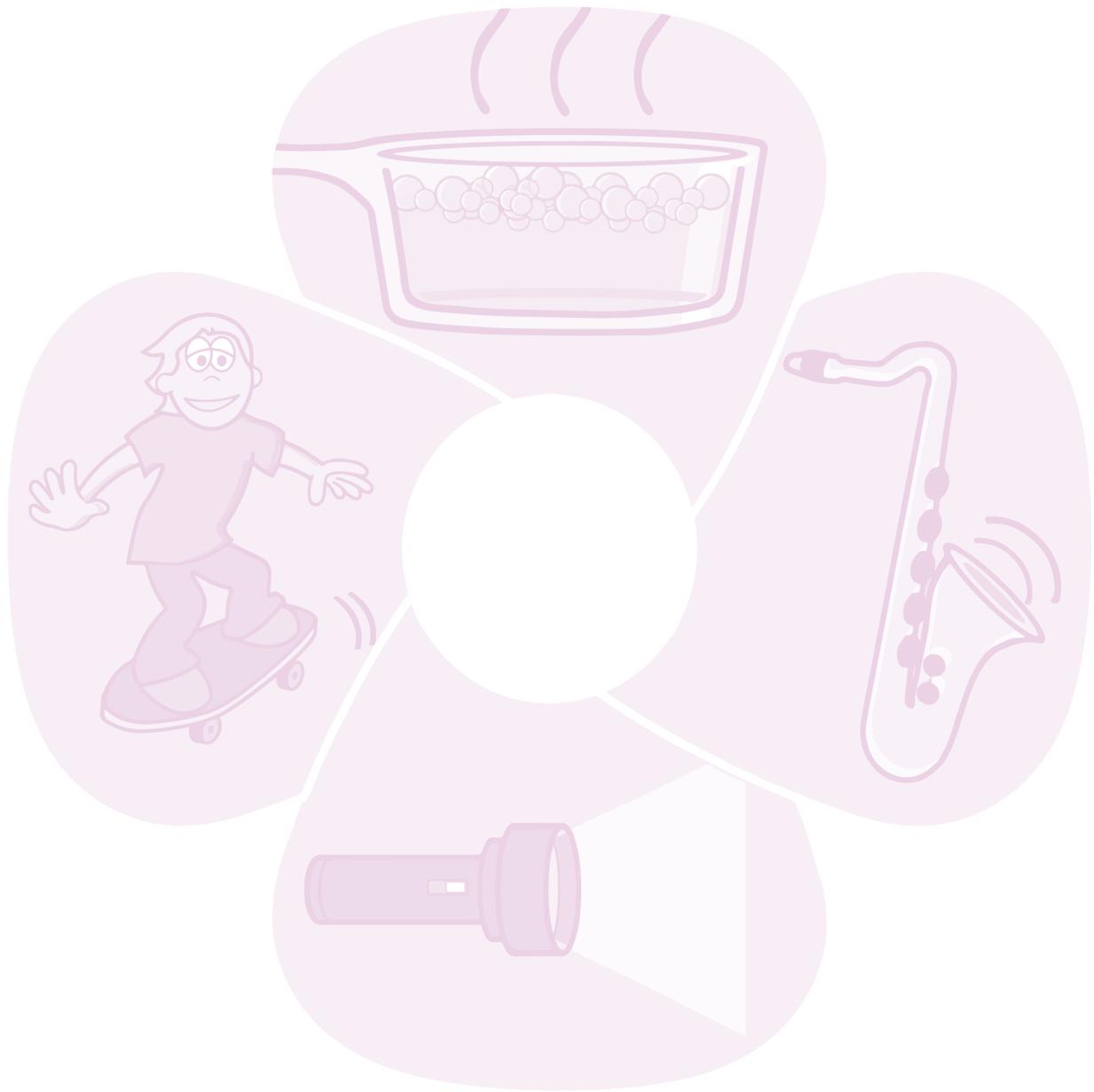
Embedded throughout this lesson are strategies for academic English language support. The following strategies or supports should be used consistently during the instructional process:

- Consider the language demands of instruction. Find ways to contextualize abstract concepts. For example, to explain the concept of energy, show pictures or video clips of machines or people using energy, or use graphic organizers with content-specific vocabulary.
- For beginning ELs, create picture word banks for 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-level students.
- Model demonstrations and procedures explicitly. For example, use body gestures while explaining concepts or provide realia (real examples, such as a flashlight or mirror), 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).
- In general, be cognizant of the amount of wait time you give ELs to allow them enough 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
basketball	pelota de basquetbol
boil	hervir
capacity	capacidad
Celsius	Celsio
cold	frio
cold water	agua fría
distance	distancia
energy	energía
Fahrenheit	Fahrenheit
false	falso
flashlight	linterna
freeze	congelar
heat	calor
hot	caliente
hot water	agua caliente
ice cube	cubo de hielo
kinetic energy	energía cinética
light	luz
measurement	medida
mechanical energy	energía mecánica
melt	derretir
mirror	espejo

English Vocabulary	Spanish Vocabulary
motion	movimiento
observe	observe
opaque	opaco
potential energy	energía potencial
predict	prediga
rubber band	liga o bandita elástica
ruler	regla
sound	sonido
spring scale	báscula
sun	sol
temperature	temperatura
thermometer	termómetro
translucent	translúcido
transparent	transparente
true	verdad
unit	unidad
vibrate	vibrar
vibrations	vibraciones
volume	volumen
water	agua
What happens when...	Que sucede cuando...





Lesson Procedures

ENGAGE

Everyday Energy

Time: Approximately 30 minutes

1. Distribute a copy of the Everyday Energy Anticipation Guide to each student.
2. Read aloud each statement on the guide. (Spanish translations are provided to support beginning ELs.)
3. Direct students to circle *Agree* if they think the statement is true and *Disagree* if they think the statement is false.
4. Inform students that they will review these statements later in the lesson to find out the answers.
5. Ask the students to write the following forms of energy in their journals, leaving space below each term to draw one or more pictures. You may want to use *motion* for *mechanical* until you define this term later in the lesson:
 - Light
 - Heat
 - Sound
 - Mechanical (Motion)
6. Tell students they will be going outside to look for examples of each type of energy. When they find one, they should draw a picture of it below the appropriate word in their journal. Inform students that they will have 10 minutes to find as many different examples as possible.

Materials

For the class

- Chart paper or whiteboard
- Markers

For each student

- Everyday Energy Anticipation Guide (see Resources section)
- Journal

7. Walk the students outside and ask them to sit in an area where they will be comfortable for 10 minutes. Remind them to be quiet so they can hear some of the examples of energy they will need for their journals.
8. After 10 minutes, walk the students back to class.
9. Draw a four-column chart as shown at right. Ask volunteers to share some of the examples of energy that they observed and documented while outside. List students' examples in the appropriate columns on the chart.
10. Ask the students if they saw any evidence of some changes energy may have caused. Then ask students why the examples of energy they observed are important to everyday life.

Light	Heat	Sound	Mechanical

English Language Support

- Model instructions explicitly to ensure that ELs are engaged and comprehend the tasks they are to perform.
- Provide ELs at the beginning and intermediate levels with Spanish translations of key terms. (Illustrated English-Spanish vocabulary cards for the four types of energy are available in the Resources section.)
- Ensure that ELs are engaged during the activity. You may want to have beginning and intermediate ELs work together.
- During discussion, allow ELs at the beginning and intermediate levels to respond in their native language or to draw their responses.

EXPLORE

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 review 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 Energy Center

Students observe that light must be present to see an object and that light follows certain patterns of behavior, such as travelling in a straight line, bouncing off shiny surfaces, and passing through clear liquids.

Materials

For each center

- Flashlight
- Index card (with hole punched in center)
- Small mirror
- Large resealable freezer bag
- Water

For each student

- Light Energy Center Instructions and Data Sheet

Heat Energy Center

Students measure the temperature of the inside of their closed hand and the temperature of ice in a freezer bag. In the process, students discover that the heat from their hand melts the ice in the bag.

Materials

For each center

- Heat Energy Center Instructions (see Resources section)
- Thermometer
- 2 resealable freezer bags
- 2 ice cubes (each in a freezer bag)
- Small ice chest (to store bagged ice cubes)
- Red pencil or marker

For each student

- Heat Energy Center Data Sheet (see Resources section)

Sound Energy Center

Students observe the sound vibrations that result from tapping a large metal spoon on a metal pot lid. Students also experience how sound vibrations travel through a solid, a liquid, and a gas.

Materials

For each center

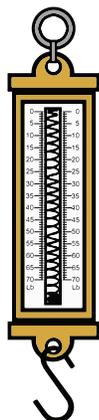
- Metal pot lid with handle
- Large metal spoon
- 3 large resealable freezer bags
- Small paperback book
- Water

For each student

- Sound Energy Center Instructions and Data Sheet (see Resources section)

Mechanical Energy Center

Students use a spring scale to observe and measure the amount of force needed to pull a large book across a table and then the amount of force needed to pull the same book with nine round pencils rolling underneath it.



Materials

For each center

- Mechanical Energy Center Instructions (see Resources section)
- Large book
- String (enough to tie crosswise around book with about 10 cm left)
- Spring scale
- 9 unsharpened pencils

For each student

- Mechanical Energy Center Data Sheet (see Resources section)

English Language Support

The activities in this section are highly engaging and provide excellent opportunities for ELs to learn abstract concepts, such as mechanical energy.

- For beginning and intermediate ELs, provide visual support of the materials at each center by pointing to each item and stating its English name (e.g., “This is a flashlight, thermometer, spring scale.”) 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 center procedure and monitor your pacing to ensure that ELs have enough time to process the information. Make intentional efforts to ask ELs questions to check for understanding.
- As ELs engage in each center activity, make intentional efforts to ask them questions. Ask ELs to demonstrate what they are learning as a formative assessment.
- Use language frames to encourage ELs to use academic language related to what they are learning (e.g., “In the light center, I learned that . . .”).

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. The teacher then provides additional activities to give students more experiences related to energy and to introduce new vocabulary.

Light Energy Center

1. Give one student from each group a flashlight. Ask the students to turn on the flashlights and place them in the middle of the group tables. Turn off the lights in the classroom for a moment, raise your hand, and ask students to look toward your hand. Then turn the lights back on. Ask:

 - Could you see my hand when the room lights were off?
Depending on the darkness of the room, most students will say no or just barely because of the flashlights.
 - Why was it hard to see when the classroom lights were off?
You cannot see objects in the dark.
 - What happens when you close your eyes? *No light can enter your eyes, so you cannot see anything.*
2. Raise your hand again and ask the students to aim their flashlights at your raised hand. Allow students a few moments to find and focus a beam of light on your hand.

 - Can you see my hand now? *Most students will be able to see your hand and the beams of light shining on it.*
 - What was needed for you to be able to see my hand? *Light, either from the overhead classroom lights or our flashlights.*
 - What must be present for us to be able to observe something with our eyes? *Light!*
 - What property of light did you discover when you used the flashlight and index card at the light center? *Light travels in straight lines.*
 - How did you realize that? *The light from the flashlight traveled in a straight line through the hole in the index card, creating a circle of light on a student's hand.*
 - What property of light did you discover when you turned on the flashlight and aimed it toward a mirror? *The light from the flashlight traveled in a straight line to the mirror and then bounced back or reflected off the surface of the mirror.*
 - How did you realize that? *The light could be seen on the wall or somewhere else in the classroom.*
 - What happened when you placed the bag of water behind the index card? *The light passed in*

Materials

For the class

- Chart paper or whiteboard
- Markers

For each group

- Flashlight

a straight line through the hole in the index card and then through the bag of water and made a spot of light on the table.

- What are the properties of water that allow light to pass through it? *Water is clear, transparent.*
- What do we call a material that allows only some light to shine through? *translucent*
- What do we call a material that does not allow any light to shine through? *opaque*
- What are some ways that you use light energy every day? List students' examples on the chart paper. Possible examples:
 - *Using light and the sense of sight to observe objects*
 - *Turning on the lights at school so we can read*
 - *Shining a flashlight in a dark place to find an object*
 - *Looking into a mirror when combing your hair*

Heat Energy Center

1. Hold a thermometer so that everyone in the classroom can see it.
2. Ask a student to come over and read aloud the temperature in degrees Celsius. *Depending on the room, it will read about 22–25°C.*
3. Ask students to refer to their Heat Energy Center Data Sheets and to raise their hand when they have found the temperature of their fist. Ask a student what the temperature was in degrees Celsius. *Human body temperature is normally about 37°C.*
 - Which was warmer, the ice, your fist, or the temperature of the room? Explain how you know. *fist; by comparing the two temperatures*
 - What would happen to the ice cube in the bag if we left it out in the room for several hours? *The ice cube would melt because the room is warmer than the ice cube, and heat energy from the room would move toward the cooler ice cube and cause it to melt.*
4. Direct students to rub their hands together quickly.
 - What did you observe when you rubbed your hands together? *My hands felt warmer or got hot when I rubbed them together.*
 - How could we measure how much warmer our hands are after we rub them together briskly? *with a thermometer*
5. Ask a student to rub his or her hands together quickly. Then have the student carefully hold the bulb of the thermometer in his or her fist. After about 20 seconds, have the student read the temperature in degrees Celsius. *Human body temperature is normally about 37°C, so the reading may be one degree or so warmer.*
 - Why was the temperature higher? *When things rub together, heat energy is often produced.*

Materials

For the class

- Thermometer
- Chart paper or whiteboard
- Markers

For each student

- Heat Energy Center Data Sheet (completed)

6. Tell students to consider again the ice cube in the bag at the heat center.
- What happened when you held the ice cube through the plastic bag? *My hand became colder, and the ice cube started to melt.*
 - What happened when you rubbed the ice cube through the plastic bag? *The ice cube began to melt faster.*
 - Why do you think that happened? *The heat energy from my hands moved toward the cooler ice cube, causing it to melt.*
 - What are some patterns we are observing about heat energy? *Heat energy can cause changes in matter, such as melting solid ice into liquid water. Heat moves from warmer areas to cooler areas. Rubbing causes heat energy to increase.*
 - What are some examples of movement of heat energy that we observe in everyday life? List students' examples on the chart paper. *Possible examples:*
 - *Heat from the sun on a hot day moves toward your frozen ice cream and melts it into a liquid.*
 - *Heat from a fireplace moves from the hot, burning logs out into a cold room, warming it up.*
 - *Heat from a burner on a stove heats a cool metal pan so we can melt butter and cook scrambled eggs.*
 - *Heat from a dryer moves into wet clothes to dry them.*

Sound Energy Center

1. Tap the metal pot lid with the metal spoon. Ask:
 - What did you observe when you tapped the metal lid with the spoon? *The lid shook or vibrated. It made a loud noise.*
 - What happened when you held the lid with your hands? *The metal lid stopped shaking or vibrating. The noise stopped.*
 - When does sound energy occur? *Sound energy occurs when matter vibrates.*
2. Hold up the three freezer bags from the sound center. Ask students the following questions about the physical properties of the contents of each bag and how the tapping of the spoon sounded through each state of matter.
 - What are the properties of the book? *The book is a solid and has pages.*
 - Why did we place the solid book in a freezer bag? *So all of the objects would be tested in the same container to make the test fair.*
 - How did the tapping sound when your ear was held against the solid book? *The taps sounded very loud and close together.*
 - What are the properties of the water in the second freezer bag? *The bag and the water are both clear. The water is a liquid and moves to take the shape of the bag.*

Materials

For the class

- Metal pot lid with handle
- Large metal spoon
- Large resealable freezer bag containing small paperback book
- Large resealable freezer bag containing water
- Large resealable freezer bag inflated with air
- Chart paper or whiteboard
- Markers

- How did the tapping sound when your ear was held against the bag of liquid water? *The taps sounded very loud and close together.*
- What are the properties of the air in the third bag? *The bag and the air are both clear. The air is a gas and fills the shape of the bag.*
- How did the tapping sound when your ear was held against the bag filled with air? *The taps sounded softer and farther apart.*
- Based on your results, sound travels faster and louder through which states of matter? *solids and liquids*
- Through which state of matter do sounds travel more slowly? *air or gases*
- What are some examples of sound energy that we observe in everyday life? List students' examples on chart paper. Possible examples:
 - *The sound from a loud speaker in a car causes vibrations that you can hear and sometimes feel.*
 - *Some musical instruments produce sounds when they are struck, such as a drum or a xylophone.*

Mechanical Energy Center

1. Give a ball a push across a desktop so that all the students can observe the ball roll.
2. Using the book and string from the mechanical energy center, demonstrate pulling the book across a desktop. Then demonstrate pulling the book with several round pencils underneath it. Ask:
 - What is a push or a pull? *A push or a pull is a force.*
 - What happened when a pushing force was applied to the ball? *The ball began to roll or move across the desk.*
 - What happened as a pulling force was applied to the book? *It began to move across the desk.*
 - Did it seem harder to pull the book with or without the round pencils rolling underneath it? *It was much easier to pull the book with the pencils rolling underneath it.*
 - How can we measure the pulling force needed to make the book move? *with a spring scale*
3. Use a spring scale to pull the book across the desk. Ask a student to read the number on the scale.
4. Explain that force is measured in newtons, which is why the spring scale has an *N* next to the measurement scale. At this age, students need only to recognize that a spring scale is a tool used to measure the force needed to move an object.

Materials

For the class

- Small ball
- Large book tied with string
- Spring scale
- 9 unsharpened pencils
- Chart paper or whiteboard
- Markers

For each student

- Mechanical Energy Center Data Sheet (completed)

5. Place 4–5 pencils under the book and pull the book with the spring scale again. Ask another student to read how many newtons it took to move the book.
- What was the difference? *Answers will vary.*
 - What do the pencils under the book remind you of? *wheels*
 - What are some other objects with wheels that we see every day? *Cars, trucks, motorcycles, bikes, wheelchairs, and trains are possible examples.*
 - What are objects with wheels designed to do? *move in some way*
 - Look at your data sheet for the center where you pulled the book and tell me the name of the center. *Mechanical Energy*
 - What do you think mechanical energy might be? *Guide the students to realize that mechanical energy is the energy an object or material has because of its motion or position and is the sum of potential energy (stored) and kinetic energy (energy in motion).*
 - Does an object need to have wheels to have mechanical energy? *No, an object has mechanical energy when it is moving, with or without wheels. The book moved when it was pulled across the desk even without the pencils under it.*
 - What are some other examples of mechanical energy? Possible examples:
 - *Wind-up toys*
 - *Spinning tops*
 - *Swinging on a swing set*
 - *A turning merry-go-round*
 - *A swimmer in the water*
 - *Someone riding a skateboard*
 - What are some examples of mechanical energy that we observe in everyday life? List students' examples on the chart paper. Possible examples:
 - *We ride a bike by pushing on the pedals to move it forward.*
 - *A bird flying in the sky pushes on the air with its wings.*
 - *Cars move fast because an engine pushes them along on wheels.*
 - *We have mechanical energy when we run or walk.*
 - *Stirring a pot of soup is movement of a spoon in a liquid.*
 - *A pencil sharpener has mechanical energy when you make it move by pushing on the handle.*

Energy in Our Classroom

As a review and application of the concepts discussed, direct students to design a graphic organizer (such as a multi-column T-chart) to classify and record the forms of energy they see in their classroom. Some examples of what students may identify are provided below:

Possible Responses

Light	Heat/Thermal	Sound	Mechanical
desk lamp	hot plate	speaker/ announcements	pencil sharpener
projector	heat vents	computer	students walking
sunlight/windows	window pane	students talking	fan

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 happened when you rubbed the ice cube through the plastic bag?"
- Watch your pacing (use a slower rate of delivery) as you ask questions and guide discussion.
- Provide wait time after asking questions to give ELs enough time to process the information.
- Provide ELs with opportunities to speak and engage by asking them recall questions and by using language frames (e.g., "The book _____ when I pulled it.>").
- 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

Part I: More About Mechanical Energy

Time: Approximately 45 Minutes

- Recap the Explore and Explain portions of the lesson involving mechanical energy.
 - What is mechanical energy? *the energy an object or material has because of its motion or position; the sum of potential energy and kinetic energy*
 - What are some examples of mechanical energy? *Answers may include those listed in the Explain portion of the lesson.*
- Tell students, "We are going outside to feel some examples of mechanical energy. We do not need any paper, but I want you to listen carefully as I describe what we are going to do. I want you to stay in your center groups and quietly walk to the swings in the playground. I will select one person to sit in a swing, and everyone else is to stand quietly nearby until I tell you what to do next."
- Walk the students to the swings outside.
- Instruct the students to watch you before doing anything.
- Select one student to sit in a swing. Standing behind the swing, hold the chains and pull the child back slightly.
- Direct the groups to do the same thing. One student in each group is to sit in a swing, and another group member is to stand behind the swing and use its chains to pull it back slightly.
- Ask students what they feel. *Answers will likely be the weight of the student in the swing.*
- Direct students to let go of the chains. Ask what happened. *The swing swung forward slightly.*
- Direct the other group members to take turns doing the same activity until every student has had a chance to pull a swing back.
- After everyone has had a turn, demonstrate pulling a student back on a swing again. This time, when the swing is pulled back, tell students it has *potential energy*.
 - When someone says you have a lot of potential, what does that mean? *You could do a lot.*
- Explain that you mean the same thing; there is *potential* for the swing to do something. Let go of the swing. As you do, point out that the potential was for movement.
- Tell students this kind of movement is called *kinetic energy*.
- Repeat that when the swing is pulled back, there is potential energy. When the swing is let go and it begins to move, there is kinetic energy.

Materials

For the class

- Playground with swings
- Computer with Internet access
- Data projector and screen
- PhET pendulum simulation: http://phet.colorado.edu/sims/pendulum-lab/pendulum-lab_en.html

For each group

- 1–2 wind-up toys (e.g., car, animal)

For each student

- Journal

14. Take students inside. Using a computer that has Internet access and is attached to a projector, display the PhET pendulum simulation for the class to see: http://phet.colorado.edu/sims/pendulum-lab/pendulum-lab_en.html.
15. To start the simulation, place the mouse cursor on the blue weight and hold down the mouse button as you “pull” the weight to one side. Then release.
16. After a few swings, hit pause when the weight is at the peak of a swing.
 - What kind of energy do we have here? *potential energy*
17. Press play to restart the swing.
 - What kind of energy do we have while the blue weight is swinging down? *kinetic energy*
18. Depending on the level of understanding of your students, you may want to discuss that while the weight is swinging up, potential energy is being built. And when the weight is swinging down, the potential energy is turning into kinetic energy.
19. If time permits, give each group of students one or two wind-up toys, such as wind-up cars or animals. Give students a few minutes to wind up the toys and let them roll around.
 - When do you see potential energy? *when the toy is wound up*
 - When do you see kinetic energy? *when the toy is rolling*
20. Ask students if they can think of other toys that use mechanical energy. *Examples include a spinning top, a bobble head toy, and a jack-in-the-box.*
21. Ask students to draw in their journals one of their favorite examples of mechanical energy and to label where we would see potential and kinetic energy in the example.

Part II: Temperature

Time: Approximately 45minutes

1. Using a computer that has Internet access and is attached to a projector, display the Math Is Fun! interactive thermometer for the class to see: <http://www.mathsisfun.com/measure/thermometer.html>.
2. Below the interactive thermometer, select “View Larger” to display a larger version.
3. Ask students to predict what the temperature of boiling water would be in Fahrenheit and in Celsius. Have them write their predictions in their journals.
4. Use the interactive thermometer to show students the temperature of boiling water (100°C).
5. Ask students to predict the temperature of ice in Fahrenheit and in Celsius and to write their predictions in their journals.

Materials

For the class

- Computer with Internet access
- Data projector and screen
- Math Is Fun! interactive thermometer:
<http://www.mathsisfun.com/measure/thermometer.html>

For each student

- Diagrams 1–4 (see Resources section)
- Journal

6. Again, use the interactive thermometer to show students the wide range of temperatures for ice (about 2° to -3°C).
7. Repeat this activity for a hot desert, hot coffee, a cool day outside, a snowy day, and a very cold day.
8. Each time, explore the range of temperatures for that case.
9. Discuss that most people in the United States use Fahrenheit. For example, weather reporters often report daily temperatures in Fahrenheit. However, scientists and many other countries use the Celsius scale. So it is helpful to know about both scales.
10. Organize the students into groups of two to three.

Give each student a copy of Diagrams 1–3, available in the Resources section. (Wait to give the students Diagram 4.) Instruct students to examine Diagram 1: Celsius Scale, Freezing to Boiling. Ask students to work in their groups to find the halfway point on the Celsius scale between freezing and boiling. *50 degrees Celsius*

11. Instruct students to look at Diagram 2: Fahrenheit Scale. Ask the groups to find the halfway point between 5 and 25 degrees Fahrenheit. *15 degrees Fahrenheit*
 - This task should prove to be more of a challenge. If students struggle, ask them leading questions, such as how far it is from 5 to 10 and from 5 to 15, or how many segments are between 5 and 25 (four; half of four is two; two segments from either 5 or 25 is 15).
 - Keep students on track. Also, ensure they start counting from 5, not zero.
 - Ask the students what the weather is like at 50 degrees Celsius. They may need to refer to their journals for some hints. *very hot*
 - Ask them what a close estimate of the same temperature is in Fahrenheit. *120 degrees Fahrenheit*

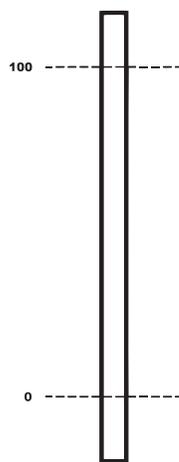


Diagram 1



Diagram 2

12. Have students examine Diagram 3: Fahrenheit Scale, Freezing to Boiling. Ask students to work in their groups to find the halfway point on the Fahrenheit scale between freezing and boiling.
122 degrees Fahrenheit
13. This task should prove to be more of a challenge. If students struggle, give them a copy of Diagram 4: Fahrenheit Scale, Freezing to Boiling Distance.
 - Diagram 4 will help give students the idea that they need to subtract 32 from 212 to determine the distance in Fahrenheit degrees from freezing to boiling.
 - Once they determine that the difference is 180, remind the students they are not finished.
 - Ask them how much half of 180 is and why we need half of that amount. Their experience doing the same task with the Celsius scale should provide students with the knowledge to divide 180 by 2 to get 90.
 - Ask the students if 90 is their answer. Wait for one child to say no and to explain why. *Because they are not starting at zero, 90 tells them how many degrees from either the freezing or the boiling point they must go to find the happy medium.*
 - Allow the groups to determine the midpoint between the two temperatures.
 - Then ask them how they got their answer. *It would be simpler to start at 32 and add 90 to get to the final solution of 122. If students struggle, refer them back to their process in Task 1 and Task 2.*
 - Ask the students what it is like at 122 degrees Fahrenheit. Again students may refer to their journals for a hint. *very hot*
 - What would be a close estimate of the same temperature in Celsius? *50 degrees Celsius*

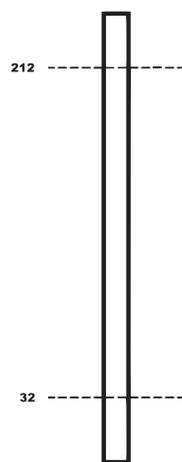


Diagram 3

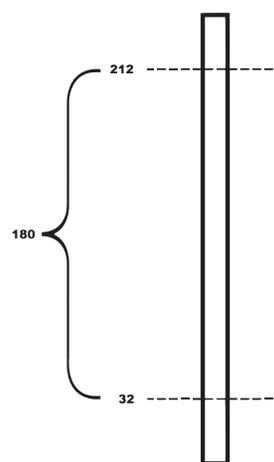
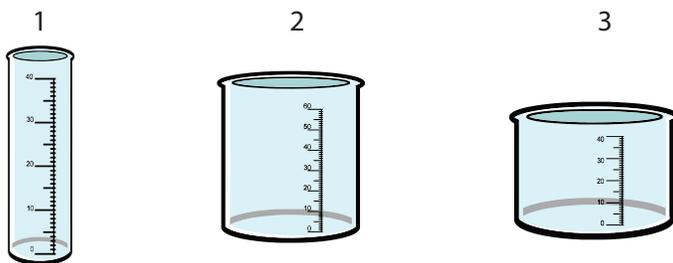


Diagram 4

Part III: States of Matter and Capacity

Time: Approximately 30 minutes

1. Set an ice cube in a clear container, and place the container where all the students can see it. Ask the students to make a drawing of the container in their journals.
2. Ask one student to take the temperature of the ice cube and tell the rest of the class so they can record it in their journals.
3. Place three empty containers of different shapes on a demonstration table. The volume of water that fills Container 1 to the highest mark should also fit into Containers 2 and 3. Three possible shapes to use are shown.



Materials

For each group

- 1 clear container
- 3 different-shaped clear containers with measurements on the side (e.g., graduated cylinders)
- Thermometer
- Ice cube
- 4 Unifix® cubes (1x1x1)
- Water

For each student

- Journal

4. Fill Container 1 with water up to the highest mark. Have students record the volume of water in their journals.
5. Pour the water from Container 1 into Container 2. Again, have students record the volume of water in their journals. Repeat the process with Container 3.
6. Ask students about the volume of water. They should have seen the pattern that the recorded volume was the same in each case—in other words, the volume remained constant. Take time to review the meaning of the term *constant* in mathematics.
7. Ask students about the form or shape of the water. *Students should respond that a liquid, such as water, takes on the shape of its container.*
8. Ask students about the location of the matching markings (such as 10 ml) on each of the containers. *Students should notice that the distance between the marks is different on the different containers.* Ask students why this is the case.
9. Lead students to the idea that the distance between the marks differs because each container has a different cross-sectional area (explain this idea without using that terminology).
 - One approach is to physically model the concept by using small Unifix® cubes of the same size, preferably 1x1x1.
 - Start by stacking four cubes one on top of the other to model Container 1 (1x1x4). Have students compare the height with the area across.
 - Then make a stack with two cubes on the bottom and two on the top to represent Container 2 (2x1x2). Again, have students compare the height with the area across.

- Last, place all four cubes together at ground level (2x2x1) and repeat the process. Students should conclude that the marks on a container used for measurement of liquids can vary depending on the shape of the container.
- 10. Refer back to the container with the ice cube after the ice has completely melted. Ask what happened to the ice. *It melted.*
- 11. Ask another student to take the temperature of the melted ice cube.
- 12. Ask students if there is less volume in the container now. *No, the water just took the shape of the container when it melted.*
- 13. Ask what caused the ice cube to melt. *heat energy*

Part IV: Reflection

Time: Approximately 15 minutes

Ask students to review their answers on the Everyday Energy Anticipation Guide from the Engage part of the lesson. Ask if they would like to change any of their answers now and why. After students respond, go over the answers with the class. (See the Everyday Energy Anticipation Guide Answer Key in the Resources section.)

Materials

For the class

- Everyday Energy Anticipation Guide Answer Key (see Resources section)

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 activities, explicitly model demonstrations, questions, and discussions by using realia (real objects), body gestures, and visuals.
- Provide a word bank with examples for key vocabulary. (Illustrated English-Spanish vocabulary cards for selected terms are available in the Resources section.)
- Provide ELs with opportunities to speak and engage by asking them recall questions and by using language frames
- Provide wait time to give ELs enough time to process information.
- 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. . .”).
- Consistently check for understanding and clarify any misconceptions or misinterpretations.
- Summarize the key points before wrapping up this part of the lesson.

EVALUATE

Two group projects for assessing student understanding are provided below. Teachers may want to allow groups to choose the project they prefer. In addition, teachers may elect to have each student complete the multiple-choice assessment to help prepare for the state assessment.

Group Project 1

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 short 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. Ask each group to include the following forms of energy—light, heat, sound, and mechanical—in its story.
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 each form of energy 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 on the next page (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 1 Rubric (see Resources section)
- Computer with Internet access
- Storytelling website such as <http://www.storybird.com>

	1-Needs Improvement	2-Satisfactory	3-Excellent
Energy	The four forms of energy are not included.	The four forms of energy are included, but an example of how each one causes change is not.	The four forms of energy are included as well as at least one example of how each one causes change.
Measurement	No measurements are included, or no explanation is given as to why no measurements are included.	One or more of the forms of measurement included is inappropriate (e.g., time for length).	The units of measurement included are used correctly, or an reason 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.

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. Students will work in their groups to create an electronic presentation (such as a computer slide show) illustrating how the four types of energy are used in a playground or at a resort.
2. Explain to the students that their group is going to design the best playground or resort that has ever been made. They will then use a combination of text and images to create a presentation about their playground or resort. (Students might use digital cameras to take photos or gather images from magazines or the Internet.)
3. The presentation should address each of the following features, which the playground/resort should have:
 - The right climate and temperatures (Celsius and Fahrenheit) for winter and summer activities
 - A place where at least one form of matter (solid, liquid, or gas) changes state
 - At least four activity areas that illustrate at least one of the four forms of energy studied: light, heat, sound, and mechanical
 - Models that indicate the volume of at least four buildings or recreational areas and how those measurements were determined

Materials

For each group

- Group Project 2 Rubric (see Resources section)
- Computer (Internet access optional)
- Presentation software
- Books with information about energy that are age appropriate
- Magazines that can be used for images
- Image scanner (optional)
- Digital camera (optional)

LESSON PROCEDURES: EVALUATE

4. 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.
5. Monitor the groups while they work to check their progress, provide feedback, review expectations, and offer assistance or guidance.
6. Have each group share its presentation with the class.

	1-Needs Improvement	2-Satisfactory	3-Excellent
Temperatures	Climate temperatures are not shown in C and F or are unrealistic for three to four seasons.	Reasonable climate temperatures are shown in C and F for two to three seasons (or two to three temperatures are unrealistic)	Reasonable climate temperatures are shown in C and F for all four seasons.
States of Matter	No change in a state of matter is included.	A change in a state of matter is included but is not realistic or accurate.	A change in a state of matter is realistically illustrated.
Forms of Energy	Illustrations or examples include a realistic use of two or fewer forms of energy.	Illustrations or examples include a realistic use of three forms of energy.	Illustrations or examples include a realistic use of all four forms of energy.
Comparisons	Illustrations or examples include the volume of no more than one building or recreational area and accurately show how it was determined.	Illustrations or examples include the volume of two to three buildings or recreational areas and accurately show how each was determined.	Illustrations or examples include the volume of four buildings or recreational areas and accurately show how each was determined.

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 (e.g., arrange the pictures in order from coldest to hottest)

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

Everyday Energy

Teacher Preparation: Make a copy of the Everyday Energy Anticipation Guide for each student.

For the class

- Chart paper or whiteboard
- Markers

For each student

- Everyday Energy Anticipation Guide
- Journal

EXPLORE

Light Energy Center

Teacher Preparation: Make a copy of the Light Energy Center Instructions and Data Sheet for each student (laminated one copy for the center). Prepare the index card and fill a freezer bag with water.

For each center

- Flashlight
- Index card (with hole punched in center)
- Small mirror
- Large resealable freezer bag
- Water

For each student

- Light Energy Center Instructions and Data Sheet

Heat Energy Center

Teacher Preparation: Copy and laminate the Heat Energy Center Instructions and make a copy of the data sheet for each student. Place an ice cube in two freezer bags and store in a small ice chest.

For each center

- Heat Energy Center Instructions (laminated for repeated use)
- Thermometer
- 2 resealable freezer bags
- 2 ice cubes (each in a freezer bag)
- Small ice chest (to store bagged ice cubes)
- Red pencil or marker

For each student

- Heat Energy Center Data Sheet

Sound Energy Center

Teacher Preparation: Make a copy of the Sound Energy Center Instructions and Data Sheet for each student (laminates one copy for the center). Place a paperback book in one large freezer bag, partially fill a second bag with water, and inflate a third bag with air.

For each center

- Metal pot lid with handle
- Large metal spoon
- 3 large resealable freezer bags
- Small paperback book
- Water

For each student

- Sound Energy Center Instructions and Data Sheet

Mechanical Energy Center

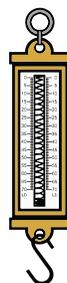
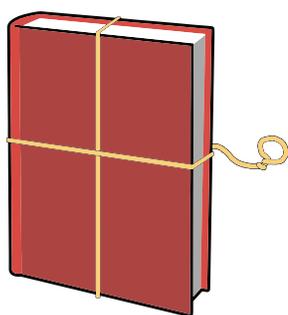
Teacher Preparation: Copy and laminate the Mechanical Energy Center Instructions and make a copy of the Mechanical Energy Center Data Sheet for each student. Tie a string crosswise around a large book, as if you were tying ribbon around a package (see example), so that the string holds the book securely when pulled. With the excess string, create a loop (remove any string beyond the loop). Students will use the loop to drag the book across a table. They will then attach the loop to the hook of a spring scale and use the scale to drag the book.

For each center

- Mechanical Energy Center Instructions
- Large book
- String (enough to tie crosswise around book with about 10 cm left)
- Spring scale
- 9 unsharpened pencils

For each student

- Mechanical Energy Center Data Sheet



EXPLAIN

For the class:

- Materials from light, heat, sound, and mechanical energy centers
- Chart paper or whiteboard
- Markers
- Small ball

ELABORATE

Part 1: More About Mechanical Energy

Teacher Preparation: In advance, access the PhET Interactive Simulations website and familiarize yourself with the pendulum simulation. Ensure that you can project the simulation onto a screen for the class to see.

For the class

- Playground with swings
- Computer with Internet access
- Data projector and screen
- PhET pendulum simulation: http://phet.colorado.edu/sims/pendulum-lab/pendulum-lab_en.html

For each group

- 1–2 wind-up toys (e.g., car, animal)

For each student

- Journal

Part II: Temperature

- Teacher Preparation: In advance, access the Math Is Fun! website and familiarize yourself with the interactive thermometer. Ensure that you can project this webpage onto a screen for the class to see. Prior to class, copy Diagrams 1–4 for each student.

For the class

- Computer with Internet access
- Data projector and screen
- Math Is Fun! website: <http://www.mathsisfun.com/measure/thermometer.html>

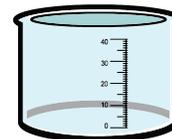
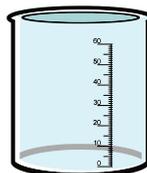
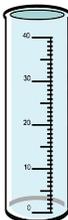
For each student

- Diagrams 1–4
- Journal

Part III: States of Matter and Capacity

For each group

- 1 clear container
- 3 different-shaped clear containers with measurements on the side (e.g., graduated cylinders)
- Thermometer
- Ice cube
- 4 Unifix® cubes (1x1x1)
- Water



For each student

- Journal

Part IV: Reflection

- Everyday Energy Anticipation Guide Answer Key

EVALUATE

Group Project 1

For each group

- Group Project 1 Rubric
- Computer with Internet access
- Collaborative storytelling website such as <http://www.storybird.com>

Group Project 2

For each group

- Group Project 2 Rubric
- Computer (Internet access optional)
- Presentation software
- Books with information about energy that are age appropriate
- Magazines that can be used for images
- Image scanner (optional)
- Digital camera (optional)

Individual Assessment

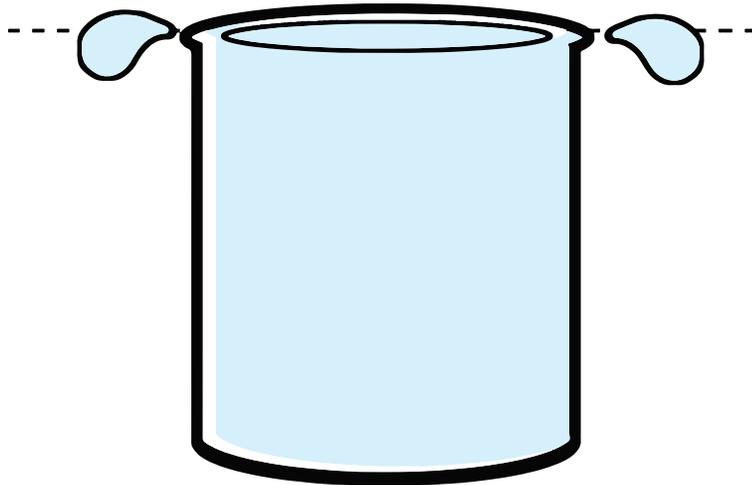
For each student

- Energy Assessment
- 2 pencils

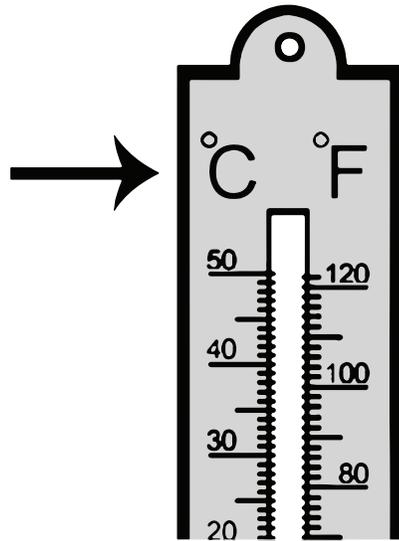
Frequent English/Spanish Vocabulary Words



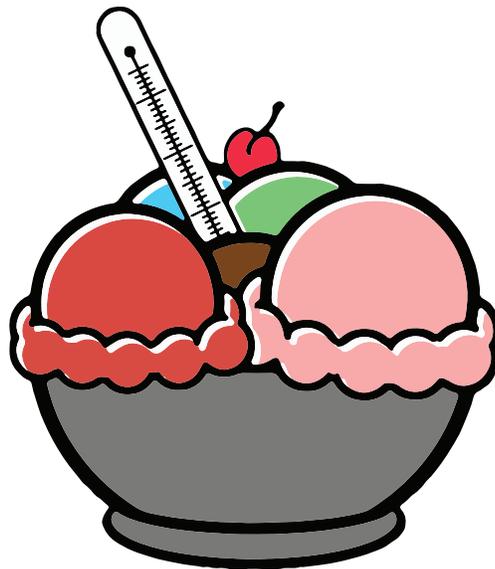
**basketball /
pelota de basquetbol**



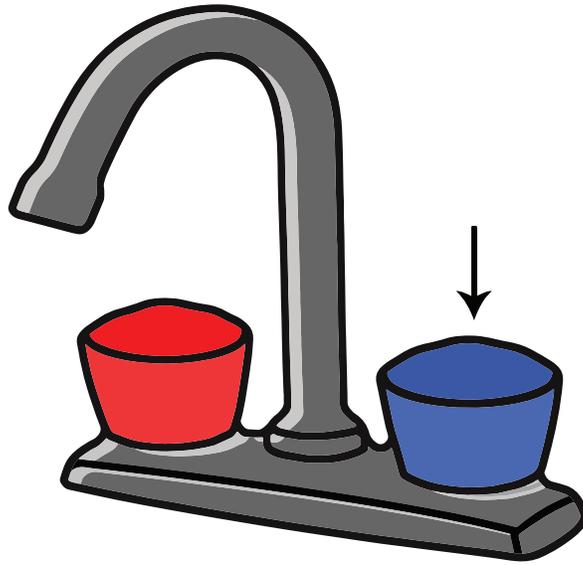
capacity / capacidad



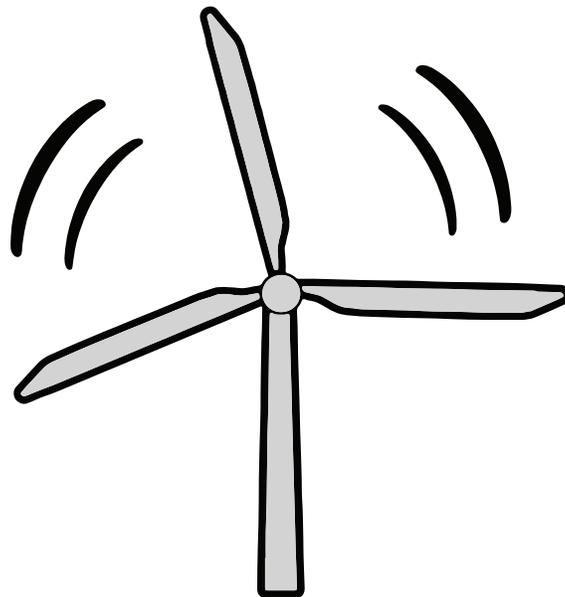
Celsius / Celsio



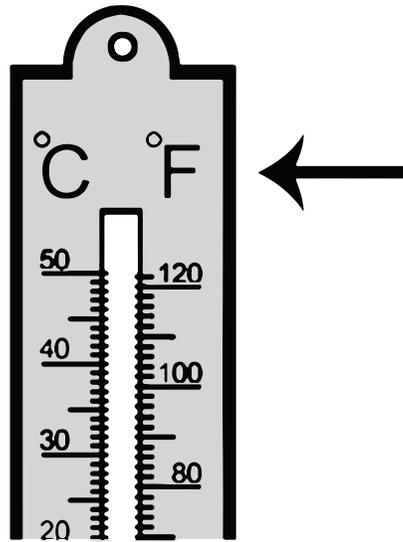
cold / frio



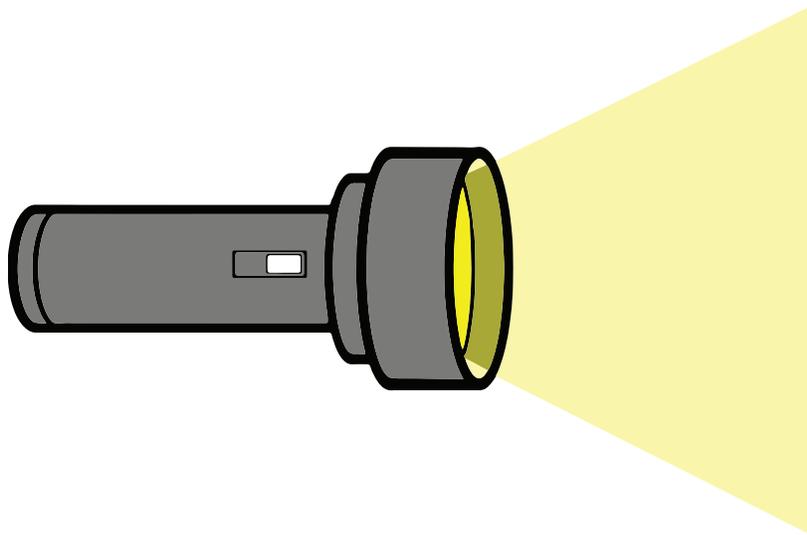
cold water / agua fría



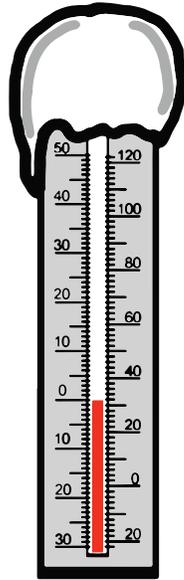
energy / energía



Fahrenheit / Fahrenheit



flashlight / linterna



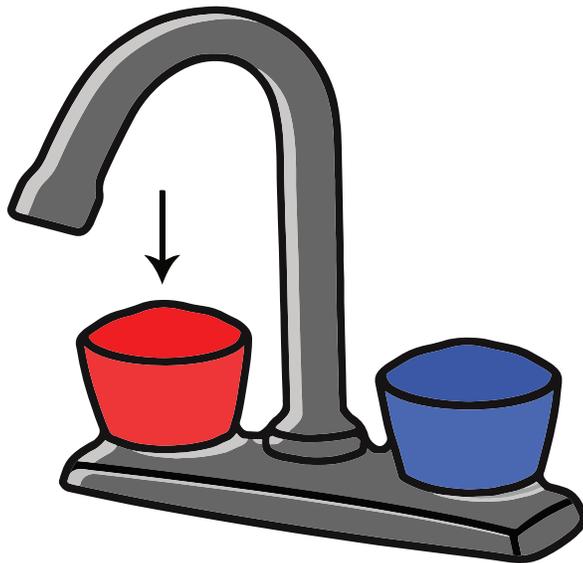
freeze / congelar



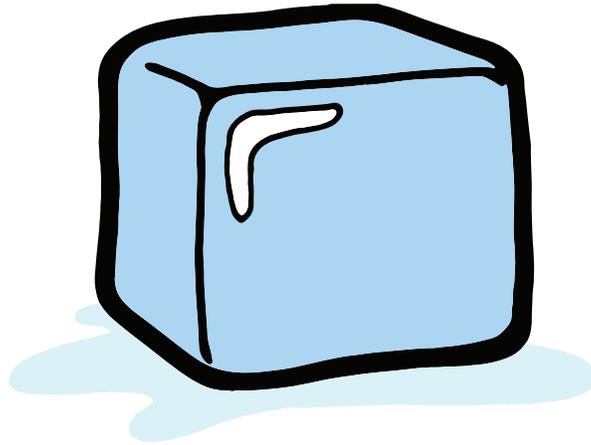
heat / calor



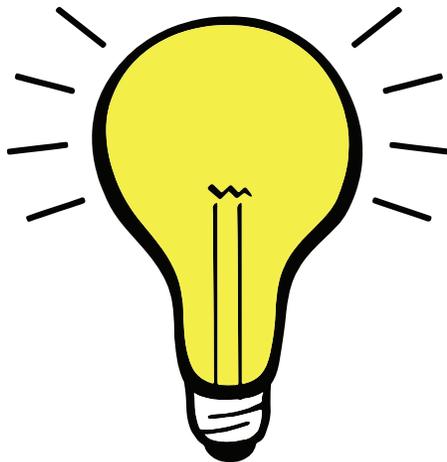
hot / caliente



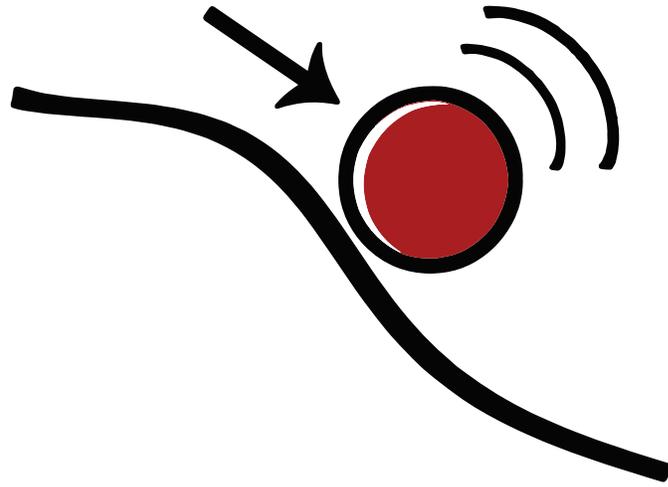
hot water / agua caliente



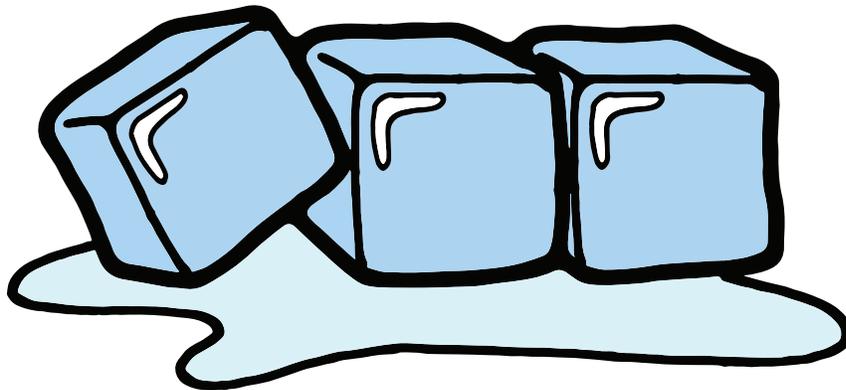
ice cube / cubo de hielo



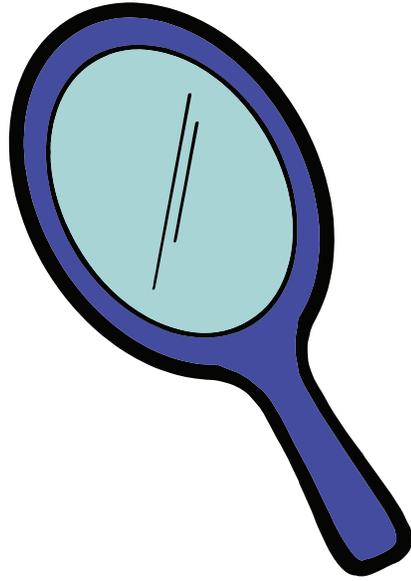
light / luz



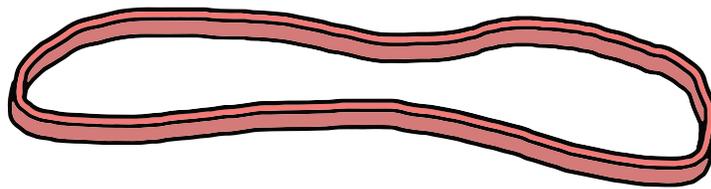
**mechanical energy /
energía mecánica**



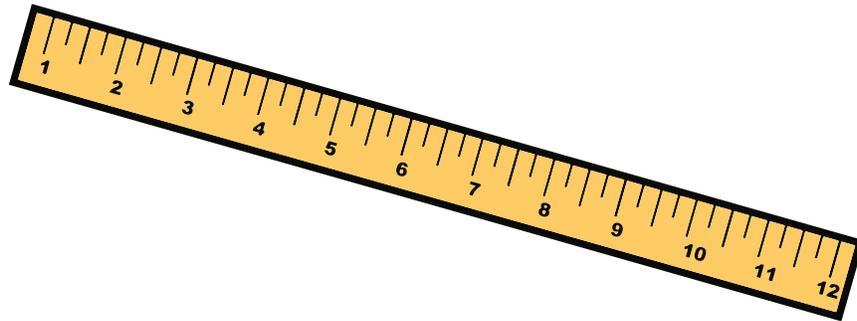
melt / derretir



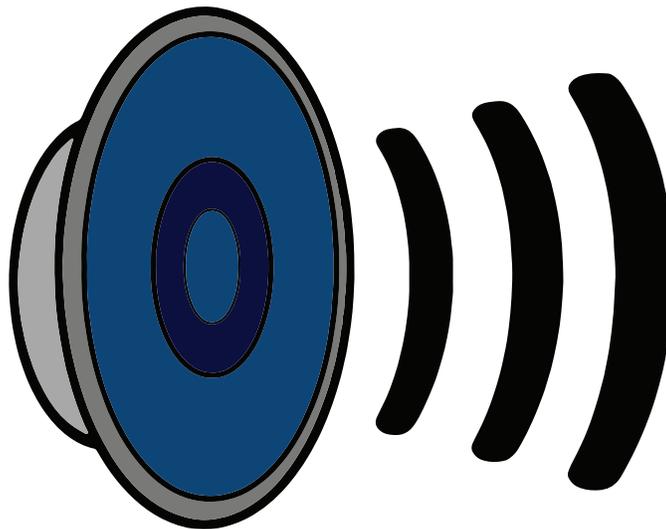
mirror / espejo



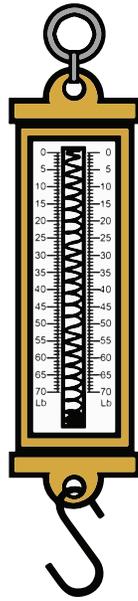
**rubber band /
liga o bandita elástica**



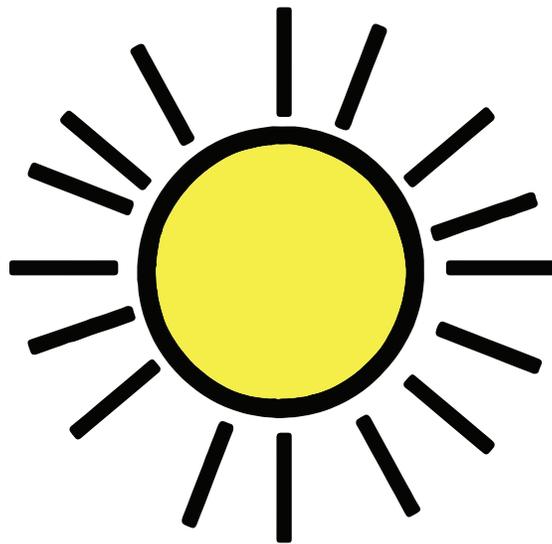
ruler / regla



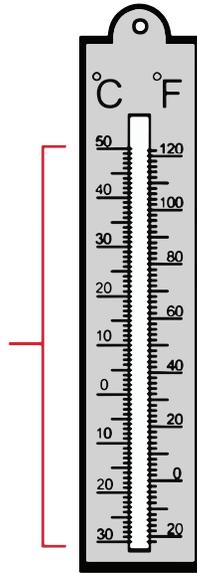
sound / sonido



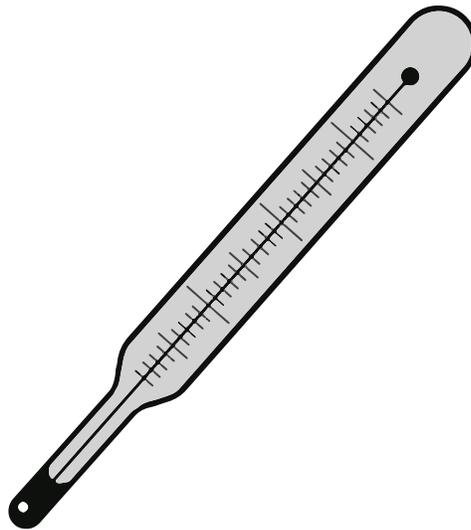
spring scale / báscula



sun / sol



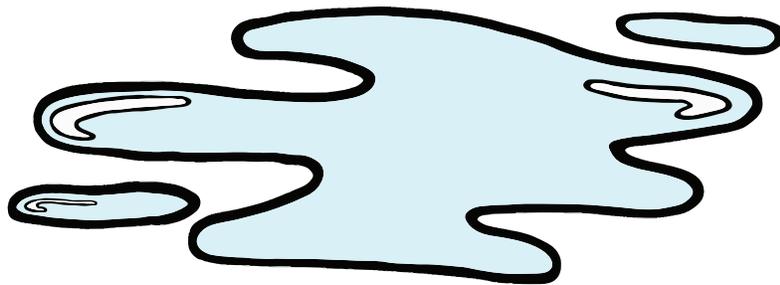
temperature / temperatura



thermometer / termómetro



vibrate / vibrar



water / agua

Everyday Energy Anticipation Guide

Circle **Agree** for statements you believe are true. Circle **Disagree** for statements you believe are false. (true/*verdad*, false/*falso*)

- | | | |
|--------------|-----------------|--|
| Agree | Disagree | 1. There are many forms of energy.
(Hay muchas formas de energía.) |
| Agree | Disagree | 2. Light energy travels in straight lines.
(La energía ligera viaja en líneas rectas.) |
| Agree | Disagree | 3. You cannot see without light energy.
(Usted no puede ver sin energía ligera.) |
| Agree | Disagree | 4. Vibrating objects produce sounds.
(Sonidos vibrantes del producto de los objetos.) |
| Agree | Disagree | 5. Sound energy can travel through solids, liquids, or gases.
(La energía sana puede viajar a través de los sólidos, de los líquidos, o de los gases.) |
| Agree | Disagree | 6. A moving ball has mechanical energy.
(Una bola móvil tiene energía mecánica.) |
| Agree | Disagree | 7. Heat is not a form of energy.
(El calor no es una forma de energía.) |
| Agree | Disagree | 8. People use different forms of energy every day.
(La gente utiliza diversas formas de energía diarias.) |

Light Energy Center Instructions and Data Sheet

Name _____ Date _____

Read all the steps before you begin the investigation.

1. Hold your hand up at eye level. Look at your hand.
2. Close your eyes. Open your eyes. When could you see your hand?
3. Pick up the index card with the hole in the center.
4. Turn on the flashlight. Aim the flashlight through the hole in the index card and toward the palm of another group member's hand, as shown below.



- What do you observe on the hand?

Light Energy Center Instructions and Data Sheet, continued

- Why do you think that happens?
- 5.** Aim the lit flashlight through the index card toward the mirror.
- What do you observe?

 - Why do you think that happens?
- 6.** Aim the lit flashlight through the index card toward the bag filled with water.
- What do you observe?

 - Why do you think that happens?
- 7.** Now aim the lit flashlight through the index card and the bag filled with water to the palm of your hand.
- What do you observe?

 - Why do you think that happens?
- 8.** Look at yourself in the mirror.
- What do you see?

 - Why do you think that happens?

Heat Energy Center Instructions

Read all the steps before you begin the investigation. Record your observations on the Heat Energy Center Data Sheet.

1. Note the temperature on the thermometer before you hold it. Record the temperature on the data sheet.
2. Hold the bulb of the thermometer inside your fist for 1 minute.
3. Record the temperature on the thermometer by marking it on the data sheet thermometer in red.
4. Open the cooler and remove the bag with the ice cube inside. Place the thermometer next to the bagged ice cube for 1 minute.
5. Record the temperature on the data sheet thermometer in red.
6. Rub your hands together quickly. Then place your hands around the bagged ice cube. Count to 20.
7. What do you observe? Why do you think that happens? Record your answers on the data sheet.
8. Put the bag with the ice cube back in the cooler.
9. Leave your station clean, neat, and dry.

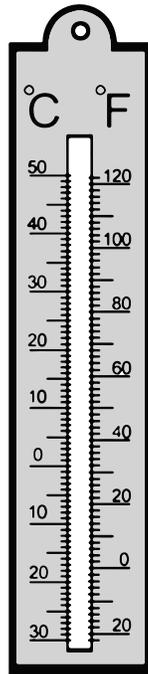
Heat Energy Center Data Sheet

Name _____ Date _____

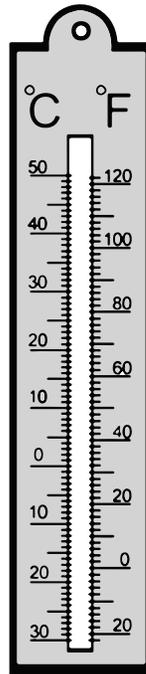
Follow the instructions at the heat energy center.

1. What is the temperature on the thermometer before you hold it? Record the temperature below in degrees Celsius.

2. Mark the thermometers in red to show the temperature of the inside of your fist and of the bagged ice cube.



Inside fist



Ice in bag

Heat Energy Center Data Sheet, continued

3. The arrow shows how heat energy moves from warmer objects to cooler objects.



Draw a picture that shows how the heat energy from your hand changed the ice in the bag.

4. What caused the temperature on the thermometer to change after you held it in your fist?
5. What caused the temperature on the thermometer to change after you held it next to the ice?
6. What did you observe after you held the bag of ice for 20 seconds? Why do you think that happened?
7. What caused the change in the properties of the ice cube as it changed from a cold solid to liquid water?

Sound Energy Center Instructions and Data Sheet

Name _____ Date _____

Read all the steps before you begin the investigation.

1. Hold the metal lid by its handle.
2. Tap the metal lid with the spoon.
 - What do you observe?

 - Why do you think that happens?
3. Repeat steps 1 and 2. Lay down the spoon and quickly hold the lid with your hand.
 - What do you observe?

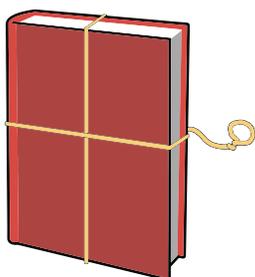
 - Why do you think that happens?
4. Place the book in the bag on the desk and then place your ear on it while a group member taps on the desk next to the book with a metal spoon.
5. Place the bag of water on the desk and then place your ear on it while a group member taps on the desk next to the bag with a metal spoon.
6. Place the bag of air on the desk and then place your ear on it while a group member taps on the desk next to the bag with a metal spoon.

Discuss with your group:

1. What happened to the lid after it was struck with the spoon?
2. Which material allows the fastest travel of sound? How do you know?
3. Which material allows the slowest travel of sound? How do you know?

Mechanical Energy Center Instructions

Read all the steps before you begin the investigation. Record your observations on the Mechanical Energy Center Data Sheet.



1. Locate the book tied with string. Put your finger in the loop of string and gently pull the book 4 or 5 inches toward yourself. Record on the data sheet what you observe.
2. Place the hook on the spring scale into the loop of string.
3. Use the scale to gently pull the book toward yourself. As you pull the book, observe the reading on the scale. The reading shows the amount of mechanical energy used to pull the book. Record the amount.
4. Remove the loop of string from the scale.
5. Line up pencils under the book so that the book no longer touches the table and can move easily.
6. Put your finger in the loop of string and gently pull the book 4 or 5 inches toward yourself. Record what you observe.
7. Keep the book on the pencils. Place the hook on the spring scale into the loop of string. Use the scale to gently pull the book toward yourself. As you pull the book, observe the reading on the scale. Record the amount.
8. Complete the rest of your data sheet.
9. Leave your station clean and neat.

Mechanical Energy Center Data Sheet

Name _____ Date _____

Follow the instructions at the mechanical energy center.

1. **Draw and Label.** What did you observe when you used your finger and the string to pull the book?

2. What amount did the spring scale show when you used the scale and the string to pull the book? Record the amount below.

Draw and Label. What did you observe?

3. **Draw and Label.** What did you observe when you put the book on pencils and used your finger and the string to pull the book?

Mechanical Energy Center Data Sheet, continued

4. What amount did the spring scale show when you pulled the book on pencils?
Record the amount below.

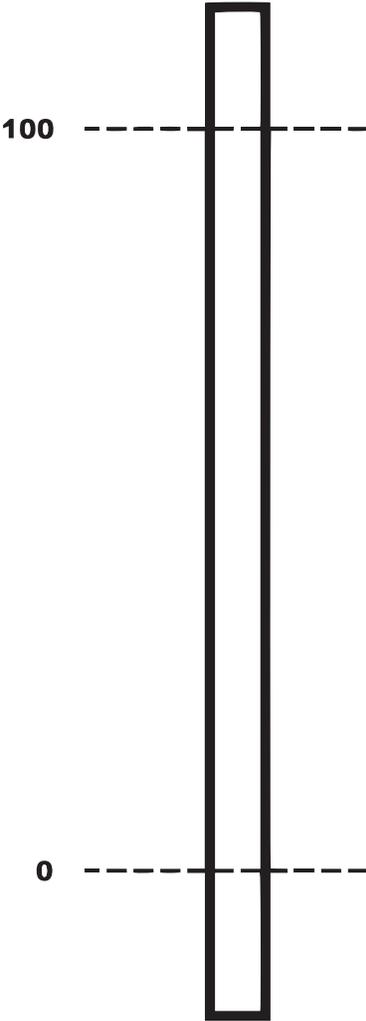
Draw and Label. What did you observe?

5. Compare the two readings from the spring scale (see Question 2 and Question 4). What was the difference in the mechanical energy when you pulled the book without pencils and when you pulled it with pencils? Record the difference below.

Discuss with your group what you learned at the center.

Diagrams 1-4

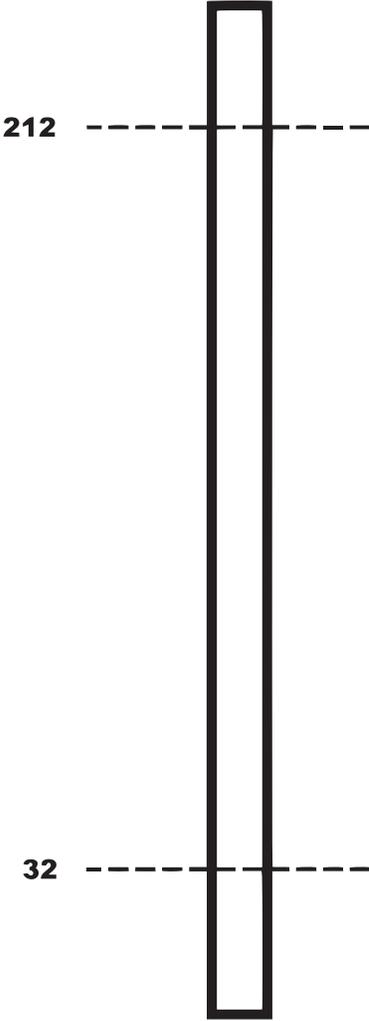
**Diagram 1:
Celsius Scale,
Freezing to Boiling**



**Diagram 2:
Fahrenheit Scale**

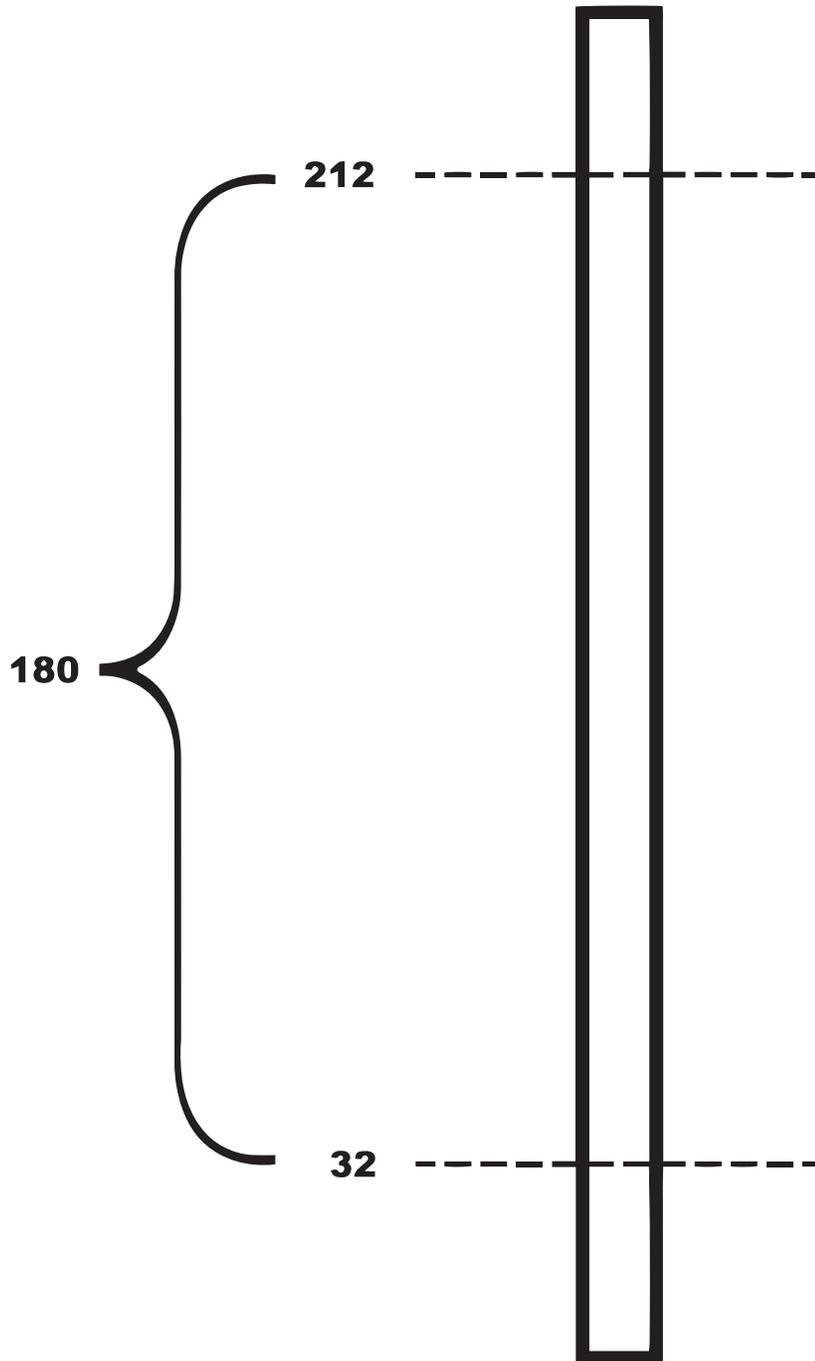


**Diagram 3:
Fahrenheit Scale,
Freezing to Boiling**



Diagrams 1–4 , continued

**Diagram 4:
Fahrenheit Scale, Freezing to Boiling Distance**



Everyday Energy Anticipation Guide Answer Key

Circle **Agree** for statements you believe are true. Circle **Disagree** for statements you believe are false. (true/*verdad*, false/*falso*)

Agree Disagree

1. There are many forms of energy.
(Hay muchas formas de energía.)

Agree Disagree

2. Light energy travels in straight lines.
(La energía ligera viaja en líneas rectas.)

Agree Disagree

3. You cannot see without light energy.
(Usted no puede ver sin energía ligera.)

Agree Disagree

4. Vibrating objects produce sounds.
(Sonidos vibrantes del producto de los objetos.)

Agree Disagree

5. Sound energy can travel through solids, liquids, or gases. (La energía sana puede viajar a través de los sólidos, de los líquidos, o de los gases.)

Agree Disagree

6. A moving ball has mechanical energy.
(Una bola móvil tiene energía mecánica.)

Agree **Disagree**

7. Heat is not a form of energy.
(El calor no es una forma de energía.)

Agree Disagree

8. People use different forms of energy every day.
(La gente utiliza diversas formas de energía diarias.)

Group Project 1 Rubric

	1-Needs Improvement	2-Satisfactory	3-Excellent
Energy	The four forms of energy are not included.	The four forms of energy are included, but an example of how each one causes change is not.	The four forms of energy are included as well as at least one example of how each form causes change.
Measurement	No measurements are included, or no explanation is given as to why no measurements are included.	One or more of the forms of measurement included is inappropriate (e.g., time for length).	The units of measurement included are used correctly, or a reason 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.

Group Project 2 Rubric

	1-Needs Improvement	2-Satisfactory	3-Excellent
Temperatures	Climate temperatures are not shown in C and F or are unrealistic for three to four seasons.	Reasonable climate temperatures are shown in C and F for two to three seasons (or two to three temperatures are unrealistic)	Reasonable climate temperatures are shown in C and F for all four seasons.
States of Matter	No change in a state of matter is included.	A change in a state of matter is included but is not realistic or accurate.	A change in a state of matter is realistically illustrated.
Forms of Energy	Illustrations or examples include a realistic use of two or fewer forms of energy.	Illustrations or examples include a realistic use of three forms of energy.	Illustrations or examples include a realistic use of all four forms of energy.
Comparisons	Illustrations or examples include the volume of no more than one building or recreational area and accurately show how it was determined.	Illustrations or examples include the volume of two to three buildings or recreational areas and accurately show how each was determined.	Illustrations or examples include the volume of four buildings or recreational areas and accurately show how each was determined.

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. On Item 6, you will write your answers.”

Answer Key

Part I

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

Part II

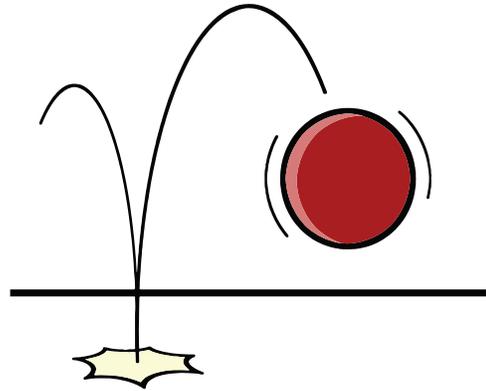
6. Television – light, mechanical, sound, heat
Grandfather clock – mechanical, sound
Oven – light, mechanical, heat
7. B
8. A

Energy Assessment

Part I

1. A third-grade student dribbles a basketball. The movement of the bouncing ball is an example of _____ .

- A mechanical energy
- B sound energy
- C heat energy
- D light energy



2. What can be done to a rubber band to produce sound?

- A cut it in half
- B soak it in water
- C wrap it around your wrist
- D stretch it and pluck it with your finger

3. What forms of energy are directly provided by the sun?

- A heat, sound
- B heat, mechanical
- C heat, light
- D light, sound

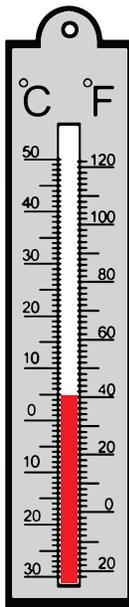
Use the chart of data collected by a third-grade student while investigating heat energy to answer questions 4 and 5.

High Temperatures Week of July 4th	
Monday	37°C
Tuesday	36°C
Wednesday	35°C
Thursday	37°C
Friday	39°C

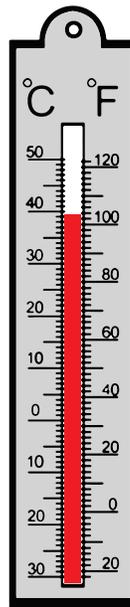
4. Most likely, the data was collected using a _____ .

- A metric ruler
- B thermometer
- C spring scale
- D hand lens

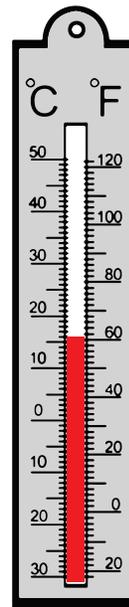
5. Which tool below shows the measurement of the heat energy on Friday?



A



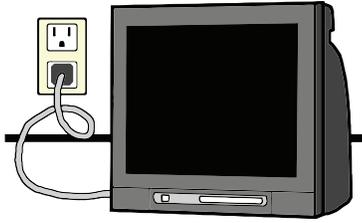
B

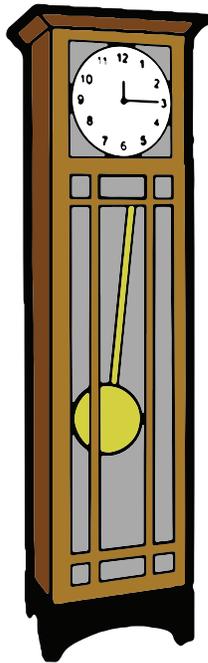


C

Part II

6. Identify the forms of energy found in each system.







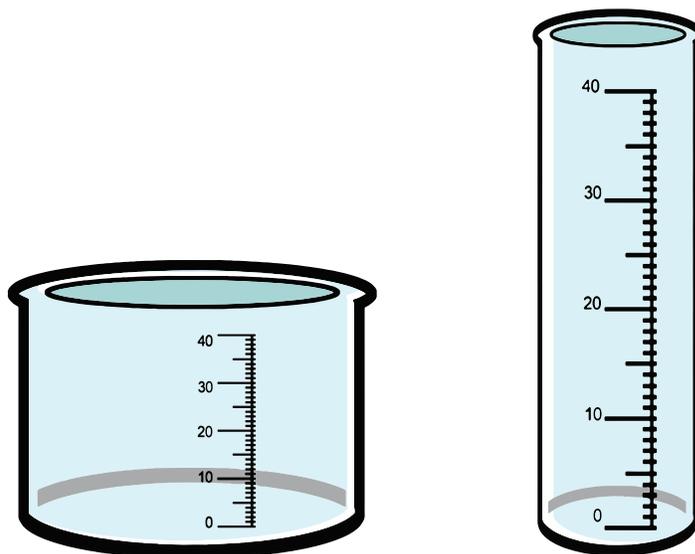
7. Given a number line, find the halfway point between 32 and 82.

- A 50
- B 57
- C 25
- D 52



8. Containers 1 and 2 have the same capacity of 40 mL. Also, the numbers on the large marks on each container are the same (10 mL, 20 mL, 30 mL, and 40 mL). You pour 20 mL of water into Container 1. Then you pour 20 mL of water into Container 2. Which of these statements is not true?

- A Container 2 has more water because the water level is higher.
- B The containers have the same amount of water in them.
- C The distance between the marks on Container 1 is different than the distance between the marks on Container 2.
- D The water level in each container goes up to the line marked 20 mL.



Reading Connections

The following books are recommended as literary resources to enhance the study of light, heat, and sound energy for Grade 3 students.

Light

Branley, F. M. (2005). *Sunshine makes the seasons* (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.

Heat

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

Sound

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

Texas Essential Knowledge and Skills (TEKS) Focus

§112.14. Science, Grade 3, Beginning with School Year 2010–2011.

(b) Knowledge and skills.

- (1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following school and home safety procedures and environmentally appropriate practices. The student is expected to:
 - (A) demonstrate safe practices as described in the Texas Safety Standards during classroom and outdoor investigations, including observing a schoolyard habitat.
- (2) Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and outdoor investigations. The student is expected to:
 - (A) plan and implement descriptive investigations, including asking and answering questions, making inferences, and selecting and using equipment or technology needed, to solve a specific problem in the natural world;
 - (B) collect data by observing and measuring using the metric system and recognize differences between observed and measured data;
 - (C) construct maps, graphic organizers, simple tables, charts, and bar graphs using tools and current technology to organize, examine, and evaluate measured data;
 - (D) analyze and interpret patterns in data to construct reasonable explanations based on evidence from investigations;
 - (F) communicate valid conclusions supported by data in writing, by drawing pictures, and through verbal discussion.
- (3) Scientific investigation and reasoning. The student knows that information, critical thinking, scientific problem solving, and the contributions of scientists are used in making decisions. The student is expected to:
 - (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;
 - (C) represent the natural world using models such as volcanoes or Sun, Earth, and Moon system and identify their limitations, including size, properties, and materials.
- (4) Scientific investigation and reasoning. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:
 - (A) collect, record, and analyze information using tools, including microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, wind vanes, rain gauges, pan balances, graduated cylinders, beakers, spring scales, hot plates, meter sticks, compasses, magnets, collecting nets, notebooks, sound recorders, and Sun, Earth, and Moon system models; timing devices, including clocks and stopwatches; and materials to support observation of habitats of organisms such as terrariums and aquariums.

- (5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:
 - (A) measure, test, and record physical properties of matter, including temperature, mass, magnetism, and the ability to sink or float;
 - (B) describe and classify samples of matter as solids, liquids, and gases and demonstrate that solids have a definite shape and that liquids and gases take the shape of their container;
 - (C) predict, observe, and record changes in the state of matter caused by heating or cooling.
- (6) Force, motion, and energy. The student knows that forces cause change and that energy exists in many forms. The student is expected to:
 - (A) explore different forms of energy, including mechanical, light, sound, and heat/thermal in everyday life;
 - (B) demonstrate and observe how position and motion can be changed by pushing and pulling objects to show work being done such as swings, balls, pulleys, and wagons.

§111.15. Mathematics, Grade 3.

- (b) Knowledge and skills.
 - (3) Number, operation, and quantitative reasoning. The student adds and subtracts to solve meaningful problems involving whole numbers. The student is expected to:
 - (B) select addition or subtraction and use the operation to solve problems involving whole numbers through 999.
 - (4) Number, operation, and quantitative reasoning. The student recognizes and solves problems in multiplication and division situations. The student is expected to:
 - (C) use models to solve division problems and use number sentences to record the solutions.
 - (11) 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 standard units to describe length, area, capacity/volume, and weight/mass. The student is expected to:
 - (A) use linear measurement tools to estimate and measure lengths using standard units;
 - (F) use concrete models that approximate cubic units to determine the volume of a given container or other three-dimensional geometric figure.
 - (12) Measurement. The student reads and writes time and measures temperature in degrees Fahrenheit to solve problems. The student is expected to:
 - (A) use a thermometer to measure temperature.

§126.3. Technology Applications, Grades 3–5.

- (b) Knowledge and skills.
- (5) Information acquisition. The student acquires electronic information in a variety of formats, with appropriate supervision. The student is expected to:
 - (A) acquire information including text, audio, video, and graphics; and
 - (B) use on-line help and documentation.
 - (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;
 - (B) use appropriate software to express ideas and solve problems including the use of word processing, graphics, databases, spreadsheets, simulations, and multimedia.
 - (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;
 - (B) use interactive technology environments, such as simulations, electronic science or mathematics laboratories, virtual museum field trips, or on-line interactive lessons, to manipulate information.
 - (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, monitor display, Internet documents, and video.

§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;

TEXAS ESSENTIAL KNOWLEDGE AND SKILLS

- (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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