



Exploring the Uses of Light, Thermal, Mechanical, Sound, and Electrical Energy



Acknowledgments

The MOSAIC Program was made possible through a grant from the Sid W. Richardson Foundation of Fort Worth, Texas. Since 1947, the Foundation has generously supported education, healthcare, human services, and culture in Texas.

MOSAIC: An Integrated Approach to Mathematics, Science, Technology, and Language represents a significant revision and update of Integrating Mathematics, Science, and Language: An Instructional *Program* (Paso Partners), produced in 1993 by Betty J. Mace-Matluck and Norma G. Hernandez, and developed by a partnership of three public schools, an institution of higher education, and SEDL specialists.

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mosaic Grade 5



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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.

	Beginning	Intermediate	Advanced	Advanced High
Listening	Beginning English learners (ELs) have little or no ability to under- stand 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 mini- mal 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 com- monly 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 foun- dational 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 foun- dational writing skills.

ELPS-TELPAS Proficiency Descriptors

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.

ENGAGE

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

In this module: Students observe discrepant events with a Ping-Pong ball and an energy ball, predict how the energy ball works by developing a labeled diagram, and then investigate cooperatively with a group to test their predictions and share the results with the class.

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

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 experience light, heat/thermal, sound, mechanical, and electrical energy. Students explore how light travels through different media, such as water, oil, and saltwater. They explore thermal energy by shaking jars of sand and placing soda cans with dark paper and aluminum foil covers under heat lamps. They explore sound

energy by building a cup-and-string model telephone system. They explore mechanical energy by using a variety of devices found in the home to make a radiometer spin. And finally, they explore electrical energy by using materials to create static electricity and to build a simple electrical circuit and a simple electromagnet.

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

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 their observations of the activities at the Explore centers and participate in teacher-led discussion as a formative assessment of student understanding.

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

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 apply and extend their knowledge of energy with a focus on deepening their understanding of light, sound, and heat energy. Students also learn how to estimate how far away a nearby thunderstorm is and how to convert temperatures in Celsius into Fahrenheit.

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.

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 small groups to create either digital stories about the different forms of energy or to plan an Energy Booth for a school carnival. 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 students' level of English language proficiency. For example, assessments may include teacher observations and students' alternative expressions of knowledge. For ELs at beginning levels, responses in their first language (when possible), acting out a response, or drawing a response is appropriate. ELs at intermediate levels should be allowed to use oral and written responses using language frames (e.g., "Today I learned that ______ happened because _____."). Advanced and advanced high ELs may be assessed in the same way as their English-speaking peers, but assessment may require linguistic support with academic English terms, such as *define, provide evidence for,* and *give an example of*.

Background Knowledge

The study of energy is abstract for elementary students. To develop their conceptual understanding of energy, provide concrete experiences that help students connect different forms 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 students' ability to observe, describe, and predict patterns in both a qualitative and quantitative manner.

Energy

Because energy is an abstract concept, teachers need to give fifth grade students a variety of opportunities to experience and interact with different forms of energy. The U.S. Department of Energy defines energy as the ability to do work or the ability to move an object. By the end of this unit, fifth grade students should be able to differentiate among several forms of energy—light, heat or thermal, sound, mechanical, and electrical—and to make everyday applications of their knowledge of energy.

Light

Many sources of light exist, but the initial energy for all light sources comes from the sun. Light travels away from its source in straight lines as waves of energy. Patterns in the behavior of light are very predictable because light moves in waves through space until it comes in contact with an object or material that changes its direction. Light can pass through, bounce off (reflect), 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 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.

The law of reflection states that if light hits a reflective surface at a certain angle (angle of incidence), it will reflect or bounce off at the same angle (angle of reflection). To determine the angle of incidence and reflection, we use zero for the normal line, which is a line perpendicular to the center of the mirror. If a light ray hits a mirror at 60 degrees from the normal, then the ray will reflect off the mirror at 60 degrees on the opposite side of the normal.

A flat mirror reflects an image that is the same size as the object, whereas curved mirrors reflect images that are bigger, smaller, or even upside down. An image from a curved mirror may be distorted because the curved edges reflect light at different angles. For example, the inner curved part of a spoon reflects an upside-down image of an object. Convex mirrors are like the outer curved part of a spoon and reflect a smaller distorted image of an object.

Heat or Thermal Energy

Thermal energy is the amount of kinetic energy contained in the particles of a substance or material. The hot particles in warm substances move faster than the particles in cool substances. When the hotter particles bump into the cooler particles, they give some of their thermal

energy to them. This action is why thermal energy flows from warmer to cooler substances. Insulators, such as foam cups, contain large air spaces where air particles are very far apart. Heat flows very slowly through foam cups because it bumps into fewer particles in the air spaces. Heat flows much faster through materials with tightly packed particles, such as metal and glass, which can serve as conductors.

Mechanical Energy

Mechanical energy is the sum of potential energy and kinetic energy. An object that has the ability to work or change its position has mechanical energy. The movements of a car, the stretching of a rubber band, or the rolling of a ball are all types of mechanical energy. For more information, the Physics Classroom (www.physicsclassroom.com/class/energy/u5l1d.cfm) provides a nice overview for teachers.

Sound

Sound is a type of energy caused by tiny, rapid back-and-forth movements called vibrations. We can hear a sound when sound waves travel to our ears and cause a vibration on the eardrums. Our ears usually detect sound waves in the air, but they can also travel through liquids or solids. In fact, sound waves travel about four times faster and farther in water than in air.

Some sounds may be difficult to identify, especially if they are traveling through a different medium than when we normally hear them. For example, many people are unable to recognize their own recorded voices. When you speak, the sound of your voice travels through the solid bones in your head to your ears as well as through the air. Your recorded voice has a different tone because you only hear the sound waves traveling through air.

Musical instruments produce specific sounds by making air vibrate at different frequencies. Frequency is a measure of how many times something moves back and forth in a second. In reed instruments, like clarinets, different notes are produced by changing the length of the area that air can vibrate, which causes different frequencies. Different notes are produced on a guitar or violin by increasing the tension on the strings, causing the strings 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 or presses the string on the fingerboard to raise the pitch of the note by allowing only a section of the string to vibrate.

Electrical Energy

Electrical energy is carried by tiny particles called electrons moving from one place to another in wires, light bulbs, or motors. The source of electrical energy may be a battery or an electrical wall outlet that is connected to an electrical power plant. Electricity has many daily uses. It provides energy for light bulbs, computers, televisions, and many other devices that we use in our daily lives. Telephones convert your voice into an electrical signal that can travel thousands of miles until a receiver turns the signal back into the sound of your voice.

Electrical energy can also be used to produce a magnet. Winding a wire carrying electrical energy into a coil and connecting it to a battery produces a magnetic field. Wrapping the coil wire around an iron nail will also magnetize the nail over time. Large electromagnets are used to pick up huge metal beams in the building industry and old cars in scrapyards.

Electrical energy can also occur in nature when large amounts of static electricity build up in clouds during a thunderstorm due to the rapid movement of particles against each other in fast-moving air currents. Lightening occurs when this static electricity is discharged in the air.

Angles

Light reflection off surfaces is used to develop the basic idea of the angle of incidence and the angle of reflection. Students must understand the basic definition of an angle as a figure formed by joining two rays at a point called the vertex of the angle. Students also should have an understanding of angle measurement in degrees; know the definitions of acute, right, and obtuse angles; and have a general feel for the relative size of angles such as 45°.

In addition, students should be well-grounded in the basic geometric concepts of perpendicular, parallel, and intersecting lines.

Proportional Reasoning

Mathematically, a relationship, such as the relationship of the speed of light to the speed of sound, can be expressed as a ratio. Ratios exist in countless situations. Once a ratio is established, the relationship remains constant. For example, a ratio of 2 to 1 (2/1) establishes the relationship of the first item being twice as large as the second item. An equivalent ratio would be 4/2 or 6/3.

Temperature

The U.S. system usually utilizes the Fahrenheit scale for measuring temperature. As a result, most students are not familiar with how hot or cold Celsius readings are. Included in the lesson is a suggested activity that will give students a simple way to estimate equivalent Fahrenheit temperatures from given Celsius temperatures.

By the end of fifth grade, students should have had experience measuring temperature using both Celsius and Fahrenheit. Although converting between the two systems is not required until the eighth grade, students need to establish an understanding of temperatures on the Celsius scale by correlating them to more familiar Fahrenheit temperatures. Note that this is more about proportional reasoning and understanding the relationship between the two scales as opposed to a focus on converting from one scale to another. By understanding the relationship, students can easily estimate equivalent benchmarks that will, in turn, help them determine the reasonableness of solutions.

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. Additionally, technology is useful to reteach a concept or to instruct students who were absent during the hands-on learning time. This module contains opportunities for students to use technology to view online assets, experiment with simulations, document and report findings, and create presentations about 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 occurs in many forms: light, heat or thermal, sound, mechanical, and electrical.
- Energy is essential in everyday life and travels through objects in a variety of ways, which can be both useful and damaging.
- Energy exhibits predictable patterns and relationships, such as how light reflects off a smooth, shiny surface.
- Changes in energy can be measured and predicted.

Concepts

By the end of this lesson, Grade 5 students should understand the following concepts:

- Energy can move from one object or material to another object or material.
- Light travels in straight lines until it comes in contact with matter.
- Light energy can be absorbed, reflected, or refracted by matter.
- Light energy reflects, or bounces off, a mirror at the same angle that it strikes the mirror.
- Light-colored or shiny surfaces reflect more light than dull, dark, or textured surfaces.
- We see an object when light reflecting off it enters our eyes.
- Light energy is refracted, or bent, when it passes from one medium or material into another because of changes in the speed and direction of light energy.
- The medium or material that light passes through may be transparent, translucent, or opaque, but very little light passes through opaque materials.
- Curved lenses in eyeglasses refract light to help us see more clearly. Lenses in microscopes refract light to allow us to see objects that are too small to see with the naked eye. And telescopes use lenses to refract light or mirrors to reflect light to allow us to see objects in space.
- Electrical energy is a movement of tiny particles called electrons through a circuit to produce light, heat, and sound.
- Thermal, or heat, energy is produced by the energy of moving particles in matter.
- The transfer of thermal energy from warmer to cooler substances allows us to heat buildings in winter and cook food.
- Mechanical energy is movement or motion.
- Vibrations produce sound, which is useful for communication, to warn of danger, and for musical enjoyment.
- Relationships exist that can be used to predict and measure change, such as using the relationship between the speed of light and the speed of sound to estimate the distance of a bolt of lightning.
- Geometric relationships exist in nature, such as the angles involved when light reflects off a smooth surface, such as a mirror.
- Investigations should be planned and implemented safely.

- We can describe, plan, and implement investigations that test one variable.
- Investigations involve asking well-defined questions, formulating testable hypotheses, and selecting and using appropriate equipment and technology.
- Information can be collected through detailed observations and accurate measurements.
- Information can be analyzed and interpreted to construct reasonable explanations from direct (observable) and indirect (inferred) evidence.
- Models can be used to represent how something that cannot be seen works or looks, such as how a soda dispensing machine works.
- Patterns can be used to determine and predict relationships, such as the relationship between the angle of incidence and the angle of reflection.
- Determining an equivalent fraction can be used to simplify a relationship.
- Proportional reasoning and basic computation can be used to convert from one scale or unit of measure to another.
- The Internet provides access to online information and simulations.
- Technology tools can be used to collect, organize, and present data.

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
angles	ángulos
ant	hormiga
battery	pila
boil	hervir
Celsius	Celsius
circuit	circuito
cold	frío
cold water	agua fría
compare	comparar
concave	cóncavo
conductor	conductor
convex	convexo
degrees	grados
different	diferente
distance	distancia
electrical energy	energía eléctrica
energy	energía
estimation	estimación
Fahrenheit	Fahrenheit
flashlight	linterna
freeze	congelar
gas	gas
heat	calor
heat energy	energía térmica
hot	caliente
hot water	agua caliente
hypothesis	hipótesis
ice cube	cubo de hielo
insulator	aislante
kilometers	kilómetros
kinetic energy	energía cinética
length	largo
light	luz
light bulb	foco
lightning	relámpago
liquid	líquido
magnetism	magnetismo
measurement	medida
mechanical energy	energía mecánica

English Vocabulary	Spanish Vocabulary
medium	medio
melt	derretir
metals	metales
miles	millas
mirror	espejo
motion	movimiento
observe	observar
opaque	орасо
patterns	pautas
perpendicular	perpendicular
potential energy	energía potencial
predict	predecir
prism	prisma
rainbow	arco iris
reflect	reflejarse
refract	refractarse
ruler	regla
seconds	segundos
solid	sólido
sound	sonido
sound energy	energía del sonido
straight	recto
sun	sol
temperature	temperatura
thermal energy	energía térmica
thermometer	termómetro
thunderstorm	tormenta eléctrica
translucent	translúcidot
transmit	transmitir
transparent	transparente
unit	unidad
variable	variable
vibrate	vibrar
vibrations	vibraciones
volume	volumen
water	agua
What happens when	Que sucede cuando
wire	alambre



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Lesson Procedures

ENGAGE

The Mystery of the Energy Ball

Time: Approximately 30 minutes

- 1. Prior to class, practice the two demonstrations below to ensure the desired results. Then set up all the materials on a central demonstration table.
- 2. At the start of class, distribute the data sheets. Then present the demonstrations to students to activate their prior knowledge about light, heat or thermal, sound, mechanical, and electrical energy:

Demonstration 1

- a. Place the Ping-Pong ball on a central demonstration table.
- b. Strike the tuning fork on your shoe and then touch the Ping-Pong ball with the tuning fork.
- c. The ball should begin to bounce up and down.

Demonstration 2

a. Place the energy ball (which looks similar to a Ping-Pong ball) on the table, being careful not to touch the two metal strips on the ball.

Materials

For the class

- □ Tuning fork
- □ Ping-Pong ball
- □ Energy ball
- □ Chart paper
- □ Markers

For each group

- □ Ping-Pong ball
- □ Energy ball
- □ Chart paper
- □ Markers
- Tape

For each student

- Energy Ball Data Sheet
- b. Hold up the ball, touching the metal strips with your thumb and index finger to complete the circuit.
- c. The ball should light up and make a warbling sound.

- 3. Ask students to observe carefully the unlit energy ball in your hand and to think of two questions about it that can only be answered with a yes or no. Allow students 2 to 3 minutes to record their questions on the data sheet.
- 4. While students ponder their questions, prepare a T-chart as shown at right.
- 5. Have students ask their yes-or-no questions about the energy ball. As they do, record the questions in the appropriate part of the chart. If students ask a question that might require an investigation or test, record that question in the section of the chart marked with a question mark.
- 6. Ask students to draw a labeled diagram or model on their data sheets of what they think the inside of the energy ball might look like. In addition, students should write an explanation of how they think the ball works. (Students may not have any idea, so remind them that they should have worked with electrical circuits in fourth grade.)
- 7. Organize students into groups of four. Assign each group member a cooperative learning role. Discuss the responsibilities of each role or job:
 - Principal Investigator-leads the investigation
 - Materials Manager–gathers and returns materials
 - Safety Technician-ensures safety rules are followed
 - Reader/Recorder-reads directions and records group information
- 8. Instruct the Materials Managers to pick up one energy ball and one Ping-Pong ball for the group.
- 9. Allow the groups 5 minutes to test the two balls and to try to make the energy ball light up.
- 10. After 5 minutes, distribute chart paper and markers. Allow time for each group to draw a large, labeled model on chart paper of the members' prediction about the inside of the energy ball. Encourage group members to share their diagram models and ideas from their data sheets about how the energy ball works.
- 11. As students work, prepare a five-column chart as shown at right.
- 12. Ask the Principal Investigator of each group to explain how the members tested the energy ball. Encourage the other members to participate by posting the model for everyone to see and indicating parts of the model as they are mentioned.
- 13. During the presentations, list on the 5-column chart any energy terms that students use as a way to elicit and diagnose prior knowledge of energy concepts. Do not reveal that the letters stand for Light, Sound, Thermal, Mechanical, and Electricity;







but write each vocabulary word or idea under the correct heading as students mention them. Use the space at the bottom of the chart for generic energy terms, such as transfer of energy. Explain to students that the class will come back to the chart later in the lesson.

- 14. Ask the Materials Managers to return the energy and Ping-Pong balls to the designated area for lab materials.
- 15. On a third piece of chart paper, draw a labeled model of the inside of the energy ball. Ask students to provide suggestions as you draw. When you are done, ask:
 - How was the Ping-Pong ball different from the energy ball? *The Ping-Pong ball had less mass, seemed empty, and did not light up or warble.*
 - What parts of the energy ball were easiest to draw? The two metal strips were easy to see and had to be pushed together to activate the energy ball.
 - What might be the source of energy? a battery
 - What else might be needed for the energy ball to light up? *a bulb for light, and wires to connect the battery to the bulb*
 - What made the warbling sound? an object that vibrates when the metal strips are pushed together
- 16. Open the demonstration energy ball to verify whether its contents resemble the class diagram model. If there is a difference, modify the model to match the actual circuit design and allow the groups time to modify their models as well. Discuss the idea of confirming or disproving a hypothesis. Explain to students that this method is the way scientists learn. In reality, they are wrong more often than they are right.
- 17. Demonstrate how to close the energy ball's circuit by touching the metal strips together as you walk around the classroom so that students can see the inside of the energy ball. Ask several volunteer students to touch the light bulb inside the ball and report what they observe. *the bulb feels warm*
- 18. Put the energy ball back together. Ask for volunteer students to make a circle at the front of the room by holding hands.
- 19. Ask two students to release their hands and hold the unlit energy ball between them.
 - Can you think of a way to light the energy ball without one person touching the two strips of metal together? Try the different ideas until someone suggests that the students on either side of the ball should each touch a metal strip, and then ask the students to try it. This action will close the circuit and light the energy ball. Again, emphasize that this method of proposing a hypothesis and then testing it is how scientists learn.
 - What might happen if two students in the circle who are not touching the energy ball release their hands? Answers may vary, but allow students to make predictions before asking two students to release their hands. The energy ball will go out because the circuit will be open.
 - What could we do to light the energy ball again? Ask those two students to hold hands again.
 - What is needed for the energy ball to remain lit? a complete circle or circuit for the energy to travel along, like an electrical circuit

English Language Support

- Model instructions explicitly to ensure that ELs are engaged and understand their tasks and roles.
- Provide ELs at the beginning and intermediate levels with Spanish translations of key terms.
- Ensure that ELs in each group are engaged. Perhaps assign beginning and intermediate ELs the Materials Manager role.
- Consistently check for understanding as ELs engage in group work.
- ELs at the beginning and intermediate levels may not be able to respond to questions in English. During discussion, allow them to respond in their native language or to draw or demonstrate their responses.

EXPLORE

General Instructions for Explore Centers

Time: Approximately 1.5 hours, including about 15 minutes per center (monitor center activity to see if students finish sooner)

This activity consists of five centers. Organize students into groups of two to three members and assign a portion of the groups to work at each center. Then rotate. A class of 25 students will need approximately two centers each for light, heat/thermal, sound, mechanical, and electrical.

- 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 to students 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

- I. Students explore the refraction of light as they observe light energy being transmitted through three identical baby food jars filled with different mediums—water, vegetable oil, and green saltwater—and reflected from a mirror. Students then observe a pencil in a clear glass with layers of water, vegetable oil, and green saltwater; and identify patterns in the behavior of the light as it passes from one medium to another.
- II. At the computer, students use an applet to explore the reflection of light rays on a smooth surface. The law of reflection states that if light hits a reflective surface at a certain angle (angle of incidence), it will reflect or bounce off at the same angle (angle of reflection.) The angles of incidence and reflection are determined by using the normal line, which is a line perpendicular to the center of the mirror.

Materials

For each center

- □ Light Energy Center Instructions (see Resources section)
- □ White sheet of paper
- □ Tape
- 3 identical baby food jars (empty)
- □ Tall, clear straight-sided glass
- □ Water
- □ Vegetable oil
- □ Salt
- □ Green food coloring
- 4 colored pencils (black, blue, yellow, green)
- Unsharpened pencil
- □ Small mirror

- □ Laser light/LED penlight
- Computer with Internet access
- Absorb Advanced Physics First Law of Reflection applet (can download in advance): http://www.absorblearning.com/media/ item.action;jsessionid =D1AE3AC95F338142 F87F59E228E6E159?q uick=15c

For each student

Light Energy Center
 Data Sheet (see
 Resources section)

Heat Energy Center

Safety goggles required

- Students measure and record the temperature of water in two prepared soda cans—one wrapped in black construction paper and one wrapped in aluminum foil—before placing the cans at an equal distance from a heat lamp for 7 minutes. Students then measure and record the temperature of the water in each can again.
- II. Students measure and record the temperature of sand in two jars. Next, the students close the jars tightly and take turns shaking one of them for 5 minutes. Students then measure and compare the temperature of the sand in each jar again.

Materials

For each center

- Heat Energy Center Instructions (see Resources section)
- □ 3 thermometers
- Empty soda can wrapped in black construction paper
- Empty soda can wrapped in aluminum foil
- □ Tape
- 200 mL of water (in measured beaker)

- Heat lamp
- 2 plastic jars with tightfitting lids
- Sand to partially fill the jars
- □ Timer
- Safety goggles (per group member)

For each student

Heat Energy Center
 Data Sheet (see
 Resources section)





Sound Energy Center

Students use the provided materials to create a cup-and-string model telephone system they can use to whisper to another student 3 meters away. Students then draw a labeled diagram of their system to show the movement of vibrations through it.

Materials

For each center

- Sound Energy Center
 Instructions (see
 Resources section)
- 2 foam cups (with holes in bottom)
- 2 plastic cups (with holes in bottom)
- 2 paper cups (with holes in bottom)
- □ 3 m dental floss
- □ 3 m yarn
- □ 3 m string

For each student

Sound Energy Center
 Data Sheet (see
 Resources section)

Mechanical Energy Center

Students observe the movement of the vanes of a radiometer when it is exposed, in turn, to the light of a flashlight, the heat from a hair dryer, and the air blown through a drinking straw. Students then predict what forms of energy caused the radiometer to move.



Electrical Energy Center

Safety goggles required

- Students rub wool and plastic together to observe the discharge of static electricity. They then use basic materials to build an electrical circuit and an electromagnet.
- II. At the computer, students explore an overview of electricity at the BBC KS3 Bitesize website.







Materials

For each center

- Electrical Energy Center
 Instructions (see
 Resources section)
- □ Paper clip
- □ Clay
- □ Wool fabric square
- □ Plastic square
- Prepared holiday lights strand (see Materials List and Details in Resources section)
- □ 2 D cell batteries
- □ Large iron nail
- □ Electrical tape strips
- 1 m of prepared insulated wire (see Materials List and Details in Resources section)

Materials

For each center

- Mechanical Energy Center Instructions (see Resources section)
- □ Radiometer
- □ LED flashlight
- □ Hair dryer
- Drinking straw

For each student

 Mechanical Energy Center Data Sheet (see Resources section)

- Safety goggles (per group member)
- Computer with Internet access
- BBC KS3 Bitesize website: http://www.bbc.co.uk/ schools/ks3bitesize/ science/energy_electricity_forces/electric_current_voltage/activity. shtml

For each student

Electrical 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 and electrical 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, heat lamp, radiometer.") and/or by 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 provides additional activities to give students more experiences related to energy and to introduce vocabulary.

Light Energy Center

- 1. Ask students about their observations at the light energy center. As you introduce academic vocabulary, write the words for students to see:
 - What was the source of light? *the laser or penlight*
 - What happened when you pointed the light at the wall and turned it on? *The light traveled in a straight line or ray to the wall and made a spot of light on the wall.*
 - How are the properties of the water, oil, and green saltwater solutions in the jars similar? *The solutions are all liquids in identical jars*.
 - How are the solutions different? The water is clear; the oil is yellow but still very clear; and the saltwater is green, making it hard to see through.
 - What is a word for clear materials that we can see through? *transparent*
 - What is a word for substances that we can partially see through? *translucent*
 - What happened when the jars of water, oil, and green saltwater solution were placed in front of the light? *Light passed through the clear jars of water and oil, as evidenced by a spot of light on the wall behind them. Some light passed through the jar of green saltwater solution, again as evidenced by less light on the wall behind it.*
 - What does the word transmit mean? to pass through
 - What does the word medium mean? Most students may say something in the middle.
 - At the light center, what was "in the middle" or in between the straight ray of light as it passed through the air toward the wall? *The ray of light was transmitted through a jar of either water, oil, or green saltwater solution.*

Materials

For the class

- Computer with Internet access
- Data projector and screen
- Absorb Advanced
 Physics Law of Reflection animation: http://
 www.physicsclass-room.com/mmedia/optics/lr.cfm
- Absorb Advanced
 Physics applet:
 http://www.absor blearning.com/media/
 item.action;jsessionid
 =D1AE3AC95F338142
 F87F59E228E6E159?q
 uick=15c
- Chart paper or whiteboard
- □ Markers
- □ Laser light or penlight

- 2. Write the word *medium* and clarify that the scientific meaning for the word is a material through which light passes.
 - Light can travel through space without a medium, but what material or medium does light pass through when it enters Earth's atmosphere? *air*
 - What might happen when light hits another medium, such as water or oil, that has more tightly packed particles than air? *The light might slow down or not be able to travel straight through the medium*.
- 3. Shine a laser pointer on the wall and slowly move each jar of liquid medium into the path of the light beam.
 - Does the spot of light on the wall change when I put the jar of water between it and the wall? Yes, the spot jumps higher on the wall and looks like a horizontal line of light rather than a round spot of light, as when it is transmitted solely through air to the wall.
 - Could the change in the position of the spot be evidence that light from the laser had to slow down or bend as it went through the water? Yes, the spot of light was in a different position because the light ray bent as it went through the water medium.
 - What happened when the oil medium was placed in the path of the light beam? The spot jumped higher on the wall and looked like a wavy vertical line of light rather than a round spot of light.
 - What happened when the green saltwater medium was placed in the path of the light beam? Less light was transmitted through the green salt solution because it is translucent, as opposed to transparent like the water and oil.
- 4. Write the word *refract* and discuss that light is refracted when it travels from one medium to another medium. When light moves from air into a denser liquid, the light gets bent or refracts as it changes speed and direction.
- 5. Ask what students observed about the glass containing the pencil. *The glass contained three layers of liquid: oil, water, and green saltwater solution.*
- 6. Then ask students to identify the properties of the mirror. The mirror is a solid object with a shiny surface on one side and a flat gray surface on the other side, so it blocks light from reaching the wall and reflects light to other parts of the room from its shiny side.
 - How did light behave when it came in contact with the mirror? *Light could not pass through the mirror because it is opaque, so the mirror created a square shadow on the wall when it blocked the light. The light bounced off the mirror and could be seen in another part of the room.*
 - What is a word for objects that block light? opaque
 - What is another word for *bounce off? reflect*
- 7. Using a computer attached to a projector, access and display the Law of Reflection animation: http://www.physicsclassroom.com/mmedia/optics/lr.cfm.
 - When you looked at the law of reflection on the computer, what were the two names for the angles? *angle of incidence and angle of reflection*
 - Which angle came first? angle of incidence
 - What happened next? angle of reflection

- 8. Next, display the interactive law of reflection applet: http://www.absorblearning.com/media/ item.action;jsessionid=D1AE3AC95F338142F87F59E228E6E159?quick=15c.
 - What happens when we move the green dot? The lines open or close.
 - How are the lines similar? Different? Answers will vary, but lead the students to realize that the angles are equal.
- 9. Explain to students that the term for these shapes is *angle*. An angle means how much of a slant lines have. Add *angle* to the word list.
- 10. Using the word *reflect*, ask students to notice the angle of reflection in the applet. Show that when you change the direction the flashlight hits the mirror, the angle the mirror reflects changes too. Ask one student to come up and manipulate the angle for the class to observe.
- 11. Organize students into pairs and ask each pair to draw one example of each of the following words in their journals:
 - a. transparent
 - b. translucent
 - c. opaque
 - d. transmit
 - e. medium
 - f. refract
 - g. reflect
 - h. angle
 - i. angle of incidence
 - j. angle of reflection

Heat Energy Center

Ask students about their observations at the heat energy center. Start by explaining to students that the things we change and test in an experiment are called *variables*.

- At the heat energy center, what one variable was different in the test with the soda cans? The cans were covered in different materials: one in foil and one in black paper.
- Which can had the highest temperature? The can covered in black paper was about 5 degrees warmer than the can covered in foil.
- Why do you think that was? The black paper absorbed light and heat, which warmed the can and water. The foil reflected light, so that can stayed cooler.
- Which color of clothing is best to avoid when you are outdoors on a hot, sunny day? Avoid wearing black or dark colors, because they absorb heat. It is best to wear light-colored clothing that will reflect light.
- What one variable was different in the test with the plastic jar of sand? *shaking the sand for 5 minutes*
- Did shaking the sand for 5 minutes result in a temperature change? Yes, the shaken sand was about 5 degrees warmer.
- What might have caused this change? The sand rubbed together when it was shaken, causing friction that resulted in heat.

Sound Energy Center

- 1. Ask volunteer students to describe the telephone system their group made at the sound energy center. Students should use their group's diagram.
 - What path did the vibrations travel from your voice to the receiver's ear? My voice created vibrations in the air, which hit the bottom of the first cup, making it vibrate. Those vibrations moved to the string and travelled along it to the bottom of the

Materials

For the class

- Human Ear Diagram (see Resources section)
- Chart paper or whiteboard
- □ Markers

second cup. It vibrated, which caused the air inside the cup to vibrate, and then those vibrations travelled to the receiver's ear.

- 2. Draw a system on the chart paper showing how the vibrations travelled.
- 3. Show the diagram of a human ear and point out the eardrum.
 - What do you think the job of the eardrum is? to receive vibrations from the air when a sound is heard and then to send nerve signals to the brain
 - Why can you hear a tiny whisper through the phone from a long distance, but not through the air? Vibrations travel faster and farther through liquids and solids than through air. Air particles are spread out, which makes the vibrations spread out.
 - How does a landline phone work? *Telephones turn your voice into an electrical signal that can travel thousands of miles until a receiver turns the signal back into the sound of your voice.*

Mechanical Energy Center

Ask students about their observations at the mechanical energy center:

- What happened to the radiometer vane on top when the light hit it? It spun.
- What was the reaction of the radiometer when sunlight energy hit it? It spun quickly.
- Which side of the radiometer vane might absorb the most light energy? the black side
- How do you know? Students may need help understanding that the black side of a vane is always on the back. Air heats on the black side faster, and the expansion of the air pushes that side of the vane away, causing it to spin.
- How could you test this? You could shine a flashlight on the black side of the vane and see how fast the radiometer spins, and then shine a flashlight on the silver side of the vane and see how fast the radiometer spins.

Electrical Energy Center

- 1. Ask students about their observations at the electrical energy center:
 - What happened when you brought the piece of plastic close to the paper clip? I saw a flash of light and heard a crackling sound.
 - Did it remind you of any similar experiences you have had with static electricity? *It reminded me of getting a shock when touching a doorknob or even of lightning on a very small scale.*
 - What is lightning? Lightning is the discharge of static electricity that builds up when materials in the atmosphere rub together during fast-moving updrafts of air.
- 2. Ask student volunteers to describe and share out the circuit their group built to light the bulb. *Answers may vary, but the circuit must be a complete path for electric particles to flow through the wires from the battery, to the bulb, and back to the battery.*
 - Do you think static electricity would light the bulb? *No, because static electricity is a very short spark of energy and would not be able to make a complete path around the circuit.*
 - How is an electromagnet different than a bar magnet? An electromagnet is made when the tiny particles of electricity are going around in coils of wire.
 - Could your electromagnet pick up a paper clip? yes
 - What other items could the electromagnet pick up? certain metals
 - How could you increase the strength of the electromagnet? by increasing the strength or number of the batteries and the number of coils around the nail
- 3. If time permits, allow students to experiment with coiling the wire around the magnet different numbers of times or with using more batteries in the circuit.

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 and demonstrations, explicitly model content by using objects, body gestures, and visuals. For example, show the diagram of the human ear and point out the eardrum as you ask, "What could be the job of the eardrum?"
- Watch your pacing (use a slower rate of delivery) as you ask questions and guide discussion.
- Provide wait time after 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 radiometer ______ when light hit 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. . .").
- Consistently check for understanding as students engage in the lesson.

ELABORATE

The Elaborate phase allows students to apply and deepen their new knowledge of energy as they experience different uses of energy.

Light Rotation General Instructions

Time: Approximately 1.5 hours, including about 15 minutes per center

Students rotate through four centers and then discuss their observations. It is strongly suggested that the teacher practice each center ahead of time to ensure the desired results. Prior to class, set up the center materials in areas of the room 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.

Tubular Reflection

Students use a paper tube model to observe the law of reflection.

Materials

For each center

- Tubular Reflection Instructions (see Resources section)
- □ White sheet of paper
- □ 2 paper towel tubes
- □ Laser pen/LED penlight
- □ Metric ruler
- □ Red marker
- Mirror in low stand (to stand on table)

For each student

□ Journal

The Magic Penny

Students observe how the position of a penny in a foam cup appears to change when water is added to the cup. They then relate the experiment to other objects they have seen underwater, which are not always in the position where we see them.

Materials

For each center

- The Magic Penny Instructions (see Resources section)
- Paper towels
- Penny

- □ Tape
- □ Small white foam cup (empty)
- □ Cup of water
- For each student
- □ Journal

Light and Lenses

Students use a card-comb system, a water-filled jar, and concave and convex lenses to make beams of light bend and refract.



Materials

For each center

- Light and LensesInstructions (seeResources section)
- Prepared index card with comb (see Materials List and Details in Resources section)
- □ Laser pen/LED penlight

- □ Black construction paper
- Baby food jar of water
- Convex demonstration lens
- Concave demonstration lens

For each student

Journal

Peepholes and Prisms

Students look through a Rainbow Peephole[™] and then shine a penlight through a prism to observe the colors of the visible light spectrum.

Materials

For each center

- Peepholes and Prisms
 Instructions (see
 Resources section)
- ☐ 3 Rainbow Peepholes[™] (round diffraction grating lenses)
- Prism
- □ LED penlight
- Rainbow-colored pencils or crayons
- For each student
- □ Journal

Light Rotation Discussion

Lead a discussion of the centers to ensure that students made the targeted connections between their experiences and the light energy concepts.

1. **Tubular Reflections.** Ask the following:

Materials

For the class

- Chart paper or whiteboard
- □ Markers

For each student

- Convex Diagram (see Resources section)
- Concave Diagram (see Resources section)
- What happened when you shone the light down one of the tubes toward the mirror? *The light traveled in a straight line down the tube, reflected off the mirror, and then traveled back down the second tube.*
- What did you notice about the red lines when the paper was refolded? The lines matched up.
- What do we call angles that have equal measures? *congruent angles* (Write *congruent* for the class to see.)

- 2. The Magic Penny. Ask the following:
 - Why does adding water to the cup make the penny appear? Adding water to the cup adds another medium for light to travel through, which causes the light to refract or bend, bringing the penny into view. (Write the word medium for the class to see.)
 - What would happen if the water were removed from the cup? If the water were removed, the light would only have to travel through air and would not be bent or refracted. As a result, we would not see the penny.
- 3. Light and Lenses. Ask the following:
 - What did the rays of light on the black paper look like as they traveled from the comb to the jar of water? *The rays were straight and parallel.*
 - What did the rays of light on the black paper look like as they traveled past the jar of water? *The rays crossed each other after going through the jar of water.*
 - How does a clear, curved object, like a jar of water or a lens, change the path of light rays? A clear, curved object causes light rays to bend, or refract, changing their direction as they pass through the object.
 - Distribute the Convex Lens and Concave Lens diagrams to students.
 - Hold up a convex lens and discuss its properties. *transparent, curved, thicker in the center than on the edges*
 - What happened when the light rays went through the convex lens? The light rays were parallel before they went through the lens. Then they bent toward each other as they refracted and crossed each other after going through the lens.
 - Hold up a concave lens and discuss its properties. *transparent, curved, caves in toward the center, thicker on the edges*
 - What happened when the light rays went through the concave lens? The light rays were parallel before they went through the lens. Then they bent outward as they refracted.
- 4. Peepholes and Prisms. Ask the following:
 - What did you observe when you looked through the peephole toward a source of light? *I saw* a rainbow of colors—red, orange, yellow, green, blue, and violet.
 - Why did the light change into 6 colors? The light was refracted as it went through the diffraction material in the peephole.
 - What did you observe when you shone a light beam through the prism? *I saw a rainbow of colors—red, orange, yellow, green, blue, and violet.*
 - What three things are needed to see a rainbow with a Rainbow Peephole[™] or prism? *light, an object to refract light, and our eyes*

Thunderstorms

Time: Approximately 15 minutes

- 1. Announce to the students that the class is now going to talk about lightning, which is a form of light energy, and thunder, which is a form of sound energy.
- 2. Ask students to recall a thunderstorm they have experienced. Encourage a few students to describe what they remember. Then ask:
 - Did you notice something strange about the thunder you heard and the lightning you saw? *Prompt students until someone says that thunder and lightning do not always happen at the same time.*
 - If a storm is off in the distance, what happens first—the thunder or the lightning? How do you know? *Students should say that they see the lightning first, then hear the thunder.*
 - Why do you think that happens? Prompt the students until someone volunteers that light energy travels faster than sound energy.
- 3. Confirm that scientists know that light energy travels faster than sound energy. As a result, people usually see lightning before they hear thunder.
 - If light travels faster than sound, how might you estimate how far away a lightning strike was? Some students may have been told how to estimate the distance a storm is from them.
- 4. Tell the students they are going to practice estimating how far away a storm is. When they see a lightning bolt, they should time the number of seconds until they hear the thunder. Give them two methods:
 - a. If you have a device that shows seconds, begin timing as soon as you see the lightning and stop as soon as you hear the thunder start.
 - b. If no timer is available, count the seconds by saying "one one thousand, two one thousand," and so on. Ask the class to practice using this method to count seconds.
- 5. Explain that the number of seconds tell us how long it took for the sound energy to reach us after we saw the lightning.
- 6. Tell students that next, they need to estimate how far away the storm is.
 - a. Divide the number of seconds by 5 to calculate the distance in miles (or by 3 for kilometers).
 - b. For example, if we counted 10 seconds from when we saw the lightning, the strike was 2 miles (or 3.3 kilometers) away.
 - c. What if we counted to 20, how far away is the storm? 4 miles or 6.6 kilometers
 - d. What about 5? 1 mile or 1.6 kilometers
 - e. What about 7? 1.4 miles or 2.3 kilometers
- 7. Ask if anyone can explain why the result is an estimate instead of an exact distance. *People may count at different speeds, so the result is not exact without a stopwatch or timer.*
- 8. Tell students that the next time they see and hear a thunderstorm in the distance, they should show someone else how to estimate how far away it is.

Stepping Into Proportional Reasoning

Time: Approximately 20 minutes

 As an exploratory activity to build a foundation for ratios and proportional reasoning, have the students go to the hall or to the playground. Using a measuring tape and masking tape, mark off a designated length. Ask a volunteer student with longer legs and another with shorter legs to walk the marked distance. Each student should count how many steps it takes to walk the designated distance and then report to the class.

Materials

For the class

- Measuring tape
- Masking tape or brightcolored tape
- □ Chart paper and stand
- □ Marker
- 2. Write both numbers side by side where the entire class can see them. (You should round to whole numbers). Ask students why the number of steps is different. *The length of each student's stride is different.*
- 3. Mentally double the number of steps taken by the taller student—that is, if he or she took 12 steps, you would have 24. Write the number below the first number of steps for that student, but do not tell students how you calculated the number. (You are informally writing a proportion). Then ask the taller student to take the new number of steps in a different direction and to mark the distance with masking tape.
- 4. Ask the class to predict how many steps it would take the shorter student to walk the same distance. Guide the students in making a hypothesis and ask them to discuss the reasoning for their prediction. The students should predict that if the taller student took twice as many steps (i.e., 24 compared to 12) to cover the new distance, then the shorter student should also take twice as many steps.
- 5. Ask the shorter student to walk the new distance and count the number of steps it takes. Write this number below the number of steps the same student took to walk the first distance. Were students' predictions correct? Explain to students that in this case, we will adjust the data for ease of computation and to keep the ratio 2 to 1. Then round or adjust the steps the shorter student took so that the second number is twice the first (e.g., if the shorter student took 18 steps to walk the first distance and 35 to walk the second, adjust the 35 to 36).
- 6. Students need to see how these relationships look mathematically. Discuss how to establish the ratio (relationship) of the taller student's steps in the first and second contexts, and how this ratio can be expressed as a fraction. Write this ratio (e.g., 12/24) on chart paper or use the numbers already written and add a fraction bar. Ask students to compare the denominator and numerator. They should see that the denominator is twice as large as the numerator.
- 7. Repeat the process in Step 6 with the steps taken by the shorter student (e.g., if the shorter student took 18 steps to walk the first distance, you would write 18/36).
- 8. Combine the two expressions into one equation (e.g., 12/24 = 18/36). Ask students for their hypothesis as to why the equation is true. Guide them in understanding that each ratio shows the same relationship (the denominator is twice as large as the numerator). Then give students additional experience in proportional reasoning by using simple contexts that result in examples such as 3/9 = 5/?. Ask students to explain the process or reasoning they used for each example.
The Relationship Between Celsius and Fahrenheit

Time: Approximately 45 minutes

- 1. Students should complete the previous activity on ratios and proportional reasoning before you present this one.
- 2. Distribute Diagram 1, which is a side-by-side comparison of the two critical points on each temperature scale: the freezing and the boiling points for water. Guide students using the following questions:
 - What do the 0 and the 100 indicate on the Celsius scale? 0 is the freezing point for water; 100 is the boiling point.
 - What do the 32 and the 212 indicate on the Fahrenheit scale? *32 is the freezing point for water; 212 is the boiling point.*
 - On the Celsius scale, how many degrees is it from 0 to 100? *100 degrees*
 - On the Fahrenheit scale, how many degrees is it from 32 to 212? *180 degrees*
 - What is the relationship between 100 degrees Celsius and
 Diagr
 180 degrees Fahrenheit? They both represent the same change in temperature.
- 3. Distribute Diagram 2, which extends the first side-by-side comparison by showing a critical idea: although the difference between the freezing and the boiling points is a different number on each scale (100 and 180), the change in temperature is the same. The reason is that the size of the units (a degree in Celsius versus a degree in Fahrenheit) is different. To provide another example, 12 inches and 1 foot are the same distance, but the numbers (12 and 1) differ because the size of each unit (inch and foot) differs. Use the ques-

tions below to guide students:

- How do you know that 100 degrees in Celsius equals the same amount of change as 180 degrees in Fahrenheit? *because they both represent the temperature difference between the freezing and the boiling points of water*
- How can the change in temperature in the two scales be the same if the numbers are different? *because the units are different sizes even though both are degrees: a degree in Celsius is not the same "size" as a degree in Fahrenheit*
- Can you give me a different example that would illustrate that idea? Possible answers include 1 yard = 3 feet, 12 inches = 1 foot; answers should give two equal distances measured by different units.





Materials

For each student Diagrams 1–4 (see



- 4. The conclusion from the side-by-side comparison of the two scales is that a change of 100 degrees Celsius is the same as a change of 180 degrees Fahrenheit. Students at this level are expected to determine equivalent fractions. Guide them using questions such as those below:
 - What is a common way to express the numeric relationship between two things? by using a ratio
 - What is a common way to express a ratio? as a fraction
 - How can we express that a change of 100 degrees in Celsius equals a change of 180 degrees in Fahrenheit as a ratio (fraction)? *100/180*
- 5. Tell students that they need to express this ratio in a simpler manner. Have them work with partners or in small groups to determine the simplest equivalent fraction of 100/180 without using any shortcuts.
- 6. After all the students have developed a solution, ask volunteers to share theirs. A possible step-by-step process to simplify 100/180 to lowest terms is provided below. It is advisable to have students do this task as indicated with no shortcuts or the use of any misleading terminology, such as *cancel*.

$$\frac{100}{180}$$

$$= \frac{10 \cdot 10}{10 \cdot 18}$$

$$= \frac{10}{10} \cdot \frac{10}{18}$$

$$= \frac{10}{10} \cdot \frac{2 \cdot 5}{2 \cdot 9}$$

$$= \frac{10}{10} \cdot \frac{2}{2} \cdot \frac{5}{9}$$

$$= \frac{5}{9}$$

- 7. Explain that this ratio (fraction) shows in a more simplified manner that a change of 5 degrees in Celsius is the same as a change of 9 degrees in Fahrenheit. This is a critical understanding and the foundation for the relationship between the two scales, as seen in Diagram 3. Distribute the diagram to students.
- 8. Tell students that by understanding this relationship, they should be able to estimate equivalent temperatures on the two scales by determining how many "chunks" of 5 (for Celsius) or 9 (for Fahrenheit) are involved in the comparison.



9. Distribute Diagram 4 to students, which extends the comparison between the two scales. Explain that the 5-to-9 ratio can be used in the same way that we determined how many steps the shorter student (call the student by name) had to take to equal the larger steps of the taller student (call the student by name). One thing is different, however. Unlike the students, who started in the same place at zero steps, the freezing point on the Fahrenheit scale is at 32 degrees. So we need to adjust for different starting points for freezing—0 degrees for Celsius and 32 degrees for Fahrenheit.



- 10. To help students understand this point, present an example to the class: If the current temperature is 15 degrees Celsius, what is the equivalent Fahrenheit temperature? Use guiding questions, such as those suggested below:
 - The key for Celsius is to determine how many chunks of 5 are involved in the problem. How many chunks of 5 are there in 15? 3 chunks of 5
 - What would be an equivalent change in Fahrenheit? 3 chunks of 9
 - Can we do this one step at a time? Yes, we can add 9 to 32 and get 41, but we have to do this two more times because we had 3 chunks of 9. So then we add 9 to 41 and get 50. Then we add 9 to 50 and get 59.
 - Is that the only way to do this? We could multiply to save time. The 3 chunks of 9 would be 27 degrees. But we are not starting at 0, so we need to add 27 to the starting point of 32 (27 + 32 = 59). So 59 degrees Fahrenheit is equivalent to 15 degrees Celsius.
- 11. Give the students two or more similar tasks, such as finding the Fahrenheit equivalent of 30 degrees Celsius. Have students work in groups. Then ask volunteer spokespeople to share their groups' solutions.
- 12. Point out that the equivalent temperatures have been whole numbers. Ask what pattern students have noticed regarding a Celsius temperature having a whole number equivalent in Fahrenheit. that a Celsius temperature that is a multiple of 5 will have a whole number equivalent in Fahrenheit
- 13. By understanding the 5-to-9 ratio of Celsius and Fahrenheit scales, students can calculate sideby-side comparisons such as the above with minimal computation. By determining equivalencies in this manner, students can build a foundation of understanding for the conversion formulas they will learn in later grades. At this point, it is sufficient to limit the conversions to those from Celsius to Fahrenheit. Conversions from Fahrenheit to Celsius are more involved and should be delayed until about Grade 7.

English Language Support

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

- Explicitly model demonstrations, questions, and discussions by using realia (real objects), body gestures, and visuals.
- For beginning and intermediate ELs, provide visual support of the materials at the centers by pointing to each item and stating its English name (e.g., "This is a tube, penny, lens, prism.") or by 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.
- Give ELs the opportunity to engage in demonstrations.
- As ELs engage in each center, make intentional efforts to ask them questions. Ask ELs to demonstrate what they are learning as a formative assessment.
- During question sessions, use language frames to encourage ELs to use academic language related to what they are learning (e.g., "In the Light and Lenses center, I learned that a jar of water makes light ______.").
- Provide wait time after questions 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 provided multiple-choice assessment to help prepare for the state assessment.

Group Project 1

Time: Approximately 1.5 hours (1 hour to develop; 30 minutes to present)

- 1. Organize students into small groups of three to four.
- Have the groups use a storytelling website such as http:// www.storybird.com to create a digital story about energy. After registering on the site, students can choose images and enter text to tell their story. You may want to preselect images on the site for students.
- 3. Ask each group to include the following forms of energy light, heat (thermal), sound, mechanical, and electrical in its story.

Materials

For each group

- Group Project 1 Rubric (see Resources section)
- Computer with Internet access
- Storytelling website such as http://www. storybird.com
- 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 below (also provided in the Resources section), which will be used to grade the digital stories. Read the rubric aloud to students row by row. After you read each row, check that students understand what is expected.
- 7. Monitor the groups while they work to check their progress, provide feedback, review expectations, and offer assistance or guidance.
- 8. Have each group present its digital story to the class.

	1-Needs Improvement	2-Satisfactory	3-Excellent
Energy	The five forms of energy are not in- cluded.	The five forms of energy are included, but an example of how each one causes change is not.	The five 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 measure- ment included is inappropriate (e.g., time for length).	The units of measure- ment 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

Time: Approximately 1.5 hours (1 hour to develop; 30 minutes to present)

- 1. Organize students into small groups of three to four. Each group will design an Energy Booth for a school carnival using materials from the Explore or Elaborate activities.
- 2. Explain to students that the Energy Booth must provide information and fun activities for at least three of the forms of energy studied—light, heat/thermal, sound, mechanical, and electrical. Students should include an explanation of each form of energy, how each form is used and changes, and how to measure each form (if relevant).
- 3. Allow the groups to examine and explore the materials from the center activities. Then ask each group to use presentation software to create a proposed plan for its booth. The proposal should include all the required information. Serving in the role

Materials

For each student

- Group Project 2 Rubric (see Resources section)
- □ Materials from Explore and Elaborate centers
- □ Books on energy that are age appropriate
- Computer (Internet) access optional)
- Presentation software

of the chairman of the carnival committee, you will review and approve each plan.

- 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 Energy Booth proposal with the class. Encourage groups to incorporate actual center materials in their presentations.
- 7. If time allows, extend the activity to have the groups prepare their booths and hold a class carnival.

	1-Needs Improvement	2-Satisfactory	3-Excellent
Energy Explanation	One form of energy is included and accurrately explained.	Two forms of energy are included and ac- curately explained.	Three or more forms of energy are includ- ed and accurately explained.
Energy Use	One form of energy is used in a realistic manner at the carni- val booth.	Two forms of energy are used in a realistic manner at the carni- val booth.	Three or more forms of energy are used in a realistic manner at the carnival booth.
Changes in Energy	An accurate change is provided for one form of energy, or no energy changes are provided.	An accurate change is provided for two forms of energy.	An accurate change is provided for three or more forms of energy.
Measurement	The measurements are accurate and appropriate for one form of energy, or no measurements are provided.	The measurements are accurate and appropriate for two forms of energy.	The measurements are accurate and appropriate for three or more forms of energy.

Individual Assessment

Time: 30 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
- English/Spanish word bank with content-specific vocabulary for ELs to use during assessments
- Linguistic support provided by monitoring ELs while they are taking the assessment
- Clarification of test questions if needed to ensure understanding of what is being asked

Advanced High:

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

Materials List and Details

ENGAGE

The Mystery of the Energy Ball

Teacher Preparation: Energy balls externally resemble Ping-Pong balls. To activate an energy ball, push together the two metal contacts on the surface of the ball. In advance, open an energy ball to examine how it works and looks inside. Practice drawing a diagram of the inside of the ball. Prior to class, make a copy of the Energy Ball Data Sheet for each student.

For the class

- □ Tuning Fork (available online at science supply stores)
- □ Ping-Pong ball
- Energy ball (available online at science supply stores)
- □ Chart paper
- □ Markers

For each group

- □ Ping-Pong ball
- □ Energy ball
- □ Chart paper
- □ Markers
- Tape

For each student

Energy Ball Data Sheet

EXPLORE

Light Center

Teacher Preparation: Copy and laminate the Light Energy Center Instructions and make a copy of the Light Energy Center Data Sheet for each student. Fill one jar with water, one with vegetable oil, and one with green-colored saltwater. Then fill the tall, clear, straight-sided glass with a bottom layer of green saltwater, a middle layer of vegetable oil, and a top layer of water. Place the jars and glass on a table in front of a sheet of paper taped to the wall. You may need to provide an object to boost the height of the jars and glass so that students can shine a light through them and onto the paper. Then access and test run the applet.

For each center

- Light Energy Center Instructions (laminate for repeated use)
- □ White sheet of paper
- □ Tape
- □ 3 identical baby food jars (empty)

- □ Tall, clear straight-sided glass
- □ Water
- □ Vegetable oil
- □ Salt
- □ Green food coloring
- □ 4 colored pencils (black, blue, yellow, green)
- □ Unsharpened pencil
- □ Small mirror
- □ Laser light or LED penlight
- □ Computer with Internet access
- Absorb Advanced Physics First Law of Reflection applet (can download in advance): http://www.absorblearning.com/media/item.action;jsessionid=D1AE3AC95F338142F87 F59E228E6E159?quick=15c

For each student

□ Light Energy Center Data Sheet

Heat Center

Teacher Preparation: In advance, wrap one empty soda can with black construction paper and wrap a second can with aluminum foil, as shown. Prior to class, copy and laminate the Heat Energy Center Instructions and make a copy of the Heat Energy Center Data Sheet for each student.



For each center

- □ Heat Energy Center Instructions (laminate for repeated use)
- □ 3 thermometers
- Empty soda can wrapped in black construction paper
- Empty soda can wrapped in aluminum foil
- □ Tape
- 200 mL of water (in measured beaker)
- □ Heat lamp
- □ 2 plastic jars with tight-fitting lids
- □ Sand to partially fill the jars
- □ Safety goggles (per group member)

For each student

□ Heat Energy Center Data Sheet



Sound Energy Center

Teacher Preparation: In advance, punch holes in the bottom of all the cups. Prior to class, copy and laminate the Sound Energy Center Instructions and make a copy of the Sound Energy Center Data Sheet for each student.

For each center

- □ Sound Energy Center Instructions (laminate for repeated use)
- □ 2 foam cups (with holes in bottom)
- 2 plastic cups (with holes in bottom)
- □ 2 paper cups (with holes in bottom)
- □ 3 m dental floss
- □ 3 m yarn
- □ 3 m string

For each student

Sound Energy Center Data Sheet

Mechanical Energy Center

Teacher Preparation: Prior to class, copy and laminate the Mechanical Energy Center Instructions and make a copy of the Mechanical Energy Center Data Sheet for each student.

For each center

- □ Mechanical Energy Center Instructions (laminate for repeated use)
- □ Radiometer (available online at science supply stores)
- LED flashlight
- □ Hair dryer
- □ Drinking straw

For each student

□ Mechanical Energy Center Data Sheet

Electrical Energy Center

Teacher Preparation: In advance, prepare the strand of holiday lights and the insulated wire (see instructions below). Then access and test run the BBC KS3 Bitesize website. Prior to class, copy and laminate the Electrical Energy Center Instructions and make a copy of the Electrical Energy Center-Data Sheet for each student.

For each center

- Electrical Energy Center Instructions (laminate for repeated use)
- □ Paper clip
- □ Clay
- □ Wool fabric square
- □ Plastic square
- Prepared holiday lights strand (see instructions below)
- 2 D cell batteries



- Large iron nail
- □ Electrical tape strips
- □ 1 m of prepared insulated wire (see instructions below)
- □ Safety goggles (per group member)
- □ Computer with Internet access



□ BBC KS3 Bitesize website: http://www.bbc.co.uk/schools/ks3bitesize/science/energy_ electricity_forces/electric_current_voltage/activity.shtml

For each student

Electrical Energy Center Data Sheet

Holiday lights preparation

Use wire cutters to cut off a strand of holiday lights that has two to three bulbs and the cord on each side of them. Using wire strippers or a small sharp knife, peel back the plastic coating on each end of the cord. You need about 2.5 cm (1 in.) of exposed wire on each end. Test the bulbs by using electrical tape to attach one exposed wire to one end of the battery and the other exposed wire to the other end of the battery. The bulbs should light.

- □ String of holiday lights
- □ Wire cutters
- □ Wire strippers or small sharp knife

Insulated wire preparation

Using wire strippers or a small sharp knife, strip the insulation from the ends of 1 meter of insulated wire. You need about 2.5 cm (1 in.) of exposed wire on each end.

- □ 1 m of insulated wire
- □ Wire strippers or small sharp knife

EXPLAIN

For the class

- □ Materials from Explore energy centers
- Human Ear Diagram
- □ Computer with Internet access
- Data projector and screen
- Absorb Advanced Physics Law of Reflection animation: http://www.physicsclassroom.com/ mmedia/optics/lr.cfm
- □ Absorb Advanced Physics First Law of Reflection applet: http://www.absorblearning.com/ media/item.action;jsessionid=D1AE3AC95F338142F87F59E228E6E159?quick=15c
- □ Chart paper or whiteboard
- □ Markers



PREPARE IN ADVANCE



Never allow both ends of the wire to touch the ends of the battery for longer than 8–10 seconds because the wire can become very hot.

ELABORATE

Tubular Reflection

Teacher Preparation: Copy and laminate the Tubular Reflection Instructions. In advance, test the center activity to ensure the desired results. You may need to provide a platform of some type to raise the paper and tubes so that students can shine a light down the tubes and hit the mirror.

For each center

- **D** Tubular Reflection Instructions (laminate for repeated use)
- □ White sheet of paper
- □ 2 paper towel tubes
- □ Laser pen or LED penlight
- □ Metric ruler
- □ Red marker
- □ Mirror in low stand (to stand on table)

For each student

□ Journal

The Magic Penny

Teacher Preparation: Copy and laminate the Magic Penny Instructions.

For each center

- □ The Magic Penny Instructions (laminate for repeated use)
- □ Paper towels
- □ Penny
- □ Tape
- □ Small white foam cup (empty)
- □ Cup of water

For each student

□ Journal

Light and Lenses

Teacher Preparation: Copy and laminate the Light and Lenses Instructions. In advance, prepare the index card and comb units (see instructions below).

For each center

- Light and Lenses Instructions (laminate for repeated use)
- □ Prepared index card with comb (see instructions below)
- □ Laser pen or LED penlight
- □ Black construction paper
- □ Baby food jar of water
- Convex and concave demonstration lenses (may be obtained online from a school science supplier)

For each student

Journal

Index card and comb preparation

Cut out a hole in the center of the index card. The diameter of the hole should be about the height of the teeth of the comb. Tape the comb across the index card lengthwise so that the teeth of the comb cover the hole. Test the center activity to ensure the desired results.

- □ Index card
- □ Small comb
- □ Scissors
- □ Tape

Peepholes and Prisms

Teacher Preparation: Copy and laminate the Peepholes and Prisms Instructions.

For each center

- D Peepholes and Prisms Instructions (laminate for repeated use)
- □ 3 Rainbow PeepholesTM (diffraction grating lenses; available online)
- □ Prism
- □ LED penlight
- □ Rainbow-colored pencils or crayons

For each student

□ Journal

Stepping Into Proportional Reasoning

For the class

- □ Measuring tape
- □ Masking tape or bright-colored tape
- □ Chart paper and stand
- □ Markers

The Relationship Between Celsius and Fahrenheit

For each student

Diagrams 1–4

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
- □ Materials from Explore and Elaborate centers
- D Books with age-appropriate information on energy
- □ Computer (Internet access optional)
- □ Presentation software

Individual Assessment

For each student

- Energy Assessment
- □ 2 pencils

RESOURCES

Frequent English/Spanish Vocabulary Words



































Energy Ball Data Sheet

Name	Date			
Demonstration				
Carefully observe the energy ball as it lights up and makes a warbling noise.				
Think of two questions about the energy ball that can be answered with a yes or no by the teacher. Write your questions on the lines below. (Example: Is there a material inside the ball that makes it light up? Yes!)				
1				
2				
Model and Explanation				
Draw a labeled diagram or model in the bo might look inside if we open it. Then explai	ox below that shows how the energy ball in in writing how you think the ball works.			
Model of the Inside of the Energy Ball	How I Think the Energy Ball Works			

Energy Ball Data Sheet, continued

Testing the Energy Ball

Work with your group to discover ways to make the energy ball light up. List them below.

Will the energy ball only light up if one person holds it? Investigate ways to make it light up with more than one person touching it. List them below.

Light Energy Center Instructions

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

Part I

- 1. Observe the sheet of white paper on the wall above the table.
- 2. Shine the laser light or penlight on the paper and mark the location, shape, and size of the light spot with a black marker.
- **3.** Without moving the light, place the jar containing water between the light and paper. Observe the light spot. Mark the location, shape, and size of the spot with the red marker.
- **4.** Without moving the light, place the jar containing vegetable oil between the light and paper. Observe the light spot. Mark the location, shape, and size of the spot with the yellow marker.
- 5. Without moving the light, place the jar containing green saltwater between the light and paper. Observe the light spot. Mark the location, shape, and size of the spot with the green marker.
- 6. Without moving the light, place the mirror between the light and wall.
- **7.** Record your observations for steps 3–6 on the data sheet.
- **8.** Observe the glass with all three liquids. Place the pencil in the glass. How does the pencil appear to change? Record your observations on the data sheet.

Part II

- 1. At the computer, locate the First Law of Reflection window.
- **2.** Place the mouse cursor on the green circle.
- **3.** Drag the circle to change the angles. The (i) is the **angle of incidence**, and the (r) is the **angle of reflection**. Observe that the two angles are always equal in any position. Draw a labeled model of the law of reflection on the data sheet.

Light Energy Center Data Sheet

Name	e Date				
Follo	ow the instructions at the light energy center.				
1.	Record your observations about the behavior of the light when it hits each item.				
	Jar of water:				
	Jar of oil:				
	lar of groop saltwator				
	Sal Ol green saltwater.				
	Mirror:				
Light Energy Center Data Sheet, continued

2. Observe the glass with the three layers and the pencil. Color the layers you observe in the glass. Describe the appearance of the pencil at each layer.



3. At the computer, observe the angles. Draw a diagram of the law of reflection with the two angles labeled.

Heat Energy Center Instructions

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



- 1. Pour 50 mL of water into each wrapped soda can.
- 2. Measure and record the temperature of the water in each can.
- 3. Put on the safety goggles. Each member of the group must wear goggles.
- **4.** Turn on the heat lamp. Place the cans under the heat lamp for 7 minutes. Make sure the cans are at an equal distance from the lamp.
- **5.** Remove the lids from the two jars containing sand. Measure and record the temperature of the sand in each jar.
- **6.** Screw the lids back on the jars tightly. Set aside one jar of sand.
- **7.** Set the timer and shake one jar of sand vigorously for 5 minutes. Take turns shaking the jar with members of your group.
- **8.** After 5 minutes, remove the lid of the jar. Measure and record the temperature of the sand in each jar again.
- **9.** After the heat lamp runs for 7 minutes, turn the lamp off. Measure and record the temperature of the water in each of the soda cans.
- **10.** Discuss the questions on the data sheet with your group.

Heat Energy Center Data Sheet

Name	Date
1.	Measure and record the temperature of the water inside the soda cans. Place the cans under the heat lamp for 7 minutes. Measure and record the temperature of the water in each can again.

	Start Temperature	7 Minutes
Water in can covered in black paper		
Water in can covered in aluminum foil		

2. Measure and record the temperature of the sand inside the jars. Close the lids on the jars tightly. Take turns shaking one jar for 5 minutes. Measure and record the temperature of the sand in the jars again.

	Start Temperature	5 Minutes
Sand in unshaken jar		
Sand in shaken jar		

Discuss the questions with your group.

- 3. What one **variable** is different in the soda cans? What about the sand?
- 4. Which soda can had the highest temperature? Why do you think this happened?
- 5. Which color of clothing is best to avoid when you are outdoors on a hot, sunny day?
- 6. Did shaking the sand for 5 minutes result in a temperature change? Why?

Sound Energy Center Instructions

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

Group Challenge

1. Use the materials at the center to make a telephone system similar to the one shown. Members of your group should be able to use the telephone system to communicate through whispers from 3 meters away.

All the cups already have holes in the bottom. Decide as a group which type of cup and string to use.

2. After testing the telephone system, draw a diagram of it on the data sheet. Label the diagram and show the movement of the vibrations from your mouth to the phone system and finally to the receiver's ear.



Sound Energy Center Data Sheet

Name _____ Date____

Draw a **labeled** diagram of your group's telephone system. Show how vibrations travel from the speaker's mouth to the phone system and finally to the receiver's ear.

Mechanical Energy Center Instructions

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

- 1. Observe the **radiometer** shown below. It resembles a light bulb with several small squares inside. These squares are called **vanes**. A radiometer measures electromagnetic radiation.
- 2. Test the three items listed to try to make the vanes in the radiometer spin.
 - flashlight
 - hair dryer
 - drinking straw
- **3.** Decide how you will test each item.
- 4. Describe on the data sheet the procedure you use to test the items.
- 5. Observe and record the results of each test.



Mechanical Energy Center Data Sheet

Name	Date
1.	Draw a labeled diagram of the radiometer. Explain how you think it might work.
2.	Describe how you tested each item and what the results were.
	Flashlight
	Hair Dryer
	Drinking Straw
3.	Predict the types of energy that caused the radiometer to spin.

Electrical Energy Center Instructions

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

Part I

- 1. Stick the paper clip into a small piece of clay to hold the clip upright.
- **2.** Hold the wool fabric in one hand and the piece of plastic in the other hand. Quickly rub the two items together four or five times.
- **3.** Place the plastic close to the paper clip without touching it. Record the results on the data sheet.
- 4. Predict what caused the results. Write your prediction on the data sheet.

Part II





- 1. Each member of the group must wear goggles.
- 2. Build a closed **circuit** that will light the strand of holiday bulbs. Use the battery and tape strips. (If the wires begin to feel too warm, disconnect one from the battery.)
- **3.** Draw a labeled diagram of your circuit on the data sheet.

Never allow both ends of the wire to touch the ends of the battery for longer than 8–10 seconds because the wire can become very hot.

RESOURCES: EXPLORE

Never allow both ends of the wire to touch the ends of the battery for longer than 8–10 seconds because the wire can become very hot. 4. Next, build an **electromagnet** using the nail, wire, battery, metric ruler, and tape strips. 5. Wrap the insulated (covered) part of the wire around the nail several times.

Leave 10–15 cm of free wire at each end of the nail.

- 6. Tape one free end of the wire to each end of the battery. To test the magnet, try to use the nail to pick up a paper clip. Wrap the wire around the nail one or two more times if the magnet cannot pick up the paper clip.
- 7. Draw a labeled diagram of your electromagnet on the data sheet.

Part III

At the computer, explore the Bitesize website to learn more about electricity.

Electrical Energy Center Instructions, continued

Electrical Energy Center Data Sheet

Nan	ne Date
Part	1
1.	Describe what happens when the plastic gets near the paper clip.
2.	Predict what you think caused the results.
3.	What are other times you have experienced the discharge of static electricity?
Part	
1.	Draw and label the circuit that lights the bulbs. Use the space below.

Electrical Energy Center Data Sheet, continued

2. Draw and label the electromagnet. Use the space below.

3. How is an electromagnet different from a bar magnet?

Human Ear Diagram



Tubular Reflection Instructions

Read all the steps before you begin the investigation.

- 1. Fold a piece of white paper lengthwise. Then unfold the paper so that you see the fold line or crease.
- 2. Use a ruler and a red marker to trace a line along the crease in the paper. When you are done, a red line should run down the center of the paper.
- **3.** Place the red line on the paper **perpendicular** to the mirror in the stand.
- 4. Place one tube on the right side of the red line and one on the left side.
- 5. Position the tubes so they are in the shape of an upside down V, with the point of the V close to the mirror.
- **6.** Shine the penlight down one tube toward the mirror.
- 7. Find the right position for both tubes to allow the light to travel down one tube, bounce off the mirror, and then travel down the other tube.
- **8.** When you find the right position, use the marker to trace a red line along the inner side of each tube to mark their location on the paper.
- **9.** Remove the tubes from the paper and observe the three lines.
- **10.** Then refold the paper along the red crease so that the lines are on the inside of the folded paper. Observe and compare the position of the two red lines marking the location of the tubes.

Observations

Record your observations in your journal.

- 1. Describe the behavior of light as it traveled up the first tube and hit the mirror.
- 2. What direction did the light travel after it hit the mirror?
- **3.** Describe the position of the tubes when light was able to bounce from the mirror and into the second tube.
- 4. What word in geometry is used for angles that have equal measures?

The Magic Penny Instructions

Read all the steps before you begin the investigation.

- **1.** Place a piece of rolled tape on the back of a penny.
- 2. Stick the penny to the inside bottom of a small foam cup.
- **3.** Stand in a position so your view of the penny is blocked by the top edge of the cup. Try to remain in this position during the next step.
- **4.** Slowly pour the water from the second cup into the first cup with the penny until you can see the penny again.
- **5.** Discuss your observations with your group. In your journal, write what you think happened to make the penny appear to move.

Light and Lenses Instructions

Read all the steps before you begin the investigation.

- 1. Observe the index card with the comb taped on it.
- 2. Hold the index card upright in the center of the black sheet of paper.
- **3.** Turn on the penlight and shine it through the comb and the hold in the card. You should see narrow slits of light on the black paper beyond the comb.
- **4.** Place the small jar of water behind the index card in the path of the narrow slits of light created by the comb.
- 5. Draw a diagram of the lab set-up in your journal. Show how the rays of light looked before and after they passed through the jar of water.
- **6.** Remove the jar of water from the paper.
- 7. Observe the convex lens, which is thicker in the middle. Hold the lens in the path of the narrow slits of light. In your journal, draw a diagram of what you observed. Show how the rays looked before and after they passed through the lens.
- 8. Observe the concave lens, which is "caved in" in the middle. Hold the lens in the path of the narrow slits of light. In your journal, draw a diagram of what you observed. Show how the rays looked before and after they passed through the lens.



Peepholes and Prisms Instructions

Read all the steps before you begin the investigation.

- 1. Hold the round Rainbow Peephole up to your eye and look toward an indoor light. Do not look directly at the sun with the peephole!
- 2. Observe the colors you see and their order.
- 3. In your journal, make a diagram of the colors you saw. Make sure to show the colors in the same order as you saw them.
- 4. Observe the glass prism. Shine the penlight through the prism as you turn it slowly near a light-colored wall. Observe the colors you see.
- In your journal, draw and color the rainbow of colors that appeared on the wall. 5.
- 6. In your journal, list the things needed to see a rainbow with a Rainbow Peephole or a prism (hint: three things are needed).



Convex Lens Diagram



Concave Lens Diagram



Diagrams 1–4











Diagrams 1–4, continued



Group Project 1 Rubric

	1-Needs Improvement	2-Satisfactory	3-Excellent
Energy	The five forms of energy are not included.	The five forms of energy are included, but an example of how each one causes change is not.	The five 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 measure- ment included is inappropriate (e.g., time for length).	The units of measure- ment 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.

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measurements accurate and ap- oriate for three	accurate change ovided for three nore forms of rgy.	ee or more forms nergy are used in alistic manner at carnival booth.	ee or more forms nergy are includ- ind accurately lained.	cellent	
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Group Project 2 Rubric in Energy Changes **Energy Use**

Measurement are accurate and appropriate for one The measurements provided. energy changes are form of energy, or no is provided for one An accurate change val booth. manner at the carniis used in a realistic One form of energy One form of energy is provided measurements are form of energy, or no rately explained. included and accu-I-Needs Improvement appropriate are accurate The measur forms of en is provided are used in are include 2-Satisfac An accurate val booth. manner at : Two forms curately exp Two forms of torms of en energy.

Energy

Explanation

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 the question.

Answer Key

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

Energy Assessment

Observe the systems below to answer questions 1–2.



- 1. The primary function of System A is to use electrical energy to produce
 - A sound

.

- **B** heat energy
- **C** magnetism
- **D** mechanical energy
- 2. Which statement is valid?
 - **A** Only System A uses an electrical circuit to produce a form of energy.
 - **B** System B changes light energy to mechanical energy.
 - **C** Each system uses an electrical circuit to produce a form of energy.
 - **D** System C does not require an energy source to perform its function.



- **4.** A student uses a hand lens to observe the parts of an ant. The ant appears larger beneath the hand lens because ______.
 - **A** the size of the lens is larger than the ant
 - **B** light is absorbed by the ant, increasing its mass
 - **C** the ant's size is reflected into both eyes of the student
 - **D** light is refracted as it is transmitted through the hand lens
- **5.** A group of science students create the system shown below. What two physical properties of light are demonstrated?



- **A** reflection; light travels in straight lines
- **B** reflection; magnetism
- **C** refraction; light travels in straight lines
- **D** refraction; the speed of light
- **6.** Light energy _____.
 - A is produced by vibrations
 - **B** moves from warmer to cooler substances
 - **C** must travel in a closed circuit
 - **D** travels in straight lines from its source

- **7.** Which one of these Celsius temperatures would typically be considered as comfortable?
 - A 5° Celsius
 - **B** 20° Celsius
 - **C** 40° Celsius
 - **D** 70° Celsius
- **8.** A beam of light is reflected off a mirror. If the angle of incidence is 60 degrees, what would be the angle of reflection?
 - A 90 degrees
 - B 120 degrees
 - C 45 degrees
 - D 60 degrees
- **9.** There is a thunderstorm in the area. You see a bolt of lightning and you immediately start to count the number of seconds. When you hear the thunder, you have counted 12 seconds. Approximately how far away from you was the lightning strike?
 - A 2.4 miles
 - B 12 miles
 - **C** 4 miles
 - D 24 miles

Reading Connections

The following books are recommended as literary resources to enhance the study of light, heat, and sound energy for Grade 5 students.

Light

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

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

Heat

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

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

Sound

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

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

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

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

Texas Essential Knowledge and Skills (TEKS) Focus

§112.16. Science, Grade 5, Beginning with School Year 2010–2011.

- (b) Knowledge and skills.
 - (1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:
 - (A) demonstrate safe practices and the use of safety equipment as described in the Texas Safety Standards during classroom and outdoor investigations.
 - (2) Scientific investigation and reasoning. The student uses scientific methods during laboratory and outdoor investigations. The student is expected to:
 - (A) describe, plan, and implement simple experimental investigations testing one variable;
 - (B) ask well-defined questions, formulate testable hypotheses, and select and use appropriate equipment and technology;
 - (C) collect information by detailed observations and accurate measuring;
 - (D) analyze and interpret information to construct reasonable explanations from direct (observable) and indirect (inferred) evidence;
 - (E) demonstrate that repeated investigations may increase the reliability of results;
 - (F) communicate valid conclusions in both written and verbal forms; and
 - (G) construct appropriate simple graphs, tables, maps, and charts using technology, including computers, to organize, examine, and evaluate information.
 - (3) Scientific investigation and reasoning. The student uses critical thinking and scientific problem solving to make informed 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) draw or develop a model that represents how something works or looks that cannot be seen such as how a soda dispensing machine works.
 - (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 calculators, microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, prisms, mirrors, pan balances, triple beam balances, spring scales, graduated cylinders, beakers, hot plates, meter sticks, magnets, collecting nets, and notebooks; timing devices, including clocks and stopwatches; and materials to support observations of habitats or organisms such as terrariums and aquariums; and
 - (B) use safety equipment, including safety goggles and gloves.

- (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) classify matter based on physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating), solubility in water, and the ability to conduct or insulate thermal energy or electric energy;
 - (D) identify changes that can occur in the physical properties of the ingredients of solutions such as dissolving salt in water or adding lemon juice to water.
- (6) Force, motion, and energy. The student knows that energy occurs in many forms and can be observed in cycles, patterns, and systems. The student is expected to:
 - (A) explore the uses of energy, including mechanical, light, thermal, electrical, and sound energy;
 - (B) demonstrate that the flow of electricity in circuits requires a complete path through which an electric current can pass and can produce light, heat, and sound;
 - (C) demonstrate that light travels in a straight line until it strikes an object or travels through one medium to another and demonstrate that light can be reflected such as the use of mirrors or other shiny surfaces and refracted such as the appearance of an object when observed through water.

§111.17. Mathematics, Grade 5.

- (b) Knowledge and skills.
 - (2) Number, operation, and quantitative reasoning. The student uses fractions in problemsolving situations. The student is expected to:
 - (A) generate a fraction equivalent to a given fraction such as 1/2 and 3/6 or 4/12 and 1/3.
 - (11) Measurement. The student applies measurement concepts. The student measures time and temperature (in degrees Fahrenheit and Celsius). The student is expected to:
 - (A) solve problems involving changes in temperature.
 - (16) Underlying processes and mathematical tools. The student uses logical reasoning. The student is expected to:
 - (A) make generalizations from patterns or sets of examples and nonexamples; and
 - (B) justify why an answer is reasonable and explain the solution process.

§126.3. Technology Applications, Grades 3–5.

(b) Knowledge and skills.

- (4) Information acquisition. The student uses a variety of strategies to acquire information from electronic resources, with appropriate supervision. The student is expected to:
 - (B) select appropriate strategies to navigate and access information on local area networks (LANs) and wide area networks (WANs), including the Internet and intranet, for research and resource sharing.

- (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;
- (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; and
 - (C) use a variety of data types including text, graphics, digital audio, and video.
- (10) Communication. The student formats digital information for appropriate and effective communication. The student is expected to:
 - (A) use font attributes, color, white space, and graphics to ensure that products are appropriate for the defined audience;
 - (B) use font attributes, color, white space, and graphics to ensure that products are appropriate for the communication media including multimedia screen displays, Internet documents, and printed materials;
- (11) Communcation. 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; and

§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:
 - identify the student's English language proficiency levels in the domains of listening, speaking, reading, and writing in accordance with the proficiency level descriptors for the beginning, intermediate, advanced, and advanced high levels delineated in subsection (d) of this section;
 - (2) provide instruction in the knowledge and skills of the foundation and enrichment curriculum in a manner that is linguistically accommodated (communicated, sequenced, and scaffolded) commensurate with the student's levels of English language proficiency to ensure that the student learns the knowledge and skills in the required curriculum;
 - (3) provide content-based instruction including the cross-curricular second language acquisition essential knowledge and skills in subsection (c) of this section in a manner that is linguistically accommodated to help the student acquire English language proficiency; and
 - (4) provide intensive and ongoing foundational second language acquisition instruction to ELLs in Grade 3 or higher who are at the beginning or intermediate level of English language proficiency in listening, speaking, reading, and/or writing as determined by the state's English language proficiency assessment system. These ELLs require focused, targeted, and systematic second language acquisition instruction to provide them with the foundation of English language vocabulary, grammar, syntax, and English mechanics necessary to support content-based instruction and accelerated learning of English.
- (c) Cross-curricular second language acquisition essential knowledge and skills.
 - (1) Cross-curricular second language acquisition/learning strategies. The ELL uses language learning strategies to develop an awareness of his or her own learning processes in all content areas. In order for the ELL to meet grade-level learning expectations across the foundation and enrichment curriculum, all instruction delivered in English must be linguistically accommodated (communicated, sequenced, and scaffolded) commensurate with the student's level of English language proficiency. The student is expected to:
 - (A) use prior knowledge and experiences to understand meanings in English;
 - (B) monitor oral and written language production and employ self-corrective techniques or other resources;
 - (C) use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary;
 - (D) speak using learning strategies such as requesting assistance, employing non-verbal cues, and using synonyms and circumlocution (conveying ideas by defining or describing when exact English words are not known);

- (E) internalize new basic and academic language by using and reusing it in meaningful ways in speaking and writing activities that build concept and language attainment;
- (F) use accessible language and learn new and essential language in the process;
- (G) demonstrate an increasing ability to distinguish between formal and informal English and an increasing knowledge of when to use each one commensurate with grade-level learning expectations; and
- (H) develop and expand repertoire of learning strategies such as reasoning inductively or deductively, looking for patterns in language, and analyzing sayings and expressions commensurate with grade-level learning expectations.

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