Shelby County Schools Science Vision

Shelby County Schools' vision of science education is to ensure that from early childhood to the end of the 12th grade, all students have heightened curiosity and an increased wonder of science; possess sufficient knowledge of science and engineering to engage in discussions; are able to learn and apply scientific and technological information in their everyday lives; and have the skills such as critical thinking, problem solving, and communication to enter careers of their choice, while having access to connections to science, engineering, and technology.

To achieve this, Shelby County Schools has employed The Tennessee Academic Standards for Science to craft meaningful curricula that is innovative and provide a myriad of learning opportunities that extend beyond mastery of basic scientific principles.

Introduction

In 2014, the Shelby County Schools Board of Education adopted a set of ambitious, yet attainable goals for school and student performance. The District is committed to these goals, as further described in our strategic plan, Destination 2025. In order to achieve these ambitious goals, we must collectively work to provide our students with high quality standards aligned instruction. The Tennessee Academic Standards for Science provide a common set of expectations for what students will know and be able to do at the end of each grade, can be located in the Tennessee Science Standards Reference. Tennessee Academic Standards for Science are rooted in the knowledge and skills that students need to succeed in post-secondary study or careers. While the academic standards establish desired learning outcomes, the curricula provides instructional planning designed to help students reach these outcomes. The curriculum maps contain components to ensure that instruction focuses students toward college and career readiness. Educators will use this guide and the standards as a roadmap for curriculum and instruction. The sequence of learning is strategically positioned so that necessary foundational skills are spiraled in order to facilitate student mastery of the standards.

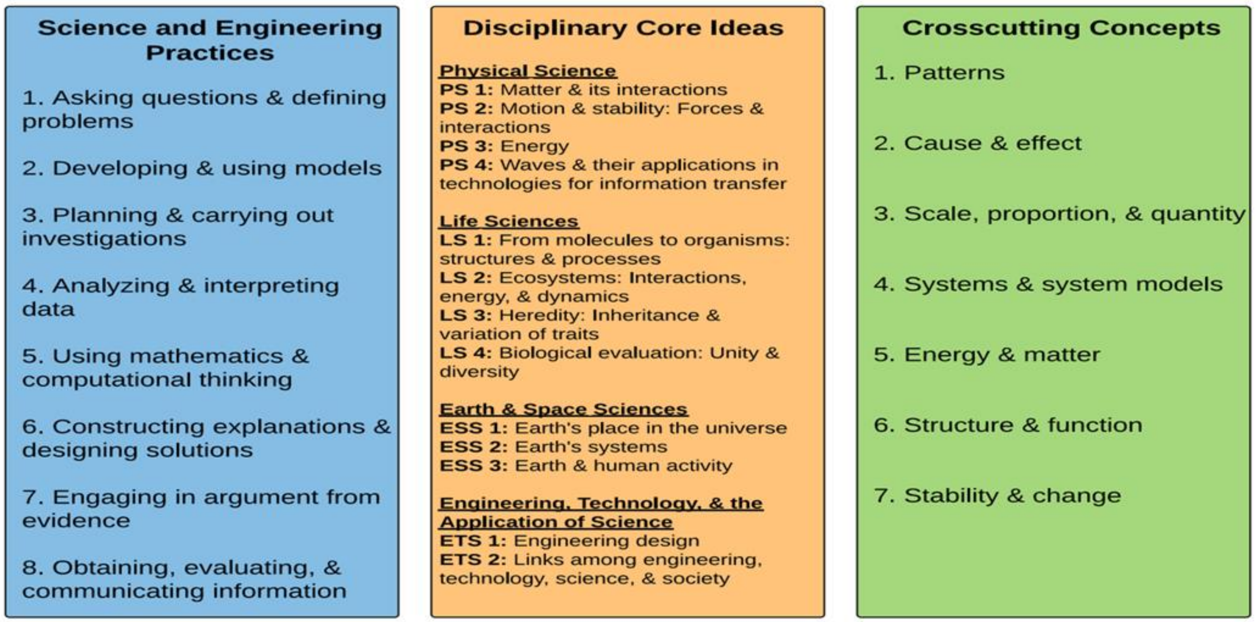
Our collective goal is to ensure our students graduate ready for college and career. Being College and Career Ready entails, many aspects of teaching and learning. We want our students to apply their scientific learning in the classroom and beyond. These valuable experiences include students being facilitators of their own learning through problem solving and thinking critically. The Science and Engineering Practices are valuable tools used by students to engage in understanding how scientific knowledge develops.These practices rest on important "processes and proficiencies" with longstanding importance in science education. The science maps contain components to ensure that instruction focuses students toward understanding how science and engineering can contribute to meeting many of the major challenges that confront society today. The maps are centered around five basic components: the Tennessee Academic Standards for Science, Science and Engineering Practices, Disciplinary Core Ideas, Crosscutting Concepts, and Phenomena.

The Tennessee Academic Standards for Science were developed using the National Research Council's 2012 publication, A Framework for K-12 Science Education as their foundation. The framework presents a new model for science instruction that is a stark contrast to what has come to be the norm in science classrooms. Thinking about science had become memorizing concepts and solving mathematical formulae. Practicing science had become prescribed lab situations with predetermined outcomes. The framework proposes a three-dimensional approach to science education that capitalizes on a child's natural curiosity. The Science Framework for K-12 Science Education provides the blueprint for developing the effective science practices. The *Framework* expresses a vision in science education that requires students to operate at the nexus of three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. The *Framework* identified a small number of disciplinary core ideas that all students should learn with increasing depth and sophistication, from Kindergarten through grade twelve. Key to the vision expressed in the *Framework* is for students to learn these disciplinary core ideas in the context of science and engineering practices. The importance of combining Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas is stated in the *Framework* as follows:

Standards and performance expectations that are aligned to the framework must take into account that students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in practices except in the context of specific content. (NRC Framework, 2012, p. 218)

To develop the skills and dispositions to use scientific and engineering practices needed to further their learning and to solve problems, students need to experience instruction in which they use multiple practices in developing a particular core idea and apply each practice in the context of multiple core ideas. We use the term "practices" instead of a term such as "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Students in grades K-12 should engage in all eight practices over each grade band**.** Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. Crosscutting concepts have value because they provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. There are seven crosscutting concepts that bridge disciplinary boundaries, uniting core ideas throughout the fields of science and engineering. Their purpose is to help students deepen their understanding of the disciplinary core ideas and develop a coherent and scientifically based view of the world.

The map is meant to support effective planning and instruction to rigorous standards. It is *not* meant to replace teacher planning, prescribe pacing or instructional practice. In fact, our goal is not to merely "cover the curriculum," but rather to "uncover" it by developing students' deep understanding of the content and mastery of the standards. Teachers who are knowledgeable about and intentionally align the learning target (standards and objectives), topic, text(s), task, and needs (and assessment) of the learners are best-positioned to make decisions about how to support student learning toward such mastery. Teachers are therefore expected--with the support of their colleagues, coaches, leaders, and other support providers--to exercise their professional judgment aligned to our shared vision of effective instruction, the Teacher Effectiveness Measure (TEM) and related best practices. However, while the framework allows for flexibility and encourages each teacher/teacher team to make it their own, our expectations for student learning are non-negotiable. We must ensure all of our children have access to rigor—high-quality teaching and learning to grade level specific standards, including purposeful support of literacy and language learning across the content areas.



Learning Progression

At the end of the elementary science experience, students can observe and measure phenomena using appropriate tools. They are able to organize objects and ideas into broad concepts first by single properties and later by multiple properties. They can create and interpret graphs and models that explain phenomena. Students can keep notebooks to record sequential observations and identify simple patterns. They are able to design and conduct investigations, analyze results, and communicate the results to others. Students will carry their curiosity, interest and enjoyment of the scientific world view, scientific inquiry, and the scientific enterprise into middle school.

At the end of the middle school science experience, students can discover relationships by making observations and by the systematic gathering of data. They can identify relevant evidence and valid arguments. Their focus has shifted from the general to the specific and from the simple to the complex. They use scientific information to make wise decision related to conservation of the natural world. They recognize that there are both negative and positive implications to new technologies.

As an SCS graduate, former students should be literate in science, understand key science ideas, aware that science and technology are interdependent human enterprises with strengths and limitations, familiar with the natural world and recognizes both its diversity and unity, and able to apply scientific knowledge and ways of thinking for individual and social purposes.

Structure of the Standards

- Grade Level/Course Overview: An overview that describes that specific content and themes for each grade level or high school course.
- Disciplinary Core Idea: Scientific and foundational ideas that permeate all grades and connect common themes that bridge scientific disciplines.
- Standard: Statements of what students can do to demonstrate knowledge of the conceptual understanding. Each performance indicator includes a specific science and engineering practice paired with the content knowledge and skills that students should demonstrate to meet the grade level or high school course standards.

Purpose of Science Curriculum Maps

This map is a guide to help teachers and their support providers (e.g., coaches, leaders) on their path to effective, college and career ready (CCR) aligned instruction and our pursuit of Destination 2025. It is a resource for organizing instruction around the Tennessee Academic Standards for Science, which define what to teach and what students need to learn at each grade level. The map is designed to reinforce the grade/course-specific standards and content (scope) and provides *suggested* sequencing, pacing, time frames, and aligned resources. Our hope is that by curating and organizing a variety of standards-aligned resources, teachers will be able to spend less time wondering what to teach and searching for quality materials (though they may both select from and/or supplement those included here) and have more time to plan, teach, assess, and reflect with colleagues to continuously improve practice and best meet the needs of their students.

The map is meant to support effective planning and instruction to rigorous standards. It is *not* meant to replace teacher planning, prescribe pacing or instructional practice. In fact, our goal is not to merely "cover the curriculum," but rather to "uncover" it by developing students' deep understanding of the content and mastery of the standards. Teachers who are knowledgeable about and intentionally align the learning target (standards and objectives), topic, text(s), task, and needs (and assessment) of the learners are best-positioned to make decisions about how to support student learning toward such mastery. Teachers are therefore expected--with the support of their colleagues, coaches, leaders, and other support providers--to exercise their professional judgment aligned to our shared vision of effective instruction, the Teacher Effectiveness Measure (TEM) and related best practices. However, while the framework allows for flexibility and encourages each teacher/teacher team to make it their own, our expectations for student learning are non-negotiable. We must ensure all of our children have access to rigor—high-quality teaching and learning to grade level specific standards, including purposeful support of literacy and language learning across the content areas.

4th Grade Quarter 2 Curriculum Map Quarter 2 Curriculum Map Feedback						
Quarter 1		**Quarter 2**		Quarter 3		Quarter 4
Structure and Procedure	Unit 1 Interactions of Living Things	**Unit 2 Energy**	Unit 3 Wave Patterns and Information Transfer	Unit 4 Earth and Its Resources	Unit 5 Earth and Its Changing Features	Unit 6 The Sun and Earth
1 week	8 weeks	**4.5 weeks**	4.5 weeks	3 weeks	6 weeks	9 weeks

UNIT 2: Energy (4.5 weeks)
Overarching Question(s)
How is energy transferred and conserved?

Unit 2: Energy, Lesson 1	**Lesson Length**	**Essential Question**	**Vocabulary**
Speed and Energy	1.5 weeks	How are speed and energy related?	speed, velocity, acceleration, force, energy, contact force, noncontact force, gravity, friction

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI(s) 4.PS3 Energy **Standard(s)** 4.PS3.1: Use evidence to explain the cause and effect relationship between the speed of an object and the energy of an object. **Explanation and Support of Standard** 4.PS3.1 3.PS3.1 introduces one type of energy: the energy of motion. All moving objects possess the energy of motion. Transfer of energy between objects can	**Learning Outcomes** Students will explain the relationship between the speed and energy of an object. **Suggested Phenomena** *Click on the phenomenon picture to view the video.* 	**Curricular Resources** Engage Inspire Science TE, p. 187-188 TE, p. 187 *(LAB)* Be a Scientist Notebook, Phenomenon, p. 197 TE, Essential Question, p. 188 TE, Science and Engineering Practices, p. 188 Explore TE, pp. 189-190 *(LAB)* Be a Scientist Notebook, p.199, Inquiry Activity: The Moving Ball

change the shape of colliding objects. These ideas together provide the evidence needed to support that faster objects have more energy as evidenced by greater change in shape. For example, a ball can be dropped onto a pillow, vs thrown downward onto a pillow. Students should be able to explain why the speed (i.e. energy) of the ball is different in each trial, and observe that the pillow changes shapes to a different degree in each instance. An equivalent investigation could be performed by dropping loosely-filled balloons of flour, or play dough and observing the subsequent change in shape. From the opposite perspective, a change in the shape of an elastic object (a spring-loaded or pop-up toy) with a visible spring can show that a greater change in the shape of the spring will give an object more speed if powered by that spring (e.g. projectile or car). The two approaches would establish the reciprocity in the speed/energy relationship: more speed means something has more energy and giving adding energy to an object increases its speed. **Suggested Science and Engineering Practice(s)** Constructing Explanations and Designing Solutions **Suggested Crosscutting Concept(s)**	Phenomenon Explanation: While running, animals convert kinetic and potential energy into elastic energy stored in their tendons and muscles as they fall, which is then converted back into kinetic and potential energy as they bounce up; just like the energy stored and released from the springs in a pogo stick.	Explain TE, pp. 190-196 Be A Scientist Notebook, p. 201: Vocabulary Video: Speed and Energy Science Handbook/eBook: Measuring Motion Science Handbook/eBook: Force and Acceleration Elaborate TE, pp. 196-198 *(LAB)* Be a Scientist Notebook, p. 205, Inquiry Activity: Mass Matters Evaluate TE, pp. 198-201 *(LAB)* Be A Scientist Notebook, p. 208, Performance Task: Test Toy Cars eAssessment **Additional Resources** Lesson: What Is Energy Lesson Lesson: What Is Energy 2 Lesson: Newton's Apple Day 1 Lesson: Newton's Apple Day 2 Lesson: Gravitational Energy Lesson: Drop and Pop - Energy and Speed Exploration Video: Fastest Speed on a Skateboard **ESL Supports and Scaffolds**

Energy and Matter **Teacher Overview** Energy can be classified as kinetic energy (energy of motion) or potential energy. An object placed on a shelf has potential energy. If the object were to fall from the shelf, the potential energy would increasingly change to kinetic energy. The kinetic energy of the object increases as it falls, and the potential energy decreases as it falls. Any object that is moving has kinetic energy. The kinetic energy of an object depends on both the speed and mass of the object. When an object is not moving, it can still have potential energy. **Misconceptions** Many students may also think that energy can be created or destroyed. For example, if wood in a campfire catches fi re, students may think that the fi re "uses up" energy, which is then lost. In fact, the energy is transferred to heat, which is dissipated back into the environment. Energy is conserved, meaning that energy can change form but is not destroyed.		WIDA Standard 4- The Language of Science To support students in speaking, refer to this resource: WIDA Doing and Talking Science To support students: **Model speaking and writing expectations for Entering Level ELs. Consider using the recommended stems to support students in their discussions and writing.** **Explain sentence stems:** Provide claims and evidence: write assertions about what was learned from the investigation, use the data as evidence to support those claims. I claim that . I know_______this because . Cause and Effect Stems: The speed changed because…… When_______happened, the speed_________because_____

4th Grade Quarter 2 Curriculum Map Quarter 2 Curriculum Map Feedback						
Quarter 1		**Quarter 2**		Quarter 3		Quarter 4
Structure and Routine	Unit 1 Interactions of Living Things	**Unit 2 Energy**	Unit 3 Wave Patterns and Information Transfer	Unit 4 Earth and Its Resources	Unit 5 Earth and Its Changing Features	Unit 6 The Sun and Earth
1 week	8 weeks	**4.5 weeks**	4.5 weeks	3 weeks	6 weeks	9 weeks

UNIT 2: Energy (4.5 weeks)
Overarching Question(s)
How is energy transferred and conserved?

Unit 2: Energy, Lesson 2	**Lesson Length**	**Essential Question**	**Vocabulary**
Energy Change in Collisions	1.5 weeks	What happens when objects collide?	work, potential energy, kinetic energy, mechanical energy, energy transfer, conservation of energy

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI(s) 4.PS3 Energy **Standard(s)** 4.PS3.2: Observe and explain the relationship between potential energy and kinetic energy. **Explanation and Support of Standard** 4.PS3.2 The idea that energy is "produced" leads to misunderstandings about energy and is an obstacle when trying to understand	**Learning Outcomes** Students will make predictions about energy changes that occur when objects collide. **Suggested Phenomena** *Click on the phenomenon picture to view the video.* 	**Curricular Resources** Engage TE, p. 203-204 TE, p. 203 Be a Scientist Notebook, p. 213, Phenomenon TE, p. 213, Essential Question TE, Science and Engineering Practices: p. 213 Explore TE, pp. 204-206 *(LAB)* Be a Scientist Notebook, p. 215, Inquiry: Collision Variables

conservation of energy. Energy always exists and just gets transferred. An object that suddenly begins to move did not produce energy. In reality, some form of stored energy was converted to energy of motion (kinetic energy.) For example, water behind a dam wall possesses potential energy and be set into motion (gain kinetic energy) when gates are opened. This standard bundles well with 4.PS3.3. **Suggested Science and Engineering Practice(s)** Obtaining, Evaluating, and Communicating Information **Suggested Crosscutting Concept(s)** Energy and Matter **Teacher Overview** A collision occurs when two objects come into contact with one another. In physics, a collision is not necessarily an accident, like a car crash. Rather, a collision is any event where two or more moving objects exert forces on each other for a short time. The contact force results from the interaction of the two objects in contact with one another. Think of kicking a soccer ball. When the ball is at rest, there are two forces acting on the	Stacked Ball Drop Experiment Phenomena Explanation: Use a large, heavy ball and a small, light ball for this experiment. You'll need a lot of room, so consider taking this activity outdoors. Hold the large ball in one hand. Place the smaller ball on top and hold it still. Take your hands off of both balls at the same time. The largest ball hits the ground and the smallest ball hits the larger one and bounces into the air. The large ball compresses and has stored energy when it hits the ground, and transfers the energy to the smaller ball as it expands and bounces upward.	 Explain TE, pp. 206-210 Be A Scientist Notebook, p. 217, Vocabulary Science Handbook/eBook: Forms of Energy Science Handbook/eBook: Energy Changes Digital Interactive: Conservation of Energy Elaborate TE, pp. 210-211 *(LAB)* Be a Scientist Notebook, p. 220, Inquiry Activity: Newton's Cradle Evaluate TE, pp. 212-213 *(LAB)* Be A Scientist Notebook, p. 221 Performance Task: Protect an Egg eAssessment **Additional Resources** Lesson: Yummy, Energy Change Lesson: Colliding Marbles Video Clip: Kinetic and Potential Energy Video: Potential and Kinetic Energy Lab: Simple Water Wheel **ESL Supports and Scaffolds** WIDA Standard 4- The Language of Science To support students in speaking, refer to this resource:

ball: gravity and the ground. You want to move the ball, so you kick it. When you kick the ball, you are supplying the contact force. The ball moves away from your foot. The ball also exerts an equal amount of force back on your foot, but since your mass is much greater and you have more energy than the stationary ball, your foot does not stop. In all cases of collisions, there is an energy transfer, which can result in motion changes on an object that was in a collision. **Misconceptions** A common misconception is that when a force that keeps an object in motion stops, the object will stop without another force being applied. Think of a soccer ball being kicked. The soccer ball may bounce and roll for some distance, but it eventually comes to a stop, seemingly without any interference from another object. In this case, the soccer ball will come to a stop due to friction between the ball, ground, and air. This friction is the result of gravity. Objects we observe in motion, such as cars and airplanes, need a constant force to keep them in motion only because they must overcome friction and gravity. If friction and gravity did not exist, an object in motion would stay in motion due to inertia.		WIDA Doing and Talking Science **Consider pre-teaching the following additional vocabulary to entering level ELs:** Relationship, collide, potential, convert, release To support students when they design their device: **Model speaking and writing expectations for Entering Level ELs. Consider using the recommended stems to support students in their discussions and writing.** Sentence stems for observation: I notice…. When____ happened_____ I noticed/observed I think_____will happen/occur when______ Write a plan: communicate ideas on an approach to answer the focus question or challenge posed in the investigation. Use adverbs such as *first*, *second*, *next*, *then*, *finally*. Brainstorming ideas: First I will , and then I will . I will need to to . Question Starters What's the connection between….? What link do you see between…

		Why do you think…? What is our evidence that…. Do we have enough evidence to make that claim? But what about this other evidence that shows…?

4th Grade Quarter 2 Curriculum Map

[Quarter 2 Curriculum Map Feedback]

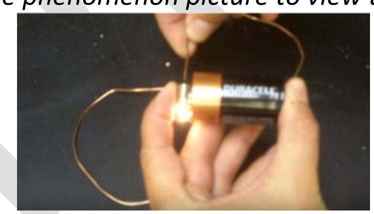
Quarter 1		Quarter 2		Quarter 3		Quarter 4
Structure and Procedure	Unit 1 Interactions of Living Things	**Unit 2 Energy**	Unit 3 Wave Patterns and Information Transfer	Unit 4 Earth and Its Resources	Unit 5 Earth and Its Changing Features	Unit 6 The Sun and Earth
1 week	9 weeks	**4.5 weeks**	4.5 weeks	3 weeks	6 weeks	9 weeks

UNIT 2: Energy (4.5 weeks)

Overarching Question(s)

How is energy transferred and conserved?

Unit 2: Lesson 3	Lesson Length	Essential Question	Vocabulary
Energy Transformations	1.5 weeks	How can stored energy be used?	battery, electric current, circuit, switch, resistor, electromagnet, generator

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI(s) 4.PS3 Energy 4.ETS1 Engineering Design **Standard(s)** 4.PS3.3: Describe how stored energy can be converted into another form for practical use. 4.ETS1.1: Categorize the effectiveness of design solutions by comparing them to specified criteria for constraints.	**Learning Outcomes** Students will make observations and use data to provide evidence that stored energy can be converted into another useful form. **Suggested Phenomena** *Click on the phenomenon picture to view the video.*  Phenomena Explanation:	**Curricular Resources** Engage TE, p. 215-216 TE, Phenomenon, p. 215 Be a Scientist Notebook, p. 225, Phenomenon TE, Essential Question: p. 216 Science and Engineering Practices: p. 216 Explore TE, pp. 216-218 *(LAB)* Be a Scientist Notebook, p. 227, Inquiry Activity: Simple Electricity

Explanation and Support of Standard 4.PS3.3 The most important idea in this standard is that energy can be stored and used later. Examples of stored (potential) energy include: food as stored chemical energy, batteries that store electrical energy, stretched rubber bands that store elastic potential energy, balls lifted off the ground result in gravitational potential energy. Each of these types of potential energy can be transferred to an object to give it kinetic energy (change its motion): Food allows us to walk, batteries may cause a fan's blades to spin, rubber bands might launch toy planes, or balls may be dropped and gain speed. *(Differentiating between types of potential energy is beyond the scope of this standard, but was here for clarity. Students can simply understand that potential energy is stored energy that can be used later.)* 4.ETS1.1 A final solution can be developed/selected only after preliminary solutions have been tested. The designs that are tested should incorporate the constraints that are part of	Electrical energy from the battery is converted into light energy. The electrical energy flows through the wire and converts into light energy when the light bulb comes on.	Explain TE, pp. 218-223 Be A Scientist Notebook, p. 229: Vocabulary Science Handbook/eBook: Energy Transformations Science Handbook/eBook: Battery Power Science Handbook/eBook: Electric Current Digital Interactive: Electric Currents in a Circuit Science Handbook/eBook: Electromagnets Elaborate TE, p. 224 Video: How a Generator Works *(LAB)* Be a Scientist Notebook, p. 234, Inquiry Activity: How a Generator Works Evaluate TE, pp. 224-227 *(LAB)* Be A Scientist Notebook, p. 235, Performance Task: Make It Work eAssessment **Additional Resources** Video/Experiment: How to Make Electromagnet Experiment Lesson: Electromagnet Lesson: Creative Circuits Video: Electromagnet Video: Electrical Circuits **ESL Supports and Scaffolds**

the design problem and a successful solution should meet the pre-determined criteria for success. Students might examine proposed design solutions meant to minimize the human impact on the land and ocean, or means of obtaining natural resources. *(Design criteria and constraints are introduced in 3.ETS1.1)* **Suggested Science and Engineering Practice(s)** Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information **Suggested Crosscutting Concept(s)** Energy and Matter **Teacher Overview** Energy can be transformed from one form to another, such as potential energy to kinetic energy or mechanical energy to electrical energy. Electrical energy can then be transformed into other forms of energy, such as light, heat, and sound energy. The law of conservation of energy states that		WIDA Standard 4- The Language of Science To support students in speaking, refer to this resource: WIDA Doing and Talking Science **Consider pre-teaching the following additional vocabulary to entering level ELs:** Convert, form To support students when they design their device: **Model speaking and writing expectations for Entering Level ELs. Consider using the recommended stems to support students in their discussions and writing.** Use graphic organizers or concept maps to support students in their analysis of what happens when energy is converted into another form. Sentence stems for observation: I notice…. When____ happened_____ I noticed/observed I think_____will happen/occur when______ Question Starters What's the connection between….? What link do you see between… Why do you think…? What is our evidence that…. Do we have enough evidence to make that claim? But what about this other evidence that shows…?

energy can only be transformed. It cannot be created or destroyed. **Misconceptions** Students may be confused by the fact that they have studied different forms of energy, and they may not be aware that one kind of energy can transform into other forms. They may be confused about how current electricity is generated, especially if they have studied static electricity. Explain that in this lesson they will make observations that show that electric currents transfer energy.		

4th Grade Quarter 2 Curriculum Map Quarter 2 Curriculum Map Feedback						
Quarter 1		**Quarter 2**		Quarter 3		Quarter 4
Structure and Routine	Unit 1 Interactions of Living Things	Unit 2 Energy	**Unit 3 Wave Patterns and Information Transfer**	Unit 4 Earth and Its Resources	Unit 5 Earth and Its Changing Features	Unit 6 The Sun and Earth
1 week	8 weeks	4.5 weeks	**4.5 weeks**	3 weeks	6 weeks	9 weeks

UNIT 2: Energy (4.5 weeks)
Overarching Question(s)
How are waves used to transfer energy and information?

Unit 3: Wave Patterns and Information Transfer, **Lesson 1**	**Lesson Length**	**Essential Question**	**Vocabulary**
How Waves Move	1.5 weeks	How do waves travel?	vibration, sound wave, medium, wavelength, frequency, pitch, amplitude, volume

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI(s) 4.PS4 Waves and Their Application in Technologies for Information Transfer 4.ETS2 Links Among Engineering, Technology, Science, and Society **Standard(s)** 4.PS4.1: Use a model of a simple wave to explain regular patterns of amplitude, wavelength, and direction.	**Learning Outcomes** Students will develop a physical model of waves to show patterns of amplitude and wavelength. **Suggested Phenomena** *Click on the phenomenon picture to view the video.*	**Curricular Resources** Engage TE, p. 233-234 TE, p. 233: Phenomenon Be a Scientist Notebook, p. 243, Phenomenon TE, p. 234 Essential Question TE, p. 234 Science and Engineering Practices Explore TE, pp. 235-236 *(LAB)* Be a Scientist Notebook, p. 7, Inquiry Activity: What Makes Sound?

4.ETS2.1: Use appropriate tools and measurements to build a model. **Explanation and Support of Standard** 4.PS4.1 As a wave travels through a medium, it will move in a regular pattern and has the ability to move objects. The pattern in the motion of the object will match the pattern of motion in the wave traveling through the medium. Second grade investigations of waves can be reused with the addition of teacher-directed observations or measurements. Objects of different sizes can be dropped into clear-sided containers of water to create waves. Varying amplitudes can be accomplished by dropping an object from different heights. Resulting waves will have different amplitudes because of the different amounts of energy transferred to the water. Students can design experiments to attempt to vary wavelength, but unless the liquid in the container is changed wavelength will not change. The wave moves across the surface of the water, but objects floating on the surface of the water will move in the same direction as the object that created the wave. So if an object is dropped to create a wave, then objects floating on the water will bob up and down, but not move horizontally.	 Seeing Sound Waves (Video) Phenomena Explanation: Sound waves are transmitted through matter, but do not carry matter with them as they move.	Explain TE, pp. 236-241 Be A Scientist Notebook, p. 248: Vocabulary Science Handbook/eBook: Sound Energy Science Handbook/eBook: Pitch and Volume Elaborate TE, p. 242 *(LAB)* Be a Scientist Notebook, p. 252, Inquiry Activity: Pitch and Water Evaluate TE, pp. 243-245 *(LAB)* Be A Scientist Notebook, p.253, Performance Task: Making Waves eAssessment **Additional Resources** Video: Pop Bottle Music Lesson: Amplitude of a Waves Lesson Lesson: What are Waves Lab: Pop Bottle Pitch and Sound Experiment **ESL Supports and Scaffolds** WIDA Standard 4- The Language of Science To support students in speaking, refer to this resource: WIDA Doing and Talking Science

4.ETS2.1 Scientists rely on tools developed and improved by engineers to gather data in order to answer questions about the natural world. Math standards in the measurement and data domain support student measurements of length, liquid volume, and mass/weight. Number fluency standards includes numbers with up to two decimal places. (e.g. measurements in centimeters with a standard centimeter ruler that also includes marked millimeters). Examples of appropriate tools and measurements may include rulers, scissors, glass lenses or mirrors to develop a pin-hole camera, a periscope, or kaleidoscope to explain the phenomena of visible light must bounce off an object and enter the eye for an object to be seen. *(It is not necessary to consider the difference between mass and weight.)* **Suggested Science and Engineering Practice(s)** Developing and Using Models **Suggested Crosscutting Concept(s)** Patterns		**Consider pre-teaching the following additional vocabulary to entering level ELs:** Wave To support students when they design their device: **Model speaking and writing expectations for Entering Level ELs. Consider using the recommended stems to support students in their discussions and writing.** Sentence stems for observation: I notice…. When____ happened_____ I noticed/observed I think_____will happen/occur when______ <u>Question Starters</u> What's the connection between….? What link do you see between… Why do you think…? What is our evidence that…. Do we have enough evidence to make that claim? But what about this other evidence that shows…?

Teacher Overview Mechanical waves, such as sound, water, and seismic waves, transmit energy from one place to another through the motion of particles. The particles themselves do not travel along the wave. Particles transfer energy from one to another, and it is the energy that moves in the direction of the wave. An object rises and falls as a water wave passes it. The object does not move in the direction that the wave is traveling. The frequency of a sound wave determines the pitch. High sounds, like the beat of a mosquito's wings, have a high frequency. Low sounds, like the croak of a toad, have a low frequency. The amount of energy in a sound wave is related to its amplitude. Sound waves with high amplitudes are made by objects vibrating with a lot of energy. Amplitude affects the volume, or loudness, of sound. **Misconceptions** Students may think that a wave causes particles to move from the source of the vibration outward. Actually, the wave moves from the source, but the individual particles that transmit energy move only a short distance. In transverse waves, the particles move up and down compared to a horizontal wave front, such as fans standing and sitting in a stadium wave. In longitudinal waves, including sound waves, the		

particles move back and forth along the direction of the wave, but they do not travel along the wave front. If students have misconceptions about amplitude and volume, then use the example of an airplane taking off. In this case, sound waves have high amplitude, so the sounds are loud. But when a girl whispers, her vocal cords only vibrate a little. In this case, the sound waves have low amplitude, so the volume is low.		

4th Grade Quarter 2 Curriculum Map [Quarter 2 Curriculum Map Feedback]					
Quarter 1	**Quarter 2**		Quarter 3		Quarter 4
Unit 1 Interactions of Living Things	Unit 2 Energy	**Unit 3 Wave Patterns and Information Transfer**	Unit 4 Earth and Its Resources	Unit 5 Earth and Its Changing Features	Unit 6 The Sun and Earth
9 weeks	4.5 weeks	**4.5 weeks**	3 weeks	6 weeks	9 weeks

UNIT 2: Wave Patterns and Information Transfer (4.5 weeks)			
Overarching Question(s)			
How are waves used to transfer energy and information?			
Unit 3: **Wave Patterns and Information Transfer, Lesson 2**	**Lesson Length**	**Essential Question**	**Vocabulary**
How Waves Affect How We see	1.5 weeks	How do animal eyes work?	absorption, reflection, refraction, concave lens, convex lens, transparent, translucent, opaque, prism

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI(s) 4.PS4 Waves and Their Application in Technologies for Information Transfer **Standard(s)** 4.PS4.2: Describe how the colors of available light sources and the bending of light waves determine what we see. **Explanation and Support of Standard** 4.PS4.2	**Learning Outcomes** Students will develop a model to describe that light reflecting from objects and entering the eyes allows objects to be seen. **Suggested Phenomena** *Click on the phenomenon picture to view the video.* *Next Page*	**Curricular Resources** Engage TE, p. 247-248 TE, Phenomenon: p. 247 Be a Scientist Notebook, p. 257, Phenomenon TE, Essential Question: p. 248 TE, Science and Engineering Practices: p.249 Explore TE, pp. 249-250

Emphasis: Objects can be seen when light reflected from the surface of objects is detected by light receptors in our eyes. In first grade, students saw that objects are visible because they either reflect or emit their own light and may produce shadows depending on whether or not light passes through them. White light can be produced from a combination of red, green, and blue light, but some activities may be better supported by explaining that white light contains the full spectrum of colors, ROYGBIV. Students can examine and record how the appearances of objects (solid-color and multi-color) change depending on the light source. Prisms can be used to bend light so that it is separated into component colors. Lenses and combinations of lenses can bend light to magnify or focus light for objects that cannot be seen with the naked eye. **Suggested Science and Engineering Practice(s)** Constructing Explanations and Designing Solutions **Suggested Crosscutting Concept(s)** Cause and Effect **Teacher Overview** This is how we and other animals view the world: The light waves reflecting from objects and entering the eye allows objects to be seen. All animals' eyes	 Wolf's Glowing Eyes Phenomena Explanation: Wolves have a special light-reflecting surface right behind their retinas called the tapetum lucidum that helps animals see better in the dark. When light enters the eye, it's supposed to hit a photoreceptor that transmits the information to the brain. But sometimes the light doesn't hit the photoreceptor, so the tapetum lucidum acts as a mirror to bounce it back for a second chance.	*(LAB)* Be a Scientist Notebook, p. 259, Inquiry Activity: Light Travels <u>Explain</u> TE, pp. 251-258 Be A Scientist Notebook, p. 261: Vocabulary Science Handbook/eBook: Light Waves *(LAB)* Be a Scientist Notebook, p. 262, Inquiry Activity: Angle of Reflection Science Handbook/eBook: What Can Light Pass Through? Science Handbook/eBook: The Way Eyes See It Science Handbook/eBook: Light and Color <u>Elaborate</u> TE, pp. 258 Digital Interactive: Why Do Some People Need Eyeglasses? Be a Scientist Notebook, p. 266, Research, Investigate, and Communicate: Why Do Some People Need Eyeglasses? <u>Evaluate</u> TE, pp. 259-261 *(LAB)* Be A Scientist Notebook, p. 267 Performance Task: It's Time to Focus eAssessment **Additional Resources**

take light from the electromagnetic spectrum and send that information as nerve signals to the brain. The brain processes this information that we interpret as images. **Misconceptions** Students may believe that all animals see things in the same way that people do. Actually, eyes differ greatly from one animal to another. For example, cats have much better night vision than humans do. Many animals have little or no color vision. Some animals see electromagnetic radiation in wavelengths that cannot be perceived by humans. For example, bees see ultraviolet light, so a flower likely appears very different to a bee than it does to a human.		Video: Things Animals Perceive that Humans Do Not Video: The Science of Light and Color Video: Invention of the Morse Code Lesson: Light Reflection Lesson: Who Turned Out the Light? Lesson: What is Visible Light? Lesson: Refraction and Rainbows Lesson: Understanding the Eye **ESL Supports and Scaffolds** WIDA Standard 4- The Language of Science To support students in speaking, refer to this resource: WIDA Doing and Talking Science To support students when they design their device: **Model speaking and writing expectations for Entering Level ELs. Consider using the recommended stems to support students in their discussions and writing.** Sentence stems for observation: I notice…. When____ happened_____ I noticed/observed I think_____will happen/occur when______ Question Starters What's the connection between….? What link do you see between…

		Why do you think…? What is our evidence that…. Do we have enough evidence to make that claim? But what about this other evidence that shows…?

4th Grade Quarter 2 Curriculum Map Quarter 2 Curriculum Map Feedback						
Quarter 1		**Quarter 2**		Quarter 3		Quarter 4
Structure and Procedure	Unit 1 Interactions of Living Things	Unit 2 Energy	**Unit 3 Wave Patterns and Information Transfer**	Unit 4 Earth and Its Resources	Unit 5 Earth and Its Changing Features	Unit 6 The Sun and Earth
1 week	8 weeks	4.5 weeks	**4.5 weeks**	3 weeks	6 weeks	9 weeks

UNIT 2: Wave Patterns and Information Transfer (4.5 weeks)			
Overarching Question(s)			
How are waves used to transfer energy and information?			
Unit 3: Wave Patterns and Information Transfer, Lesson 3	**Lesson Length**	**Essential Question**	**Vocabulary**
How Waves Transmit Information	1.5 weeks	How do we use patterns and waves to transmit information?	Echo, echolocation, coding, binary code

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI(s) 4.PS4 Waves and Their Application in Technologies for Information Transfer **Standard(s)** 4.PS4.3: Investigate how lenses and digital devices like computers or cell phones use waves to enhance human senses. 4.ETS2.2: Determine the effectiveness of multiple solutions to a design problem given the criteria and the constraints.	**Learning Outcomes** Students will generate and compare multiple solutions to transmit information using patterns of waves. **Suggested Phenomenon** *Next Page* ↓	**Curricular Resources** Engage Inspire Science TE, p. 263-264 TE, p. 263: Phenomenon Be a Scientist Notebook, p. 271, Phenomenon TE, p. 264: Essential Question TE, p. 264: Science and Engineering Practices Explore TE, pp. 264-266 *(LAB)* Be a Scientist Notebook, p. 273, Inquiry Activity: Using Waves to Transmit Information

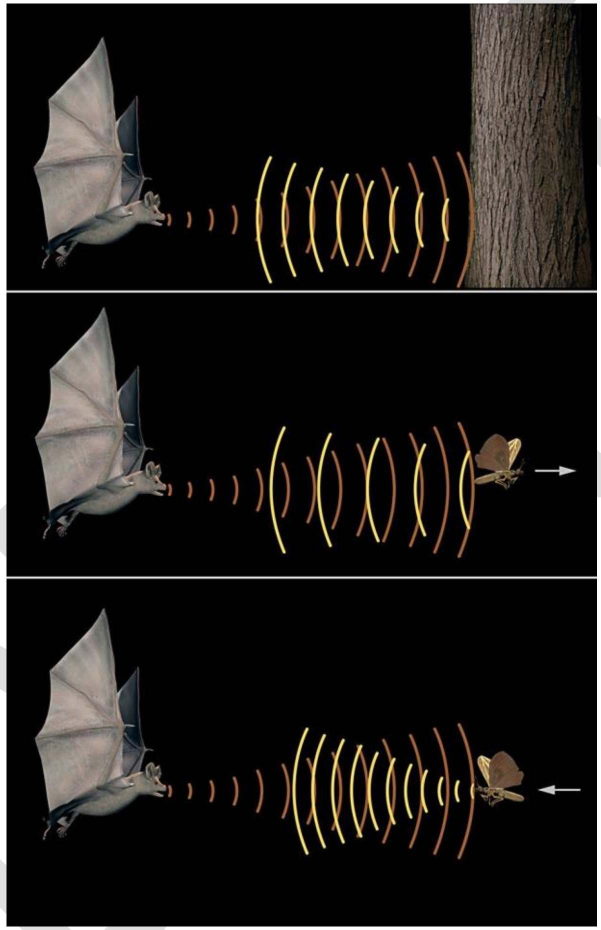
4.ETS2.3: Explain how engineers have improved existing technologies to increase their benefits, to decrease known risks, and to meet societal demands. (artificial limbs, seatbelts, cell phones).

Explanation and Support of Standard
4.PS4.3
Using combinations of lenses, we are able to extend the range of the human senses. While our eyes might not be able to see details in the surface of a piece of paper, a hand lens or the combination of lenses in a microscope extend our vision into a smaller realm. Likewise, binoculars and telescopes allow us to see greater distances.

The digital devices included in the standard all work by making storing digital information and allow us to transfer this information so that it can be experienced indirectly. Digital information can be transferred over distances. This idea bundles well with 4.PS4.1 which explores the idea that waves transfer energy (here, information) from one point to another.

While it is also possible to transfer information over distances by voice or using early non-digital systems mentioned in 2.PS4.2. However, these early systems were less reliable as distance increased.

Click on the phenomenon picture to view the video.



Bat Using Echolocation on Prey

Explain
TE, pp. 266-273
Be A Scientist Notebook, p. 275: Vocabulary
Video: Information Transfer
Science Handbook/eBook: Reflection of Sound
Digital Interactive: Echolocation in Animals
Science Files: How Does Technology Help Us Transfer Information?
(LAB) Be a Scientist Notebook, p. 278, Inquiry Activity: Morse Code

Elaborate
TE, pp. 273-275
(LAB) Be a Scientist Notebook, p. 281, Inquiry Activity: What's That Say?

Evaluate
TE, pp. 275-277
(LAB) Be A Scientist Notebook, p. 284, Performance Task: Pixel Message
Video: Patterns and Waves for Essential Question: How do we use patterns and waves to transmit information?
eAssessment

Additional Resources
Lesson: Binary Code
Lesson: Bats and Their Amazing Hearing
Video: Echolocation

4.ETS2.2 A final solution can be developed/selected only after preliminary solutions have been tested. The designs that are tested should incorporate the constraints that are part of the design problem and a successful solution should meet the pre-determined criteria for success. Students might examine proposed design solutions meant to minimize the human impact on the land and ocean, or means of obtaining natural resources. *(Design criteria and constraints are introduced in 3.ETS1.1)* 4.ETS2.3 The standard names three respective examples of the impacts of technology on society. The history of artificial limbs can be a case study for the improvement of existing technologies over time. Seat belts and car safety features, such as air bags, are improvements to automobiles in order to address the known risks of car travel. And, while cell phones may have originally been developed to make communication more convenient, the devices have developed to meet society's demand for other conveniences such as the ability to take pictures, send text-based messages, search on the internet, etc. Technologies, such as the internet and social	Phenomenon Explanation: Echolocation is the use of sound waves and echoes to determine where objects are in space. Bats use echolocation to navigate and find food in the dark.	Video: What are Pixels Song & Video: Echolocation - Awesome Music Video! **ESL Supports and Scaffolds** WIDA Standard 4- The Language of Science To support students in speaking, refer to this resource: WIDA Doing and Talking Science To support students when they design their device: **Model speaking and writing expectations for Entering Level ELs. Consider using the recommended stems to support students in their discussions and writing.** Sentence stems for observation when building models: I notice…. When____ happened_____ I noticed/observed I think_____will happen/occur when______ Sequencing stems: First I…. The next step is…. Question Starters What's the connection between….? What link do you see between…

media, have changed the ways that people interact with each other. **Suggested Science and Engineering Practice(s)** Planning and Carrying Out Investigations Constructing Explanations and Designing Solutions **Suggested Crosscutting Concept(s)** Patterns **Teacher Overview** Mechanical waves travel through a medium. The medium can be a solid, liquid, or gas. Mechanical waves can be longitudinal (moving forward and back) or transverse (moving up and down or side to side). The waves differ in how they move through the medium. An example of a longitudinal wave is the seismic wave produced by an earthquake. An example of a transverse wave is a ripple in a pond created when a stone is dropped in the water. This lesson focuses on the use of mechanical waves, specifically longitudinal waves. Echolocation is the use of sound waves and echoes to determine where objects are in space. Bats use echolocation to navigate and find food in the dark. When the sound waves that they emit hit an object, they bounce off and return to a bat's ears as an echo. Bats listen to		Why do you think…? What is our evidence that…. Do we have enough evidence to make that claim? But what about this other evidence that shows…?

the echoes to figure out where objects are, how big they are, and what their shapes are. **Misconceptions** Students may believe that a wave carries matter along with it as it moves. This is not the case: Energy travels along the wave, not matter. Place a cork in a wave pool. The cork will not travel a significant horizontal distance, but it does travel up and down. The cork is matter and moves within a plane in an up-and-down motion. Students may think of waves as only occurring in a body of water. Students should know, however, that waves are all around us; sound waves are always traveling through the air (a medium) to our ears. Light waves travel without a medium, but they are all around us as well.		