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.

Science and Engineering Practices

1. Asking questions & defining problems
2. Developing & using models
3. Planning & carrying out investigations
4. Analyzing & interpreting data
5. Using mathematics & computational thinking
6. Constructing explanations & designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, & communicating information

Disciplinary Core Ideas

Physical Science
PS 1: Matter & its interactions
PS 2: Motion & stability: Forces & interactions
PS 3: Energy
PS 4: Waves & their applications in technologies for information transfer

Life Sciences
LS 1: From molecules to organisms: structures & processes
LS 2: Ecosystems: Interactions, energy, & dynamics
LS 3: Heredity: Inheritance & variation of traits
LS 4: Biological evaluation: Unity & diversity

Earth & Space Sciences
ESS 1: Earth's place in the universe
ESS 2: Earth's systems
ESS 3: Earth & human activity

Engineering, Technology, & the Application of Science
ETS 1: Engineering design
ETS 2: Links among engineering, technology, science, & society

Crosscutting Concepts

1. Patterns
2. Cause & effect
3. Scale, proportion, & quantity
4. Systems & system models
5. Energy & matter
6. Structure & function
7. Stability & change

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.

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Physical Science Quarter 3 Curriculum Map
Quarter 3 Curriculum Map Feedback

Quarter 1			Quarter 2	**Quarter 3**			Quarter 4	
Structures and Routine	Unit 1 Matter	Unit 2 Chemical Reactions	Unit 3 Motions and Stability	**Unit 4 Energy and Machines**	Unit 5 Heat and Electricity	Unit 6 Nuclear Energy	Unit 7 Waves	Unit 8 Electromagnetic Radiation
Week 1	3 Weeks	5 Weeks	9 Weeks	**4 Weeks**	3 Weeks	2 Weeks	4 Weeks	5 Weeks

UNIT 4 Energy and Machines [4 weeks]

Overarching Question

How is energy transferred and conserved?

Unit	**Lesson Length**	**Essential Question(s)**	**Vocabulary**
Unit 4 Energy and Machines	5 days	• What is the difference between kinetic energy and potential energy? • How can you calculate kinetic energy? • What are some different forms of potential energy? • How can you calculate gravitational potential energy?	Energy, system, kinetic energy, potential energy, elastic potential energy, chemical potential energy, gravitational potential energy

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI PSCI.PS3: Energy **Standards** PSCI.PS3.1 Identify and give examples of the various forms of energy (kinetic, gravitational potential, elastic potential) and solve mathematical problems regarding the work-energy theorem and power. **Explanation and Support of Standard** In 6.PS3 students were introduced to the various types of energy and mechanisms for their transformations. Students should now be able to quantify	**Learning Outcomes** • Understand that work is done on an object when a force causes a displacement of the object. Use mathematical computation to calculate work ($W = Fd$). • Understand the net work done on a body equals its change in kinetic energy. • Understand kinetic energy is the energy of an object due to its motion. • Use mathematical computation to calculate kinetic energy $\left(\mathrm{KE} = \frac{1}{2}\,\mathrm{mv2}\right)$. • Understand that potential energy is stored energy due to an object's position. Use mathematical computation to calculate potential energy (PE = m x g x h).	**Curricular Resources** **Textbook Resources** Glencoe Physical Science, Chapter 4 Section 2: Describing Energy pps. 114-119 **Engage** Khan Academy Introduction to Work and Energy Khan Academy Work and Energy (Part 2) Bozeman Science Definitions of Energy Quick Demo Kinetic Energy TE pp. 116 Quick Demo Gravitational Potential Energy TE pp. 118 Gravitational Potential Energy Animation found in Chapter 4 Section 2 resources run time 2:26 mins. Video Lab Bouncing Balls Animation found in Chapter 4 Section 2 resources run time 3:56 mins.

the total energy of a system as well as quantify each different type of energy in a system. Energy is an abstract concept that does not have a physical form. It is a substance-like quantity that is recognized to be conserved as a system change. Calculations present an opportunity to observe that potential energies are due to the positions of objects within a field, while kinetic energy is based on an object's mass and motion. Students can evaluate the total energy of a system by imagining that there are different types of energy storage accounts, just as money can be stored in different accounts. Energy can be transferred into or out of any of these accounts. Three different processes can account for all energy changes: working, heating, and radiating. In energy storage due to field effects, such as gravitational or electrostatic fields, the field itself stores the potential energy and not the object in the field. Students should understand that a given task will require a certain minimum amount of energy. In accordance with the work-energy theorem, this would be described as work done on the system. Power incorporates a rate element into this discussion.

Suggested Science and Engineering Practices

Use mathematics and computational thinking: To solve problems for work ($W = f \times d$) and power ($P = W/t$).

- Understand that potential energy can be classified into different types (e.g., gravitational, chemical, and elastic).
- Use mathematical computation to demonstrate how the work energy theorem states that the work done by all forces acting on an object equals the change in the object's kinetic energy ($W = \Delta KE = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$).
- Explain how work transfers energy from one place to another or from one form to another.
- Understand the unit of work and energy is Joules (J).

Suggested Phenomenon

The moving hammer has kinetic energy and can do work on the puck, which can rise against gravity and ring the bell.
(Referencing:
Ring-the-bell game)

Explore
MiniLab Interpret Data from a Slingshot p. 117

Explain
Solve for Kinetic Energy p. 116
Solve for Gravitational Potential Energy p. 119

Elaborate
Post Reading: Cooperative Project TE pg. 118
Discussion: Riding an Elevator TE pg. 118

Evaluate
Section 2 Review: 20-25 pg. 119
Assessment Process TE pg. 119

Additional Resources
Teach Engineering Curricular Unit: Simple Machines
Rube Goldberg Teaching Resources
The Physics Classroom Work, Energy, and Power
Reasoning's and solutions of Newton's laws

ACT Standard(s) Connection
IOD 403. Translate information into a table, graph, or diagram

ACT Content Connection(s)
Heat and work (PS)
Kinetic and potential energy (PS)

Ask questions: To determine the various forms of energy present in a given system. **<u>Suggested Crosscutting Concept</u>** **Energy and Matter** Students demonstrate and explain conservation of mass and energy in systems, including systems with inputs and outputs. **Cause and Effect** Students use cause and effect models at one scale to make predictions about the behavior of systems at different scales.		

Physical Science Quarter 3 Curriculum Map Quarter 3 [Curriculum Map Feedback]()								
Quarter 1			Quarter 2	**Quarter 3**			Quarter 4	
Structures and Routine	Unit 1 Matter	Unit 2 Chemical Reactions	Unit 3 Motions and Stability	**Unit 4 Energy and Machines**	Unit 5 Heat and Electricity	Unit 6 Nuclear Energy	Unit 7 Waves	Unit 8 Electromagnetic Radiation
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UNIT 4 Energy and Machines [4 weeks]			
[Overarching Question]()			
How is energy transferred and conserved?			
Unit	**Lesson Length**	**[Essential Question(s)]()**	**Vocabulary**
Unit 4 Energy and Machines	5 days	• What is the law of conservation of energy? • What is mechanical energy? • Why is mechanical energy not always conserved? • How are power and energy related?	law of conservation of energy, mechanical energy, power, horsepower, watts
Standards and Related Background Information		**Instructional Focus**	**Instructional Resources**

DCI
PSCI.PS3: Energy

Standard(s)
PSCI.PS3. 5 Investigate the relationships among kinetic, potential, and total energy within a closed system (the law of conservation of energy).

in conjunction with

PSCI.PS3.4 Collect data and present your findings regarding the law of conservation of energy and the efficiency, mechanical advantage, and power of the refined device.

Explanation and Support of Standard
An understanding of conservation of energy should lead to conversations about the efficiency of a device. A well-designed device should utilize as much of the available energy as possible for the desired task. Other energy will be converted to forms, such as heat and noise, which may not be immediately useful based on the intended use for the device. Students can investigate kinetic, potential, and total energy within a closed system using various phenomena for example the Dropping the Ball and Pendulum Swing.

Misconceptions
- Students might think that energy can be converted into things other than energy or that other things can be converted into energy. Energy can only be converted into other forms of energy, and other things cannot be converted into energy.
- Some students might not realize that when the bob of a pendulum reaches its

PS.3.5: Learning Outcomes
- Understand that energy cannot be created nor destroyed.
- Understand that mechanical energy is equal to the total kinetic energy and potential energy in a system. Since energy is conserved in a system, the mechanical energy must remain the same, but the amounts of kinetic and potential energy can change as one form gets transformed into another.
- Use the formulas for mechanical energy (ME = PE + KE), kinetic energy $E_k = 1/2mv^2$, and potential energy ($PE = m\ x\ g\ x\ h$) to solve problems in ideal situations (ignore friction and air resistance) to determine the amounts of potential and kinetic energy of objects as they are lifted or fall.
- Understand that Initial mechanical energy equals final mechanical energy (in the absence of friction).

PS.3.4: Learning Outcomes
- Understand the law of conservation of energy states that the total amount of energy remains constant in an isolated system (i.e., energy is neither created nor destroyed but it can be transformed from one type to another).
- Understand efficiency is the ratio of useful work output to total input.

$$Efficiency = \frac{useful\ work\ output}{total\ work\ input}\ x\ 100$$

- Understand mechanical advantage is the ratio of the force exerted by a simple machine to the force applied to the machine. Example: The distance a load will be moved will be a fraction of the distance through which effort is applied.
- Understand power is the rate at which work is done or the rate of energy transfer.

Curricular Resources

Textbook Resources
Glencoe Physical Science Chapter 4, Section 3: Conservation of Energy pps. 120 - 129

Engage
Virtual Lab Energy Conversions How is energy converted from one form to another?
Energy Transformation Virtual Lab Handout

Applying Practices Modeling Changes in Energy go to the ConnectEd resources tab.

Applying Practices Earth Power go to the ConnectEd resources tab. Students will design, build, and refine a device that converts energy from one form to another, using materials provided by their teacher. Energy conversions can be simple, such as the transformation of potential energy to kinetic energy when dropping an object, to more complex energy conversions, such as the transformation of the potential chemical energy in gasoline and oxygen into mechanical energy that accelerates a car in an internal combustion engine.

Demo Marble Energy p. 124 TE The purpose is to demonstrate the conservation of mechanical energy. Needed Materials: 2 m of plastic tubing, ring stands with clamps (2), marble

MiniLab Calculate Your Power p. 126

Solve for Power p. 126

Explore

maximum height, it momentarily stops, and when it is at its lowest part of its swing, its velocity is highest.

Suggested Science and Engineering Practice

- **Develop and use models:** To explain energy transfer within a closed system. *Suggested: L-O-L charts*
- **Use mathematics and computational thinking:** To solve for different variables.
- **Design a solution:** For given rollercoaster construction plans. *Include a rationale for the first hill on a roller-coaster always being the tallest.*
- **Plan and carry out an investigation:** To determine the effect of length and/or roughness of an inclined plane.
- **Analyze and interpret data:** Regarding the mechanical advantage and efficiency of a simple machine.
- **Obtain, evaluate, and communicate information:** Regarding the law of conservation of energy on a refined device.

Suggested Crosscutting Concept

Systems and System Models

Students make predictions from models considering assumptions and approximations.

Energy and Matter

Students demonstrate and explain conservation of mass and energy in systems, including systems with inputs and outputs.

- Understand machines with different power ratings do the same amount of work in different time intervals.
- Understand due to friction, not all the work done on a machine is used to do the work the machine was intended to accomplish. Some of the
- work is incidental and is transferred to another form of energy (e.g., heat, sound, light).

Suggested Phenomenon

View the suggested phenomenon videos and choose one to engage students.

EQ: What does a roller coaster have to do with energy and physics?

Law of Conservation of Energy (Roller Coaster Demo) 2:45 mins
How Roller Coasters Work
PolerCoaster POV – No limits Coaster 2 Animation 3:44 mins
Warning: Animation can cause motion sickness.
Twisted Colossus - POV animation 2:43 mins

Explain

Elaborate

Evaluate

Additional Resources

ACT Standard(s) Connection

EMI 404. Identify similarities and differences between models

SIN 405. Determine which experiments utilized a given tool, method, or aspect of design

ACT Content Connection(s)

Kinetic and potential energy (PS)

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UNIT 4 Energy and Machines [4 weeks]

Overarching Question

How is energy transferred and conserved?

Unit	Lesson Length	Essential Question(s)	Vocabulary
Unit 4 Energy and Machines	10 days	• What is work? • How can work be calculated when force and motion are parallel to each other? • How do machines make doing work easier? • What are mechanical advantage and efficiency?	Work, Joule, applied force, machine, simple machine, compound machine, efficiency, mechanical advantage,

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI PSCI.PS3: Energy **Standard** PSCI.PS3.3 Design, build, and refine a device within design constraints that has a series of simple machines to transfer energy and/or do mechanical work. **Explanation and Support of Standard** Students design, build, and refine a device within design constraints. The device could be a Rube Goldberg machine with the following as examples of constraints: Require that their Rube Goldberg machine contain a certain number of steps; Ensure it carries out a specific task; and Make certain it remains within a strict time frame.	**Learning Outcomes** • Experiment with selected simple machines to discover the relationship between force and distance. • Solve problems related to force, work, and power. • Identify various types of simple machines. • Recognize the simple machines found in a compound machine. • Investigate the factors that determine the speed of an object rolling down a ramp. • Solve application problems related to mechanical advantage and the efficiency of simple machines, given appropriate equations (MA=FO/FI and Eff=WO/WI). • Design and construct a device with design constraints for example a Rube Goldberg machine. **Suggested Phenomenon**	**Curricular Resources** **Textbook Resources** Glencoe Physical Science Chapter 4, Section 1: Work and Energy pps. 106-112 **Engage** Phet Interactive Simulation: The Ramp Demonstration of simple machines Bozeman Science Energy, Work, and Power **Quick Demo Calculate Work** pp. 108 **Ted Ed** How does work...work? - Peter Bohacek **Explore** Energy of a Bouncing Ball Lab Conservation of Energy Labs – Dropping the Ball Vernier Physical Science – Simple Machines #s 20, 21, 22 First Class Levers, Pulleys, and An Inclined Plane Vernier Physics Explorations and Projects - #16 Rube Goldberg Machine

Students develop a plan for the device in which they do the following: Identify what scientific principles provide the basis for the energy conversion design; Identify the forms of energy that will be converted from one form to another in the designed system; Identify losses of energy by the design system to the surrounding environment; Describe the scientific rationale for choices of materials and structure of the device, including how student-generated evidence influenced the design; and Describe that this device is an example of how the application of scientific knowledge and engineering design can increase benefits for modern civilization while decreasing costs and risk. Emphasis is on both qualitative and quantitative evaluations of devices.

Misconceptions

- Increasing Work – Students might think that a machine decreases the amount of work necessary to complete a task. This is false. The output work done by a machine never exceeds the work input to the machine. However, a machine can make work easier in three ways. It can change the size of a force, change the distance over which the force acts, and change the direction of a force.
- Efficiency and Mechanical Advantage – Students often confuse efficiency and mechanical

A Rube Goldberg machine displays several key principles, including conservation of energy, conservation of momentum, and ideas about vital forces of an engineered device.

Amazing Rube Goldberg Machines
America's Got Talent - Steve Price (aka "Sprice") Shows Off His Complex Rube Goldberg Machine
The Lemonade Machine

Explain
Simple Machine Practice

Elaborate

Evaluate
Lab: Mechanical Advantage and Efficiency TE/SE pg. 113
Hands-on Activity: Design Your Own Rube Goldberg Machine

- Timeframe: 2 – 8 class periods
- Engineer and cartoonist Rube Goldberg is famous for his crazy machines that accomplish everyday tasks in overly complicated ways. Students use their new understanding of types of simple machines to design and build their own Rube Goldberg machines that perform simple tasks in no less than 10 steps.

Additional Resources
Teach Engineering Curricular Unit: Simple Machines
Rube Goldberg Teaching Resources
The Physics Classroom Work, Energy, and Power
Reasoning's and solutions of Newton's laws

ACT Standard(s) Connection
IOD 403. Translate information into a table, graph, or diagram

ACT Content Connection(s)
Heat and work (PS)
Kinetic and potential energy (PS)

advantage. Both are output to input ratios. Efficiency is a ratio of output work to input work and mechanical advantage is a ratio of output force to input force. Efficiency of a machine must always be less than 1 and mechanical advantage of a machine can be less than 1, equal to 1, or greater than 1. • Energy Conversions – Students may think that energy can be converted to things other than energy or that other things can be converted into energy. **<u>Suggested Science and Engineering Practice</u>** **Construct an explanation and design a solution** Students construct an explanation through the construction of a Rube Goldberg machine using five of the six simple machines to perform a given task. **<u>Suggested Crosscutting Concept</u>** **Systems and System Models** Students make predictions from models considering assumptions and approximations. **Energy and Matter** Students demonstrate and explain conservation of mass and energy in systems, including systems with inputs and outputs.		

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UNIT 5 Heat and Electricity [3 weeks]			
Overarching Question			
How is energy transferred and conserved?			
Unit	**Lesson Length**	**Essential Question**	**Vocabulary**
Unit 5 Heat and Electricity	8 days	• How is energy transferred between objects or systems?	Heat, temperature, absolute zero, thermal expansion, specific heat, calorimeter, conduction, thermal conductor, thermal insulator, convection, convection current, radiation, thermodynamics

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI PSCI.PS3: Energy **Standard(s)** PSCI.PS3.2 Plan and conduct an investigation, to provide evidence that thermal energy will move as heat between objects of two different temperatures, resulting in a more uniform energy distribution (temperature) among the objects. ***in conjunction with*** PSCI.PS3.6 Determine the mathematical relationships among heat, mass, specific heat capacity, and temperature change using the equation $Q = mCp\Delta T$. **Explanation and Support of Standard(s)** **PS3.2**: Thermal energy is the energy of a system due to the motion of the particles in that system.	**Learning Outcomes** • Define temperature. • Explain how thermal energy and temperature are related? • What is the difference between thermal energy and heat? • How can you calculate changes in thermal energy? • Define conduction, convection, and radiation. • Contrast thermal conductors and thermal insulators. • Explain how thermal insulators are used to control the transfer of thermal energy. **Suggested Phenomenon** Heat is thermal energy that is transferred from a warmer object to a cooler object.	**Curricular Resources** **Textbook Resources** Glencoe Physical Science Chapter 5, Section 1: Temperature, Thermal Energy and Heat pps. 138-143; Section 2: Conduction, Convection, and Radiation pps. 144-150 **Engage** **Teacher's Pet -** The Flow of Energy: Heat **Bozeman Science** – Heat Exchange **Khan Academy -** Thermal conduction, convection, and radiation | Thermodynamics | **Visual w/Activity:** Brittle Balloon **Animation**: **Animation:** **Explore**

One object can transfer its thermal energy to another object through the processes of heating or radiating. Convection and conduction are processes which require a physical medium to transfer the thermal energy. In the case of conduction, two objects are in direct contact, while convection transfers thermal energy through a liquid or gaseous medium. Radiation is a unique form of energy transfer which can transfer without a medium. One packet of this energy is called a photon. The energy of the photon determines the effect that it will have when it interacts with matter. Low energy photons such microwaves add to the motion of matter and result in an increase of the thermal energy. Photons carry energy from the sun to Earth. Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water. **PS.3.6** Students use the algebraic descriptions of the initial and final energy state of the system, along with the energy flows to create a computational model that is based on the principle of the conservation of energy. Students use the computational model to calculate changes in the energy of one component of the system when changes in the energy of the other components and the energy flows are known. **Misconceptions** • The first law of thermodynamics states that when energy is transferred, it is conserved.	**Which has more thermal energy, an iceberg or a cup of hot coffee?** 	**Mini Lab:** Compare Thermal Conductors TE/SE p 149. **Virtual Lab:** Insulation Properties **Lab**: Convection in Gases and Liquids TE/SE p. 151 **Inquiry Lab**: Passive Solar Heating TE/SE p. 154 **Mini Lab** Convery Energy TE/SE p. 156 **Lab:** Conduction in Gases TE/SE p. 160 **Explain** **Demo:** Temperature and Convection TE/SE p. 145 **Quick Demo**: Compare Specific Heats TE/SE p. 141 **Quick Demo**: Observe Radiant Heat TE/SE p. 153 **Elaborate** **Practice Problems**: Solve for Thermal Energy p.142**.** **Evaluate** **Additional Resources** **ACT Standard(s) Connection** SIN 403. Identify a control in an experiment SIN 404. Identify similarities and differences between experiments. **ACT Content Connection(s)** Heat and work (PS) States, Classes and Properties of Matter (PS)

• Students think that people close doors and windows to keep cold air out, but cold is the absence of heat. Therefore, people are trying to keep the heat inside. • The second law of thermodynamics states that thermal energy is always transferred from a hotter object to a cooler object, dispersing the energy. The transfer of energy continues until the objects in contact are in thermal equilibrium (i.e., the same temperature). • Thermal energy depends on mass and temperature. Temperature is a measure of the average kinetic energy of the particles in an object. • Students might confuse radiation as a form of energy transfer with nuclear ration or radioactivity. In both cases, radiation involves sending out energy as electromagnetic waves. In nuclear radiation, radioactive nuclei of atoms break down and emit particles and electromagnetic waves. In thermal radiation, matter emits electromagnetic waves of a much lower frequency. **<u>Suggested Science and Engineering Practice</u>** **Asking and developing solutions** Students ask questions to describe the relationship between hear, temperature, and thermal energy. **Plan and conduct an investigation** Students will plan and carry out an investigation to provide evidence to support the fact that heat is moving thermal energy proportional to temperature. **<u>Suggested Crosscutting Concept</u>** **Energy and Matter**		

Students demonstrate and explain conservation of mass and energy in systems, including systems with inputs and outputs. **Cause and Effect** Students use cause and effect models at one scale to make predictions about the behavior of systems at different scales.		

Physical Science Quarter 3 Curriculum Map

Quarter 3 [Curriculum Map Feedback]

Quarter 1			Quarter 2	**Quarter 3**			Quarter 4	
Structures and Routines	Unit 1 Matter	Unit 2 Chemical Reactions	Unit 3 Motions and Stability	Unit 4 Energy and Machines	**Unit 5 Heat and Electricity**	Unit 6 Nuclear Energy	Unit 7 Waves	Unit 8 Electromagnetic Radiation
Week 1	3 Weeks	5 Weeks	9 Weeks	4 Weeks	**3 Weeks**	2 Weeks	4 Weeks	5 Weeks

UNIT 5 Heat and Electricity [3 weeks]

[Overarching Question]

How is energy transferred and conserved?

Unit	Lesson Length	[Essential Question(s)]	Vocabulary
Unit 5 Heat and Electricity	8 days	• What is the difference between conductors and insulators? • How does Ohm's law relate current, voltage difference, and resistance?	Charging by contact, charging by induction, conductor, electric field, electroscope, insulator, law of conservation of charge, static electricity, Ohm's law, electric circuit, electric current, resistance, voltage difference, electrical power, parallel circuit, series circuit

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI PSCI.PS3: Energy **Standard(s)**	**Learning Outcomes** • Construct circuit diagrams and solve application problems related to voltage, resistance, and current in a series circuit (V=IR).	**Curricular Resources** **Textbook Resources** Glencoe Physical Science, Chapter 6 Electricity pps. 170 - 191

PSCI.PS3.7 Demonstrate Ohm's Law through the design and construction of simple series and parallel circuits.

Explanation
Ohm's law relates the current through a device or portion of a circuit to the voltage drop observed across that device. The voltage drop across a device will increase in a linear fashion as the current through that device is increased. The resistance of the device is given by the ratio of voltage drop to current across the device. In an ohmic device, this ratio will be constant. Simple, single-loop circuits may be analyzed by considering each resistor as part of the total (equivalent) resistance of the circuit. (It may be beneficial to describe non-ohmic devices, but such devices are beyond the scope of this standard.)

Misconceptions
- Students might confuse radiation as a form of energy transfer with nuclear ration or radioactivity. In both cases, radiation involves sending out energy as electromagnetic waves. In nuclear radiation, radioactive nuclei of atoms break down and emit particles and electromagnetic waves. In thermal radiation, matter emits electromagnetic waves of a much lower frequency.
- Students might believe that positive charges flow through wires; however, it is negatively charged electrons that flow in a wire.

- Analyze factors that affect the strength and direction of electric forces and fields.
- Describe how electric charges are transferred and explain why electric discharges occur.
- Describe electric current and identify the two types of current.
- Describe conduction and classify materials as good electrical conductor or good electrical insulators.
- Explain how voltage produces electric current.
- Calculate voltage, current, and resistance using Ohm's law.
- Analyze circuit diagrams for series circuits and parallel circuits.

Suggested Phenomenon
Power Supplied to Electrical Heater

The electrical heater is a commonly used appliance in winters. Provided with the resistance of heater coil and applied voltage, We can calculate the power supplied to this heater. Let's assume that resistance of heater coil is 5 ohm and input voltages are 120V. We can use the formula from Ohmic Wheel: $P = V^2/R$ to find the power, $P = 120^2/5$ ohm = 2880 watt. This

Engage

Explore

Explain

Elaborate

Evaluate

Additional Resources
PSCI.PS3.7: Circuits, Ohms Law Lesson and Appendices
- Students develop and use a model to explain how energy flows through the created circuit.
- Students obtain, evaluate, and communicate what parts of a system must be present to produce energy flow in a circuit.
- Students use mathematics and computational thinking to determine the directly proportional and inversely proportional relationships in Ohm's Law and complete calculations using the formula.

ACT Standard(s) Connection
EMI 403. Determine which models imply certain information

ACT Content Connection(s)
Electrical Circuits (PS)

• When it comes to static electricity, a walk across a carpet floor can generate a spark of 1500 volts or more; however, the electric current in the situation is low. Electric current poses the true danger not the voltage. • Students should understand that many alternative energy resources are ideal for use in certain geographic areas, on a small scale in rural areas, or in developing societies. **<u>Suggested Science and Engineering Practice</u>** **Develop and use models** Students can develop and use models to explain circuit diagrams and build a working circuit. **Mathematical and computational thinking** Student will use mathematical and computational thinking to solve for each variable in ohm's law independently. **<u>Suggested Crosscutting Concept</u>** **Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	power can then be multiplied with time to calculate the electricity bill at our premises.	

Structures and Routines	Unit 1 Matter	Unit 2 Chemical Reactions	Unit 3 Motions and Stability	Unit 4 Energy and Machines	**Unit 5 Heat and Electricity**	Unit 6 Nuclear Energy	Unit 7 Waves	Unit 8 Electromagnetic Radiation
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UNIT 5 Heat and Electricity [3 weeks]

Overarching Question(s)

How is energy transferred and conserved?

Unit	Lesson Length	Essential Question(s)	Vocabulary
Unit 5 Heat and Electricity	4 days	• How do moving electric charges and magnets interact? • What is the electromagnetic force? • How do an electromagnet's properties affect its magnetic field strength? • How does an electric motor operate?	Electric current, electromagnetic force, electromagnetism, electromagnet, galvanometer, electric motor, solenoid

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI PSCI.PS3: Energy **Standard(s)** PSCI.PS2.7 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field. **Explanation** Ohm's law relates the current through a device or portion of a circuit to the voltage drop observed across that device. The voltage drop across a device will increase in a linear fashion as the current through that device is increased. The resistance of the device is given by the ratio of voltage drop to current across the device. In an ohmic device, this ratio will be constant. Simple, single-loop circuits may be analyzed by considering each	**Learning Outcomes** • Plan and conduct an investigation to collect evidence that an electric current can produce a magnetic field. • Construct an explanation using (collected) evidence, for the production of a magnetic field by an electric current. **Suggested Phenomenon** A compass needle will change its orientation when it is placed near a wire carrying an electric current. 	**Curricular Resources** **Textbook Resources** Glencoe Physical Science, Chapter 7 Section 2 Electricity and Magnetism pp. 211 **Engage** Quick Demo: Electromagnets TE/SE pp. 210 Khan Academy: Introduction to Magnetism **Explore** **Mini Lab:** Observe Fields TE/SE pp. 211 **Evaluate** Section 2 Review; TE/SE pp. 215 **Additional Resources** **ACT Standard(s) Connection**

resistor as part of the total (equivalent) resistance of the circuit. (It may be beneficial to describe non-ohmic devices, but such devices are beyond the scope of this standard.) **Misconceptions** • Electricity and magnetism are two aspects of a single force, the electromagnetic force. Electromagnetic waves consist of magnetic and electric fields oscillating at right angles to each other. • The right-hand rule can be used to determine the direction of the magnetic field. • Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. • When a wire carries a strong, steady current, the needles of any compasses nearby move to align with the magnetic field created by the electric current. **Suggested Science and Engineering Practice** Plan and conduct an investigation Construct an explanation **Suggested Crosscutting Concept** Systems and System Models Cause and Effect		EMI 401. Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text. **ACT Content Connection(s)** Electrical Circuits (PS) Magnetism (PS)

Physical Science Quarter 3 Curriculum Map Quarter 3 Curriculum Map Feedback								
Quarter 1			Quarter 2	**Quarter 3**			Quarter 4	
Structures and Routine	Unit 1 Matter	Unit 2 Chemical Reactions	Unit 3 Motions and Stability	Unit 4 Energy and Machines	Unit 5 Heat and Electricity	**Unit 6 Nuclear Energy**	Unit 7 Waves	Unit 8 Electromagnetic Radiation
Week 1	3 Weeks	5 Weeks	9 Weeks	4 Weeks	3 Weeks	**2 Weeks**	4 Weeks	5 Weeks

UNIT 6 Nuclear Energy [2 weeks]

Overarching Question(s)

How do food and fuel provide energy?
If energy is conserved, why do people say it is produced or used?

Unit	Lesson Length	Essential Question(s)	Vocabulary
Unit 6 Nuclear Energy	10 days	• What are fusion and fission? • How does a nuclear reactor convert nuclear energy into thermal energy? • What are the advantages and disadvantages of using nuclear energy to generate electricity?	Fission, fusion, nuclear reactor, nuclear waste

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI PSCI.PS1: Matter & Its Interactions **Standard(s)** **PSCI.PS1.14** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. **PSCI.PS1.15** Communicate scientific and technical information about nuclear energy and radioactive isotopes with respect to their impact on society. **Explanation** To build an understanding of nuclear processes, students should attribute the existence of the nucleus and nuclear stability to neutrons and the strong nuclear force. The process of fusion is facilitated when two nuclei are forced near one another to the point where strong nuclear forces	**Learning Outcomes** • Distinguish between fission and fusion. • Develop and use models to illustrate composition of the atomic nucleus before and after fission and/or fusion. • Construct an explanation of the use of atomic structure and radioactive decay. • Ask questions and define problems regarding the construction and design of a nuclear power plant. • Research a nuclear power plant near you and nuclear waste disposal. • Determine if a contaminated radioactive site can be reclaimed. **Suggested Phenomenon**	**Curricular Resources** **Textbook Resources** Glencoe Physical Science, Chapter 8 Section 2 Nuclear Energy pps. 241 - 247 **Engage** **BrainPOP** Nuclear Energy **Quick Demo** Nuclear Fuel Pellets TE/SE p. 242 **Bozeman Science** – Nuclear Processes (10:09 minutes) **Explore** **Make a Model –** Reactor Core **Explain** **Apply Science –** Can a contaminated radioactive site be reclaimed? p. 246 **Elaborate**

exceed repulsive electromagnetic forces. Due the random movements of nucleons, decay processes are also random but can be charted exhibiting consistent patterns. These patterns are useful in radiometric dating on varying scales

Misconceptions

- The water that is used as a coolant in a nuclear reactor core becomes contaminated with radioactive material. This water is not the same water that is cooled and released into rivers and streams. The water that is released into the environment does not come into direct contact with the reactor core or water that cools the reactor core. It exchanges heat with the contaminated water through a heat exchanger.

Suggested Science and Engineering Practice

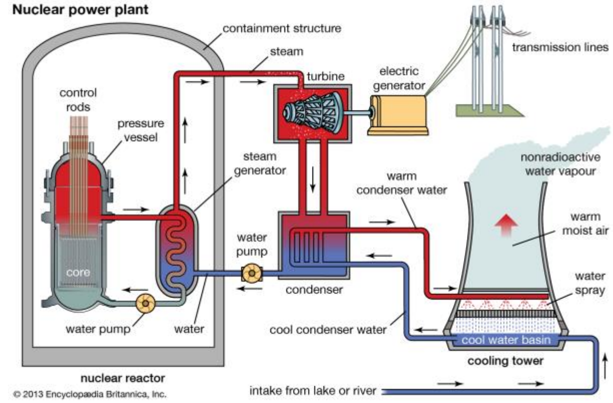
Developing and using models
Students create models which are responsive and incorporate features that are not visible in the natural world but have implications on the behavior of the modeled systems and can identify limitations of their models.

Obtaining, evaluating, and communicating information
Students can critically read scientific literature, integrating, extracting, and accurately simplifying main ideas from multiple sources while maintaining accuracy and validating data whenever possible. Students can provide written and oral explanations for phenomena and multipart systems using models, graphs, data tables, and diagrams.

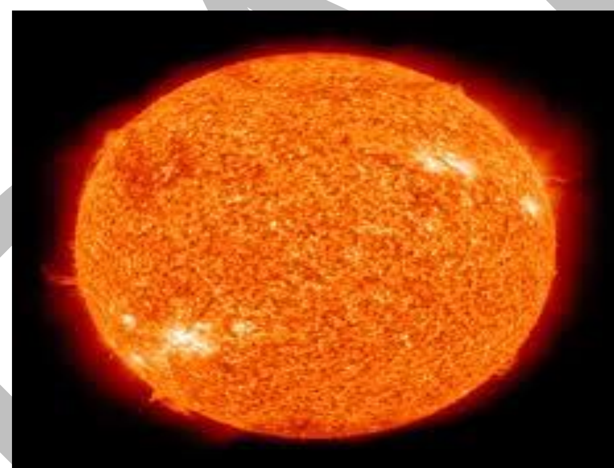
Suggested Crosscutting Concept

Cause and Effect
Students use cause and effect models at one scale to make predictions about the behavior of systems at different scales.

Energy and Matter
Students reconcile conservation of mass in nuclear processes.



Option A: Nuclear fission can be controlled and used to generate electricity.



Option B: Nuclear fusion is the process happening in stars, including the sun, to produce energy.

Evaluate

Additional Resources

[The Tennessee Valley Authority (TVA)]

TVA's overarching Environmental Policy is to produce clean, reliable and affordable power, support sustainable economic growth in the Tennessee Valley and promote proactive environmental sustainability in a balanced and ecologically sound manner.

As a good steward, it is TVA's duty to promote the proper use of the Tennessee River watershed and its natural resources by the public. They are committed to sustainability and continuous improvement, proactive stewardship in managing our natural resources and environmental footprint and maintaining compliance with all applicable environmental and legal requirements.

ACT Standard(s) Connection

EMI 502. Determine whether presented information or new information, supports or contradicts a simple hypothesis or conclusion, and why.

ACT Content Connection(s)

Atomic Structure (PS)

	 **Option C**: Archeologists use radioactive decay patterns to date ancient artifacts.	

Textbook Resources	DCIs and Standards	Videos	Additional
Textbook	DCI	Videos Khan Academy Illuminations (NCTM) Discovery Education The Futures Channel The Teaching Channel Teachertube.com	ACT & SAT TN ACT Information & Resources ACT College & Career Readiness Mathematics Standards SAT Connections SAT Practice from Khan Academy