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

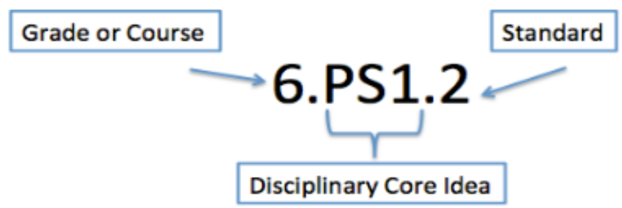
Learning Progression
At the end of the elementary science experience, students can observe and measure phenomena using appropriate tools. They are able to organize objects and ideas into broad concepts first by single properties and later by multiple properties. They can create and interpret graphs and 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 Curriculum Map Feedback Survey								
Quarter 1			Quarter 2	**Quarter 3**			Quarter 4	
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Week 1	3 Weeks	5 Weeks	9 Weeks	**3 Weeks**	4 Weeks	2 Weeks	4 Weeks	5 Weeks

UNIT 4 Energy and Machines [3 weeks]			
Overarching Question(s)			
How is energy transferred and conserved?			
Unit	**Lesson Length**	**Essential Question**	**Vocabulary**
Unit 4 Energy and Machines	1 week	• 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. **Explanations** In 6.PS3 students were introduced to the various types of energy and mechanisms for their transformations. Students should now be able to quantify 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	**Learning Outcomes** **Phenomenon** Use the Wind Generators photo on page 105 and/or show a clip from one of the following videos. A wind generator transforms some of the kinetic energy from the wind's motion into energy for spinning the turbines. Ask students to predict how the wind speed directly behind a wind generator relates to the wind speed in front of the generator. Answer: The wind speed behind the wind generator would be slower because some of the wind's energy of motion (kinetic energy) has been converted to energy for spinning the turbines.	**Curricular Resources** **Engage** Khan Academy Introduction to work and energy https://www.youtube.com/watch?v=2WS1sG9fhOk Khan Academy Work and energy (part 2) https://www.youtube.com/watch?v=3mier94pbnU Bozeman Science Definitions of Energy https://www.youtube.com/watch?v=DGVtH5xmb9M **Quick Demo Kinetic Energy** TE pg. 116 **Quick Demo Gravitational Potential Energy** TE pg. 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. **Explore** MiniLab Interpret Data from a Slingshot p. 117

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. **Misconceptions** **Science and Engineering Practices** **Develop and Use Models** Students can create models for the interactions of two separate systems. Students can test the predictive abilities of their models in a real-world setting and make comparisons of two models of the same process or system. **Crosscutting Concept** **Energy and Matter**	Questions to Ask • Why is a source energy a key element of every civilization? • Where does the energy come from that causes the wind turbines to rotate? • How is a modern wind turbine like and different from a windmill that provides energy to grind grain or to pump water? • Why does electrical energy fill a major part of the energy demand of modern cities? Climbing Wind Turbines for a Living | That's Amazing https://www.youtube.com/watch?v=xUjCD-fFU9k Big Wind | Fully Charged 15:59 mins https://www.youtube.com/watch?v=1Rd55DuJPx4 How do Wind Turbines work? https://www.youtube.com/watch?v=qSWm_nprfqE	**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 **Textbook Resources** Glencoe Physical Science, Chapter 4 Section 2: Describing Energy pgs. 114-119 **Performance Tasks** Design Your Own Lab Swinging Energy p.128 - 129 The handout for this lab is found on the my.mheducation.com site for Chapter 4. Click on the link for Lab 2. There are two versions. **Additional Resources** Teach Engineering Curricular Unit: Simple Machines https://www.teachengineering.org/curricularunits/view/cub_simp_machines_curricularunit Rube Goldberg Teaching Resources https://www.rubegoldberg.com/education/teaching-resources/ The Physics Classroom Work, Energy, and Power https://www.physicsclassroom.com/class/energy Reasoning's and solutions of Newton's laws http://www3.ncc.edu/faculty/ens/schoenf/phy101/pdf/Ch4_CQ.PDF

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

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Week 1	3 Weeks	5 Weeks	9 Weeks	**3 Weeks**	4 Weeks	2 Weeks	4 Weeks	5 Weeks

UNIT 4 Energy and Machines [3 weeks]			
Overarching Question(s)			
How is energy transferred and conserved?			
Unit	**Lesson Length**	**Essential Question**	**Vocabulary**
Unit 4 Energy and Machines	1 weeks	• 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	Learning Outcomes	Curricular Resources
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** 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. 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**	• 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. **Phenomenon** View the phenomenon videos and choose which ones to show to students. Amazing Rube Goldberg Machines https://thewonderofscience.com/phenomenon/2018/7/8/amazing-rube-goldberg-machines Steve Price (aka "Sprice") Shows Off His Complex Rube Goldberg Machine - America's Got Talent https://www.youtube.com/watch?v=7UdzAaw-H0o The Lemonade Machine https://www.youtube.com/watch?v=Av07QiqmsoA	**Engage** Phet Interactive Simulations The Ramp https://phet.colorado.edu/en/simulation/the-ramp Demonstration of simple machines http://www.cosi.org/downloads/activities/simplemachines/sm1.html Bozeman Science Energy, Work, and Power http://www.bozemanscience.com/energy-work-power Khan Academy Introduction to work and energy https://www.youtube.com/watch?v=2WS1sG9fhOk Khan Academy Work and energy (part 2) https://www.youtube.com/watch?v=3mier94pbnU **Quick Demo Calculate Work** pg. 108 **Explore** Energy of a Bouncing Ball Lab- http://galileo.phys.virginia.edu/education/outreach/8thgradesol/EnergyBall.htm Conservation of Energy Labs – Dropping the Ball https://www.arborsci.com/cool/lab-9-7-mechanics-chapter-9-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 **Explain** **Elaborate** **Evaluate** 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. https://www.teachengineering.org/activities/view/rube_goldberg_machine

• 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 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. **Science and Engineering Practice** **Using mathematics and computational thinking** Students can create computational or mathematical models for interactions in the natural world using unit equivalencies. **Crosscutting Concept** **Energy and Matter**		Simple machine homework: http://www.biologycorner.com/physics/mechanics/elab_simple_machines.html **Textbook Resources** Glencoe Physical Science Chapter 4, Section 1: Work and Energy pgs. 106-112 **Performance Tasks** Lab: Mechanical Advantage and Efficiency TE/SE pg. 113 **Additional Resources** Teach Engineering Curricular Unit: Simple Machines https://www.teachengineering.org/curricularunits/view/cub_simp_machines_curricularunit Rube Goldberg Teaching Resources https://www.rubegoldberg.com/education/teaching-resources/ The Physics Classroom Work, Energy, and Power https://www.physicsclassroom.com/class/energy Reasoning's and solutions of Newton's laws http://www3.ncc.edu/faculty/ens/schoenf/phy101/pdf/Ch4_CQ.PDF

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UNIT 4 Energy and Machines [3weeks]			
Overarching Question(s)			
How is energy transferred and conserved?			
Unit	Lesson Length	Essential Question	Vocabulary
Unit 4 Energy and Machines	1 week	• 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.PS3.4 Collect data and present your findings regarding the law of conservation of energy and the efficiency, mechanical advantage, and power of the refined device. PSCI.PS3. 5 Investigate the relationships among kinetic, potential, and total energy within a closed system (the law of conservation of energy). Explanation 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	Learning Outcomes • Understand that energy cannot be created nor destroyed. Phenomenon View the phenomenon videos and choose which ones to show to students. What does a roller coaster have to do with energy and physics? Law of Conservation of Energy (Roller Coaster Demo) 2:45 mins https://www.youtube.com/watch?v=LrRdKmjhOgw How Roller Coasters Work Article https://science.howstuffworks.com/engineering/structural/roller-coaster3.htm PolerCoaster POV - Nolimits Coaster 2 Animation 3:44 mins Warning: Animation can cause motion sickness. https://www.youtube.com/watch?v=2GVmvtVA5p8 Twisted Colossus - POV animation 2:43 mins https://www.youtube.com/watch?v=EZo67kUcJXM	Curricular Resources Engage Phet Interactive Simulations The Ramp https://phet.colorado.edu/en/simulation/the-ramp Demonstration of simple machines http://www.cosi.org/downloads/activities/simplemachines/sm1.html Bozeman Science Energy, Work, and Power http://www.bozemanscience.com/energy-work-power Explore Energy of a Bouncing Ball Lab- http://galileo.phys.virginia.edu/education/outreach/8thgradesol/EnergyBall.htm Conservation of Energy Labs – Dropping the Ball https://www.arborsci.com/cool/lab-9-7-mechanics-chapter-9-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 Explain Elaborate Evaluate 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. https://www.teachengineering.org/activities/view/rube_goldberg_machine Simple machine homework: http://www.biologycorner.com/physics/mechanics/elab_simple_machines.html Textbook Resources

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 maximum height, it momentarily stops, and when it is at its lowest part of its swing, its velocity is highest. <u>Science and Engineering Practice</u> Planning and Carrying out controlled investigations Students plan and perform investigations to aid in the development of a predictive model for interacting variables, considering the quantity of data with respect to experimental uncertainty, and select methods for collection and analysis of data. <u>Crosscutting Concept</u> Energy and Matter Students demonstrate and explain conservation of mass and energy in systems, including systems with inputs and outputs.		<u>Performance Tasks</u> Design Your Own Lab Swinging Energy p.128 - 129 The handout for this lab is found on the my.mheducation.com site for Chapter 4. Click on the link for Lab 2. There are two versions. <u>Additional Resources</u> Teach Engineering Curricular Unit: Simple Machines https://www.teachengineering.org/curricularunits/view/cub_simp_machines_curricularunit Rube Goldberg Teaching Resources https://www.rubegoldberg.com/education/teaching-resources/ The Physics Classroom Work, Energy, and Power https://www.physicsclassroom.com/class/energy Reasoning's and solutions of Newton's laws http://www3.ncc.edu/faculty/ens/schoenf/phy101/pdf/Ch4_CQ.PDF

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UNIT 1 WEEK 1 [5 days]: STRUCTURES AND ROUTINES
This week is for teachers to establish routines and procedures during the first week of school. No content is to be taught during this week.

UNIT 4 Matter [weeks]			
Overarching Question(s)			
What causes matter to change states? How does gas behave under different conditions?			
Unit	Lesson Length	Essential Question	Vocabulary
Standards and Related Background Information		Instructional Focus	Instructional Resources

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Curriculum and Instruction- Science			
RESOURCE TOOLKIT Quarter 3 Physical Science			
Textbook	DCIs and Standards	Videos	Additional Resources
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