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 a meaningful curriculum 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 curriculum 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

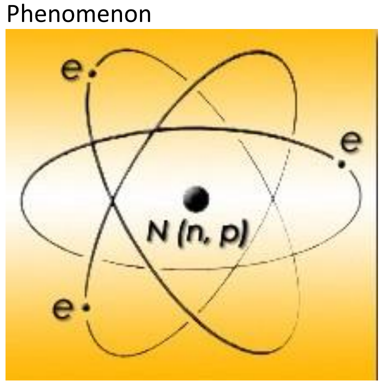
This map is a guide to help teachers and their support providers (e.g., coaches, leaders) on their path to effective, college and career ready (CCR) aligned instruction and our pursuit of Destination 2025. It is a resource for organizing instruction around the Tennessee Academic Standards for Science, which defines 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.

Physical World Concepts Quarter 4 Curriculum Map Curriculum Map Feedback Survey			
Quarter 1	Quarter 2	Quarter 3	**Quarter 4**
Unit 1 Motion and Stability: Forces and Interaction	Unit 2 Energy	Unit 3 Waves and Their Applications in Technologies for Information Transfer	**Unit 4 Matter and Its Interactions**
9 weeks	9 weeks	9 weeks	**9 weeks**

Unit 4: Matter and Its Interactions [9 Weeks]
Overarching Question(s)
How do particles combine to form the variety of matter one observes?

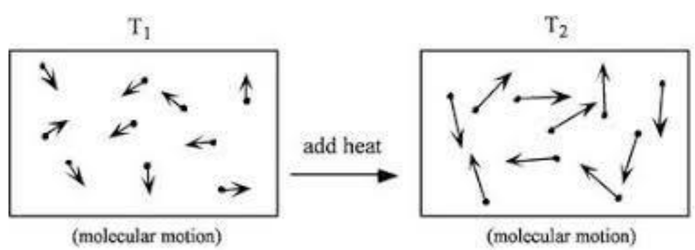
Unit, Lesson	Lesson Length	Essential Question	Vocabulary
Unit 4 Matter and Its Interactions	**2 Weeks**	• What do we base our current understanding of the structure of the atom on? • Why is it important to understand atomic structure? • What is atom? • Are there pieces of matter smaller than an atom?	atom, protons, neutrons, electrons, mass number

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI PS1 Matter and its Interactions **Standard** **PWC.PS1.1** Using the Bohr model of an atom, describe the following features and components of an atom: protons, neutrons, electrons, mass, number and types of particles, structure, and organization. **Misconceptions** • Atoms can be changed to new elements with the addition or subtraction of a proton. • When water evaporate it is converted to hydrogen and oxygen • Air is not a matter. **Science and Engineering Practice** 2. Developing and using models **Cross Cutting Concepts** 3. Energy & Matter	**Learning Outcomes** • Identify the parts of an atom. • Describe the properties and location of subatomic particles. • Explain how particles behave like waves. Phenomenon 	**Curricular Materials** **Engage** Animation: Bohr model of an atom **Explore** Lab: Atomic Orbit **Explain** **Elaborate** **Evaluate** **Textbook** **No textbook adopted for this subject**

Physical World Concepts Quarter 4 Curriculum Map Curriculum Map Feedback Survey			
Quarter 1	Quarter 2	Quarter 3	**Quarter 4**
Unit 1 Motion and Stability: Forces and Interaction	Unit 2 Energy	Unit 3 Waves and Their Applications in Technologies for Information Transfer	**Unit 4 Matter and Its Interactions**
9 weeks	9 weeks	9 weeks	**9 weeks**

Unit 4: Matter and Its Interactions [9 Weeks]
Overarching Question(s)
How do particles combine to form the variety of matter one observes?

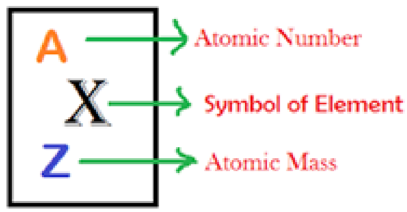
Unit, Lesson	Lesson Length	Essential Question	Vocabulary
Unit 4 Matter and Its Interactions	**2 Weeks**	• What is temperature? • How the temperature of a substance change? • What is heat capacity? • How can we use heat capacity to describe the energy required to change the temperature of a substance?	Internal energy, temperature, heat, phase change.

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI PS1 Matter and its Interactions **Standard** **PWC.PS1.2** Use the kinetic molecular theory to explain how molecular motion is related to internal energy, temperature, heat, phase change, and expansion and contraction. **PWC.PS1.3** Use data collected from a calorimeter to construct a phase diagram to explain both the constant temperature and linearly changing segments of a graph. **Misconceptions** • Cold is transferred from one object to another. • Objects that keep things warm (sweaters, mittens, blankets) are sources of heat.	**Learning Outcomes** • Investigate the relationship between temperature and kinetic energy. • Distinguish among internal energy, temperature, and heat. • Compare Fahrenheit, Celsius, and Kelvin temperature • Investigate heat changes using calorimetry **Phenomenon** 	**Curricular Materials** **Engage** Animation: Heat, Temperature and Specific Heat **Explore** Virtual Lab: Specific Heat **Explain** **Elaborate** **Evaluate** **Textbook** **No textbook adopted for this subject**

• Some substances (flour, sugar, air) cannot heat up. • Objects that readily become warm (conductors of heat) do not readily become cold. **Science and Engineering Practice** 3. Planning and Carrying Out Investigations 4. Analyzing and Interpreting Data **Cross Cutting Concepts** 3.Systems and System Models		

Physical World Concepts Quarter 4 Curriculum Map Curriculum Map Feedback Survey			
Quarter 1	Quarter 2	Quarter 3	**Quarter 4**
Unit 1 Motion and Stability: Forces and Interaction	Unit 2 Energy	Unit 3 Waves and Their Applications in Technologies for Information Transfer	**Unit 4** **Matter and Its Interactions**
9 weeks	9 weeks	9 weeks	**9 weeks**

Unit 4: Matter and Its Interactions [9 Weeks]			
Overarching Question(s)			
How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?			
Unit, Lesson	**Lesson Length**	**Essential Question**	**Vocabulary**
Unit 4 **Matter and Its Interactions**	1 Week	• What particles make up the nucleus? What is the general term for them? What are those particles composed of? • What is the definition of the atomic number? What is its symbol? • What is the definition of the atomic mass number? What is its symbol? • What is the definition of mass defect? • What is the definition of binding energy? • What distinguishes a nuclear reaction from an ordinary chemical reaction? • What is the spontaneous emission of radiation from nuclei called? What are the three types?	Atomic number, mass number, radioactivity, radioactive decay, binding energy

Standards and Related Background Information	Instructional Focus	Instructional Resources
<u>DCI</u> PS1 Matter and its Interactions **<u>Standard</u>** **PWCS.PS1.4** Describe three forms of radioactivity in terms of changes in atomic number and mass number in order to write balanced equations for the three forms of radioactive decay. **<u>Misconceptions</u>** • Radioactivity first appeared during World War II. • Atoms cannot be changed from one element to another. • Neutrons and protons have no internal structure. • Once a material is radioactive it is radioactive forever. **<u>Science and Engineering Practice</u>** 8. Obtaining, evaluating, and communicating information **<u>Cross Cutting Concepts</u>** 6. System & System Models	**<u>Learning Outcomes</u>** • Describe three forms of radioactivity in terms of changes in atomic number or mass number. • Write balanced equations for the three forms of radioactive decay. **<u>Phenomenon</u>** 	**<u>Curricular Materials</u>** **<u>Engage</u>** Video: Atomic Number and Mass Number **<u>Explore</u>** **<u>Explain</u>** **<u>Elaborate</u>** **<u>Evaluate</u>** **<u>Textbook</u>** **No textbook adopted for this subject**

Physical World Concepts Quarter 4 Curriculum Map Curriculum Map Feedback Survey			
Quarter 1	Quarter 2	Quarter 3	**Quarter 4**
Unit 1 Motion and Stability: Forces and Interaction	Unit 2 Energy	Unit 3 Waves and Their Applications in Technologies for Information Transfer	**Unit 4** **Matter and Its Interactions**
9 weeks	9 weeks	9 weeks	**9 weeks**
Unit 4: Matter and Its Interactions [9 Weeks]			
Overarching Question(s)			
What forces hold nuclei together and mediate nuclear processes?			

Unit, Lesson	Lesson Length	Essential Question	Vocabulary

<table>
<tr>
<td>Unit 4
Matter and Its
Interactions</td>
<td>2 Weeks</td>
<td>• What is the definition of binding energy?
• What is the spontaneous emission of radiation from nuclei called? What are the three types?
• What is nuclear fusion and where does it occur?</td>
<td>Nuclear fission, nuclear fusion, alpha decay, beta decay, gamma decay</td>
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<tr>
<th colspan="2">Standards and Related Background Information</th>
<th>Instructional Focus</th>
<th>Instructional Resources</th>
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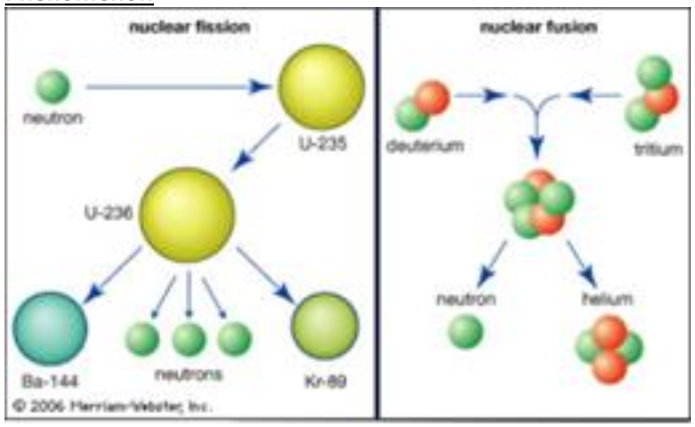
<tr>
<td colspan="2"><u>DCI</u>
PS1 Matter and its Interactions

<u>Standard</u>
PWC.PS1.5 Create a model that illustrates the difference between nuclear fission and nuclear fusion in terms of transmutation.

<u>Misconceptions</u>
• Fission and fusion are the same; fission is more powerful than fusion.
• Fission and fusion are the same; fission is more powerful than fusion.
• nuclear fusion power is a virtually unlimited source of energy.

<u>Science and Engineering Practice</u>
8. Obtaining, evaluating, and communicating information

<u>Cross Cutting Concepts</u>
1.Cause & Effect</td>
<td><u>Learning Outcomes</u>
• Distinguish between nuclear fission and nuclear fusion in terms of transmutation.
• Explain how a chain reaction is utilized by nuclear reactors.
• Compare fission and fusion reactors.

<u>Phenomenon</u>

</td>
<td><u>Curricular Materials</u>
<u>Engage</u>
Animation: <u>Nuclear Fission and Fusion</u>

<u>Explore</u>
Lab: <u>Radioactivity</u>

<u>Explain</u>

<u>Elaborate</u>

<u>Evaluate</u>

<u>Textbook</u>
No textbook adopted for this subject</td>
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Waves and Their Applications in Technologies for Information Transfer</td><td>Unit 4
Matter and Its Interactions</td></tr>
<tr><td>9 weeks</td><td>9 weeks</td><td>9 weeks</td><td>9 weeks</td></tr>
<tr><th colspan="4">Unit 4: Matter and Its Interactions [9 Weeks]</th></tr>
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Overarching Question(s)			
What forces hold nuclei together and mediate nuclear processes?			
Unit, Lesson	**Lesson Length**	**Essential Question**	**Vocabulary**
Unit 4 **Matter and Its Interactions**	**1 Week**	• Investigate how the activity of protactinium changes with time, modelling decay, using half-life in simple calculations. • How does probability of emission relate to lifetime of a radioactive material?	Half-life, radiation, radioactivity, radioactive beam, nuclear reactions

Standards and Related Background Information

DCI
PS1 Matter and its Interactions

Standard
PWC.PS1.6 Through experimental data collections, investigate the concept of half-life

Misconceptions
- Half-life time is half of the time it takes for a sample to be used up.
- For radioactive materials half the nuclei decay in one half life and the rest in a second half-life.

Science and Engineering Practice
1. Asking questions and defining problems
2. Developing and using models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in Argument from Evidence
8. Obtaining, evaluating, and communicating information

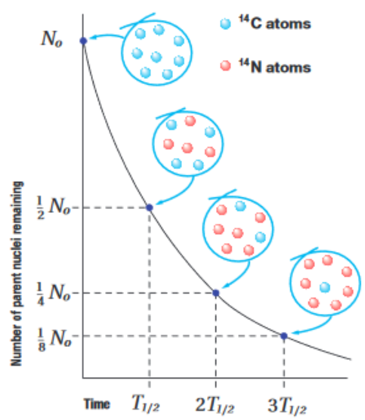
Cross Cutting Concepts
1. Stability and Change
2. Energy and Matter
3. Scale, Proportion, and Quantity

Instructional Focus

Learning Outcomes
- Measure the activity of a radioactive source
- Calculate the decay constant and the half-life of a radioactive substance.

Phenomenon

Half-Life of Carbon-14 The radioactive isotope carbon-14 has a half-life of 5715 years. In each successive 5715-year period, half the remaining carbon-14 nuclei decay to nitrogen-14.



Instructional Resources

Curricular Materials

Engage
Video: Half Life

Explore
Lab: Half Life

Explain

Elaborate

Evaluate

Textbook
No textbook adopted for this subject

No textbook for this subject		
RESOURCE TOOLKIT		
Physical World Concepts Quarter 4		
DCIs PS1 Matter and Its Interactions **Standard(s)** PWC.PS1.1 PWC.PS1.2 PWC.PS1.3 PWC.PS1.4 PWC.PS1.5 PWC.PS1.6	**Websites/ Videos** **Animation: Bohr Model of an Atom:** https://youtu.be/fm2C0ovz-3M **Lab: Atomic Orbit:** https://www.golabz.eu/lab/building-atomic-orbitals **Heat, Temperature and Specific heat** **Animation:** https://youtu.be/TqJFIBODrjM **Virtual Lab: Specific Lab:** https://youtu.be/iBz9DYrWzFc **Atomic # and Mass # Animation** https://youtu.be/_S7ov25y3_M **Nuclear Fission and Fusion animation** https://youtu.be/xrk7Mt2fx6Y **Radioactivity Lab** https://www.golabz.eu/lab/radioactivity-lab **Half Life animation: https://youtu.be/BJcPwfylYHU** **Half Life Lab:** **https://www.golabz.eu/lab/radioactivity-lab**	**Additional Resources** **ACT & SAT** TN ACT Information & Resources ACT College & Career Readiness Mathematics Standards SAT Connections SAT Practice from Khan Academy Khan Academy Illuminations (NCTM)