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.

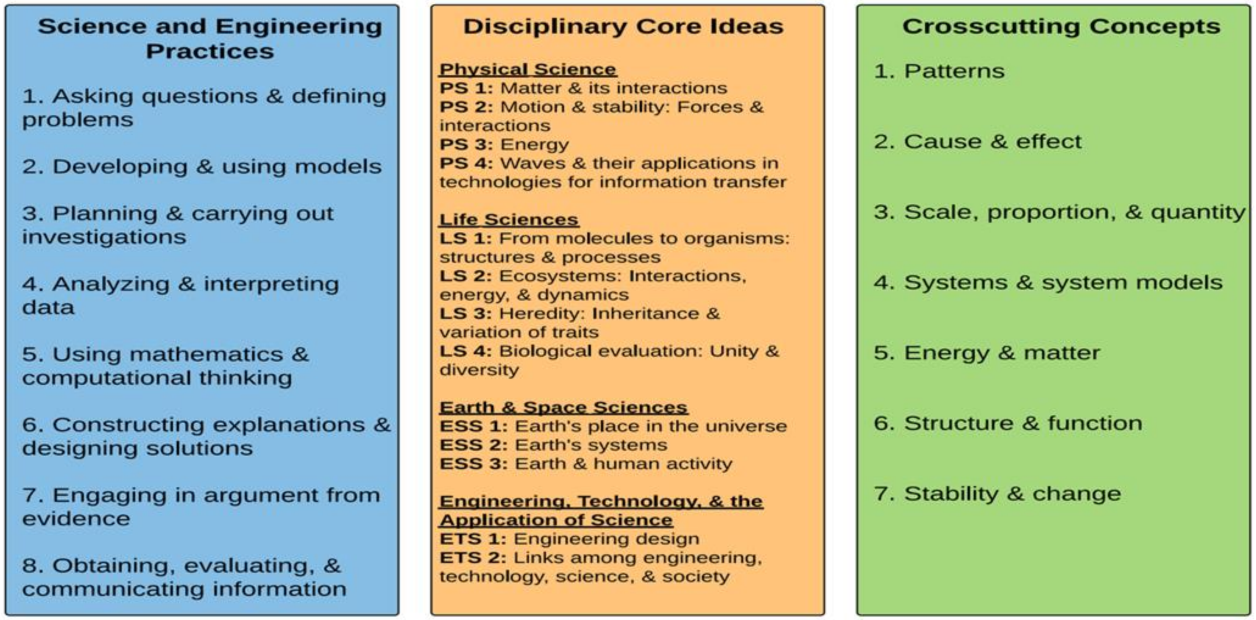
Our collective goal is to ensure our students graduate ready for college and career. Being College and Career Ready entails, many aspects of teaching and learning. We want our students to apply their scientific learning in the classroom and beyond. These valuable experiences include students being facilitators 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

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

<u>Life Sciences</u>
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

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

<u>Engineering, Technology, & the Application of Science</u>
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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Chemistry Quarter 4 Curriculum Map Quarter 4 Curriculum Map Feedback					
Quarter 1		**Quarter 2**	**Quarter 3**		**Quarter 4**
Unit 1 Atomic Structure	Unit 2 Interactions of Matter Part I	Unit 3 Interactions of Matter Part II	Unit 4 Interactions of Matter Part III	Unit 5 Matter and Energy	Unit 6 Acid & Bases and Nuclear Chemistry
5 weeks	4 weeks	9 weeks	3 weeks	**6 weeks**	9 weeks

Unit 6 Acid & Bases and Nuclear Chemistry (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 6	9 weeks	• How is a substance identified as either an acid or base? • What are the characteristic properties of acids and bases? • How is an acid or base classified as a strong or weak acid or base? • How is pH used to classify a substance as an acid or base?	Acidic solution, basic solution, Arrhenius model, strong acid, weak acid, ionization, ionization constant, strong base, weak base, dissociation, self-ionization of water, pH, pOH, neutralization reaction, salt, titration, titrant, equivalence point, acid-base indicator, endpoint.

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI CHEM1.PS1: Matter and its Interactions **Standards** CHEM1PS1.8 Identify acids and bases as a special class of compounds with a specific set of properties. **Explanation** The concept of pH. Is first introduced in seventh grade as a chemical property of matter. Students should be introduced to multiple explanations of acid and base behavior to permit classification of common substances (e.g. baking soda, ammonia, carbon dioxide) as acids or bases. To further develop discussions of solubility, qualitative discussions of the differences between strong and weak acids are appropriate. (Calculations of	**Learning Outcomes** • Identify substance as an acid or base according to its formula • Investigate the acidity/ basicity of substances with various indicators (e.g. Litmus paper and phenolphthalein indicators). • Identify the physical and chemical properties of acids and bases. • Predict the products of a neutralization reaction involving inorganic acids and bases. **Phenomena** What makes a lemon sour, and our coffee bitter? How do giant sinkholes spontaneously appear? And how in the world did they get that red stain out of your white shirt?	**Curricular Resources** **Engage** **Explore** **Laboratory Activities/Investigations:** Modern Chemistry Teacher Resources: **https://coralreef.noaa.gov/education/oa/virtual_lab/** **Explaine** **Simulations** Modern Chemistry Teacher Resources **http://ww2.kqed.org/quest/2014/12/12/ocean-acidification-and-marine-life/** **https://tn.pbslearningmedia.org/resource/nvls-sci-acidification/what-is-ocean-acidification/#.WyLGGqdKjIU**

pH or ion concentrations are beyond the scope of this standard. Discussions of pH beyond the scope of this standard. Conjugate pairs are beyond the scope of this standard.) **Misconceptions** Students often think that the term weak acid and base refer to the reactivity of the acid or base and the pH of the acid and base. Therefore, it is important to emphasize that just because an acid or base is weak does not mean that it has a higher pH for bases or a lower for acids. pH and strength of acids and bases are two different concepts. For example, hydrofluoric acid is considered a weak acid because it does not ionize completely but it is a very reactive acid that can actually dissolve glass and has pH of approximately 3. **Science and Engineering Practices** **Engaging in arguments from evidence** Students critically evaluate evidence supporting an argument and create written or oral arguments that invoke empirical evidence, scientific reasoning and scientific explanations. **Crosscutting Ideas** **Systems and System Models** Students create and manipulate a variety of different models: physical, mathematical, and computational.	Fundamental changes in seawater chemistry are occurring throughout the world's oceans. Since the beginning of the industrial revolution, the release of carbon dioxide (CO_2) from humankind's industrial and agricultural activities has increased the amount of CO_2 in the atmosphere. The ocean absorbs about a quarter of the CO_2 we release into the atmosphere every year, so as atmospheric CO_2 levels increase, so do the levels in the ocean. Initially, many scientists focused on the benefits of the ocean removing this greenhouse gas from the atmosphere. However, decades of ocean observations now show that there is also a downside — the CO_2 absorbed by the ocean is changing the chemistry of the seawater, a process called OCEAN ACIDIFICATION.	**Elaborate** **Articles**: https://www.pmel.noaa.gov/co2/story/Ocean+Acidification https://www.pmel.noaa.gov/co2/story/Buoys+and+Autonomous+Systems https://www.pmel.noaa.gov/co2/story/Ocean+Carbon+Uptake **Evaluate** **Performance Tasks:** • Identify an acid or base by its formula. • Identify properties of acids and bases. • Identify an acid and a base by its pH. • Calculate pH from hydrogen and hydroxide concentrations. **Textbook:** Modern Chemistry Chap. 14 & 15

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Unit, Lesson	**Lesson Length**	**Essential Question**	**Vocabulary**
Unit 6	9 weeks	• What are alpha and beta decay? • How are nuclear equations written and balanced? • How can a graph be used to determine the half-life of an isotope? • How can fission and fusion be differentiated by examining nuclear equations? • What are global benefits of the production of nuclear energy? • How can you use a nuclear equation to describe radioactivity? • How are half-life problems solved when given the time elapsed, isotope, or half-life of the isotope.	Radioactivity, x-ray, transmutation, nucleon, band of stability, strong nuclear forces, radioactive decay, fission, fusion, half-life, ionizing radiation, radiation, alpha decay, beta decay, radiochemical dating, nuclear reactor, transuranium elements, core, radiotracers, gamma rays, artificial transmutation, daughter nuclide, parent nuclide, decay series, nuclide, change reaction, critical mass, control rod, shielding.
Standards and Related Background Information		**Instructional Focus**	**Instructional Resources**
DCI CHEM1.PS1: Matter and its Interactions **Standard** CHEM1PS1.9 Draw models (qualitative models such as pictures or diagrams to demonstrate understanding of radioactivity stability and decay). Understand and differentiate between fission and fusion reactions. Use models (graphs		**Learning Outcomes** • Identify substance as an acid or base according to its formula • Investigate the acidity/ basicity of substances with various indicators (e.g. Litmus paper and phenolphthalein indicators). • Identify the physical and chemical properties of acids and bases.	**Curricular Resources** **Engage** **Explore** **Laboratory Activities/Investigations:** Modern Chemistry Teacher Resources: **Explain**

or tables) to explain the concept of half-life and its use in determining the age of materials (such as radiometric dating. 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 exceed repulsive electromagnetic forces. Due to 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 Students often believe that all radioactive material is dangerous and that they should never come in contact with radioactive material. Therefore, teaching should include the beneficial uses of radioactive material such as medical use, use in smoke detectors, radioactive dating, radioactive markers used in fertilizer, use for the production of electricity and presence even in foods. Students are often confused by beta particles (electrons) being emitted from the nucleus. Emphasize that the electron is emitted when a neutron breaks down into a proton and electron. Science and Engineering Practices **Science and Engineering Practices** **Analyzing and Interpreting Data** Students form explanations that incorporate sources (including models, peer reviewed	• Predict the products of a neutralization reaction involving inorganic acids and bases. **Phenomena** What makes a lemon sour, and our coffee bitter? How do giant sinkholes spontaneously appear? And how in the world did they get that red stain out of your white shirt? Fundamental changes in seawater chemistry are occurring throughout the world's oceans. Since the beginning of the industrial revolution, the release of carbon dioxide (CO2) from humankind's industrial and agricultural activities has increased the amount of CO2 in the atmosphere. The ocean absorbs about a quarter of the CO2 we release into the atmosphere every year, so as atmospheric CO2 levels increase, so do the levels in the ocean. Initially, many scientists focused on the benefits of the ocean removing this greenhouse gas from the atmosphere. However, decades of ocean observations now show that there is also a downside — the CO2 absorbed by the ocean is changing the chemistry of the seawater, a process called OCEAN ACIDIFICATION.	**Simulations** https://www.ck12.org/c/physics/radioactivity/?utm_source=projectphenomena&utm_medium=website&utm_campaign=ngss https://www.ck12.org/physics/isotopes-and-nuclear-stability/?utm_source=projectphenomena&utm_medium=website&utm_campaign=ngss **Elaborate** **Articles**: Modern Chemistry Student Book: https://interactives.ck12.org/simulations/physics/marie-curies-classroom/app/index.html?utm_source=projectphenomena&utm_medium=website&utm_campaign=ngss **Performance Tasks:** • Describe nuclear decay. • Differentiate between fission and fusion. • Calculate the half-life of a sample by the amount left over time. • Calculate the amount of a sample over a given time by its half-life. **Textbook:** Modern Chemistry Chap. 21

publications, their own investigations), invoke scientific theories, and can evaluate the degree to which data and evidence support a given conclusion. **<u>Crosscutting Ideas</u>** **Energy and Matter** Students reconcile conservation of mass in nuclear processes.		

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Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI CHEM1.PS1: Matter and its Interactions **Standard** CHEM1.PS1.10 Compare alpha, beta, and gamma radiation in terms of mass, charge, and penetrating power. Identify examples of applications of different radiation types in	**Learning Outcomes** • Students will be able to differentiate alpha, beta and gamma radiation. • Students will be able to identify the harmful effects of radiation. • Students will be able to identify ways radiation is used to help in society.	**Curricular Resources** **Engage** **Explore** **Laboratory Activities/Investigations:** Teacher Resources: Modeling Radioactive Decay: Using paper and pennies. **Explain**

everyday life (such as it applications in cancer treatment). **Explanation** Nuclear decay processes occur due to random movements of nucleons resulting in variations in potential energy. At some point, the potential energy becomes great enough for a decay process to occur. Students should be familiar with the particles emitted during decay as well as changes to the composition of the nucleus. Forms of nuclear radiation include alpha decay, beta decay (electron and positron emission), and gamma radiation. (Discussions of the weak nuclear force are beyond the scope of this standard, but may be incorporated for enrichment.) **Misconceptions** All radioactive material is harmful.	**Phenomenon** In our daily lives, radioactivity is present but not always noticed. It is unique situations where this stands out. When we go to the dentist or we get hurt, we often have to get X-rays. Why do the technicians cover us with a heavy apron and then go behind a screen? Unfortunately, many of us are affected by cancer and are familiar with chemotherapy. What are some of the side effects of treatment? Why does it seem that we make the patient so sick just to cure them of something else? We are often told the age of artifacts that are found. How do we know that age? How does Radiocarbon Dating work?	**Videos** Textbook Resources: Why It Matters: Nuclear Chemistry **Elaborate** **Articles**: Modern Chemistry Student Book: **Evaluate** **Performance Tasks:** • Identify types of radiation. • Create a decay series for alpha and beta decays. • Use correct notation for radiation and isotopes. • Describe some uses for and side effects of radiation. **Textbook:** Half-life 21.2 Radioactive Decay 12.2

Curriculum and Instruction- Science			
RESOURCE TOOLKIT			
Quarter 4		**Chemistry**	
DCIs and Standards **DCI** **CHEM1.PS1:** Matter and Its Interactions **Standard** CHEM1PS1.8 CHEM1PS1.9 CHEM1PS1. 10	**Textbook** Modern Chemistry 5E Lesson Resource Link	**Videos** Khan Academy Illuminations (NCTM) Discovery Education The Futures Channel The TeachingChannel Teachertube.com **Simulations** **http://ww2.kqed.org/quest/2014/12/12/ocean-acidification-and-marine-life/** **https://tn.pbslearningmedia.org/resource/nvls-sci-acidification/what-is-ocean-acidification/#.WyLGGqdKjIU** **https://www.ck12.org/c/physics/radioactivity/?utm_source=projectphenomena&utm_medium=website&utm_campaign=ngss** **https://www.ck12.org/physics/isotopes-and-nuclear-stability/?utm_source=projectphenomena&utm_medium=website&utm_campaign=ngss** https://www.pmel.noaa.gov/co2/story/Ocean+Acidification https://www.pmel.noaa.gov/co2/story/Buoys+and+Autonomous+Systems https://www.pmel.noaa.gov/co2/story/Ocean+Carbon+Uptake	**Additional Resources:** **ACT & SAT** TN ACT Information & Resources ACT College & Career Readiness Mathematics Standards SAT Connections SAT Practice from Khan Academy