Shelby County Schools Science Vision

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

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

Introduction

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

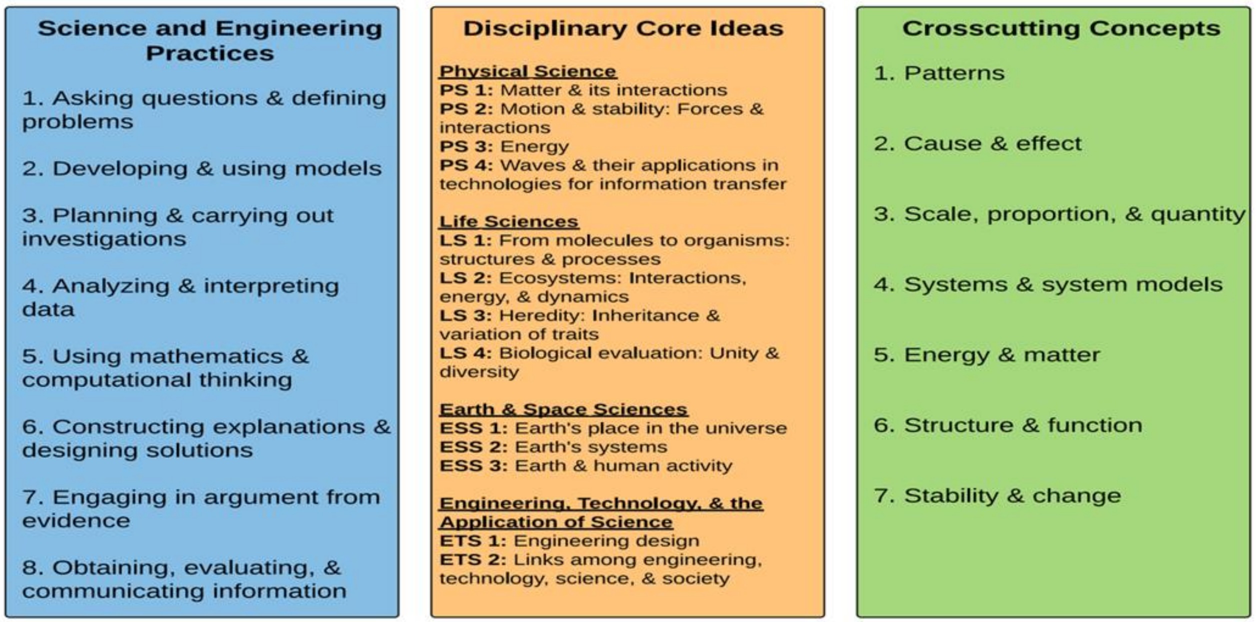
Our collective goal is to ensure our students graduate ready for college and career. Being College and Career Ready entails, many aspects of teaching and learning. We want our students to apply their scientific learning in the classroom and beyond. These valuable experiences include students being facilitators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

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

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

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

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



Learning Progression

At the end of the elementary science experience, students can observe and measure phenomena using appropriate tools. They are able to organize objects and ideas into broad concepts first by single properties and later by multiple properties. They can create and interpret graphs and models that explain phenomena.

Students can keep notebooks to record sequential observations and identify simple patterns. They are able to design and conduct investigations, analyze results, and communicate the results to others. Students will carry their curiosity, interest and enjoyment of the scientific world view, scientific inquiry, and the scientific enterprise into middle school.

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

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

Structure of the Standards

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

Purpose of Science Curriculum Maps

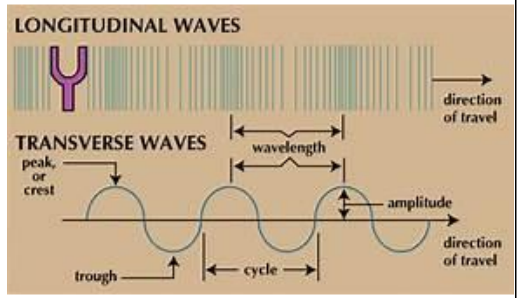
This map is a guide to help teachers and their support providers (e.g., coaches, leaders) on their path to effective, college and career ready (CCR) aligned instruction and our pursuit of Destination 2025. It is a resource for organizing instruction around the Tennessee Academic Standards for Science,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

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

Physics Quarter 4 Curriculum Map Quarter 4 Curriculum Map Feedback Survey											
Quarter 1			Quarter 2			Quarter 3			**Quarter 4**		
Unit 1 One Dimensional Kinematics	Unit 2 Two Dimensional Kinematic	Unit 3 Forces	Unit 4 Work and Energy	Unit 5 Momentum	Unit 6 Circular Motion and Gravitation	Unit 7 Heat Energy and Thermo.	Unit 8 Electric Forces, Fields and Energy	Unit 9 Capacitors, Resistors and Circuits	**Unit 10 Waves and Sound**	Unit 11 Light and Light Behaviors	Unit 12 Nuclear Physics
3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	3 weeks	2 weeks	4 weeks	3 weeks	**3 weeks**	4 weeks	2 weeks

UNIT 10: Waves and Sound **[3 weeks]**			
Overarching Question			
What are the characteristic properties and behaviors of waves?			
Unit, Lesson	**Lesson Length**	**Essential Question(s)**	**Vocabulary**
Unit 10 Waves and Sound	1 Week	• What are waves? • What do waves do? • What are the parts of a wave? • What causes waves? • What are two kinds of waves? • What are the characteristics of mechanical and electromagnetic waves?	amplitude, period, frequency, medium, mechanical wave, crest, trough, wavelength, transverse wave, longitudinal wave

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI PS4: Waves and their applications in technologies for information transfer **Standard(s)** **PHYS.PS4.1** Know wave parameters (i.e., velocity, period, amplitude, frequency, angular frequency) as well as how these quantities are defined in the cases of longitudinal and transverse waves	**Learning Outcomes** • Identify the amplitude of vibration. • Recognize the relationship between period and frequency. • Calculate the period and frequency of an object vibrating with simple harmonic motion. • Distinguish local particle movement from overall wave motion. • Interpret waveforms of traverse and longitudinal waves.	**Curricular Materials** **Engage** Demonstrations • Period and Frequency; TE pg. 374 • Relationship Between the Length and the Period of a Pendulum; TE pg. 375 • Wave Motion; TE pg. 380 • Transverse Waves; TE pg. 381 • Longitudinal Waves; TE pg. 383

PHYS.PS4.3 Understand that the reflection, refraction, and transmission of waves at an interface between two media can be modeled on the basis of characteristics of specific wave parameters and parameters of the medium. **Explanation** Standard 4.PS4.1 is a student's introduction to waves. At this time, students address the properties of amplitude, wavelength and direction of a wave and principles of superposition of waves, but not by name. In 8.PS4.1, students revisit the topic adding frequency to their models and beginning to consider wave speed, but without mentioning factors affecting the speed of the waves. PHYS.PS2.3 includes discussion of rotational motion which can pair with discussions of simple harmonic motion to clarify angular velocity and angular speed. Discussions regarding the origin of waves can fully develop these ideas. PHYS.PS4.3: The focus of this standard is on developing an understanding for the behavior of waves at a boundary. To demonstrate these principles, it is suggested that students create waves on a coiled spring or string and send these waves towards either a free or fixed end or through a different weight of string. For instance, wave can be created in a section of a lighter string then transmitted towards a point where that string terminates into a heavier segment of string. In doing so, it is possible to observe the effects on wave amplitude and a discussion of energy differences. Students should extend their observations of these mechanical waves to wave behaviors at other scales.	• Apply the relationship among wave speed, frequency, ad wavelength to solve problems. • Predict when a reflected wave will be inverted. **Suggested Phenomenon** 	• Amplitude, Wavelength, and Wave Speed; TE pg. 384 • Wave Reflection; TE pg. 390 Interactive Demonstrations • Simple Harmonic of a Simple Pendulum • Simple Harmonic Motion of a Mass-Spring System Animated Physics: Section 11.3: Characteristics of a Wave **Explore:** Virtual Lab: • Simple Harmonic Motion • Hooke's Law • Motion of a Pendulum PhET Lab: Pendulum Lab; Fourier: Making Waves; Wave on a String. Probeware Lab: Pendulum Periods Core Skills Lab: Simple Harmonic Motion of a Pendulum STEM Lab: Tensile Strength and Hooke's Law **Explain** Classroom Practice: • SHM of a Simple Pendulum; TE/SE pgs. 376-377 • SHM of a Mass-Spring System; TE/SE pgs. 378-379 • Wave Speed; TE/SE pg. 385 Interactive Reader: • Section 11.3: Properties of Waves • Section 11.2: Measuring Simple Harmonic Motion • Section 11.4: Wave Interactions **Elaborate** Conceptual Challenge; TE/SE pg. 377 Sample Problems

Misconceptions • Waves transport matter. (Waves transport energy; not matter.) • There must be a medium for a wave to travel through. (Only mechanical waves need a medium in order to propagate. Electromagnetic waves do not need a medium in order to propagate.) • Waves do not have energy. (Waves are an energy transport phenomenon that transport energy along a medium without transporting matter.) • Frequency is connected to loudness for all amplitudes. (Frequency refers to how often the particles of a medium vibrate within a unit of time when a wave passes through the medium. The loudness of a sound.) **Suggested Science and Engineering Practice** **Constructing explanations and designing solutions:** *Students form explanations that incorporate sources (including models, peer reviewed publications, their own investigations), invoke scientific theories, and can evaluate the degree to which data and evidence support a given conclusion.* **Suggested Cross Cutting Concepts** **Systems and System Models:** *Students create and manipulate a variety of different models: physical, mathematical, computational.*		• Section 11.2 Sample Problem Set I: Sample Problem B: Simple Harmonic Motion of a Simple Pendulum • Section 11.2 Sample Problem Set II: Sample Problem B: Simple Harmonic Motion of a Simple Pendulum • Section 11.2 Sample Problem Set I: Sample Problem C: Simple Harmonic Motion of a Mass-Spring System • Section 11.2 Sample Problem Set II: Sample Problem C: Simple Harmonic Motion of a Mass-Spring System **Evaluate** Ch. 11 Section 2 Formative Assessment; TE/SE pg. 379 Ch. 11 Section 3 Formative Assessment; TE/SE pg. 386 Interactive Review: Concept Map: Wave Classifications Section 11.2 Quiz Section 11.3 Quiz **Textbook:** *HMH TN Physics*: Ch. 11 Vibrations and Waves • Section 11.2 Measuring Simple Harmonic Motion; pgs. 374-379 • Section 11.3 Properties of Waves; pgs. 380-386 • Section 11.4 Wave Interactions; pgs. 390 **Additional Resources** HMD Science Explore: Ch. 11 Vibrations and Waves Science Standards Guide: PS4.1: Properties of Waves; pgs. 65-66, PS4.3: Reflection, Refraction, and Transmission; pgs. 69-70; Teacher Guide Graphing Calculator: Pendulum Activity; Student Activity Sheet Ch. 11 Section Study Guides

		Ch. 11 Chapter Study Guide Ch. 11 SAT Bellringer

Physics Quarter 4 Curriculum Map

Quarter 4 Curriculum Map Feedback Survey

Quarter 1			Quarter 2			Quarter 3			**Quarter 4**		
Unit 1 One Dimensional Kinematics	Unit 2 Two Dimensional Kinematic	Unit 3 Forces	Unit 4 Work and Energy	Unit 5 Momentum	Unit 6 Circular Motion and Gravitation	Unit 7 Heat Energy and Thermo.	Unit 8 Electric Forces, Fields and Energy	Unit 9 Capacitors, Resistors and Circuits	**Unit 10 Waves and Sound**	Unit 11 Light and Light Behaviors	Unit 12 Nuclear Physics
3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	3 weeks	2 weeks	4 weeks	3 weeks	**3 weeks**	4 weeks	2 weeks

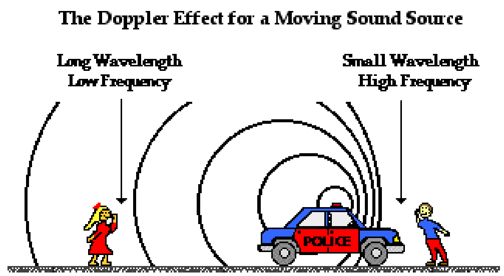
UNIT 10: Waves and Sound **[3 weeks]**

Overarching Question(s)

How are waves used to transfer energy and information?
What are the characteristic properties and behaviors of waves?

Unit, Lesson	Lesson Length	Essential Question(s)	Vocabulary
Unit 10 Waves and Sound	1 Week	• What aspects of sound quality are affected by how the waves travel? • What do you notice as a fire truck passes by you with its siren on?	Medium, crest, longitudinal wave, mechanical wave, trough, transverse wave, wavelength, compression, pitch, rarefaction, Doppler effect

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI PS4: Waves and their applications in technologies for information transfer **Standard** **PHYS.PS4.2** Describe parameters of a medium that affect the propagation of a sound wave through it.	**Learning Outcomes** • Explain how sound waves are produced. • Relate frequency to pitch. • Compare the speed of sound in various media.	**Curricular Materials** **Engage** Animated Physics: Section 11.3: Characteristics of a Wave Demonstrations: • Sound Waves in a Solid; TE pg. 408 • The Doppler Effect; TE pg. 410

Explanation The focus of this discussion should be properties of the medium, specifically the density of the material. The density becomes a factor in optics and considering transmission of electromagnetic waves. Students can be led to make their descriptions by experimenting with coiled springs stretched to varying lengths. The topic of linear mass density can be used to explore analogous properties in the air. **Misconceptions** • Some individuals may be able to hear sounds slightly below 20 Hz or above 20,000 Hz because the range of frequencies defined as audible is based on the ability of the average human ear. • Waves transport matter. • There must be a medium for a wave to travel through. • Waves do not have energy. • All waves travel the same way. • Big waves travel faster than small waves in the same. **Suggested Science and Engineering Practice** **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.* **Suggested Cross Cutting Concepts** **Structure and Function**	• Recognize the Doppler effect, and determine the direction of a frequency shift when there is relative motion between a source and an observer. **Suggested Phenomenon**  	**Explore** Virtual Lab: Speed of Sound PhET Lab: Wave Interference Discovery Lab: Resonance and the Nature of Sound Skills Practice Lab: Speed of Sound Probeware Lab: Speed of Sound **Explain** Interactive Reader: Section 12.1: Sound Waves **Elaborate** Why It Matters: Ultrasound Images; TE/SE pg. 408 Conceptual Challenge; TE/SE pg. 409 The Doppler Effect and the Big Bang; TE/SE pgs. 430-431 Wave Propagation; TE/SE pg. 433 **Evaluate** Ch. 12 Section 1 Formative Assessment; TE/SE pg. 411 Interactive Review: Concept Map: Sound Waves Ch. 12.1 Quiz **Textbook** HMH Physics –Chapter 11: Vibrations and Waves • Section 11.3: Properties of Waves; pgs. 380-386 HMH Physics –Chapter 12: Sound • Section 12.1: Sound Waves; pgs. 406-411 **Additional Resources:** HMD Science Explore: Ch. 11: Vibrations and Waves HMD Science Explore: Ch. 12: Sound Science Standards Guide: PS4.2: Propagation of Sound through a Medium; pgs. 67-68; Teacher Guide Graphing Calculator: Doppler Effect Ch. 12 Section Study Guides Ch. 12 Chapter Study Guide

Students apply patterns in structure and function to unfamiliar phenomena.		

Physics Quarter 4 Curriculum Map Quarter 4 [Curriculum Map Feedback Survey]											
Quarter 1			Quarter 2			Quarter 3			**Quarter 4**		
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3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	3 weeks	2 weeks	4 weeks	3 weeks	**3 weeks**	4 weeks	2 weeks

UNIT 10: Waves and Sound **[3 weeks]**			
[Overarching Question(s)]			
How are waves used to transfer energy and information? What are the characteristic properties and behaviors of waves?			
Unit, Lesson	**Lesson Length**	**Essential Question(s)**	**Vocabulary**
Unit 10 Waves and Sound	1 Week	• How do we describe the motion of waves? • How do the different forms of energy travel? • What affects how the different forms of energy travel? • What are the properties of a compression wave? • What aspects of sound quality are affected by how the waves travel? • What are the properties of a compression wave?	Intensity, loudness, decibel, resonance
Standards and Related Background Information		**Instructional Focus**	**Instructional Resources**

DCI

PS4: Waves and their applications in technologies for information transfer

Standard

PHYS.PS4.4 Communicate scientific and technical information about how the principle of superposition explains the resonance and harmonic phenomena in air columns and on strings.

Explanation

In 4.PS4.1, students examine the effects of superposition of waves, but do not explore the behavior of waves at boundaries. Building on 4.PS4.3, the behavior of a wave at a free or fixed boundary can create patterns where successive waves produced by a source interact with those reflected off a boundary. Discussions should include general development of the idea of harmonics. Once established, this topic can be extended to the specific function of stringed instruments such as guitars of simple open or closed tubes. The phenomena of resonance can be produced using a tuning fork held above a section of rigid tubing which is lowered or lifted into a pail of water. Resonance can be heard clearly at multiple points, providing an opportunity to model the source of resonance and relate the resonance points to the wavelength of the wave produced. The phenomenon of beats can be used to provide an introduction to this topic as it too is an audible phenomenon. Quick demonstrations of beats can be performed without tuning forks using multiple open windows in a browser simultaneously playing different frequencies.

Learning Outcomes

- Calculate the intensity of sound waves.
- Relate intensity, decibel level, and perceived loudness.
- Explain why resonance occurs.
- Differentiate between the harmonic series of open and closed pipes.
- Calculate the harmonics of a vibrating string and of open and closed pipes.
- Relate the frequency difference between two waves to the number of beats heard per second.

Suggested Phenomenon

https://youtu.be/7bx3xx7sB0c

Curricular Materials

Engage

Animated Physics: Resonance

Demonstrations:

- Resonance; TE pg. 416
- Seeing Sound; TE pg. 421

Interactive Demonstrations:

- Intensity of Sound Waves
- Harmonics

Explore

Online Lab:

PhET Lab: Sound & Resonance

QuickLab: Section 12.2: Resonance; TE/SE pg. 416

STEM Lab: Building a Musical Instrument

Quick Lab: A Pipe Closed At One End; TE/SE pg. 423

Probeware Lab: Sound Waves and Beats

Explain

Classroom Practice:

- Intensity of Sound Waves; TE/SE pg. 413
- Harmonics; TE/SE pgs. 424-425

Interactive Reader:

- Section 12.2: Sound Intensity and Resonance
- Section 12.3: Harmonics

Elaborate

Conceptual Challenge; TE/SE pg. 417

Why It Matters: Hearing Loss; TE/SE pg. 419

Why It Matters: Reverberation; TE/SE pg. 427

Conceptual Challenge; TE/SE pg. 428

Sample Problems:

- Section 12.2 Sample Problem Set I: Sample Problem A: Intensity of Sound Waves

Misconceptions • Frequency or intensity alone cannot determine which sounds are audible. Both factors must be taken into account. • Sound travels faster through air than through objects • All sound waves are audible • Sound cannot do work • When frequency increases wave length increases **Suggested Science and Engineering Practice** **Obtaining, evaluating, and communicating information** *Students can provide written and oral explanations for phenomena and multipart systems using models, graphs, data tables, and diagrams* **Suggested Cross Cutting Concepts** **Pattern** *Students recognize, classify, and record patterns in quantitative data from empirical research and mathematical representations*		• Section 12.2 Sample Problem Set II: Sample Problem A: Intensity of Sound Waves • Section 12.3 Sample Problem Set I: Sample Problem B: Harmonics • Section 12.3 Sample Problem Set II: Sample Problem B: Harmonics **Evaluate** Ch. 12 Section 2 Formative Assessment; TE/SE pg. 418 Ch. 12 Section 3 Formative Assessment; TE/SE pg. 428 Section 12.2 Quiz Section 12.3 Quiz **Textbook** HMH Physics – Chapter 12: Sound • Section 12.2: Sound Intensity and Resonance; pgs. 412-419 • Section 12.3: Harmonics; pgs. 420-429 **Web Resources** HMD Science Explore: Ch. 12: Sound Science Standards Guide: PS4.4: Superposition, Resonance, and Harmonics; pgs. 71-72; Teacher Guide Ch. 12 Section Study Guides Ch. 12 Chapter Study Guide

Physics Quarter 4 Curriculum Map Quarter 4 Curriculum Map Feedback Survey											
Quarter 1			Quarter 2			Quarter 3			**Quarter 4**		
Unit 1	Unit 2	Unit 3 Forces	Unit 4	Unit 5 Momentum	Unit 6	Unit 7 Heat Energy	Unit 8 Electric Forces,	Unit 9	Unit 10	**Unit 11 Light and Light**	Unit 12 Nuclear Physics

One Dimensional Kinematics	Two Dimensional Kinematic		Work and Energy		Circular Motion and Gravitation	and Thermo.	Fields and Energy	Capacitors, Resistors and Circuits	Waves and Sound	**Behaviors**	
3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	**4 weeks**	2 weeks

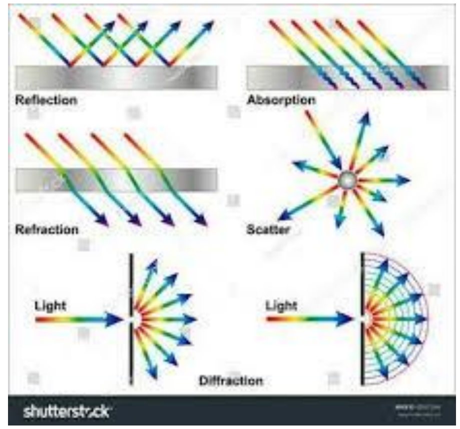
UNIT 11: Light and Light Behaviors **[4 Weeks]**

Overarching Question(s)

What is light? How can one explain the varied effects that involve light? What other forms of electromagnetic radiation are there?

Unit, Lesson	Lesson Length	Essential Question(s)	Vocabulary
Unit 11 Light and Light Behaviors	2 Weeks	• Examine properties of light waves. • Investigate reflection, refraction, diffraction, and interference of light waves.	Refraction, index of refraction, coherence, path difference, order number, total internal reflection, critical angle, dispersion, chromatic aberration

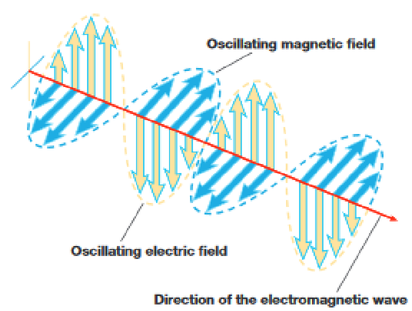
Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI PS4: Waves and their applications in technologies for information transfer **Standard** **PHYS.PS4.6** Plan and conduct controlled scientific investigations to construct explanations of light's behavior (reflection, refraction, transmission, interference) including the use of ray diagrams. **PHYS.PS4.9** Investigate how information is carried in optical systems and use Snell's law to describe the properties of optical fibers. **Explanation** In PHYS.PS4.3 students examine the behaviors of mechanical waves moving through a medium. Though the terminology in this standard is comparable, this standard focuses on optics of light. Students should work with lenses and mirrors to	**Learning Outcomes** • Recognize situations in which refraction will occur. • Identify which direction light will bend when it passes from one medium to another. • Use Snell's law. **Suggested Phenomenon**	**Curricular Materials** **Engage** Animated Physics: • Refraction and Total Internal Reflection • Diffraction Demonstrations: • Refraction from Air to Water; TE pg. 485 • Refraction in Various Materials; TE pg. 486 • Underwater Appearance; TE pg. 487 • Interference in Sound Waves; TE pg. 520 • Interference in a Ripple Tank; TE pg. 521 • How Distance Traveled Affects Interference; TE pg. 522 • Thin-Film Interference; TE pg. 523 • Critical Angle; TE pg. 502 • Fiber Optics—Bending Light; TE pg. 505 • Dispersion; TE pg. 505 Interactive Demonstrations: • Snell's Law • Interference

build an understanding of the behaviors of light as it interacts with surfaces (reflection, refraction, transmission). In 4.PS4.1 and PHYS.PS4.1, students investigated interference patterns with mechanical waves. Using a pair of speakers and an online tone/frequency generator, it is possible to demonstrate that sound waves, like mechanical waves, can interfere with each other. In such a demonstration, students are able to hear variations in the volume of the sound as they walk in a straight line across the field of sound created by the speakers. **PHYS.PS4.9**: As light travels from one medium to another, the path of light is bent. Snell's law can be used to determine the critical angle for a medium. This angle represents the angle at which the light does not exit the medium but instead is reflected back into the medium. Fiber optic cables utilize this phenomenon by transmitting light that reflects off of the internal walls of the cable rather than escaping the cable. **<u>Misconception</u>** • Shiny objects reflect more light than dull objects. • Light always passes straight through transparent objects (without changing direction). • The frequency of light changes as light enters a different medium. Students may think that the frequency of light changes as light enters a different medium. Point out that the frequency cannot change. If the refracted frequency were less than the		**<u>Explore</u>** PhET Lab: Bending Light & Geometric Optics Discovery Lab: Refraction and Lenses Virtual Lab: Refraction of Light STEM Lab: Fiber Optics Quick Lab: Periscope; TE/SE pg. 503 **<u>Explain</u>** Classroom Practice: • Snell's Law; TE/SE pgs. 488-489 • Interference; TE/SE pgs. 524-525 • Critical Angle; TE/SE pgs. 503-504 Interactive Reader: • Section 14.1 Refraction • Section 14.3 Optical Phenomena • Section 15.1: Interference **<u>Elaborate</u>** Conceptual Challenge; TE/SE pg. 487 Why It Matters: Fiber Optics; TE/SE pg. 504 Sample Problems • Section 14.1 Sample Problem Set I: Sample Problem A: Snell's Law • Section 14.1 Sample Problem Set II: Sample Problem A: Snell's Law **<u>Evaluate</u>** Ch. 14 Section 1 Formative Assessment; TE/SE pg. 489 Ch. 15 Section 1 Formative Assessment; TE/SE pg. 525 Section 14.1 Quiz Section 15.1 Quiz **Textbook**

incident frequency, wave crests would have to "pile up" somewhere. If the refracted frequency were greater than the incident frequency, wave crests would have to "pop up" from nowhere. **Suggested Science and Engineering Practice** **Asking questions** *Questions should facilitate empirical investigation.* **Developing and using models** *Student models are functioning prototypes and are able to generate data useful for both computation and problem solving.* **Suggested Cross Cutting Concepts** **Structure and Function** *Students apply patterns in structure and function to unfamiliar phenomena.* **Cause and Effect** *Students design a system to produce a desired outcome.*		HMH Physics – Refraction - Chapter 14 • Section 14.1: Refraction; TE/SE pgs. 484-489 • Section 14.3: Optical Phenomena; TE/SE pgs. 502-505 HMH Physics—Chapter 15 • Section 15.1: Interference; TE/SE pgs. 520-525 **Additional Online Resources:** **Web Resource**: HMD Science Explore: Ch. 14: Refraction & Chapter 15: Interference & Diffraction Science Standards Guide: PS4.6: Light Behavior and Ray Diagrams; pgs. 75-76, PS4.9: Snell's Law and Optical Fibers; pgs. 81-82; Teacher Guide

Physics Quarter 4 Curriculum Map Quarter 4 Curriculum Map Feedback Survey											
Quarter 1			Quarter 2			Quarter 3			**Quarter 4**		
Unit 1 One Dimensional Kinematics	Unit 2 Two Dimensional Kinematic	Unit 3 Forces	Unit 4 Work and Energy	Unit 5 Momentum	Unit 6 Circular Motion and Gravitation	Unit 7 Heat Energy and Thermo.	Unit 8 Electric Forces, Fields and Energy	Unit 9 Capacitors, Resistors and Circuits	Unit 10 Waves and Sound	**Unit 11 Light and Light Behaviors**	Unit 12 Nuclear Physics
3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	**4 weeks**	2 weeks
UNIT 11: Light and Light Behaviors **[4 Weeks]**											
Overarching Question(s)											

What is light? How can one explain the varied effects that involve light? What other forms of electromagnetic radiation are there?			
Unit, Lesson	**Lesson Length**	**Essential Question(s)**	**Vocabulary**
Unit 11 Light and Light Behaviors	2 Weeks	• How do we utilize the waves on the electromagnetic spectrum? • Why do we need to be concerned about excessive exposure to cell phone use?	Electromagnetic radiation, photon, Microwaves, Infrared, uncertainty principle

Standards and Related Background Information	**Instructional Focus**	**Instructional Resources**
DCI PS4: Waves and their applications in technologies for information transfer. **Standard(s)** **PHYS.PS4.5** Evaluate the characteristics of the electromagnetic spectrum by communicating the similarities and differences among the different bands. Research and determine methods and devices used to measure these characteristics. **PHYS.PS4.7** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model. **Explanation** The visible portion of the electromagnetic spectrum will be familiar to students, as will the ideas of x-rays, microwaves, and radiowaves. However, students often struggle to see these phenomena as multiple manifestations of the same principles. It may be beneficial to relate these discussions to the physiology of the human eye, specifically the function of the rhodopsin photopigment. As a demonstration: the light bulbs on the front of	**Learning Outcomes** • Describe electromagnetic waves and how they are made. • Recognize that electricity and magnetism are two aspects of a single electromagnetic force. • Recognize the dual nature of light and matter. • Calculate the de Brogile wave **Suggested Phenomenon** **An Electromagnetic Wave** An electromagnetic wave consists of electric and magnetic field waves at right angles to each other. The wave moves in the direction perpendicular to both oscillating waves. 	**Curricular Materials** **Engage** Animated Physics: • Section 21.3: The Photoelectric Effect Demonstrations: • Can De Graaff Generator; TE pg. 721 Interactive Demonstration: • De Broglie Waves **Explore** PhET Lab: Radio Waves and Electromagnetic Fields **Explain** Interactive Reader: • Section 20.4 Electromagnetic Waves • Section 21.3: Quantum Mechanics **Elaborate** Classroom Practice: • De Brogile Waves; TE/SE pgs. 757-758 Sample Problems: • Section 21.3 Sample Problem Set I: Sample Problem D: De Broglie Waves

remote controls emit light outside of the visible spectrum; however, inexpensive cell phone cameras lack IR filters (as well as some front facing cameras on more current cell phones). Rendering the IR light visible can help student to understand that many devices function by capturing the energy of electromagnetic waves. An additional option would be the creation of a crystal radio using a germanium diode. **PHYS.PS4.7** Most students willingly accept the particle behavior of light. As early as first grade, students have experimented with the behavior of light and observed that shadows can be created if some of the particles of light are blocked. Introductory explanations of the photoelectric effect can provide more advanced evidence for the particle behavior. Properties of wave behavior can be demonstrated by observing interference patterns in Young's double slit experiment. Simple models using strips of paper to represent waves can provide a more tangible experience to understand the interference phenomena. **Misconception** • Students may be perplexed about the bright colors that appear under low frequency ultraviolet light, or black light. Explain that the materials used in black-light posters absorb ultraviolet radiation and then reemit the energy at longer wavelengths of light. This process, called fluorescence, produces the glowing colors that are seen under the invisible ultraviolet light.		• Section 21.3 Sample Problem Set II: Sample Problem D: De Broglie Waves **Evaluate** Section 20.4 Formative Assessment; TE/SE pg. 723 Section 20.4 Quiz Section 21.3 Quiz Section 21.3 Formative Assessment; TE/SE pg. 761 **Textbook** HMH Physics –Chapter 20: Electromagnetic Induction • Section 20.4: Electromagnetic Waves; pgs. 721-723 HMH Physics –Chapter 21: Atomic Physics • Section 21.3: Electromagnetic Waves; pgs. 755-761 **Additional Resources** HDM Science Explore: Ch. 20: Electromagnetic Induction HDM Science Explore: Ch. 21: Atomic Physics Science Standards Guide: PS4.5: Electromagnetic Spectrum; pgs. 73-74, PS4.7: Wave and Particle Models; pgs. 77-78; Teacher Guide

• The concept of matter waves is probably new and unusual to most students. Because students have no experience with matter waves, they may not understand the nature of such waves. The meaning of de Broglie's hypothesis is that we may picture the electron in two ways: as a particle in motion or as a wave occupying a certain region in space. Encourage students to discuss their mental images of electron waves to prepare them for the probability interpretation of matter waves. Also assure them that these ideas remain puzzling to many people. **<u>Suggested Science and Engineering Practice</u>** **Analyzing and interpreting data** *Students should use data to revise and optimize devices already in operation.* **<u>Cross Cutting Concepts</u>** **Pattern** *Students recognize, classify, and record patterns in quantitative data from empirical research and mathematical representations.*		

Physics Quarter 4 Curriculum Map Quarter 4 Curriculum Map Feedback Survey											
Quarter 1			Quarter 2			Quarter 3			**Quarter 4**		
Unit 1	Unit 2	Unit 3 Forces	Unit 4	Unit 5 Momentum	Unit 6	Unit 7 Heat Energy	Unit 8 Electric Forces,	Unit 9	Unit 10	Unit 11 Light and Light	**Unit 12 Nuclear Physics**

One Dimensional Kinematics	Two Dimensional Kinematic		Work and Energy		Circular Motion and Gravitation	and Thermo.	Fields and Energy	Capacitors, Resistors and Circuits	Waves and Sound	Behaviors	
3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	4 weeks	**2 weeks**

UNIT 12: Nuclear Physics [2 Weeks]

Overarching Question(s)

How do particles combine to form the variety of matter one observes?

Unit, Lesson	Lesson Length	Essential Question	Vocabulary
Unit 12 **Nuclear Physics**	1 Week	• What is radioactive decay? • What about an atom changes when radioactive decay occurs? • What is an alpha particle made from? • What household device emits alpha particles? • What is a beta particle? • Compare/Contrast -how alpha and beta decay cause transmutation. • Is radioactivity a blessing or a curse? • What misconceptions do the general public have about nuclear power?	alpha decay, beta decay, gamma decay, photons

Standards and Related Background Information	Instructional Focus	Instructional Resources
DCI PHYS.PS1: Matter and Its Interactions **Standard** PHYS.PS1.2 Recognize and communicate examples from everyday life that use radioactive decay processes. **Explanation**	**Learning Outcomes** • Describe the three modes of nuclear decay. • Predict the products of nuclear decay. • Calculate the decay constant and the half-life of a radioactive substance.	**Curricular Materials** **Engage** Animated Physics: Section 22.2 Alpha, Beta, and Gamma Radiation Interactive Demonstration: Nuclear Decay Demonstration: • Electron Beam Deflection; TE pg. 783 **Explore**

The appropriateness of radioactive decay for an everyday process is largely due to the nature of the products of a decay process. More energetic particles are more likely to cause damage to living systems. Alpha particles are low energy particles and permit the utilization of alpha decay reactions in household devices such as smoke detectors. Beta decay is frequently utilized in medical diagnostics in the form of radiotracers. Large scale power generation utilizes nuclear fission to heat water and drive turbines, but must be carefully monitored due to the powerful gamma radiation released. Discussions of this standard should focus on the energy released during the decay and the potential consequences of this energy.

Misconception

- Atoms can be changed to new elements with the addition or subtraction of a proton.
- All radioactivity is destructive.
- The rate of radioactive decay can change.

Suggested Science and Engineering Practice

Obtaining, evaluating, and communicating information

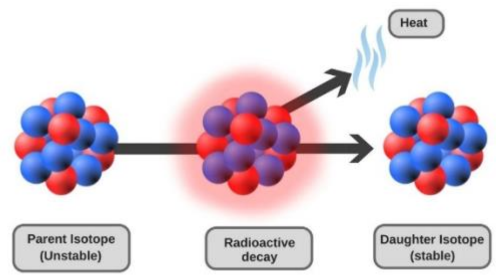
Students can provide written and oral explanations for phenomena and multipart systems using models, graphs, data tables, and diagrams

Suggested Cross Cutting Concepts

Systems and System Models

Students design or define systems in order to evaluate a specific phenomenon or problem.

Suggested Phenomenon



PhET Simulations: Alpha Decay; Beta Decay; Radioactive Dating Game; Nuclear Fission

Explain

Classroom Practice:

- Nuclear Decay; TE/SE pg. 786

Elaborate

Sample Problems:

- Section 22.2 Sample Problem Set I: Sample Problem B: Nuclear Decay
- Section 22.2 Sample Problem Set II: Sample Problem B: Nuclear Decay

Conceptual Challenge; TE/SE pg. 787

Evaluate

Section 22.2 Quiz

Textbook

HMH Physics – Chapter 22: Subatomic Physics

- Section 2: Nuclear Decay pgs. 781-785

Additional Online Resources

HMD Science Explore: Ch. 22 Subatomic Physics

Science Standards Guide: PS1.2: Radioactive Decay in Everyday Life; pgs. 3-4; Teacher Guide

Physics Quarter 4 Curriculum Map Quarter 4 Curriculum Map Feedback Survey											
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3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	4 weeks	**2 weeks**

UNIT 12: Nuclear Physics [2 Weeks]			
Overarching Question(s)			
How do particles combine to form the variety of matter one observes?			
Unit, Lesson	**Lesson Length**	**Essential Question**	**Vocabulary**
Unit 12 Nuclear Physics	0.5 Weeks	• 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	**Instructional Focus**	**Instructional Resources**
DCI PHYS.PS1: Matter and Its Interactions **Standard** PHYS.PS1.3 Investigate and evaluate the expression for calculating the percentage a remaining atom (N(t) = N0e^-λt) using simulated models, calculations, and/or graphical representations. Define the half-life (t1/2) and decay constant (λ). Perform an investigation on probability and calculate	**Learning Outcomes** • Measure the activity of a radioactive source • Calculate the decay constant and the half-life of a radioactive substance. **Suggested Phenomenon**	**Curricular Materials** **Engage** Interactive Demonstration: Nuclear Decay Demonstration: • Electron Beam Deflection; TE pg. 783 **Explore** **PhET Simulations:** Radioactive Dating Game **Core Skill Lab**: Half-life

half-life from acquired data. (Does not require use of actual radioactive samples.)

<u>Explanation</u>

As a general concept, half-life is the amount to time required for random processes to decay half the isotopes in a sample. Two common misconceptions for students are: 1) That the decayed isotopes are disappearing after decay and 2) That a sample is completely gone after two half-lives. The expression given relates the given size of a radioactive sample to the original sample size, Euler's number (e), the decay constant, and elapsed time. Euler's number is an irrational number with a value of ~2.718. The origin of this number is in exponential growth of systems. Graphically, Euler's number is multiplied by the original sample size (the value of the sample size (y) when time is zero (x)). In this case, the system is not a decay system so Euler's number is raised to a negative exponent. Lambda represents the decay constant for this particular isotope and t is the elapsed time for the sample to decay.

<u>Misconceptions</u>

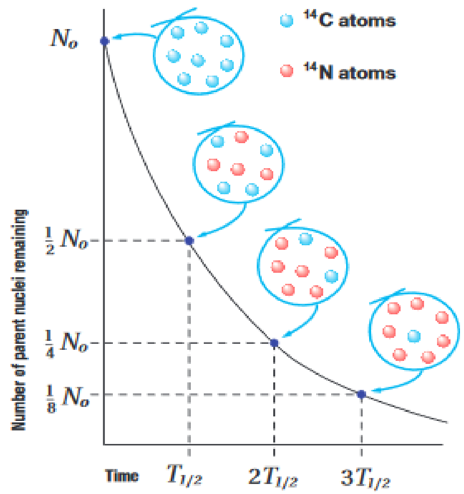
- Half-life time is half of the time it takes for a sample to be used up.
- For radioactive materials half the nuclei decay in one half-life and the rest in a second half-life.

<u>Suggested Science and Engineering Practice</u>

Using mathematics and computational thinking

Students can create computational or mathematical models for interactions in the natural world using unit equivalencies.

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.



<u>Explain</u>

Classroom Practice:

- Measuring Nuclear Decay; TE/SE pgs. 788-789

Interactive Reader:

- Section 22.2: Nuclear Decay

<u>Elaborate</u>

Sample Problems:

- Section 22.2 Sample Problem Set I: Sample Problem C: Measuring Nuclear Decay
- Section 22.2 Sample Problem Set II: Sample Problem C: Measuring Nuclear Decay

Conceptual Challenge; TE/SE pg. 787

<u>Evaluate</u>

Section 22.2 Quiz

Interactive Review Concept Map: Radioactive Decay

Section 22.3 Quiz

<u>Textbook</u>

HMH Physics – Chapter 22: Subatomic Physics

- Section 2: Nuclear Decay pgs. 787-790

Additional Online Resources

HMD Science Explore: Ch. 22 Subatomic Physics

Science Standards Guide: PS1.3: Half-life Calculations; pgs. 5-6; Teacher Guide

Graphing Calculator Activity: Nuclear Decay

Suggested Cross Cutting Concepts **Energy and Matter** *Students reconcile conservation of mass in nuclear processes*		

<table>
<tr><td colspan="12">Physics Quarter 4 Curriculum Map
Quarter 4 Curriculum Map Feedback Survey</td></tr>
<tr><td colspan="3">Quarter 1</td><td colspan="3">Quarter 2</td><td colspan="3">Quarter 3</td><td colspan="3">Quarter 4</td></tr>
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</table>

<table>
<tr><td colspan="4">UNIT 12: Nuclear Physics [2 Weeks]</td></tr>
<tr><td colspan="4">Overarching Question(s)</td></tr>
<tr><td colspan="4">How do particles combine to form the variety of matter one observes?</td></tr>
<tr><td>Unit, Lesson</td><td>Lesson Length</td><td>Essential Question</td><td>Vocabulary</td></tr>
<tr><td>Unit 12
Nuclear Physics</td><td>0.5 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>Binding energy, fission, fusion, radioactive decay</td></tr>
<tr><td colspan="2">Standards and Related Background Information</td><td>Instructional Focus</td><td>Instructional Resources</td></tr>
<tr><td colspan="2"><u>DCI</u>
PHYS.PS1: Matter and Its Interactions</td><td><u>Learning Outcomes</u>
• Distinguish between nuclear fission and nuclear fusion.</td><td><u>Curricular Materials</u>
<u>Engage</u></td></tr>
</table>

Standard
PHYS.PS1.1 Develop models to illustrate the changes in the composition of the nucleus of an atom and the energy released during the processes of fission, fusion, and radioactive decay.

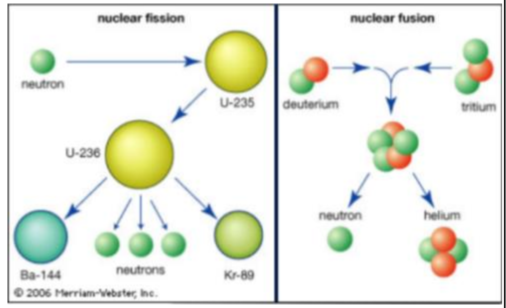
Explanation
To build an understanding of nuclear processes, students should attribute the existence of the nucleus and nuclear stability to neutrons and the strong nuclear force. In any case, radioactive decay results in the formation of a nucleus with a lower energy. During the decay processes, particles, photons, or both can be emitted by a nucleus. A parallel can be drawn between the production of photons of light when an electron moves between energy level and the energetic photons released during nuclear decay. In nuclear decay however, the energy changes are much greater, and consequently the energy of the emitted particles (especially gamma particles) is much greater and well beyond the visible portion of the spectrum.

Misconceptions
- Fission and fusion are the same; fission is more powerful than fusion.

Suggested Science and Engineering Practice
Constructing explanations and designing solutions
Students form explanations that incorporate sources (including models, peer reviewed publications, their own investigations), invoke scientific theories, and can evaluate the degree to which data and evidence support a given conclusion.

- Explain how a chain reaction is utilized by nuclear reactors.
- Compare fission and fusion reactors.

Phenomenon



Explore
STEM Lab: HMH Physics Section 22.3: A Chain Reaction
PhET Simulations: Alpha Decay; Beta Decay; Radioactive Dating Game; Nuclear Fission

Explain
Interactive Reader:
- Section 22.3: Nuclear Reactions
- Section 5.3: Conservation of Energy

Elaborate
The Equivalence of Mass and Energy; TE/SE pgs. 178-179

Evaluate
Section 22.3 Formative Assessment; TE/SE pg. 794

Textbook
HMH Physics – Chapter 5: Work and Energy
- Section 5.3 Physics on Edge, pgs. 178-179

HMH Physics – Chapter 22: Subatomic Physics
- Section 2: Nuclear Decay pgs. 781-787
- Section 3: Nuclear Reactions, pgs. 791-794

Additional Resources
HMD Science Explore: Ch. 22 Subatomic Physics
Science Standards Guide: PS1.1: Fission, Fusion and Radioactive Decay; pgs. 1-2; Teacher Guide

<u>Suggested Cross Cutting Concepts</u> **Energy and Matter** *Students demonstrate and explain conservation of mass and energy in systems, including systems with inputs and outputs.*		

Curriculum and Instruction- Science			
RESOURCE TOOLKIT			
Quarter 4 Physics			
Textbook Resources *HMH TN Physics*: Ch. 11 Vibrations and Waves • Section 11.2 Measuring Simple Harmonic Motion; pgs. 374-379 • Section 11.3 Properties of Waves; pgs. 380-386 • Section 11.4 Wave Interactions; pgs. 390 HMH Physics –Chapter 12: Sound • Section 12.1: Sound Waves; pgs. 406-411 • Section 12.2: Sound Intensity and Resonance; pgs. 412-419 • Section 12.3: Harmonics; pgs. 420-429 HMH Physics – Refraction - Chapter 14 • Section 14.1: Refraction; TE/SE pgs. 484-489 • Section 14.3: Optical Phenomena; TE/SE pgs. 502-505 HMH Physics—Chapter 15 • Section 15.1: Interference; TE/SE pgs. 520-525 HMH Physics –Chapter 20: Electromagnetic Induction • Section 20.4: Electromagnetic Waves; pgs. 721-723 HMH Physics –Chapter 21: Atomic Physics • Section 21.3: Electromagnetic Waves; pgs. 755-761 HMH Physics – Chapter 22: Subatomic Physics • Section 2: Nuclear Decay pgs. 781-785 HMH Physics – Chapter 22: Subatomic Physics • Section 2: Nuclear Decay pgs. 787-790 HMH Physics – Chapter 5: Work and Energy • Section 5.3 Physics on Edge, pgs. 178-179	**DCIs and Standards** **DCI(s)** PS4: Waves and their applications in technologies for information transfer PS1: Matter and Its Interactions **Standard(s)** PHYS.PS4.1 PHYS.PS4.2 PHYS.PS4.3 PHYS.PS4.4 PHYS.PS4.5 PHYS.PS4.6 PHYS.PS4.7 PHYS.PS4.9 PHYS.PS1.1 PHYS.PS1.2 PHYS.PS1.3	**Videos** Khan Academy Illuminations (NCTM) Discovery Education The Futures Channel The Teaching Channel Teachertube.com Acceleration Lab:	ACT & SAT TN ACT Information & Resources ACT College & Career Readiness Mathematics Standards SAT Connections SAT Practice from Khan Academy

HMH Physics – Chapter 22: Subatomic Physics • Section 2: Nuclear Decay pgs. 781-787 • Section 3: Nuclear Reactions, pgs. 791-794			