**Purpose of Science Curriculum Maps**

This map is meant 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 TN State Standards, 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—the major work of the grade (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.

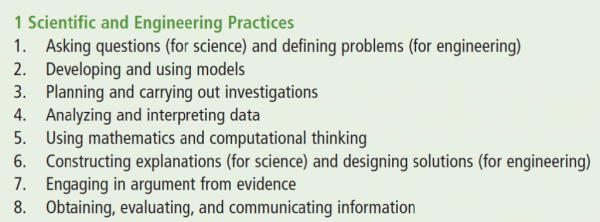
 The map is meant to support effective planning and instruction to rigorous standards. It is *not* meant to replace teacher planning, prescribe pacing or instructional practice.  In fact, our goal is not to merely “cover the curriculum,” but rather to “uncover” it by developing students’ deep understanding 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.

**Introduction**

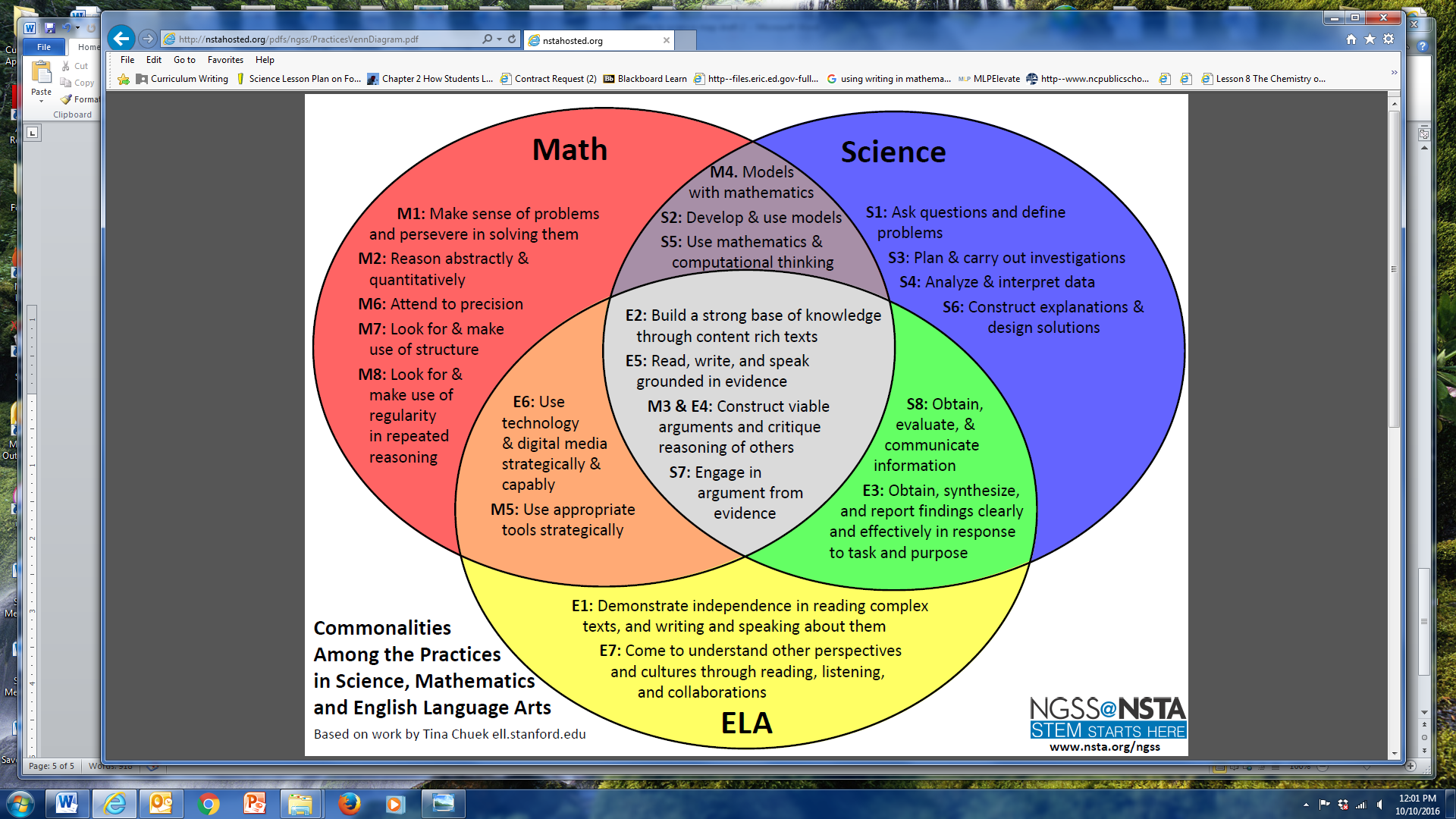
In 2014, the Shelby County Schools Board of Education adopted a set of ambitious, yet attainable goals for school and student performance. The District is committed to these goals, as further described in our strategic plan, Destination 2025. In order to achieve these ambitious goals, we must collectively work to provide our students with high quality, College and Career Ready standards-aligned instruction. The Tennessee State Standards provide a common set of expectations for what students will know and be able to do at the end of a grade. College and Career Ready Standards are rooted in the knowledge and skills 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. The standards for science practice describe varieties of expertise that science educators at all levels should seek to develop in their students. These practices rest on important “processes and proficiencies” with longstanding importance in science education. The Science Framework emphasizes process standards of which include planning investigations, using models, asking questions and communicating information**. The science maps contain components to ensure that instruction focuses students toward college and career readiness. The maps are centered around four basic components: the state standards and framework (Tennessee Curriculum Center), components of the 5E instructional model (performance tasks), scientific investigations (real world experiences), and informational text (specific writing activities).**

*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.

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 practicesover each grade band**.** This guide provides specific goals for science learning in the form of grade level expectations*,* statements about what students should know and be able to do at each grade level.

Science is not taught in isolation. There are commonalities among the practices of science (science and engineering), mathematics (practices), and English Language Arts (student portraits). There is an early focus on informative writing in ELA and science. There’s a common core in all of the standards documents (ELA, Math, and Science). At the core is: reasoning with evidence; building arguments and critiquing the arguments of others; and participating in reasoning-oriented practices with others. The standards in science, math, and ELA provide opportunities for students to make sense of the content through solving problems in science and mathematics by reading, speaking, listening, and writing. Early writing in science can focus on topic specific details as well use of domain specific vocabulary. Scaffold up as students begin writing arguments using evidence during middle school. In the early grades, science and mathematics aligns as students are learning to use measurements as well as representing and gathering data. As students’ progress into middle school, their use of variables and relationships between variables will be reinforced consistently in science class. Elements of the commonalities between science, mathematics and ELA are embedded in the standards, outcomes, content, and connections sections of the curriculum maps.



An instructional model or learning cycle, such as the 5E model is a sequence of stages teachers may go through to help students develop a full understanding of a lesson concept. Instructional models are a form of scaffolding, a technique a teacher uses that enables a student to go beyond what he or she could do independently. Some instructional models are based on the constructivist approach to learning, which says that learners build or construct new ideas on top of their old ideas. Engage captures the students’ attention. Gets the students focused on a situation, event, demonstration, of problem that involves the content and abilities that are the goals of instruction. In the explore phase, students participate in activities that provide the time and opportunities to conducts activities, predicts, and forms hypotheses or makes generalizations. The explain phase connects students’ prior knowledge and background to new discoveries. Students explain their observations and findings in their own words. Elaborate, in this phase the students are involved in learning experience that expand and enrich the concepts and abilities developed in the prior phases. Evaluate, in this phase, teachers and students receive feedback on the adequacy of their explanations and abilities. The components of instructional models are found in the content and connection columns of the curriculum maps.



**Science Curriculum Maps Overview**

**The science maps contain components to ensure that instruction focuses students toward college and career readiness. The maps are centered around four basic components: the state standards and framework (Tennessee Curriculum Center), components of the 5E instructional model (performance tasks), scientific investigations (real world experiences), informational text (specific writing activities), and NGSS (science practices).**

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.

**How to Use the Science Curriculum Maps**

**Tennessee State Standards**

The TN State Standards are located in the first three columns. Each content standard is identified as the following: grade level expectations, embedded standards, and outcomes of the grade/subject. Embedded standards are standards that allow students to apply science practices. Therefore, you will see embedded standards that support all science content. It is the teachers' responsibility to examine the standards and skills needed in order to ensure student mastery of the indicated standard.

**Content**

The performance tasks blend content, practices, and concepts in science with mathematics and literacy. Performance tasks should be included in your plans. These can be found under the column content and/or connections. Best practices tell us that making objectives measureable increases student mastery.

**Connections**

District and web-based resources have been provided in the Instructional Support and Resources column. The additional resources provided are supplementary and should be used as needed for content support and differentiation.

(More Academic Vocabulary support can be found at the following link: <http://www.berkeleyschools.net/wp-content/uploads/2013/05/BUSD_Academic_Vocabulary.pdf>)

Following the vocabulary development work of Beck, McKeown and Kucan, the CCSS references three tiers of words that are vital to academic achievement:

* Tier One words are the words of everyday speech usually learned in the early grades… Tier Two words (what the Standards refer to as general academic words) are far more likely to appear in written texts than in speech. They appear in all sorts of texts: informational texts (words such as relative, vary, formulate, specificity, and accumulate), technical texts (calibrate, itemize, periphery), and literary texts (dignified, faltered).
* Tier Two words often represent subtle or precise ways to say relatively simple things—saunter instead of walk, for example. Because Tier Two words are found across many types of texts, they are highly generalizable.
* Tier Three words (what the Standards refer to as domain-specific words) are specific to a domain or field of study (lava, legislature, circumference, aorta) and key to understanding a new concept within a text… Recognized as new and “hard” words for most readers (particularly student readers), they are often explicitly defined by the author of a text, repeatedly used, and otherwise heavily scaffolded (e.g., made a part of a glossary).

It is important to target specific instruction on Tier 2 and Tier 3 vocabulary words to help students develop deep understanding that cannot be acquired through independent reading. Since Tier 3 words are typically targeted in content specific instruction, it's particularly important and challenging to identify and target Tier 2 words, since they appear across all disciplines.

Basic Guidelines for effective structured language practice strategies:

* Make the target language rigorous, and mandatory.
* Never use structured language practice strategies with language that hasn’t been explicitly taught first.
* Post the graphic organizers or word banks and sentence frames that you’ve taught. Require students to use them during the activity and continuously remind them to focus on their use of the language.
* Use a timer, chime, or other signal to mark the beginning, transitions, and ending of the activity. Keep it moving! Don’t adjust your pace to allow all students to finish. If you use these strategies regularly, students will increase their speed to match your snappy pace.
* Circulate to monitor for participation as well as accuracy. Provide targeted support as needed.
* Take it to writing. A brief written product (sentence(s) in a journal, language log, note sheet, poster, post-it, exit ticket…) helps hold all students accountable.

Strategies include

* Classroom Instructional Strategy - <https://drive.google.com/drive/folders/0B_iyFfHv_OU6Z1FHOWN2TFFpdDQ>
* Word Webs - <https://drive.google.com/drive/folders/0B_iyFfHv_OU6Z1FHOWN2TFFpdDQ>
* Academic Vocabulary Log - <https://drive.google.com/drive/folders/0B_iyFfHv_OU6Z1FHOWN2TFFpdDQ>

| State Standards | Embedded Standards | Outcomes | Content | Connections |
| --- | --- | --- | --- | --- |
| **Standard 2 - Thermodynamics - 2 weeks** | | | | |
| **CLE 3231.2.1** Develop an understanding of temperature, heat, and internal energy.  **CLE 3231.2.2** Compare Celsius, Kelvin and the Absolute temperature scales.  **CLE 3231.2.3** Investigate exchanges in internal energy.  Scaffolded (Unpacked) Items  1.Kinetic energy is energy due to the motion of an object.  2. Any object with mass which is moving through space has translational kinetic energy, which is the form of kinetic energy important in thermodynamics.  3. Molecules are very small objects with very small mass which have kinetic energy.  4. At one point in time, a molecule in a substance has a given kinetic energy which can change as it collides with other molecules.  5. Over time, one molecule in a substance has an average kinetic energy.  6. At one point in time, all the molecules in a substance have a range of kinetic energies with a specific average value that equals the average kinetic energy of one molecule in the substance over time.  7. The average kinetic energy of the molecules of a substance is proportional to the absolute temperature of the substance.  8. The term thermal energy is also referred to as internal energy.  Internal energy is the sum of the average kinetic energies of all molecules in a substance.  9. A temperature difference between two substances in contact will cause the hotter substance to transfer internal energy to the cooler substance.  10. The internal energy transferred from a hotter body to a cooler body is called heat.  11. Temperature scales are human inventions to measure the perceived sense of hot and cold.  12. A common temperature scale is the Celsius scale that is based on the freezing and boiling points of water.  13. The Celsius scale is not an absolute scale and as such is not directly proportional to the internal energy of a substance.  14. A common absolute temperature scale is the Kelvin scale.  15. The Kelvin scale has the same degree size as the Celsius scale.  16. The Kelvin scale has its zero point at the temperature at which all molecular kinetic energy would be zero, and molecules would cease moving.  17. The zero point on the Kelvin scale has not been reached, and is theoretically impossible to reach. | **CLE 3231. Inq.2** Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.  **CLE 3231. Inq.4** Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.  **CLE 3231.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.  **CLE. 3231.Math.1** Graph relationships and functions between manipulated (independent) variables and responding (dependent) variables.  **CLE. 3231.Math.2** Solve for variables in an algebraic formula. | Relate temperature changes with the changes of kinetic energy and the flow of heat energy.  Solve an applied problem of heat exchange with respect to specific heat.  Given a schematic of a refrigeration process, identify the four parts of the process.  Describe all forms of heat exchange.  Distinguish between isovolumetric, isothermal, and adiabatic thermodynamic processes.  Demonstrate a conceptual understanding of the First and Second Laws of Thermodynamics and their implications in natural phenomena. | **Holt Physics – Thermodynamics Chapter 10**  10.1 Relationship Between Heat and  Work  10.2 The First Law of  Thermodynamics  10.3 The Second Law of  Thermodynamics  Demonstration – Work from Heat – p. 336  Practice Problems pp. 338, 346, 355  Quick Lab p. 357  Graphing Calculator Practice p. 362  **SciLinks:** ([www.scilinks.org](http://www.scilinks.org)) (sign in)  Temperature Scales  Conduction & Convection  Specific Heat Capacity  Heat Pumps  Greenhouse Gases  Energy Transfer  Thermodynamics  Heat Engines  Entropy | **Academic Vocabulary**  System, environment, isovolumertric process, isothermal process, adiabatic, cyclic process, entropy  **Performance Tasks**  **Why it Matters** – Have students read the Gasoline Engine article on page 348. Have students point out the differences between an ideal heat engine and the internal-combustion engine. Have students prepare an illustration of the differences.  **Inventor -Turbine** -Imagine that an inventor is asking you to invest your savings in the development of a new turbine that will produce cheap electricity. The turbine will take in 1000J of energy from fuel to supply 650J of work, which can then be used to power a generator. The energy removed as heat to a cooling system will raise the temperature of 0.10 kg of water by 1.2 0C. Are these figures consistent with the first and second laws of thermodynamics? Would you consider investing in this project? Write a business letter to the inventor explaining how your analysis affected your decision.  . |
| **Standard 3 - Waves - 2 weeks** | | | | |
| **CLE 3231.3.3** Understand wave mechanics.  **CLE 3231.3.4** Examine the Doppler Effect.  **CLE 3231.3.5** Explore the characteristics and properties of sound.  Scaffolded (Unpacked) Items  1. Sound is a mechanical wave and specifically a compression or longitudinal wave.  2. Sound produces oscillations in pressure as it travels through the air.  3. Sound can travel through other media besides air, such as water or metals.  4. We hear sounds when the oscillations in air pressure that characterize it make our eardrum oscillate back and forth. The mechanism of our middle and inner ears produce the biological perception of sound in our brains.  5.The higher the frequency of a sound waves, the higher the perceived pitch of the sound.  6. The Doppler Effect is the perception that the pitch of a sound is different when there is relative motion of the source of the sound and the detector of the sound.  7. When the source and the detector are moving toward each other, the perceived pitch of the sound is higher.  8. When the source and the detector are moving away from each other, the perceived pitch of the sound is lower.  Tennessee Academic Vocabulary for Sound | Physics  [**Compression**](http://www.tncurriculumcenter.org/concept/Compression) [http://tncurriculumcenter.org/images/map/icons/wikipedia_16.jpg](http://en.wikipedia.org/wiki/compression)  [**Doppler**](http://www.tncurriculumcenter.org/concept/Doppler) [http://tncurriculumcenter.org/images/map/icons/wikipedia_16.jpg](http://en.wikipedia.org/wiki/Doppler)\*  [**Frequency**](http://www.tncurriculumcenter.org/concept/Frequency) [http://tncurriculumcenter.org/images/map/icons/wikipedia_16.jpg](http://en.wikipedia.org/wiki/frequency)\*  [**Longitudinal**](http://www.tncurriculumcenter.org/concept/Longitudinal) [http://tncurriculumcenter.org/images/map/icons/wikipedia_16.jpg](http://en.wikipedia.org/wiki/longitudinal)  [**Pitch**](http://www.tncurriculumcenter.org/concept/Pitch) [http://tncurriculumcenter.org/images/map/icons/wikipedia_16.jpg](http://en.wikipedia.org/wiki/pitch)  \* Terms not included on the TDOE Academic Vocabulary list  Why is sound defined as a mechanical wave?  What type of motion do air molecules undergo when sound passes through air?  What happens between the striking of a tuning fork and the perception of sound?  How are these concepts of sounds that musicians refer to as pitch and that physicists refer to as frequency related?  What are some common examples of the Doppler effect? | **CLE 3231. Inq.2** Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.  **CLE 3231. Inq.4** Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.  **CLE 3231.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.  **CLE. 3231.Math.1** Graph relationships and functions between manipulated (independent) variables and responding (dependent) variables.  **CLE. 3231.Math.2** Solve for variables in an algebraic formula. | **SPI.3231.3.4** Differentiate among the wave interactions of reflection, refraction, diffraction, or interference (constructive and destructive interferences).  **SPI.3231.3.5** Solve sound problems related to speed of sound in air at various temperatures.  **SPI.3231.3.6** Demonstrate a proficiency in solving problems related to wavelength, frequency, period, and speed of mechanical waves. | **Holt Physics, Chapter – Vibrations and Waves – Chapter 11**  11.1 Simple Harmonic Motion  11.2 Measuring Simple Harmonic Motion  11.3 Properties of Waves  11.4 Wave Interactions  Demonstration – a Vibrating Spring p. 368  Practice Problems pp. 370, 378, 381,  387,  Quick Lab. P. 374  Graphing Calculator Practice p. 399  Inquiry Lab – Simple Harmonic Motion of a Pendulum  **SciLinks:** [**www.scilinks.org**](http://www.scilinks.org) **(Sign in)**  Hooke’s Law  Pendulum  Wave Motion  **Holt Physics, Chapters – Sound – Chapter 12**  12.1 Sound Waves  12.2 Sound Intensity and Resonance  12.3 Harmonics  Practice Problems pp. 415, 427  Quick Lab – Resonance – p. 418  Quick Lab – A Pipe Closed at One End – p. 425  Graphing Calculator Practice p. 436  Skills Practice Lab – Speed of Sound pp. 440-441  **SciLinks:**[**www.scilinks.org**](http://www.scilinks.org)(Sign in)  Sound  Doppler Effect  Harmonics  Acoustics | **Academic Vocabulary**  Simple harmonic motion, amplitude, period, frequency, medium, mechanical wave, transverse wave, crest, trough, wavelength, longitudinal wave, constructive interference, constructive interference, standing wave, node, antinode  **Performance Tasks**  **Designing an Experiment –** Design an experiment to compare the spring constant and period of oscillation of a system built with two or more springs connected in two ways: in series (attached end to end) and in parallel (one end of each spring anchored to a common point).  **Research –** Research the active noise reduction (ANR) technology used in noise cancelling headphones. How does it work? What are some other applications that use ANR technology? Choose one application and create a brochure to explain how it works.  **Academic Vocabulary**  Compression, rarefaction, pitch, Doppler effect, intensity, decibel, resonance, fundamental frequency, harmonic series, timbre, beat  **Performance Tasks**  **Science – Technology – Society -- Noise Pollution**  Read the article on pp. 442-443 on Noise Pollution. Have students complete the Researching the Issue on p. 443. |
| **Standard 4 - Optics - 2 weeks** | | | | |
| **CLE 3231.4.1** Describe the characteristics of the electromagnetic spectrum.  **CLE 3231.4.2** Investigate the interaction of light waves.  **CLE 3231.4.5** Investigate the phenomenon of color. | **CLE 3231. Inq.2** Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.  **CLE 3231. Inq.4** Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.  **CLE 3231.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.  **CLE. 3231.Math.1** Graph relationships and functions between manipulated (independent) variables and responding (dependent) variables.  **CLE. 3231.Math.2** Solve for variables in an algebraic formula. | Distinguish among the various categories of the electromagnetic spectrum.  Calculate the frequency or wavelength of electromagnetic radiation.  Recognize that light has a finite speed.  Explain polarization of light.  Solve problems related to Snell’s law. | **Holt Physics – Light and Reflection - Chapter 13**  13.1 Characteristics of Light  13.2 Flat Mirrors  13.3 Curved Mirrors  13.4 Color and Polarization  Practice Problems pp. 449, 462, 466  Quick Lab. – Curved Mirrors p. 457  Quick Lab – Polarization of Sunlight p. 473  Graphing Calculator Practice p. 481  Skills Practice Lab – Brightness of Light pp. 484-485    **SciLinks: (**[**www.scilinks.org**](http://www.scilinks.org)**)**  Electromagnetic Spectrum  Light Bulbs  Mirrors  Telescopes  Color    **Holt Physics – Light and Reflection - Chapter 14**  14.1 Refraction  14.2 Thin Lenses  14.3 Optical Phenomena  Practice Problems pp. 493, 501, 508,  Quick Lab – Focal Length –p. 496  Quick Lab – Prescription Glasses – p. 502  Quick Lab – Periscope – p. 507  Graphing Calculator Practice p. 518  Skills Practice Lab – Converging Lenses – pp. 522-523  **SciLinks: (**[**www.scilinks.org**](http://www.scilinks.org)**)**  Snell’s Law  Lenses  Abnormalities of the Eye  Fiber Optics  Dispersion of Light | **Academic Vocabulary**  Electromagnetic wave, reflection, angle of incidence, angle of reflection, virtual image, concave spherical mirror, real image, convex spherical mirror, linear polarization  **Performance Tasks**  **Designing an Experiment –** Suntan lotion include compounds that absorb the ultraviolet radiation in sunlight and therefore prevent the ultraviolet radiation from damaging skin cells. Design experiments to test the properties of carrying grades (SPFs) of suntan lotions. Plan to use blueprint paper, film, plants, or other light-sensitive items. Write down the questions that will guide your inquiry, the materials you will need, the procedures you plan to follow, and the measurements you will take. Perform the experiments and report or demonstrate your finding in class.  **Research –** The Egyptian scholar Alhazen studies lenses, mirrors, rainbows, and other light phenomena early in the Middle Ages. Research his scholarly work, his life, and his relationship with the Caliph al-Hakim. How advanced were Alhazen’s inventions and theories? Summarize you finding and report them to the class.  **Academic Vocabulary**  Refraction, index of refraction, lens, total internal reflection, critical angle, dispersion, chromatic aberration  **Writing in Physics –** When the Indian physicist Venkata Raman first saw the Mediterranean Sea, he proposed that its blue color was due to the structure of water molecules rather than to the scattering of light from suspended particles. Later, he won the Nobel Prize for work related to the implications of this hypothesis. Research Raman’s life and work. Find out about his background and the challenges and opportunities he met on this way to becoming a physicist. Create a presentation about him in the form of a report, poster, short video, or computer presentation.  **Performance Tasks**  **Interview –** Interview an optometrist, optician, or ophthalmologist. Find out what equipment and tools each uses. What kinds of eye problems each is able to correct? What training is necessary for each career? |
| **Standard 4 - Optics - 2 weeks** | | | | |
| **CLE 3231.4.3** Explore the optics of lenses.  **CLE 3231.4.4** Analyze the optics of mirrors.  Scaffolded (Unpacked) Items  1.The path that light takes when it travels can be modelled mathematically as a ray.  2. Interaction of a ray of light with an optical device can alter the path of the light.  3. Light waves reflect, refract, diffract, and undergo interference like mechanical waves.  Images may be formed when light traveling from an object interacts with a lens or a mirror.  4. Images can be characterized as real or virtual. Real images are created by light rays that converge and virtual images are created by light rays that diverge.  Image orientation can be characterized as upright or inverted.  5. Image size can be characterized as reduced, enlarged, or true-sized.  6. Lenses form images through the process of refraction.  7. Refraction can be described mathematically using Snell’s Law, which can be used to predict how much light will bend at the boundary between two mediums.  8. Refraction in convex lenses causes light rays to converge to form real or virtual images.  9. Whether the image is real or virtual depends upon the location of the object relative to the focal length of the lens.  10. Refraction in concave lenses causes light rays to diverge to form virtual images.  11. Mirrors form images through the process of reflection.  12. Reflection of an object in a plane mirror creates an image that is upright and true-sized.  13. Reflection in concave mirrors causes light rays to converge to form real or virtual images.  14. Whether the image is real or virtual depends upon the location of the object relative to the focal length of the mirror.  15. Reflection in convex mirrors causes light rays to diverge to form virtual images. | **CLE 3231. Inq.2** Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.  **CLE 3231. Inq.4** Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.  **CLE 3231.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.  **CLE. 3231.Math.1** Graph relationships and functions between manipulated (independent) variables and responding (dependent) variables.  **CLE. 3231.Math.2** Solve for variables in an algebraic formula. | Given a drawing of a laboratory optics bench with a singular lens; choose the measurements that will enable the calculation of focal length.  Identify the properties of light related to reflection, refraction, diffraction, and interference of light waves.  Using light ray diagrams, identify the path of light using a convex lens, a concave lens, a plane mirror, a concave mirror and a convex mirror. | **Holt Physics – Interference and Diffraction - Chapter 15**  15.1 Interference  15.2 Diffraction  15.3 Lasers  Practice Problems pp. 531, 538  Graphing Calculator Practice p. 551  Skills Practice Lab – Diffraction – pp. 554-555    **SciLinks:(**[**www.scilinks.org**](http://www.scilinks.org)**) (Sign in)**  Diffraction  Lasers  Bar Codes | **Academic Vocabulary**  Coherence, path difference, order number, diffraction, resolving power, laser  **Performance Tasks**  **Design Simulation –** Design simulations of interference patterns. Use a computer to draw many concentric circles at regular distances to represent waves traveling from a point source. Photocopy the page onto two transparencies and lay them on an overhead projector. Vary the distances between “source points,”  And observe how these variations affect interference patterns. Design transparencies with thicker lines with larger separations to explore the effect of wavelength on interference.  . |
| **Standard 6 - Nuclear Science - 1 week** | | | | |
| **CLE 3231.6.1** Investigate the properties and structure of the atom.  Scaffolded (Unpacked) Items  1.The Standard Model states that matter consists of protons, neutrons and electrons.  2. The Standard Model of matter postulates that the atom has a nucleus that contains neutrons and protons. Protons are positively charged; neutrons have zero charge.  3. The masses of the protons and neutrons are nearly the same.  4. The Standard Model restricts the position of electrons to outside of the nucleus.  5. Electrons are negatively charged.  6. The mass of an electron negligible compared to protons and neutrons.  7. The location of the electron outside of the nucleus is determined by it energy.  8. The atomic number of an atom is solely due to the number of protons that each nucleus contains  .  **CLE 3231.6.2** Investigate properties of the quantum theory.  **CLE 3231.6.3** Explore the dynamics of the nucleus: radioactivity, radiocarbon/uranium dating, and half-life.  **CLE 3231.6.4** Compare and contrast nuclear fission and nuclear fusion.  Scaffolded (Unpacked) Items  1. Quantum theory says that fundamental values of charge, energy, mass and other quantities have a minimum value. All other values are an integer multiple of that fundamental value.  2. The nucleus of some atoms is unstable.  3. Stability can be restored through the process of radioactivity.  4. Radioactivity is the spontaneous release of matter and or energy by a nucleus.  5. There are 3 major categories of radioactivity particles: Alpha, release of a Helium nucleus; Beta, the release or capture of an electron; Gamma, the release or capture of a high-energy photon.  6. The time that it takes for a number of like atoms to decay to half of that number is termed the half-life for that atom.  7. Different types of matter may have different half-lives.  8. The age of a dead organism may be determined by examining the ratio of Carbon 12 to Carbon 14.  9. Other radioactive atoms like uranium may be used to determine the age of matter which contains that atom.  10. Nuclear fission is the process by which an atom breaks into lower atomic number components.  11. Nuclear fusion is the process by which atoms of a given atomic number are combined to create a larger atomic number atom. | **CLE 3231. Inq.2** Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.  **CLE 3231. Inq.4** Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.  **CLE 3231.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.  **CLE. 3231.Math.1** Graph relationships and functions between manipulated (independent) variables and responding (dependent) variables.  **CLE. 3231.Math.2** Solve for variables in an algebraic formula | Solve half-life problems.  Identify parts of an atom (protons, electrons, neutrons, nucleus, and electron cloud).  Describe and identify the three basic forms of radioactivity (alpha particles, beta particles, and gamma rays)  Identify nuclear reactions given descriptions of the reactions.  Identify the major historical achievements of modern nuclear physicists related to the discovery of atomic particles, quantum theory, and the standard model. | **Holt Physics – Atomic Physics Chapter 21**  21.1 Quantization of Energy  21.2 Models of the Atom  12.3 Quantum Mechanics  Practice Problems pp. 755, 758, 769, 774,  Quick Lab – Atomic Spectra p. 765  Graphing Calculator Practice p. 780  Skills Practice Lab – The Photoelectric Effect pp. 784 - 785  **SciLinks:** [**www.scilinks.org**](http://www.scilinks.org)(Signin)  Max Planck  Early Atomic Theory  Modern Atomic Theory  Atomic Nucleus  Radioactive Decay  Fission/Fusion  **Holt Physics – Subatomic Physics Chapter 22**  22.1 The Nucleus  22.2 Nuclear Decay  22.3 Nuclear Reactions  22.4 Particle Physics  Practice Problems pp. 796, 802, 805  Graphing Calculator Practice p. 822  Skills Practice Lab – Half-Life pp. 826 -827  **SciLinks:** [**www.scilinks.org**](http://www.scilinks.org) **(Sign** in)  Atomic Nuclear  Radioactive Decay  Fission/Fusion | **Academic Vocabulary**  Blackbody radiation, ultraviolet catastrophe, photoelectric effect, photon, work function, Compton shift, emission spectrum, absorption spectrum uncertainty principle  **Performance Tasks**  **Research –** Conduct research on the history of atomic theory. Create a timeline that shows the development of modern atomic theory, beginning with John Dalton’s contributions in 1808. Include the discoveries of J. J. Thompson, Ernest Rutherford, Niels Bohr, and Erwin Schrodinger. Students may also include other significant discoveries in the history of atomic theory. In addition, add historical events to the timeline to provide context for the scientific discoveries, and include illustration with key entries.  **Academic Vocabulary**  Isotope, strong force, binding energy, half-life  **Performance Tasks**  **Science – Technology – Society**  **What Can We Do with Nuclear Waste?**  Read the article on pp. 828 – 829 Do the Researching the Issue p. 828  **Designing an Experiment** – You are designing a nuclear power plant for a space station to be established on Mars. Material A is radioactive and has a half-life of two years. Material B is also radioactive and has a half-life of one year. Atoms of material B have one half mass of atoms material A. Discuss the benefit s and drawbacks involved with each of these fuels. |

| **Toolbox** | | | |
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| **Unit 4.1- Temperature, Heat and**  **Thermodynamics** | **Unit 4.2- Mechanical Waves/Sound Waves** | **Unit 4.3- Electromagnetic Waves, Light and Color** | **Unit 4.5 Nuclear Physics** |
| **PhET Simulations**  The Greenhouse Effect  HyperPhysics Notes – Heat & Thermodynamics  <http://hyperphysics.phy-astr.gsu.edu/hbase/heacon.html#heacon> | **PhET Simulations**  **(**[**http://phet.colorado.edu/en/simulations/category/physics**](http://phet.colorado.edu/en/simulations/category/physics)**)**  Masses & Springs  Normal Modes  Pendulum Lab  Radio Waves & Electromagnetic Fields  Resonance  Sound  Waves on a String  **The Physics Classroom Applets (Tutorials Available)**  **(**[**http://www.physicsclassroom.com/mmedia/index.cfm**](http://www.physicsclassroom.com/mmedia/index.cfm)**)**  Waves, Sound & Light  **The Physics Classroom Lab Sheets**  **(**[**http://www.physicsclassroom.com/lab/**](http://www.physicsclassroom.com/lab/)**)**  Wave Basics  Sound & Music  **Ripple Tank (Interference, Doppler, & others)**  <http://www.falstad.com/ripple/>  **HyperPhysics Notes – Periodic Motion**  <http://hyperphysics.phy-astr.gsu.edu/hbase/permot.html#permot>  **HyperPhysics Notes – Sound**  http://hyperphysics.phy-astr.gsu.edu/hbase/sound/soucon.html#soucon  **Standing Wave Visual/Demo**  <http://www.walter-fendt.de/ph14e/stwaverefl.htm> | **PhET Simulations**  Color Vision  **The Physics Classroom Applets (Tutorials Available)**  Waves, Sound & Light  **The Physics Classroom Lab Sheets**  Light & Color    **Shockwave Physics Studios**  **(**[**http://www.physicsclassroom.com/shwave/**](http://www.physicsclassroom.com/shwave/)**)**  RGB Lighting  Painting with CMY  **HyperPhysics Notes – Light & Vision**  <http://hyperphysics.phy-astr.gsu.edu/hbase/ligcon.html#c1>  **Unit 4.4 Optics**  **PhET Simulations**  Bending Light  Geometric Optics  Lasers  Wave Interference  **The Physics Classroom Applets (Tutorials Available)**  Ray Optics  **The Physics Classroom Lab Sheets**  Reflection & Mirrors  Refraction & Lenses  **Shockwave Physics Studios**  **(**[**http://www.physicsclassroom.com/shwave/**](http://www.physicsclassroom.com/shwave/)**)**  Least Time Principle  Refraction of Light  Lenses  **HyperPhysics Notes – Light & Vision**  <http://hyperphysics.phy-astr.gsu.edu/hbase/ligcon.html#c1> | **PhET Simulations**  Alpha Decay  Beta Decay  Nuclear Fission  Simplified MRI  HyperPhysics Notes – Nuclear  <http://hyperphysics.phy-astr.gsu.edu/hbase/nuccon.html#c1>  **HyperPhysics Notes – Quantum**  <http://hyperphysics.phy-astr.gsu.edu/hbase/quacon.html#quacon> |