A Correlation of

Pearson
Oregon High School Science Program
Biology, Chemistry, Physics, and Earth Science
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To the

2014 Oregon Science Standards (NGSS)
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HS-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

**HS-LS1.** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]

MILLER & LEVINE BIOLOGY: Students are introduced to the structure of DNA in Lesson 12.2 (pp. 344-348) and to DNA replication in Lesson 12.3 (pp. 350-352). Lessons 13.1 and 13.2 (pp. 362-371) provide evidence for how the structure of DNA determines the structure of proteins.

Students construct an explanation based on evidence about how the structure of DNA determines the structure of proteins: Students explain how the unique structure of DNA makes the functions of DNA possible (Q2, p. 355). Students write a paragraph explaining the central dogma of molecular biology—information is transferred from DNA to RNA to protein (TE p. 371). Students explain the roles of the three types of RNA in using the information stored in DNA to make proteins (Q38, p. 388).

**HS-LS1-2.** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

MILLER & LEVINE BIOLOGY: Students are introduced to levels of organization in Lesson 7.4 (p. 216). Plant structure and function is addressed throughout Chapter 23 (pp. 664-687). Lessons 27.1 (pp. 782-786), 27.2 (pp. 787-790), 27.4 (pp. 794-798), 28.2 (pp. 814-818), 28.3 (pp. 819-826), and 28.4 (pp. 827-830) focus on the interacting systems in animals. The corresponding systems in humans are addressed in Lessons 30.1 (pp. 862-867), 30.3 (pp. 875-881), 30.4 (pp. 882-887), 31.1 (pp. 896-900), 32.1 (pp. 922-927), 33.1 (pp. 948-953), 33.3 (pp. 963-969), 34.1 (pp. 978-981), 34.2 (pp. 982-987), and 35.1 (pp. 1010-1013). 35.2, Immune System, pp. 1014-1019

Representative examples of how students develop and use a model to illustrate the organization of systems that provide specific functions: Students draw a diagram of a cell membrane and use it to explain how the cell regulates what enters or leaves the cell (Q1 and Q2, p. 219). Students make a model of a seed plant and explain how the model would change if the plant grew in a wet environment (Q1 and Q2, p. 689). Students draw a Venn diagram to relate the four levels of organization in the human body (Q3, p. 867). Students evaluate the usefulness of a swimming pool filter as a model for a nephron (Q1, p. 889).

**HS-LS1-3.** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]

MILLER & LEVINE BIOLOGY: The term homeostasis is defined in Lesson 1.3 (p. 19). Students learn how cells maintain homeostasis in Lesson 7.4 (pp. 214-217) and the role that stomata play in maintaining homeostasis in plants in Lesson 23.4 (pp. 682-683). The term feedback inhibition is defined in Lesson 25.1 (p. 732). Lesson 28.4 (pp. 827-830) explains why all body systems must work together. Mechanisms that control kidney function, gas exchange, and blood glucose levels are discussed in Lesson 30.4 (p. 886), Lesson 33.3 (pp. 966-967), and Lesson 34.2 (p. 984), respectively.

Students plan and conduct investigations that provide evidence about homeostasis and feedback mechanisms: Students examine leaves to determine the average number of stomata per square inch (Quick Lab, p. 683). Students develop a method for maintaining water at a specific temperature for fifteen minutes (Quick Lab, p. 866). Students explore how plant hormones affect leaf loss (Lab Manual A, pp. 147-150) and how chemicals affect heart rate in Daphnia (Lab Manual A, pp. 265-269).

**HS-LS1-4.** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. [Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]

MILLER & LEVINE BIOLOGY: The process of cell division is described in Lesson 10.2 (pp. 279-285). The process of cell differentiation is introduced in Lesson 10.4 (pp. 292-297). In Lesson 13.4 (pp. 381-383), students learn that genes control the differentiation of cells in complex organisms.

Students use a model to illustrate their understanding of cellular division in complex organisms: Students use a Visual Summary of mitosis to explain the critical relationship between the breakdown of the nuclear envelope and the formation of the mitotic spindle (p. 285). Students draw a model of the cell cycle for a eukaryotic cell; label key events that result in growth and cell division; and expand the model to include two additional rounds of cell division (Q1 and Q2, p. 299). Students with special needs use physical models of cells to feel and describe the structural differences between stem cells and differentiated cells (TE p. 295). Students compare the processes cells use to regulate gene expression to a “build to order” manufacturing model (Q4, p. 385).
**HS-LS1-5.** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. [Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment Boundary: Assessment does not include specific biochemical steps.]

**MILLER & LEVINE BIOLOGY:** The term photosynthesis is defined in Lesson 3.2 (p. 70) and in Lesson 8.1 (p. 228). Lesson 8.2 (pp. 230-234) presents an overview of the process of photosynthesis. Lesson 8.3 (pp. 235-241) provides details about the light-dependent and light-independent sets of reactions.

Representative examples of how students use a model to illustrate the conversion of light energy into chemical energy during photosynthesis: Students use a visual model to determine what happens to the ATP and NADPH produced during the light-dependent reactions (Figure 8-7, p. 233). Students use a visual model to determine how many molecules of ATP are needed for each iteration of the Calvin cycle (Figure 8-11, p. 238). Students draw and label a model of a chloroplast; indicate the key events in the conversion of sunlight to chemical energy; and expand the model to show the location of photosystems (Q1 and Q2, p. 243). Students working in small groups construct a physical model of photosynthesis that includes both the light-dependent and light-independent reactions (TE p. 242).

**HS-LS1-6.** Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.]

**MILLER & LEVINE BIOLOGY:** Carbon compounds are introduced in Lesson 2.3 (pp. 45-49). Students learn about the organelles that build proteins and the organelles that capture and store energy in Lesson 7.2 (pp. 200-202). Lesson 13.2 (pp. 366-371) provides more details about the synthesis of proteins in ribosomes. Lesson 30.2 (pp. 865-873) focuses on the nutrients in food that supply the raw materials that are used to build and repair tissues. In Lesson 30.3 (pp. 875-881), students learn how the digestive system converts food into small molecules that can be used by cells in the body.

Students construct an explanation based on evidence for how elements combine to form carbon-based molecules: Students demonstrate their understanding of how the body converts food into useful molecules by developing an analogy for each of the four functions of the digestive system (TE p. 875).

**HS-LS1-7.** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]

**MILLER & LEVINE BIOLOGY:** Lesson 9.1 (pp. 250-253) provides an overview of cellular respiration. Lesson 9.2 (pp. 254-260) provides additional details.

Representative examples of how students use a model to illustrate their understanding of cellular respiration: Students make a sketch of the overall process of cellular respiration (TE p. 254). Students make a simplified drawing of cellular respiration that shows how the reactants and products at each stage are related (TE p. 259). Groups of students write a screenplay that shows how energy is produced in a cell (TE p. 266). Students use sketches to show how the processes of respiration and cellular respiration are related (Q37, p. 270).
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<tr>
<td>Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.</td>
<td><strong>In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.</strong> (HS-LS1-4)</td>
<td><strong>Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.</strong> (HS-LS1-2), (HS-LS1-4)</td>
</tr>
<tr>
<td>M &amp; L BIOLOGY SE/TE: 219, Q1 and Q2 689, Q3 867, Q1 889, Q1</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 279-285, The Process of Cell Division 292-297, Cell Differentiation 325, Gametes to Zygotes 381-382, Genetic Control of Development 995-998, Fertilization and Early Development</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 203, Quick Lab 206, Visual Summary 275, Quick Lab 285, Visual Summary 1036, STEM Activity</td>
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<tr>
<td>Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.</td>
<td><strong>The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.</strong> (HS-LS1-5)</td>
<td><strong>Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.</strong> (HS-LS1-5), (HS-LS1-6)</td>
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<td>M &amp; L BIOLOGY SE/TE: 233, Figure 8-7 238, Figure 8-11 243, Q1 and Q2 270, Q37 285, Visual Summary 299, Q1 and Q2 385 Q4</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 70, Energy From the Sun 230-234, Photosynthesis: An Overview 235-241, The Process of Photosynthesis 1036, STEM Activity</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 237, Zooming In 238, Zooming In 243, Q4 245, Chapter Mystery, Q2 and Q3 1036, STEM Activity</td>
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<td>M &amp; L BIOLOGY TE: 242 Summative Performance Task 254, Teach for Understanding 259, Check for Understanding 266, Summative Performance Task 295 Differentiated Instruction</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 45-49, Carbon Compounds</td>
<td><strong>M &amp; L BIOLOGY TE:</strong> 226, Teach for Understanding 242, Transfer Performance Task 266, Summative Performance Task</td>
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<td>Planning and Carrying Out Investigations</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> Add for Understanding</td>
<td>Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)</td>
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<td>Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.</td>
<td><strong>M &amp; L BIOLOGY TE:</strong> 253, Comparing Photosynthesis and Respiration 260, Q5</td>
<td><strong>M &amp; L BIOLOGY TE:</strong> 255, Address Misconceptions</td>
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<tr>
<td>M &amp; L BIOLOGY SE/TE: 683, Quick Lab 866, Quick Lab 1036, STEM Activity</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 200-201, Organelles That Build Proteins</td>
<td>Structure and Function</td>
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<td>Lab Manual Bk A: 147-150, Plant Hormones and Leaves 265-269 The Effect of Chemicals on Heart Rate</td>
<td><strong>Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.</strong> (HS-LS1-1)</td>
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<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td>▪ As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another and release energy to the surrounding environment and to maintain body temperature. Cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. (HS-LS1-7)</td>
<td>Stability and Change</td>
</tr>
<tr>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 355, Q2 388, Q38</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 250-253, Cellular Respiration: An Overview 254-260, The Process of Cellular Respiration</td>
<td>Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)</td>
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<tr>
<td><strong>M &amp; L BIOLOGY TE:</strong> 371, Evaluate Understanding</td>
<td></td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 687, Nutrient Transport 732, Quick Lab 828, Analyzing Data 1018, Visual Summary</td>
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<td>▪ Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-6)</td>
<td><strong>Lab Manual Bk A:</strong> 279-282, Modeling Breathing</td>
<td><strong>Biology.com:</strong> Chapter 28 Data Analysis, Metabolic Activity</td>
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<td><strong>M &amp; L BIOLOGY TE:</strong> 875, Teach for Understanding</td>
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<td><strong>Connections to Nature of Science</strong></td>
<td><strong>Stability and Change</strong></td>
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<td><strong>Scientific Investigations Use a Variety of Methods</strong></td>
<td>▪ Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)</td>
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<td>▪ Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 4-15, Lessons 1.1 and 1.2 provide background information in support of this scientific practice.</td>
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Key: SE = Student Edition; TE = Teacher’s Edition
### Common Core State Standards Connections:

**ELA/Literacy** -

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<th>Standard</th>
<th>Description</th>
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<tr>
<td>RST.11-12.1</td>
<td>Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1),(HS-LS1-6)</td>
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<tr>
<td>WHST.9-12.2</td>
<td>Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-LS1-1),(HS-LS1-6)</td>
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<tr>
<td>WHST.9-12.5</td>
<td>Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-6)</td>
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<tr>
<td>WHST.9-12.7</td>
<td>Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3)</td>
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<tr>
<td>WHST.11-12.8</td>
<td>Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3)</td>
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<tr>
<td>WHST.9-12.9</td>
<td>Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1),(HS-LS1-6)</td>
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<td>SL.11-12.5</td>
<td>Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2),(HS-LS1-4)</td>
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**Mathematics** -

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<th>Standard</th>
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<tr>
<td>MP.4</td>
<td>Model with mathematics. (HS-LS1-4)</td>
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<tr>
<td>HSF-IF.C.7</td>
<td>Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-LS1-4)</td>
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<tr>
<td>HSF-BF.A.1</td>
<td>Write a function that describes a relationship between two quantities. (HS-LS1-4)</td>
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**Grades 9-12 include:**

- From Molecules to Organisms: Structures and Processes, Ecosystems: Interactions, Energy, and Dynamics, Heredity: Inheritance and Variation of Traits, Biological Evolution: Unity and Diversity, Earth’s Place in the Universe, Earth’s Systems, Earth and Human Activity, Matter and Its Interactions, Motion and Stability: Forces and Interactions, Energy, Waves and their Applications in Technologies for Information Transfer, and Engineering Design
### HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

**HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.]

**MILLER & LEVINE BIOLOGY:** The concept of carrying capacity is introduced in Lesson 5.1 (p. 135). Students learn about factors that affect population growth, such as competition and predation, in Lesson 5.2 (pp. 137-141). Lesson 5.3 (pp. 142-145) provides a historical overview of human population growth and explains how to use age-structure diagrams to analyze population growth.

Students use mathematics and computational representations to explain factors that affect carrying capacity: Students identify the general trends in a graph of moose and wolf populations and the factors that affect the size of the populations (TE p. 139). Students explain how the size of a population can continue to grow as its rate of growth decreases (Q1, p. 147). Students use a table of world population milestones to identify a trend in population growth (Q31, p. 150).

**HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]

**MILLER & LEVINE BIOLOGY:** Population size is addressed throughout Chapter 5 (pp. 130-145). The concept of biodiversity is addressed in Lesson 6.3 (pp. 166-172).

Students use mathematics and computational representations to explain factors that affect biodiversity: Students use a graph to explain the decline of fish populations in the North Atlantic (p. 176). Students use a graph to compare the growth of native and foreign species in the U.S. between 1850 and 1996 (p. 184).

**HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.** [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]

**MILLER & LEVINE BIOLOGY:** Students are introduced to autotrophs and heterotrophs as they study the relationship between consumers and producers in Lesson 3.2 (pp. 69-72). The interdependence of these categories of organisms is reinforced in Lesson 8.1 (pp. 226-228) and Lesson 9.1 (pp. 250-253). Lesson 21.3 (pp. 610-614) provides a detailed comparison of autotrophic protests and heterotrophic protests.

Students construct an explanation based on evidence for how matter and energy are cycled in aerobic and anaerobic conditions: Students apply what they have learned about producers and consumers to explain the source of energy for cave-dwelling organisms (Q13, p. 90). Students explain how whales are able to stay underwater for up to 45 minutes (Chapter Mystery, pp. 249 and 269).

**HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen, and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]

**MILLER & LEVINE BIOLOGY:** The concept of energy transfer between organisms is introduced in Lesson 3.2 (pp. 69-72). Lesson 3.3 (pp. 73-78) describes food chains and food webs. Students also learn about pyramids of energy and biomass. Cycles of matter are addressed in Lesson 3.4 (pp. 79-86).

Students use mathematical representations to support claims for the cycling of energy and matter: Students calculate the energy available at each level in a pyramid of energy (Analyzing Data, p. 77). Struggling students use Calories to understand the 10-percent rule of energy transfer (TE p. 77). Students draw an energy pyramid for a five-step food chain and calculate the energy available at the highest trophic level (Q2, p. 78). Students use a food web to calculate the percentage of energy originally captured by primary producers that is available to specific consumers (Q2, p. 89). Students use a graph to explore the effect of rainfall on plant tissue productivity (Q27 and Q28, p. 92).
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**HS-LS2-5.** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.  

*Clarification Statement: Examples of models could include simulations and mathematical models.  [Assessment Boundary: Assesment does not include the specific chemical steps of photosynthesis and respiration.]*

**MILLER & LEVINE BIOLOGY:** The cycling of carbon between the biosphere, atmosphere, hydrosphere, and geosphere is addressed in Lesson 3.4 (pp. 82-83). Certain aspects of the cycle are reinforced in Lesson 8.2 (pp. 232-233) and Lesson 9.1 (pp. 251-252).

Students *develop a model* to illustrate the role of photosynthesis and cellular respiration in the carbon cycle: Students *design* a museum exhibit about the movement of matter in ecosystems (TE p. 88).

**HS-LS2-6.** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.  

*Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and, extreme changes, such as volcanic eruption or sea level rise.*

**MILLER & LEVINE BIOLOGY:** Students study community interactions in Lesson 4.2 (pp. 99-104). Students study primary and secondary succession in Lesson 4.3 (pp. 106-109). Students learn about different types of population growth in Lesson 5.1 (pp. 130-155) and factors that limit population growth in Lesson 5.2 (pp. 137-141).

Students *evaluate claims, evidence, and reasoning* about what happens to populations in stable and unstable conditions: Students *predict* how changes in an ecosystem will affect the population size of predators and prey (Analyzing Data, p. 102). They *construct* arguments from evidence about whether succession has occurred in a closed aquatic community (Quick Lab, p. 108). Students *predict* how the removal of a predator from an ecosystem would affect its prey (Q2, p. 147).

**HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*

*Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.*

**MILLER & LEVINE BIOLOGY:** Lesson 6.1 (pp. 154-157) provides an overview of the impact of human activities on the environment and of sustainable development. Students learn about ways that humans can use resources wisely in Lesson 6.2 (pp. 158-165). Lesson 6.3 (pp. 166-172) discusses the value of biodiversity, threats to biodiversity, and ways to conserve biodiversity. Lesson 6.4 (pp. 173-179) uses case studies to teach students ways to meet ecological challenges.

Students *design and evaluate solutions* for reducing the impact of humans on the environment and biodiversity: Students *evaluate* ways to reduce dry trash (Quick Lab, p. 155). Students *evaluate* reintroduction of species as a way to maintain biodiversity (Analyzing Data, p. 172). Students *determine* ways that their school can conserve water (Q4, p. 181). Groups of students pick a specific region that is threatened by human actions and then *create* a Web site that describes the problem and potential solutions (TE p. 122). Students *research* the reduction of mussel populations in tide pools off the Pacific Coast and propose a possible solution (pp. 61a-61b).

**HS-LS2-8.** Evaluate the evidence for the role of group behavior on individual and species’ chances to survive and reproduce.  

*Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.*

**MILLER & LEVINE BIOLOGY:** In Lesson 29.1 (pp. 840-841), students learn that many behaviors are essential to survival. Lesson 29.2 (pp. 847-851) expands the concept to include group behaviors such as migration.

Students *evaluate evidence* for the role of group behavior in the ability of individuals and species to survive and reproduce: Students *explain* how a social behavior in an animal aids in the survival of a species (Q30, p. 856). Students *evaluate* evidence of how wolves behave in a pack (Chapter 29 STEM activity, Yellowstone Wolves).

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

Key: SE = Student Edition; TE = Teacher’s Edition
### Science and Engineering Practices

<table>
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<tr>
<th>Developing and Using Models</th>
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| Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds. | **LS2.A:** Interdependent Relationships in Ecosystems  
- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)  
**M & L BIOLOGY SE/TE:**  
100-101, Competition  
132-133, Exponential Growth  
134-135, Logistic Growth  
138-140, Density-Dependent Limiting Factors | **Cause and Effect**  
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)  
**M & L BIOLOGY TE:**  
848, How Science Works  
**Biology.com:** Chapter 29 STEM activity, Yellowstone Wolves |
| Using Mathematics and Computational Thinking | **LS2.B:** Cycles of Matter and Energy Transfer in Ecosystems  
- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)  
**M & L BIOLOGY SE/TE:**  
69-70, Primary Producers  
226-228, Energy and Life  
250, Chemical Energy and Food  
1035, STEM Activity | **Scale, Proportion, and Quantity**  
- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)  
**M & L BIOLOGY SE/TE:**  
150, Analyzing Data  
**M & L BIOLOGY TE:**  
143, Connect to Math  
**Biology.com:** Chapter 3 Data Analysis, Counting on Nature |
| Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.  
- Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)  
**M & L BIOLOGY SE/TE:**  
147, Q1  
150, Q31 | **Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)  
**M & L BIOLOGY SE/TE:**  
133, Figure 5-4  
**M & L BIOLOGY TE:**  
133, Connect to Math  
**Systems and Model Systems**  
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5)  
**M & L BIOLOGY SE/TE:**  
83, Figure 3-17  
1035, STEM Activity  
**M & L BIOLOGY TE:**  
242, Transfer Performance Task |
| **M & L BIOLOGY TE:**  
88, Summative Performance Task | **Energy and Matter**  
- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4)  
**M & L BIOLOGY SE/TE:**  
70, Figure 3-5  
71, Figure 3-6  
77, Figure 3-11 | **Key:** SE = Student Edition; TE = Teacher’s Edition  
**M & L BIOLOGY TE:**  
70, Address Misconceptions  
82, Address Misconceptions |
## Science and Engineering Practices

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<tr>
<td>Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</td>
<td>Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)</td>
<td>Energy drives the cycling of matter within and between systems. (HS-LS2-3)</td>
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<tr>
<td>▪ Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS2-3)</td>
<td></td>
<td>M &amp; L BIOLOGY SE/TE: 79, Visual Analogy 92, Q. 26</td>
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<tr>
<td>M &amp; L BIOLOGY SE/TE: 90, Q113, 249 and 269, Chapter 9 Mystery</td>
<td></td>
<td>M &amp; L BIOLOGY TE: 69, Build Background 70, Quick Facts</td>
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<tr>
<td>▪ Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)</td>
<td></td>
<td>Stability and Change</td>
</tr>
<tr>
<td>M &amp; L BIOLOGY SE/TE: 155, Quick Lab 172, Analyzing Data 181, Q4 61a-61b, Unit 2 Project 1035, STEM Activity</td>
<td>▪ A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)</td>
<td>▪ Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HS-LS2-7)</td>
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<td>M &amp; L BIOLOGY TE: 122, Transfer Performance Task</td>
<td></td>
<td>M &amp; L BIOLOGY SE/TE: 123, Q2 124, Q18 126, Analyzing Data 179, Q3 183, Chapter Mystery</td>
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<tr>
<td>Engaging in Argument from Evidence</td>
<td>▪ Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)</td>
<td>M &amp; L BIOLOGY TE: 69, Build Background 70, Quick Facts 106, How Science Works 108, Differentiated Instruction 176, Use visuals</td>
</tr>
<tr>
<td>Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.</td>
<td>▪ M &amp; L BIOLOGY SE/TE: 136, What Can Be Done About Invasive Mussels? 154-156, The Effect of Human Activity 159, Soil Erosion 160-162, Water Pollution 163-164, Air Pollution 165, Air Quality and Sustainability 168, Altered Habitats</td>
<td>Biology.com: Virtual Lab, Introduction to Ecology</td>
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<tr>
<td>▪ Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)</td>
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<td>M &amp; L BIOLOGY SE/TE: 102, Analyzing Data 108, Quick Lab 147, Q2</td>
<td>▪ LS2.C: Ecosystem Dynamics, Functioning, and Resilience</td>
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<td>▪ LS2.D: Social Interactions and Group Behavior</td>
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<td>▪ Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)</td>
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<td>▪ Evaluation of evidence behind currently accepted explanations to determine the merits of arguments. (HS-LS2-8)</td>
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# A Correlation of the Pearson High School Science Program
(Biology, Chemistry, Physics, and Earth Science) to the 2014 Oregon Science Standards (NGSS)

## Science and Engineering Practices

### Connections to Nature of Science

**Scientific Knowledge is Open to Revision in Light of New Evidence**
- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2),(HS-LS2-3)

**M & L BIOLOGY SE/TE:**
- 63 and 91, Chapter 3 Mystery
- 95 and 125, Chapter 4 Mystery

**M & L BIOLOGY TE:**
- 100, How Science Works

### Disciplinary Core Ideas

**LS4.D: Biodiversity and Humans**
- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary to HS-LS2-7)*

**M & L BIOLOGY SE/TE:**
- 494-497, The Process of Speciation
- 546-548 Speciation and Extinction

**M & L BIOLOGY TE:**
- 166-167, The Value of Biodiversity
- 168-170, Threats to Biodiversity
- 170-171, Conserving Biodiversity
- 174-179, Ecology in Action

**PS3.D: Energy in Chemical Processes**
- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to HS-LS2-5)*

**M & L BIOLOGY SE/TE:**
- 70, Energy From the Sun
- 230-234, Photosynthesis: An Overview
- 235-241, The Process of Photosynthesis

**ETS1.B: Developing Possible Solutions**
- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary to HS-LS2-7)*

**M & L BIOLOGY SE/TE:**
- 175, Case Study #1, Atmospheric Ozone
- 176, Case Study #2, North Atlantic Fisheries
- 177-179, Case Study #3, Climate Change
- S71a-S71b, Unit 6 Project, A Living Roof

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Key: SE = Student Edition; TE = Teacher’s Edition
| Connections to other DCIs in this grade-band: | HS.PS1.B (HS-LS1-5), (HS-LS1-6), (HS-LS1-7), (HS-LS2-3), (HS-LS2-5); HS.PS2.B (HS-LS1-7); HS.PS3.B (HS-LS1-5), (HS-LS1-7), (HS-LS2-3), (HS-LS2-4); HS.PS3.D (HS-LS2-3), (HS-LS2-4); HS.ESS2.A (HS-LS2-3); HS.ESS2.D (HS-LS2-5); HS-LS2; (HS-LS2-6), (HS-LS2-7); HS.ESS3.A (HS-LS2-2), (HS-LS2-7); HS.ESS3.C (HS-LS2-2), (HS-LS2-7); HS.ESS3.D (HS-LS2-2) |
| Articulation across grade-bands: | MS.PS1.A (HS-LS1-6); MS.PS1.B (HS-LS1-5), (HS-LS1-6), (HS-LS1-7), (HS-LS2-3); MS.PS3.D (HS-LS1-5), (HS-LS1-6), (HS-LS1-7), (HS-LS2-3), (HS-LS2-4), (HS-LS2-5); MS.LS2.A (HS-LS2-1), (HS-LS2-2), (HS-LS2-6); MS.LS2.B (HS-LS1-5), (HS-LS1-7), (HS-LS2-3), (HS-LS2-4), (HS-LS2-5); MS.LS2.C (HS-LS2-1), (HS-LS2-2), (HS-LS2-6), (HS-LS2-7); MS.ESS2.A (HS-LS2-5); MS.ESS2.E (HS-LS1-6); MS.ESS3.A (HS-LS2-1), (HS-LS2-2), (HS-LS2-6), (HS-LS2-7); MS.ESS3.D (HS-LS2-7); MS.ESS3.E (HS-LS2-6) |

| Common Core State Standards Connections: |

**ELA/Literacy** -

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS2-1), (HS-LS2-2), (HS-LS2-5), (HS-LS2-6), (HS-LS2-7)

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)

RST.10.8 Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-LS2-1), (HS-LS2-2), (HS-LS2-3)

WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS2-3)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7)

**Mathematics** -

MP.2 Reason abstractly and quantitatively. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-6), (HS-LS2-7)

MP.4 Model with mathematics. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)

HSS-ID.A.1 Represent data with plots on the real number line. (HS-LS2-6)

HSS-ID.A.2 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6)

HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)
Students who demonstrate understanding can:

**HS-LS3-1.** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

**MILLER & LEVINE BIOLOGY:** In Lesson 7.2 (p. 197), students learn that the nucleus of a cell contains chromosomes with DNA. In Lesson 10.2 (pp. 279-280), students learn about the role of chromosomes in cell division. Lesson 12.1 (pp. 342-343) provides a general description of the role of DNA. Lesson 12.2 (pp. 344-348) describes the structure of DNA. In Lesson 13.2 (pp. 366-367), students learn how the instructions for characteristic traits (the genetic code) are stored in DNA. Students ask questions about the role of DNA and chromosomes in the inheritance of characteristic traits: Students write a series of questions about one component of the process that translates the genetic code into proteins (Q4, p. 371). Students write questions about the transmission of traits (In Your Notebook, p. 396).

**HS-LS3-2.** Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

**MILLER & LEVINE BIOLOGY:** Students are introduced to the process of DNA replication in Lesson 12.3 (pp. 350-353) and mutations in Lesson 13.3 (pp. 372-376). Lesson 17.1 (pp. 482-486) connects genetics to evolutionary theory. Lesson 17.2 (pp. 487-492) focuses on the mechanisms by which genetic variation is introduced into populations. Students revisit the effect of mutations on evolution in Lesson 17.4 (pp. 498-500).

Students defend claims based on evidence about the causes of inheritable genetic variations: Students write an argument to support a claim about antibiotic use as a cause of genetic variation in bacteria (p. 499). Students use evidence to choose the correct hypothesis about the evolution of two fish populations (Analyzing Data, p. 500). Students defend the claim that evolution is ecology over time (Q38, p. 506).

**HS-LS3-3.** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.]

**MILLER & LEVINE BIOLOGY:** The term probability is defined in Lesson 11.2 (p. 313) in relation to genetic crosses. Exceptions to Mendel’s principles are discussed in Lesson 11.3 (pp. 319-320) as to how the environment can affect the expression of genes (p. 321). Lesson 14.1 (pp. 392-397) focuses on the variation of traits in humans.

Students apply concepts of statistics and probability to the variation of traits: Students use probability to explore the inheritance of height in plants (Q2b, p. 318). Students use a Punnett square to show the results of a two-factor cross and explain why the actual results do not match the expected results (Q1 and Q2, p. 331). Students use probability to explain the inheritance of smooth coats in guinea pigs (Q12, p. 332). Students use data to draw conclusions about the inheritance of eye color in fruit flies (Analyzing Data, p. 334).

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

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<th>Science and Engineering Practices</th>
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<th>Crosscutting Concepts</th>
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<td><strong>Asking Questions and Defining Problems</strong></td>
<td><strong>LS1.A: Structure and Function</strong>&lt;br&gt; All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary to HS-LS3-1) [Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.]</td>
<td><strong>Cause and Effect</strong>&lt;br&gt; Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2)</td>
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<td><strong>M &amp; L BIOLOGY SE/TE:</strong> 371, Q4 396, In Your Notebook</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong>&lt;br&gt; 197, The Nucleus 310, Genes and Alleles 342-343, The Role of DNA 366-367, The Genetic Code 1037, STEM Activity</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong>&lt;br&gt; 332, Q6 334, Q28 356, Q8 358, Use Science Graphics 381, Analyzing Data 386, Q17 413, Q15 414, Analyzing Data</td>
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<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong>&lt;br&gt; 330, Transfer Performance Task 336b, Assess and Remediate, Constructing Explanations 370, How Science Works</td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong>&lt;br&gt; 332, Q6 334, Q28 356, Q8 358, Use Science Graphics 381, Analyzing Data 386, Q17 413, Q15 414, Analyzing Data</td>
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</table>
### Science and Engineering Practices

- Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3)

### Disciplinary Core Ideas

#### LS3:A: Inheritance of Traits
- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species’ characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)

#### LS3:B: Variation of Traits
- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)

### Crosscutting Concepts

#### Scale, Proportion, and Quantity
- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)

### Engaging in Argument from Evidence

Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
- Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)

### Connections to Nature of Science

#### Science is a Human Endeavor
- Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3)

### M & L BIOLOGY SE/TE:
- 318, Q2b
- 331, Q1 and Q2
- 332, Q.12
- 334, Analyzing Data
- 1037, STEM Activity

### M & L BIOLOGY SE/TE:
- 434, Form Your Opinion
- 500, Analyzing Data
- 506, Q38

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Connections to other DCIs in this grave-band:  

- **HS.LS2.A** (HS-LS3-3); **HS.LS2.C** (HS-LS3-3); **HS.LS4.B** (HS-LS3-3); **HS.LS4.C** (HS-LS3-3)

Articulation across grade-bands:  

- **MS.LS2.A** (HS-LS3-3); **MS.LS3.A** (HS-LS3-1),(HS-LS3-2); **MS.LS3.B** (HS-LS3-1),(HS-LS3-2),(HS-LS3-3); **MS.LS4.C** (HS-LS3-3)

Common Core State Standards Connections:

**ELA/Literacy -**

- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS3-1),(HS-LS3-2)

- **RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-LS3-1)

**WHST.9-12.1**
Write arguments focused on discipline-specific content. (HS-LS3-2)

**Mathematics -**

- **MP.2** Reason abstractly and quantitatively. (HS-LS3-2),(HS-LS3-3)
Students who demonstrate understanding can:

**HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.** [Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.]

**MILLER & LEVINE BIOLOGY:** Lesson 16.1 (pp. 450-453) describes what Darwin observed during the voyage of the Beagle. Lesson 16.3 (pp. 460-464) presents Darwin’s argument for evolution by natural selection. In Lesson 16.4 (pp. 465-463), students learn about other empirical evidence that supports Darwin’s argument. Lesson 17.4 (pp. 498-501) presents the molecular evidence for evolution.

Students **communicate scientific information** about the multiple lines of evidence for biological evolution: Students **write** a paragraph explaining how evidence since Darwin’s time has strengthened his theories (Q6, p. 473). Students **write and refine** a paragraph about how descent with modification can explain the diversity of life today (Q19, p. 477). Students **write** a paragraph explaining how Earth’s age supports the theory of evolution (Q35, p. 478). Students **write** a newspaper article about the theory of evolution for an audience that knows nothing about the subject (Q37, p. 478).

**HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.** [Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

**MILLER & LEVINE BIOLOGY:** The foundation for understanding the evidence for evolution is laid in Lesson 4.2 (pp. 100-101) where the competitive exclusion principle is discussed; in Lessons 5.1 and 5.2 (pp. 139-141) where population growth and limits to growth are discussed; and in Lesson 13.3 (pp. 372-376) where mutations are discussed. In Lesson 16.3 (pp. 460-464), students are introduced to the concept of natural selection. In Lesson 17.2 (pp. 487-489), students learn about the impact of genetic variation on natural selection. In the Chapter 17 Lab, Competing for Resources, students use assorted tools to simulate the competition of birds for seeds.

Students **construct an explanation based on evidence** that evolution results primarily from four factors: Students **use** experimental data to explain how genetic variation is important in the survival of a species (Q5b, p. 473). Students **explain** how the process of natural selection accounts for the diversity of the organisms that Darwin observed on the Galápagos Islands (Q23, p. 477). Students **describe** three lines of evidence that support the theory of evolution (Q36, p. 478).

**HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.** [Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]

**MILLER & LEVINE BIOLOGY:** In Lesson 16.3 (pp. 460-463), students learn how advantageous traits affect survival. In Lesson 16.4 (pp. 471-473), students learn how scientists can observe natural selection in a natural environment.

Students **apply concepts of statistics and probability** to the relationship between advantageous traits and population size: Students **identify** a trend in bird survival based on beak size (Figure 16-18, p. 473). Students **use** statistics to explore drug resistance as an advantageous trait for bacteria (Analyzing Data, p. 591). Students **learn** how the presence of mycorrhizae affects the growth and survival of plants (Analyzing Data, p. 624).

**HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.** [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]

**MILLER & LEVINE BIOLOGY:** Lesson 17.1 (pp. 482-486) introduces the concepts of a gene pool and allele frequency. In Lesson 17.2 (pp. 487-492), students learn how natural selection affects allele frequencies. In Lesson 17.3 (pp. 494-497), students learn how different types of isolation can lead to the adaptation of populations.

Students **construct an explanation based on evidence** for how natural selection leads to adaptation of populations: Students **explain** why rapid evolution is likely to occur in a small population that has been separated from the main population (Q19, p. 566). Students **explain** how the evolution of a vascular system affected the ability of plants to survive in various environments (Q2, p. 657). Students **explain** why it is adaptive for seeds to remain dormant before they germinate (Q3b, p. 707).
**HS-LS4-5.** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. \[Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.\]

**MILLER & LEVINE BIOLOGY:** In Lesson 17.3 (pp. 494-497), students learn how different types of isolation can lead to the formation of new species. Lesson 19.2 (pp. 546-548) discusses the processes that influence whether species survive or become extinct.

Students evaluate the evidence for claims that environmental conditions may result in speciation or extinction: Students explore evidence that climate change is causing a genetic decline in alpine chipmunks (pp. 447a-447b). Students provide evidence for the claim that major geologic changes often go hand in hand with mass extinctions (Q18, p. 566). Students use evidence to suggest an explanation for the Permian mass extinction (Chapter Mystery, Q2, p. 567).

**HS-LS4-6.** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. \[Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.\]

**MILLER & LEVINE BIOLOGY:** Lesson 6.3 (pp. 166-172) discusses the value of biodiversity, threats to biodiversity, and ways to conserve biodiversity. The Unit 2 Project, Disappearing Mussels! (pp. 61a-61b), asks students to recommend ways to prevent the decline of marine populations.

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

**Science and Engineering Practices**
- Analyzing and Interpreting Data
  - Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
    - Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS4-3)

**M & L BIOLOGY SE/TE:**
- 473, Figure 16-18
- 591, Analyzing Data
- 624, Analyzing Data

**Using Mathematics and Computational Thinking**
- Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
  - Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

**M & L BIOLOGY SE/TE:**
- 374, Quick Lab, Modeling Mutations
- 447a-447b, Unit 5 Project
- 571a-571b, Unit 6 Project

**M & L BIOLOGY TE:**
- 96, Evidence of Understanding
- 158, Evidence of Understanding

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<tr>
<th>Disciplinary Core Ideas</th>
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<tr>
<td><strong>LS4.C: Adaptation</strong></td>
<td><strong>Patterns</strong></td>
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<tr>
<td>Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment’s limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)</td>
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<td>Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3),(HS-LS4-4)</td>
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<td>460-463, Evolution by Natural Selection 1038, STEM Activity</td>
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<td><strong>M &amp; L BIOLOGY SE/TE:</strong></td>
<td><strong>M &amp; L BIOLOGY SE/TE:</strong></td>
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<tr>
<td>461, Visual Summary</td>
<td>466, Visual Summary</td>
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<td>470, Analyzing Data</td>
<td>473, Figure 16-18</td>
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<td>506, Use Science Graphics</td>
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<td>1038, STEM Activity</td>
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<td>462, Quick Facts</td>
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<td>471, Connect to the Real World</td>
<td>474, Transfer Performance Task</td>
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<td><strong>Biology.com:</strong></td>
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<tr>
<td>Chapter 16 STEM activity, Bird Beaks</td>
<td>Chapter 19 Data Analysis, Extinctions</td>
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### Science and Engineering Practices

<table>
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<th>Constructing Explanations and Designing Solutions</th>
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<tr>
<td>Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</td>
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<tr>
<td>• Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS4-2),(HS-LS4-4)</td>
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### Disciplinary Core Ideas

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<thead>
<tr>
<th>LS4.D: Biodiversity and Humans</th>
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<tr>
<td>• Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline and sometimes the extinction of some species. (HS-LS4-3),(HS-LS4-6)</td>
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### Crosscutting Concepts

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<tr>
<th>Connections to Nature of Science</th>
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<tr>
<td>Scientific knowledge assumes an order and consistency in natural systems</td>
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<td>• Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1),(HS-LS4-4)</td>
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<td>478, Q36</td>
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<td>566, Q19</td>
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<td>657, Q2</td>
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<td>707, Q3b</td>
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### Engaging in Argument from Evidence

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### Obtaining, Evaluating, and Communicating Information

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<td>566, Q18 (p. S66)</td>
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<td>567, Chapter Mystery, Q2</td>
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<td>1038, STEM Activity</td>
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<td>473, Q6</td>
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<td>477, Q19</td>
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<td>478, Q35 &amp; Q37</td>
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A Correlation of the Pearson High School Science Program (Biology, Chemistry, Physics, and Earth Science) to the 2014 Oregon Science Standards (NGSS)

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<td><strong>Connections to Nature of Science</strong></td>
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<tr>
<td>Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena</td>
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<tr>
<td>- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1)</td>
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M & L BIOLOGY SE/TE:
13. Scientific Theories
473, Evaluating Evolutionary Theory
473 Q6
459, Biology & History (p. 459)

M & L BIOLOGY TE:
455, How Science Works
462, Address Misconceptions
483, How Science Works
548, How Science Works

Connections to other DCIs in this grade-band: HS.LS2.A (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5); HS.LS2.D (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5); HS.LS3.A (HS-LS4-1); HS.LS3.B (HS-LS4-1),(HS-LS4-2) (HS-LS4-3),(HS-LS4-5); HS.ESS1.C (HS-LS4-1); HS.ESS2.D (HS-LS4-6); HS.ESS2.E (HS-LS4-2),(HS-LS4-5),(HS-LS4-6); HS.ESS3.A (HS-LS4-2),(HS-LS4-5),(HS-LS4-6); HS.ESS3.C (HS-LS4-6); HS.ESS3.D (HS-LS4-6); HS.ESS3.E (HS-LS4-6)

Articulation across grade-bands: MS.LS2.A (HS-LS4-2),(HS-LS4-3),(HS-LS4-5); MS.LS2.C (HS-LS4-5),(HS-LS4-6); MS.LS3.A (HS-LS4-1); MS.LS3.A (HS-LS4-1); MS.LS4.A (HS-LS4-1); MS.LS4.B (HS-LS4-2),(HS-LS4-3),(HS-LS4-4); MS.LS4.C (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),MS.LS4.D (HS-LS4-5); MS.LS4.E (HS-LS4-1); MS.ESS3.C (HS-LS4-5),(HS-LS4-6)

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS4-5)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4)

WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS4-6)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS4-6)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5)

SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (HS-LS4-1),(HS-LS4-2)

Mathematics -

MP.2 Reason abstractly and quantitatively. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5)

MP.4 Model with mathematics. (HS-LS4-2)

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Students who demonstrate understanding can:

**HS-ESS1-1.** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun’s core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun’s radiation varies due to sudden solar flares (“space weather”), the 11-year sunspot cycle, and non-cyclical variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun’s nuclear fusion.]

**PEARSON EARTH SCIENCE:** Sunspots, prominences, and solar flares are discussed in Chapter 24, Lesson 3, “The Active Sun” (pp. 687-688). Nuclear fusion and the transport of energy to the surface of the sun are introduced in Chapter 24, Lesson 3, “The Solar Interior” (p. 689) and in Chapter 25, Lesson 2, “Prostar Stage” (p. 708). Content relating to sunspots and transport of energy to Earth appears in Chapter 24, “Earth & Space—Solar Variability and Climate Change” (p. 691). Chapter 24, Lesson 3, “How Old Is the Sun?” (p. 690) addresses the life span of the sun.

**HS-ESS1-2.** Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. [Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).]

**PEARSON EARTH SCIENCE:** Chapter 24, Lesson 1 “Spectroscopy” (p. 676) contains background content relating to emission spectra. The Doppler effect is explained on page 677. The use of the red shift phenomenon to measure the motion of distant galaxies is explained in Chapter 25, Lesson 3, “The Expanding Universe” (pp. 718-719). Chapter 25, Lesson 3, “The Big Bang” (p. 720) discusses the roles of the red shift and cosmic microwave background radiation as evidence for the Big Bang Theory. Students construct an explanation of the Big Bang Theory in Assessment 25.3, exercise 5 on page 721 and Chapter 25 Assessment, exercises 22 and 23 on page 725.

**HS-ESS1-3.** Communicate scientific ideas about the way stars, over their lifecyle, produce elements. [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.] [Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.]

**PEARSON EARTH SCIENCE:** Relevant content relating to how stars produce elements is introduced in Chapter 25, Lesson 2, “Main-Sequence Stage” (p. 708) and “Nucleosynthesis”.

**HS-ESS1-4.** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.] [Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler’s Laws of orbital motions should not deal with more than two bodies, nor involve calculus.]

**PEARSON EARTH SCIENCE:** Chapter 23, Lesson 1 (p. 644) introduces the orbits of the planets in the Solar System. Mathematical representations of the motion of orbiting objects are discussed in “Johannes Kepler” on page 618. Students use computational representations to predict the motion of orbiting objects in Assessment 22.1, exercise 7 on page 621 and in Chapter 22 Assessment, exercise 14 on page 639.

**HS-ESS1-5.** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).]

**PEARSON EARTH SCIENCE:** Chapter 9, Lesson 1, “The Continental Puzzle” (pp. 248-252) and Chapter 9, Lesson 2, “Evidence for Sea-Floor Spreading” (pp. 257-260) describe the evidence of crustal movements in support of the theory of plate tectonics, which is introduced and explained in Chapter 9, Lesson 3 (pp. 261-269) and Chapter 9, Lesson 4, “Mechanisms of Plate Motion” (pp. 270-271). Radiometric dating is explained in Chapter 12, Lesson 3 (pp. 348-349). Students evaluate evidence regarding the age of crustal rock in Assessment 9.2, exercises 5 and 8 on page 260 and in Chapter 9 Assessment, exercise 26 page 276.

**HS-ESS1-6.** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth’s formation and early history. [Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth’s oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]

**PEARSON EARTH SCIENCE:** The early history of Earth is addressed in Chapter 1, Lesson 1, “Formation of Earth” (pp. 4-5); Chapter 8, Lesson 4 “Discovering Earth’s Composition” (p. 237); and Chapter 13, Lesson 1, “Precambrian Earth” (pp. 364-366). Students apply scientific reasoning and evidence to construct an account of Earth’s formation in Chapter 4, Lesson 8 Assessment exercise 5 on page 237 and Chapter 13 Assessment, exercise 22 on page 390.

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

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<td>Developing and Using Models</td>
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| Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). | **ESS1A: The Universe and Its Stars**
- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1) | **Patterns**
- Empirical evidence is needed to identify patterns. (HS-ESS1-5) |
| Using Mathematical and Computational Thinking | **HS-ESS1-2**
- The study of stars’ light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3) | **Scale, Proportion, and Quantity**
- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1) |
| Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. | **Pearson Earth Science SE/TE:** 676, Emission Spectrum 677, The Doppler Shift 677, exercises 3 and 4 696, exercises 24 and 32 703, Stellar Brightness 718-719, The Expanding Universe 721, exercise 4 725, exercises 14 and 22 726, exercise 27 | **Pearson Earth Science SE/TE:** 689, The Solar Interior 690, How Old Is the Sun? |
| **Pearson Earth Science SE/TE:** 618, Johannes Kepler 621, exercise 7 639, exercise 14 | **ESS1A: The Universe and Its Stars**
- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-2) | **Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).** (HS-ESS1-4) |
| Constructing Explanations and Designing Solutions | **Pearson Earth Science SE/TE:** 720, The Big Bang 721, exercise 5 725, exercises 22 and 23 | **Pearson Earth Science SE/TE:** 618, Johannes Kepler 621, exercise 7 639, exercise 14 |
| Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent, student-generated sources of evidence consistent with scientific ideas, principles, and theories. | **Pearson Earth Science SE/TE:** 689, Nuclear Fusion 712, Nucleosynthesis | **Energy and Matter**
- Energy cannot be created or destroyed—only moved between one place and another place, between objects and/or fields, or between systems. (HS-ESS1-2) |
| **Pearson Earth Science SE/TE:** 390, exercise 22 | **ESS1B: Earth and the Solar System**
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2),(HS-ESS1-3) | **Pearson Earth Science SE/TE:** 364-366, Precambrian Earth 390, exercise 22 |
| **Pearson Earth Science SE/TE:** 720, The Big Bang 721, exercise 5 725, exercises 22 and 23 | **Pearson Earth Science SE/TE:** 618, Johannes Kepler 621, exercise 7 639, exercise 14 | **Connections to Engineering, Technology, and Applications of Science** |
| Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (MS-ESS1-6) | **Pearson Earth Science SE/TE:** 364-366, Precambrian Earth 390, exercise 22 | **Interdependence of Science, Engineering, and Technology**
- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2),(HS-ESS1-4) |

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<td><strong>ESS1.C: The History of Planet Earth</strong>&lt;br&gt; Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)</td>
<td><strong>Connections to Nature of Science</strong>&lt;br&gt; <strong>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</strong>&lt;br&gt; • Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-ESS1-2)</td>
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<td><strong>Pearson Earth Science SE/TE:</strong>&lt;br&gt; 257-260, Evidence for Sea-Floor Spreading&lt;br&gt; 260, exercises 5 and 8&lt;br&gt; 276, exercise 26</td>
<td><strong>Pearson Earth Science SE/TE:</strong>&lt;br&gt; 336-337, Uniformitarianism&lt;br&gt; 720, The Big Bang</td>
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<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td><strong>ESS2.B: Plate Tectonics and Large-Scale System Interactions</strong>&lt;br&gt; • Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. (ESS2.B Grade 8 GBE) (secondary to HS-ESS1-5)</td>
<td><strong>Pearson Earth Science SE/TE:</strong>&lt;br&gt; 261-269, Theory of Plate Tectonics&lt;br&gt; 730, STEM Activity - Plate Tectonics: Measuring Plate Movement</td>
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<tr>
<td>• Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5)</td>
<td><strong>Pearson Earth Science SE/TE:</strong>&lt;br&gt; 237, Discovering Earth's Composition&lt;br&gt; 349, Age of Earth&lt;br&gt; 633, Lunar History&lt;br&gt; 664, Meteorites and the Age of the Solar System</td>
<td><strong>Pearson Earth Science SE/TE:</strong>&lt;br&gt; 720, The Big Bang&lt;br&gt; 721, exercise 5</td>
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<td>• Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-ESS1-3)</td>
<td><strong>Pearson Earth Science SE/TE:</strong>&lt;br&gt; 351, Radiometric Dating of Sedimentary Rocks&lt;br&gt; 347, Discovering Earth's Composition</td>
<td><strong>Pearson Earth Science SE/TE:</strong>&lt;br&gt; 351, Radiometric Dating of Sedimentary Rocks&lt;br&gt; 347, Discovering Earth's Composition</td>
</tr>
</tbody>
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**Connections to Nature of Science**

**Crosscutting Concepts**

**Key:** SE = Student Edition; TE = Teacher’s Edition
### Science and Engineering Practices

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<thead>
<tr>
<th>Disciplinary Core Ideas</th>
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<tr>
<td><strong>PS4.B Electromagnetic Radiation</strong></td>
<td></td>
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<tr>
<td>- Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. <em>(secondary to HS-ESS1-2)</em></td>
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<tr>
<td><strong>Pearson Earth Science SE/TE:</strong></td>
<td></td>
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<tr>
<td>676, Spectroscopy</td>
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<tr>
<td>677, exercise 3</td>
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<td>695, exercise 15</td>
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</table>

**Connections to other DCIs in this grade-band:**
- **HS.PS1.A** (HS-ESS1-2),(HS-ESS1-3); **HS.PS1.C** (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3); **HS.PS2.A** (HS-ESS1-6); **HS.PS2.B** (HS-ESS1-4),(HS-ESS1-6); **HS.PS3.A** (HS-ESS1-1),(HS-ESS1-2); **HS.PS3.B** (HS-ESS1-2),(HS-ESS1-5); **HS.PS4.A** (HS-ESS1-2); **HS.ESS2.A** (HS-ESS1-5),(HS-ESS1-6)

**Articulation of DCIs across grade-bands:**
- **MS.PS1.A** (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3); **MS.PS2.A** (HS-ESS1-4); **MS.PS2.B** (HS-ESS1-4),(HS-ESS1-6); **MS.PS4.B** (HS-ESS1-1),(HS-ESS1-2); **MS.ESS1.A** (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4); **MS.ESS1.B** (HS-ESS1-1),(HS-ESS1-4),(HS-ESS1-6); **MS.ESS1.C** (HS-ESS1-5),(HS-ESS1-6); **MS.ESS2.A** (HS-ESS1-1),(HS-ESS1-5),(HS-ESS1-6); **MS.ESS2.B** (HS-ESS1-5),(HS-ESS1-6); **MS.ESS2.D** (HS-ESS1-1)

**Common Core State Standards Connections:**

**ELA/Literacy -**
- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-5),(HS-ESS1-6)*
- **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *(HS-ESS1-5),(HS-ESS1-6)*
- **WHST.9-12.1** Write arguments focused on discipline-specific content. *(HS-ESS1-6)*
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. *(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-5)*
- **SL.11-12.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(HS-ESS1-3)*

**Mathematics -**
- **MP.2** Reason abstractly and quantitatively. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)*
- **MP.4** Model with mathematics. *(HS-ESS1-1),(HS-ESS1-4)*
- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)*
- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)*
- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)*
- **HSA-SS-1.A.1** Interpret expressions that represent a quantity in terms of its context. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*
- **HSA-SS-1.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*
- **HSA-SS-1.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)*
- **HSA-IF.B.5** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *(HS-ESS1-6)*
- **HSS-ID.B.6** Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. *(HS-ESS1-6)*

Key: SE = Student Edition; TE = Teacher’s Edition
Students who demonstrate understanding can:

**HS-ESS2-1.** Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).] [Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth’s surface.]

**PEARSON EARTH SCIENCE:** Relevant content relating to Earth’s internal and surface processes is introduced Chapter 5, Lesson 1, “Weathering” on pages 126-132; Chapter 5, lesson 2, “Soil Erosion” on pages 140-142; Chapter 5, Lesson 3, Mass Movement on pages 143-147; Chapter 6, Lesson 2, The Work of Streams on pages 164-168; Chapter 6, Lesson 3 “Caverns” on pages 176-178 and “Karst Topographies” on pages 178-179; Chapter 7, Lesson 1, Glaciers on pages 192-197; Chapter 7, Lesson 2, Deserts on pages 201-202; Chapter 7, Lesson 3, Landscapers Shaped by Wind on pages 203-207; “How Earth Works—Erosion” on pages 208-209; Chapter 8, Lesson 1, What is an Earthquake? On pages 218-221; Chapter 9, Plate Tectonics on pages 248-271; Chapter 10, Volcanoes and Other Igneous Activity on pages 280-297; Chapter 10, “How Earth Works—Effects of Volcanoes” on pages 298-299; Chapter 11, Mountain Building on pages 308-329; Chapter 14, Lesson 2, Ocean Floor Features on pages 401-405; Chapter 14, Lesson 3, Seafloor Sediments on pages 407-409; and Chapter 16, Lesson 3, Shoreline Processes and Features on pages 461-467


**HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth’s systems. [Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth’s surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

**MILLER & LEVINE BIOLOGY:** Lesson 6.1 (pp. 154-157) discusses the effects of agriculture, development, and industry on Earth’s surface. In Lesson 6.2 (pp. 158-165), students learn how poor management of resources can lead to desertification and deforestation. Case Study #3 in Lesson 6.4 (pp. 177-179) addresses the causes and effects of climate change.

Students analyze geoscience data about how a change to Earth’s surface can cause changes to other Earth systems: Students use a map of desertification risk to categorize the risk of desertification in their local area (Figure 6-6, p. 159). Students compare data on global land-surface air temperature, mean global sea ice, and global sea level (p. 177).

**PEARSON EARTH SCIENCE:** The effects of feedback on Earth’s systems is introduced in “Facts and Figures” (TE page 20). Chapter 13, Lesson 3, “Precambrian Time” and Chapter 21, Lesson 3, “Global Climate Change” address feedback in the contexts of early Earth systems and climate change.

**HS-ESS2-3.** Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection. [Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth’s three-dimensional structure obtained from seismic waves, records of the rate of change of Earth’s magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth’s layers from high-pressure laboratory experiments.]

**PEARSON EARTH SCIENCE:** Chapter 8, Lesson 4, “Earth’s Layered Structure” (pp. 233-237) and Chapter 9, Lesson 4, Mechanisms of Plate Motion (pp. 270-271) describe the Earth’s interior and the process of mantle convection. The Paleomagnetism and the Ocean Floor Inquiry Exploration Lab (pp. 272-273) is an investigation of change in the Earth’s magnetic field. Chapter 10, Lesson 1, “Volcanoes and Plate Tectonics” (pp. 280-285) discusses heat transfer in the context of volcanism.

Students develop a model of Earth’s interior in Chapter 8, Lesson 4, “Reading Strategy: Sequence” on page 233.

**HS-ESS2-4.** Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate. [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth’s orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]

**MILLER & LEVINE BIOLOGY:** Lesson 3.4 (p. 80) introduces the different processes involved in biogeochemical cycles. In Lesson 4.1 (pp. 96-98) and Lesson 4.4 (pp. 110-116), students learn about factors that affect climate. In Lesson 6.2 (p. 159), students learn how deforestation can affect local climates. Case Study #3 in Lesson 6.4 (pp. 177-179) provides details about the effects of human activity on climate change. Lesson 19.3 (pp. 553-555) discusses long-term changes in atmospheric composition.
Students **use a model** to describe how variations in energy flow can result in climate change: Students **create** labeled diagrams to show that they understand the factors that affect global climate (TE p. 96). Students **model** the relationship between latitude and solar energy (TE p. 97).

**PEARSON EARTH SCIENCE:** Chapter 21, Lesson 3, “Climate Changes” (pp. 600-603) summarizes processes that cause climate change, and a discussion of observations of sunspot cycles as evidence for climate change appears in Chapter 24, “Earth & Space—Solar Variability and Climate Change” (p. 691).

Students **use a model** to describe the relation between the flow of energy from the sun and the orbit of Earth in Chapter 21, “Teacher Demo—Earth’s Motions and Climate” on TE page 601.

**HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. ![Clarification Statement](https://www.thechange.org/clarification-statement)

**PEARSON EARTH SCIENCE:** “Chemical Weathering” (pp. 129-130) gives an example of how the properties of water affect Earth materials. The movement of water and its role in erosion and transport are discussed in Chapter 6, Lesson 1, Running Water (pp. 158-163) and Chapter 6, Lesson 2, The Work of Streams (pp. 164-170). The role of water in magma formation is explained in Chapter 21, Lesson 3, “Human Impacts on Climate,” on page 601.

Students **investigate** erosion of soil by moving water in Chapter 6, Lesson 1, “Teacher Demo—The Ability to Erode” on TE page 160.

**HS-ESS2-6.** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. ![Clarification Statement](https://www.thechange.org/clarification-statement)

**MILLER & LEVINE BIOLOGY:** The cycling of carbon between the biosphere, atmosphere, hydrosphere, and geosphere is addressed in Lesson 3.4 (pp. 82-83). Certain aspects of the cycle are reinforced in Lesson 8.2 (pp. 232-233) and Lesson 9.1 (pp. 251-252).

**PEARSON EARTH SCIENCE:** The carbon cycle is described in “Earth & Its Systems—The Carbon Cycle” (p. 85). Information regarding cycling of carbon dioxide in Earth systems is introduced in Chapter 21, Lesson 3, “Human Impacts on Climate,” on page 602.

**HS-ESS2-7.** Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth. ![Clarification Statement](https://www.thechange.org/clarification-statement)

**MILLER & LEVINE BIOLOGY:** Lesson 19.1 (pp. 544-545) explains how changes in Earth’s physical environment affect life on Earth and how biological forces affect Earth’s physical environment. Lesson 22.1 (pp. 636-637) provides the specific example of how the evolution of plants changed the environment in ways that enabled new species to evolve. In Lesson 21.3 (pp. 610-611) and Lesson 21.4 (pp. 622-623), students learn about the key roles photosynthetic protists and fungi play in support of aquatic and terrestrial life forms.

Students **construct an argument based on evidence** about the coevolution of the biosphere and Earth’s other systems: Students **argue** how life would be different on Earth without photosynthetic plants (TE p. 555).

**PEARSON EARTH SCIENCE:** The coevolution of Earth systems and life on Earth is introduced in Chapter 13, Lesson 1, “Precambrian Life” (pp. 364-368). Additional information about the coevolution of the atmosphere and life on land appears in Chapter 13, Lesson 1, “Facts and Figures—Ozone and Live on Land” and “Integrate Biology—Origin of Life on Earth” (TE p. 367).

Students are prompted to **construct an argument** while answering questions in the “Ask” section of “Integrate Biology—Origin of Life on Earth” on TE page 367.

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Key: SE = Student Edition; TE = Teacher’s Edition
A Correlation of the Pearson High School Science Program
(Biology, Chemistry, Physics, and Earth Science)
to the 2014 Oregon Science Standards (NGSS)

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
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</table>
| Developing and Using Models       | **ESS2.B: Plate Tectonics and Large-Scale System Interactions**  
Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).  
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1), (HS-ESS2-3), (HS-ESS2-6)  
**Pearson Earth Science SE/TE:**  
233, Reading Strategy  
730, STEM Activity  
**Pearson Earth Science TE:**  
167, Build Science Skills  
195, Build Science Skills  
257, Build Science Skills  
297, Build Science Skills  
- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)  
**Pearson Earth Science TE:**  
601, Teacher Demo—Earth’s Motions and Climate  
**Planning and Carrying Out Investigations**  
Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.  
- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)  
**Analyzing and Interpreting Data**  
Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.  
- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2)  
**M & L Biology SE/TE:**  
159, Figure 6-6  
177 Case Study #3 | **Pearson Earth Science SE/TE:**  
270-271, Mechanisms of Plate Motion  
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth’s surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth’s crust. (ESS2.B Grade 8 GBE) (HS-ESS2-1)  
**Pearson Earth Science SE/TE:**  
261-268, Theory of Plate Tectonics  
**Pearson Earth Science TE:**  
257, Build Science Skills  
**ESS2.C: The Roles of Water in Earth’s Surface Processes**  
- The abundance of liquid water on Earth’s surface and its unique combination of physical and chemical properties are central to the planet’s dynamics. These properties include water’s exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)  
**Pearson Earth Science SE/TE:**  
127, Frost Wedging  
129-130, Chemical Weathering  
140-141, How Water Erodes Soil  
158-159, The Water Cycle  
281, Water Content  
424, Ocean Temperature Variation  
504-506, Water’s Changes of State  
590-591, Bodies of Water  
590, Quick Lab  
**Pearson Earth Science TE:**  
160, Teacher Demo—The Ability to Erode | **Cause and Effect**  
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4)  
**M & L Biology SE/TE:**  
115, Analyzing Data  
126, Analyzing Data  
556, Analyzing Data  
**Pearson Earth Science SE/TE:**  
600-603, Climate Changes  
691, Earth & Space—Solar Variability and Climate Change  
**Energy and Matter**  
- The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)  
**M & L Biology SE/TE:**  
253, Comparing Photosynthesis and Respiration  
260, Q5  
**M & L Biology TE:**  
70, Address Misconceptions  
82, Address Misconceptions  
255, Address Misconceptions  
- Energy drives the cycling of matter within and between systems. (HS-ESS2-3)  
**Pearson Earth Science SE/TE:**  
270-271, Mechanisms of Plate Motion  
280-285, Volcanoes and Plate Tectonics  
**Structure and Function**  
- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)  
**Pearson Earth Science SE/TE:**  
41-42, Covalent Bonds  
42, Figure 7  
**Pearson Earth Science TE:**  
160, Teacher Demo—The Ability to Erode |  
Key: SE = Student Edition; TE = Teacher’s Edition
### Science and Engineering Practices

**Engaging in Argument from Evidence**

Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend an argument. Arguments may also come from current scientific or historical episodes in science.

- Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)

**M & L Biology TE:**

555, Check for Understanding

**Pearson Earth Science TE:**

367, Integrate Biology—Origin of Life on Earth

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### Disciplinary Core Ideas

**ESS2.D: Weather and Climate**

- The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space. (HS-ESS2-4)

**M & L Biology SE/TE:**

96, Weather and Climate

96-98, Factors That Affect Climate

**Pearson Earth Science SE/TE:**

588-591, Factors that Affect Climate

601, Solar Activity

691, Earth & Space—Solar Variability and Climate Change

**Pearson Earth Science TE:**

601, Teacher Demo—Earth’s Motions and Climate

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7)

**M & L Biology SE/TE:**

555, Production of Free Oxygen

**Pearson Earth Science SE/TE:**

85, Earth & Its Systems—The Carbon Cycle

365, The Atmosphere Evolves

367-368, Precambrian Life

602, Human Impacts on Climate

**Pearson Earth Science TE:**

367, Integrate Biology—Origin of Life on Earth

- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6),(HS-ESS2-4)

**M & L Biology SE/TE:**

177-179, Case Study #3, Climate Change

**Pearson Earth Science SE/TE:**

602, Human Impact on Climate

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### Crosscutting Concepts

**Stability and Change**

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS2-7)

**M & L Biology SE/TE:**

629, Q22

630, Q33

**M & L Biology TE:**

544, Differentiated Instruction

553, Teach For Understanding

555, Build Study Skills

611, Build Reading Skills

622, Differentiated Instruction

623, Connect to Earth Science

**Pearson Earth Science SE/TE:**

364-366, Precambrian Earth

367-368, Precambrian Life

**Pearson Earth Science TE:**

367, Integrate Biology—Origin of Life on Earth

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1)

**Pearson Earth Science TE:**

309, Time

323, Quick Lab – Rates of Mountain Building

**Pearson Earth Science TE:**

167, Build Science Skills

195, Build Science Skills

257, Build Science Skills

297, Build Science Skills

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

**M & L Biology SE/TE:**

164, Analyzing Data

175, Case Study #1

**Pearson Earth Science SE/TE:**

364-368, Precambrian Time

602-603, Global Climate Change

**Pearson Earth Science TE:**

20, Facts and Figures

367, Facts and Figures

367, Integrate Biology – Origin of Life on Earth

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<th>Science and Engineering Practices</th>
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<tbody>
<tr>
<td>▪ Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4)</td>
<td><strong>ESS2.E: Biogeology</strong>  ▪ The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it. (HS-ESS2-7)</td>
<td><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
</tr>
<tr>
<td><strong>M &amp; L Biology SE/TE:</strong> 115, Analyzing Data 126, Analyzing Data 556, Analyzing Data</td>
<td><strong>M &amp; L Biology SE/TE:</strong> 553-555, The Mysteries of Life’s Origins 610-611, Autotrophic Protists 622-623, The Ecology of Fungi</td>
<td><strong>Interdependence of Science, Engineering, and Technology</strong>  ▪ Science and engineering complement each other in the cycle known as research and development (R&amp;D). Many R&amp;D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS2-3)</td>
</tr>
<tr>
<td><strong>M &amp; L Biology TE:</strong> 70, Quick Facts 82, Quick Facts 87, How Science Works 177, Quick Facts (p. 177)</td>
<td><strong>Pearson Earth Science SE/TE:</strong> 364-368, Precambrian Time 369-376, The Paleozoic Era</td>
<td><strong>Pearson Earth Science SE/TE:</strong> 730, STEM Activity</td>
</tr>
<tr>
<td><strong>Pearson Earth Science SE/TE:</strong> 600-603, Climate Changes</td>
<td><strong>Pearson Earth Science TE:</strong> 367, Integrate Biology—Origin of Life on Earth</td>
<td><strong>Influence of Engineering, Technology, and Science on Society and the Natural World</strong>  ▪ New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS2-2)</td>
</tr>
<tr>
<td><strong>Pearson Earth Science TE:</strong> 601, Teacher Demo—Earth’s Motions and Climate</td>
<td><strong>PS4.A: Wave Properties</strong>  ▪ Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3)</td>
<td><strong>M &amp; L Biology TE:</strong> 152a, Building Scientific Literacy, STEM 153, Building Scientific Literacy, STEM 161, How Science Works</td>
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Key: SE = Student Edition; TE = Teacher’s Edition
Connections to other DCIs in this grade-band: **HS.PS1.A** (HS-ESS2-5),(HS-ESS2-6); **HS.PS1.B** (HS-ESS2-5),(HS-ESS2-6); **HS.PS2.B** (HS-ESS2-1),(HS-ESS2-3); **HS.PS3.A** (HS-ESS2-4); **HS.PS3.B** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5); **HS.PS3.D** (HS-ESS2-3),(HS-ESS2-6); **HS.PS4.B** (HS-ESS2-2); **HS.LS1.C** (HS-ESS2-6); **HS.LS2.A** (HS-ESS2-7); **HS.LS2.B** (HS-ESS2-2),(HS-ESS2-6); **HS.LS2.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-7); **HS.LS4.A** (HS-ESS2-7); **HS.LS4.B** (HS-ESS2-7); **HS.LS4.C** (HS-ESS2-2),(HS-ESS2-7); **HS.LS4.D** (HS-ESS2-2),(HS-ESS2-7); **HS.ESS1.C** (HS-ESS2-4); **HS.ESS3.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **HS.ESS3.D** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6)

Articulation of DCIs across grade-bands: **MS.PS1.A** (HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6); **MS.PS1.B** (HS-ESS2-3); **MS.PS2.B** (HS-ESS2-1),(HS-ESS2-3); **MS.PS3.A** (HS-ESS2-3),(HS-ESS2-4); **MS.PS3.B** (HS-ESS2-3),(HS-ESS2-4); **MS.PS3.D** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.PS4.B** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.LS1.C** (HS-ESS2-4); **MS.LS2.A** (HS-ESS2-7); **MS.LS2.B** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-6); **MS.LS2.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-7); **MS.LS4.A** (HS-ESS2-7); **MS.LS4.B** (HS-ESS2-7); **MS.LS4.C** (HS-ESS2-2),(HS-ESS2-7); **MS.ESS1.C** (HS-ESS2-3),(HS-ESS2-7); **MS.ESS2.A** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6),(HS-ESS2-7); **MS.ESS2.B** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6); **MS.ESS2.C** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6),(HS-ESS2-7); **MS.ESS2.D** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-5); **MS.ESS2.E** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-5),(HS-ESS2-6); **MS.ESS3.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.ESS3.D** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6)

Common Core State Standards Connections:

**ELA/Literacy**

**RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS2-2),(HS-ESS2-3)

**RST.11-12.2** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2)

**WHST.9-12.1** Write arguments focused on discipline-specific content. (HS-ESS2-7)

**WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-ESS2-5)

**SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4)

**Mathematics**

**MP.2** Reason abstractly and quantitatively. (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)

**MP.4** Model with mathematics. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)

**HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)

**HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6)

**HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6)
HS-ESS3 Earth and Human Activity

Students who demonstrate understanding can:

**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

**MILLER & LEVINE BIOLOGY:** Lesson 5.2 (pp. 140-141) explains how natural disasters are a limiting factor for population growth. Lesson 6.2 (pp. 160-162) discusses the importance of freshwater for humans. Lesson 24.4 (pp. 715-718) focuses on the effect of agriculture on human civilizations.

Students **construct an explanation** for how natural resources, natural hazards, or climate influence human activity: Students **explore** how the presence or absence of trees affected the inhabitants of Easter Island (pp. 153 and 183). Students **explain** how the domestication of a crop contributed to the rise of civilization in a specific region (p. 719).

**PEARSON EARTH SCIENCE:** Chapter 6, Running Water and Groundwater (pp. 156-180) introduces relevant content relating to fresh water as a natural resource. Fertile soil is introduced in Chapter 5, Lesson 2, Soil (pp. 133-142). The use of minerals, fossil fuels, water, air, and land as natural resources is discussed in Chapter 4, “Earth’s Resources” (pp. 92-117). Natural hazards are addressed in Chapter 8, Lesson 3, Earthquake Hazards (pp. 222-232); and in Chapter 10, Lesson 2, The Nature of Volcanic Eruptions (pp. 286-294). Chapter 8, Lesson 3, “Tsunami” on (p. 230); Chapter 5, Lesson 3, “Mass Movements” (pp. 143-147); and Chapter 5, Lesson 2, “Soil Erosion” (pp. 140-142) discuss surface processes that result in natural hazards. Severe weather is introduced in Chapter 20, Lesson 3, “Hurricanes” (pp. 575-577); and Chapter 6, Lesson 2, “Floods and Flood Control” (pp. 168-169). Chapter 7, Lesson 1, “Integrate Biology” (TE p. 197) and Chapter 21, Lesson 3, “Climate Changes” (pp. 600-604) address natural hazards associated with climate change.

Students **construct an explanation** based on evidence of how human activities could change due to environmental influences in Chapter 21, Lesson 3, Assessment exercise 6 on page 603.

**HS-ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

**PEARSON EARTH SCIENCE:** Energy and Mineral Resources are introduced in Chapter 4, Lesson 1 (pp. 94-101). Chapter 4, Lesson 2, “Alternative Energy Sources” (pp. 102-107) and Chapter 4, Lesson 4, “Protecting Resources” (pp. 113-116) address energy and mineral resource conservation.

**HS-ESS3-3.** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

**MILLER & LEVINE BIOLOGY:** Chapter 6 (pp. 154-172) discusses the effect of human activity on the environment.

Students **create a computational simulation** to illustrate the relationship between management of natural resources and biodiversity: Students **use** mathematical and computational tools to analyze data about the genetic decline of alpine chipmunks due to climate change caused by human activities (pp. 447a-447b).

**PEARSON EARTH SCIENCE:** Natural resources are discussed in Chapter 1, Lesson 4, “Earth System Science” (pp. 18-22) and in Chapter 4, “Earth’s Resources” (pp. 92-117).

**HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

**MILLER & LEVINE BIOLOGY:** Lessons 6.1, 6.2, and 6.3 (pp. 156-172) focus on the impact of humans on the environment.

Students **evaluate or refine a technological solution** that reduces impacts of human activities on natural systems: Students **evaluate** ways to reduce dry trash (Quick Lab, p. 155). Students **design** a green roof system for a building (pp. 571a-571b).

**PEARSON EARTH SCIENCE:** Lessons 4.3 (pp. 108-112) and 4.4 (pp. 113-117) summarize the possible effects of human activity on natural systems. Students **evaluate** their own packaging design solution intended to mitigate the effects of waste disposal in the Design to Reduce Waste STEM Activity (p. 729).

Key: SE = Student Edition; TE = Teacher’s Edition
HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

**MILLER & LEVINE BIOLOGY:** Case Study #3 in lesson 6.4 (pp. 177-179) addresses the causes and effects of climate change.

Students analyze geoscience data about global climate change: Students analyze data on air temperature, sea ice, sea level, and greenhouse gas emissions (pp. 177-178).

**PEARSON EARTH SCIENCE:** Relevant content relating to climate change is introduced in Chapter 21, Lesson 3, “Climate Changes” (pp. 600-604). Students forecast effects of global warming on Earth systems in the Section 21.3 Assessment (p. 603).

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

**MILLER & LEVINE BIOLOGY:** Lesson 3.4 (pp. 79-85) describes biogeochemical cycles. Lessons 6.1, 6.2, 6.3, and 6.4 (pp. 152-179) address ways humans modify Earth’s systems.

Students use computational representations to illustrate relationships among Earth’s systems: Students interpret data about the effect of rainfall on plant productivity (p. 92). Students interpret data on air pollution trends (Analyzing Data, p. 164). Students compare data on land-surface air temperature, global sea ice, and global sea level (p. 177).

**PEARSON EARTH SCIENCE:** The Earth system is described in Chapter 1, Lesson 4, “Earth System Science” (pp. 18-22). Chapter 21, Lesson 3, “Human Impact on Climate” (pp. 602-603) addresses human effects on Earth systems.

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
<td><strong>ESS2.D: Weather and Climate</strong></td>
<td></td>
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<tr>
<td>Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.</td>
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<tr>
<td>M &amp; L Biology SE/TE: 177-178, Case Study #3</td>
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<tr>
<td>Pearson Earth Science SE/TE: 606-607, Exploration Lab</td>
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<tr>
<td>• Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HS-ESS3-6)</td>
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<tr>
<td>M &amp; L Biology SE/TE: 164, Greenhouse Gases 178, Case Study #3, Climate Change</td>
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<tr>
<td>Pearson Earth Science SE/TE: 602-603, Human Impact on Climate Changes</td>
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<tr>
<td><strong>ESS3.A: Natural Resources</strong></td>
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<tr>
<td>• Resource availability has guided the development of human society. (HS-ESS3-1)</td>
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<td><strong>Cause and Effect</strong></td>
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<tr>
<td>• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1)</td>
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<tr>
<td>M &amp; L Biology TE: 107, How Science Works 118, Quick Facts 159, Quick Facts 160, Biology in Depth</td>
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<tr>
<td>Pearson Earth Science SE/TE: 603, exercise 6</td>
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<td><strong>Systems and System Models</strong></td>
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<tr>
<td>• When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6)</td>
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<tr>
<td>M &amp; L Biology TE: 131, How Science Works</td>
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<tr>
<td>Pearson Earth Science SE/TE: 602-603, Human Impact on Climate Changes</td>
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<tr>
<td>Science and Engineering Practices</td>
<td>Disciplinary Core Ideas</td>
<td>Crosscutting Concepts</td>
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<tr>
<td><strong>Using Mathematics and Computational Thinking</strong></td>
<td>▪ All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)</td>
<td><strong>Stability and Change</strong></td>
</tr>
<tr>
<td>Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</td>
<td><strong>Pearson Earth Science SE/TE:</strong> 94-101, Energy and Mineral Resources 102-107, Alternative Energy Sources 113-116, Protecting Resources</td>
<td>▪ Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3),(HS-ESS3-5)</td>
</tr>
<tr>
<td>▪ Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)</td>
<td><strong>M &amp; L Biology SE/TE:</strong> 447a-447b , Unit 4 Project</td>
<td><strong>M &amp; L Biology SE/TE:</strong> 175, Case Study #1 177-179, Case Study #3</td>
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<tr>
<td><strong>M &amp; L Biology SE/TE:</strong> 92, Use Science Graphics 164, Analyzing Data 177, Case Study #3</td>
<td>▪ Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)</td>
<td>▪ Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)</td>
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<tr>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>ESS3.B: Natural Hazards</strong></td>
<td><strong>M &amp; L Biology SE/TE:</strong> 63 and 91, Chapter 3 Mystery 130 and 149, Chapter 5 Mystery</td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.</td>
<td>▪ Natural hazards and other geologic events have shaped the course of human history; they have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)</td>
<td><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
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<tr>
<td>▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1)</td>
<td><strong>ESS3.C: Human Impacts on Earth Systems</strong></td>
<td><strong>Influence of Engineering, Technology, and Science on Society and the Natural World</strong></td>
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<td><strong>M &amp; L Biology SE/TE:</strong> 153 and 183, Chapter 6 mystery 719, Biology &amp; History</td>
<td>▪ The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)</td>
<td>▪ Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3)</td>
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<tr>
<td><strong>Pearson Earth Science SE/TE:</strong> 603, exercise 6</td>
<td><strong>M &amp; L Biology SE/TE:</strong> 156-157, Sustainable Development 158-165, Using Resources Wisely 174-179, Ecology in Action</td>
<td><strong>M &amp; L Biology SE/TE:</strong> 11, The Role of Technology 87, Technology &amp; Biology</td>
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<tr>
<td><strong>M &amp; L Biology SE/TE:</strong> 155, Quick Lab 571a-571b, Unit 6 Project</td>
<td>▪ Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)</td>
<td><strong>Pearson Earth Science SE/TE:</strong> 20-21, People and the Environment 102-107, Alternative Energy Sources 113-115, Protecting Resources 731, STEM Activity</td>
</tr>
<tr>
<td><strong>Pearson Earth Science SE/TE:</strong> 729, STEM Activity</td>
<td><strong>M &amp; L Biology SE/TE:</strong> 158-165, Using Resources Wisely 170-171, Conserving Biodiversity 174-179, Ecology in Action</td>
<td>▪ Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2),(HS-ESS3-4)</td>
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<tr>
<td><strong>ESS3.D: Global Climate Change</strong></td>
<td><strong>Pearson Earth Science SE/TE:</strong> 113-116, Protecting Resources 729, STEM Activity</td>
<td><strong>M &amp; L Biology TE:</strong> 162, Biology in Depth</td>
</tr>
<tr>
<td>▪ Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)</td>
<td><strong>Pearson Earth Science SE/TE:</strong> 177-179, Case Study #3, Climate Change</td>
<td><strong>Pearson Earth Science SE/TE:</strong> 102-107, Alternative Energy Sources 113-116, Protecting Resources 729, STEM Activity 730, STEM Activity</td>
</tr>
<tr>
<td><strong>M &amp; L Biology SE/TE:</strong></td>
<td><strong>Pearson Earth Science SE/TE:</strong> 602, Human Impact on Climate Changes</td>
<td><strong>Pearson Earth Science SE/TE:</strong> 102-107, Alternative Energy Sources 113-116, Protecting Resources 729, STEM Activity 730, STEM Activity</td>
</tr>
</tbody>
</table>

Key: SE = Student Edition; TE = Teacher’s Edition
### Science and Engineering Practices

**Engaging in Argument from Evidence**

Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations). (HS-ESS3-2)

**Pearson Earth Science SE/TE:**
- 729, STEM Activity

#### Connections to Nature of Science

**Scientific Investigations Use a Variety of Methods**

- Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5)

**Pearson Earth Science SE/TE:**
- 25, Understanding Earth

- New technologies advance scientific knowledge. (HS-ESS3-5)

**M & L Biology SE/TE:**
- 87, Technology & Biology

**M & L Biology TE:**
- 87, How Science Works
- 152a, Building Scientific Literacy, STEM
- 162, Biology in Depth

#### Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based on empirical evidence. (HS-ESS3-5)

**M & L Biology SE/TE:**
- 177-179, Case Study #3

**M & L Biology TE:**
- 152a, Building Scientific Literacy, Writing

**Pearson Earth Science SE/TE:**
- 23-24, What is Scientific Inquiry?
- 602, Human Impact on Climate Changes

### Disciplinary Core Ideas

- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

**M & L Biology SE/TE:**
- 175, Case Study #1, Atmospheric Ozone
- 177-179, Case Study #3, Climate Change

**Pearson Earth Science SE/TE:**
- 602, Human Impact on Climate

#### ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-ESS3-2), (secondary HS-ESS3-4)

**M & L Biology SE/TE:**
- A-16 and A-17, Appendix C, Technology & Design

**Pearson Earth Science SE/TE:**
- 94-101, Energy and Mineral Resources
- 102-107, Alternative Energy Sources
- 113-116, Protecting Resources
- 729, STEM Activity

### Crosscutting Concepts

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3)

**M & L Biology TE:**
- 97, Biology in Depth
- 152a, Building Scientific Literacy, STEM
- 153, Building Scientific Literacy, STEM

**Pearson Earth Science SE/TE:**
- 102-107, Alternative Energy Sources
- 113-116, Protecting Resources

- Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2)

**Pearson Earth Science SE/TE:**
- 102-107, Alternative Energy Sources

### Connections to Nature of Science

**Science is a Human Endeavor**

- Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

**M & L Biology SE/TE:**
- 105, Careers & Biology

**M & L Biology TE:**
- 120, How Science Works

**Pearson Earth Science SE/TE:**
- 23-24, What is Scientific Inquiry?

**Science Addresses Questions About the Natural and Material World**

- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2)

**Pearson Earth Science SE/TE:**
- 102-107, Alternative Energy Sources
- 113-116, Protecting Resources

- Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)

**Pearson Earth Science SE/TE:**
- 102-107, Alternative Energy Sources
- 113-116, Protecting Resources

- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

**Pearson Earth Science SE/TE:**
- 102-107, Alternative Energy Sources
- 113-116, Protecting Resources

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Key: SE = Student Edition; TE = Teacher’s Edition
### Science and Engineering Practices

- Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)

### Disciplinary Core Ideas

#### M & L Biology SE/TE:
177-179, Case Study #3

#### Pearson Earth Science SE/TE:
- 23-24, What is Scientific Inquiry?
- 602, Human Impact on Climate Changes
- 601, Customize for Inclusion Students

#### Pearson Earth Science TE:
- 177, Single explanation.
- 179, Multiple lines of evidence supporting a single explanation.

### Crosscutting Concepts

**Connections to other DCIs in this grade-band:**
- HS.PS1.B (HS-ESS3-3); HS.PS3.B (HS-ESS3-2),(HS-ESS3-5); HS.PS3.D (HS-ESS3-2),(HS-ESS3-5);
- HS.LS1.C (HS-ESS3-5); HS.LS2.A (HS-ESS3-2),(HS-ESS3-3); HS.LS2.B (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-6); HS.LS2.C (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-4),(HS-ESS3-6); HS.LS4.D (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); HS.ESS2.A (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-6); HS.ESS2.D (HS-ESS3-5); HS.ESS2.E (HS-ESS3-3)

**Articulation of DCIs across grade-bands:**
- MS.PS1.B (HS-ESS3-3); MS.PS3.B (HS-ESS3-5); MS.PS3.D (HS-ESS3-2),(HS-ESS3-5); MS.LS2.A (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); MS.LS2.B (HS-ESS3-2),(HS-ESS3-3); MS.LS2.C (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); MS.LS4.C (HS-ESS3-3);
- MS.LS4.D (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); MS.ESS2.A (HS-ESS3-1),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-5),(HS-ESS3-6); MS.ESS2.C (HS-ESS3-6); MS.ESS2.D (HS-ESS3-5); MS.ESS2.E (HS-ESS3-3),(HS-ESS3-4); MS.ESS3.A (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); MS.ESS3.B (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6); MS.ESS3.C (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); MS.ESS3.D (HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)

### Common Core State Standards Connections:

**ELA/Literacy - RST.11-12.1**
- Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-4),(HS-ESS3-5)

**RST.11-12.2**
- Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS3-5)

**RST.11-12.7**
- Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ESS3-5)

**RST.11-12.8**
- Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-2),(HS-ESS3-4)

**WHST.9-12.2**
- Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)

**Mathematics - MP.2**
- Reason abstractly and quantitatively. (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)

**MP.4**
- Model with mathematics. (HS-ESS3-3),(HS-ESS3-6)

**HSN-QA.1**
- Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)

**HSN-QA.2**
- Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)

**HSN-QA.3**
- Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)
**HS-PS1 Matter and Its Interactions**

**HS-PS1-1.** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.  

*Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.*  

*[Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]*

PEARSON CHEMISTRY: Students are introduced to the patterns of electrons in atoms in Lesson 5.2 (pp. 134-137). In Lesson 6.1 (pp. 160-166) students are introduced to how the periodic table is organized and that elements with similar properties are in the same column in the periodic table. The classification of elements into groups based on their electron configuration, and the information that can be obtained from the periodic table in order to predict the properties of an element are presented in Lesson 6.2 (pp. 167-173). In Lesson 6.3 (pp. 174-182) periodic trends are explained, including atomic size, electronegativity, and ionization energy.

Students use the periodic table as a model to predict properties of elements: Students use the periodic table to write electron configurations (Q9, p. 173). Students make a 3-D model to relate electronegativity to the position of an element in the periodic table (Small-Scale Lab, p. 184). Students relate color to electron configuration (Small-Scale Lab, p. 200). In the Periodic Patterns STEM Activity (p.906), students use the traditional and alternative forms of the periodic table to predict properties of the elements.

**HS-PS1-2.** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.  

*Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.*  

*[Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]*

PEARSON CHEMISTRY: The five types of chemical reactions are presented in Lesson 11.2 (pp. 356-367). Students learn about reactions in aqueous solutions and the prediction of the formation of a precipitate in Lesson 11.3 (pp. 369-374).

Students construct an explanation for the outcome of simple chemical reactions: Students construct an explanation for the prediction of a precipitate (Q30, p. 373). Students explain the classification of reactions (Performance Tasks, p. 375).

**HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.  

*Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.*  

*[Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.]*

PEARSON CHEMISTRY: In Lesson 7.2 (pp. 201-207) students learn how ionic bonding affects the crystal structure and properties of ionic compounds. In Lesson 7.3 (pp. 209-212) students learn how covalent bonding affects the crystal structure and properties of metals. In Lesson 8.1 (pp. 222-224) students learn how molecular bonding affects the properties of molecular compounds. In Lesson 8.1 (pp. 224-225) students compare the structures and properties of molecule compounds to ionic compounds. In Lesson 8.2 (pp. 236-237) students learn how the strength of covalent bonds is related to bond dissociation energy. In Lesson 8.4 (pp. 247-253) students learn how intermolecular attractions affect the properties of substances. In Lessons 13.1 (p. 420), 13.2 (p. 425) and 13.3 (p. 431) students learn how intermolecular attractions affect the properties of solids, liquids, and gases.

Students conduct an investigation to compare the conductivity of substances (Quick Lab, p. 207). Students plan and conduct investigations to infer differences in polarity through paper chromatography (Small-Scale Lab, p. 254). In the Bulk Properties STEM Activity (p. 907), students plan and conduct an investigation to compare the surface tensions of various liquids.

**HS-PS1-4.** Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.  

*Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.*  

*[Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]*

PEARSON CHEMISTRY: Lesson 8.2 (pp. 236-237) introduces bond dissociation energy. Lesson 17.2 (pp. 562-568) teaches students how to measure and express the enthalpy of a reaction. Collision theory, activation energy, and the comparison of the energy of reactants and products are introduced in Lesson 18.1 (pp. 596-601). Lesson 18.5 (pp. 627-634) teaches students about free energy and spontaneous reactions.

Students develop a model of a spontaneous reaction (TE Performance Task, p. 636).

**HS-PS1-5.** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.  

*Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.*  

*[Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]*

PEARSON CHEMISTRY: Lesson 18.1 (pp. 596-597) explains the effects of collisions on reaction rates. Lesson 18.1 (p. 598) explains the effects of temperature and concentration on reaction rates. Lesson 18.3 (pp. 612-615) explains the effects of concentration and temperature on equilibrium.

Students apply scientific principles and evidence in order to solve the chapter mystery, Explosive Sugar (p. 593). In the Rate of Change During a Reaction STEM Activity (p. 908), students apply evidence from a graph to explain the effects of changing concentration.
<table>
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| HS-PS1-6. **Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.** [Clarification Statement: Emphasis is on the application of Le Chatelier’s Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.]

**PEARSON CHEMISTRY:** The concepts of reversible reactions and equilibrium are presented in Lesson 18.3 (pp. 609-611). Students learn about Le Chatelier’s principle in Lesson 18.3 (pp. 612-615).

Students specify a change in conditions that would affect equilibrium (Q17, 18 p. 615; Q68, p. 638).

| HS-PS1-7. **Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students’ use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include complex chemical reactions.]

**PEARSON CHEMISTRY:** The law of conservation of mass is explained in Lesson 2.4 (p. 50). Students are introduced to balancing chemical equations in Lesson 11.1 (pp. 346-354). Students learn to write and balance the five different types of chemical reactions in Lesson 11.2 (pp. 356-367). Students are introduced to stoichiometry in Lesson 12.1 (pp. 384-389). In Lesson 12.2 (pp. 390-398) students learn how to use mole ratios and molar mass to solve stoichiometric calculations.

Students use mathematical representations to show that atoms and mass are conserved in a chemical reaction; In the sample problems of Lesson 11.1 (pp. 349-353) students balance the atoms in the reactants and products of a chemical reaction. In the sample problems and Lesson Check of Lesson 11.2 (pp. 359-367), students show that the mass of the reactants equals the mass of the products. In the sample problems and Lesson Check of Lesson 12.2 (pp. 391-398), students solve for unknown quantities using mole ratios and molar mass conversions.

| HS-PS1-8. **Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.** [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]

**PEARSON CHEMISTRY:** Nuclear reactions and radioactive decay are introduced in Lesson 25.1 (pp. 876-879). Students learn about the process of radioactive decay in Lesson 25.2 (pp. 880-886). Students learn about fission and fusion in Lesson 25.3 (pp. 888-891).

Students develop a model of radioactive decay in the Small-Scale Lab Radioactivity and Half-Lives (p. 887). Students develop a model of radiation intensity in the Quick Lab Inverse-Square Relationships (p. 896).

**PEARSON PHYSICS:** Relevant content relating to the composition of the nucleus is introduced in Chapter 26, Lesson 2, “Radioactivity” on pages 917-924 and Chapter 26, Lesson 3, “Applications of Nuclear Physics” on pages 925-930.

Students develop models to illustrate changes in the nucleus during radioactive decay in Chapter 26, Lesson 2, Figure 26.6, “Radioactive decay: the conversion of mass to energy in large nuclei” on page 919; Chapter 26, Lesson 2, Guided Example 26.3, “Alpha Decay of Uranium-238” on page 920 and Practice Problems numbers 10 and 12 on page 921; Chapter 26, Lesson 2, Guided Example 26.4, “Beta Decay of Carbon-14” on page 922; and Practice Problems 13 and 15 on page 923.

Students develop models to illustrate nuclear fission in Chapter 26, Lesson 3, Guided Example 26.5, “A Fission Reaction of Uranium-235” on pages 926-927 and Practice Problem 25 on page 927.
### Science and Engineering Practices

**Developing and Using Models**
- Modeling in 9-12 builds on K-8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
  - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-1, HS-PS1-8)

**Pearson Chemistry SE/TE:**
- 887, Small-Scale Lab: Radioactivity and Half-Lives
- 896, Quick Lab: Inverse-Square Relationships

**Pearson Chemistry TE:**
- 636, Performance Task
- 889, Teacher Demo
- 898, Performance Tasks

**Pearson Physics SE/TE:**
- 911-916, The Nucleus
- 919-920, Nuclear Decay and Mass-Energy Equivalence
- 926-928, Nuclear Fission
- 929-930, Nuclear Fusion
- 935, exercises 35 and 36
  - Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

**Pearson Chemistry SE/TE:**
- 184, Small-Scale Lab: Periodicity in Three Dimensions
- 906, STEM Activity

**Planning and Carrying Out Investigations**
- Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
  - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)

**Pearson Chemistry SE/TE:**
- 200, Small-Scale Lab: Electron Configurations of Ions
- 254, Small-Scale Lab: Paper Chromatography of Food Dyes
- 907, STEM Activity

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<th>Disciplinary Core Ideas</th>
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### PS1.A: Structure and Properties of Matter
- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)

**Pearson Chemistry SE/TE:**
- 105-109, Structure of the Nuclear Atom
- 128-132, Revising the Atomic Model
- 134-137, Electron Arrangement in Atoms

**Pearson Physics SE/TE:**
- 884-885, The Nuclear Model
- 888, Bohr’s Model of the Hydrogen Atom
  - The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1, HS-PS1-2)

**Pearson Chemistry SE/TE:**
- 162, Today’s Periodic Table
- 162, Today’s Periodic Table
- 168-169, Figure 6.9: Periodic Table
- 170, Electron Configurations in groups
- 171, Figure 6.11: Representative Elements
- 172, Figure 6.13: Electron Configurations
- 173, Sample Problem 6.1
- 173, Lesson Check 6.2: Q12, 13, 15, 16
- 906, STEM Activity
  - The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3, secondary to HS-PS2-6)

**Pearson Chemistry SE/TE:**
- 200, Small-Scale Lab: Electron Configurations of Ions
- 201-207, Ionic Bonds and Ionic Compounds
- 207, Quick Lab: Solutions Containing Ions
- 209-212, Bonding in Metals
- 236-237, Bond Dissociation Energies
- 238, Quick Lab: Strengths of Covalent Bonds
- 239, Powder Coating
- 250-251, Attraction Between Molecules
- 252, Intermolecular Attractions and Molecular Properties
- 252, Figure 8.28: Diamond
- 253, Table 8.5: Characteristics of Ionic and Molecular Compounds
- 420, Kinetic Theory and a Model for Gases
- 425, A Model for Liquids
- 431, A Model for Solids

**Pearson Chemistry TE:**
- 210, Teacher Demo
- 213, Performance Tasks
- 235, Paramagnetism
- 250, Teacher Demo
- 251, Apply Concepts
- 251, Draw a Diagram
- 252, Teacher Demo

### Patterns
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1, HS-PS1-2, HS-PS1-3, HS-PS1-5)

**Pearson Chemistry SE/TE:**
- 174-182, Periodic Trends
- 200, Small-Scale Lab: Electron Configurations of Ions
- 201-207, Ionic Bonds and Ionic Compounds
- 209-212, Bonding in Metals
- 236-237, Bond Dissociation Energies
- 238, Quick Lab: Strengths of Covalent Bonds
- 361, Activity Series of Metals
- 366-367, Classifying Reactions
- 593, Chapter Mystery
- 596-597, Collision Theory
- 598, Factors Affecting Reaction Rates
- 612-615, Factors Affecting Equilibrium
- 906, STEM Activity

**Pearson Chemistry TE:**
- 185, Performance Tasks

### Energy and Matter
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8)

**Pearson Chemistry SE/TE:**
- 876-879, Types of radiation
- 880-881, Nuclear Stability and Decay
- 899, Math Tutor

**Pearson Chemistry TE:**
- 876, Focus on ELL
- 879, Evaluate

**Pearson Physics SE/TE:**
- 917-924, Lesson 26.2: Radioactivity
- 926-928, Nuclear Fission
- 929-930, Nuclear Fusion
  - The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

**Pearson Chemistry SE/TE:**
- 50, Conservation of Mass
- 346-354, Balancing Chemical Equations
- 356-367, Types of Chemical Reactions
- 369-373, Reactions in Aqueous Solution
- 384-389, The Arithmetic of Equations
- 390-398, Chemical Calculations
Using Mathematics and Computational Thinking
Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
- Use mathematical representations of phenomena to support claims. (HS-PS1-7)

Pearson Chemistry SE/TE:
352-353, Describing Chemical Reactions: Sample Problems 11.2, 11.3
354, Describing Chemical Reactions: Lesson Check Q10, 11
359-365, Types of Chemical Reactions: Samples Problems 11.4 - 11.7
367, Types of Chemical Reactions: Lesson Check Q21, 23
908, STEM Activity

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)

Pearson Chemistry SE/TE:
593, Chapter Mystery
598, Figure 18.6
641, Q111

Pearson Chemistry TE:
598, Critical Thinking

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2)

Pearson Chemistry SE/TE:
373, Q30

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<td><strong>Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)</strong></td>
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<td><strong>PS1.B: Chemical Reactions</strong></td>
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<td>Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4),(HS-PS1-5)</td>
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<td><strong>Pearson Chemistry SE/TE:</strong></td>
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<td>236-237, Bond Dissociation Energies 596-597, Collision Theory 598, Factors Affecting Reaction Rates 612-615, Factors Affecting Equilibrium 909, STEM Activity</td>
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<td>599, Teacher Demo</td>
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<td><strong>PearsonChem.com:</strong></td>
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<tr>
<td>Kinetic Art: Collision Theory</td>
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<td>In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)</td>
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<td><strong>Pearson Chemistry SE/TE:</strong></td>
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<td>609-611, Reversible Reactions 612-615, Factors Affecting Equilibrium 909, STEM Activity</td>
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<td><strong>Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4)</strong></td>
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<td><strong>Pearson Chemistry SE/TE:</strong></td>
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<tr>
<td>562-568, Measuring and Expressing Enthalpy Changes 594-601, Rates of Reaction 627-634, Free Energy and Entropy</td>
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<tr>
<td><strong>Stability and Change</strong></td>
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<td>Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)</td>
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<td><strong>Pearson Chemistry SE/TE:</strong></td>
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<td>612-615, Factors Affecting Equilibrium 627-634, Free Energy and Entropy 908, STEM Activity</td>
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Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7)

Pearson Chemistry SE/TE:

Pearson Chemistry TE:
349, Apply Concepts

Key: SE = Student Edition; TE = Teacher’s Edition
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<td>- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</td>
<td>- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)</td>
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**Pearson Chemistry SE/TE:**
592, 641 Chapter Mystery: Explosive Sugar

| PS1.C: Nuclear Processes | |
|--------------------------| |
| - Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8) | |

**Pearson Chemistry SE/TE:**
876, Radioactivity
877-879, Types of Radiation
877, Figure 25.2: Alpha Decay
878, Figure 25.3: Beta Decay
880-881, Nuclear Stability and Decay
882-884, Half-Life
885-886, Transmutation Reactions
888, Nuclear Fission
888, Figure 25.11: Fission of Uranium
891, Nuclear Fusion
891, Figure 25.14: Fusion in the Sun

**Pearson Chemistry TE:**
877, Explain-Radioactivity
877, Misconception Alert
877, Explain -Types of Radiation
878, Explore -Teacher Demo
878, Check for Understanding
889, Explain-Nuclear Fission
889, Explore -Teacher Demo

**Pearson Physics SE/TE:**
917-924, Lesson 26.2: Radioactivity
926-928, Nuclear Fission
929-930, Nuclear Fusion
935, exercises 35 and 36

Key: SE = Student Edition; TE = Teacher’s Edition
### Science and Engineering Practices

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<td><strong>Pearson Chemistry SE/TE:</strong> 612-615, Factors Affecting Equilibrium</td>
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**Connections to other DCIs in this grade-band:**

- HSS1.C (HS-PS1-1), (HS-PS1-2), (HS-PS1-4), (HS-PS1-7); HSS2.B (HS-PS1-7); HSS3.A (HS-PS1-4), (HS-PS1-5), (HS-PS1-8); HSS3.B (HS-PS1-4), (HS-PS1-6), (HS-PS1-7), (HS-PS1-8); HSS3.C (HS-PS1-8); HSS3.D (HS-PS1-4), (HS-PS1-8); HSS1.A (HS-PS1-8); HSS1.C (HS-PS1-8), HSS2.C (HS-PS1-2), (HS-PS1-3); HSS3.A (HS-PS1-8); HSS3.C (HS-PS1-8)

**Articulation to DCIs across grade-bands:**

- MS.PS1.A (HS-PS1-1); MS.PS1-2), (HS-PS1-3), (HS-PS1-4), (HS-PS1-5), (HS-PS1-7), (HS-PS1-8); MS.PS1.B (HS-PS1-1), (HS-PS1-2), (HS-PS1-4), (HS-PS1-5), (HS-PS1-6), (HS-PS1-7), (HS-PS1-8); MS.PS1.C (HS-PS1-8); MS.PS2.B (HS-PS1-3), (HS-PS1-4), (HS-PS1-5), (HS-PS1-6); MS.PS3.A (HS-PS1-5); MS.PS3.B (HS-PS1-5); MS.PS3.D (HS-PS1-4); MS.LS1.A (HS-PS1-4), (HS-PS1-7); MS.LS2.B (HS-PS1-7); MS.LS2.A (HS-PS1-7), (HS-PS1-8)

**Common Core State Standards Connections:**

**ELA/Literacy**

- **RST.9-10.7**
  - Translate quantitative or technical information expressed in words into a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. (HS-PS1-1)

- **RST.11-12.1**
  - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3), (HS-PS1-5)

- **WHST.11-12.2**
  - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-PS1-2), (HS-PS1-5)

- **WHST.11-12.5**
  - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2)

- **WHST.11-12.7**
  - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3), (HS-PS1-6)

- **WHST.11-12.8**
  - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)

- **WHST.11-12.9**
  - Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)

**SL.11-12.5**

- Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)

**Mathematics**

- **MP.2**
  - Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS1-7)

- **MP.4**
  - Model with mathematics. (HS-PS1-4), (HS-PS1-8)

- **HSN.QA.1**
  - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2), (HS-PS1-3), (HS-PS1-4), (HS-PS1-5), (HS-PS1-7), (HS-PS1-8)

- **HSN.QA.2**
  - Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4), (HS-PS1-7), (HS-PS1-8)

- **HSN.QA.3**
  - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2), (HS-PS1-3), (HS-PS1-4), (HS-PS1-5), (HS-PS1-7), (HS-PS1-8)

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**Key:** SE = Student Edition; TE = Teacher’s Edition
**HS-PS2 Motion and Stability: Forces and Interactions**

Students who demonstrate understanding can:

**HS-PS2.1.** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]

PEARSON PHYSICS: Chapter 5, “Newton’s Laws of Motion” (pp. 153-176) equips students with the definitions and mathematical tools required to compare data from to the expected results of Newton’s Second Law. Students apply Newton’s Second Law in Chapter 5, “Physics Lab—Static and Kinetic Friction” on page 178.

In the “Skateboarding and Newton’s Second Law of Motion” STEM activity (pp. S1-S2), students make measurements of the motion of a skateboarder down a ramp and analyze and interpret the resulting data to explain how it supports Newton’s second law.

**HS-PS2.2.** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. [Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] [Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.]

PEARSON PHYSICS: Relevant content relating to conservation of momentum is introduced in Chapter 7, Lesson 3, “Conservation of Momentum” on pages 242-247; Chapter 7, Lesson 4, “Collisions” on pages 248-256; Chapter 7, “Physics Lab: Momentum Conservation during a Collision” on page 258; and Chapter 8, Lesson 3, “Torque” on pages 281-289.

Students use mathematical representations to support conservation of momentum of a system in Guided Example 7.7, “Tippy Canoe” and Practice Problems 30-33 on pages 244-245; Lesson Check 7.3, exercises 39-41 on page 247; Mastering Physics Problem Solving 7.94, 7.95, 7.96, and 7.97; and Mastering Physics Lesson Check 7.39 and 7.41.

**HS-PS2.3.** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.]

PEARSON PHYSICS: Students analyze the forces present during an automobile collision in the Chapter 5, Assessment, Read, Reason, and Respond on page 186. Additional relevant content appears in Chapter 7, Lesson 2, particularly in the section “Increasing the time of impact decreases the force” on pages 240-241.

**HS-PS2.4.** Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.] [Assessment Boundary: Assessment is limited to systems with two objects.]

PEARSON PHYSICS: Newton’s and Coulomb’s Laws are introduced in Chapter 9, Lesson 1, “Newton’s Law of Universal Gravity” (pp. 307-312) and in Chapter 19, Lesson 2, “Electric Force” (pp. 683-688).


**HS-PS2.5.** Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.]

PEARSON PHYSICS: Electric current and batteries are defined in Chapter 21, Lesson 1, “Electric Current, Resistance, and Semiconductors” (pp. 745-750). Chapter 22, Lesson 2, “Magnetism and Electric Currents” (pp. 789-795) and Chapter 23, Lesson 1, “Electricity from Magnetism” in the section titled “Motion in a magnetic field can induce a current” (pp. 825-827) describe the relationship between electric current and magnetic field.

Students conduct an investigation to observe the generation of electric current by a changing magnetic field in the “Electromagnetic Induction” Physics Lab on p. 842.
HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]

PEARSON CHEMISTRY: Explanations and models of ionic compounds that explain their properties are located throughout Chapter 7 (pp. 192-219). The molecular structure of carbohydrates is introduced in Lesson 24.2 (pp. 841-843). The molecular structure of amino acids and proteins is introduced in Lesson 24.3 (pp. 844-848). The molecular structure of lipids is introduced in Lesson 24.4 (pp. 850-853). The molecular structure of nucleic acids is introduced in Lesson 24.5 (pp. 854-861). Students learn about ions and ionic bonding in Lessons 7.1 and 7.2 (pp. 194-208). The relationship of the structure of ionic compounds to the properties of ionic compounds is explained in Lesson 7.2 (pp. 204-207). The relationship of the molecular structure of metals to the properties of metals is explained in Lesson 7.3 (pp. 209-212). Students learn about the structure of molecular compounds in Lesson 8.1 and 8.2 (pp. 222-238). The relationship of bond polarity and intermolecular attractions to the properties of molecular compounds is explained in Lesson 8.4 (pp. 247-253). The correlation between the structure and properties of water is explained in terms of electrical forces in Lesson 15.1 (pp. 488-492).

Students communicate scientific and technical information about the molecular-level structure: Students relate the properties and structures of starch and cellulose (p. 843, Q13). Students relate the properties and structure of metals (p. 212, Q26; p. 216, Qs 81, 83; p. 217, Q94). Students relate the properties and structure of polar molecules (p. 257, Q68). Students relate the properties and structure of water (p. 493, Q7).

PEARSON PHYSICS: Electrical conductivity of materials is discussed in Chapter 19, Lesson 1, “Electric Charges and Forces” (pp. 681-682) and in Chapter 21, Lesson 1, “Electric Current, Resistance, and Semiconductors” (pp. 752 and 754).

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
</table>
| **Planning and Carrying Out Investigations** | **PS2.A: Forces and Motion**
- Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) | **Patterns**
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4) |
| **Pearson Physics SE/TE:**
817, Inquiry Lab: What are the components of a simple electric motor?  
842, Physics Lab: Electromagnetic Induction S1-S2, STEM Activity | **Pearson Physics SE/TE:**
153-158, Newton’s Second Law  
S1-S2, STEM Activity | **Pearson Physics SE/TE:**
307, Gravity affects everything in the universe  
313-319, Applications of Gravity  
683-688, Electric Force |
| **Analyzing and Interpreting Data** | **Pearson Physics SE/TE:**
242-247, Conservation of Momentum | **Cause and Effect**
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1),(HS-PS2-5) |
| **Pearson Physics SE/TE:**
817, Inquiry Lab: What are the components of a simple electric motor?  
842, Physics Lab: Electromagnetic Induction S1-S2, STEM Activity | **Pearson Physics SE/TE:**
242-247, Conservation of Momentum  
248-256, Collisions  
258, Momentum Conservation During a Collision | **Pearson Physics SE/TE:**
178, Physics Lab: Static and Kinetic Friction  
S1-S2, STEM Activity |
| **PEARSON PHYSICS:** | **PEARSON PHYSICS:**
178, Physics Lab: Static and Kinetic Friction S1-S2, STEM Activity | **PEARSON PHYSICS:**
257, Physics & You: Take it Further – Design |

Key: SE = Student Edition; TE = Teacher’s Edition
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<tr>
<td>Using Mathematics and Computational Thinking</td>
<td>PS2.B: Types of Interactions</td>
<td>Systems and System Models</td>
</tr>
<tr>
<td>Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</td>
<td>- Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)</td>
<td></td>
</tr>
<tr>
<td>Pearson Physics SE/TE: 244-245, Guided Example 7.7 247, exercises 39-41 696, Investigating Coulomb’s Law</td>
<td>Pearson Physics SE/TE: 307-312, Newton’s Law of Universal Gravitation 683-688, Electric Force 696, Physics Lab: Investigating Coulomb’s Law</td>
<td>- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6),(secondary to HS-PS1-1),(secondary to HS-PS1-3)</td>
<td>- Structure and Function</td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</td>
<td>Pearson Physics SE/TE: 201-203, Formation of Ionic Compounds 204-206, Properties of Ionic Compounds 209-210, Metallic Bonds and Metallic Properties 226-231, The Octet Rule in Covalent Bonding 232-233, Coordinate Covalent Bonds 240-241, Molecular Orbitals 242-243, VSEPR Theory 244-246, Hybrid Orbitals 247-250, Bond Polarity 250-251, Attractions Between Molecules 252, Intermolecular Attractions and Molecular Properties 488-491, Water in the Liquid State 489, Figure 15.2: Polarity of H2O 491, Quick Lab: Surface Tension 492-493, Water in the Solid State 494-495, Solutions</td>
<td>- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)</td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information in 9-12 builds on K-8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.</td>
<td>Pearson Chemistry TE: 213, Performance Tasks: Quenching 255, Performance Tasks: What Did It?</td>
<td>- Pearson Chemistry SE/TE:</td>
</tr>
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<td>(continued) Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)</td>
<td>(continued) Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6),(secondary to HS-PS1-1),(secondary to HS-PS1-3)</td>
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<tr>
<td>Pearson Physics SE/TE: 735, Physics &amp; You: How Things Work</td>
<td>Pearson Physics SE/TE: 681-682, Not all materials are good conductors 752-753, A wire’s resistance is affected by several factors 754, Semiconductors</td>
<td></td>
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<tr>
<td><strong>Connections to Nature of Science</strong></td>
<td><strong>PS3.A: Definitions of Energy</strong></td>
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<tr>
<td>Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena</td>
<td>...and “electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5)</td>
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<tr>
<td>▪ Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4)</td>
<td>Pearson Physics SE/TE: 745-750, Electric Current</td>
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<tr>
<td>Pearson Physics SE/TE: 9, Well-tested hypotheses lead to theories</td>
<td><strong>ETS1.A: Defining and Delimiting Engineering Problems</strong></td>
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<tr>
<td>▪ Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4)</td>
<td>▪ Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3)</td>
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<tr>
<td><strong>PS7</strong>-<strong>S8, STEM Activity</strong></td>
<td>▪ Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS2-3)</td>
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<td>Pearson Physics SE/TE: 745-750, Electric Current S7-S8, STEM Activity</td>
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### Connections to other DCIs in this grade-band:
- **HS.PS3.A** (HS-PS2-4), (HS-PS2-5); **HS.PS3.C** (HS-PS2-1); **HS.PS4.B** (HS-PS2-5); **HS.ESS1.B** (HS-PS2-4); **HS.ESS2.A** (HS-PS2-5)

### Articulation to DCIs across grade-bands:
- **MS.PS1.A** (HS-PS2-5); **MS.PS2.A** (HS-PS2-1), (HS-PS2-2), (HS-PS2-3); **MS.PS2.B** (HS-PS2-4), (HS-PS2-5), (HS-PS2-6); **MS.PS3.C** (HS-PS2-1), (HS-PS2-2), (HS-PS2-3); **MS.ESS1.B** (HS-PS2-4), (HS-PS2-5)

### Common Core State Standards Connections:
#### ELA/Literacy -
- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS2-1), (HS-PS2-6)
- **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-PS2-6)
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS2-3), (HS-PS2-5)
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS2-5)
- **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1), (HS-PS2-5)

#### Mathematics -
- **MR.2** Reason abstractly and quantitatively. (HS-PS2-1), (HS-PS2-2), (HS-PS2-4)
- **MR.4** Model with mathematics. (HS-PS2-1), (HS-PS2-2), (HS-PS2-4)
- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1), (HS-PS2-2), (HS-PS2-4), (HS-PS2-5), (HS-PS2-6)
- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1), (HS-PS2-2), (HS-PS2-4), (HS-PS2-5), (HS-PS2-6)
- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1), (HS-PS2-2), (HS-PS2-4), (HS-PS2-5), (HS-PS2-6)
- **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1), (HS-PS2-4)
- **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1), (HS-PS2-4)
- **HSA-CED.A.1** Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1), (HS-PS2-2)
- **HSA-CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-PS2-1), (HS-PS2-2)
- **HSA-CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1), (HS-PS2-2)
- **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-PS2-1)
- **HSS-ID.A.1** Represent data with plots on the real number line (dot plots, histograms, and box plots). (HS-PS2-1)
HS-PS3 Energy

Students who demonstrate understanding can:

**HS-PS3-1.** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]

**PEARSON PHYSICS:** Chapter 6, Lesson 3, “Conservation of Energy” (pp. 206-211) introduces the computational model for conservation of mechanical energy. The transfer of thermal energy is discussed quantitatively in Chapter 10, Lesson 3, “Heat Capacity” (pp. 358-366) and the Chapter 10, Physics Lab: Investigating Specific Heat Capacity” on page 376.


**HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields. [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]

**PEARSON CHEMISTRY:** Atomic spectra and the quantization of energy are explained in Lesson 5.3 (pp. 138-148). The kinetic theory of gases is introduced in Lesson 13.1 (pp. 420-424). The effects of the energy of moving particles on the properties of liquids are explained in Lesson 13.2 (pp. 425-430). The gas laws and the energy of gas particles are discussed in Lesson 14.2 (pp. 456-463). Nuclear Radiation is introduced in Lesson 25.1 (pp. 876-879).

Students develop and use a model of atomic emission spectra in the Small-Scale Lab Atomic Emission Spectra (p. 149). Students develop and use a model to explain kinetic theory in the Performance Task Comic Strip (TE p. 442).

**PEARSON PHYSICS:** The relationship between temperature and the motion of particles is established in Chapter 10, Lesson 1, “Temperature, Energy, and Heat” (pp. 343-345).

Chapter 6, Lesson 2, “Work and Energy—Potential Energy” (pp. 202-204) and Chapter 9, Lesson 1, “Newton’s Law of Universal Gravity—Gravity is a force field” (p. 312) discuss the storage of energy in gravitational potential fields. Energy storage in electric fields is covered in Chapter 20, Lesson 2, “Electrical Potential Energy and Electric Potential” (pp. 718-719). Energy transfer by waves is introduced in Chapter 13, Lesson 3, “Wave and Wave Properties” (pp. 470-471).

Students use models of energy at the macroscopic scale in Chapter 10, Figure 10.3 “Establishing thermal equilibrium” on page 345; Chapter 13, Lesson 1, Figures 13.16 and 13.17 on page 471; Chapter 14, Lesson 1, Figure 14.2 “Wave properties of sound” on page 494.

**HS-PS3-3.** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

**PEARSON CHEMISTRY:** Electrochemical processes and voltaic cells are explained in Lesson 21.1 (pp. 728-736). Electrolytic cells are explained in Lesson 21.3 (pp. 745-751).

Students build a device to convert chemical energy to electrical energy in the Chemistry & You A Lemon Battery (p. 744).


The conversion of electric energy to other forms is discussed in Chapter 21, Lesson 3, “Power and Energy in Electric Circuits” on pages 769-771; Chapter 23, Lesson 2, “Electric Generators and Motors” on pages 828-831;

Students build a device that converts mechanical energy into thermal energy in the Chapter 11, Physics Lab: “The Mechanical Equivalent of Heat” on page 408. Students build and refine a device that converts mechanical into electrical energy in the Chapter 23, Physics Lab: “Electromagnetic Induction” on page 842.

In the “Solar Oven” STEM Activity (pp. S3-S4), students design, build, test, and refine an oven that converts solar energy to thermal energy to cook food.

Key: SE = Student Edition; TE = Teacher’s Edition
A Correlation of the Pearson High School Science Program  
(Biology, Chemistry, Physics, and Earth Science)  
to the 2014 Oregon Science Standards (NGSS)

HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]

PEARSON CHEMISTRY: Thermochemistry, heat, and heat capacity are introduced in Lesson 17.1 (pp. 556-561).

PEARSON PHYSICS: Relevant content relating to the distribution of energy within a closed system is introduced in Chapter 10, Lesson 1, “Temperature, Energy, and Heat” (pp. 343-349); Chapter 10, Lesson 3, Guided Example 10.9 “Cooling Off” (pp. 364-365); Chapter 11, Lesson 1, “The First Law of Thermodynamics” (pp. 385-392); Chapter 11, Lesson 2, “Thermal Processes” on (pp. 393-400); and Chapter 11, Lesson 3, “The Second and Third Laws of Thermodynamics” on (pp. 400-406).

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other, including an explanation of how the change in energy of the objects is related to the change in energy of the field.] [Assessment Boundary: Assessment is limited to systems containing two objects.]

PEARSON PHYSICS: Chapter 20, Lesson 1, “The Electric Field” (pp. 705-717) and Chapter 20, Lesson 2, “Electric Potential Energy and Electric Potential” (pp. 718-727) discuss the electric field, the forces due to an electric field, and changes in energy of an electric field. Magnetic fields and magnetic field interactions are covered in Chapter 22, Lesson 1, “Magnets and Magnetic Fields” on pages 783-788; Chapter 22, Lesson 2, “Magnetism and Electric Currents” on pages 789-795; Chapter 22, Lesson 3, “The Magnetic Force” on pages 796-800; and Chapter 23, Lesson 4, “Electricity from Magnetism” on pages 817-827.

Students develop a model of objects interacting through an electric field in Chapter 20 Inquiry Lab: “How can electric fields be made stronger?” on page 705. Students use models of two objects interacting through electric fields in Chapter 20, Lesson 1, “Electric field lines for systems of charges” on page 714 and Figure 20.12 “Charging by induction” on page 717.

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
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<tbody>
<tr>
<td>Developing and Using Models</td>
<td>PS3.A: Definitions of Energy</td>
<td>Cause and Effect</td>
</tr>
<tr>
<td>Modeling in 9-12 builds on K-8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.</td>
<td>• Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. There is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1),(HS-PS3-2)</td>
<td>• Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5)</td>
</tr>
<tr>
<td>Pearson Chemistry SE/TE:</td>
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<td>Pearson Physics SE/TE:</td>
</tr>
<tr>
<td>149, Atomic Emission Spectra</td>
<td>138-149, Atomic Emission Spectra and the Quantum Mechanical Model</td>
<td>675-682, Electric Charge</td>
</tr>
<tr>
<td>442, Performance Task: Comic Strip</td>
<td>425-430, The Nature of Liquids</td>
<td>783-788, Magnetism and Magnetic Fields</td>
</tr>
<tr>
<td>PearsonChem.com:</td>
<td>436-441, Changes of State</td>
<td>Systems and System Models</td>
</tr>
<tr>
<td>Kinetic Art: The Hydrogen Emission Spectra</td>
<td>454, Temperature</td>
<td>• When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4)</td>
</tr>
<tr>
<td>494, exercises 42-45</td>
<td>460-461, Gay-Lussac’s Law</td>
<td>562-563, Calorimetry</td>
</tr>
<tr>
<td>714, Figure 20.7</td>
<td>475, Small-Scale Lab: Diffusion</td>
<td>Pearson Physics SE/TE:</td>
</tr>
<tr>
<td>717, Figure 20.12</td>
<td>876-879, Nuclear Radiation</td>
<td>385-392, The First Law of Thermodynamics</td>
</tr>
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<td></td>
<td>Pearson Chemistry TE Only:</td>
<td>400-406, The Second and Third Laws of Thermodynamics</td>
</tr>
<tr>
<td></td>
<td>454, Extend, Balls in Sports</td>
<td>459, Critical Thinking</td>
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Key: SE = Student Edition; TE = Teacher’s Edition
A Correlation of the Pearson High School Science Program
(Biology, Chemistry, Physics, and Earth Science) to the 2014 Oregon Science Standards (NGSS)

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<th>Science and Engineering Practices</th>
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<tr>
<td>Planning and Carrying Out Investigations</td>
<td>(continued) Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1),(HS-PS3-2)</td>
<td>• Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)</td>
</tr>
<tr>
<td>Using Mathematics and Computational Thinking</td>
<td>385-387, The First Law of Thermodynamics 718-727, Electrical Potential Energy and Electric Potential</td>
<td>• Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2)</td>
</tr>
<tr>
<td>Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponents and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</td>
<td>• At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3)</td>
<td>Pearson Chemistry SE/TE: 138-149, Atomic Emission Spectra and the Quantum Mechanical Model 420-424, The Nature of Gases 425-430, The Nature of Liquids</td>
</tr>
<tr>
<td>• Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)</td>
<td>Pearson Physics SE/TE: 197-201, Kinetic Energy</td>
<td>Pearson Physics SE/TE: 206-211, Conservation of Energy</td>
</tr>
<tr>
<td>364-365, Guided Example 10.9</td>
<td>475, exercise 41 718-720, Electrical Potential Energy and Electric Potential</td>
<td>723, Energy is conserved in electrical systems</td>
</tr>
<tr>
<td>366, exercise 42-45</td>
<td>749, A battery produces a voltage difference 765-771, Power and Energy in Electric Circuits</td>
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</tr>
<tr>
<td>376, Physics Lab: Investigating Specific Heat Capacity 705, Inquiry Lab</td>
<td>53-54, STEM Activity</td>
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</tr>
<tr>
<td>MasteringPhysics:</td>
<td>These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as either motions of particles or energy stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)</td>
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</tr>
<tr>
<td></td>
<td>534, Light behaves like a wave and a particle 536-537, Light is an electromagnetic wave 718-720, Electrical Potential Energy and Electric Potential</td>
<td>750, Electrons move very slowly through wires</td>
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<td>750, Electrons move very slowly through wires</td>
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<td>Constructing Explanations and Designing Solutions</td>
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<tr>
<td>Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</td>
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<tr>
<td>-</td>
<td>PS3.B: Conservation of Energy and Energy Transfer</td>
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<td>- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)</td>
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<tr>
<td></td>
<td>- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4)</td>
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<td></td>
<td>Pearson Chemistry SE/TE: 750-751, Using Electrolysis in Metal Processing</td>
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<td>- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)</td>
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<td>- The availability of energy limits what can occur in any system. (HS-PS3-1)</td>
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<tr>
<td></td>
<td>Pearson Physics SE/TE: 400-406, The Second and Third Laws of Thermodynamics</td>
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<td></td>
<td>Connections to Engineering, Technology, and Applications of Science</td>
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<td>Influence of Science, Engineering, and Technology on Society and the Natural World</td>
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<tr>
<td></td>
<td>- Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3)</td>
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<tr>
<td></td>
<td>Pearson Chemistry SE/TE: 732-736, Using Voltaic Cells as Energy Sources 750, Using Electrolysis in Metal Processing</td>
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<td></td>
<td>Connections to Nature of Science</td>
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<td></td>
<td>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</td>
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<td></td>
<td>- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)</td>
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<td><strong>PS3.C: Relationship Between Energy and Forces</strong></td>
<td>• When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)</td>
<td></td>
</tr>
<tr>
<td><strong>Pearson Physics SE/TE:</strong></td>
<td>718-727, Electrical Potential Energy and Electric Potential 783-788, Magnetism and Magnetic Fields</td>
<td></td>
</tr>
<tr>
<td><strong>PS3.D: Energy in Chemical Processes</strong></td>
<td>• Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4)</td>
<td></td>
</tr>
<tr>
<td><strong>Pearson Chemistry SE/TE:</strong></td>
<td>728-736, Voltaic Cells 732-736, Using Voltaic Cells as Energy Sources</td>
<td></td>
</tr>
<tr>
<td><strong>Pearson Physics SE/TE:</strong></td>
<td>385-392, The First Law of Thermodynamics 400-406, The Second and Third Laws of Thermodynamics 750, Resistance 768, Resistors get hot and dissipate power</td>
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</tbody>
</table>

**ETS1.A: Defining and Delimiting Engineering Problems**

• Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. *(secondary to HS-PS3-3)*

**Pearson Physics SE/TE:**

### Connections to other DCIs in this grade-band:

- **HS.PS1.A** (HS-PS3-2); **HS.PS1.B** (HS-PS3-1),(HS-PS3-2); **HS.PS2.B** (HS-PS3-2),(HS-PS3-5); **HS.LES2.B** (HS-PS3-1); **HS.LESS2.A** (HS-PS3-1),(HS-PS3-4); **HS.LESS3.A** (HS-PS3-3)

### Articulation to DCIs across grade-bands:

- **MS.PS1.A** (HS-PS3-2); **MS.PS2.B** (HS-PS3-2),(HS-PS3-5); **MS.PS3.A** (HS-PS3-1),(HS-PS3-2),(HS-PS3-3); **MS.PS3.B** (HS-PS3-1),(HS-PS3-3),(HS-PS3-4); **MS.PS3.C** (HS-PS3-2), (HS-PS3-5); **MS.ESS2.A** (HS-PS3-1),(HS-PS3-4)

### Common Core State Standards Connections:

#### ELA/Literacy -

- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-PS3-4)*
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. *(HS-PS3-3),(HS-PS3-4),(HS-PS3-5)*
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *(HS-PS3-4),(HS-PS3-5)*
- **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. *(HS-PS3-4),(HS-PS3-5)*
- **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. *(HS-PS3-1),(HS-PS3-2),(HS-PS3-5)*

#### Mathematics -

- **MP.2** Reason abstractly and quantitatively. *(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5)*
- **MP.4** Model with mathematics. *(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5)*
- **H.NA.Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. *(HS-PS3-1),(HS-PS3-3)*
- **H.NA.Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. *(HS-PS3-1),(HS-PS3-3)*
- **H.NA.Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-PS3-1),(HS-PS3-3)*
HS-PS4 Waves and their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

**HS-PS4-1.** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

**PEARSON CHEMISTRY:** Electromagnetic radiation and frequency, wavelength and speed of light are introduced in Lesson 5.3 (pp. 138-141).

Students use mathematical representations to study the relationships of the frequency, wavelength, and speed of light (p. 141; p. 146, Q3; p. 148, Q24; p. 149)

**PEARSON PHYSICS:** Chapter 13, Lesson 3, “Waves and Wave Properties” (pp. 470-475) and Lesson 4, “Interacting Waves” (pp. 476-482) discuss the properties of waves and mathematical representations of those properties. Students explore mathematical representations of wave properties in the Chapter 13, Physics Lab: “Standing Waves on a Coiled Spring” on page 484. Sound waves and variation in the speed of waves in different materials is introduced in Chapter 14, Lesson 1, “Sounds Waves and Beats” on pages 493-495.

Students use mathematical representations in an investigation to determine the speed of sound in air in the Chapter 14, Physics Lab: “Determining the Speed of Sound” on page 521. In the “Seismic Mapping” STEM Activity (pp. S5-S6), students use a graphical diagram to represent the paths of seismic waves traveling through media of various densities below the surface of the Earth and the changes in wave speed and frequency that occur as the wave reflects or refracts at boundaries between media.

**HS-PS4-2.** Evaluate questions about the advantages of using a digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]

**PEARSON PHYSICS:** Some mechanisms for digital transmission and storage of information are described in Chapter 16, Lesson 1, Physics & You: Technology on page 568; Chapter 18, Physics & You: Technology on page 653. Chapter 21, Lesson 1, “Transistors are the basis of modern computers” (p. 756) describes the role of transistors and microchips in handling digital information.

**HS-PS4-3.** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]

**PEARSON CHEMISTRY:** Wave properties and electromagnetic radiation are explained in Lesson 5.3 (pp. 138-142). Students learn about photons and how light acts as a particle in Lesson 5.3 (p. 142-144; p. 148, Q20).

**PEARSON PHYSICS:** Relevant content on the wave and particle models of electromagnetic radiation is introduced in Chapter 15, Lesson 1, “The Nature of Light—Light behaves like a wave and a particle” (p. 534); Chapter 18, Lesson 1, “Interference” (pp. 637-646); Chapter 18, Lesson 2, “Diffraction” on (pp. 654-661); Chapter 24, Lesson 1, “Quantized Energy and Photons” (pp. 851-861); and Chapter 24, Lesson 2, “Wave-Particle Duality” (pp. 864-866).

**HS-PS4-4.** Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. [Clarification Statement: Emphasis is on the idea that different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]

**PEARSON CHEMISTRY:** The effect of UV radiation on human tissue is introduced in the Elements Handbook (p. R41). The effect of gamma radiation on matter is introduced in Lesson 25.1 (pp. 877, 879).

Students have the opportunity to research the consequences of over-exposure to alpha, beta, and gamma radiation in Lesson 25.4 (TE p. 897).

**PEARSON PHYSICS:** Examples of the effects of absorption of different frequencies of electromagnetic radiation by matter appear in Chapter 15, Lesson 2, “Color and the Electromagnetic Spectrum” (p. 540) and in Chapter 26, Lesson 3, “Applications of Nuclear Physics—Radiation in Medicine” (pp. 934-935).
HS-PS4-5. **Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.** [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

**PEARSON CHEMISTRY:** Students learn about devices that detect radiation in Lesson 25.4 (pp. 894-895). Students learn about the practical uses of radioisotopes in Lesson 25.4 (pp. 896-897).

**PEARSON PHYSICS:** The “Physics & You” pages introduce various technological devices that use waves to transmit and capture information or energy. For examples, see Chapter 3, “Microbursts” (p. 102); Chapter 4, “Global Positioning Systems” (p. 141); Chapter 10 “Optical Pyrometer” (p. 375); Chapter 14, “Sonar Mapping” (p. 520); Chapter 16, “The Hubble Space Telescope (HST)” (p. 587); Chapter 18 “X-ray Diffraction” (p. 665). Students also explain how a seismic wave source and an array of seismic detectors use the principles of wave interactions with matter to map the Earth’s subsurface in the “Seismic Mapping” STEM Activity (pp. SS-56).

The “Take It Further” exercises associated with these “Physics & You” features require students to communicate technical information about devices. Students write reports about how technologies that use waves function in “Writing about Science” Assessment exercises in Chapter 9 (exercise 114 on p. 340), Chapter 16 (exercise 101 on p. 594), and Chapter 24 (exercise 98 on p. 880).

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<td><strong>Asking Questions and Defining Problems</strong></td>
<td><strong>PS3.D: Energy in Chemical Processes</strong></td>
<td><strong>Cause and Effect</strong></td>
</tr>
<tr>
<td>Asking questions and defining problems in grades 9-12 builds from grades K-8 experiences and progress to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.</td>
<td>- Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy. (secondary to HS-PS4-5)</td>
<td>- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1)</td>
</tr>
<tr>
<td>- Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS-PS4-2)</td>
<td><strong>Pearson Physics SE/TE:</strong> 862-863, The photoelectric effect has practical applications</td>
<td><strong>Pearson Chemistry SE/TE:</strong> 140, Atomic Emission Spectra</td>
</tr>
<tr>
<td><strong>Using Mathematics and Computational Thinking</strong></td>
<td><strong>PS4.A: Wave Properties</strong></td>
<td><strong>Pearson Physics SE/TE:</strong> 470-475, Waves and Wave Properties SS-S6, STEM Activity</td>
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<tr>
<td>Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</td>
<td>- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)</td>
<td>- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS4-4)</td>
</tr>
<tr>
<td>- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1)</td>
<td><strong>Pearson Chemistry SE/TE:</strong> 138-141, Light and Emission Spectra</td>
<td><strong>Pearson Chemistry SE/TE:</strong> 894, Detecting Radiation 879, Gamma Radiation R41, Transition Metals: Sunscreens</td>
</tr>
<tr>
<td><strong>Pearson Chemistry SE/TE:</strong> 138-141, Light and Emission Spectra 146, Chemistry &amp; You: Light Emitting Diodes 151, Math Tune-Up: Atomic Emission Spectra and Photons</td>
<td><strong>Pearson Physics SE/TE:</strong> 470-475, Waves and Wave Properties SS-S6, STEM Activity</td>
<td>- Systems can be designed to cause a desired effect. (HS-PS4-5)</td>
</tr>
<tr>
<td><strong>Pearson Physics SE/TE:</strong> 521, Physics Lab SS-S6, STEM Activity</td>
<td></td>
<td><strong>Systems and System Models</strong></td>
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- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-PS4-3)

**Pearson Physics SE/TE:** 864-866, Wave Particle Duality
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<td><strong>Engaging in Argument from Evidence</strong></td>
<td>- [From the 3-5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)</td>
<td><strong>Stability and Change</strong></td>
</tr>
<tr>
<td>Pearson Chemistry TE: 139, Light as a Particle 143, Connect to Physics 147, Quantum Mechanics: Interpret Data</td>
<td><strong>PS4.B: Electromagnetic Radiation</strong>  - Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3)</td>
<td>- Systems can be designed for greater or lesser stability. (HS-PS4-2)</td>
</tr>
<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td><strong>Pearson Physics SE/TE:</strong> 476-482, Interacting Waves</td>
<td><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information in 9-12 builds on K-8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)</td>
<td><strong>Pearson Chemistry SE/TE:</strong> 138-139, Light and Atomic Emission Spectra 142-143, The Quantum Concept and Photons</td>
<td><strong>Interdependence of Science, Engineering, and Technology</strong></td>
</tr>
<tr>
<td>Pearson Chemistry TE: 894, Engage: Build Background 897, Extend: Connect to Medicine</td>
<td><strong>Pearson Physics SE/TE:</strong> 534, Light behaves like a wave and a particle 637-646, Interference 654-661, Diffraction 857-861, Quantized Energy and Photons—Quantized Light 864-866, Wave Particle Duality</td>
<td>- Science and engineering complement each other in the cycle known as research and development (R&amp;D). (HS-PS4-5)</td>
</tr>
<tr>
<td>Communicate technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS4-5)</td>
<td><strong>When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)</strong></td>
<td><strong>Pearson Physics SE/TE:</strong> 102, Microbursts 141, Global Positioning 332, GPS satellites have relatively low orbits 375, Optical Pyrometer 498, Physics &amp; You: Technology 512, Physics &amp; You: Technology 520, Sonar Mapping 536-544, Color and the Electromagnetic Spectrum 587, The Hubble Space Telescope 653, Physics &amp; You: Technology 665, X-ray Diffraction 862-863, The photoelectric effect has practical applications 873, Solar Installation SS56, STEM Activity</td>
</tr>
<tr>
<td><strong>Interdependence of Science, Engineering, and Technology</strong></td>
<td><strong>Pearson Physics SE/TE:</strong> 540, X-rays 540, Gamma rays 934-935, Applications of Nuclear Physics—Radiation in Medicine</td>
<td>- Modern civilization depends on major technological systems. (HS-PS4-2),(HS-PS4-5)</td>
</tr>
<tr>
<td>Key: SE = Student Edition; TE = Teacher’s Edition</td>
<td><strong>Photovoltaic materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)</strong></td>
<td><strong>Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS4-2)</strong></td>
</tr>
</tbody>
</table>
### Science and Engineering Practices

#### Connections to Nature of Science

**Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**
- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-PS4-3)

**Pearson Physics SE/TE:** 864-866, Wave Particle Duality

<table>
<thead>
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<th>Disciplinary Core Ideas</th>
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<tbody>
<tr>
<td><strong>PS4.C: Information Technologies and Instrumentation</strong></td>
<td><strong>Pearson Chemistry SE/TE:</strong> 894-895, Detecting Radiation 896-897, Using Radiation</td>
</tr>
<tr>
<td>- Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)</td>
<td><strong>Pearson Physics SE/TE:</strong> 102, Microbursts 141, Global Positioning Systems 862-863, The photoelectric effect has practical applications 873, Solar Installation SS-56, STEM Activity</td>
</tr>
</tbody>
</table>

**Connections to other DCIs in this grade-band:**  HS.PS1.C (HS-PS4-4); HS.PS3.A (HS-PS4-4),(HS-PS4-5); HS.PS3.D (HS-PS4-3),(HS-PS4-4); HS.ESS1.A (HS-PS4-3); HS.ESS2.A (HS-PS4-1); HS.ESS2.D (HS-PS4-3)

**Articulation to DCIs across grade-bands:**  MS.PS3.D (HS-PS4-4); MS.PS4.A (HS-PS4-1),(HS-PS4-2),(HS-PS4-5); MS.PS4.B (HS-PS4-1),(HS-PS4-2),(HS-PS4-3),(HS-PS4-4),(HS-PS4-5); MS.PS4.C (HS-PS4-2),(HS-PS4-5); MS.ISS1.C (HS-PS4-4); MS.ESS2.D (HS-PS4-4)

### Common Core State Standards Connections:

**ELA/Literacy -**
- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)
- **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-1),(HS-PS4-4)
- **RST.11-12.8** Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)
- **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-PS4-5)
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS4-4)

**Mathematics -**
- **MP.2** Reason abstractly and quantitatively. (HS-PS4-1),(HS-PS4-3)
- **MP.4** Model with mathematics. (HS-PS4-1)
- **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1),(HS-PS4-3)
- **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1),(HS-PS4-3)
- **HSA.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1),(HS-PS4-3)

Key: SE = Student Edition; TE = Teacher’s Edition
Students who demonstrate understanding can:

**HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

- **MILLER & LEVINE BIOLOGY:** In Lesson 1.2 (p. 11), students learn that technology, science, and society are closely linked. Lesson 1.2 (pp. 14-15) describes the relationship between science and society. In Lesson 15.4 (pp. 436-439), students explore the ethics and impacts of biotechnology.

  - **ETS1 Engineering and Design**

  - **Criterion:** Specify criteria and constraints for solutions that account for societal needs and wants: In the Unit 8 Project, Body Mechanics (pp. 859a-859b), students analyze how medical technologies can account for the needs of people living with disabilities or chronic diseases. Students analyze how cross-pollination affects the genetics of corn populations (Chapter 17 STEM activity, Pollination or Contamination). Students analyze the factors involved with replacing a heart (Chapter 33 STEM activity, The Artificial Heart of the Matter).

- **PEARSON PHYSICS:** In the “Solar Oven” STEM Activity, students specify criteria and constraints for the design of a solar oven intended to solve the problem of heating food or water in areas where access to electricity or fuel is scarce.

- **PEARSON CHEMISTRY:** The process of reverse osmosis desalination as a solution for obtaining drinkable water is explained in the Chemistry & You feature Reverse Osmosis Desalination (pp. 502-503). The global challenge of reducing air pollution caused by automobile emissions is discussed in the Chemistry & You feature Natural Gas Vehicles (pp. 476-477).

- **PEARSON EARTH SCIENCE:** In the “Solar Oven” STEM Activity, students specify criteria and constraints for the design of a solar oven intended to solve the problem of heating food or water in areas where access to electricity or fuel is scarce.

- **PEARSON EARTH SCIENCE:** In the Design to Reduce Waste STEM Activity (p. 729), students design packaging to help address the global challenge of solid waste management, including identifying criteria for size, cost effectiveness, safety, and material use.

**HS-ETS1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

- **MILLER & LEVINE BIOLOGY:** In Appendix C, Technology & Design (pp. A-16 and A-17), students learn the general process for designing a solution to a problem.

  - **ETS1 Engineering and Design**

  - **Criterion:** Specify criteria and constraints for solutions that account for societal needs and wants: In the Unit 6 Project, A Living Roof (pp. 571a-571b), students design a green roof. Students redesign product packaging to reduce solid waste (Chapter 6 STEM activity, Redesign to Reduce Waste). Students design a mosquito net to help combat malaria outbreaks (Chapter 21 STEM activity, Malaria and Fungi). Students design technology to help protect workers from blood-borne pathogens (Chapter 35 STEM activity, Reducing the Spread of Bloodborne Pathogens).

- **PEARSON CHEMISTRY:** The real-world problem of acid rain, including stone monument erosion is explored in the Chemistry & You feature Stone Erosion (p. 671). Students investigate the effects of a weak acid on chalk as a simulation of stone erosion in the On Your Own feature (p. 671). Further awareness of the problem is elicited in the Elements Handbook (p. R23).

- **PEARSON PHYSICS:** Students design a solar oven as part of a solution to the problem of limited access to electricity or fuel in the “Solar Oven” STEM Activity (p. 53-54).

- **PEARSON EARTH SCIENCE:** In the Design to Reduce Waste STEM Activity (p. 729), students break down the complex issue of solid waste management to a smaller engineering problem of designing food or product packaging.

**HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

- **MILLER & LEVINE BIOLOGY:** In Appendix C, Technology & Design (pp. A-16 and A-17), students learn to evaluate constraints and make trade-offs.

  - **ETS1 Engineering and Design**

  - **Criterion:** Specify criteria and constraints for solutions that account for societal needs and wants: In the Unit 1 Project, Harnessing the Fear of Water (pp. 1a-1b), students determine the criteria for a technological solution to a specific problem. In the Unit 4 Project, Food Fight! (pp. 305a-305b), students evaluate the use of GM foods as a way to increase crop yields. In the Unit 8 Project, Body Mechanics (pp. 859a-859b), students identify the criteria and constraints for a prosthetic limb.

- **PEARSON CHEMISTRY:** The process of reverse osmosis desalination is explained in the Chemistry & You feature Reverse Osmosis Desalination (pp. 502-503). The process of single-stream recycling is introduced in the Chemistry & You feature Recycled Mixtures (pp. 52-53). The process of bioremediation to clean up oil spills is introduced in the Chemistry & You feature Bioremediation (p. 784).

  - **ETS1 Engineering and Design**

  - **Criterion:** Specify criteria and constraints for solutions that account for societal needs and wants: In the Unit 1 Project, Harnessing the Fear of Water (pp. 1a-1b), students determine the criteria for a technological solution to a specific problem. In the Unit 4 Project, Food Fight! (pp. 305a-305b), students evaluate the use of GM foods as a way to increase crop yields. In the Unit 8 Project, Body Mechanics (pp. 859a-859b), students identify the criteria and constraints for a prosthetic limb.

- **PEARSON PHYSICS:** Students evaluate the utilization of reverse osmosis for water filtration in the 21st Century Learning feature of Lesson 15.2 (TE p. 502). Students evaluate the feasibility of recycling in a rural community in the 21st Century Learning feature of Lesson 2.4 (TE p. 52).

- **PEARSON EARTH SCIENCE:** Students evaluate current practices in the fishing industry to compare their profitability and possible impacts in the environment in the Bystach Problem STEM Activity (p. 728). In the Design to Reduce Waste STEM Activity (p. 729), students prioritize criteria to be met by their packaging design solution.
**A Correlation of the Pearson High School Science Program**
*(Biology, Chemistry, Physics, and Earth Science)*

to the 2014 Oregon Science Standards (NGSS)

### HS-ETS1-4.
Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

**PEARSON EARTH SCIENCE:** For the packaging design solution that they propose in the Design to Reduce Waste STEM Activity (p. 729), students model the impact over time on the cost of the packaged product and on landfill volume.

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<th>Science and Engineering Practices</th>
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<td><strong>Asking Questions and Defining Problems</strong></td>
<td><strong>ETS1.A: Defining and Delimiting Engineering Problems</strong></td>
<td><strong>Systems and System Models</strong></td>
</tr>
<tr>
<td>Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.</td>
<td>▪ Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)</td>
<td>▪ Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-ETS1-4)</td>
</tr>
<tr>
<td>M &amp; L Biology SE/TE:</td>
<td><strong>M &amp; L Biology SE/TE:</strong></td>
<td><strong>M&amp;B Biology SE/TE:</strong></td>
</tr>
<tr>
<td>8S9a-8S9b, Unit 8 Project</td>
<td>14-15, Science and Society</td>
<td>1035, STEM Activity</td>
</tr>
<tr>
<td>1036, STEM Activity</td>
<td>436-439, Ethics and Impacts of Biotechnology</td>
<td><strong>Pearson Physics SE/TE:</strong></td>
</tr>
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<td>Biology.com:</td>
<td><strong>Pearson Physics SE/TE:</strong></td>
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<tr>
<td>Chapter 17 STEM activity</td>
<td>S3-S4, STEM Activity</td>
<td>S3-S6, STEM Activity</td>
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<tr>
<td>Chapter 33 STEM activity</td>
<td><strong>Pearson Earth Science SE/TE:</strong></td>
<td>S7-S8, STEM Activity</td>
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<td><strong>Pearson Earth Science SE/TE:</strong></td>
<td>729, STEM Activity</td>
<td><strong>Pearson Earth Science SE/TE:</strong></td>
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<td>729, STEM Activity</td>
<td>731, STEM Activity</td>
<td>728, STEM Activity</td>
</tr>
<tr>
<td><strong>Using Mathematics and Computational Thinking</strong></td>
<td><strong>Systems and System Models</strong></td>
<td>730, STEM Activity</td>
</tr>
<tr>
<td>Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</td>
<td>▪ Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)</td>
<td></td>
</tr>
<tr>
<td><strong>Pearson Physics SE/TE:</strong></td>
<td><strong>Systems and System Models</strong></td>
<td><strong>Pearson Earth Science SE/TE:</strong></td>
</tr>
<tr>
<td>S5-S6, STEM Activity</td>
<td><strong>Pearson Physics SE/TE:</strong></td>
<td>729, STEM Activity</td>
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<tr>
<td><strong>Pearson Earth Science SE/TE:</strong></td>
<td>728, STEM Activity</td>
<td>731, STEM Activity</td>
</tr>
<tr>
<td>729, STEM Activity</td>
<td><strong>Pearson Earth Science SE/TE:</strong></td>
<td>730, STEM Activity</td>
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</table>
| **Constructing Explanations and Designing Solutions** | ETS1.B: Developing Possible Solutions  
- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) | **Connections to Engineering, Technology, and Applications of Science**  
- Influence of Science, Engineering, and Technology on Society and the Natural World  
  - New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)  
  - M & L Biology SE/TE: 123, Building Scientific Literacy, STEM |
| Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. | |  
- Design a solution to a complex real-world problem, based on scientific knowledge, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) |
| **M & L Biology SE/TE:** S71a-S71b, Unit 6 Project 1035, STEM Activity | **Pearson Chemistry SE/TE:** S02-S03, Chemistry & You: Reverse Osmosis Desalination  
784, Chemistry & You: Bioremediation 909, STEM Activity | **Biology.com:**  
- Chapter 14 STEM activity, Human Genomes and Medicine  
- Chapter 15 STEM activity, Recombinant DNA in Genetically Modified Organisms  
- Chapter 31 STEM activity, Technology and Physical Disabilities |
| **M & L Biology SE/TE:** S3-S4, STEM Activity  
S7-S8, STEM Activity | **Pearson Chemistry TE:** S02, 21st Century Learning  
S03, Explain: Make a Connection  
S03, Extend: Connect to Environmental Science |  
- Pearson Chemistry SE/TE: S78, STEM Activity  
729, STEM Activity |
| **Pearson Earth Science SE/TE:** 729, STEM Activity | **Pearson Physics SE/TE:** S3-S4, STEM Activity |  
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) |
| **M & L Biology SE/TE:** 1a-1b, Unit 1 Project 305a-305b, Unit 4 Project 859a-859b Unit 8 Project | **Pearson Earth Science SE/TE:** 728, STEM Activity  
729, STEM Activity |  
- Pearson Earth Science SE/TE: 728, STEM Activity  
729, STEM Activity |
| **Pearson Chemistry TE:** S2, 21st Century Learning  
S02, 21st Century Learning | **ET51.C: Optimizing the Design Solution**  
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2) |  
- Pearson Physics SE/TE: S3-S4, STEM Activity  
S7-S8, STEM Activity  
**Pearson Earth Science SE/TE:** 729, STEM Activity |
| **Pearson Physics SE/TE:** S3-S4, STEM Activity  
S7-S8, STEM Activity | **M & L Biology SE/TE:** A-16 and A-17, Appendix C 1036, STEM Activity |  
- Pearson Earth Science SE/TE: 730, STEM Activity  
731, STEM Activity |
| **Pearson Earth Science SE/TE:** 728, STEM Activity  
729, STEM Activity | **Pearson Chemistry SE/TE:** 909, STEM Activity |  
| **Pearson Physics SE/TE:** S3-S4, STEM Activity  
S7-S8, STEM Activity | **Pearson Earth Science SE/TE:** 730, STEM Activity  
731, STEM Activity |

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Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include:

| Physical Science: | HS-PS2-3, HS-PS3-3 |

Connections to HS-ETS1.B: Designing Solutions to Engineering Problems include:

| Earth and Space Science: | HS-ESS3-2, HS-ESS3-4, Life Science: | HS-LS2-7, HS-LS4-6 |

Connections to HS-ETS1.C: Optimizing the Design Solution include:

| Physical Science: | HS-PS1-6, HS-PS2-3 |

Articulation of DCIs across grade-bands: *MS.ETS1.A* (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4); *MS.ETS1.B* (HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4); *MS.ETS1.C* (HS-ETS1-2),(HS-ETS1-4)

Common Core State Standards Connections:

**ELA/Literacy** -

| RST.11-12.7 | Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1),(HS-ETS1-3) |
| RST.11-12.8 | Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3) |
| RST.11-12.9 | Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3) |

**Mathematics** -

| MP.2 | Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) |
| MP.4 | Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) |

*This performance expectation integrates traditional science content with engineering through a practice or disciplinary core idea.*