

HS-PS1-1 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<p>1 Asking questions (for science) and defining problems (for engineering)</p> <p>2 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.</p> <ul style="list-style-type: none"> • Use a model to predict the relationships between systems or between components of a system. <p>3 Planning and carrying out investigations</p> <p>4 Analyzing and interpreting data</p> <p>5 Using mathematics and computational thinking</p> <p>6 Constructing explanations (for science) and designing solutions (for engineering)</p> <p>7 Engaging in argument from evidence</p> <p>8 Obtaining, evaluating, and communicating information</p>	<p>Structure and Properties of Matter:</p> <ul style="list-style-type: none"> • Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. • 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. 	<p>HS-PS1-1 <i>Students who demonstrate understanding can:</i></p> <p>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.</p> <p>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.</p> <p>Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.</p>

Crosscutting Concepts: 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>RST.9-10.7 Translate quantitative or technical information expressed in words in 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.</p>	<p>N/A</p>

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HS-PS1-2 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<p>1 Asking questions (for science) and defining problems (for engineering)</p> <p>2 Developing and using models</p> <p>3 Planning and carrying out investigations</p> <p>4 Analyzing and interpreting data</p> <p>5 Using mathematics and computational thinking</p> <p>6 Constructing explanations (for science) and designing solutions (for engineering) 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.</p> <ul style="list-style-type: none"> • 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. <p>7 Engaging in argument from evidence</p> <p>8 Obtaining, evaluating, and communicating information</p>	<p>Structure and Properties of Matter:</p> <ul style="list-style-type: none"> • 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. <p>Chemical Reactions:</p> <ul style="list-style-type: none"> • 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. 	<p>HS-PS1-2 <i>Students who demonstrate understanding can:</i></p> <p>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, knowledge of the patterns of chemical properties, and formation of compounds.</p> <p>Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen. Reaction classification aids in the prediction of products (e.g. synthesis/combination decomposition, single displacement, double displacement, oxidation/reduction, acid/base).</p> <p>Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.</p>

Crosscutting Concepts: 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p> <p>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.</p>	<p>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.</p> <p>HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

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K-2

3-5

6-8

9-12

HS-PS1-3 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<ol style="list-style-type: none"> 1 Asking questions (for science) and defining problems (for engineering) 2 Developing and using models 3 Planning and carrying out investigations Planning and carrying out investigations to answer questions or test solutions to problems 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. <ul style="list-style-type: none"> • 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. 4 Analyzing and interpreting data 5 Using mathematics and computational thinking 6 Constructing explanations (for science) and designing solutions (for engineering) 7 Engaging in argument from evidence 8 Obtaining, evaluating, and communicating information 	<p>Structure and Properties of Matter:</p> <ul style="list-style-type: none"> • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. 	<p>HS-PS1-3 <i>Students who demonstrate understanding can:</i></p> <p>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.</p> <p>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. The intent of the performance expectation is limited to evaluation of bulk scale properties and not micro scale properties.</p> <p>Assessment Boundary: Assessment does not include Raoult’s law calculations of vapor pressure.</p>

Crosscutting Concepts: 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>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.</p> <p>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.</p> <p>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.</p> <p>WHST.9-12.7.9 Draw evidence from informational texts to support analysis, reflection, and research.</p>	<p>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.</p> <p>HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

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HS-PS1-4 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<p>1 Asking questions (for science) and defining problems (for engineering)</p> <p>2 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.</p> <ul style="list-style-type: none"> • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. <p>3 Planning and carrying out investigations</p> <p>4 Analyzing and interpreting data</p> <p>5 Using mathematics and computational thinking</p> <p>6 Constructing explanations (for science) and designing solutions (for engineering)</p> <p>7 Engaging in argument from evidence</p> <p>8 Obtaining, evaluating, and communicating information</p>	<p>Structure and Properties of Matter:</p> <ul style="list-style-type: none"> • 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. <p>Chemical Reactions:</p> <ul style="list-style-type: none"> • 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. 	<p>HS-PS1-4 <i>Students who demonstrate understanding can:</i></p> <p>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.</p> <p>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.</p> <p>Assessment Boundary: N/A</p>

Crosscutting Concepts: Energy and Matter

- 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>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.</p>	<p>MP.4 Model with mathematics.</p> <p>HS-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.</p> <p>HS-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HS-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

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HS-PS1-5 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<ul style="list-style-type: none"> ➊ Asking questions (for science) and defining problems (for engineering) ➋ Developing and using models ➌ Planning and carrying out investigations ➍ Analyzing and interpreting data ➎ Using mathematics and computational thinking ➏ Constructing explanations (for science) and designing solutions (for engineering) 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. <ul style="list-style-type: none"> • Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. ➐ Engaging in argument from evidence ➑ Obtaining, evaluating, and communicating information 	<p>Chemical Reactions:</p> <ul style="list-style-type: none"> • 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. 	<p>HS-PS1-5 <i>Students who demonstrate understanding can:</i></p> <p>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.</p> <p>Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.</p> <p>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.</p>

Crosscutting Concepts: 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>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.</p> <p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>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.</p> <p>HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

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HS-PS1-6 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<ol style="list-style-type: none"> 1 Asking questions (for science) and defining problems (for engineering) 2 Developing and using models 3 Planning and carrying out investigations 4 Analyzing and interpreting data 5 Using mathematics and computational thinking 6 Constructing explanations (for science) and designing solutions (for engineering) 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. <ul style="list-style-type: none"> • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7 Engaging in argument from evidence 8 Obtaining, evaluating, and communicating information 	<p>Chemical Reactions:</p> <ul style="list-style-type: none"> • 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. <p>Optimizing the Design Solution:</p> <ul style="list-style-type: none"> • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain over others (trade-offs) may be needed. 	<p>HS-PS1-6 <i>Students who demonstrate understanding can:</i></p> <p>Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*</p> <p>Clarification Statement: Emphasis is on the application of Le Chatlier’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.</p> <p>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.</p>

Crosscutting Concepts: Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>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.</p>	<p>N/A</p>

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HS-PS1-7 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<ol style="list-style-type: none"> 1 Asking questions (for science) and defining problems (for engineering) 2 Developing and using models 3 Planning and carrying out investigations 4 Analyzing and interpreting data 5 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. <ul style="list-style-type: none"> • Use mathematical representations of phenomena to support claims. 6 Constructing explanations (for science) and designing solutions (for engineering) 7 Engaging in argument from evidence 8 Obtaining, evaluating, and communicating information 	<p>Chemical Reactions:</p> <ul style="list-style-type: none"> • 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. 	<p>HS-PS1-7 <i>Students who demonstrate understanding can:</i></p> <p>Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.</p> <p>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 (i.e., Conservation of Mass and Stoichiometry). Emphasis is on assessing students’ use of mathematical thinking and not on memorization and rote application of problem-solving techniques.</p> <p>Assessment Boundary: Assessment does not include complex chemical reactions.</p>

Crosscutting Concepts: Energy and Matter

- The total amount of energy and matter in closed systems is conserved.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
N/A	<p>MP.2 Reason abstractly and quantitatively.</p> <p>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.</p> <p>HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

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HS-PS1-8 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<p>1 Asking questions (for science) and defining problems (for engineering)</p> <p>2 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.</p> <ul style="list-style-type: none"> Develop a model based on evidence to illustrate the relationships between systems or between components of a system. <p>3 Planning and carrying out investigations</p> <p>4 Analyzing and interpreting data</p> <p>5 Using mathematics and computational thinking</p> <p>6 Constructing explanations (for science) and designing solutions (for engineering)</p> <p>7 Engaging in argument from evidence</p> <p>8 Obtaining, evaluating, and communicating information</p>	<p>Nuclear Processes:</p> <ul style="list-style-type: none"> Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. 	<p>HS-PS1-8 <i>Students who demonstrate understanding can:</i></p> <p>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.</p> <p>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.</p> <p>Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.</p>

Crosscutting Concepts: Energy and Matter

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>N/A</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>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.</p> <p>HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

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K-2

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9-12

HS-PS2-6 Motion and Stability: Forces and Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<p>1 Asking questions (for science) and defining problems (for engineering)</p> <p>2 Developing and using models</p> <p>3 Planning and carrying out investigations</p> <p>4 Analyzing and interpreting data</p> <p>5 Using mathematics and computational thinking</p> <p>6 Constructing explanations (for science) and designing solutions (for engineering)</p> <p>7 Engaging in argument from evidence</p> <p>8 Obtaining, evaluating, and communicating information 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.</p> <ul style="list-style-type: none"> • 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). 	<p>Types of Interactions:</p> <ul style="list-style-type: none"> • 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. 	<p>HS-PS2-6 <i>Students who demonstrate understanding can:</i></p> <p>Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*</p> <p>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.</p> <p>Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.</p>

Crosscutting Concepts: Structure and Function

- 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>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.</p> <p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p>	<p>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.</p> <p>HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

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HS-PS3-3 Energy

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<ol style="list-style-type: none"> 1 Asking questions (for science) and defining problems (for engineering) 2 Developing and using models 3 Planning and carrying out investigations 4 Analyzing and interpreting data 5 Using mathematics and computational thinking 6 Constructing explanations (for science) and designing solutions (for engineering) 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. <ul style="list-style-type: none"> • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. 7 Engaging in argument from evidence 8 Obtaining, evaluating, and communicating information 	<p>Definitions of Energy:</p> <ul style="list-style-type: none"> • At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. <p>Defining and Delimiting Engineering Problems: (secondary to HS-PS3-3)</p> <ul style="list-style-type: none"> • 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. <hr/> <p><i>* Connections to Engineering, Technology, and Application of Science</i></p> <p>Interdependence of Science, Engineering, and Technology:</p> <ul style="list-style-type: none"> • 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. 	<p>HS-PS3-3 <i>Students who demonstrate understanding can:</i></p> <p>Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*</p> <p>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.</p> <p>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.</p>

Crosscutting Concepts: Energy and Matter

- 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>WH ST .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.</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p> <p>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.</p> <p>HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

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HS-PS3-4 Energy

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<ol style="list-style-type: none"> 1 Asking questions (for science) and defining problems (for engineering) 2 Developing and using models 3 Planning and carrying out investigations Planning and carrying out investigations to answer questions or test solutions to problems 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. <ul style="list-style-type: none"> • 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. 4 Analyzing and interpreting data 5 Using mathematics and computational thinking 6 Constructing explanations (for science) and designing solutions (for engineering) 7 Engaging in argument from evidence 8 Obtaining, evaluating, and communicating information 	<p>Conservation of Energy and Energy Transfer:</p> <ul style="list-style-type: none"> • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. • Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). 	<p>HS-PS3-4 <i>Students who demonstrate understanding can:</i></p> <p>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).</p> <p>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.</p> <p>Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.</p>

Crosscutting Concepts: System and System Models

- 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>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.</p> <p>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.</p> <p>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.</p> <p>WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>

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HS-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<ol style="list-style-type: none"> 1 Asking questions (for science) and defining problems (for engineering) 2 Developing and using models 3 Planning and carrying out investigations 4 Analyzing and interpreting data 5 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. <ul style="list-style-type: none"> • Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. 6 Constructing explanations (for science) and designing solutions (for engineering) 7 Engaging in argument from evidence 8 Obtaining, evaluating, and communicating information 	<p>Wave Properties:</p> <ul style="list-style-type: none"> • 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. 	<p>HS-PS4-1 <i>Students who demonstrate understanding can:</i></p> <p>Use mathematical representations to describe relationships among the frequency, wavelength, and speed of waves.</p> <p>Clarification Statement: Examples of data could include relationship to the electromagnetic spectrum.</p> <p>Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.</p>

Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>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.</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p> <p>HAS-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.</p> <p>HAS-SSE.A.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.</p> <p>HAS.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p>

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

HS-PS4-3 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
<p>1 Asking questions (for science) and defining problems (for engineering)</p> <p>2 Developing and using models</p> <p>3 Planning and carrying out investigations</p> <p>4 Analyzing and interpreting data</p> <p>5 Using mathematics and computational thinking</p> <p>6 Constructing explanations (for science) and designing solutions (for engineering)</p> <p>7 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 worlds. Arguments may also come from current scientific or historical episodes in science.</p> <ul style="list-style-type: none"> • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. <p>8 Obtaining, evaluating, and communicating information</p>	<p>Wave Properties:</p> <ul style="list-style-type: none"> • 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. <p>Electromagnetic Radiation:</p> <ul style="list-style-type: none"> • 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. 	<p>HS-PS4-3 <i>Students who demonstrate understanding can:</i></p> <p>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.</p> <p>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.</p> <p>Assessment Boundary: Assessment does not include using quantum theory.</p>

Crosscutting Concepts: Cause and Effect

- 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
<p>RST.9-10.8 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. (H S -</p> <p>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.</p> <p>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.</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>HAS-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.</p> <p>HAS-SSE.A.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.</p> <p>HAS.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p>

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