

2016 WYOMING SCIENCE

CONTENT AND PERFORMANCE STANDARDS

WYOMING STATE BOARD OF EDUCATION

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Effective September 23, 2016

TO BE FULLY IMPLEMENTED IN DISTRICTS BY THE BEGINNING OF SCHOOL YEAR 2020-2021

ACKNOWLEDGEMENT

The Wyoming State Board of Education would like to thank the Wyoming Department of Education, as well as educators, parents and community members, business and industry representatives, community college representatives, and the University of Wyoming representatives for their help with the development of these science standards.

**Jillian Balow, Superintendent of Public Instruction
Wyoming Department of Education**

**Brent Young and Lisa Weigel, Chief Policy Officer
Julie Magee, Division Director
Accountability Division**

**Laurie Hernandez, Standards Team Supervisor
Mike Cosenza, Jill Stringer, Monica Mosier, and Barb Marquer—WDE Standards Team Facilitators**

**Wyoming Department of Education
Hathaway Building, 2nd Floor
2300 Capitol Avenue
Cheyenne, WY 82002-0050**

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2016 WYOMING SCIENCE CONTENT AND PERFORMANCE STANDARDS

INTRODUCTION

The Wyoming Science Content and Performance Standards (WyCPS) were last reviewed and approved in 2008 in accordance with Wyoming state statute W.S. 21-2-304(c). The 2016 Wyoming Content and Performance Standards were developed collaboratively through the contributions of Science Standard Review Committee (SSRC) members from across the state. The committee's work was informed and guided by initial public input through community forums, as well as input solicited from specific stakeholder groups.

INTRODUCTION TO STANDARDS

Content Standards: Content standards define what students are expected to know and be able to do by the time they graduate. They do not dictate what methodology or instructional materials should be used, nor how the material is delivered.

Benchmarks: Benchmarks (also called performance expectations in this document) specify what students are expected to know and be able to do at the end of each of the benchmark grade levels. These benchmarks specify the skills and content students must master along the way in order to demonstrate proficiency of the content standard by the time they graduate. In this standards document, you will find these are broken out into individual grades for Kindergarten through 5th grade and then banded by grade bands for middle school/junior high school and high school grade levels (6-8 and 9-12).

RATIONALE

Today, quality science education enables students to learn science by being actively involved with scientific and engineering practices as they progress from kindergarten through 12th grade. They are encouraged to be inquisitive, to actively explore their environment, and become productive, scientifically literate citizens. The standards we present here provide the necessary foundation for local school district decisions about curriculum, assessments, and instruction. Implementation of the new standards will better prepare Wyoming high school graduates for the rigors of college and/or careers. In turn, Wyoming employers will be able to hire workers with a strong science and engineering base — both in specific content areas and in critical thinking and inquiry-based problem solving.

The Wyoming Science Content and Performance Standards support that:

- all students can engage in sophisticated science and engineering practices.
- students must have the opportunity to conduct investigations, solve problems, and engage in discussions.
- students learn through relevant context and use modeling to explain observed phenomena.
- students move beyond facts and terminology to develop explanations and design solutions supported by evidence-based arguments and reasoning.
- students discuss open-ended questions that focus on the strength of the evidence used to generate claims.
- students develop summaries of information through multiple sources, including science-related magazine and journal articles and web-based resources.
- students develop questions that drive multiple investigations with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas.
- students write reports, create posters, and design media presentations that explain and add credibility to their argument.
- students develop a better understanding of the science they are researching by accessing professional scientists and engineers through various means.
- students communicate and defend their research to an authentic audience such as at colloquiums with secondary students.

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ORGANIZATION OF STANDARDS

These standards were informed by *A Framework for K-12 Science Education* (National Research Council, 2012), the Next Generation Science Standards (National Academies Press, 2013), and the unique needs of Wyoming. They are distinct from prior science standards in that they integrate three dimensions of learning within each standard and have intentional connections across standards, grade bands, and subjects. The three dimensions are crosscutting concepts, disciplinary core ideas, and science and engineering practices.

Dimension 1: Crosscutting Concepts (CCC)

The seven crosscutting concepts have application across all domains of science. As such, they provide one way of linking across the domains of the Disciplinary Core Ideas.

Dimension 2: Disciplinary Core Ideas (DCI)

The continuing expansion of scientific knowledge makes it impossible to teach all of the ideas related to a given discipline in exhaustive detail during the K-12 years. But given the cornucopia of information available today, virtually at a touch, an important role of science education is not to teach “all the facts” but rather to prepare students in the four domains of science with sufficient core knowledge so that they can later acquire additional information on their own. The four domains referenced are: 1) physical science, 2) life science, 3) earth and space science, and 4) engineering, technology and applications of science.

Dimension 3: Science and Engineering Practices (SEP)

The SEPs describe (a) the major practices that scientists employ as they investigate and build models and theories about the world, and (b) a key

set of engineering practices that engineers use as they design and build systems. We use the term “practices” instead of skills to emphasize that engaging in a scientific investigation requires not only skill but also knowledge that is specific to each practice.

Cross-curricular connections to Wyoming Content and Performance Standards in English Language Arts (ELA), Mathematics, Social Studies (S.S.), Physical Education (P.E.), Health, Fine and Performing Arts (FPA), and Career and Vocational Education (CVE) are identified and referenced within the science standards. These are intended as suggestions for areas where other content standards can be integrated in the teacher’s instruction and lessons. The connection would be dependent on the curricula.

2016 Wyoming Science Standards

Physical Science	PS1 - Matter and Its Interactions							
	K	1	2	3	4	5	6-8	9-12
	PS2 - Motion and Stability: Forces and Interactions							
	K	1	2	3	4	5	6-8	9-12
	PS3 - Energy							
Life Science	K	1	2	3	4	5	6-8	9-12
	PS4 - Waves and Their Applications in Technologies for Information Transfer							
	K	1	2	3	4	5	6-8	9-12
	ETS - Engineering, Technology, and Applications of Science							
Earth & Space	LS1 - From Molecules to Organisms: Structure and Processes							
	K	1	2	3	4	5	6-8	9-12
	LS2 - Ecology: Interactions, Energy, and Dynamics							
	K	1	2	3	4	5	6-8	9-12
ETS	LS3 - Heredity: Inheritance and Variation of Traits							
	K	1	2	3	4	5	6-8	9-12
	LS4 - Biological Evolution: Unity and Diversity							
ETS	ESS1 - Earth's Place in the Universe							
	K	1	2	3	4	5	6-8	9-12
	ESS2 - Earth's Systems							
ETS	K	1	2	3	4	5	6-8	9-12
	ESS3 - Earth and Human Activity							
ETS	ETS - Engineering, Technology, and Applications of Science							
	K	1	2	3	4	5	6-8	9-12

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On the next page you will find how to read this document and understand its many components.

WYOMING CROSS-CURRICULAR CONNECTIONS

At the bottom of each standards page, you will find where these science standards tie in with other content areas, such as the following:

- ELA
- Mathematics
- Social Studies
- Health
- Physical Education
- Career & Vocational Education
- Fine & Performing Arts

These standards can be found on the WDE website at
<http://edu.wyoming.gov/educators/standards>

INTERNATIONAL SOCIETY FOR TECHNOLOGY IN EDUCATION (ISTE) CONNECTIONS

The Committee suggests educators use the following ISTE standards in their science curriculum, instruction, and activities, where appropriate. Standard 3 has been identified throughout the document, however others may apply depending on the curriculum used.

[2007 ISTE Standards for Students](#)

1. Creativity and innovation
2. Communication and collaboration
3. Research and information fluency
4. Critical thinking, problem solving, and decision making
5. Digital citizenship
6. Technology operations and concepts

RESOURCES / REFERENCES

National Research Council [NRC]. (2012). [A Framework for K-12 Science Education](#): Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press.

NGSS Lead States (2013). [Next Generation Science Standards: For States, By States](#). Washington, DC: National Academies Press.

National Research Council. (2015). [Guide to Implementing the Next Generation Science Standards](#) (pp. 8-9). Washington, DC: National Academies Press.

How to Read This Document

Earth's Place in the Universe [4-ESS1-1]

Grade Level

Performance Expectations (PE) are the benchmarks; the skills and content students should master.

Clarification Statements provide further explanation or examples to support educators.

The State Assessment Boundary is to be considered when developing classroom and district assessments and gives limitations to the state assessment.

Symbol denotes WY examples are given or can be considered in instruction



Performance Expectations (Benchmark)

4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

Clarification Statement: Examples of evidence from patterns (may include, but not limited to, Wyoming specific examples) could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom indicating that over time a river cut through the rock.

State Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.

Three Dimensions of Learning

Crosscutting Concepts

Patterns can be used as evidence to support an explanation.

Disciplinary Core Ideas

The History of Planet Earth:

- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes.
- The presence and location of certain fossil types indicate the order in which rock layers were formed.

Science & Engineering Practices

Constructing explanations and designing solutions in 3-5 builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Identify the evidence that supports particular points in an explanation.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections

W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic.

W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.

W.4.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

Social Studies Connections

SS5.5.2 Explain how physical features, patterns, and systems impact different regions and how these features may help us generalize and compare areas within the state, nation, or world.

Mathematics Connections

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

4.MD.A.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table.

Science Standard Code [4.ESS1-1] means Grade 4, Earth & Space Science, Standard 1, Benchmark 1

Crosscutting Concepts (CCC) represent themes that span across engineering and science disciplines.

Disciplinary Core Ideas (DCI) represent a set of ideas for K-12 science education.

Science & Engineering Practices (SEP) will help students develop problem solving skills and understand their world through investigation.

Wyoming Cross-Curricular Connections identify possible connections to other WY Content & Performance Standards. These are intended to be suggestions and may be relevant depending on curriculum and instruction.

2016 WYOMING SCIENCE CONTENT AND PERFORMANCE STANDARDS

CONTENT REVIEW COMMITTEE (2015 – 2016)

Jennifer Albrandt, Converse CSD #2

Sheila St. Amour, Laramie

Polly Beebout, Natrona CSD #1

Ryan Bennett, Laramie

Ray Bieber, Park CSD #1

Perry F. Cook, Lander

Joanne Cornelison, Cheyenne, retired Laramie CSD #1

Paul Crips, Cheyenne, retired Laramie CSD #1

Shannon Cunningham, Laramie CSD #1

Elizabeth David, Sublette CSD #1

Mauro E. Diaz, Natrona CSD #1

Sharla Dowding, Converse CSD #2

Peter Ellsworth, Laramie, retired UW

Debra Freitas, Platte CSD #1

Jane Frye, Worland, retired Washakie CSD #1

Michael Gregory, Sublette CSD #1

Jennifer Hammock, Fremont CSD #38

Miken Harnish, Platte CSD #1

Barbara Ann Harvey, St. Stephens Indian HS

Ana Houseal, UW

Retta Hudlow, Sublette CSD #1

Jeff Hymas, Etna

London Jenks, Hot Springs CSD #1

Sarah Konrad, Ph.D., UW, WY EPSCOR

Janel Korhonen-Goff, Casper

Barb Marquer, Cheyenne

Brett McDonald, CWC

Dave Mullens, Laramie

Astrid Northrup, NWC (Petroleum Engineer)

Nikki Osterland, Cody

Jenefer Pasqua, Laramie CSD #1

Sarah Ramsey-Walters, UW

Josh Sandlian, Platte CSD #1

JoAnn Schubert, Converse CSD #2

Doug Scribner, Weston CSD #1

Michael Selmer, Laramie

Gary Shockey, Jackson

Sue Spencer, Jelm

Teresa Strube, Albany CSD #1

Bertha Tracy, Rawlins, retired Carbon CSD #1

Lesley Urasky, Carbon CSD #1



Matter and Its Interactions [HS-PS1-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</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>State Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.</p>	Crosscutting Concepts	<p>Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations or phenomena.</p>
	Disciplinary Core Ideas	<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.
	Science & Engineering Practices	<p>Developing and using models 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.9-10.7 Translate quantitative or technical information 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>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>



Matter and Its Interactions [HS-PS1-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS1-2. Construct 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, and revise, as needed.</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.</p> <p>State Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.</p>	Crosscutting Concepts	<p>Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations or phenomena.</p>
	Disciplinary Core Ideas	<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.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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>



Matter and Its Interactions [HS-PS1-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the macroscopic scale to infer the strength of electrical forces between particles.</p> <p><i>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 macroscopic properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.</i></p> <p><i>State Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.</i></p>	Crosscutting Concepts	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.
	Disciplinary Core Ideas	<p>Structure and Properties of Matter:</p> <ul style="list-style-type: none"> The structure and interactions of matter at the macroscopic scale are determined by electrical forces within and between atoms.
	Science & Engineering Practices	<p>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.</p> <ul style="list-style-type: none"> Plan and conduct an investigation individually or collaboratively to produce data to serve as the basis for evidence. In the design: decide on types, amounts, 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).

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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>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>



Matter and Its Interactions [HS-PS1-4]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>Clarification Statement: Emphasis is on the idea that a chemical reaction, as a system, 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.</i></p> <p><i>State Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.</i></p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<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.
	Science & Engineering Practices	<p>Developing and using models 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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>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>



Matter and Its Interactions [HS-PS1-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS1-5. Apply scientific principles and use 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>State 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	<p>Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations or phenomena.</p>
	Disciplinary Core Ideas	<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.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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"> Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
Wyoming Cross-Curricular Connections		
ELA / Literacy Connections		Mathematics Connections
<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>



Matter and Its Interactions [HS-PS1-6]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS1-6. Evaluate the design of a chemical system by changing conditions to produce increased amounts of products at equilibrium, and refine the design, as needed.</p> <p>Clarification Statement: Emphasis is on the application of Le Chatelier’s Principle by evaluating and 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>State 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	Much of science deals with constructing explanations of how things change and how they remain stable.
	Disciplinary Core Ideas	<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 (tradeoffs) may be needed.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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"> Refine a solution to a complex real-world problem, based on scientific knowledge, student- generated sources of evidence, prioritized criteria, and tradeoff considerations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>



Matter and Its Interactions [HS-PS1-7]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.</p> <p><i>Clarification Statement: Emphasis is on using mathematical ideas beyond memorization and rote application of problem solving techniques 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></p> <p><i>State Assessment Boundary: Assessment does not include complex chemical reactions.</i></p>	Crosscutting Concepts	The total amount of energy and matter in closed systems is conserved.
	Disciplinary Core Ideas	<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.
	Science & Engineering Practices	<p>Using mathematics 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.</p> <ul style="list-style-type: none"> Use mathematical representations of phenomena to support claims.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
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>



Matter and Its Interactions [HS-PS1-8]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>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.</i></p> <p><i>State Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.</i></p>	Crosscutting Concepts	<p>In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.</p>
	Disciplinary Core Ideas	<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.
	Science & Engineering Practices	<p>Developing and using models 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.

Wyoming Cross-Curricular Connections

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



Motion and Stability: Forces and Interactions [HS-PS2-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>Clarification Statement: Examples of data could come from lab experiments or 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.</p> <p>State Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.</p>	Crosscutting Concepts	<p>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p>
	Disciplinary Core Ideas	<p>Forces and Motion:</p> <ul style="list-style-type: none"> Newton’s second law accurately predicts changes in the motion of macroscopic objects.
	Science & Engineering Practices	<p>Analyzing and interpreting data in 9–12 builds on K–8 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.</p> <ul style="list-style-type: none"> 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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.11-12.7 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>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> <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> <p>HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.</p> <p>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.</p> <p>HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems.</p> <p>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.</p> <p>HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p> <p>HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by in hand in simple cases and using technology for more complicated cases.</p> <p>HSS-ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).</p>



Motion and Stability: Forces and Interactions [HS-PS2-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.</p> <p>State Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.</p>	Crosscutting Concepts	<p>When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.</p>
	Disciplinary Core Ideas	<p>Forces and Motion:</p> <ul style="list-style-type: none"> Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.
	Science & Engineering Practices	<p>Using mathematics 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.</p> <ul style="list-style-type: none"> Use mathematical representations of phenomena to describe explanations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
N/A	<p>MP.2 Reason abstractly and quantitatively. MP.4 Model with mathematics. 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. HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. 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. HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p>



Motion and Stability: Forces and Interactions [HS-PS2-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>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.</p> <p>State Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.</p> <p>Engineering, Technology & Application of Science Connections HS-ETS1-2 (pg. 247) HS-ETS1-3 (pg. 248) HS-ETS1-4 (pg. 249)</p>	Crosscutting Concepts	Systems can be designed to cause a desired effect.
	Disciplinary Core Ideas	<p>Forces and Motion: If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.</p> <p>Defining and Delimiting Engineering Problems:</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.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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"> Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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>MP.2 Reason abstractly and quantitatively. MP.4 Model with mathematics.</p>



Motion and Stability: Forces and Interactions [HS-PS2-4]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS2-4. Use mathematical representations to predict the gravitational and/or electrostatic forces between objects using Newton’s Law of Gravitation and/or Coulomb’s Law, respectively.</p> <p>Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and/or electric fields.</p> <p>State Assessment Boundary: Assessment is limited to systems with two objects.</p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<p>Types of Interactions:</p> <ul style="list-style-type: none"> • 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. • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. • Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.
	Science & Engineering Practices	<p>Using mathematics 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.</p> <ul style="list-style-type: none"> • Use mathematical representations of phenomena to describe explanations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
N/A	<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> <p>HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.</p> <p>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.</p>



Motion and Stability: Forces and Interactions [HS-PS2-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>State Assessment Boundary: Assessment is limited to designing and conducting investigations with common materials and tools.</p>	Crosscutting Concepts	Systems can be designed to cause a desired effect.
	Disciplinary Core Ideas	<p>Types of Interactions:</p> <ul style="list-style-type: none"> Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.
	Science & Engineering Practices	<p>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.</p> <ul style="list-style-type: none"> Plan and conduct an investigation individually or collaboratively to produce data to serve as the basis for evidence. In the design process decide on types, amounts, 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).

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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>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>



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

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of materials.</p> <p><i>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.</i></p> <p>Engineering, Technology & Application of Science Connections HS-ETS1-1 (pg. 246) HS-ETS1-4 (pg. 249) HS-ETS1-5 (pg. 250)</p>	<p>Crosscutting Concepts</p>	<p>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.</p>
	<p>Disciplinary Core Ideas</p>	<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>Science & Engineering Practices</p>	<p>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).

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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>

Energy [HS-PS3-1]



Performance Expectations (Benchmark)

HS-PS3-1. Create or apply 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.

State 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.

Engineering, Technology & Application of Science Connections
HS-ETS1-4 (pg. 249)

Three Dimensions of Learning

Crosscutting Concepts

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.

Disciplinary Core Ideas

Definitions of Energy:

- 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.

Conservation of Energy and Energy Transfer:

- 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.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- 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.
- The availability of energy limits what can occur in any system.

Science & Engineering Practices

Using mathematics 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.

- Create a computational model or simulation of a phenomenon, designed device, process, or system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections

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.

Mathematics Connections

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

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.

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Energy [HS-PS3-2]



Performance Expectations (Benchmark)

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

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.

Three Dimensions of Learning

Crosscutting Concepts

Energy cannot be created nor destroyed it only moves between one place and another place, between objects and/or fields, or between systems.

Disciplinary Core Ideas

Definitions of Energy:

- 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.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

Science & Engineering Practices

Developing and using models 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 and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections

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.

Mathematics Connections

MP.2 Reason abstractly and quantitatively.
MP.4 Model with mathematics.

Energy [HS-PS3-3]



Performance Expectations (Benchmark)

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 a variety of energy forms and efficiency.

State Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with common materials.

Engineering, Technology & Application of Science Connections
HS-ETS1-2 (pg. 247)
HS-ETS1-4 (pg. 249)

Three Dimensions of Learning

Crosscutting Concepts

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.

Disciplinary Core Ideas

Definitions of Energy:

- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

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.

Interdependence of Science, Engineering, and Technology:

- 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.

Science & Engineering Practices

Constructing explanations (for science) and designing solutions (for engineering) 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, 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections

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.

Social Studies Connections

SS12.3.3 Analyze and evaluate the impact of current and emerging technologies at the micro and macroeconomic levels (e.g., jobs, education, trade, and infrastructure) and their impact on global economic interdependence.

Mathematics Connections

MP.2 Reason abstractly and quantitatively.
MP.4 Model with mathematics.
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.
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Energy [HS-PS3-4]



Performance Expectations (Benchmark)

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.

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.

State Assessment Boundary: Assessment is limited to investigations based on common materials and tools.

Three Dimensions of Learning

Crosscutting Concepts

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.

Disciplinary Core Ideas

Conservation of Energy and Energy Transfer:

- 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).

Science & Engineering Practices

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.

- Plan and conduct an investigation individually or collaboratively to produce data to serve as the basis for evidence. In the design: decide on types, amounts, 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).

Wyoming Cross-Curricular Connections

ELA / Literacy Connections

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.

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.

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.

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Social Studies Connections

SS12.3.3 Analyze and evaluate the impact of current and emerging technologies at the micro and macroeconomic levels (e.g., jobs, education, trade, and infrastructure) and their impact on global economic interdependence.

Mathematics Connections

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

Energy [HS-PS3-5]



Performance Expectations (Benchmark)

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.

State Assessment Boundary: Assessment is limited to systems containing two objects.

Three Dimensions of Learning

Crosscutting Concepts

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.

Disciplinary Core Ideas

Relationship Between Energy and Forces:

- When two objects interacting through a field change relative position, the energy stored in the field is changed.

Science & Engineering Practices

Developing and using models 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections

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.

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.

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

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.

Mathematics Connections

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.



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

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.</p> <p>Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum or glass, sound waves traveling through air or water, and seismic waves traveling through the Earth.</p> <p>State Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.</p> <p>Engineering, Technology & Application of Science Connections HS-ETS1-2 (pg. 247) HS-ETS1-4 (pg. 249) HS-ETS1-5 (pg. 250)</p>	Crosscutting Concepts	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
	Disciplinary Core Ideas	<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.
	Science & Engineering Practices	<p>Using mathematics 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.</p> <ul style="list-style-type: none"> Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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. MP.4 Model with mathematics. HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. 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. HSA-CED.A.4 Rearrange formulas to highlight a quantity in interest, using the same reasoning as in solving equations.</p>



Waves and Their Applications in Technologies for Information Transfer [HS-PS4-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS4-2. Evaluate the advantages and disadvantages of using digital transmission and storage of information.</p> <p><i>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.</i></p> <p>Engineering, Technology & Application of Science Connections HS-ETS1-1 (pg. 246) HS-ETS1-3 (pg. 248) HS-ETS1-5 (pg. 250)</p>	Crosscutting Concepts	Systems can be designed for greater or lesser stability.
	Disciplinary Core Ideas	<p>Wave Properties:</p> <ul style="list-style-type: none"> Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. <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.
	Science & Engineering Practices	<p>Asking questions (for science) and defining problems (for engineering) in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.</p> <ul style="list-style-type: none"> Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Social Studies Connections	Mathematics Connections
<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.</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 conclusion in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.</p>	<p>SS12.3.2 Analyze and evaluate how people organize for the production, distribution, and consumption of goods and services in various economic systems (e.g., capitalism, communism, and socialism).</p> <p>SS12.3.3 Analyze and evaluate the impact of current and emerging technologies at the micro and macroeconomic levels (e.g., jobs, education, trade, and infrastructure) and their impact on global economic interdependence.</p> <p>SS12.6.1 Analyze, evaluate, and/or synthesize multiple sources of information in diverse formats and media 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>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>



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

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-PS4-3. Evaluate evidence 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><i>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.</i></p> <p><i>State Assessment Boundary: Assessment does not include using quantum theory.</i></p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<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.
	Science & Engineering Practices	<p>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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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.</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 conclusion 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>HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.</p> <p>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.</p> <p>HSA-CED.A.4 Rearrange formulas to highlight a quantity in interest, using the same reasoning as in solving equations.</p>



Rationale for Removal of HS-PS4-4:

- This standard was re-written as HS-ETS1-5 (see page 250)
- The intent of the science and engineering practice was kept and the application broadened to encompass all science disciplines.
- Removal does not affect the learning progressions.



Waves and Their Applications in Technologies for Information Transfer [HS-PS4-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.</i></p> <p><i>State Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.</i></p> <p>Engineering, Technology & Application of Science Connections HS-ETS1-1 (pg. 246) HS-ETS1-3 (pg. 248)</p>	Crosscutting Concepts	<p>Systems can be designed to cause a desired effect.</p>
	Disciplinary Core Ideas	<p>Energy in Chemical Processes:</p> <ul style="list-style-type: none"> Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy. <p>Wave Properties:</p> <ul style="list-style-type: none"> Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. <p>Electromagnetic Radiation:</p> <ul style="list-style-type: none"> Photoelectric materials emit electrons when they absorb light of a high- enough frequency. <p>Information Technologies and Instrumentation:</p> <ul style="list-style-type: none"> Multiple technologies based on the understanding of waves and their interactions with matter are part of every day 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. <p>Interdependence of Science, Engineering, and Technology:</p> <ul style="list-style-type: none"> Modern civilization depends on major technological systems.
	Science & Engineering Practices	<p>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 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).

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Social Studies Connections	Mathematics Connections
<p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p>	<p>SS12.6.2 Assess the extent to which the reasoning and evidence in a text supports the author's claims.</p>	<p>MP.2 Reason abstractly and quantitatively. MP.4 Model with mathematics. 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.</p>

High School



Students in high school continue their learning from the middle school grades to develop more complete understanding of these four areas: Physical Science, Life Science, Earth and Space Science, and Engineering, Technology, and Applications of Science.

These standards and benchmarks include the most fundamental concepts of science, but are intended to leave room for expanded study in upper-level high school courses. The high school performance expectations allow high school students to explain more in-depth phenomena across the science disciplines, **science and engineering practices**, and **crosscutting concepts**.

The **Science and Engineering Practices** students will be expected to perform are :

1. ask relevant questions and define problems
2. develop and use models
3. plan and carry out investigations
4. analyze and interpret data
5. use mathematics and computational thinking
6. construct explanations and design solutions
7. engage in argument from evidence
8. obtain, evaluate, and communicate information

The **Crosscutting Concepts** that help students deepen their understanding of the **disciplinary core ideas** and develop a coherent and scientifically-based view of the world are:

1. patterns
2. cause and effect: mechanisms, and explanation
3. scale, proportion, and quantity
4. systems and system models
5. energy and matter: flows, cycles, and conservation
6. structure and function
7. stability and change

Life Sciences

Students in high school develop an understanding of key concepts that will help them make sense of life science. The ideas are built upon students' science understanding of **disciplinary core ideas**, **science and engineering practices**, and **crosscutting concepts** from earlier grades. There are four life science **Disciplinary Core Ideas** in high school: 1) *From Molecules to Organisms: Structures and Processes*, 2) *Ecosystems: Interactions, Energy, and Dynamics*, 3) *Heredity: Inheritance and Variation of Traits*, and 4) *Biological Evolution: Unity and Diversity*. The performance expectations for high school life science blend **core ideas** with **scientific and engineering practices** and **crosscutting concepts** to support students in developing useable knowledge that can be applied across the science disciplines. While the performance expectations in high school life science couple particular practices with specific **disciplinary core ideas**, instructional decisions should include use of many practices underlying the performance expectations.

The performance expectations in **LS1: From Molecules to Organisms: Structures and Processes** help students formulate an answer to the question, "How do organisms live and grow?" The LS1 **Disciplinary Core Idea** is presented as three components: **Structure and Function**, **Growth and Development of Organisms**, and **Organization for Matter and Energy Flow in Organisms**. In these performance expectations, students demonstrate that they can use investigations and gather evidence to support explanations of cell function and reproduction. They understand the role of proteins as essential to the work of the cell and living systems. Students can use models to explain photosynthesis, respiration, and the cycling of matter and flow of energy in living organisms. The cellular processes can be used as a model for understanding of the hierarchical organization of organism.

The performance expectations in **LS2: Ecosystems: Interactions, Energy, and Dynamics** help students formulate an answer to the question, "How and why do organisms interact with their environment, and what are the effects of these interactions?" The LS2 **Disciplinary Core Idea** includes four components: **Interdependent Relationships in Ecosystems**, **Cycles of Matter and Energy Transfer in Ecosystems**, **Ecosystem Dynamics, Functioning and Resilience**, and **Social**



High School Life Sciences (continued)

Interactions and Group Behavior. High school students can use mathematical reasoning to demonstrate understanding of fundamental concepts of carrying capacity, factors affecting biodiversity and populations, and the cycling of matter and flow of energy among organisms in an ecosystem. These mathematical models provide support of students' conceptual understanding of systems and their ability to develop design solutions for reducing the impact of human activities on the environment and maintaining biodiversity.

The performance expectations in **LS3: Heredity: Inheritance and Variation of Traits** help students formulate answers to the questions: "How are characteristics of one generation passed to the next? How can individuals of the same species and even siblings have different characteristics?" The LS3 **Disciplinary Core Idea** includes two components: **Inheritance of Traits** and **Variation of Traits**. Students are able to ask questions, make and defend a claim, and use concepts of probability to explain the genetic variation in a population. Students demonstrate understanding of why individuals of the same species vary in how they look, function, and behave. Students can explain the mechanisms of genetic inheritance and describe the environmental and genetic causes of gene mutation and the alteration of gene expression.

The performance expectations in **LS4: Biological Evolution: Unity and Diversity** help students formulate an answer to the question, "What evidence shows that different species are related?" The LS4 **Disciplinary Core Idea** involves four components: **Evidence of Common Ancestry and Diversity**, **Natural Selection**, **Adaptation**, and **Biodiversity and Humans**. Students can construct explanations for the processes of natural selection and evolution and communicate how multiple lines of evidence support these explanations. Students can evaluate evidence of the conditions that may result in new

species and understand the role of genetic variation in natural selection. Additionally, students can apply concepts of probability to explain trends in populations as those trends relate to advantageous heritable traits in a specific environment.

The **crosscutting concepts** of **cause and effect** and **systems and system models** play an important role in students' understanding of the evolution of life on Earth.



From Molecules to Organisms: Structure and Processes [HS-LS1-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS1-1. 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.</p> <p><i>Clarification Statement: Explanations emphasize basic DNA replication, transcription, and translation.</i></p> <p><i>State 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.</i></p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<p>Structure and Function:</p> <ul style="list-style-type: none"> Systems of specialized cells within organisms help them perform the essential functions of life. 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, which carry out most of the work of cells.
	Science & Engineering Practices	<p>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 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p> <p>WHST.9-12.9 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>



From Molecules to Organisms: Structure and Processes [HS-LS1-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multi-cellular organisms.</p> <p><i>Clarification Statement:</i> 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.</p> <p><i>State Assessment Boundary:</i> Assessment does not include interactions and functions at the molecular or chemical reaction level.</p>	<p>Crosscutting Concepts</p>	<p>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.</p>
	<p>Disciplinary Core Ideas</p>	<p>Structure and Function:</p> <ul style="list-style-type: none"> Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.
	<p>Science & Engineering Practices</p>	<p>Developing and using models 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 and use a model based on evidence to illustrate the relationships between systems or between components of a system.
Wyoming Cross-Curricular Connections		
<p>ELA / Literacy Connections</p>		<p>Mathematics Connections</p>
<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.2 Reason abstractly and quantitatively. MP.4 Model with mathematics.</p>



From Molecules to Organisms: Structure and Processes [HS-LS1-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.</p> <p><i>Clarification Statement: Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.</i></p> <p><i>State Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.</i></p>	Crosscutting Concepts	Feedback (negative and positive) can stabilize or destabilize a system.
	Disciplinary Core Ideas	<p>Structure and Function:</p> <ul style="list-style-type: none"> Feedback mechanisms maintain a living system’s internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Outside that range (e.g., at a too high or too low external temperature, with too little food or water available) the organism cannot survive.
	Science & Engineering Practices	<p>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.</p> <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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p> <p>HSF-BF.A.1 Write a function that describes a relationship between two quantities.</p>



From Molecules to Organisms: Structure and Processes [HS-LS1-4]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.</p> <p>Clarification Statement: Cellular division should include a description of the entire cell cycle along with the phases of mitosis.</p> <p>State Assessment Boundary: Assessment does not include specific gene control mechanisms.</p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<p>Growth and Development of Organisms:</p> <ul style="list-style-type: none"> 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.
	Science & Engineering Practices	<p>Developing and using models 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 based on evidence to illustrate the relationships between systems or between components of a system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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>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.</p> <p>HSF-BF.A.1 Write a function that describes a relationship between two quantities.</p>



From Molecules to Organisms: Structure and Processes [HS-LS1-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.</p> <p><i>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.</i></p> <p><i>State Assessment Boundary: Assessment does not include specific biochemical steps.</i></p>	<p>Crosscutting Concepts</p>	<p>Changes in energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.</p>
	<p>Disciplinary Core Ideas</p>	<p>Organization for Matter and Energy Flow in Organisms:</p> <ul style="list-style-type: none"> The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
	<p>Science & Engineering Practices</p>	<p>Developing and using models 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 based on evidence to illustrate the relationships between systems or between components of a system.
Wyoming Cross-Curricular Connections		
ELA / Literacy Connections		Mathematics Connections
<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.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p> <p>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.</p>



From Molecules to Organisms: Structure and Processes [HS-LS1-6]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS1-6. Construct explanations and revise, as needed, based on evidence for: 1) how carbon, hydrogen, and oxygen may combine with other elements to form amino acids and/or other large carbon-based molecules, and 2) how other hydrocarbons may also combine to form large carbon-based molecules.</p> <p>Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations. Other hydrocarbons should include, but are not limited to: lipids, carbohydrates, and proteins.</p> <p>State Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecule subgroups, such as saturated vs. unsaturated fats or identification of specific amino acids.</p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<p>Organization for Matter and Energy Flow:</p> <ul style="list-style-type: none"> The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into large molecules that can be assembled into large molecules (such as proteins or DNA), used for example to form new cells. As matter and energy flow through different organization levels of living systems, chemical elements are recombined in different ways to form different products.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <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>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> <p>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.</p>



From Molecules to Organisms: Structure and Processes [HS-LS1-7]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of sugar molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.</p> <p>Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration. The term “molecules” is synonymous with “food” in other grade level bands.</p> <p>State Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.</p>	Crosscutting Concepts	<p>Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.</p>
	Disciplinary Core Ideas	<p>Organization for Matter and Energy Flow in Organisms:</p> <ul style="list-style-type: none"> As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.
	Science & Engineering Practices	<p>Developing and using models 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 based on evidence to illustrate the relationships between systems or between components of a system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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.2 Reason abstractly and quantitatively. MP.4 Model with mathematics.</p>



Ecosystems: Interactions, Energy, and Dynamics [HS-LS2-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.</p> <p>Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among independent factors including boundaries, resources, climate, and competition in the Rocky Mountain region. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical, regional, or current data sets.</p> <p>State Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.</p> <p>Engineering , Technology & Application of Science Connections—HS-ETS1-4 (pg. 249)</p>	Crosscutting Concepts	The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
	Disciplinary Core Ideas	<p>Interdependent Relationships in Ecosystems:</p> <ul style="list-style-type: none"> 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.
	Science & Engineering Practices	<p>Using mathematics 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.</p> <ul style="list-style-type: none"> Use mathematical and/or computational representations of phenomena or design solutions to support explanations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</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>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>



Ecosystems: Interactions, Energy, and Dynamics [HS-LS2-2]

HS Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data. Revision refers to the scientific practice of modifying explanations using additional data analysis and/or research.</p> <p>State Assessment Boundary: Assessment is limited to provided data.</p> <p>Engineering, Technology, and Applications of Science Connections—HS-ETS1-4 (pg. 249)</p>	Crosscutting Concepts	Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.
	Disciplinary Core Ideas	<p>Interdependent Relationships in Ecosystems:</p> <ul style="list-style-type: none"> 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. <p>Ecosystem Dynamics, Functioning, and Resilience:</p> <ul style="list-style-type: none"> 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.
	Science & Engineering Practices	<p>Using mathematics 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.</p> <ul style="list-style-type: none"> Use mathematical representations of phenomena or design solutions to support and revise explanations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</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>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>



Ecosystems: Interactions, Energy, and Dynamics [HS-LS2-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS2-3. Construct an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions, and revise as needed.</p> <p>Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments. Examples could include bioremediation of hydrocarbons or other materials, sewage / waste treatment, or decomposition.</p> <p>State Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.</p> 	Crosscutting Concepts	Energy drives the cycling of matter within and between systems.
	Disciplinary Core Ideas	<p>Cycles of Matter and Energy Transfer in Ecosystems:</p> <ul style="list-style-type: none"> • Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <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>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>



Ecosystems: Interactions, Energy, and Dynamics [HS-LS2-4]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.</p> <p>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.</p> <p>State Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.</p>	Crosscutting Concepts	<p>Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.</p>
	Disciplinary Core Ideas	<p>Cycles of Matter and Energy Transfer in Ecosystems:</p> <ul style="list-style-type: none"> Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.
	Science & Engineering Practices	<p>Using mathematics 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.</p> <ul style="list-style-type: none"> Use mathematical representations of phenomena or design solutions to support claims.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
N/A	<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>



Ecosystems: Interactions, Energy, and Dynamics [HS-LS2-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>State Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.</p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<p>Cycles of Matter and Energy Transfer in Ecosystems:</p> <ul style="list-style-type: none"> 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. <p>Energy in Chemical Processes:</p> <ul style="list-style-type: none"> The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.
	Science & Engineering Practices	<p>Developing and using models 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 components of a system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
N/A		<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>



Ecosystems: Interactions, Energy, and Dynamics [HS-LS2-6]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex biotic and abiotic interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a modified ecosystem.</p> <p><i>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.</i></p> <p>Engineering , Technology & Application of Science Connections—HS-ETS1-5 (pg. 250)</p>	Crosscutting Concepts	Much of science deals with constructing explanations of how things change and how they remain stable.
	Disciplinary Core Ideas	<p>Ecosystem Dynamics, Functioning, and Resilience:</p> <ul style="list-style-type: none"> • 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.
	Science & Engineering Practices	<p>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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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.</p> <p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <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>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>HSS-ID.A.1 Represent data with plots on the real number line.</p> <p>HSS-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.</p> <p>HSS-IC.B.6 Evaluate reports based on data.</p>



Ecosystems: Interactions, Energy, and Dynamics [HS-LS2-7]

Performance Expectations (Benchmark)

Three Dimensions of Learning

HS-LS2-7. Evaluate and assess impacts on the environment and biodiversity in order to refine or design a solution for detrimental impacts or enhancement for positive impacts.

Clarification Statement: Examples of impacts could include urbanization, reclamation projects, building dams, habitat restoration, and dissemination of invasive species.

Engineering , Technology & Application of

Science Connections

HS-ETS1-1 (pg. 246)

HS-ETS1-2 (pg. 247)

HS-ETS1-3 (pg. 248)

HS-ETS1-4 (pg. 249)

Crosscutting Concepts

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

Disciplinary Core Ideas

Ecosystem Dynamics, Functioning, and Resilience:

- Moreover, anthropogenic changes (included 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.

Biodiversity and Humans:

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

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.

Science & Engineering Practices

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, 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections

- 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.
- 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.
- 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.
- 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.

Mathematics Connections

- MP.2** Reason abstractly and quantitatively.
- 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.
- HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling.
- HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.



Ecosystems: Interactions, Energy, and Dynamics [HS-LS2-8]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.</p> <p><i>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.</i></p>	Crosscutting Concepts	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
	Disciplinary Core Ideas	<p>Social Interactions and Group Behavior:</p> <ul style="list-style-type: none"> Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.
	Science & Engineering Practices	<p>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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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.</p> <p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <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>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>MP.4 Model with mathematics.</p>



Heredity: Inheritance and Variation of Traits [HS-LS3-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>State Assessment Boundary: Assessment does not include the biochemical mechanism of specific steps in the process.</p>	Crosscutting Concepts	<p>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p>
	Disciplinary Core Ideas	<p>Structure and Function:</p> <ul style="list-style-type: none"> 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. <p>Inheritance of Traits:</p> <ul style="list-style-type: none"> 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 protein, some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known functions.
	Science & Engineering Practices	<p>Asking questions (for science) and defining problems (for engineering) in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.</p> <ul style="list-style-type: none"> Ask question that arise from examining models or a theory to clarify relationships.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>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.</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>



Heredity: Inheritance and Variation of Traits [HS-LS3-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.</p> <p>State Assessment Boundary: Assessment does not include the biochemical mechanism of specific steps in the process.</p> <p>Engineering , Technology & Application of Science Connections—HS-ETS1-5 (pg. 250)</p>	Crosscutting Concepts	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
	Disciplinary Core Ideas	<p>Variation of Traits:</p> <ul style="list-style-type: none"> 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 cause mutations in genes, and variables mutations are inherited. Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in the population. Thus the variation and distribution of traits observe depends on both genetic and environmental factors.
	Science & Engineering Practices	<p>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"> Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>WHST.9-12.1 Write arguments focused on discipline-specific content.</p>		<p>MP.2 Reason abstractly and quantitatively.</p>



Heredity: Inheritance and Variation of Traits [HS-LS3-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.</p> <p><i>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.</i></p> <p><i>State Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.</i></p>	Crosscutting Concepts	<p>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).</p>
	Disciplinary Core Ideas	<p>Variation of Traits:</p> <ul style="list-style-type: none"> Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in the population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.
	Science & Engineering Practices	<p>Analyzing and interpreting data in 9–12 builds on K–8 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.</p> <ul style="list-style-type: none"> 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.
Wyoming Cross-Curricular Connections		
ELA / Literacy Connections		Mathematics Connections
N/A		MP.2 Reason abstractly and quantitatively.



Biological Evolution: Unity and Diversity [HS-LS4-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.</p> <p><i>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, biochemical similarities, and order of appearance of structures in embryological development.</i></p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<p>Evidence of Common Ancestry and Diversity:</p> <ul style="list-style-type: none"> Genetic information provides evidence of common ancestry and diversity. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.
	Science & Engineering Practices	<p>Analyzing and interpreting data in 9-12 builds on K-8 experiences and progress to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.</p> <ul style="list-style-type: none"> Analyze and interpret data to determine similarities and differences in findings.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p> <p>WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>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.</p>		<p>MP.2 Reason abstractly and quantitatively.</p>



Biological Evolution: Unity and Diversity [HS-LS4-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>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.</p> <p>State Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.</p>	Crosscutting Concepts	<p>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p>
	Disciplinary Core Ideas	<p>Natural Selection: Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.</p>
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p> <p>WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>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.</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>



Biological Evolution: Unity and Diversity [HS-LS4-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations. Further development may include allele frequency calculations.</p> <p>State Assessment Boundary: Assessment is based on statistical and graphical analysis.</p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<p>Natural Selection:</p> <ul style="list-style-type: none"> Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. <p>Adaptation:</p> <ul style="list-style-type: none"> 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. Adaptation also means that the distribution of traits in a population can change when conditions change.
	Science & Engineering Practices	<p>Analyzing and interpreting data in 9–12 builds on K–8 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.</p> <ul style="list-style-type: none"> 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p> <p>WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.</p>		<p>MP.2 Reason abstractly and quantitatively.</p>



Biological Evolution: Unity and Diversity [HS-LS4-4]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.</p> <p><i>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 change in climate, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.</i></p>	Crosscutting Concepts	<p>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p>
	Disciplinary Core Ideas	<p>Adaptation:</p> <ul style="list-style-type: none"> 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. 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.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p> <p>WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.</p>		<p>MP.2 Reason abstractly and quantitatively.</p>



Biological Evolution: Unity and Diversity [HS-LS4-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>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.</i></p> <p>Engineering , Technology & Application of Science Connections HS-ETS1-5 (pg. 250)</p>	Crosscutting Concepts	<p>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p>
	Disciplinary Core Ideas	<p>Adaptation:</p> <ul style="list-style-type: none"> 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. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species’ adaptation over time is lost.
	Science & Engineering Practices	<p>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 evidence behind currently accepted explanations or solutions to determine the merits of arguments.

Wyoming Cross-Curricular Connections

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



Biological Evolution: Unity and Diversity [HS-LS4-6]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-LS4-6. Create and/or use a simulation to evaluate the impacts of human activity on biodiversity.</p> <p><i>Clarification Statement: Emphasis is on examining positive and negative impacts of human activity. Examples could include cost benefit analysis of proposed actions, protection for threatened or endangered species, reclamation projects and/or efforts to maintain biodiversity.</i></p>  <p>Engineering , Technology & Application of Science Connections HS-ETS1-1 (pg. 246) HS-ETS1-2 (pg. 247) HS-ETS1-3 (pg. 248) HS-ETS1-4 (pg. 249)</p>	Crosscutting Concepts	<p>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p>
	Disciplinary Core Ideas	<p>Adaptation:</p> <ul style="list-style-type: none"> 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.
	Science & Engineering Practices	<p>Using Mathematics and Computational Thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, and 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.</p> <ul style="list-style-type: none"> Create or revise a simulation of a phenomenon, designed device, process, or system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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>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>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>

High School



Students in high school continue their learning from the middle school grades to develop more complete understanding of these four areas: Physical Science, Life Science, Earth and Space Science, and Engineering, Technology, and Applications of Science.

These standards and benchmarks include the most fundamental concepts of science, but are intended to leave room for expanded study in upper-level high school courses. The high school performance expectations allow high school students to explain more in-depth phenomena across the science disciplines, **science and engineering practices**, and **crosscutting concepts**.

The **Science and Engineering Practices** students will be expected to perform are :

1. ask relevant questions and define problems
2. develop and use models
3. plan and carry out investigations
4. analyze and interpret data
5. use mathematics and computational thinking
6. construct explanations and design solutions
7. engage in argument from evidence
8. obtain, evaluate, and communicate information

The **Crosscutting Concepts** that help students deepen their understanding of the **disciplinary core ideas** and develop a coherent and scientifically-based view of the world are:

1. patterns
2. cause and effect: mechanisms, and explanation
3. scale, proportion, and quantity
4. systems and system models
5. energy and matter: flows, cycles, and conservation
6. structure and function
7. stability and change

Earth & Space Sciences

Students in high school continue to develop their understanding of the three **disciplinary core ideas** in the Earth and Space Sciences. The high school performance expectations in Earth and Space Science build on the middle school ideas and skills and allow high school students to explain more in-depth phenomena central not only to the earth and space sciences, but to life and physical sciences as well. These performance expectations blend the **core ideas** with **scientific and engineering practices** and **crosscutting concepts** to support students in developing useable knowledge to explain ideas across the science disciplines. While the performance expectations shown in high school earth and space science couple particular practices with specific **disciplinary core ideas**, instructional decisions should include use of many **practices** that lead to the performance expectations.

The performance expectations in **ESS1: Earth's Place in the Universe**, help students formulate an answer to the question: "What is the universe, and what is Earth's place in it?" The ESS1 **Disciplinary Core Idea** is broken down into three components: **The Universe and Its Stars**, **Earth and the Solar System**, and **The History of Planet Earth**. Students examine the processes governing the formation, evolution, and workings of the solar system and universe. Some concepts studied are fundamental to science, such as understanding how the matter of our world formed during the Big Bang and within the cores of stars. Others concepts are practical, such as understanding how short-term changes in the behavior of our sun directly affect humans. Engineering and technology play a large role here in obtaining and analyzing the data that support the theories of the formation of the solar system and universe.

The performance expectations in **ESS2: Earth's Systems**, help students formulate an answer to the question: "How and why is Earth constantly changing?" The ESS2 **Disciplinary Core Idea** is broken down into five components: **Earth Materials and Systems**, **Plate Tectonics and Large-Scale System Interactions**, **The Roles of Water in Earth's Surface**, **Processes, Weather and Climate**, and **Biogeology**. Students develop models and explanations for the ways that feedbacks between different Earth systems control the appearance of Earth's surface. Central



High School Earth & Space Sciences (continued)

to this is the tension between internal systems, which are largely responsible for creating land at Earth's surface, and the sun-driven surface systems that tear down the land through weathering and erosion. Students begin to examine the ways that human activities cause feedbacks that create changes to other systems. Students understand the system interactions that control weather and climate, with a major emphasis on the mechanisms and implications of climate change. Students model the flow of energy between different components of the weather system and how this affects chemical cycles such as the carbon cycle.

The performance expectations in **ESS3: Earth and Human Activity** help students formulate an answer to the question: "How do Earth's surface processes and human activities affect each other?" The ESS3 **Disciplinary Core Idea** is broken down into four components: **Natural Resources**, **Natural Hazards**, **Human Impact on Earth Systems**, and **Global Climate Change**. Students understand the complex and significant interdependencies between humans and the rest of Earth's systems through the impacts of natural hazards, our dependencies on natural resources, and the significant environmental impacts of human activities. Engineering and technology figure prominently here, as students use mathematical thinking and the analysis of geoscience data to examine and construct solutions to the many challenges facing long-term human sustainability on Earth.



Earth's Place in the Universe [HS-ESS1-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>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-cyclic variations over centuries.</i></p> <p><i>State Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.</i></p>	Crosscutting Concepts	<p>The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.</p>
	Disciplinary Core Ideas	<p>The Universe and Its Stars:</p> <ul style="list-style-type: none"> The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. <p>Energy in Chemical Processes and Everyday Life:</p> <p>Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.</p>
	Science & Engineering Practices	<p>Developing and using models 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 components of a system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</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 in 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> <p>HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.</p> <p>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.</p> <p>HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p>



Earth's Place in the Universe [HS-ESS1-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>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).</i></p>	Crosscutting Concepts	Energy cannot be created or destroyed—only moved between one place and another place, between objects and/or fields, or between systems.
	Disciplinary Core Ideas	<p>The Universe and Its Stars:</p> <ul style="list-style-type: none"> See page 226a that follows. <p>Electromagnetic Radiation:</p> <ul style="list-style-type: none"> See page 226a that follows.
	Science & Engineering Practices	<p>Constructing Explanations and Designing Solutions</p> <ul style="list-style-type: none"> Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</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 in 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> <p>HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.</p> <p>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.</p> <p>HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p>



Earth's Place in the Universe [HS-ESS1-2] continued

Disciplinary Core Ideas

The Universe and Its Stars:

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
- 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.
- 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.

Electromagnetic Radiation:

- 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.



Earth's Place in the Universe [HS-ESS1-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.</p> <p><i>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.</i></p> <p><i>State Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.</i></p>	Crosscutting Concepts	In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
	Disciplinary Core Ideas	<p>The Universe and Its Stars:</p> <ul style="list-style-type: none"> The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. Other than the hydrogen and helium, 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.
	Science & Engineering Practices	<p>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 information (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).

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<p>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p> <p>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.</p>		<p>MP.2 Reason abstractly and quantitatively.</p>



Earth's Place in the Universe [HS-ESS1-4]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.</p> <p><i>Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as natural solar system objects.</i></p> <p><i>State 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.</i></p>	Crosscutting Concepts	<p>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).</p>
	Disciplinary Core Ideas	<p>Earth and the Solar System:</p> <ul style="list-style-type: none"> Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. <p>Interdependence of Science, Engineering, and Technology:</p> <ul style="list-style-type: none"> Science and engineering compliment 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.
	Science & Engineering Practices	<p>Using mathematics 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.</p> <ul style="list-style-type: none"> Use mathematical representations of phenomena or design solutions to support and revise explanations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
N/A	<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 in 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> <p>HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context.</p> <p>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.</p> <p>HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p>



Earth's Place in the Universe [HS-ESS1-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>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 decreasing with distance away from a central ancient core (a result of past plate interactions).</i></p>	Crosscutting Concepts	<p>Much of science deals with constructing explanations of how things change and how they remain stable.</p>
	Disciplinary Core Ideas	<p>Plate Tectonics and Large-Scale System Interactions:</p> <ul style="list-style-type: none"> • 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.
	Science & Engineering Practices	<p>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"> • Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p>RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a scientific or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.</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 in 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>



Earth's Place in the Universe [HS-ESS1-6]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>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. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest rocks), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.</i></p>	Crosscutting Concepts	<p>Much of science deals with constructing explanations of how things change and how they remain stable.</p>
	Disciplinary Core Ideas	<p>History of Planet Earth:</p> <ul style="list-style-type: none"> Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over years. Studying these objects can provide information about Earth's formation and early history.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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"> Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</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>WHST.9-12.1 Write arguments focused on <i>discipline-specific content</i>.</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 in 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> <p>HSF-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.</p> <p>HSS-ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how those variables are related.</p>



Earth's Systems [HS-ESS2-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>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). Focus on the varying rates of process.</i></p> <p><i>State Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.</i></p>	Crosscutting Concepts	Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.
	Disciplinary Core Ideas	<p>Earth Materials and Systems:</p> <ul style="list-style-type: none"> Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. <p>Plate Tectonics and Large-Scale System Interactions:</p> <ul style="list-style-type: none"> Plate tectonics is the unifying theory that explains the past and current movements of 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.
	Science & Engineering Practices	<p>Developing and using models 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 components of a system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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.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 in 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>



Earth's Systems [HS-ESS2-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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 systems.</p> <p>Clarification Statement: Examples of system interactions could include how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; how a decrease in greenhouse gases contributes to a decrease in global surface temperature which leads to an increase in glacial ice, or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.</p> <p>Engineering , Technology & Application of Science Connections HS-ETS1-5 (pg. 250)</p>	Crosscutting Concepts	Feedback (negative or positive) can stabilize or destabilize a system.
	Disciplinary Core Ideas	<p>Earth Materials and Systems:</p> <ul style="list-style-type: none"> Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. <p>Weather and Climate:</p> <ul style="list-style-type: none"> The foundation for Earth's global climate system 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.
	Science & Engineering Practices	<p>Analyzing and interpreting data in 9–12 builds on K–8 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.</p> <ul style="list-style-type: none"> 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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.11-12.2 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.</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 in 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>



Earth's Systems [HS-ESS2-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.</p> <p><i>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.</i></p>	Crosscutting Concepts	Energy drives the cycling of matter within and between systems.
	Disciplinary Core Ideas	<p>Earth Materials and Systems:</p> <ul style="list-style-type: none"> Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface features, its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. <p>Plate Tectonics and Large-Scale System Interactions:</p> <ul style="list-style-type: none"> The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. <p>Waves Properties: (secondary to HS-ESS2-3)</p> <ul style="list-style-type: none"> Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.
	Science & Engineering Practices	<p>Developing and using models 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 components of a system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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>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.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 in 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>



Earth's Systems [HS-ESS2-4]

Performance Expectations (Benchmark)

Three Dimensions of Learning

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.

State 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.

Engineering , Technology & Application of Science Connections

HS-ETS1-4 (pg. 249)

HS-ETS1-5 (pg. 250)

Crosscutting Concepts

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

Disciplinary Core Ideas

Earth and the Solar System:

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the Earth. These phenomena cause a cycle of ice ages and other changes in climate.

Earth Materials and Systems:

- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

Weather and Climate:

- The foundation for Earth's global climate system 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.

Science & Engineering Practices

Analyzing and interpreting data in 9–12 builds on K–8 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 computational models in order to make valid and reliable scientific claims.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections

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.

Mathematics Connections

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

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

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.



Earth's Systems [HS-ESS2-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.</p> <p><i>Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids). Emphasis could be on local, regional and Wyoming state hydrological resources and features.</i></p> 	<p>Crosscutting Concepts</p>	<p>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.</p>
	<p>Disciplinary Core Ideas</p>	<p>The Role of Water in Earth's Surface Processes:</p> <ul style="list-style-type: none"> 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.
	<p>Science & Engineering Practices</p>	<p>Planning and carrying out investigations in 9-12 builds on 6-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.</p> <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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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>HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>



Earth's Systems [HS-ESS2-6]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.</p> <p><i>Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.</i></p> <p>Engineering , Technology & Application of Science Connections HS-ETS1-4 (pg. 249)</p>	Crosscutting Concepts	The total amount of energy and matter in closed systems is conserved.
	Disciplinary Core Ideas	<p>Biogeology:</p> <ul style="list-style-type: none"> Organisms ranging from bacteria to human beings are a major driver of the global carbon and they influence global climate by modifying the chemical makeup of the atmosphere. The abundance of carbon in the atmosphere is reduced through the ocean floor accumulation of marine sediments and the accumulation of plant biomass.
	Science & Engineering Practices	<p>Developing and using models 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 components of a system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
N/A		<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 in 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>



Earth's Systems [HS-ESS2-7]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.</p> <p><i>Clarification Statement:</i> Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.</p> <p><i>State Assessment Boundary:</i> Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.</p> <p>Engineering , Technology & Application of Science Connections HS-ETS1-5 (pg. 250)</p>	<p>Crosscutting Concepts</p>	<p>Much of science deals with constructing explanations of how things change and how they remain stable.</p>
	<p>Disciplinary Core Ideas</p>	<p>Weather and Climate:</p> <ul style="list-style-type: none"> Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. <p>Biogeology:</p> <ul style="list-style-type: none"> The many dynamic and delicate feedback mechanisms between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.
	<p>Science & Engineering Practices</p>	<p>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"> Construct an oral and written argument or counter-arguments based on data and evidence.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<p>WHST.9-12.1 Write arguments focused on <i>discipline-specific content</i>.</p>		<p>MP.2 Reason abstractly and quantitatively. MP.4 Model with mathematics.</p>



Earth and Human Activity [HS-ESS3-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>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.</p> <p>Engineering , Technology & Application of Science Connections HS-ETS1-1 (pg. 246) HS-ETS1-5 (pg. 250)</p> 	Crosscutting Concepts	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
	Disciplinary Core Ideas	<p>Natural Resources:</p> <ul style="list-style-type: none"> Resource availability has guided the development of human society. <p>Natural Hazards:</p> <ul style="list-style-type: none"> 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.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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 in 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>



Earth and Human Activity [HS-ESS3-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS3-2. Evaluate competing design solutions for developing, managing, and using energy and mineral resources based on cost-benefit ratios.</p> <p><i>Clarification Statement: Cost-benefit analysis should be based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, and ethical considerations). Emphasis needs to include the conservation, recycling, and reuse of resources (e.g., minerals, metals, and water) where possible, and on minimizing impacts where it is not. Examples include developing best practices for wind, hydroelectric, and solar energy, agricultural soil use, mining (for coal, and oil shales), and pumping (for petroleum and natural gas).</i></p> <p>Engineering , Technology & Application of Science Connections HS-ETS1-1 (pg. 246) HS-ETS1-3 (pg. 248) HS-ETS1-5 (pg. 250)</p> 	Crosscutting Concepts	<p>Engineers continuously modify these systems to increase benefits while decreasing costs and risks. Analysis of costs and benefits is a critical aspect of decisions about technology.</p>
	Disciplinary Core Ideas	<p>Natural Resources:</p> <ul style="list-style-type: none"> 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. Developing Possible Solutions: (secondary to HS-ESS3-2) 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.
	Science & Engineering Practices	<p>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 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).

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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>



Earth and Human Activity [HS-ESS3-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS3-3. Use computational tools to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.</p> <p><i>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.</i></p> <p>Engineering , Technology, & Application of Science Connections HS-ETS1-1 (pg. 246) HS-ETS1-2 (pg. 247) HS-ETS1-3 (pg. 248) HS-ETS1-4 (pg. 249) HS-ETS1-5 (pg. 250)</p>	Crosscutting Concepts	Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.
	Disciplinary Core Ideas	<p>Human Impacts on Earth Systems:</p> <ul style="list-style-type: none"> The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
	Science & Engineering Practices	<p>Using mathematics 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.</p> <ul style="list-style-type: none"> Create a computational model or simulation of a phenomenon, design device, process or system.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
N/A		<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>



Earth and Human Activity [HS-ESS3-4]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.</p> <p><i>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). Technological solutions to evaluate could include landscape reclamation, reducing, reusing, and recycling resources, emission control systems, or evaporation control.</i></p> <p><i>Examples for limiting future impacts could range from local efforts to large-scale design solutions.</i></p> <p>Engineering , Technology & Application of Science Connections HS-ETS1-1 (pg. 246) HS-ETS1-3 (pg. 248) HS-ETS1-4 (pg. 249) HS-ETS1-5 (pg. 250)</p>	Crosscutting Concepts	Feedback (negative or positive) can stabilize or destabilize a system.
	Disciplinary Core Ideas	<p>Human Impacts on Earth Systems:</p> <ul style="list-style-type: none"> Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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"> Design or refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
<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>HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose in 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>



Earth and Human Activity [HS-ESS3-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS3-5. Analyze 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.</p> <p><i>Clarification Statement: Examples of evidence, for both data and climate model outputs, are for changes in climate (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmospheric and oceanic composition).</i></p> <p><i>State Assessment Boundary: Assessment is limited to one example of a change in climate and its associated impacts.</i></p>	Crosscutting Concepts	<p>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p>
	Disciplinary Core Ideas	<p>Natural Resources:</p> <ul style="list-style-type: none"> Most elements exist in Earth’s crust at concentrations too low to be extracted, but in some locations where geological processes have concentrated them extraction is economically viable.
	Science & Engineering Practices	<p>Constructing explanations (for science) and designing solutions (for engineering) 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 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.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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.11-12.2 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.</p> <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>HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose in 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>



Earth and Human Activity [HS-ESS3-6]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ESS3-6. Use the results of a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.</p> <p>Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. Consideration should be given to both positive and negative modification results.</p> <p>State Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.</p>	Crosscutting Concepts	<p>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.</p>
	Disciplinary Core Ideas	<p>Weather and Climate:</p> <ul style="list-style-type: none"> Current models predict that, though 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. <p>Global Climate Change:</p> <ul style="list-style-type: none"> 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.
	Science & Engineering Practices	<p>Using Mathematics 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.</p> <ul style="list-style-type: none"> Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
N/A	<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 in 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>

High School



Students in high school continue their learning from the middle school grades to develop more complete understanding of these four areas: Physical Science, Life Science, Earth and Space Science, and Engineering, Technology, and Applications of Science.

These standards and benchmarks include the most fundamental concepts of science, but are intended to leave room for expanded study in upper-level high school courses. The high school performance expectations allow high school students to explain more in-depth phenomena across the science disciplines, [science and engineering practices](#), and [crosscutting concepts](#).

The [Science and Engineering Practices](#) students will be expected to perform are :

1. [ask relevant questions and define problems](#)
2. [develop and use models](#)
3. [plan and carry out investigations](#)
4. [analyze and interpret data](#)
5. [use mathematics and computational thinking](#)
6. [construct explanations and design solutions](#)
7. [engage in argument from evidence](#)
8. [obtain, evaluate, and communicate information](#)

The [Crosscutting Concepts](#) that help students deepen their understanding of the [disciplinary core ideas](#) and develop a coherent and scientifically-based view of the world are:

1. [patterns](#)
2. [cause and effect: mechanisms, and explanation](#)
3. [scale, proportion, and quantity](#)
4. [systems and system models](#)
5. [energy and matter: flows, cycles, and conservation](#)
6. [structure and function](#)
7. [stability and change](#)

Engineering, Technology, and Applications of Sciences

At the high school level students are expected to engage with major global issues at the interface of science, technology, society and the environment, and to bring to bear the kinds of analytical and strategic thinking that prior training and increased maturity make possible. As in prior levels, these capabilities can be thought of in three stages—defining the problem, developing possible solutions, and improving designs.

Defining the problem at the high school level requires both qualitative and quantitative analysis. For example, the need to provide food and fresh water for future generations comes into sharp focus when considering the speed at which world population is growing, and conditions in countries that have experienced famine. While high school students are not expected to solve these challenges, they are expected to begin thinking about them as problems that can be addressed, at least in part, through engineering.

Developing possible solutions for major global problems begins by breaking them down into smaller problems that can be tackled with engineering methods. To evaluate potential solutions students are expected to not only consider a wide range of criteria, but to also recognize that criteria need to be prioritized. For example, public safety or environmental protection may be more important than cost or even functionality. Decisions on priorities can then guide tradeoff choices.

Improving designs at the high school level may involve sophisticated methods, such as using computer simulations to model proposed solutions. Students are expected to use such methods to take into account a range of criteria and constraints, to try and anticipate possible societal and environmental impacts, and to test the validity of their simulations by comparison to the real world.

Connections with other science disciplines help high school students develop these capabilities in various contexts. For example, in the life sciences students are expected to design, evaluate, and refine a solution for reducing human impact on the environment (HS-LS2-7) and to create or revise a simulation to test solutions for mitigating adverse impacts of human activity on biodiversity (HS-LS4-6). In the physical



High School Engineering, Technology, and Applications of Science (continued)

sciences, students solve problems by applying their engineering capabilities along with their knowledge of conditions for chemical reactions (HS-PS1-6), forces during collisions (HS-PS2-3), and conversion of energy from one form to another (HS-PS3-3). In the Earth and space sciences students apply their engineering capabilities to reduce human impacts on Earth systems, and improve social and environmental cost-benefit ratios (HS-ESS3-2, HS-ESS3-4).

By the end of 12th grade students are expected to achieve all five HS-ETS1 performance expectations (HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4, and HS-ETS1-5) related to a single problem in order to understand the interrelated processes of engineering design. These include **analyzing major global challenges, quantifying criteria and constraints for solutions; breaking down a complex problem into smaller, more manageable problems, evaluating alternative solutions based on prioritized criteria and trade-offs, evaluate the validity and reliability of claims in a variety of materials, and using a computer simulation to model the impact of proposed solutions.** While the performance expectations shown in High School **Engineering, Technology, and Applications of Science** couple particular practices with specific **disciplinary core ideas**, instructional decisions should include use of many practices that lead to the performance expectations.



Engineering, Technology, & Applications of Science [HS-ETS1-1]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>Clarification Statement: Examples of challenges could include rural cell phone coverage, geothermal energy use, and sage grouse population.</i></p> <p><u>Science Standards Connections</u></p> <p>HS-LS2-7 (pg. 212) HS-ESS3-1 (pg. 238) HS-LS4-6 (pg. 222) HS-ESS3-2 (pg. 239) HS-PS2-6 (pg. 187) HS-ESS3-3 (pg. 240) HS-PS4-2 (pg. 194) HS-ESS3-4 (pg. 241) HS-PS4-5 (pg. 196)</p>	Crosscutting Concepts	Influence of Science, Engineering, and Technology on Society and the Natural World <ul style="list-style-type: none"> • 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.
	Disciplinary Core Ideas	Defining and Delimiting Engineering Problems: <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. • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
	Science & Engineering Practices	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. <ul style="list-style-type: none"> • Analyze complex real-world problems by specifying criteria and constraints for successful solutions.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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>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>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.</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>



Engineering, Technology, & Applications of Science [HS-ETS1-2]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>Clarification Statement: Emphasis is on creativity, innovation, and inquiry.</p> <p>Science Standards Connections</p> <p>HS-PS2-3 (pg. 184)</p> <p>HS-PS3-3 (pg. 190)</p> <p>HS-PS4-1 (pg. 193)</p> <p>HS-LS2-7 (pg. 212)</p> <p>HS-LS4-6 (pg. 222)</p> <p>HS-ESS3-3 (pg. 240)</p>	Crosscutting Concepts	<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 criteria over others (trade-offs) may be needed.
	Disciplinary Core Ideas	<i>Intentionally Left Blank</i>
	Science & Engineering Practices	<p>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"> Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Wyoming Cross-Curricular Connections		
ELA / Literacy Connections		Mathematics Connections
N/A		MP.4 Model with mathematics.



Engineering, Technology, & Applications of Science [HS-ETS1-3]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p><i>Clarification Statement: Examples could include evaluation of historical, present day, and potential future challenges which take into account shifts in cultural norms and values, societal priorities, and/or technology.</i></p> <p><u>Science Standards Connections</u></p> <p>HS-PS2-3 (pg. 184) HS-ESS3-2 (pg. 239) HS-PS4-2 (pg. 194) HS-ESS3-3 (pg. 240) HS-PS4-5 (pg. 196) HS-ESS3-4 (pg. 241) HS-LS2-7 (pg. 212) HS-LS4-6 (pg. 222)</p>	<p>Crosscutting Concepts</p>	<p>Influence of Science, Engineering, and Technology on Society and the Natural World:</p> <ul style="list-style-type: none"> • 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.
	<p>Disciplinary Core Ideas</p>	<p>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.</p>
	<p>Science & Engineering Practices</p>	<p>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"> • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	Mathematics Connections
<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>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>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.</p>	<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>



Engineering, Technology, & Applications of Science [HS-ETS1-4]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>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.</p> <p>Clarification Statement: Examples can include using spreadsheets to modify and evaluate data, PhET simulations, GIS spatial modeling, etc.</p> <p><u>Science Standards Connections</u></p> <p>HS-PS2-3 (pg. 184) HS-LS2-2 (pg. 207) HS-PS2-6 (pg. 187) HS-LS2-7 (pg. 212) HS-PS3-1 (pg. 188) HS-LS4-6 (pg. 222) HS-PS3-3 (pg. 190) HS-ESS2-4 (pg. 234) HS-PS4-1 (pg. 193) HS-ESS2-6 (pg. 236) HS-LS2-1 (pg. 206) HS-ESS3-3 (pg. 240) HS-ESS3-4 (pg. 241)</p>	Crosscutting Concepts	<p>Systems and System Models:</p> <ul style="list-style-type: none"> 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.
	Disciplinary Core Ideas	<p>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.</p>
	Science & Engineering Practices	<p>Using Mathematics 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.</p> <ul style="list-style-type: none"> Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections		Mathematics Connections
N/A		<p>MP.2 Reason abstractly and quantitatively.</p> <p>MP.4 Model with mathematics.</p>



Engineering, Technology, & Applications of Science [HS-ETS1-5]

Performance Expectations (Benchmark)	Three Dimensions of Learning	
<p>HS-ETS1-5. Evaluate the validity and reliability of claims in a variety of materials.</p> <p><i>Clarification Statement: Examples of materials could include trade books, scientific publications, magazines, web resources, videos, and other passages that may reflect bias.</i></p> <p><u>Science Standards Connections</u></p> <p>HS-PS2-6 (pg. 187) HS-ESS2-2 (pg. 232) HS-PS4-1 (pg. 193) HS-ESS3-1 (pg. 238) HS-PS4-2 (pg. 194) HS-ESS3-2 (pg. 239) HS-LS2-6 (pg. 211) HS-ESS2-7 (pg. 237) HS-LS2-7 (pg. 212) HS-ESS3-3 (pg. 240) HS-LS3-2 (pg. 215) HS-ESS3-4 (pg. 241) HS-LS4-5 (pg. 221) HS-ESS2-4 (pg. 234)</p>	Crosscutting Concepts	<p>Cause and Effect:</p> <ul style="list-style-type: none"> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
	Disciplinary Core Ideas	<i>Intentionally Left Blank</i>
	Science & Engineering Practices	<p>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"> Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible.

Wyoming Cross-Curricular Connections

ELA / Literacy Connections	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.</p> <p>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <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>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>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</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>MP.2 Reason abstractly and quantitatively.</p>

Appendices/Resources that are available include:

- **Appendix A - A Model of the Three Dimensions of Science Learning**
- **Appendix B - Three Dimensions of Learning Framework**
- **Appendix C - ISTE Standards (International Society of Technology in Education)**
- **Appendix D - Connections to the Literacy Standards, ELA, and Mathematics Standards**
- **Appendix E - Disciplinary Core Ideas**
- **Appendix F - Science & Engineering Practices**
- **Appendix G - Crosscutting Concepts**
- **Appendix H - Nature of Science**
- **Appendix I - Engineering, Technology, and Applications of Science**
- **Appendix J - Glossary**
- **Appendix K - Acronyms**

These and other resources can be found at

<https://edu.wyoming.gov/educators/standards/science>