Maine Learning Results: Science and Engineering 9-12 (2019)

Vertical Alignment

I = Introductory *D = Developing* *P = Proficient* *F = Fluent*

*** denotes an essential standard/indicator**

Earth and Space Sciences

HS-ESS1 Earth's Place in the Universe

	Earth Sci	Bio	Chem	Physics	Other
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. Further explanation: 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. Developing and Using Models, The Universe and its Stars, Energy in Chemical Processes and Everyday Life, Scale, Proportion and Quantity	***P/F**				Astronomy: 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. Further explanation: Emphasis is on the Astronomyronomical 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). Constructing Explanations and Designing Solutions, The Universe and its Stars, Electromagnetic Radiation, Energy and Matter	D				Astronomy: P
HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements. Further explanation: 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. Obtaining, Evaluating, and Communicating Information, The Universe and its Stars, Energy and Matter	D				Astronomy: P
HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. Further explanation: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons. Using Mathematical and Computational Thinking, Earth and the Solar System, Scale, Proportion, and Quantity	D				Astronomy: D
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. Further explanation: 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	***P/F**				

increasing with distance away from a central ancient core (a result of pAstronomy plate interactions). Examples could also be found from looking at differences between coAstronomyal Maine and interior Maine rock types and their ages as evidence to explain the formation of land structures and plate boundaries that cause them. Engaging in Argument from Evidence, The History of Planet Earth, Plate Tectonics and Large-Scale System Interactions, Nuclear Processes, Patterns					
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. Further explanation: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces. Constructing Explanations and Designing Solutions, The History of Planet Earth, Stability and Change	**Earth Sci** I/D	**Bio**	**Chem**	**Physics**	**Other** Astronomy: P
HS-ESS2 Earth's Systems					
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. Further explanation: 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 wAstronomying, and coAstronomyal erosion). An example could be to utilize Maine Geologic maps, including tectonic maps, as data to create a model to illustrate how Maine's land features or oceanic features were formed. Consider looking to Maine's glacial history, features formed and materials deposited by glaciers. Developing and Using Models, Plate Tectonics and Large-Scale System Interactions, Earth Materials and Systems, Stability and Change	**Earth Sci** ***P/F**	**Bio**	**Chem**	**Physics**	**Other**
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. Further explanation: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coAstronomyal erosion; and how the loss of wetlands causes a decrease in local humidity that further reduces the wetlands' extent. An example could consider timber harvesting practices related to erosion and water runoff issues, river damming, or coAstronomyal erosion of Maine's beaches and dunes. Analyzing and Interpreting Data, Earth Materials and Systems, Stability and Change	**Earth Sci** I	**Bio**	**Chem**	**Physics**	**Other**
HS-ESS2-3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. Further explanation: 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	**Earth Sci** ***P/F**	**Bio**	**Chem**	**Physics**	**Other**

from high-pressure laboratory experiments. Developing and Using Models, Earth Materials and Systems, Plate Tectonics and Large-Scale System Interactions, Wave Properties, Energy and Matter					
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. Further explanation: Examples of the causes of climate change differ by timescale, over 1-10 years; large volcanic eruptions, ocean circulation; 10s to 100s of years: changes in human activity, ocean circulation, solar output; 10s a-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10s-100s of millions of years: long-term changes in atmospheric composition. Consider the climatic impacts of the Gulf stream and the Labrador currents on the Gulf of Maine, e.g. water temperature changes and fishing industry disruptions. Developing and Using Models, Earth and the Solar System, Earth Materials and Systems, Weather and Climate, Scale, Proportion, and Quantity	**Earth Sci** P	**Bio**	**Chem**	**Physics**	**Other**
HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. Further explanation: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide evidence for the 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, and 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). Draw connections to Maine phenomena such as ice jams, frost heaves and potholes. Planning and Carrying Out Investigations, The Role of Water in Earth's Surface Processes, Structure and Function	**Earth Sci** ***P/F**	**Bio**	**Chem**	**Physics**	**Other**
HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. Further explanation: 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. Developing and Using Models, Weather and Climate, Energy and Matter	**Earth Sci** D	**Bio**	**Chem**	**Physics**	**Other**
HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. Further explanation: 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; and how the evolution of corals created reefs that altered patterns of erosion and deposition along coAstronomylines and provided habitats for the evolution of new life forms. Engaging in Argument from Evidence, Weather and Climate, Biogeology, Stability and Change	**Earth Sci** ***P/F**	**Bio**	**Chem**	**Physics**	**Other**
HS-ESS3 Earth and Human Activity					
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.	**Earth Sci** ***D/P**	**Bio**	**Chem**	**Physics**	**Other**

Further explanation: 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 wAstronomying 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. Other examples include the impacts of climate change on Maine's ski industry, fishing industry, maple sugar industry and on sea levels or droughts. Constructing Explanations and Designing Solutions, Natural Resources, Natural Hazards, Cause and Effect					
HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. Further explanation: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use (for farming, timber industry, blueberry and potato crops), mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen. Engaging in Argument from Evidence, Natural Resources, Developing Possible Solutions	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
					?ENV
HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. Further explanation: Examples of factors that affect the management of natural resources include costs of resource extraction and wAstronomye 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. Consider the effects of urban sprawl and the loss of farmland. Using Mathematics and Computational Thinking, Human Impacts on Earth Systems, Stability and Change	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
					?ENV
HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. Further explanation: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean). Other examples include the use of propane-powered buses in Acadia (evaluate pros and cons). Constructing Explanations and Designing Solutions, Developing Possible Solutions, Stability and Change	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
					?ENV
HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecAstronomy of the current rate of global or regional climate change and associated future impacts to Earth's systems. Further explanation: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition). Analyzing and Interpreting Data, Global Climate Change, Stability and Change	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
	I/D				
HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
	D				?ENV

Further explanation: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations. Use and interpret graphs and data of carbon dioxide levels in the Gulf of Maine for oysters and sea scallops. Consider the impacts of ocean acidification on shellfish. Using Mathematics and Computational Thinking, Weather and Climate, Global Climate Change, Systems and System Models					

Engineering, Technology, and Applications of Science

HS-ETS1 Engineering Design

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. Further explanation: Examples of challenges include local and global climate change issues, biodiversity loss or United Nations sustainable development goals.Asking Questions and Defining Problems, Defining and Delimiting Engineering Problems,	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
					Wood: D/P Metal: D/P ?ENV

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. Further explanation: Examples could include transportation issues, dams, green energy and wind power in Maine. Constructing Explanations and Designing Solutions, Optimizing the Design Solution,	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
				D/P	Wood: P Metal: P ?ENV

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. Further explanation: Examples could include lobstering and exports of lobster, dry wells and water conservation in Maine, or saltwater intrusion in coAstronomyal Maine wells. Constructing Explanations and Designing Solutions, Developing Possible Solutions,	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
				D/P	Wood: D/P Metal: D/P ?ENV

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. Using Mathematics and Computational Thinking, Developing Possible Solutions, Systems and System Models	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
					Wood: D/P Drafting:D ?ENV

Life Sciences

HS-LS1 From Molecules to Organisms: Structures and Processes

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. Further explanation: Emphasis is on protein synthesis from DNA to codon to amino acid sequence. Constructing Explanations and Designing Solutions, Structure and Function, Structure and Function	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
		***P**			

	Earth Sci	Bio	Chem	Physics	Other
HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. Further explanation: 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 elAstronomyic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system. Another example could be the water and nutrient intake in soft shell clams. Developing and Using Models, Structure and Function, Systems and System Models		I			Anatomy: D
HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. Further explanation: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels. Another example is commonly observed in the daphnia heart rate response to changes in temperature, caffeine, alcohol, or nicotine. Planning and Carrying out Investigations, Structure and Function, Stability and Change	Earth Sci	Bio	Chem	Physics	Other
		I			Anatomy: I
HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. Developing and Using Models, Growth and Development of Organisms, Systems and System Models	Earth Sci	Bio	Chem	Physics	Other
		*P			
HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. Further explanation: 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. Models may focus on Maine based economy of photosynthetic organisms such as seaweeds, potatoes and pine trees. Developing and Using Models, Organization for Matter and Energy flow in Organisms, Energy and Matter	Earth Sci	Bio	Chem	Physics	Other
		I/D			
HS-LS1-6 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. Further explanation: Emphasis is on using evidence from models and simulations to support explanations. Constructing Explanations and Designing Solutions, Organization for Matter and energy Flow in Organisms, Energy and Matter	Earth Sci	Bio	Chem	Physics	Other
HS-LS1-7 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy. Further explanation: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration. An example could be a moose eating a lily pad, the lily pad producing energy for the moose and the breathing of oxygen by the moose to enable the process of cellular respiration. Developing and Using Models, Organization for Matter and Energy Flow in Organisms, Energy and Matter	Earth Sci	Bio	Chem	Physics	Other
		I			
HS-LS2 Ecosystems: Interactions, Energy, and Dynamics					

	Earth Sci	Bio	Chem	Physics	Other
HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. Further Explanation: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets. Examples could include a look at historical data of the population of a species that has moved north into Maine, such as opossum, and how it has changed as the climate in Maine has changed. Observe data of the populations of harbor seals and the effect that a hunting ban has had on their population and the resulting increase in the number of large predatory sharks in the Gulf of Maine. Using Mathematics and Computational Thinking, Interdependent Relationships in Ecosystems, Scale, Proportion, and Quantity		I/D (if time)			
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. Further explanation: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data. Examples could include a graphical analysis of historical data on the population of trout and/or landlocked salmon before and after the introduction of bass into Moosehead Lake. Or data on a variety of populations (biodiversity) affected by dredging for sea scallops. Using Mathematics and Computational Thinking, Interdependent Relationships in Ecosystems, Scale, Proportion, and Quantity		I/D (if time)			
HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. Further explanation: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments. An example could include a classroom lab activity around a Winogradsky Column with groups changing a variable such as temperature or light. Additional examples could look at the fermentation processes when blue-green algae is grown in aerobic and anaerobic environments. Constructing Explanations and Designing Solutions, Cycles of Matter and Energy Transfer in Ecosystems, Energy and Matter					
HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. Further Explanation: 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. An example could include an illustration of a food pyramid students may find in Maine (e.g. seaweed → snail → fish → shark, or grass → insects → turkeys → foxes). Using Mathematics and Computational Thinking, Cycles of Matter and Energy Transfer in Ecosystems, Energy and Matter		***D**			
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. Further explanation: Examples of models could include simulations and mathematical models. Models may include multi-media illustration of the carbon cycle to include a Maine ecosystem they are familiar with such as pond, seaside, farm, forest, etc. Developing and Using Models, Cycles of Matter and Energy Transfer, Energy in Chemical Processes, Systems and System Models		I			

	Earth Sci	Bio	Chem	Physics	Other
HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. Further explanation: 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. Examples could include how the number of moose hunting licenses impacts other populations or how fishing limits or shortened seasons decreases the catch of many fish species and the effects on ground fish or smaller fish. Engaging in Argument from Evidence, Ecosystem Dynamics, Functioning, and Resilience, Stability and Change		D			
HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. Further explanation: Examples of human activities can include urbanization, building dams, and dissemination of invasive species. Potential Maine connections include the effects of: salting the roads in winter, introducing green crabs into coAstronomyal waters, introducing invasive species into Maine lakes, or examining historical data on water pollution in the Androscoggin during the height of mill activity, closing of mills and legislation on water quality. Constructing Explanations and Designing Solutions, Ecosystem Dynamics, Functioning, and Resilience, Biodiversity and Humans, Developing Possible Solutions, Stability and Change	I				?ENV
HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. Further explanation: 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. Examples could include turkeys flocking to evade hunters or Canada geese migrating to and through Maine for breeding purposes. Engaging in Argument from Evidence, Social Interactions and Group Behavior, Cause and Effect					Zoo: I

HS-LS3 Heredity: Inheritance and Variation of Traits

	Earth Sci	Bio	Chem	Physics	Other
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 Further explanation: Emphasis is on the asking of clarifying questions about the general principles of genetics. An example is how cystic fibrosis (one of the most common autosomal recessive inherited diseases in Maine) is passed from parents to children. Asking Questions and Defining Problems, Structure and Function, Inheritance of Traits, Cause and Effect		***F**			
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. Further explanation: Emphasis is on using data to support arguments for the way variation occurs. Provide data on specific mutations caused by environmental factors. Engaging in Argument from Evidence, Variation of Traits, Cause and Effect		***D**			
HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.					

Further explanation: 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. An example would be the population of red fox in Maine and the incidences of the red allele vs. the sable allele. Analyzing and Interpreting Data, Variation of Traits, Scale, Proportion, and Quantity		*P			
HS-LS4 Biological Evolution: Unity and Diversity					
HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. Further explanation: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development. Obtaining, Evaluating, and Communicating Information, Evidence of Common Ancestry and Diversity, Patterns	Earth Sci	Bio	Chem	Physics	Other
		*D			
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. Further explanation: Emphasis is on using evidence to explain the influence each of the four factors has on a 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. Constructing Explanations and Designing Solutions, Adaptation, Cause and Effect	Earth Sci	Bio	Chem	Physics	Other
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. Further explanation: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations. Observe historical data for the distribution of humpback whales in the Gulf of Maine looking specifically at skin pigmentation. Analyzing and Interpreting Data, Natural Selection, Adaptation, Patterns	Earth Sci	Bio	Chem	Physics	Other
		I			
HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations. Further explanation: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations. Constructing Explanations and Designing Solutions, Adaptation, Cause and Effect	Earth Sci	Bio	Chem	Physics	Other
		I			
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. Further explanation: 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. Engaging in Argument from Evidence, Adaptation, Cause and Effect	Earth Sci	Bio	Chem	Physics	Other
		I			

HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. Further explanation: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species. Using Mathematics and Computational Thinking, Biodiversity and Humans, Developing Possible Solutions, Cause and Effect	Earth Sci	Bio	Chem	Physics	Other
					?ENV ?Zoo

Physical Science

HS-PS1 Matter and Its Interactions

HS-PS1-1 Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. Further explanation: 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. Examples include the properties and bonding of water and the rusting of metals as found in guardrails, ship parts, etc. Consider the metal compounds found in fireworks. Developing and Using Models, structure and properties of matter, types of interactions, patterns	Earth Sci	Bio	Chem	Physics	Other
	D/P		***P**		***APChem: F**

HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. Further explanation: Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, or carbon and hydrogen. Examples could include ocean salt formation, combustion (as found in the burning of fuels in Maine homes, cars and the trucking industry) or the detection of carbon monoxide in a home (complete vs incomplete combustion). Constructing Explanations and Designing Solutions, structure and properties of matter, chemical reaction, patterns	Earth Sci	Bio	Chem	Physics	Other
	D/P		***P**		***APChem: F**

HS-PS1-3 Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. Further explanation: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension. Examples could consider why we salt roads in the winter, differences in melting points of water vs saltwater, the production of maple syrup or the strength of Maine minerals. Planning and Carrying out Investigations, structure and properties of matter, types of interactions, patterns	Earth Sci	Bio	Chem	Physics	Other
	I		D		AP Chem: F

HS-PS1-4 Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends on the changes in total bond energy. Further explanation: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved. Developing and Using Models, structure and properties of matter, Energy and Matter	Earth Sci	Bio	Chem	Physics	Other
			***D**		***APChem: F**

	Earth Sci	Bio	Chem	Physics	Other
HS-PS1-5 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. Further explanation: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules. Examples could include the varied rates of oxidation of metals in winter vs in summer or the rate of dissolution of calcium shells in the ocean due to an increase in carbon dioxide and an increase in temperature from global warming. Constructing Explanations and Designing Solutions, Chemical Reactions, patterns	I		***D**		***APChem: F**
HS-PS1-6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. Further explanation: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products. Other examples to consider include the Kraft paper making process, soap making or rock candy formation. Constructing Explanations and Designing Solutions, structure and properties of matter, Chemical Reactions, Types of Interactions, Optimizing Design Solution patterns, cause and effect, scale, proportion, and quantity	Earth Sci	Bio	Chem	Physics	Other
			***D**		***APChem: F**
HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Further explanation: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques. Examples could include the proportion of ingredients combined in baked goods or the combustion of fuels. Using Mathematics and Computational Thinking, Chemical Reactions, Energy and Matter	Earth Sci	Bio	Chem	Physics	Other
	D		***P**		***APChem: F**
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. Further explanation: 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. Examples could include radon gas in basements, thorium in white gas mantles or, historically, Wiscasset's Maine Yankee nuclear power plant and Fukushima in Japan. Developing and engineering practices, Nuclear Processes, patterns, cause and effect, scale, proportion, and quantity	Earth Sci	Bio	Chem	Physics	Other
	D/P		D		
HS-PS2 Motion and Stability: Forces and Interactions					
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. Further explanation: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or moving object being pulled by a constant force. Examples could include the acceleration of a snowmobile in different gears (same mass with different forces creating different accelerations) or the comparison of gas mileage between a truck vs a truck hauling a boat (same acceleration with different masses). Analyzing and Interpreting Data, Types of Interactions, Forces and Motion, Cause and Effect	Earth Sci	Bio	Chem	Physics	Other
				***D/P**	Wood: D

	Earth Sci	Bio	Chem	Physics	Other
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. Further explanation: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle. Examples could include jumping off a boat or canoe and the total momenta of all the various pieces exploding from fireworks. Using Mathematics and Computational Thinking, Forces and Motion, Systems and System Models				I	
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. Further explanation: Examples of evaluation and refinement could include determining the success of a 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. Examples could also include the barriers on the sides of NASCAR tracks, truck safety hills on the sides of highways, bike helmets or car bumpers. Constructing Explanations and Designing Solutions, structure and properties of matter, Forces and Motion, Defining and Delimiting Engineering Problems, Optimizing the Design Solution, types of interactions, Cause and Effects	Earth Sci	Bio	Chem	Physics	Other
				***D/P**	Pre-Eng: D
HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. Further explanation: Emphasis is on both quantitative and conceptual descriptions of gravitational and electrical fields. Using Mathematics and Computational Thinking, Types of Interactions, Patterns	Earth Sci	Bio	Chem	Physics	Other
				D/P	APChem: 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. Further explanation: Examples could include wind turbines or generators along with any DC motorized toy. Planning and Carrying out an Investigation, Types of Interactions, Definitions of Energy, Cause and Effect	Earth Sci	Bio	Chem	Physics	Other
				D	
HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. Further explanation: 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. Examples could also include composite material substitutes for wood and the structure of solar cells along with how they work. Obtaining, Evaluating, and Communicating Information, Structure and Property of Matter, Types of Interactions, Structure and Function	Earth Sci	Bio	Chem	Physics	Other
			I	I	
HS-PS3 Energy					
HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. Further explanation: Emphasis is on explaining the meaning of mathematical expressions used in the model. Examples could include wind turbines, hydroelectric or tidal power. Further examples could be found in FunTown USA roller coAstronomyers or any sport (e.g. why a hockey puck	Earth Sci	Bio	Chem	Physics	Other
				***P**	

changes motion, a baseball being hit, etc.). Using Mathematics and Computational Thinking, Definitions of Energy, Conservation of Energy and Energy Transfer, Systems and System Models					
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). Further explanation: 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. Developing and Using Models, Definitions of Energy, Energy and Matter	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
				D	
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. Further explanation: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency. Consider the Wind Blade Challenge or use of a solar oven when camping. Constructing Explanations and Designing Solutions, Definitions of Energy, Defining and Delimiting Engineering Problems, Energy and Matter	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
				D/P	PreEngineering: D/P
HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). Further explanation: 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. Other examples can be found in heat pumps for radiant heat systems, insulation (to prevent heat transfer) or the use of hot rocks to warm a tent when camping. Planning and Carrying out an Investigation, Conservation of Energy and Energy Transfer, Energy in Chemical Processes, Systems and System Models	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
			***P**		
HS-PS3-5 Develop and use a model of two objects interacting through electrical or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. Further explanation: 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. Developing and Using Models, Relationship between Energy and Forces, Cause and Effect	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
				D	
HS-PS4 Waves and Their Applications in Technologies for Information Transfer					
HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. Further explanation: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth. Examples include rainbows and how to aim when spearfishing. Using Mathematics and Computational Thinking, Wave Properties, Cause and Effect	**Earth Sci**	**Bio**	**Chem**	**Physics**	**Other**
	I				

	Earth Sci	Bio	Chem	Physics	Other
HS-PS4-2 Evaluate questions about the advantages of using a digital transmission and storage of information. Further explanation: 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. Asking Questions and Defining Problems, Wave Properties, Stability and Change					?ENV
HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. Further explanation: 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. Engaging in Argument from Evidence, Wave Properties, Systems and System Models	Earth Sci	Bio	Chem	Physics	Other
HS-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. Further explanation: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias. Arguments around evidence could be made for dangers of cell phone usage or living near high voltage power lines. Obtaining, Evaluating, and Communicating Information, Electromagnetic Radiation, Cause and Effect	Earth Sci	Bio	Chem	Physics	Other
					?ENV Astronomy: I
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. Further explanation: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology. Obtaining, Evaluating, and Communicating Information, Wave Properties, Electromagnetic Radiation, Information Technologies and Instrumentation, Cause and Effect	Earth Sci	Bio	Chem	Physics	Other
	I				