

NSTA Science Content Analysis Form: Secondary Science
Instructions for Preparing for Your Review

The Tables below include the conceptual questions related to Disciplinary Core Ideas from the *A Framework for K-12 Science Education Practices, Crosscutting Concepts, and Core Ideas* (2012). With licensure requirements varying from state to state, the requirements for each science discipline has been developed. Based upon the state’s requirement for single-field, dual-field, and/or broad-field licensure, the table should be completed for each licensure area (e.g., Biology, Chemistry, Physics, Earth Science, Chemistry-Biology, and Broad-field). For undergraduate programs, the cells on the right should be completed with the course acronym and number in which the concept for answering the question is found. **Only courses that are completed by all candidates in that program or licensure track can be used to complete the table.** At the graduate level, the Content Analysis Form can be used as a Transcript Analysis Form for science content knowledge. Your program does not have to be aligned completely with the standards at least initially. An 80% alignment between the NSTA content standards and program coursework is expected within each content table.

Instructions for Completing the Forms

For each program or licensure area, complete the content analysis as follows:

- If your institution prescribes the coursework in science for each teaching major and minor, as is the case in most undergraduate programs, enter in column B the acronym/numbers and titles of the required courses that address the subject matter identified in column A. Include advising sheets or programs of study as a separate attachment.
- If you accept candidates with science coursework taken elsewhere, state the advising requirement using the advising sheet that ensures that candidates have studied the subject matter content in column A. Include the advising sheets in the appendix.
- DO NOT provide syllabi. Include brief content descriptions for courses ONLY when the course titles are not reasonably descriptive of the content. (“Ecology” is reasonably descriptive, while “Integrative Science” is not descriptive). Be sure to refer reviewers to the descriptor.
- If a course has a typical science name (such as Analytical Chemistry), but the content in that course is atypical (if there is a significant amount of environmental science in the course), include brief content descriptions.
- Note that the same courses or advising requirements may appear multiple times in these tables.
- If you do not have a requirement that covers a particular topic, simply enter “not covered.” Do not leave the space blank. NOTE: Science content may be in science courses or in education courses.

Special instructions: Secondary Physical Science is usually a composite of two disciplines (chemistry and physics) but sometimes also includes earth/space sciences. General science usually includes all four traditional subject area disciplines.

The *A Framework for K-12 Science Education Practices, Crosscutting Concepts, and Core Ideas* (2012) and the 2012 NSTA Preservice Science Teacher Preparation Standards were used as the basis for developing the questions.

Life Science High School

Conceptual Understanding for Teachers at 9-12	Required course number & name or advising
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	requirements
LS1.A: STRUCTURE AND FUNCTION <i>How do the structures of organisms enable life's functions?</i>	
What is a cell?	
How do cells function similarly and differently in unicellular and multicellular organisms?	
What are major organelles, and how do these impact cell function?	
Which scientists were most important in the development of cell theory and what did they contribute to the theory?	
What are the roles of DNA and chromosomes in determining an individual's traits?	
What are the relationships among DNA, genes, and protein synthesis?	
What is the importance of proteins for cells?	
How is cell theory an example of a scientific theory?	
How can the relationships among the hierarchical system of cells, tissues, organs, and systems be modeled?	
How do organismal systems interact to assist in an organism's life processes?	
What tools are used to examine microscopic structures?	
LS1.B: GROWTH AND DEVELOPMENT OF ORGANISMS <i>How do organisms grow and develop?</i>	
How do plants and animals ensure the continuation of their species?	
What specialized structures/behaviors are used by plants and animals to ensure reproductive success?	
What empirical evidence supports an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively?	
How do organisms grow and develop?	
What factors (genetic and environmental) impact the growth of organisms?	
How do these genetic and environmental factors impact the growth of organisms?	
What is the relationship among mitosis, differentiation, and gene expression in the development of multicellular organisms?	
How do cells grow and divide in multicellular organisms?	
In what ways do different organisms grow and develop?	
What argument can be constructed for why meiosis is essential for sexual reproduction?	
How can the similarities and differences between mitosis and meiosis be modeled?	
LS1.C: ORGANIZATION FOR MATTER AND ENERGY FLOW IN ORGANISMS <i>How do organisms obtain and use the matter and energy they need to live and grow?</i>	
How do organisms obtain and use the matter and energy they need to live and grow?	
How does energy flow in a typical food chain?	
How do organisms obtain energy through the chemical processes	

of photosynthesis, cellular respiration, and digestion?	
In what different ways do aerobic and anaerobic bacteria achieve their energy needs?	
What processes enable organisms to construct complex organic molecules from simple elements?	
What occurs during the light and dark reactions of photosynthesis?	
What is the evidence for why photosynthesis is important for life on earth?	
How does cellular respiration result in a net transfer of energy?	
What models depict how matter and energy flow through living systems?	
How are more complex carbon based molecules formed from simple sugar molecules?	
What is the role of enzymes in the breakdown and synthesis of molecules?	
LS1.D: INFORMATION PROCESSING	
<i>How do organisms detect, process, and use information about the environment?</i>	
How are different signals transferred from a sense receptor to the brain?	
How does the brain impact behavior and memory?	
How do organisms detect, process, and use information about the environment?	
What are the main regions of the brain, and what functions are associated with each of these regions?	
What are reflexes, and how do they differ from more complex behaviors?	
What is the importance of homeostasis?	
How do feedback mechanisms impact an organism's internal conditions and mediate behaviors?	
What are the impacts of emotions and memory on behavior?	
LS2.A: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS	
<i>How do organisms interact with the living and nonliving environments to obtain matter and energy?</i>	
What types of community relationships exist among populations in an ecosystem?	
How do these relationships impact different populations within a community?	
How do the abiotic factors impact the biotic components of an ecosystem?	
What determines the carrying capacity of a particular environment?	
What is the importance of carrying capacity on sustainability of an ecosystem?	
What evidence would support the claim that complex interactions within an ecosystem help to maintain relatively stable numbers and types of organisms in that ecosystem?	
LS2.B: CYCLES OF MATTER AND ENERGY TRANSFER IN ECOSYSTEMS	
<i>How do matter and energy move through an ecosystem?</i>	
How do matter and energy move through an ecosystem?	
What are the roles of producers, consumers, and decomposers in cycling in an ecosystem?	
What is the history of the development of current understanding of photosynthesis?	

What model best illustrates the role of photosynthesis and respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere and geosphere?	
How does cellular respiration result in a net transfer of energy?	
How do aerobic and anaerobic respiration compare in terms of reactants, products, and energy production?	
How can the change in mass and energy moving through a food web be modeled?	
Why is the amount of energy reduced as it moves through a food web?	
How can mathematical modeling be used to depict how the efficiency of energy flow impacts the number of organisms at increasingly higher trophic levels?	
In what ways is the process of cellular respiration similar to the burning of fossil fuels as it relates to the carbon cycle?	
LS2.C: ECOSYSTEM DYNAMICS, FUNCTIONING, AND RESILIENCE <i>What happens to ecosystems when the environment changes?</i>	
What happens to ecosystems when the environment changes?	
How does a disruption to a physical or biological component of an ecosystem impact population dynamics?	
Why is biodiversity within an ecosystem important?	
In what ways is homeostasis (resilience) of populations in an ecosystem maintained?	
What anthropogenic changes have occurred in the environment?	
In what ways can anthropogenic changes disrupt an ecosystem?	
What is the relationship between anthropogenic changes and the species extinction?	
LS2.D: SOCIAL INTERACTIONS AND GROUP BEHAVIOR <i>How do organisms interact in groups so as to benefit individuals?</i>	
What factors might influence the evolution of group behaviors in a species?	
What role does group behavior plays in the survival of individuals and species?	
LS3.A: INHERITANCE OF TRAITS <i>How are the characteristics of one generation related to the previous generation?</i>	
How are characteristics of one generation passed to the next?	
What are the relationships among genes, proteins and traits?	
In what ways do mutations occur?	
How do gene mutations result in changes in an organism?	
How was the structure and model of DNA developed, critiqued, and accepted?	
What technologies were used in the development of the DNA model?	
Who are some of the notable scientists that developed and advanced the knowledge generated from DNA?	
How does the structure of the DNA molecule impact its function?	
How do DNA sequences lend themselves to regulatory functions?	
LS3.B: VARIATION OF TRAITS <i>Why do individuals of the same species vary in how they look, function, and behave?</i>	
Why do individuals of the same species vary in how they look, function, and behave?	
What are the relationships among DNA, nucleotide sequences, protein formation, allele, gene, and chromosome?	

How can you model the process of DNA replication?	
In what ways does genetic variability occur (e.g., sexual reproduction, crossing over, recombination, mutations, environmental interactions)?	
How do sexual and asexual reproduction compare in terms of producing genetic diversity?	
How do both genetic and environmental factors affect expression of traits?	
In what ways is genetic variability important?	
How is the probability of occurrence of traits in future generations based on parental genotypes calculated?	
Who are some of the notable scientists that developed and advanced the basic understanding of genetics?	
LS4.A: EVIDENCE OF COMMON ANCESTRY AND DIVERSITY <i>What evidence shows that different species are related?</i>	
How does the fossil record document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth?	
What types of evidence support the process of evolution?	
How is the current classification system based on similarities and differences in the anatomical, physiological and functional characteristics of organisms?	
Given a data set about DNA sequences, how can a phylogenetic tree be constructed?	
LS4.B: NATURAL SELECTION <i>How does genetic variation among organisms affect survival and reproduction?</i>	
How can there be so many similarities among organisms yet so many different kinds of plants, animals, and microorganisms?	
How can genetic variation impact an individual's or species' reproductive advantage?	
How can artificial selection influence the presence of certain characteristics of organisms?	
What technologies have changed the way humans influence the inheritance of desired traits in organisms?	
How are shifts in the numerical distribution of traits used as evidence to support that advantageous heritable traits tend to increase in a population?	
What is the relationship among natural selection, adaptations, and evolution?	
Which scientists were important in the development of the theories of evolution by natural selection, and what did they contribute to the theory?	
LS4.C: ADAPTATION <i>How does the environment influence populations of organisms over multiple generations?</i>	
How can mathematical modeling be used to describe how natural selection may lead to increases and decreases of specific traits in populations over time?	
What main factors are necessary for evolution to occur?	
How can biotic and abiotic differences in ecosystems impact a change in gene frequency over time?	
What is meant by virulence and resistance?	
What is the potential impact of a new pathogen on a population?	

How has the increase in prescribing antibiotics impacted the evolution of bacteria?	
LS4.D: BIODIVERSITY AND HUMANS <i>What is biodiversity, how do humans affect it, and how does it affect humans?</i>	
In what ways can changes in environmental conditions (e.g., drought, deforestation, flood) and the rate of change of the environment affect the distribution or disappearance of traits in a species?	
What is the importance of sustaining biodiversity to support and enhance life on Earth?	
What are potential causes of extinction?	
What are potential causes of speciation?	
How can modeling predict and test the impacts of proposed solutions for protection of a threatened or endangered species?	
What are some impacts of human activity on biodiversity?	

Supporting Competencies for Life Science

Conceptual Understanding for Teachers at 9-12	Required course number & name or advising requirements
CHEMISTRY	
What is matter?	
What trends exist in the Periodic Table and how do those trends reflect atomic structure?	
In what ways do atoms combine to form novel substances?	
What conventions do chemists use for naming chemical compounds and writing chemical formulas?	
How does a balanced chemical reaction represent conservation of mass in a given chemical reaction?	
How is half-life used to determine the age of rocks and other natural materials?	
PHYSICS	
What is energy and how is it measured?	
How is energy transferred between objects?	
What are the conceptual and mathematical relationships among energy, work, and power?	
What is meant by conservation of energy and conservation of mass?	
What is the relationship between thermal energy and temperature?	
EARTH AND SPACE SCIENCE	
How do Earth's major systems interact to impact Earth processes?	
How do humans depend on Earth's resources?	
What human activities have positively and negatively impacted Earth's climate?	
How do the chemical and physical properties of water and its movement create changes in the surface and subsurface of the Earth?	
MATHEMATICS	
How are statistics used by scientists to support arguments	
How are mathematical models used in life sciences?	

Conceptual Understanding for Teachers at 9-12	Required course number & name or advising requirements
PS1.A: STRUCTURE AND PROPERTIES OF MATTER <i>How do particles combine to form the variety of matter one observes?</i>	
What is matter?	
What are the properties of the various states of matter?	
What are chemical and physical properties and how are they used to identify substances?	
What are the relationships among number of moles, volume, temperature, and pressure of gases?	
What is the structure of an atom?	
What models are commonly used and how were they developed over time?	
What are the limitations of the Bohr model of the atom?	
How are atomic spectra related to our understanding of atomic structure?	
How was the Periodic Table developed?	
What trends exist in the Periodic Table and how do those trends reflect atomic structure?	
In what ways do atoms combine to form novel substances?	
How is the stability of a molecule related to its energy?	
What are the characteristics of different types of bonding and how can these be predicted using the Periodic Table?	
How can bonding characteristics be used to determine the shape of a molecule?	
How can bonding characteristics and molecular shape be used to determine the polarity of a molecule?	
What conventions do chemists use for naming chemical compounds and writing chemical formulas?	
PS1.B: CHEMICAL REACTIONS <i>How do substances combine or change (react) to make new substances?</i> <i>How does one characterize and explain these reactions and make predictions about them?</i>	
How does kinetic molecular theory explain chemical processes?	
How is energy involved in a chemical reaction?	
How does a balanced chemical reaction represent conservation of mass in a given chemical reaction?	
How can the products and amount of a chemical reaction be predicted given the reactants?	
How does an activity series help to predict the nature of a chemical reaction?	
How can chemical half reactions be combined to create electrochemical cells?	
How does the strength of an acid and base impact the resulting reaction?	
How does pH change over the course of a titration?	
In what ways can the rate of a chemical reaction be changed?	
In what ways can the chemical equilibrium shift in a reaction?	

In what ways are chemical processes used in the mining of metals, minerals, ores, and elements?	
In what ways are chemical processes used in biological phenomena?	
PS1.C: NUCLEAR PROCESSES <i>What forces hold nuclei together and mediate nuclear processes?</i>	
How do the number of protons, electrons, and neutrons change during nuclear decay?	
How does the amount of radioactive materials change over the course of a nuclear decay reaction?	
How is half-life used to determine the age of rocks and other natural materials?	
PS3.A: DEFINITIONS OF ENERGY <i>What is energy?</i>	
How does energy change during phase changes for a material?	
How does enthalpy change during a chemical reactions?	
What are the relationships between enthalpy, entropy and free energy? And how do they predict the spontaneity of a reaction?	
How is electrical energy produced in a voltaic cell?	
How are cell reactions and standard cell potential calculated for a voltaic cell?	
How does electrolysis occur?	
What evidence is there for the wave particle duality of electrons?	
PS3.B: CONSERVATION OF ENERGY AND ENERGY TRANSFER <i>What is meant by conservation of energy?</i> <i>How is energy transferred between objects or systems?</i>	
What is the relationship between energy of a system and its surroundings? How can this relationship be used to determine the heat of a reaction?	
PS4.B: ELECTROMAGNETIC RADIATION <i>What is light? How can one explain the varied effects that involve light?</i> <i>What other forms of electromagnetic radiation are there?</i>	
How do quantum mechanical models and molecular orbital theory improve our ability to explain chemical behavior?	
How do organisms use simple elements to form complex organic molecules?	
How does cellular respiration result in a net transfer of energy?	
How do carbon, hydrogen, and oxygen from glucose molecules combine with other elements to form more complex carbon based molecules?	
What is the role of enzymes in the breaking down and synthesis of molecules?	
What is the structure of DNA?	
What is the relationship among DNA, genes, and protein synthesis?	
What are the different ways in which carbon atoms combine to make different classes of organic compounds?	
How do different functional groups predict the properties and reactivity of organic compounds?	

How does the structure of reactants in an organic reaction predict the products?	
What is the greenhouse effect?	
What are common greenhouse gases and how do they contribute to climate change?	
How can chemistry help to mitigate global climate change?	
How can chemistry help to mitigate other air quality concerns?	

Supporting Competencies for Chemistry

Conceptual Understanding for Teachers at 9-12	Required course number & name or advising requirements
PHYSICS	
What is energy and how is it measured?	
How is energy transferred between objects?	
How do we model energy and energy changes at the particulate level?	
What is the relationship between thermal energy and temperature?	
LIFE SCIENCE	
What are major organelles, and how do these impact cell function?	
How do organisms obtain and use the matter and energy they need to live and grow?	
What are the structural relationships among DNA, proteins, and genes?	
How do matter and energy move through an ecosystem?	
How does the environment influence populations of organisms over multiple generations?	
How do organisms grow and develop?	
EARTH AND SPACE SCIENCE	
How do Earth's major systems interact to impact Earth processes?	
How do humans depend on Earth's resources?	
What human activities have positively and negatively impacted Earth's climate?	
How do the chemical and physical properties of water and its movement create changes in the surface and subsurface of the Earth?	
MATHEMATICS	
How can mathematical and statistical models evaluate the strength of a conclusion?	
How are mathematical models used in chemistry?	
What are the applications of calculus in chemistry?	

Conceptual Understanding for Teachers at 9-12	Required course number & name or advising requirements
PS1.C: NUCLEAR PROCESSES <i>What forces hold nuclei together and mediate nuclear processes?</i>	
What forces hold nuclei together and mediate nuclear processes?	
How do the number of protons, electrons, and neutrons change during nuclear decay?	
How does the amount of radioactive materials change over the course of a nuclear decay reaction?	
How is half-life used to determine the age of rocks and other natural materials?	
What different star life cycles exist? What properties of stars dictate their end of life states?	
PS2.A: FORCES AND MOTION <i>How can one predict an object's continued motion, changes in motion, or stability?</i>	
How can one predict an object's continued motion, changes in motion, or stability?	
What are the relationships among mass, velocity, acceleration, force, and momentum for macroscopic objects?	
How do Newton's Laws of Motion apply to macroscopic objects in a system?	
How can one predict an object's continued motion, changes in motion, or stability?	
How can models help explain the variety of interactions observed for forces?	
What are the conceptual and mathematical relationships among velocity and mass for objects in a closed system?	
How are the conservation of momentum and energy related?	
Why are some physical systems more stable than others?	
PS2.B: TYPES OF INTERACTIONS <i>What underlying forces explain the variety of interactions observed?</i>	
What underlying forces explain the variety of interactions observed?	
What is the nature of the gravitational relationship between two masses?	
What is the nature of the electrostatic relationship between two electrical charges? What are the mathematical representations of Newton's Law of Gravitation and Coulomb's Law of Electrostatic Forces?	
How are electric currents and magnetic fields related?	
What are the practical applications of the relationship between electric currents and magnetic fields?	
How do strong and weak nuclear forces in an atomic nucleus function?	
PS2.C: STABILITY AND INSTABILITY IN PHYSICAL SYSTEMS <i>Why are some physical systems more stable than others?</i>	
Why are some physical systems more stable than others?	
How do feedback mechanisms maintain stability in closed systems?	
How is the Second Law of Thermodynamics applied to two	

components in a closed system?	
PS3.A: DEFINITIONS OF ENERGY <i>What is energy?</i>	
What is energy and how do we measure it?	
How is energy manifested?	
What are the conceptual and mathematical relationships among energy, work, and power?	
How is energy transferred between objects?	
How are efficiency and conservation of energy related?	
How do we model energy and energy changes at the particulate level?	
What is relationship between thermal energy and temperature?	
How is energy harnessed?	

PS3.B: CONSERVATION OF ENERGY AND ENERGY TRANSFER <i>What is meant by conservation of energy?</i> <i>How is energy transferred between objects or systems?</i>	
How do the amount and properties of matter affect the energy needed to change the temperature of the sample?	
How do various energy diagrams represent mechanical, light, and electric interactions?	
How is energy (electrical, thermal, and magnetic) transferred from one object to another object in a closed system?	
How does energy (electrical, thermal, and magnetic) change when energy flows in and out of a system?	
How is energy converted from one form to another?	
What are the practical applications of energy conversion for real-world examples?	
What is meant by conservation of energy?	
How can mathematical expressions be used to predict and describe system behavior?	
PS3.C RELATIONSHIP BETWEEN ENERGY AND FORCES <i>How are forces related to energy?</i>	
What are the conceptual and mathematical relationships between two objects interacting through electrical or magnetic fields?	
How are forces related to energy?	
What are the conceptual and mathematical relationships among conservation of mass, momentum, energy, and charge?	
PS3.D: ENERGY IN CHEMICAL PROCESSES AND EVERYDAY LIFE <i>How do food and fuel provide energy?</i> <i>If energy is conserved, why do people say it is produced or used?</i>	
What are the chemical processes in which plants produce sugar?	
How is energy released from complex molecules containing carbon?	
In what ways can a mechanical system be made more energy efficient?	

How does Earth receive seemingly unlimited energy?	
PS4.A: WAVE PROPERTIES <i>What are the characteristic properties and behaviors of waves?</i>	
What are the different types of waves?	
What is the relationship among, frequency, wavelength, and speed of waves traveling in different media?	
What happens to light what it interacts with different materials?	
What other forms of electromagnetic radiation are there?	
How can information be digitized and communicated using the electromagnetic spectrum?	
What are the characteristic properties and behaviors of waves?	
What is resonance and how is the concept applied to everyday events?	
PS4.B: ELECTROMAGNETIC RADIATION <i>What is light? How can one explain the varied effects that involve light?</i> <i>What other forms of electromagnetic radiation are there?</i>	
What is light?	
How does light behave given the two models of electromagnetic behavior (e.g., particle versus wave)?	
What forms of electromagnetic radiation exist?	
What are the different models for electromagnetic radiation?	
What are some practical applications of electromagnetic radiation?	
How does electromagnetic radiation affect matter?	
How does electromagnetic radiation influence the emission of energy by an atom?	
PS4.C: INFORMATION TECHNOLOGIES AND INSTRUMENTATION <i>How are instruments that transmit and detect waves used to extend human senses?</i>	
How do different technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy?	
How are instruments that transmit and detect waves used to explore the world around us beyond what we can see and hear?	

Supporting Competencies for Physics

Conceptual Understanding for Teachers at 9-12	Required course number & name or advising requirements
CHEMISTRY	
What is matter?	
What trends exist in the Periodic Table and how do those trends reflect atomic structure?	
In what ways do atoms combine to form novel substances?	
What conventions do chemists use for naming chemical compounds and writing chemical formulas?	

How does a balanced chemical reaction represent conservation of mass in a given chemical reaction?	
LIFE SCIENCE	
How do matter and energy move through an ecosystem?	
How do organisms obtain and use the matter and energy they need to live and grow?	
EARTH AND SPACE SCIENCE	
What is the universe, and what goes on in stars?	
What are the predictable patterns caused by Earth's motion in the Solar System?	
How do the properties and movements of water shape Earth's surface and affect its systems?	
How do people model and predict the effects of human activities on Earth's climate?	
MATHEMATICS	
How can mathematical and statistical models evaluate the strength of a conclusion?	
How are mathematical models used in physics?	
What are the applications of calculus and differential equations in physics?	

Earth and Space Science for High School

Conceptual Understanding for Teachers at 9-12	Required course number & name or advising requirements
ESS1.A: THE UNIVERSE AND ITS STARS <i>What is the Universe and what goes on in Stars?</i>	
How can the position and motion of the Sun, planets, and stars be observed, described, predicted, and explained with models?	
What evidence is used to support the current model for the formation and expansion of the universe?	
What nuclear reactions take place that result in the Sun radiating energy?	
How will the nuclear reactions in the Sun change over time?	
What do the spectra of distant stars reveal about their age and history?	
How do the spectra of stars and galaxies provide evidence of their chemical composition?	
What is the relationship between velocity and relative distance from Earth for these spectra?	
ESS1.B: EARTH AND THE SOLAR SYSTEM <i>What are the predictable patterns caused by Earth's motion in the Solar System?</i>	
What types of objects can be found in the Solar System?	
does gravity affect the motion of objects around the sun and/or around planets?	
What causes seasonal change on Earth?	
How can the mathematical representations of Kepler's Laws provide predictions of natural and man-made objects in the solar system?	
What is the nature and period of oscillations in Earth's motions?	
What positive and negative feedback can be seen in these oscillations?	
ESS1.C: HISTORY OF PLANET EARTH <i>How do people reconstruct and date events in Earth's planetary history?</i>	
What evidence is collected and how is it interpreted to reconstruct Earth's history?	
What are the limitations of analyzing rock strata and the fossil record in reconstructing Earth's history?	
In what ways can the decay of radioactive isotopes be used to establish an absolute age for Earth materials?	
How do tectonic processes affect current patterns of continental and ocean floor features?	
How do the mineralogic and chemical compositions of Earth and solar system materials inform about the conditions of Earth's earliest history?	
How does the record of impacts and collisions provide information on the history of the Solar System?	
ESS2.A: EARTH MATERIALS AND SYSTEMS <i>How do Earth's major systems interact?</i>	
How do Earth's major systems interact to impact Earth processes?	

What spatial and temporal scales must be employed to observe changes and interactions in Earth's systems?	
In what ways can Earth's dynamic systems be modeled, over both short and long time spans?	
How does Earth's internal energy drive small- and large-scale crustal processes?	
How is the rate of change in Earth processes interrelated?	
How can seismic wave data indicate differences in density in the crust and mantle of the Earth?	
What causes motion in the Earth's mantle?	
How can the sequence of rocks in a given area provide evidence of the plate tectonic environment of their formation?	
ESS2.B: PLATE TECTONICS AND LARGE-SCALE SYSTEM INTERACTIONS <i>Why do the continents move, and what causes earthquakes and volcanoes?</i>	
How does Plate Tectonic theory provide explanatory and predictive power for describing the evolution of Earth's surface?	
How does Plate Tectonics explain the distribution of rocks and minerals at Earth's surface?	
What map-pattern evidence can be employed to make retrodictions of the previous positions of Earth's plates?	
What are the sources of energy that drive Earth's surface and subsurface processes	
ESS2.C: THE ROLES OF WATER IN EARTH'S SURFACE PROCESSES <i>How do the properties and movements of water shape Earth's surface and affect its systems?</i>	
How do the chemical and physical properties of water and its movement create changes in the surface and subsurface of the Earth?	
How does water mediate and facilitate short- and long-term Earth processes in the surface and subsurface?	
ESS2.D: WEATHER AND CLIMATE <i>What regulates weather and climate?</i>	
How can data and models be used to extrapolate weather and climate patterns?	
What is the difference between weather and climate?	
What regulates weather and climate?	
What energy transformations occur to incoming solar radiation as it is transferred between Earth systems?	
What is the evidence in the rock and sediment record for changes in climate?	
What are drivers for climate change?	
Based on current rates of change in energy levels, what are some valid extrapolations for changes in climate and the impact on the biosphere, hydrosphere, and lithosphere?	
ESS2.E: BIOGEOLOGY <i>How do living organisms alter Earth's processes and structures?</i>	
How have organisms on Earth evolved in response to changes in the Earth's major systems?	
How can organisms impact Earth's major systems?	
How would the Earth's lithosphere, atmosphere, and hydrosphere be different in the absence of life?	

<p>ESS3.A: NATURAL RESOURCES</p> <p><i>How do humans depend on Earth's resources?</i></p>	
How do humans depend on Earth's resources?	
What has caused Earth's resources to be unevenly distributed?	
How has technology been employed to develop and exploit renewable energy resources?	
How can non-renewable resources be responsibly managed to sustain human use?	
<p>ESS3.B: NATURAL HAZARDS</p> <p><i>How do natural hazards affect individuals and societies?</i></p>	
What tools and models can be employed to make reliable predictions about the timing and intensity of natural hazards?	
How can we use information about past natural hazards to assist in forecasting future hazards?	
How have occurrences of natural hazards in local and regional environments driven human movements and populations in those environments?	
<p>ESS3.C: HUMAN IMPACTS ON EARTH SYSTEMS</p> <p><i>How do humans change the planet?</i></p>	
How have organisms responded to changes in their environment as a result of human activity?	
What changes in human behavior and technology can mitigate the negative impacts humans have had on Earth systems?	
What is the impact of different resource management approaches on natural resources long-term availability to people?	
<p>ESS3.D: GLOBAL CLIMATE CHANGE</p> <p><i>How do people model and predict the effects of human activities on Earth's climate?</i></p>	
What human activities have positively impacted Earth's climate?	
What human activities have negatively impacted Earth's climate?	
How can knowledge from STEM areas and social science disciplines be used to mitigate the impact of humans on the Earth's climate?	
What technological resources are available to advance positive feedback and mitigate negative feedback caused by resource use by people?	

Supporting Competencies for Earth and Space Science

Conceptual Understanding for Teachers at 9-12	Required course number & name or advising requirements
CHEMISTRY	
What is matter?	
What trends exist in the Periodic Table and how do those trends reflect atomic structure?	
In what ways do atoms combine to form novel substances?	
What conventions do chemists use for naming chemical compounds and writing chemical formulas?	
How does a balanced chemical reaction represent conservation of mass in a given chemical reaction?	
How does the amount of radioactive materials change over the course of a nuclear decay reaction?	
LIFE SCIENCE	
What are major organelles, and how do these impact cell function?	
How do organisms obtain and use the matter and energy they need to live and grow?	
What are the structural relationships among DNA, proteins, and genes?	
How do matter and energy move through an ecosystem?	
How does the environment influence populations of organisms over multiple generations?	
How do organisms grow and develop?	
PHYSICS	
What is energy and how is it measured?	
How is energy transferred between objects?	
What are the conceptual and mathematical relationships among energy, work, and power?	
What is meant by conservation of energy and conservation of mass?	
What is the relationship between thermal energy and temperature?	
MATHEMATICS	
How are statistics used by scientists to support arguments?	
How are mathematical models used in earth and space science?	