MS.ESS-SS Space Systems

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Construct explanations for the occurrences of day/night cycles, seasons, tides, eclipses, and lunar phases based on patterns of the observed motions of celestial bodies.** [*Assessment Boundary: Kepler's Laws of orbital motion are not used as the basis for evidence at this level.*]

b. **Obtain, evaluate, and communicate information about the expansion and scale of the Universe to support the Big Bang theory.** [Clarification Statement: Evidence should include qualitative discussions of the cosmic background of radiation, the motions of galaxies away from each other, and the resulting prevalence of hydrogen and helium in the universe.]

c. **Construct and use models to describe the location of Earth with respect to the sizes and structures of the Solar System, Milky Way galaxy, and Universe.** [*Assessment Boundary: Mathematical models are not expected; use AU for Solar System scale, use light years for universal scale.*]

d. **Use models to support explanations of the composition, structure, and formation of the solar system from a disk of dust and gas, drawn together by gravity.**

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

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.
- Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (c), (d)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 6–8 builds on 3–5 and progresses to evaluate the merit and validity of ideas and methods.
- Read critically using scientific knowledge and reasoning to evaluate data, hypotheses, conclusions, and competing information. (b)

Disciplinary Core Ideas

ESS1.A: The Universe and Its Stars
- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (a)
- The universe began with a period of extreme and rapid expansion known as the Big Bang. Nearly all observable matter in the universe is hydrogen or helium, which formed in the first minutes after the Big Bang. (b)
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (c)

ESS1.B: Earth and the Solar System
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. This system appears to have formed from a disk of dust and gas, drawn together by gravity. (d)
- This model of the solar system can explain tides, eclipses of the sun and the moon, and the apparent motions of the planets in the sky relative to the stars. (a)
- Earth's spin axis is fixed in direction (in the short-term) but tilted relative to its orbit around the sun; the differential intensity of sunlight on different areas of Earth over the year is a result of that tilt, as are the seasons that result. (a)

PS2.C: Stability and Instability in Physical Systems
- A system can be changing but have a stable repeating cycle of changes; such observed regular patterns allow predictions about the system's future (e.g., Earth orbiting the sun). (a)

Crosscutting Concepts

Patterns
Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs and charts can be used to identify patterns in data. (a),(d)

Scale, Proportion, and Quantity
Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. The observed function of natural and designed systems may change with scale. (b)

Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. Scientific relationships can be represented through the use of algebraic expressions and equations. (c)

Connections to other DCIs in this grade-level: **MS.LS-GDRO, MS.PS-FM, MS.PS-IF, MS.PS-E**

Articulation of DCIs across grade-levels: **1.PC, 5.SSS, HS.ESS-SS**

Common Core State Standards Connections: [Note: Connections will be made more complete and explicit in future releases.]

ELA

W.6.1	Write arguments to support claims with clear reasons and relevant evidence.
W.6.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
W.7.1	Write arguments to support claims with clear reasons and relevant evidence.
W.7.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
SL.7.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
W.8.1	Write arguments to support claims with clear reasons and relevant evidence.
W.8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
SL.8.4	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.

Mathematics

MP.4	Model with mathematics.
8.F	Use functions to model relationships between quantities.

NEXT GENERATION SCIENCE STANDARDS

MS.ESS-HE The History of Earth

How to read the standards » Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Construct explanations for patterns in geologic evidence to determine the relative ages of a sequence of events that have occurred in Earth's past.** [Clarification Statement: Evidence can be field evidence or representations like models of geologic cross-sections. Events may include sedimentary layering, fossilization, folding, faulting, igneous intrusion, and/or erosion.]

b. **Use models of the geologic time scale in order to organize major events in Earth's history.** [Clarification Statement: Models may be either temporal like a clock or spatial like a football field.] [*Assessment Boundary: Memorization of specific periods or epochs of the geologic timescale is not intended.*]

c. **Construct explanations from evidence for how different geologic processes shape Earth's evolution over widely varying scales of space and time.** [Clarification Statement: Chemical erosion of a mountain occurs at molecular scales while mountain building can occur through large-scale tectonic processes; meteor impacts are nearly instantaneous, mountain building can take many millions of years. It is appropriate to use regional geographical features familiar to students of that state.]

d. **Use empirical evidence from the rock and fossil record to investigate how past geologic events have caused major extinctions of life forms on Earth and how these extinctions have subsequently allowed other life forms to flourish.**

e. **Use models of the geosphere and biosphere that highlight system interactions to explain how the geosphere and biosphere co-evolve over geologic time.** [*Assessment Boundary: Use the examples of weathering and erosion of land surfaces, composition of soils and atmosphere, and distribution of water in the hydrosphere.*]

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

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.

- Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (b), (e)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

- Formulate a question that can be investigated within the scope of the classroom, school laboratory, or field with available resources and, when appropriate, frame a hypothesis (that is, a possible explanation that predicts a particular and stable outcome) based on a model or theory. (d)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- Apply scientific reasoning to show why the data are adequate for the explanation or conclusion. (a)
- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (c)

Disciplinary Core Ideas

ESS1.C: The History of Planet Earth

- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Earth has changed significantly since its formation along with the rest of the solar system 4.6 billion years ago. Major historical events include the formation of mountain chains and ocean basins, evolution and extinction of particular living organisms, volcanic eruptions, periods of massive glaciation, and the development of watersheds and rivers through glaciation and water erosion. (b)
- Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (a)

ESS2.A: Earth's Materials and Systems

- Earth's systems interact over scales that range from microscopic to global in size, and operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (c)

ESS2.E: Biogeology

- The evolution of life is shaped by Earth's varying geologic conditions. Sudden changes in these conditions (e.g., meteor impacts or major volcanic eruptions) have caused mass extinctions in Earth's past. However, these changes, as well as more gradual ones, have also allowed other existing or new life forms to flourish. (d)
- Organisms continually evolve to new and often more complex forms as they adapt to new environments. (e)
- The evolution and proliferation of living things over geologic time have in turn changed the rates of weathering and erosion of land surfaces, altered the composition of Earth's soils and atmosphere, and affected the distribution of water in the hydrosphere. (e)

Crosscutting Concepts

Scale, Proportion, and Quantity
Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. The observed function of natural and designed systems may change with scale. (a)

Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. Scientific relationships can be represented through the use of algebraic expressions and equations. (b)

Stability and Change
Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. Small changes in one part of a system might cause large changes in another part. Stability might be disturbed either by sudden events or gradual changes that accumulate over time. Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms. (c),(d),(e)

Connections to other DCIs in this grade-level: **MS.LS-NSA, MS.LS-IRE**

Articulation of DCIs across grade-levels: **K.OTE, 2.IOS, 2.ECS, 4.PSE, HS.ESS-HE**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA

WHST.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

W.6.1 Write arguments to support claims with clear reasons and relevant evidence.

W.6.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

SL.6.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.
SL.6.3	Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not.
W.7.1	Write arguments to support claims with clear reasons and relevant evidence.
W.7.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
SL.7.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.
SL.7.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
W.8.1	Write arguments to support claims with clear reasons and relevant evidence.
W.8.1	Write arguments to support claims with clear reasons and relevant evidence.
W.8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
SL.8.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.
SL.8.4	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.
Mathematics	
MP.3	Reason abstractly and quantitatively.
MP.4	Model with mathematics.
8.F	Use functions to model relationships between quantities.
8.SP	Investigate patterns of association in bivariate data.

NEXT GENERATION SCIENCE STANDARDS

MS.ESS-EIP Earth's Interior Processes

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Use models to explain how the flow of energy drives a cycling of matter between Earth's surface and deep interior.** *[Assessment Boundary: The thermodynamic processes that drive convection are not required, only a description of those motions. This explanation should include mid-ocean ridges and ocean trenches.]*

b. **Develop and use models of ancient land and ocean basin patterns to explain past plate motions.** *[Assessment Boundary: Explanations should be based on fossil evidence, evidence from rock formations, continent shapes, and seafloor structures.]*

c. **Use representations of current plate motions, based on data from modern techniques like GPS, to predict future continent locations** [Clarification Statement: Representations may include maps.]

d. **Plan and carry out investigations that demonstrate the chemical and physical process that form rocks and cycle Earth materials.** *[Assessment Boundary: Students will use various materials to replicate,stimulate, and demonstrate the processes of crystallization, heating and cooling, weathering, deformation, and sedimentation involved. Investigations should focus on connecting, correlating, and identifying parts of the rock cycle.]*

e. **Construct explanations for how the uneven distribution of Earth's mineral and energy resources, which are limited and often non-renewable, are a result of past and current geologic processes, including plate motions.**

f. **Analyze and interpret data sets to describe the history of natural hazards in a region in order to identify the patterns of hazards that allow for forecasts of the locations and likelihoods of future events.** *[Assessment Boundary: Hazards, in this standard are limited to those resulting from Earth's interior process such as volcanoes, earthquakes, and tsunamis.]*

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

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.
- Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (a),(b),(c)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
- Plan and carry out investigations individually and collaboratively, identifying independent and dependent variables and controls. (d)

Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Distinguish between causal and correlational relationships. (f)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (e)

Disciplinary Core Ideas

ESS1.C: The History of Planet Earth
- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (a)

ESS2.A: Earth's Materials and Systems
- Earth's internal processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from Earth's hot interior. The flow of energy and cycling of matter produce chemical and physical changes in Earth's interior materials and living organisms. (a)
- Solid rocks can be formed by the cooling of molten rock, the accumulation and consolidation of sediments, or the alteration of older rocks by heat, pressure, and fluids. (d)

ESS2.B: PLate Tectonics and Large-Scale System Interactions
- The top part of the mantle, along with the crust, forms structures known as tectonic plates. (b),(c)
- Organisms continually evolve to new and often more complex forms as they adapt to new environments. (e)
- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (b)

ESS3.A: Natural Resources
- Humans depend on Earth's interior for many different resources. Mineral and energy resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (e)

ESS3.B: Natural Hazards
- Some natural hazards, such as volcanic eruptions, are preceded by phenomena that allow for reliable predictions. Others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. However, mapping the history of natural hazards in a region and developing an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (f)

Crosscutting Concepts

Cause and Effect
Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (b),(c),(d)

Energy and Matter
Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). The transfer of energy can be tracked as energy flows through a designed or natural system. (a),(e)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World
All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies are driven by people's needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Technology use varies over time and from region to region. (f)

Connections to other DCIs in this grade-level: **MS.ESS-ESP, MS.PS-IF, MS.PS-E, MS.PS-CR, MS.PS-SPM**

Articulation of DCIs across grade-levels: **K.WEA, 3.WCL, 4.PSE, 5.ESI, HS.ESS-ES, HS.ESS-HS**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA

WHST.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
W.6.1	Write arguments to support claims with clear reasons and relevant evidence.
W.7.1	Write arguments to support claims with clear reasons and relevant evidence.
SL.7.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
W.8.1	Write arguments to support claims with clear reasons and relevant evidence.
SL.8.4	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.

Mathematics

MP.3	Reason abstractly and quantitatively.
MP.4	Model with mathematics.
8.F	Use functions to model relationships between quantities.
8.SP	Investigate patterns of association in bivariate data.

MS.ESS.ESP Earth's Surface Processes

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Use models to explain how weathering, erosion, and deposition of Earth materials by the movement of water shape landscapes and create underground formations.** [Clarification Statement: Models may include maps.]

b. **Model multiple pathways for the cycling of water through the atmosphere, geosphere, and hydrosphere as it changes phase and moves in response to energy from the sun and the force of gravity.** [*Assessment Boundary: Heat of vaporization and heat of condensation are not to be addressed.*]

c. **Plan and conduct investigations to explain how temperatures and salinity cause changes in density which affect the separation and movement of water masses within the ocean.** [*Assessment Boundary: Complex system interactions such as the Coriolis Effect are not required.*]

d. **Plan and carry out investigations of the variables that affect how water causes the erosion, transportation, and deposition of surface and subsurface materials as evidence of how matter cycles through Earth's systems.**

e. **Apply scientific knowledge to design engineered solutions to natural hazards that result from surface geologic and hydrologic processes.** [Clarification Statement: Examples of natural hazards are flooding, avalanches, and landslides. Direct methods engineers use to control flooding include building artificial levees and dams.]

f. **Generate and revise causal explanations for how physical and chemical interactions among rocks, sediments, water, air, and organisms contribute to the weathering and erosion of rocks and the formation of soil.**

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

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.
- Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (a),(b)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
- Plan and carry out investigations individually and collaboratively, identifying independent and dependent variables and controls. (c)
- Collect data and generate evidence to answer scientific questions or test design solutions under a range of conditions. (d)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Apply scientific reasoning to show why the data are adequate for the explanation or conclusion. (f)
- Apply scientific knowledge to explain real-world examples or events and solve design problems. (e)

Disciplinary Core Ideas

ESS2.A: Earth's Materials and Systems
- Earth's surface processes are the result of energy flowing and matter cycling within and among the planet's surface systems. This energy is derived from electromagnetic radiation from the sun. This flow of energy and cycling of matter produce chemical and physical changes in Earth's surface materials and living organisms. (b),(d)
- Physical and chemical interactions among rocks, sediments, water, air, and plants and animals produce soil. (f)

ESS2.C: The Roles of Water in Earth's Surface Processes
- Water continually cycles among the land, ocean, and atmosphere via transpiration, evaporation, condensation, precipitation, and the downhill runoff on land. Global movements of water and changes in its chemical phase are driven by sunlight and gravity. (b)
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (c)
- Water's movements both on the land and underground cause weathering and erosion, which change the land's surface features and create underground formations. (a)

ESS3.B: Natural Hazards
- Surface-related geologic processes create natural resources needed by humans and cause natural hazards that pose challenges to human society (e.g., landslides and coastal erosion). (e)

Crosscutting Concepts

Cause and Effect
Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (c),(d),(f)

Systems and System Models
Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy, matter, and information flows within systems. Models are limited in that they only represent certain aspects of the system under study. (a),(b)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World
All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies are driven by people's needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Technology use varies over time and from region to region. (e)

Connections to other DCIs in this grade-level: **MS.ESS-EIP, MS.LS-MEOE, MS.PS-IF, MS.PS-CR, MS.PS-WER, MS.PS- SMP**

Articulation of DCIs across grade-levels: **K.WEA, 3.WCI, 4.PSE, 5.ESI, HS.ESS-ES, HS.ESS-HS**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA

WHST.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

W.6.1 Write arguments to support claims with clear reasons and relevant evidence.

W.7.1 Write arguments to support claims with clear reasons and relevant evidence.

SL.7.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
W.8.1	Write arguments to support claims with clear reasons and relevant evidence.
SL.8.4	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.
Mathematics	
MP.3	Reason abstractly and quantitatively.
MP.4	Model with mathematics.
7.RP	Analyze proportional relationships and use them to solve real-world and mathematical problems.
8.F	Use functions to model relationships between quantities.

NEXT GENERATION SCIENCE STANDARDS

MS.ESS.WC Weather and Climate

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Generate and revise causal explanations given specific temperature and precipitation data sets at different geographic locations to answer questions about the interactions that influence weather.** [Clarification Statement: Factors that interact and influence weather should include sunlight, ocean, atmosphere, ice, landforms, and living things.][*Assessment Boundary: Students consider interactions between only two variables at a time.*]

b. **Construct models to describe and explain how circulation in the atmosphere and ocean results from unequal heating of Earth's surface and is influenced by latitude, altitude, geography, and Earth's rotation.** [Clarification Statement: Atmospheric and oceanic circulation may include Hadley cells, the Gulf Stream, and the prevailing westerlies and trade winds.][*Assessment Boundary: Students do not need to explain the mechanism causing the Coriolis Effect.*]

c. **Use mathematics to analyze weather data and forecasts to identify patterns and variations that cause weather forecasts to be issued in terms of probabilities.** [Clarification Statement: Averages and basic probability should be used to analyze weather data.]

d. **Construct explanations, from models of oceanic and atmospheric circulation, for the development of local and regional climates.** [Clarification Statement: The ocean and atmosphere are responsible for redistributing both water and heat about Earth's surface, and these patterns of circulation are the direct causes of local and regional climates.] [*Assessment Boundary: Students should construct explanations for their own local climate.*]

e. **Use models of Earth's atmosphere and surface to explain how energy from the sun is absorbed and retained by various greenhouse gases in Earth's atmosphere, thereby regulating Earth's average surface temperature and keeping Earth habitable.** [*Assessment Boundary: Explanations should include an understanding that energy can take different forms and can be tracked as it moves through Earth's systems. Students do not have to explain the differing wavelengths of radiation received and reemitted from Earth's surface. Amount of energy absorbed by different resevoirs is not assessed at this level.*]

f. **Construct a model to track and explain the inputs, outputs, pathways, and storage of carbon among the geosphere, biosphere, hydrosphere, and atmosphere.** [*Assessment Boundary: Details of biogeochemical reactions involving carbon and actual amounts of reactants and products are not assessed at this level.*]

g. **Use argumentation to evaluate the competing demands for various human uses of fresh water and biosphere resources.** [*Assessment Boundary: Arguments should take into account the uneven distribution of the resources and the natural limits to their availability.*]

h. **Use maps and other visualizations to analyze large data sets that illustrate the frequency, magnitude, and resulting damage from severe weather events in order to assess the likelihood and severity of future events.**

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

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.
- Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (b),(e),(f)

Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigation, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Use graphical displays (e.g., maps) of large data sets to identify temporal and spatial relationships. (h)

Using Mathematics and Computational Thinking
Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.
- Use mathematical concepts such as ratios, averages, basic probability, and simple functions, including linear relationships, to analyze data. (c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Apply scientific reasoning to show why the data are adequate for the explanation or conclusion. (a)
- Construct explanations from models or representations. (d)

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.
- Use oral and written arguments supported by empirical evidence and reasoning to support or refute an argument for a phenomenon or a solution to a problem. (g)

Disciplinary Core Ideas

ESS2.C: The Roles of Water in Earth's Surface Processes
- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (a),(b),(d)

ESS2.D: Weather and Climate
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (a),(b)
- Because these patterns are so complex, weather can only be predicted probabilistically. (c),(e)
- The ocean and land exert major influences on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it via oceanic and atmospheric circulation. The patterns of differential heating, together with Earth's rotation and the configuration of continents and oceans, control the large-scale patterns of oceanic and atmospheric circulation. (a),(b),(d)
- Greenhouse gases in the atmosphere absorb and retain the energy radiated from land and ocean surfaces, thereby regulating Earth's average surface temperature and keeping Earth habitable. (e)

ESS2.E: Biogeology
- Organisms ranging from bacteria to human beings are a major driver of the global carbon cycle, and they influence global climate by modifying the chemical makeup of the atmosphere. (e),(f)

ESS3.A: Natural Resources
- Humans depend on Earth's ocean, atmosphere, and biosphere for many different resources. Fresh water and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of weather -and climate-related processes. (g)

ESS3.B: Natural Hazards
- Severe weather events (e.g., hurricanes, floods, forest fires) are often preceded by observable phenomena that allow for reliable predictions. Constant monitoring of weather hazards in a region and the development of an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (h)

Crosscutting Concepts

Cause and Effect
Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (a),(b),(c),(d),(h)

Energy and Matter
Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). The transfer of energy can be tracked as energy flows through a designed or natural system. (e),(f)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World
All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies are driven by people's needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Technology use varies over time and from region to region. (g)

Connections to other DCIs in this grade-level: **MS.LS-MEOE, MS.PS-IF, MS.PS-E, MS.PS-CR, MS.PS-WER, MS.PS- SPM**

Articulation of DCIs across grade-levels: **K.WEA, 3.WCI, 4.PSE, 5.ESI, HS.ESS-ES, HS.ESS-HS**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA

WHST.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
WHST.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
W.6.1	Write arguments to support claims with clear reasons and relevant evidence.
W.7.1	Write arguments to support claims with clear reasons and relevant evidence.
SL.7.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
W.8.1	Write arguments to support claims with clear reasons and relevant evidence.
SL.8.4	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.

Mathematics

MP.3	Reason abstractly and quantitatively.
MP.4	Model with mathematics.
7.RP	Analyze proportional relationships and use them to solve real-world and mathematical problems.

MS.ESS-HI Human Impacts

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Use system models and representations to explain how human activities significantly impact:(1) the geosphere, (2) the hydrosphere, (3) the atmosphere, (4) the biosphere, and (5) global temperatures.**[Clarifying Statement: System models and representations include diagrams, charts, and maps. Examples of human impacts are changes in land use and resource development (geosphere); water pollution and urbanization (hydrosphere); air pollution in the form of gases, aerosols, and particulates (atmosphere); changes to natural environments (biosphere); release of greenhouse gases (global temperatures).]

b. **Generate and revise qualitative explanations from data for the impacts on Earth's systems that result from increases in human population and rates of consumption.** [Assessment Boundary: Students should be provided with modified regional databases on human populations and rates of consumption. "Impacts" include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.]

c. **Design engineering solutions for stabilizing changes to communities by: (1) using water efficiently, (2) minimizing human impacts on environments and local landscapes by reducing pollution, and (3) reducing the release of greenhouse gases.**

d. **Ask questions to refine and develop and explanation for the way technological monitoring of Earth's systems can provide the means of informing the public of ways to modify human impacts on Earth's systems.**

e. **Use empirical evidence to evaluate technologies that utilize renewable energy resources.** [Assessment Boundary: Students will evaluate these technologies based on their cost, benefit, sustainability, and environmental impacts.]

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

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to formulating and refining empirically testable questions and explanatory models.
- Ask questions to refine a model, an explanation, or an engineering problem. (d)

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.
- Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (a)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Apply scientific reasoning to show why the data are adequate for the explanation or conclusion. (b)
- Apply scientific knowledge to explain real-world examples or events and solve design problems. (c)

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.
- Use oral and written arguments supported by empirical evidence and reasoning to support or refute an argument for a phenomenon or a solution to a problem. (e)

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems
- Humans have become one of the most significant agents of change in the near-surface Earth system. Human activities have significantly altered the biosphere, geosphere, hydrosphere, and atmosphere. (a)
- As human populations and per-capita consumption of natural resources increase, so do the impacts on Earth's systems unless the activities and technologies involved are engineered otherwise. (b),(c)
- Continued monitoring of the changes to Earth's surface provides a deeper understanding of the way in which human activities are impacting Earth's systems, providing the basis for social policies and regulations that can reduce these impacts. (d)

ESS3.D: Global Climate Change
- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature ("global warming"). (a)
- Reducing the amount of greenhouse gases released into the atmosphere can reduce the degree to which global temperatures will increase. (c)
- Renewable energy resources and the technologies to exploit them are being rapidly developed. (e)

Crosscutting Concepts

System and System Models
Systems may interact with other systems; they may have sub-systems and be part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. Models are limited in that they only represent certain aspects of the system under study. (a)

Stability and Change
Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. Small changes in one part of a system might cause large changes in another part. Stability might be disturbed either by sudden events or gradual changes that accumulate over time. Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms. (c)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology
Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. Science and technology drive each other forward. (d)

Influence of Science, Engineering, and Technology on Society and the Natural World
All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies are driven by people's needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Technology use varies over time and from region to region. (b),(e)

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