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Scienc
Developing and Using Models
Analyzing and Interpreting Data
Constructing Explanations and Designing Solutions

Obtaining, Evaluating, and Communicating Information
Planning and Carrying Out Investigations

Engaging in Argument from Evidence
Using Mathematics and Computational Thinking
Cı
Patterns

Cause and Effect
Scale, Proportion, and Quantity
Energy and Matter
Systems and System Models
Stability and Change

Conne

Scientific Knowledge is Based on Empirical Evidence

Knowledge Assumes an Order and Consistency in

Questions About the Natural and

Knowledge is Open to Revision in Light

Connections to Eng

Science, Engineering, and

Influence of Science, Engineering and

Engineering and Technology on Society and the Natural World
MS-PS1 M **D**
PS3.A: Definitions of Energy
MS-E
MS-ESS2-1 MS-ESS2-2 MS-ESS2-3

MS-ESS2-4 **MS-ESS2-5** **MS-ESS2-6**
D
ESS2.A: Earth's Materials and Systems
MS-ESS3 I
MS-ESS3-1 **MS-ESS3-2** **MS-ESS3-3** **MS-ESS3-4** **MS-ESS3-5**
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ESS3.C: Human Impacts on Earth Systems
ESS3.D: Global Climate Change
<u>MS-ETS</u>
MS-ETS1-1 **MS-ETS1-2** **MS-ETS1-3** **MS-ETS1-4**

Common Core

ELA/ Literacy

MATH

Middle Level 6-8

e and Engineering Practices

	Heating Up
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems	X
●Develop a model to predict and/or describe phenomena.	
●Develop a model to describe unobservable mechanisms.	
●Develop and use a model to describe phenomena.	
●Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.	
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.	X
●Analyze and interpret data to determine similarities and differences in findings.	
●Construct and interpret graphical displays of data to identify linear and nonlinear relationships.	
●Analyze and interpret data to provide evidence for phenomena.	
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.	
●Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.	
●Apply scientific ideas or principles to design an object, tool, process or system.	
●Apply scientific ideas to construct an explanation for realworld phenomena, examples, or events.	X

●Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	
●Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.	

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.	X
●Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	
●Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.	

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.	X
●Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	
●Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.	
●Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.	

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.	
●Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.	
● Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	
●Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.	X
●Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	
●Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	
●Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	
●Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to	

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.	X
●Use mathematical representations to describe and/or support scientific conclusions and design solutions.	

rosscutting Concepts

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

●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. ●Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. ●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.	X
●Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. ●Phenomena that can be observed at one scale may not be observable at another scale.	X
●Matter is conserved because atoms are conserved in physical and chemical processes. ●Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. ●The transfer of energy can be tracked as energy flows through a designed or natural system.	X
●Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. ●Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.	X
●Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. ●Small changes in one part of a system might cause large changes in another part.	X

●Stability might be disturbed either by sudden events or gradual changes that accumulate over time.	

ections to Nature of Science

●Science disciplines share common rules of obtaining and evaluating empirical evidence.	X
●Science knowledge is based upon logical and conceptual connections between evidence and explanations.	
●Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through	X
●Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society	X
●Science findings are frequently revised and/or reinterpreted based on new evidence.	X

gineering, Technology, and Applications of Science

●Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led	X
●The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	

●Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.	X
●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.	

atter and Its Interactions

Disciplinary Core Ideas

●Some chemical reactions release energy, others store energy.	
●The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.	X
●The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or	

SS2 Earth’s Systems

Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.	X
Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at varying time and	
Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence	

Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.	
Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather	
Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic	

Disciplinary Core Ideas

●All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is	X
●The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a	

Earth and Human Activity

Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater	
Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies	
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	
Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.	
Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	X

Disciplinary Core Ideas

●Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.	X
● Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth	

●Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's	X

S1 Engineering Design

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into	X
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of	
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an	

Connections

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.	
RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical	X
RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information	X

SL.8.5, Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and	X
WHST.6-8.1 Write arguments focused on discipline-specific content.	X
WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources	X
WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the	X
WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.	X

6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities.	
6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems.	
6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plot	X
6.SP.B.5 Summarize numerical data sets in relation to their contexts.	X
7.EE.B.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form,	
7.RP.A.2 Recognize and represent proportional relationships between quantities.	
MP.2 Reason abstractly and quantitatively.	X

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Developing and Using Models
Analyzing and Interpreting Data
Constructing Explanations and Designing Solutions

Obtaining, Evaluating, and Communicating Information
Asking Questions and Defining Problems

Planning and Carrying Out Investigations
Engaging in Argument from Evidence

Using Mathematics and Computational Thinking
C
Patterns
Cause and Effect
Scale, Proportion, and Quantity

Energy and Matter
Structure and Function
Systems and System Models
Stability and Change
<u>Conne</u>
Scientific Knowledge is Based on Empirical Evidence

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
Knowledge Assumes an Order and Consistency in
Questions About the Natural and
Knowledge is Open to Revision in Light
<u>**Connections to Eng**</u>
Science, Engineering, and
Influence of Science, Engineering and Technology on Society and the Natural World

Natural World

MS-PS1 M

MS-PS1-1.

MS-PS1-2.

MS-PS1-3.

MS-PS1-4.

MS-PS1-5.

MS-PS1-6.

D

PS1.A: Structure and Properties of Matter

PS1.B: Chemical Reactions
PS3.A: Definitions of Energy
MS-PS2 Moti
MS-PS2-1. **MS-PS2-2.** **MS-PS2-3.** **MS-PS2-4.** **MS-PS2-5.**
D

PS2.A: Forces and Motion
PS2.B: Types of Interactions
MS-PS3-1 **MS-PS3-2** **MS-PS3-3**

MS-PS3-4 **MS-PS3-5**
D
PS3.A: Definitions of Energy
PS3.B: Conservation of Energy and Energy Transfer
PS3.C: Relationship Between Energy and Forces

MS-PS4 Wav **Technologi**
MS-PS4-1 **MS-PS4-2** **MS-PS4-3**
D
PS4.A: Wave Properties
PS4.B: Electromagnetic Radiation
PS4.C: Information Technologies and Instrumentation

MS-LS1 Fro **Struc**
MS-LS1-1 **MS-LS1-2** **MS-LS1-3** **MS-LS1-4** **MS-LS1-5** **MS-LS1-6** **MS-LS1-7** **MS-LS1-8**
D
LS1.A: Structure and Function

LS1.B: Growth and Development of Organisms

LS1.C: Organization for Matter and Energy Flow in Organisms

LS1.D: Information Processing

PS3.D: Energy in Chemical Processes and Everyday Life

MS-LS2 Ecosy

MS-LS2-1 **MS-LS2-2** **MS-LS2-3** **MS-LS2-4** **MS-LS2-5**
D
LS2.A: Interdependent Relationships in Ecosystems
Matter and Energy Transfer in
LS2.C: Ecosystem Dynamics,

Functioning, and Resilience
LS4.D: Biodiversity and Humans
MS-LS3 H… V…
MS-LS3-1. **MS-LS3-2.**
D…
LS3.A: Inheritance of Traits
LS3.B: Variation of Traits

MS-LS4 Biol

MS-LS4-1 **MS-LS4-2** **MS-LS4-3** **MS-LS4-4** **MS-LS4-5** **MS-LS4-6**
D
LS4.A: Evidence of Common Ancestry and Diversity
LS4.B: Natural Selection

LS4.C: Adaptation
MS-ESS1 Ea
MS-ESS1-1 **MS-ESS1-2** **MS-ESS1-3** **MS-ESS1-4**
D
ESS1.A: The Universe and Its Stars
ESS1.B: Earth and the Solar System

ESS1.C: The History of Planet Earth
MS-E
MS-ESS2-1 **MS-ESS2-2** **MS-ESS2-3** **MS-ESS2-4** **MS-ESS2-5** **MS-ESS2-6**
D
ESS2.A: Earth's Materials and Systems
Tectonics and Large-Scale System

ESS2.C: The Roles of Water in Earth's Surface Processes
ESS2.D: Weather and Climate
<u>MS-ESS3 I</u>
MS-ESS3-1 **MS-ESS3-2** **MS-ESS3-3** **MS-ESS3-4** **MS-ESS3-5**
<u>D</u>

ESS3.A: Natural Resources
ESS3.B: Natural Hazards
ESS3.C: Human Impacts on Earth Systems
ESS3.D: Global Climate Change

MS-ETS

MS-ETS1-1
MS-ETS1-2
MS-ETS1-3
MS-ETS1-4

and Delimiting an Engineering
ETS1.B: Developing Possible Solutions
ETS1.C: Optimizing the Design Solution

Common Core

ELA/ Literacy

MATH

Middle Level 6-8

e and Engineering Practices	Heating Up
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems	X
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●Develop a model to describe unobservable mechanisms.	
●Develop and use a model to describe phenomena.	
●Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.	
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.	X
●Analyze and interpret data to determine similarities and differences in findings.	
●Construct and interpret graphical displays of data to identify linear and nonlinear relationships.	
●Analyze and interpret data to provide evidence for phenomena.	
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.	
●Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.	
●Apply scientific ideas or principles to design an object, tool, process or system.	
●Apply scientific ideas to construct an explanation for realworld phenomena, examples, or events.	X

●Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	
●Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.	

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.	X
●Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	
●Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.	

Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.	
●Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	
●Ask questions to identify and clarify evidence of an argument.	
●Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.	

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.	X
●Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	
●Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.	
●Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.	

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.	X
●Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.	
● Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	
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●Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	
●Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	
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●Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to	

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.	X
●Use mathematical representations to describe and/or support scientific conclusions and design solutions.	

rosscutting Concepts

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

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

●Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.	X
●Phenomena that can be observed at one scale may not be observable at another scale.	

●Matter is conserved because atoms are conserved in physical and chemical processes.	

●Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.	X
●The transfer of energy can be tracked as energy flows through a designed or natural system.	

●Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	
●Structures can be designed to serve particular functions.	
●Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.	

●Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.	X
●Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.	

●Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.	X
●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.	

ctions to Nature of Science

●Science disciplines share common rules of obtaining and evaluating empirical evidence.	X
●Science knowledge is based upon logical and conceptual connections between evidence and explanations.	

●Laws are regularities or mathematical descriptions of natural phenomena.	
●Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through	X
●Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society	X
●Science findings are frequently revised and/or reinterpreted based on new evidence.	X

gineering, Technology, and Applications of Science

●Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led	X
●The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	
●Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.	X

●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.	

atter and Its Interactions

Develop models to describe the atomic composition of simple molecules and extended structures.	
Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical	
Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.	
Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when	
Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is	
Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by	

isciplinary Core Ideas

●Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.	
●Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can	
●Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.	
●In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to	
●Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).	

●The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.	
●Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original	
●The total number of each type of atom is conserved, and thus the mass does not change.	

●Some chemical reactions release energy, others store energy.	
●The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.	X
●The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or	

on and Stability: Forces and Interactions

Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.	
Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object	
Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.	
Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on	
Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting	

isciplinary Core Ideas

● For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).

● The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.

● All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.

● Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.

● Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.

● Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through

MS-PS3 Energy

Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the

Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	
Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is	

Disciplinary Core Ideas

●Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.	
● A system of objects may also contain stored (potential) energy, depending on their relative positions.	
●Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.	

● When the motion energy of an object changes, there is inevitably some other change in energy at the same time.	
● The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.	
● Energy is spontaneously transferred out of hotter regions or objects and into colder ones.	

●When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.	

es and Their Applications in es for Information Transfer

Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the	
Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.	
Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.	

isciplinary Core Ideas

●A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.	
●A sound wave needs a medium through which it is transmitted.	

●When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.	
●The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.	
●A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media.	
●However, because light can travel through space, it cannot be a matter wave, like sound or water waves.	

●Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.	

m Molecules to Organisms:
:tures and Processes

Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and	
Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.	
Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	
Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal	
Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of	
Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into	
Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth	
Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	

)isciplinary Core Ideas

●All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).	
● Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.	
● In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.	

● Animals engage in characteristic behaviors that increase the odds of reproduction.

● Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

● Genetic factors as well as local conditions affect the growth of the adult plant.

● Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.

● Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.

● Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to

● Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as

● The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen.

● Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these

ystems: Interactions, Energy, and Dynamics

Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms	
Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	
Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	
Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem	
Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	

Disciplinary Core Ideas

●Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.	
● In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may	
●Growth of organisms and population increases are limited by access to resources.	
● Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.	

●Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and	

●Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	

● Biodiversity describes the variety of species found in Earth’s terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health.

●Changes in biodiversity can influence humans’ resources, such as food, energy, and medicines, as well as ecosystem services

leredity: Inheritance and 'ariation of Traits

Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins

Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual

isciplinary Core Ideas

●Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many

●Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.

● In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring.

●In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though

logical Evolution: Unity and Diversity

Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life	
Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms	
Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple	
Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some	
Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of	
Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific	

Disciplinary Core Ideas

●The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in	
●Anatomical similarities and differences between various organisms living today and between them and organisms in the	
●Comparison of the embryological development of different species also reveals similarities that show relationships not	

● Natural selection leads to the predominance of certain traits in a population, and the suppression of others.	
● In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One	

●Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

rth’s Place in the Universe

Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun

Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

Analyze and interpret data to determine scale properties of objects in the solar system.

Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s

isciplinary Core Ideas

●Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.

●Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.

●The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in

● This model of the solar system can explain eclipses of the sun and the moon. Earth’s spin axis is fixed in direction over the

●The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

●The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the	
●Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches.	

SS2 Earth's Systems

Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.	X
Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and	
Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence	
Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.	
Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather	
Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic	

Disciplinary Core Ideas

●All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is	X
●The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a	
●Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates	
●Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization,	

●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.	
●Global movements of water and its changes in form are propelled by sunlight and gravity.	
●Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.	
●Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features	

●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.	
●Because these patterns are so complex, weather can only be predicted probabilistically.	
●The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and	

Earth and Human Activity

Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater	
Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies	
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	
Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.	
Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	X

Disciplinary Core Ideas

●Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, 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 past geologic processes.	
●Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help	
●Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. ● Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth	X
●Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's	X

S1 Engineering Design

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into	X
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of	
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an	

●The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be	

●A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.	
●A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.	
●Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.	
● Models of all kinds are important for testing solutions.	
●There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a	

●Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.	
●The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	

Connections

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.	
RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical	X
RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information	X
SL.8.5, Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and	X

WHST.6-8.1 Write arguments focused on discipline-specific content.	X
WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources	X
WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the	X
WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.	X

6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities.	
6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems.	
6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plot	X
6.SP.B.5 Summarize numerical data sets in relation to their contexts.	X
7.EE.B.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form,	
7.RP.A.2 Recognize and represent proportional relationships between quantities.	
MP.2 Reason abstractly and quantitatively.	X

S

Developing and Using Models

Analyzing and Interpreting Data

Designing Solutions

Communicating Information

Problems

Investigations

Evidence

Computational Thinking

Patterns

Cause and Effect

Scale, Proportion, and Quantity

Energy and Matter

Structure and Function

Systems and System Models

Stability and Change

Empirical Evidence

Explain Natural Phenomena

Systems

World

Evidence

Connections to En

Engineering, and Technology

the Natural World

MS-PS

MS-PS1-1.
MS-PS1-2.
MS-PS1-3.
MS-PS1-4.
MS-PS1-5.
MS-PS1-6.

PS1.A: Structure and Properties of Matter

PS1.B: Chemical Reactions

PS3.A: Definitions of Energy

MS-PS2 Motion

MS-PS2-1.
MS-PS2-2.
MS-PS2-3.
MS-PS2-4.
MS-PS2-5.

PS2.A: Forces and Motion

PS2.B: Types of Interactions

MS-PS3-1
MS-PS3-2
MS-PS3-3
MS-PS3-4
MS-PS3-5

PS3.A: Definitions of Energy

and Energy Transfer

Energy and Forces

MS-PS4 Waves a

MS-PS4-1
MS-PS4-2

MS-PS4-3

PS4.A: Wave Properties

PS4.B: Electromagnetic Radiation

and Instrumentation

MS-LS1 From Molecu

MS-LS1-1

MS-LS1-2
MS-LS1-3
MS-LS1-4
MS-LS1-5
MS-LS1-6
MS-LS1-7
MS-LS1-8

LS1.A: Structure and Function

of Organisms

Organisms

LS1.D: Information Processing

Life

MS-LS2 Ecosyste

MS-LS2-1
MS-LS2-2
MS-LS2-3
MS-LS2-4
MS-LS2-5

Relationships in Ecosystems

Energy Transfer in Ecosystems

Functioning, and Resilience

LS4.D: Biodiversity and Humans

MS-LS3 Hered

MS-LS3-1.
MS-LS3-2.

LS1.B: Growth and Development of Organisms

LS3.A: Inheritance of Traits

LS3.B: Variation of Traits

MS-LS4 Biol

MS-LS4-1
MS-LS4-2

MS-LS4-3
MS-LS4-4
MS-LS4-5
MS-LS4-6

Ancestry and Diversity

LS4.B: Natural Selection

LS4.C: Adaptation

MS-ESS

MS-ESS1-1
MS-ESS1-2
MS-ESS1-3
MS-ESS1-4

Stars

System

Earth

MS-ESS2-1
MS-ESS2-2
MS-ESS2-3
MS-ESS2-4

MS-ESS2-5
MS-ESS2-6

Earth

Systems

Large-Scale System Interactions

Earth's Surface Processes

ESS2.D: Weather and Climate

MS-ES

MS-ESS3-1
MS-ESS3-2
MS-ESS3-3
MS-ESS3-4
MS-ESS3-5

ESS3.A: Natural Resources

ESS3.B: Natural Hazards

ESS3.C: Human Impacts on Earth Systems

ESS3.D: Global Climate Change

MS

MS-ETS1-1
MS-ETS1-2
MS-ETS1-3
MS-ETS1-4

Problem

Solutions

Solution

Middle Level 6-8

Science and Engineering Practices

Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems

●Develop a model to predict and/or describe phenomena.

●Develop a model to describe unobservable mechanisms.

●Develop and use a model to describe phenomena.

●Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.

investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

●Analyze and interpret data to determine similarities and differences in findings.

●Construct and interpret graphical displays of data to identify linear and nonlinear relationships.

●Analyze and interpret data to provide evidence for phenomena.

include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

●Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (MSPS1-6)

●Apply scientific ideas or principles to design an object, tool, process or system.

●Apply scientific ideas to construct an explanation for realworld phenomena, examples, or events.

(including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

that predict phenomena.

evaluating the merit and validity of ideas and methods.

are supported or not supported by evidence.

and visual displays to clarify claims and findings.

progresses to specifying relationships between variables, and clarifying arguments and models.

hypothesis based on observations and scientific principles.

●Ask questions to identify and clarify evidence of an argument.

knowledge that may limit possible solutions.

evidence to support explanations or design solutions.

be recorded, and how many data are needed to support a claim.

for evidence that can meet the goals of the investigation.

design solutions under a range of conditions.

investigation.

reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

investigation.

support or refute an explanation or a model for a phenomenon or a solution to a problem.

●Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.

●Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.

●Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.

using mathematical concepts to support explanations and arguments.

solutions.

Crosscutting Concepts

●Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

●Graphs and charts can be used to identify patterns in data.

●Patterns can be used to identify cause and effect relationships.

systems.

●Cause and effect relationships may be used to predict phenomena in natural or designed systems.

only be described using probability.

●Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

●Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among differen types of quantities provide information about the magnitude of properties and processes.

systems that are too large or too small.

●Phenomena that can be observed at one scale may not be observable at another scale.

●Matter is conserved because atoms are conserved in physical and chemical processes

matter.

●The transfer of energy can be tracked as energy flows through a designed or natural system.

materials, and how materials can be shaped and used.

●Structures can be designed to serve particular functions.

complex natural structures/systems can be analyzed to determine how they function.

outputs—and energy and matter flows within systems.

complex systems.

the changes over time and forces at different scales.

●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

Connections to Nature of Science

●Science disciplines share common rules of obtaining and evaluating empirical evidence.
explanations.

●Laws are regularities or mathematical descriptions of natural phenomena.

that are understandable through measurement and observation.

decisions that society takes.

●Science findings are frequently revised and/or reinterpreted based on new evidence.

gineering, Technology, and Applications of Science

scientific discoveries have led to the development of entire industries and engineered systems

time.
scientific investigations.
environment.

51 Matter and Its Interactions

Develop models to describe the atomic composition of simple molecules and extended structures.
determine if a chemical reaction has occurred.
resources and impact society.
pure substance when thermal energy is added or removed.
reaction and thus mass is conserved.
thermal energy by chemical processes.

Disciplinary Core Ideas

●Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.
given conditions) that can be used to identify it
●Gases and liquids are made of molecules or inert atoms that are moving about relative to each othe
but do not change relative locations.

(e.g., crystals).

predicted using these models of matter.

different properties from those of the reactants.

●The total number of each type of atom is conserved, and thus the mass does not change.

●Some chemical reactions release energy, others store energy.

●The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.

temperature, the total number of atoms in the system, and the state of the material.

n and Stability: Forces and Interactions

objects.

the forces on the object and the mass of the object.

forces.

are attractive and depend on the masses of interacting objects.

between objects exerting forces on each other even though the objects are not in contact.

Disciplinary Core Ideas

(Newton’s third law).

change in motion.

people, these choices must also be shared.

between the interacting objects.

but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.

respectively).

MS-PS3 Energy

mass of an object and to the speed of an object.

different amounts of potential energy are stored in the system.

thermal energy transfer.

temperature of the sample.

changes, energy is transferred to or from the object.

Disciplinary Core Ideas

and grows with the square of its speed.
positions.
of matter present.

the same time.
amount depends on the nature of the matter, the size of the sample, and the environment.
● Energy is spontaneously transferred out of hotter regions or objects and into colder ones.

transferred to or from the object.

nd Their Applications in Technologies for Information Transfer

amplitude of a wave is related to the energy in a wave.
various materials.
Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

Disciplinary Core Ideas

●A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.
●A sound wave needs a medium through which it is transmitted.

depending on the object's material and the frequency (color) of the light.
transparent materials (e.g., air and water, air and glass) where the light path bends.
bending of light at a surface between media.
waves.

●Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.

ules to Organisms: Structures and Processes

many different numbers and types of cells.

contribute to the function.
composed of groups of cells.
reproduction of animals and plants respectively.
influence the growth of organisms.
matter and flow of energy into and out of organisms.
molecules that support growth and/or release energy as this matter moves through an organism.
the brain for immediate behavior or storage as memories.

Disciplinary Core Ideas

(multicellular).
the boundary that controls what enters and leaves the cell.
organs that are specialized for particular body functions.

●Animals engage in characteristic behaviors that increase the odds of reproduction.
features for reproduction.
● Genetic factors as well as local conditions affect the growth of the adult plant.

immediately or stored for growth or later use.
down and rearranged to form new molecules, to support growth, or to release energy.

in the brain, resulting in immediate behaviors or memories.

carbon-based organic molecules and release oxygen.
dioxide and other materials.

ems: Interactions, Energy, and Dynamics

populations of organisms in an ecosystem.
ecosystems.
of an ecosystem.
components of an ecosystem affect populations.
Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Disciplinary Core Ideas

with other living things and with nonliving factors.
constrains their growth and reproduction.
●Growth of organisms and population increases are limited by access to resources.

● Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.

the living and nonliving parts of the ecosystem.

physical or biological component of an ecosystem can lead to shifts in all its populations.

● Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. Th completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.

well as ecosystem services that humans rely on—for example, water purification and recycling.

ity: Inheritance and Variation of Traits

structure and function of the organism.
genetic information and sexual reproduction results in offspring with genetic variation.

Disciplinary Core Ideas

●Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.

proteins, which can affect the structures and functions of the organism and thereby change traits.

●Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.

acquired from each parent. These versions may be identical or may differ from each other.
harmful, and some neutral to the organism.

ogical Evolution: Unity and Diversity

natural laws operate today as in the past.
modern organisms and between modern and fossil organisms to infer evolutionary relationships.

across multiple species to identify relationships not evident in the fully formed anatomy.
environment.
influence the inheritance of desired traits in organisms.
increases and decreases of specific traits in populations over time.

Disciplinary Core Ideas

of life on Earth.
of lines of evolutionary descent.
relationships not evident in the fully-formed anatomy.

others.
passed on to offspring.

changes.

1 Earth's Place in the Universe

phases, eclipses of the sun and moon, and seasons.
system.
Analyze and interpret data to determine scale properties of objects in the solar system.
used to organize Earth's 4.6-billion-year-old history.

Disciplinary Core Ideas

described, predicted, and explained with models.
universe.

asteroids that are held in orbit around the sun by its gravitational pull on them.
across the year.
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.

MS-ESS2 Earth's Systems

process.
surface at varying time and spatial scales.
structures to provide evidence of the past plate motions.
sun and the force of gravity.

changes in weather conditions.
atmospheric and oceanic circulation that determine regional climates.

Disciplinary Core Ideas

trenches.

living organisms.
its future. (MS-ESS2-2)

distances, collided, and spread apart. (MS-ESS2

condensation and crystallization, and precipitation, as well as downhill flows on land.
patterns.

interconnected ocean currents.
change the land’s surface features and create underground formations.

geography, all of which can affect oceanic and atmospheric flow patterns.
●Because these patterns are so complex, weather can only be predicted probabilistically.
releasing it over time, and globally redistributing it through ocean currents.

SS3 Earth and Human Activity

mineral, energy, and groundwater resources are the result of past and current geoscience processes.
development of technologies to mitigate their effects.
environment.
consumption of natural resources impact Earth’s systems.
the past century.

Disciplinary Core Ideas

around the planet as a result of past geologic processes.

geologic forces can help forecast the locations and likelihoods of future events.

●Human activities have significantly altered the biosphere, sometimes damaging or destroying natur
habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.

negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

understanding of human behavior and on applying that knowledge wisely in decisions and activities.

S-ETS1 Engineering Design

natural environment that may limit possible solutions.

criteria and constraints of the problem.

criteria for success.

process such that an optimal design can be achieved.

to limit possible solutions.

it.

the test results, in order to improve it.

solution that is better than any of its predecessors.

● Models of all kinds are important for testing solutions.

problem.

into the new design.

greater refinement and ultimately to an optimal solution.