

Engineering Design

Students who demonstrate understanding can...

MS-ETS1-1.

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

ETS1.A: Defining and Delimiting Engineering Problems

☐The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)

ETS1.B: Developing Possible Solutions

☐There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)

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. (MS-ETS1-1)

☐The uses of technologies and 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. (MS-ETS1-1)

Asking Questions and Defining Problems

☐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. (MS-ETS1-1)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3)

WHST.6-8.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ETS1-1)

Mathematics

MP.2 Reason abstractly and quantitatively. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3), (MS-ETS1-4)

7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3)

MS-ETS1-2.

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

ETS1.B: Developing Possible Solutions

☐There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)

Engaging in Argument from Evidence

☐Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2), (MS-ETS1-3)

WHST.6-8.7 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. (MS-ETS1-2)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ETS1-2)

Mathematics

MP.2 Reason abstractly and quantitatively. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3), (MS-ETS1-4)

7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3)

MS-ETS1-3.

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.

ETS1.B: Developing Possible Solutions

☐☐ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)

☐☐ Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)

ETS1.C: Optimizing the Design Solution

☐☐ 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. (MS-ETS1-3)

Analyzing and Interpreting Data

☐☐ Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ETS1-3)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2), (MS-ETS1-3)

Mathematics

MP.2 Reason abstractly and quantitatively. (MS-ETS1-1),(MS-ETS1-2), (MS-ETS1-3), (MS-ETS1-4)

7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3)

MS-ETS1-4.

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

ETS1.B: Developing Possible Solutions

☐☐ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)

☐☐ Models of all kinds are important for testing solutions. (MS-ETS1-4)

ETS1.C: Optimizing the Design Solution

☐☐ 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. (MS-ETS1-4)

Developing and Using Models

☐☐ Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)

ELA/Literacy

SL.8.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ETS1-4)

Mathematics

MP.2 Reason abstractly and quantitatively. (MS-ETS1-1),(MS-ETS1-2), (MS-ETS1-3), (MS-ETS1-4)

CHEMICAL REACTIONS

Students who demonstrate understanding can...

07-PS1-2.

Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with HCl.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]

PS1.A: Structure and Properties of Matter

- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (07-PS1-2) (Note: This Disciplinary Core Idea is also addressed by 06-PS1-3.)

PS1.B: Chemical Reactions

- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (07-PS1-2), (07-PS1-5) (Note: This Disciplinary Core Idea is also addressed by 06-PS1-3.)

Patterns

- Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (07-PS1-2)

Analyzing and Interpreting Data

□□ Analyze and interpret data to determine similarities and differences in findings. (07-PS1-2)

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (07-PS1-2)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (07-PS1-2)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (07-PS1-2), (07-PS1-5)

Mathematics –

MP.2 Reason abstractly and quantitatively. (07-PS1-2), (07-PS1-5)

6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (07-PS1-2), (07-PS1-5)

6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (07-PS1-2)

6.SP.B.5 Summarize numerical data sets in relation to their context (07-PS1-2)

07-PS1-5.

Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter, and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]

PS1.B: Chemical Reactions

- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (07-PS1-2), (07-PS1-5) (Note: This Disciplinary Core Idea is also addressed by 06-PS1-3.)
- The total number of each type of atom is conserved, and thus the mass does not change. (07-PS1-5)

Energy and Matter

- Matter is conserved because atoms are conserved in physical and chemical processes. (07-PS1-5)

Developing and Using Models

□□ Develop a model to describe unobservable mechanisms. (07-PS1-5)

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

□□ Laws are regularities or mathematical descriptions of natural phenomena. (07-PS1-5)

ELA/Literacy

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (07-PS1-2), (07-PS1-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (07-PS1-2), (07-PS1-5)

MP.4 Model with mathematics. (07-PS1-5)

6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (07-PS1-2), (07-PS1-5)

07-PS1-6.

Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* [Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]

PS1.B: Chemical Reactions

☐☐Some chemical reactions release energy, others store energy. (07-PS1-6)

ETS1.B: Developing Possible Solutions

☐☐A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (secondary to 07-PS1-6)

ETS1.C: Optimizing the Design Solution

☐☐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 the characteristics may be incorporated into the new design. (secondary to 07-PS1-6)

☐☐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. (secondary to 07-PS1-6)

Energy and Matter

☐☐The transfer of energy can be tracked as energy flows through a designed or natural system. (07-PS1-6)

Constructing Explanations and Designing Solutions

☐☐Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (07-PS1-6)

ELA/Literacy

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (07-PS1-6)

WHST.6-8.7 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. (07-PS1-6)

Energy

07-PS3-2.

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. [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]

PS3.A: Definitions of Energy

☐☐A system of objects may also contain stored (potential) energy, depending on their relative positions. (07-PS3-2)

PS3.C: Relationship Between Energy and Forces

☐☐When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (07-PS3-2)

Systems and System Models

☐☐Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. (07-PS3-2)

Developing and Using Models

☐☐Develop a model to describe unobservable mechanisms. (07-PS3-2)

ELA/Literacy

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (07-PS3-2)

07-PS3-3.

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

PS3.A: Definitions of Energy

☐☐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. (07-PS3-3),(07-PS3-4)

PS3.B: Conservation of Energy and Energy Transfer

☐☐Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (07-PS3-3)

ETS1.A: Defining and Delimiting an Engineering Problem

☐☐The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to 07-PS3-3)

ETS1.B: Developing Possible Solutions

☐☐A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to 07-PS3-3)

Energy and Matter

☐☐The transfer of energy can be tracked as energy flows through a designed or natural system. (07-PS3-3)

Constructing Explanations and Designing Solutions

☐☐Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (07-PS3-3)

ELA/Literacy

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (07-PS3-3),(07-PS3-4)

WHST.6-8.7 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. (07-PS3-3),(07-PS3-4)

07-PS3-4.

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.

[Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

PS3.A: Definitions of Energy

☐☐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. (07-PS3-3),(07-PS3-4)

PS3.B: Conservation of Energy and Energy Transfer

☐☐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. (07-PS3-4)

Scale, Proportion, and Quantity

☐☐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. (08-PS3-1),(07-PS3-4)

Planning and Carrying Out Investigations

☐☐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. (07-PS3-4)

Scientific Knowledge is Based on Empirical Evidence

Science knowledge is based upon logical and conceptual connections between evidence and explanations (07-PS3-4),(07-PS3-5)

ELA/Literacy

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (07-PS3-3),(07-PS3-4)

WHST.6-8.7 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. (07-PS3-3),(07-PS3-4)

Mathematics

MP.2 Reason abstractly and quantitatively. (08-PS3-1),(07-PS3-4),(07-PS3-5)

6.SP.B.5 Summarize numerical data sets in relation to their context. (07-PS3-4)

07-PS3-5.

Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]

PS3.B: Conservation of Energy and Energy Transfer

When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (07-PS3-5)
Energy and Matter

Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (07-PS3-5)

Engaging in Argument from Evidence

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. (07-PS3-5)

Scientific Knowledge is Based on Empirical Evidence

Science knowledge is based upon logical and conceptual connections between evidence and explanations (07-PS3-4),(07-PS3-5)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (08-PS3-1),(07-PS3-5)

WHST.6-8.1 Write arguments focused on discipline content. (07-PS3-5)

Mathematics

MP.2 Reason abstractly and quantitatively. (08-PS3-1),(07-PS3-4),(07-PS3-5)

6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (08-PS3-1),(07-PS3-5)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (08-PS3-1),(07-PS3-5)

8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (08-PS3-1),(07-PS3-5)

Forces and Interactions

Students who demonstrate understanding can...

07-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

[Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]

PS2.B: Types of Interactions

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. (07-PS2-3)

Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (07-PS2-3),(07-PS2-5)

Asking Questions and Defining Problems

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. (07-PS2-3)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (06-PS2-1),(07-PS2-3)

Mathematics

MP.2 Reason abstractly and quantitatively. (06-PS2-1),(06-PS2-2),(07-PS2-3)

07-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]

PS2.B: Types of Interactions

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. (07-PS2-4)

Systems and System Models

Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (06-PS2-1),(07-PS2-4),

Engaging in Argument from Evidence

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. (07-PS2-4)

Scientific Knowledge is Based on Empirical Evidence

Science knowledge is based upon logical and conceptual connections between evidence and explanations. (06-PS2-2),(07-PS2-4)

ELA/Literacy

WHST.6-8.1 Write arguments focused on discipline-specific content. (07-PS2-4)

07-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields. Assessment is limited to qualitative evidence for the existence of fields.]

PS2.B: Types of Interactions

Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (07-PS2-5)

Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (07-PS2-3),(07-PS2-5)

Planning and Carrying Out Investigations

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. (07-PS2-5)

ELA/Literacy

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (06-PS2-1),(06-PS2-2),(07-PS2-5)

WHST.6-8.7 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. (06-PS2-1),(06-PS2-2),(07-PS2-5)

Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can...

07-LS1-6.

Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.]

[Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]

PS3.D: Energy in Chemical Processes and Everyday Life

☐☐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. (secondary to 07-LS1-6)

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

☐☐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. (07-LS1-6)

Energy and Matter

☐☐Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (07-LS1-6)

Constructing Explanations and Designing Solutions

☐☐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. (07-LS1-6)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

☐☐Science knowledge is based upon logical connections between evidence and explanations. (07-LS1-6)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (07-LS1-6),(06-LS2-1),(08-LS2-4)

RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (07-LS1-6)

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (07-LS1-6)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (07-LS1-6),(08-LS2-4)

Mathematics

6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (07-LS1-6),(06-LS2-3)

07-LS1-7.

Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]

PS3.D: Energy in Chemical Processes and Everyday Life

☐☐Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (secondary to 07-LS1-7)

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

☐☐Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (07-LS1-7)

Energy and Matter

☐☐Matter is conserved because atoms are conserved in physical and chemical processes. (07-LS1-7)

Developing and Using Models

☐☐Develop a model to describe unobservable mechanisms. (07-LS1-7)

Mathematics

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (07-LS1-7),(06-LS2-3)

Structure, Function, and Information Processing

Students who demonstrate understanding can...

07-LS1-1.

Conduct an investigation to provide evidence that living things are made of cells, either one cell or many different numbers and types of cells. [Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living cells, and understanding that living things may be made of one cell or many and varied cells.]

LS1.A: Structure and Function

☐☐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). (07-LS1-1)

Scale, Proportion, and Quantity

☐☐Phenomena that can be observed at one scale may not be observable at another scale. (07-LS1-1)

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. (07-LS1-1)

Planning and Carrying Out Investigations

☐☐Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (07-LS1-1)

ELA/Literacy

WHST.6-8.7 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. (07-LS1-1)

Mathematics

6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (07-LS1-1),(07-LS1-2),(07-LS1-3)

07-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.]

LS1.A: Structure and Function

☐☐Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (07-LS1-2)

Structure and Function

☐☐Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural and designed structures/systems can be analyzed to determine how they function. (07-LS1-2)

Developing and Using Models

☐☐Develop and use a model to describe phenomena. (07-LS1-2)

ELA/Literacy

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (07-LS1-2)

Mathematics

6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (07-LS1-1),(07-LS1-2),(07-LS1-3)

07-LS1-3.

Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal

functioning of those systems.] [Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.]

LS1.A: Structure and Function

☐☐ 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. (07-LS1-3)

Systems and System Models

☐☐ Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (07-LS1-3)

Connections to Nature of Science

Science is a Human Endeavor

☐☐ Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (07-LS1-3)

Engaging in Argument from Evidence

☐☐ Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (07-LS1-3)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (07-LS1-3)

RI.6.8 Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (07-LS1-3)

WHST.6-8.1 Write arguments focused on discipline content. (07-LS1-3)

Mathematics

6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (07-LS1-1),(07-LS1-2),(07-LS1-3)

Growth, Development, and Reproduction Organisms

Students who demonstrate understanding can...

07-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

LS1.B: Growth and Development of Organisms

☐☐ Animals engage in characteristic behaviors that increase the odds of reproduction. (07-LS1-4)

☐☐ Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (07-LS1-4)

Cause and Effect

☐☐ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (07-LS1-4), (07-LS1-5), (08-LS4-5)

Engaging in Argument from Evidence

☐☐ Use 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. (07-LS1-4)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (07-LS1-4),(07-LS1-5),(08-LS3-1),(08-LS3-2),(08-LS4-5)

RI.6.8 Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (07-LS1-4)

WHST.6-8.1 Write arguments focused on discipline content. (07-LS1-4)

Mathematics

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (07-LS1-4),(07-LS1-5)

6.SP.B.4 Summarize numerical data sets in relation to their context. (07-LS1-4),(07-LS1-5)

07-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]

LS1.B: Growth and Development of Organisms

☐☐ Genetic factors as well as local conditions affect the growth of the adult plant. (07-LS1-5)

Cause and Effect

☐☐ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (07-LS1-4), (07-LS1-5), (08-LS4-5)

Constructing Explanations and Designing Solutions

☐☐ 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. (07-LS1-5)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (07-LS1-4),(07-LS1-5),(08-LS3-1),(08-LS3-2),(08-LS4-5)

RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (07-LS1-5)

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (07-LS1-5)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (07-LS1-5)

Mathematics

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (07-LS1-4),(07-LS1-5)

6.SP.B.4 Summarize numerical data sets in relation to their context. (07-LS1-4),(07-LS1-5)

Waves and Electromagnetic Radiation

Students who demonstrate understanding can...

07-PS4-1.

Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]

PS4.A: Wave Properties

☐☐ A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (07-PS4-1)

Patterns

☐☐ Graphs and charts can be used to identify patterns in data. (07-PS4-1)

Using Mathematics and Computational Thinking

☐☐ Use mathematical representations to describe and/or support scientific conclusions and design solutions. (07-PS4-1)

Scientific Knowledge is Based on Empirical Evidence

☐☐ Science knowledge is based upon logical and conceptual connections between evidence and explanations. (07-PS4-1)

Mathematics

MP.2 Reason abstractly and quantitatively. (07-PS4-1)

MP.4 Model with mathematics. (07-PS4-1)

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (07-PS4-1)

6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (07-PS4-1)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (07-PS4-1)

8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (07-PS4-1)

07-PS4-2.

Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

[Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]

PS4.A: Wave Properties

☐☐ A sound wave needs a medium through which it is transmitted. (07-PS4-2)

PS4.B: Electromagnetic Radiation

☐☐ 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. (07-PS4-2)

☐☐ 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. (07-PS4-2)

☐☐ A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (07-PS4-2)

☐☐ However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (07-PS4-2)

Structure and Function

☐☐ Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (07-PS4-2)

Developing and Using Models

☐☐ Develop and use a model to describe phenomena. (07-PS4-2)

ELA/Literacy

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (07-PS4-1),(07-PS4-2)

07-PS4-3.

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. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.]

[Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

PS4.C: Information Technologies and Instrumentation

☐☐ Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (07-PS4-3)

Structure and Function

☐☐ Structures can be designed to serve particular functions. (07-PS4-3)

Influence of Science, Engineering, and Technology on Society and the Natural World

- Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (07-PS4-3)

- Advances in technology influence the progress of science and science has influenced advances in technology. (07-PS4-3)

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods.

☐☐ Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (07-PS4-3)

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (07-PS4-3)

RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (07-PS4-3)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (07-PS4-3)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (07-PS4-3)

Space Systems

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (07-LS1-4),(07-LS1-5),(08-LS3-1),(08-LS3-2),(08-LS4-5)

RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (07-LS1-5)

RI.6.8 Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (07-LS1-4)

WHST.6-8.1 Write arguments focused on discipline content. (07-LS1-4)

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (07-LS1-5)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (07-LS1-5)

Mathematics

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (07-LS1-4), (07-LS1-5)

6.SP.B.4 Summarize numerical data sets in relation to their context. (07-LS1-4), (07-LS1-5)