Grade 8 Proficiency Scales for "Understand and Use Core Ideas in Science and Engineering"

Earth & Space Sciences: Solar System & Earth's History

- ESS1: Earth's Place in the Universe
- ESS3: Earth and Human Activity

Life Science: Inheritance & Variation of Traits; Evolution

- LS3: Heredity: Inheritance and Variation of Traits
- LS4: Biological Evolution: Unity and Diversity

Physical Sciences: Forces & Motion; Waves & Energy

- PS2: Motion and Stability: Forces and Interactions
- PS3: Energy
- PS4: Waves and their Applications in Technologies for Information Transfer

Engineering: Define Problems; Plan, Develop, & Optimize Solutions

- ETS1: Engineering Design

Score 4.0 Exceeds the Standard (E)
Score 3.0 Mastery of Grade-Level Standard (M)
Score 2.0 Progressing Toward Grade-Level Standard (P)
Score 1.0 Initial Progress Toward Grade-Level Standard (IP)
Score 0.0 Even with Help, No Success (NP)
Not Evaluated (NE)

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<table>
<tr><th colspan="2">Earth and Space Sciences</th></tr>
<tr><td colspan="2">ESS1: Earth's Place in the Universe</td></tr>
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MS-ESS1-1: Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. [Clarification Statement: Examples of models can be physical, graphical, or conceptual.] [Assessment Boundary: N/A.]

MS-ESS1-2: Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as their school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]

MS-ESS1-3: Analyze and interpret data to determine scale properties of objects in the solar system. [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]

MS-ESS1-4: Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]</td></tr>
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ESS1.A: The Universe and Its Stars
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<tr><td>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1)</td><td>● Model the arcing paths of the Sun, Moon, and stars through the night's sky in relation to Earth's axis</td></tr>
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Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)	● Place Earth in its appropriate relative position within our solar system ● Describe (in degrees of magnitude) the relative spatial scales involved from solar systems to galaxies to broader clusters in the universe ● Consider scale (in mass, distance, and time) as a factor determining which components are relevant when understanding the solar system, galaxy, or universe

ESS1.B: Earth and the Solar System

DCI Elements	Sample Assessment Targets
The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2), (MSESS1-3)	● Describe gravity as the attractive force that keeps solar systems and galaxies together ● Describe the fundamental relationships between the attractive force of gravity acting upon two objects and their masses (linear) and/or the distance separating them (nonlinear) ● Predict continuing orbital behavior among celestial bodies (without Kepler's laws) and consider hypotheticals of the introduction or removal of bodies (e.g., what would happen to orbits if the Sun were to disappear?) ● Organize given data on solar system objects from various Earth- and space-based instruments to allow for interpretation ● Describe that different representations illustrate different characteristics of objects in the solar system, including differences in scale ● Use quantitative analyses to describe similarities and differences among solar system objects by describing patterns of features of those objects at different scales including: distance from the Sun, diameter, surface features, structure, and composition ● Identify advances in solar system science made possible by improved engineering and new developments in engineering made possible by advances in science ● Use the patterns found in multiple types of data at varying scales to draw conclusions and the identifying characteristics of different categories of solar system objects based on their features, composition, and locations within the solar system ● Use patterns in data as evidence to describe how two objects may be similar when viewed at one scale but may appear to be quite different when viewed at a different scale ● Use the organization of data to facilitate drawing conclusions about the patterns of scale properties at more than one scale, such as those that are too large or too small to directly observe
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 short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)	● Describe the spatial and temporal relationships among the Earth-Moon-Sun system ● Identify the Sun as the original source of light/energy that illuminates the Moon and warms Earth ● Model the path of light from a source as a line directed towards another object and the behaviors of light (e.g., reflection) ● Explain lunar phases in terms of the relative positions of the Sun, Earth, and Moon ● Describe how the Moon's equal rotational and orbital speeds results in the inability to see the far side of the Moon from Earth ● Ability to identify and describe the role of the tilt in the Moon's orbital plane with respect to Earth's orbit around the Sun in terms of the frequency and type of lunar and solar eclipses ● Identify and describe the role of Earth's axial tilt in causing seasons despite minimal change in the proximity to the Sun ● Contrast sunlight received by the northern and southern hemispheres leading to opposite experiences of winter/summer

ESS1.C: The History of Planet Earth

DCI Elements	Sample Assessment Targets
The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record	● Articulate how events in the approximately 4.6-billion-year history of Earth are organized relative to each other on geologic timescales ● Use evidence and reasoning to describe how relative ordering is determined using rock strata, layering, major geologic events, and the fossil record

	provide only relative dates, not an absolute scale. (MS-ESS1-4)	• Identify and describe geologic evidence such as types and order of rock strata, the fossil record, and major geologic events • Use multiple, valid sources of evidence, which could include experiments, to construct an explanation about the historical events on Earth • Use scientific reasoning to connect evidence to an explanation of the timeline of Earth's history
Score 1.5	In addition to score 1.0 performance, partial success at score 2.0 performance	
Score 1.0	With help, students demonstrate partial success at Score 2.0 content and Score 3.0 content.	
Score 0.5	With help, partial success at score 1.0 performance	
Score 0.0	Even with help, no success of Score 2.0 and Score 3.0 content.	

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MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.] [Assessment Boundary: N/A.]</td></tr>
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ESS3.C: Human Impacts on Earth Systems
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<tr><th>DCI Elements</th><th>Sample Assessment Targets</th></tr>
<tr><td>Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3), (MS-ESS3-4)</td><td>● Identify changes in human population over various time spans within and between different geographic regions
● Identify changes in the availability of natural resources of a region and relate those changes to the needs of human populations
● Describe how changes in the availability of natural resources of a region will impact the ecology of the region
● Explain how humans can cause a change in one region to impact other Earth systems (e.g., the conversion of arable land for farming impacts erosion)
● Describe potential design solutions in terms of their effect on limiting resource use
● Describe potential design solutions in terms of the needs of a changing human population
● Describe how various technologies can monitor or minimize the negative impact on the environment
● Describe the relationship between population size and per capita resource consumption
● Draw inferences about changes to existing social wants/needs based on existing trends in growth to population size/per capita resource consumption
● Consider the role of economic conditions in the viability of a proposed technology to limit the negative impacts of human activity on the environment</td></tr>
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Score 0.5	With help, partial success at score 1.0 performance
Score 0.0	Even with help, no success of Score 2.0 and Score 3.0 content.

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Life Sciences

LS3: Heredity: Inheritance and Variation of Traits

Grade 8

Score 4.0

The student uses and demonstrates a three-dimensional understanding of the Disciplinary Core Idea above the grade level band expectation. Refer to corresponding Enhanced Learning Progressions to see DCI elements and targets above the grade level expectation.

Score 3.5

In addition to score 3.0 performance, partial success at score 4.0 performance

Score 3.0

The student demonstrates understanding by explaining phenomena and solving problems using the three-dimensions of NGSS, including the identified Disciplinary Core Idea, the Science and Engineering Practices, and Crosscutting Concepts. The performance expectation below is a possible example of such demonstration of understanding. Other equivalent three-dimensional learning targets may also be used to demonstrate mastery.

MS-LS3-1: Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]

Score 2.5

In addition to score 2.0 performance, partial success at score 3.0 performance

Score 2.0

The student demonstrates some understanding of ideas related to the Disciplinary Core Idea. These elements include prerequisite knowledge, skills, strategies, and vocabulary that students will need to achieve mastery of grade-level standards. Students at this level are not using all dimensions of NGSS to explain phenomena and solve problems. Sample Assessment Targets marked with an asterisk (*) are considered essential for all students.

LS3.A: Inheritance of Traits

DCI Elements	Sample Assessment Targets
Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)	• Recognize that chromosomes contain genes and that different versions of genes (alleles) exist for different proteins • Recognize that each distinct gene has a certain sequence (code) which determines the structure of a specific set of proteins • Recognize that protein structure influences protein function • Recognize that specific proteins affect the traits of individual organisms • Describe how mutations in genes can result in changes to proteins • Describe how changes to proteins can affect observable structures and functions in organisms

LS3.B: Variation of Traits

DCI Elements	Sample Assessment Targets
In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)	• Explain how genetic mutations can result in trait changes that are beneficial, harmful, or neutral for the organism

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Life Sciences	
LS4: Biological Evolution: Unity and Diversity	
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Score 2.5	In addition to score 2.0 performance, partial success at score 3.0 performance

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LS4.A: Evidence of Common Ancestry and Diversity

DCI Elements	Sample Assessment Targets
The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1)	● Identify patterns between sedimentary rock layers and the relative age of rock layers ● Identify time periods when a given fossil organism is present ● Identify periods of time when changes in the absence or presence of a large number of fossil organisms can be observed ● Identify patterns of change in the level of complexity of anatomical structures in the fossil record over time ● Analyze and interpret the data in fossils for the existence, diversity, extinction, and change in life forms throughout the history of Earth ● Recognize observed patterns in the fossil record as evidence for when mass extinctions occurred ● Recognize observed patterns in the fossil record as evidence for when organisms emerged, evolved, or went extinct ● Recognize observed patterns in the fossil record as evidence for increasing diversity and complexity of organisms on Earth
Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2)	● Articulate a statement about the similarities and differences, and the evolutionary relationships among modern organisms and between fossil organisms and modern organisms ● Identify and/or describe evidence of similarities and differences in anatomical patterns in modern living organisms and between modern living organisms and fossilized organisms ● Use reasoning to connect evidence to a claim that organisms are more likely to be closely related if they share a pattern of similar anatomical features due to the cause-and-effect relationship between genetic makeup and anatomy ● Use reasoning to connect evidence to a claim that living organisms can be linked to extinct organisms that share basic anatomical features by observing changes over time in anatomical features in the fossil record and that evolutionary descent of organisms can be inferred from these changes
Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)	● Identify linear and nonlinear relationships including patterns of similarities in embryos across species by using organized pictorial displays ● Identify linear and nonlinear relationships including patterns of changes as embryos develop by using organized pictorial displays ● Describe evidence of relatedness among apparently diverse species using patterns of changes and similarities in embryo development shown in organized pictorial displays

LS4.B: Natural Selection

DCI Elements	Sample Assessment Targets
Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)	● Identify and describe the evidence that individuals in a species are not identical and genetic variations are inherited ● Identify and describe the evidence to support that some individuals are better suited to survive and reproduce in a specific environment ● Identify and describe cause-and-effect relationships between traits and the probability of survival and reproduction of a given organism in a specific environment ● Describe natural selection in that the proportion of individuals with the best suited traits for the environment will be more likely to survive and reproduce; therefore, the given traits will increase in frequency over many generations ● Describe natural selection in that the proportion of individuals with disadvantageous traits for the environment will be less likely to survive and reproduce; therefore, the given traits will decrease over many generations

	In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5) ● Identify the effect of selective breeding on a species ● Identify the purpose and effect of genetic engineering ● Identify the purpose and effect of gene therapy ● Describe that humans employ artificial selection to both promote positive features in organisms and remove negative ones ● Describe the possible social effects of using technology to influence genetic transmission in species ● Gather and synthesize information about the technologies used in genetic engineering

LS4.C: Adaptation

DCI Elements	Sample Assessment Targets
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. (MS-LS4-6)	● Describe that species respond to changes in the environment over generations ● Identify that individuals with favorable traits are more likely to pass on their inherited traits ● Identify that environmental conditions act as a selective pressure ● Identify traits that support successful survival based on environmental conditions ● Identify that the most favorable traits to the environment become more common in a population ● Identify that traits that do not support survival based on the environmental conditions will decrease in frequency within a given population over time ● Recognize that not all populations are able to adapt and survive ● Describe natural selection as a mechanism of evolution that acts over many generations

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MS-PS2-1: Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]

MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]

MS-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.]

MS-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.]

MS-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, and is limited to qualitative evidence for the existence of fields.]</td></tr>
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PS2.A: Forces and Motion
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<tr><td>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</td><td>● Identify action-reaction pairs of forces and the objects/components involved
● Recognize that the force exerted on a pair of interacting objects is of the same magnitude but opposite in direction regardless of each object's mass</td></tr>
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object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1)	● Recognize that action-reaction pairs of forces do not cancel each other because they are acting on separate objects ● Recognize that during a collision between two objects, the object with smaller mass has greater acceleration, and the object with greater mass has smaller acceleration, but the action-reaction force between each object is the same magnitude ● Apply the concept of action-reaction pairs of forces to a design problem/solution involving a collision ● Apply the concept of action-reaction pairs of forces involving a collision to a design problem/solution within given criteria/constraints
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. (MS-PS2-2)	● Identify the objects interacting within a system (object or group of objects under investigation) as well as the forces acting upon them (which may be external to the system) ● Describe the relative magnitude and direction of the forces exerted onto a system and whether or not they balance each other ● Describe the relationship between the mass of an object (or system of objects), the sum of the forces acting on that object, and the acceleration that the object experiences ● Describe the balance of the forces exerted on an object (or system of objects) based on the measurement of the object's 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. (MS-PS2-2)	● Describe how the choice of a reference frame is an arbitrary selection based on ease of analysis ● Choose a reference frame for the investigation that best facilitates measurement of mass, motion, and/or force ● Choose the appropriate units for measuring mass, force, and motion in light of the relationship among the three and the effect of a reference frame choice

PS2.B: Types of Interactions

DCI Elements	Sample Assessment Targets
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. (MS-PS2-3)	● Describe how the magnetic interactions between two objects are affected by the strength of the magnetic force, taking into consideration the distance and relative orientation of the objects ● Identify the relationship between the circuit features (such as magnitude of an electric current or the number of turns of wire in a coil) and the resulting magnetic forces that arise ● Identify the effect of distance between two electric charges, their magnitude and sign, or nearby magnetic forces on the resulting electric forces acting upon those charges ● Describe patterns in data that correspond to proportional relationships between factors that affect the magnitude and direction of electromagnetic force experienced by two interacting objects ● Distinguish between instances in which observed interactions match predictions and instances in which observations are unexpected ● Distinguish between investigations which are and are not possible within a particular scope (e.g., in the classroom, in informal learning settings, in museums, or in a laboratory)
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. (MS-PS2-4)	● Identify the variables associated with gravitational interactions ● Identify that gravitational interactions are always attractive and occur at a distance and not through direct contact ● Recognize that all gravitational interactions (gravitational forces) require a system of two or more objects ● Describe that, for the same distance, the force between two objects increases or decreases directly with an increase or decrease in the mass of the interacting objects ● Describe that, for the same masses, the force between two objects increases or decreases inversely with the distance between the two interacting objects

		• Describe why some effects of gravitational interactions, which apply universally, may only be observable in interactions between very massive objects • Identify and represent, using models such as force diagrams, the relative magnitude and direction of the force each object exerts on the other • Identify evidence that gravitational interactions are always attractive, require at least two interacting objects, and are directed towards the center of mass of the other object
	Forces that act at a distance (electric and magnetic) can be explained by fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively). (MS-PS2-5)	• Identify properties of gravitational, electric, or magnetic fields • Recognize what type of field is appropriate to analyze for a given physical situation • Provide evidence that an interaction between two objects occurring over some distance must exist through a field rather than direct contact • Investigate and/or measure the presence of electric or magnetic forces either through the motion of objects, suspension of objects, or simulation of objects that produce electric or magnetic fields • Evaluate an experimental design to assess whether data produced by the investigation provides evidence of fields existing between objects that are not in contact with each other
Score 1.5	In addition to score 1.0 performance, partial success at score 2.0 performance	
Score 1.0	With help, students demonstrate partial success at Score 2.0 content and Score 3.0 content.	
Score 0.5	With help, partial success at score 1.0 performance	
Score 0.0	Even with help, no success of Score 2.0 and Score 3.0 content.	

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Physical Sciences

PS3: Energy

Grade 8

Score 4.0

The student uses and demonstrates a three-dimensional understanding of the Disciplinary Core Idea above the grade level band expectation. Refer to corresponding Enhanced Learning Progressions to see DCI elements and targets above the grade level expectation.

Score 3.5

In addition to score 3.0 performance, partial success at score 4.0 performance

Score 3.0

The student demonstrates understanding by explaining phenomena and solving problems using the three-dimensions of NGSS, including the identified Disciplinary Core Idea, the Science and Engineering Practices, and Crosscutting Concepts. The performance expectations below is a possible example of such demonstration of understanding. Other equivalent three-dimensional learning targets may also be used to demonstrate mastery.

MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.] [Assessment Boundary: N/A.]

MS-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.]

Score 2.5

In addition to score 2.0 performance, partial success at score 3.0 performance

Score 2.0

The student demonstrates some understanding of ideas related to the Disciplinary Core Idea. These elements include prerequisite knowledge, skills, strategies, and vocabulary that students will need to achieve mastery of grade-level standards. Students at this level are not using all dimensions of NGSS to explain phenomena and solve problems. Sample Assessment Targets marked with an asterisk (*) are considered essential for all students.

PS3.A: Definitions of Energy

DCI Elements	Sample Assessment Targets
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. (MS-PS3-1)	• Demonstrate through graphical displays that when the mass and/or the speed of an object increases, the kinetic energy increases • Demonstrate through graphical displays that when the mass and/or the speed of an object decreases, the kinetic energy decreases • Demonstrate through graphical displays that kinetic energy and mass have a linear proportional relationship • Demonstrate through graphical displays that kinetic energy and speed have a proportional relationship that is nonlinear • Draw comparisons between the rate of change between mass and kinetic energy, and speed and kinetic energy (i.e., the kinetic energy doubles as the mass of the object doubles, yet the kinetic energy quadruples as the speed of the object doubles)
A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)	• Create a model to represent the forces involved in the interaction of two objects in a system • Create a model in which the potential energy of a system changes as the distance between two objects in the system

<table>
<tr><td></td><td>PS3.C: Relationship Between Energy and Forces<table><tr><th>DCI Elements</th><th>Sample Assessment Targets</th></tr><tr><td>When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)</td><td>● Describe that when two objects interact at a distance, each object exerts a force on the other that can cause energy to be transferred to or from the objects
● Describe that when energy is transferred to two attracting objects (causing them to move apart), the potential energy of the two-object system increases
● Describe that when energy is transferred to two repelling objects (causing them to move closer), the potential energy of the two-object system increases</td></tr></table></td></tr>
<tr><td>Score 1.5</td><td>In addition to score 1.0 performance, partial success at score 2.0 performance</td></tr>
<tr><td>Score 1.0</td><td>With help, students demonstrate partial success at Score 2.0 content and Score 3.0 content.</td></tr>
<tr><td>Score 0.5</td><td>With help, partial success at score 1.0 performance</td></tr>
<tr><td>Score 0.0</td><td>Even with help, no success of Score 2.0 and Score 3.0 content.</td></tr>
</table>

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Physical Sciences

PS4: Waves and their Applications in Technologies for Information Transfer

Grade 8

Score 4.0	The student uses and demonstrates a three-dimensional understanding of the Disciplinary Core Idea above the grade level band expectation. Refer to corresponding Enhanced Learning Progressions to see DCI elements and targets above the grade level expectation.
Score 3.5	In addition to score 3.0 performance, partial success at score 4.0 performance
Score 3.0	The student demonstrates understanding by explaining phenomena and solving problems using the three-dimensions of NGSS, including the identified Disciplinary Core Idea, the Science and Engineering Practices, and Crosscutting Concepts. The performance expectations below is a possible example of such demonstration of understanding. Other equivalent three-dimensional learning targets may also be used to demonstrate mastery. **MS-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.] **MS-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.] **MS-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.]
Score 2.5	In addition to score 2.0 performance, partial success at score 3.0 performance
Score 2.0	The student demonstrates some understanding of ideas related to the Disciplinary Core Idea. These elements include prerequisite knowledge, skills, strategies, and vocabulary that students will need to achieve mastery of grade-level standards. Students at this level are not using all dimensions of NGSS to explain phenomena and solve problems. Sample Assessment Targets marked with an asterisk (*) are considered essential for all students. **PS4.A: Wave Properties**

DCI Elements	Sample Assessment Targets
A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)	• Identify the properties of a simple mathematical wave model of a phenomenon • Mathematically represent the properties of a simple wave e.g., wavelength, frequency, amplitude) • Relate the properties of a mathematical model of a wave to their corresponding properties in physical phenomena • Relate the properties of a wave to the energy of the wave • Use a mathematical model to predict how a change in one property of a wave will change the amount of energy present or transmitted
A sound wave needs a medium through which it is transmitted. (MS-PS4-2)	• Identify the type of wave, such as matter waves (sound, water, etc.) and light waves • Describe how the medium through which a sound wave travels affects properties like speed, frequency, amplitude, or wavelength • Identify wave properties such as amplitude and frequency, which for light waves are connected to brightness and color, respectively

PS4.B: Electromagnetic Radiation

DCI Elements	Sample Assessment Targets
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. (MS-PS4-2)	• Describe the three ways in which waves can interact with material (reflection, absorption, and transmission) and that the interaction occurring depends on the object's material and the frequency of the wave
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. (MS-PS4-2)	• Describe the movement of light and its interaction with various transparent media as straight lines which bend at material transitions • Describe why certain materials are good for certain functions, such as lenses and mirrors, sound absorbers, colored light filters, and sound barriers next to highways
A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2)	• Describe properties of light (brightness, color, and the frequency-dependent bending of light at a surface between different media) using a model that governs wave behavior
However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)	• Determine the position of the source of a wave using a model • Differentiate between light and matter waves, since light does not require a physical material for propagation, but matter waves do

PS4.C: Information Technologies and Instrumentation

DCI Elements	Sample Assessment Targets
Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)	• Gather evidence from multiple sources that is sufficient to support a claim that digital signals are more reliable than analog signals • Describe specific features that make digital transmission of signals more reliable than analog transmission of signals • Describe at least one technology that uses digital encoding and transmission of information • Describe how digital encoding and transmission of information is used to advance scientific investigations and measurement

Score 1.5	In addition to score 1.0 performance, partial success at score 2.0 performance
Score 1.0	With help, students demonstrate partial success at Score 2.0 content and Score 3.0 content.
Score 0.5	With help, partial success at score 1.0 performance
Score 0.0	Even with help, no success of Score 2.0 and Score 3.0 content.

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Physical Sciences

ETS1: Engineering Design

Grade 8

Score 4.0

The student uses and demonstrates a three-dimensional understanding of the Disciplinary Core Idea above the grade level band expectation. Refer to corresponding Enhanced Learning Progressions to see DCI elements and targets above the grade level expectation.

Score 3.5

In addition to score 3.0 performance, partial success at score 4.0 performance

Score 3.0

The student demonstrates understanding by explaining phenomena and solving problems using the three-dimensions of NGSS, including the identified Disciplinary Core Idea, the Science and Engineering Practices, and Crosscutting Concepts. The performance expectations below is a possible example of such demonstration of understanding. Other equivalent three-dimensional learning targets may also be used to demonstrate mastery.

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. [Clarification Statement: N/A.] [Assessment Boundary: N/A.]

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. [Clarification Statement: N/A.] [Assessment Boundary: N/A.]

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. [Clarification Statement: N/A.] [Assessment Boundary: N/A.]

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. [Clarification Statement: N/A.] [Assessment Boundary: N/A.]

Score 2.5

In addition to score 2.0 performance, partial success at score 3.0 performance

Score 2.0

The student demonstrates some understanding of ideas related to the Disciplinary Core Idea. These elements include prerequisite knowledge, skills, strategies, and vocabulary that students will need to achieve mastery of grade-level standards. Students at this level are not using all dimensions of NGSS to explain phenomena and solve problems. Sample Assessment Targets marked with an asterisk (*) are considered essential for all students.

ETS1.A: Defining and Delimiting Engineering Problems

DCI Elements	Sample Assessment Targets
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. (MS-ETS1-1) (secondary to MS-PS3-3)	• Describe a problem that is solvable by developing a tool, object, process, or system • Identify features of the system that bound the problem such as: The relevant stakeholders; the needs that are to be met by the solution; issues are related to the problem; the environmental and societal impacts of the solution; how stakeholders rate the relative importance of the different issues and components of the system • Identify the major components, including their relationships within the system, and the system boundaries in order to clarify the definition of the problem • Define criteria for the solution, including meeting the needs of the individuals that need the problem solved and comparisons of different solutions (qualitative and/or quantitative) • Define constraints for the solution, including safety, other related issues, needs of individuals and/or groups, desires of individuals and/or groups, potential effects on individuals and/or groups, potential negative environmental effects of the solution, potential failure to solve the problem, and/or the time, materials, and cost for solving the problem

ETS1.B: Developing Possible Solutions

DCI Elements	Sample Assessment Targets
A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) (secondary to MS-PS1-6)	• Identify the components relevant to testing ideas about the problem being solved including criteria and constraints • Test a proposed solution • Modify a solution based on test results
There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. MS-ETS1-2), (MS-ETS1-3) (secondary to MS-PS3-3) (secondary to MS-LS2-5)	• Describe a given design solution, including identifying the scientific knowledge related to the problem and solution, identifying how the solution solves the problem, and identifying the given supported design solution • Identify and describe the additional evidence needed for evaluation of a solution by comparing the problem context to similar problems that were solved in the past • Identify and describe the additional evidence needed for evaluation of a solution in light of possible impacts on society and the environment • Define and describe the criteria and constraints for evaluating the design solution collaboratively with other students • Use a systematic method to identify the strengths and weaknesses of each solution • Evaluate each solution against each set of criteria and constraints • Compare solutions based on their performance • Construct an argument by making a claim supported by evidence and reasoning about the relative effectiveness of each competing solution and include the strengths and weaknesses of each solution • Evaluate the effectiveness of three or more potential design solutions to an engineering problem based on provided data • Identify appropriate analysis techniques to analyze data based on the problem definition • Identify relationships in data sets between design solutions and given criteria and constraints
Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)	• Identify similarities and differences in various features of multiple potential (or pre-existing) design solutions. • Identify unique characteristics of each design that best meet the given criteria and constraints on the basis of analyzed data
Models of all kinds are important for testing solutions. (MS-ETS1-4)	• Develop a model and identify the components relevant to testing ideas about the designed system

ETS1.C: Optimizing the Design Solution

DCI Elements	Sample Assessment Targets
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. (MS-ETS1-3 (secondary to MS-PS1-6)	• Compile the best features of each design into a new and improved redesigned solution based on analyzed data and fundamental physical principles
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) (secondary to MS-PS1-6)	• Use a model to generate data to represent the functioning of a proposed solution • Consider iterations of a proposed solution as components of the model are modified • Describe how data generated by the model can be used to optimize the solution through iterative modification and testing

Score 1.5	In addition to score 1.0 performance, partial success at score 2.0 performance

Score 1.0	With help, students demonstrate partial success at Score 2.0 content and Score 3.0 content.
Score 0.5	With help, partial success at score 1.0 performance
Score 0.0	Even with help, no success of Score 2.0 and Score 3.0 content.

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